

Smart Grid Solution

Power Reliability

Benefits of integrated design

**Cooper
Power Systems**
by **EAT•N**

Power Reliability

is the **sum** of all the **details**



Designing, building and validating power grid solutions has never been easy. Today, growing complexity of the modern electrical grid can increase risk and cost just to ensure the integrity of the system. Adding to this intricacy is a growing number of manufacturers offering a wide array of products, ever-changing standards and product test requirements, and new technologies—all competing for a place in the Smart Grid future.

Grid operators and designers must balance these technological advances with the critical need for maximum system reliability.

Today, both large and small electrical power distribution organizations are looking for the flexibility to choose their power system reliability integrator and service support team, including warranty return and application assistance.



The importance of managing this interoperability complexity was clearly on display during the 2013 Super Bowl. Most of the power industry watched the darkness in surprise and concern. As the investigation followed, many industry leaders were forced to consider:

- Interoperation between the power system and equipment; in this case, a protection system
- Interoperation within the protection system's sub-components

Eaton is uniquely qualified to offer holistic, integrated and fully tested systems



Solution

All systems, regardless of how simple or complex, require knowledge to make them function — knowledge of the characteristics, capabilities and requirements of sub-systems or components. This effort to merge knowledge into a system is holistic integration.

Multiple options for interoperability exist. Some companies approach sub-component integration as an internal effort. Others rely on a single component supplier with minimal experience in other sub-system components to act as a packager. The better option is to choose a company with expansive expertise in all the components being integrated.

Eaton, an industry leader in power distribution from apparatus to advanced intelligent controls, fully integrates each sub-system component – including sensors, signals, firmware and hardware – all in a high voltage, high surge application. Our expertise, proven by decades of reliable performance, is unmatched in the industry. We understand power systems, global applications, hardware, firmware, software designs, and global standards all needed for secure and reliable integration.

We further provide both technical and operational benefits including:

- Single-point responsibility
- Interoperability of sub-systems
- Testing developed to industry standards
- System expertise
- Integration engineered in a learning organization
- Increased reliability through continuous innovation

Reliable solutions around power flow, protection, communications, and security require the involvement of complete systems integrators. When selecting which system integrator to partner with, Eaton stands apart because of our long history, and intimate knowledge of power system requirements, sub-system requirements, and the unique interface requirements within power apparatus. Because of our long history in innovation, we can uniquely trouble-shoot and support the integration using various user-defined options.

When it comes to decades-long power grid reliability – the details matter.

Sub-component expertise



Single-point responsibility

For more than 60 years, customers have valued Eaton as a one-stop solution provider for power system problems around:

- Overcurrent/overvoltage protection
- Volt/VAR optimization
- Automation
- Power switching and system reconfiguration products
- Design
- Testing
- Certification
- Integration with Eaton's Cooper Power Systems apparatus, and select control and automation equipment companies

Because we design ALL aspects of the system, Eaton is uniquely qualified to service all of these elements regardless of source of manufacturer.

Knowledge and support

Technical support is key to delivering our value as customers often inquire about protection and troubleshooting for both Eaton and non-Eaton products. We extend the expertise to our supply base as well, designing, testing, certifying, and continuously improving upon the process and equipment we make.



To assure proper service levels, we maintain internal **expertise** on the sub-components of the systems we sell.

Today's Smart Grid

The electric power grid is said to be an engineering marvel, arguably the largest and most complex machine in the world; a machine with a personality, capable of delivering unique effects to anything connected to it. From surges, elevated fault currents, asymmetry, changes in fault or load current direction, to high or low voltages, or induced or radiated fields, Eaton has the expertise to account for power system nuances – those defined in the industry standards, and others that we have learned over decades of interoperability research.

Interoperability of sub-systems

The design of an integrated system should be able to define sub-system requirements such as:

- Electrical ratings
- Thermal ranges and their impact on ratings
- Compatibility
- Environmental
- Sustainability
- Manufacturability

Each of these impacts the design of the system.

Interface requirements for the sub-system include timing, voltage levels, circuit design for surge immunity, mechanical impacts and others.

Eaton remains committed to offering full control integration including necessary:

- Sensor design, thermal ranges and accuracy
- Sensor interfaces to the power system and apparatus
- Automation interfaces and the power to run them

- Apparatus/control process signaling
- Power sources and their connections to the system
- Cabling and reliability to electrical and environmental stresses
- Cabinetry and climate control
- Continued delivery of added functionality for protective and emerging automation
- Cyber security solution packages

Testing developed to industry standards

Industry organizations such as the Institute of Electrical and Electronics Engineers (IEEE)[™] and the International Electrotechnical Commission (IEC) have established minimum standards for reclosers, voltage regulators, switches, and fault interruption devices. Clauses within them establish system considerations or type tests that verify the interdependency between apparatus and the controlling devices. Not only do we understand and fully adhere to these standards, we are part of many standards development committees.

Examples of system-level testing include:

- Reclosing and overcurrent trip calibration
- Time-current tests
- Minimum tripping currents
- Surge withstand tests
- Fast transient surges and simulated surge arrester operation

These tests are designed to verify design integrity such as the interdependency between the apparatus and the control, and will often point out vulnerabilities which need to be addressed before a design is released. Standards reflect that these tests be performed by the supplier. The supplier with the most complete understanding of the entire system and system interactions has the greatest opportunity to optimize system capability and performance.



Substation voltage regulators with controls



Smart VFI pad-mounted switchgear



NOVA™ three-phase recloser and control

Eaton's Cooper Power Systems product expertise:

- Reclosers and controls
- Voltage regulators and controls
- Pad-mounted switchgear and controls
- Capacitor banks and controls
- Pad-mounted capacitors and controls
- Smart sensors
- Electrical distribution system automation and optimization software
- Substation automation hardware and software

System expertise

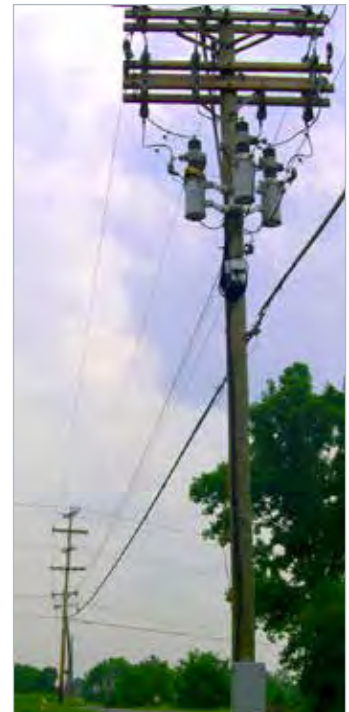
Eaton has the ability to apply added knowledge and testing from IEEE, IEC and other applicable but not directly mandated standards. For example, experience taught us that surge immunity from external sensor inputs, communications, radios and other added components in the equipment environment highlighted areas of design focus for us – areas often compromised by others. As electronics become smaller, cheaper, and less power hungry, they are more likely to be added to control equipment used for regulators, reclosers, switchgear and capacitors. Therefore, it is also a growing reality that peripheral equipment may cause problems beyond those designed for in base designs, and must be addressed by an experienced integrator.

Integration engineered in a learning organization

Above the product and technology, it is ultimately about the people and tools that equip them to do amazing things. Eaton employees are professionals who receive rigorous training both in the factory and in the field. In addition, our learning organization mentality provides the venue to solve problems that may occur, tools like root cause analysis and advanced problem solving techniques (APS), to not only solve the immediate issue, but to put in place corrections so the problem never arises again. We also store the knowledge for use in error-proofing future designs.



Capacitor bank



NOVA single-phase reclosers and control

Innovation Timeline

Eaton's Cooper Power Systems has a long history of innovation and an industry-leading position in underground distribution. With more than 60 years of experience, we know switchgear, relays, and an unsurpassed array of underground distribution products, in addition to automation products and expertise to optimize reliability and productivity on your distribution system.

1946

Kyle™ three-phase hydraulic recloser introduced

1956

Three-phase recloser with ground trip introduced

1959

Step voltage regulator with direct drive tap changer introduced

1961

Solid state electronic recloser control Introduced

1968

Single-phase vacuum recloser introduced

1971

All-film dielectric capacitor introduced

1978

Smart switch for Distribution Automation (DA) introduced

1984

Microprocessor-based control for voltage regulators and reclosers introduced

1986

Extended foil/solderless capacitor introduced

1988

VFI pad-mounted switchgear introduced

1993

DSM/2 introduced, the precursor to Yukon™ advanced energy services software platform

1997

Pad-mounted regulator introduced

1998

NOVA™ three-phase vacuum recloser introduced

1999

Yukon software allows utilities to remotely read meters, control peak load, and monitor assets

Increased reliability through innovation



32-Step voltage regulator with CL-7 single-phase version of multi-phase control

Innovation in apparatus and controls is continuous

Recognizing the need to empower users to customize logic in their controls, Eaton developed an industry-leading graphical customization environment we call the Idea Workbench™. Today it is used and modified to solve some of the most complex needs for customers in communications, protection and reconfiguration schemes.

There is a continuing trend in adding voltage sensors to equipment as an inexpensive sensor "node" on the power system. The sensors can be embedded in the equipment itself to simplify installation. However, many compromise accuracy to accomplish this. The Eaton Internal Voltage Sensor (IVS) on reclosers provides accuracies <2% across the thermal range of the equipment.

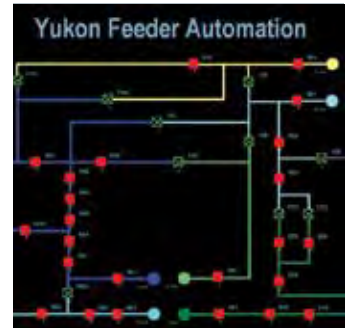
These are a few examples of continuous innovation that drives productivity for our customers. These are also examples of innovation brought about by a unique understanding of the entire system.

What is the future?

Today, few, if any companies buy a "standard" product because, in large part each power system is unique, and is continuously evolving. The requirements today will not look anything like the needs tomorrow. Our plans are to further develop and grow our current Eaton's Cooper Power Systems control and apparatus offering, and grow our flexibility and capability in Engineered-to-Order (ETO) support to be the major source of power reliability systems.



GridAdvisor™ Series II smart sensor



Yukon™ feeder automation software



Form 4D recloser control

- 2000**
NOVA triple-single recloser introduced
- 2001**
Capacitor bank control devices launched, the first step in Integrated Volt/VAR Control (IVVC)
- 2004**
CL-6A regulator control introduced
- 2005**
Three-in-one pad-mounted regulator introduced
- 2006**
Automated M-Force switch introduced

- 2007**
Quik-Drive™ tap-changer polymer insulating board offers fastest regulation response
- 2008**
OutageAdvisor™ introduced ability to communicate from distribution system to control center
- 2009**
Ethernet communications introduced
- 2010**
Integrated Volt/VAR Control [IVVC] capabilities for Power Factor correction introduced

- 2011**
Mobile capacitor banks introduced
- 2013**
Smart Vacuum Fault Interruption (VFI) pad-mounted switchgear introduced
- 2013**
CL-7 multi-phase voltage regulator control
- 2013**
GridAdvisor™ Series II smart sensor introduced
- 2014**
Pad-mount source transfer (PST) system with iST control introduced

For Eaton's Cooper Power Series
product information, call
1-877-277-4636 or visit:
www.CooperPower.com

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