

# Substation-grade automation devices, a cost effective choice for utilities

Electrical substations are some of the most challenging environments for electronic devices because of their harsh environmental and electrical conditions. For that reason, specific product standards are associated to the substation environment in order to make sure that devices installed in substations, such as automation products, are reliable and robust.

The difference between industrial-grade and substation-grade products, also known as utility-grade, is not always well understood and can lead to the wrong choice of equipment to be installed in a substation, thinking that the cost difference will result in real savings. However, when it comes to reliability, the additional funds for purchasing a substation-grade device will prove to be extremely well invested considering all costs saved in commissioning, troubleshooting, repair, maintenance and even device replacement.

This document explains the reasons for electrical substations to require substation-grade equipment. It then lists the standards associated to substation-grade compliancy and details the strict development and testing that go into Eaton's automation products in order to be able to claim that they are substation-grade and can be installed in a substation with unattended assistance for years.

Finally, we list some of Eaton's automation products features that stand apart from standard industrial and commercial products and make these Eaton products so exceptionally reliable for utilities.



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## The electrical substation

Electrical substations are known to be extremely challenging environments for electronic components. They are often geographically isolated and unmanned; consequently the risk of climate-control and equipment failure is real and therefore the equipment must be highly reliable and robust.

The consequence of an equipment failure in a substation can be extremely costly and result in unnecessary outages. Therefore it is important to rely on premium equipment that ensures the required reliability and robustness.

The following table briefly summarizes the conditions to which the electronic equipment is exposed in electrical substations and the consequences on the equipment.

**Table 1. Conditions expected in a substation and the consequences on the equipment**

The equipment is exposed to	Consequence on the equipment
Extreme temperature	Quite often, the equipment must be installed in a harsh environment, indoors or outdoors in the substation area. This can lead to stress on electronic components with forced cold or warm reboots on the devices.
Mechanical stress	Substations are often located in remote areas not easily accessible. The equipment must be transported to these locations, making its way over bumpy roads and thus exposed to shock and bumps. Once installed in the substation, turbine vibrations and circuit breaker operations constantly put mechanical stress on the equipment.
Electromagnetic disturbances	High Voltages:  High voltage exposure affects electronic components. The electromagnetic field present in a substation is mainly due to operating high power equipment like switchgear and circuit breakers and by the current flowing through power lines. In case of fault conditions, the situation is even more critical on the power equipment and consequently on the electronic components in the substation.  This electromagnetic field can cause the following phenomenon in electronic equipment: <ul style="list-style-type: none"> <li>• Interference</li> <li>• Data corruption</li> <li>• Data loss</li> <li>• Misoperation (system reboot, system freeze, etc.)</li> <li>• Electronic failure</li> </ul>
	Voltage variation:  Voltage variations like power outages, surges and voltage ripples mainly affect the equipment's power supply and can cause these critical pieces of equipment to fail.
	Electrostatic discharge (ESD)  Due the important electromagnetic fields in the substation area, the ESD phenomenon is quite present. The damage caused by ESD to electronic components can be severe and even destroy the component. For this reason, the equipment must be protected by supplying proper grounding paths to protect its sensitive circuits.

## The power behind products standards

Fundamental standards are basic standards that can be used autonomously or to define a product standard. A product standard is intended for covering the requirements of a product in a specific environment such as the substation environment.

For that, both the manufacturers and power utilities work together to define product standards so they can inherit the knowledge about what happens in the challenging world of a substation and this is the reason why these standards are so powerful for guiding utilities in building reliable operation within a substation environment with a longer life expectancy.

Examples of common known fundamental standards are ESD (IEC 61000-4-2), EFT (IEC 61000-4-4), and Surge (IEC 61000-4-5), etc.

### Product standards associated to the substation-grade compliancy

The following product standards determine the ability of the hardware to operate reliably in a substation. These standards cover different aspects: Climatic, Mechanical, and Electromagnetic Compatibility (EMC) and, finally, Safety.

- IEC 61850-3: General requirements for communication networks and systems for power utility automation. These requirements focus on the construction, design, and environmental conditions for utility communication and automation devices in power plant and substation environments.
- IEEE 1613: Environmental and testing requirements for communication networking devices installed in transmission and distribution facilities. This standard addresses issues for equipment enclosure, temperature ranges, electrical phenomena, and other issues related to transmission and distribution facilities.
- IEC 60255-1: Common rules and requirements for measuring relays and protection equipment including control interface equipment.
- IEC 61010-1: General safety requirements for measurement, control and computing equipment to ensure that hazards to the operator and the surrounding areas are reduced to a tolerable level.

### Being able to see the limitation set by the manufacturer

These product standards permit some limitations related to the electromagnetic compatibility, mechanical and climatic fundamental standards. It is important to understand that different products claiming to be IEC 61850-3 and IEEE 1613 compliant do not have the same conformance level, nor the same level of performance.

For example, a manufacturer could specify that their device can be installed in a substation, in location P, which is a shielded zone normally located in the substation control room. This signifies that their device cannot withstand electromagnetic interference. These shielded zones are very expensive to build and are rarely present in substations. The IEC 61850-3ed2.0 standard allows this possibility.

The product standards are quite complex and they involve a rigorous design process to achieve a reliable and robust product. Claiming such standards without proof does not mean much. Eaton's strong ethics and core values, like integrity and transparency, give you the assurance to get the quality that you deserve.

## What to expect from Eaton's products

Eaton's substation-grade development process is oriented towards the substation-grade compliancy while keeping safety foremost in mind. Right from the start, significant effort is invested in certification test definition and testing.

Eaton has made **no compromise** for its substation automation products in order to meet or exceed substation-grade standards compliancy without restrictions.

Compliance to product standards is validated by independent accredited ISO/IEC17025:2005 testing laboratories with the appropriate scope of accreditation. Test reports are available to customers on demand.

### Tests

Test setups are designed in order to have a fully functional product with all features running simultaneously, like in a real installation.

Software diagnostics are rigorously validated, these diagnostics ensure that all features are accounted for and allow for fast troubleshooting.

Communications ports are monitored at the physical layer to ensure good error detection, no protocols with error correction are involved during type tests. We perform type tests according to the required levels for each type of port using the performance criterions as per product standards.

### Safety

Eaton takes safety very seriously: our products are CB Scheme compliant and marked cTUVus. Both these compliancies are validated by an independent accredited testing laboratory.

### Climatic requirements

Eaton's substation products operate in weather-protected locations. The risk of failure of the climate-control equipment can lead to an unconditioned environment which is reflected mainly by a wide range of operating temperature on the electronic equipment. This also includes the ability to deal with humidity and change of temperature as seen in the many substations.

### Mechanical requirements

Eaton's substation products can handle severe mechanical vibration caused mainly by power generators which is critical to have a reliable product over time.

Due to the remote location of a great number of substations, which often involves bumpy roads to bring in the equipment, phenomena such as shock bump, vibration and seism are covered.

### Electromagnetic Compatibility (EMC) requirements

Due to the equipment's exposure to elevated electromagnetic fields caused by the proximity of high and medium voltage lines, electromagnetic compatibility is a very important part of the applicable product standards.

Eaton's substation automation products are immune to electromagnetic interference up to the level of a protection device per the IEC 61850-3. They are also class 2 (error free) products per the IEEE 1613 and IEC 61850-3ed2.0, which is the performance criteria required by a protection device.

Eaton's substation automation products can operate in power stations low-, medium-, and high-voltage substations with several types of signal port connections; for example local and field connections, and connections to high voltage equipment according to IEC-61850-3. There is no inherent limit on the use of Eaton's equipment in a substation.

## How Eaton makes its products more robust

In addition to product standard compliancy, Eaton implements several features to make its products more robust. This extra effort allows our products to stand apart from standard industrial and commercial products and have a proven history of reliability and performance for substation environments.

**Table 2. Features that makes Eaton's automation products even more robust**

Component or functionality	What makes it substation-grade and better
Industrial components	Eaton's automation products are entirely built with industrial components operating in a wide temperature range (-40 °C to 85 °C), ensuring high reliability and long product life-time.
Power supply	A power supply is a frequent cause of failure in electronic devices. Having hot-swappable dual power supplies on some SMP products* allows redundancy of independent power sources to increase reliability and availability. *: available on the SMP SG-4260 automation platform and the SMP SC-2200 computing platform
Heat dissipation	Moving parts are usually the first cause of failure in electronic devices. Eaton does not use fans for heat dissipation in its substation devices. The electronic design makes that the components are kept as cool as possible. This greatly reduces the risk of failure and improves reliability, ensuring a long product life-time.
Internal and external SSD	As mentioned above, moving parts are usually the first cause of failure in electronic devices. Eaton does not use rotating drives for its operating system and data storage. Solid State Drives (SSD) or Compact Flash cards are used.
Enclosure	Eaton devices use an IP30 enclosure, which is better than the required IP20 to be compliant to the standard IEC 61850-3. The smaller the holes in the enclosure, the higher is the protection on the device. The design of the enclosure is also important to ensure good overall performance of the electronic components.
Error coding code memory (ECC)	The electromagnetic field present in substations increases the risk for data corruption. Eaton's SMP SC-2200 computer is equipped with industrial SSD drives with error correcting code embedded memory, improving reliability by correcting unwanted bit flips that could lead to computer crashes if not corrected.
Out-of-band management (OOB)	Substations are located in wide geographical areas without easy access. Eaton's substation-grade SMP SC-2200 computer, equipped with the Intel® Xeon® processor and the PC expansion module, has Out-of-band management capabilities. It provides remote access to the computer, outside the production network, in order to manage and secure the PC in situations where it is off, hung or crashed.
Hardware RAID configuration on external SSD	Eaton's substation-grade SMP SC-2200 computer can implement flexible hardware RAID configurations to enable fast data access and improve data integrity.
Help meeting NERC CIP compliancy	Eaton products provide utilities with the tools necessary to access substation devices for data retrieval and remote maintenance. Eaton solutions help utilities put their substation data to use while meeting NERC CIP requirements, both at the substation and enterprise level.
Wurldtech Achilles communication certification	The Wurldtech Achilles Communications Certification verifies the network robustness of industrial control devices and their capability to maintain their primary functionality while subjected to a standardized set of network tests.

## Conclusion

Product standards provide the guidance needed by utilities to building reliable operation within a substation environment. This challenging environment demands robust and reliable electronic equipment to avoid the high cost and inconvenience of having to repair or replace a device that failed in the field. The sole fact of sending a technician to the field, only once, to repair or replace a failed device compensates for the additional funds needed for purchasing a substation-grade device.

Substation-grade equipment may look expensive at first glance. However, when looking at the advantages of these robust devices which allow savings on troubleshooting, maintenance and replacement costs, it becomes clear that these products are worth the investment.

Eaton is committed to do business right and all its substation-grade products provide the assurance of trouble-free life because they fully meet the substation-grade requirements, without limitation.

Eaton's substation-grade automation devices have been running trouble-free for over 15 years in the harsh environment of substations and these devices are evolving to provide smarter and more secure substations with advanced technologies.

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