

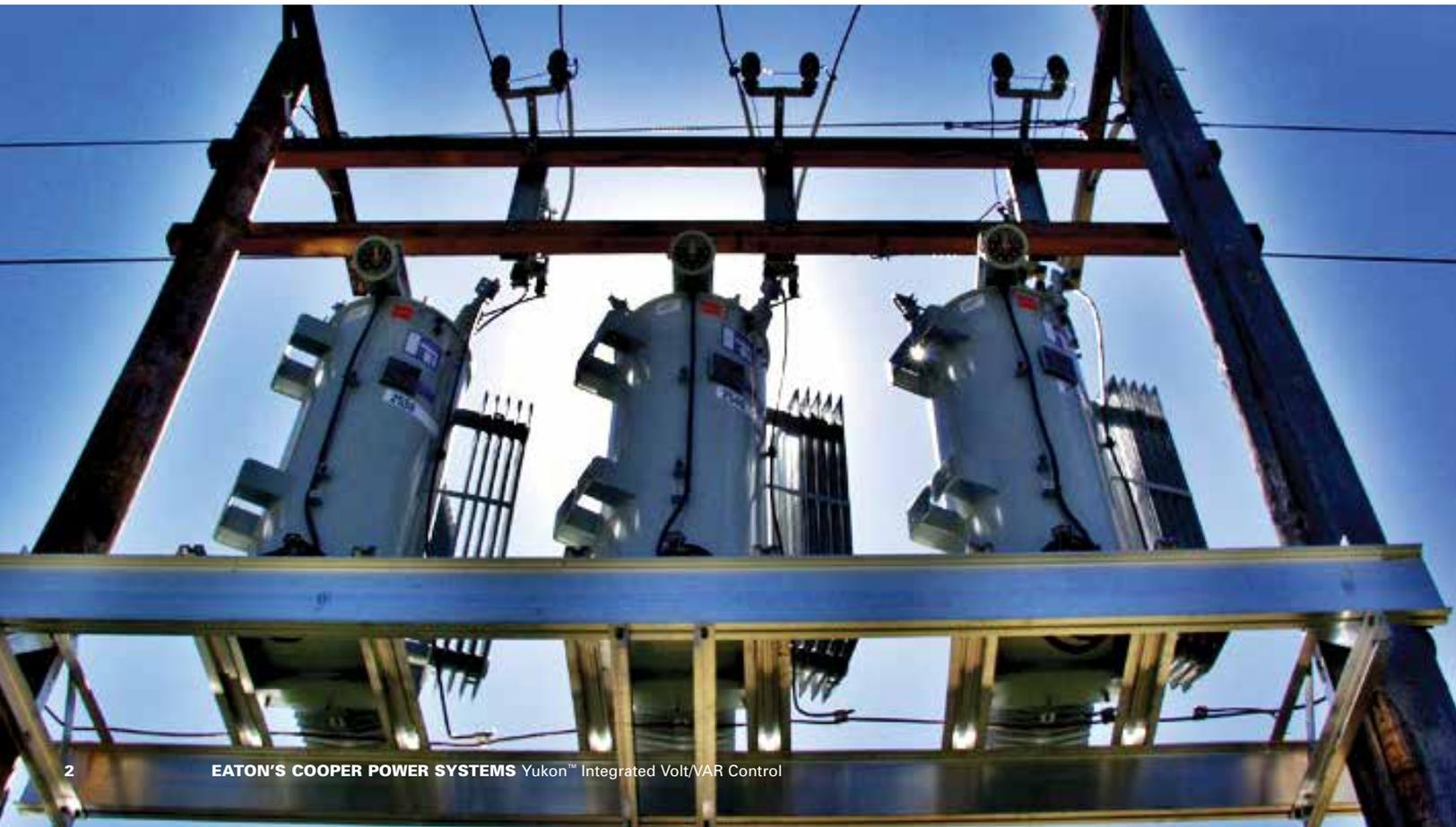
Yukon™ energy automation software platform

Integrated Volt/VAR Control

For more efficient, higher quality,
and less costly power.

**Cooper
Power Systems**
by **EAT•N**

Integrated Volt/VAR Control enables Smart Grid power quality strategies



Providing smarter solutions for a smarter grid

Our company offers a comprehensive portfolio of power systems products and engineering expertise, backed by 100+ years of financial stability. Eaton's Cooper Power Systems is uniquely positioned to provide integrated solutions for a Smarter Grid.

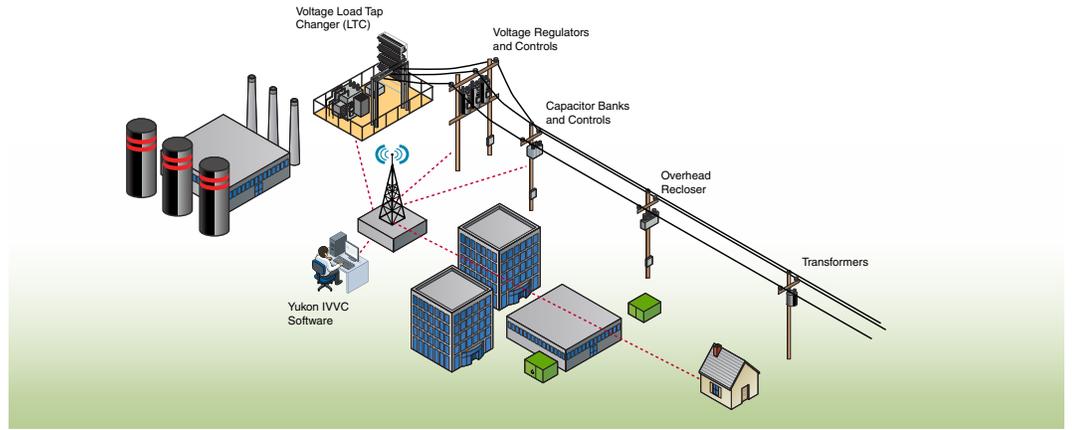


Figure 1. Typical diagram illustrating how Yukon IVVC application works within a power distribution system.

Eaton's Cooper Power Systems Yukon™ Integrated Volt/VAR Control (IVVC) is innovative automation software that furthers system optimization. Besides managing power factor and voltage flatness of a system—power quality—it can support Conservation Voltage Reduction (CVR), a voltage reduction strategy that reduces demand and energy usage by lowering distribution line voltages to the lower end of the ANSI standard voltage range. This sophisticated automation results in:

- a greater percentage of energy delivered to paying customers
- deferred installation costs of new generation plants
- a greener energy footprint from less consumed energy

For utilities, this means power that's more efficient, higher quality, and less costly.

IVVC manages power factor and saves energy

The Yukon IVVC application collects real-time feeder voltages, watts, and VAR flow from regulators, capacitors, and any additional monitoring points, such as customer meters or medium voltage sensors. Yukon analyzes this data in its advanced algorithm, which combines both voltage regulation and power factor correction in real time to determine which capacitor banks and regulators operate. This ensures optimum performance from the distribution system to which IVVC is applied.

Implementing this control scheme flattens each feeder's voltage profile and lowers average voltages, resulting in significant energy savings while managing power factor to minimize technical losses. A key advantage to the Yukon IVVC algorithm is its use of real-time substation and feeder voltage, watt and VAR measurements to support voltage and power factor forecasting without requiring an impedance model.



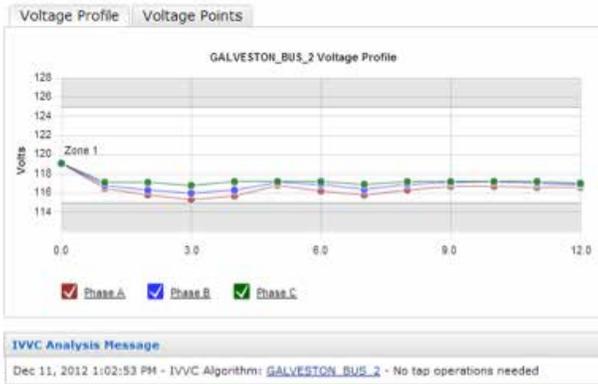


Figure 2. Real-time voltage monitoring

| IVVC Device | Event Description | Timestamp |
|-------------|---------------------------------------|---------------------|
| 13575 | Var: 444.60 (103.64% change), Open | 01/29/2013 13:55:01 |
| 13575 | Open Sent, IVVC: 0/Var: -1421 | 01/29/2013 13:52:05 |
| LINE_69 | Lower Tap Position | 01/29/2013 12:35:45 |
| 14703 | Var: -1008.70 (112.21% change), Open | 01/29/2013 08:58:24 |
| 14703 | Open Sent, IVVC: 0/Var: -5048 | 01/29/2013 08:53:57 |
| LINE_69 | Lower Tap Position | 01/29/2013 01:18:13 |

Figure 3. Recent events log

Yukon Volt/VAR Management is a powerful and user-friendly tool

A strength of the Yukon Volt/VAR management software application is the depth of functionality in its browser-based user interface. The Yukon user interface allows the user to easily manage and monitor the status of substations, buses, feeders, and power quality devices. Yukon processes and visually displays this information in real time with graphs and alerts that update frequently to enable users to see the present status of the distribution system.

Yukon Volt/VAR management software applications use a heuristic analysis algorithm, and as a result, do not require an impedance model. This makes it very easy to implement and maintain.

Voltage and power factor targets are utility-defined and can be easily modified to support transmission VAR requirements or to initiate a demand reduction

event via CVR. Yukon Volt/VAR management software applications also include powerful tools, such as reporting and trending which allow the user to easily organize historical data and display it on customizable graphs. These can be used to view historical data or analyze the effectiveness of the Volt/VAR management strategies.

Eaton's Cooper Power Systems provides integrated solutions

Software, hardware, and consulting services complete the package

In addition to the Yukon Volt/VAR management software applications, Eaton's Cooper Power Systems offers an entire Volt/VAR management solution including analysis software, intelligent devices and apparatus, and services. The company is a longtime provider of power quality equipment to electric utilities— including:

- Power systems analysis software and implementation services
- Capacitor banks
- Capacitor bank controls
- Voltage regulators
- Voltage regulator controls
- Smart sensors

The Eaton's Cooper Power Systems engineering consulting services team offers utilities a complete turnkey solution encompassing:

- Network modeling
- Initial network performance diagnostics
- Volt/VAR optimization studies
- Equipment installation and commissioning

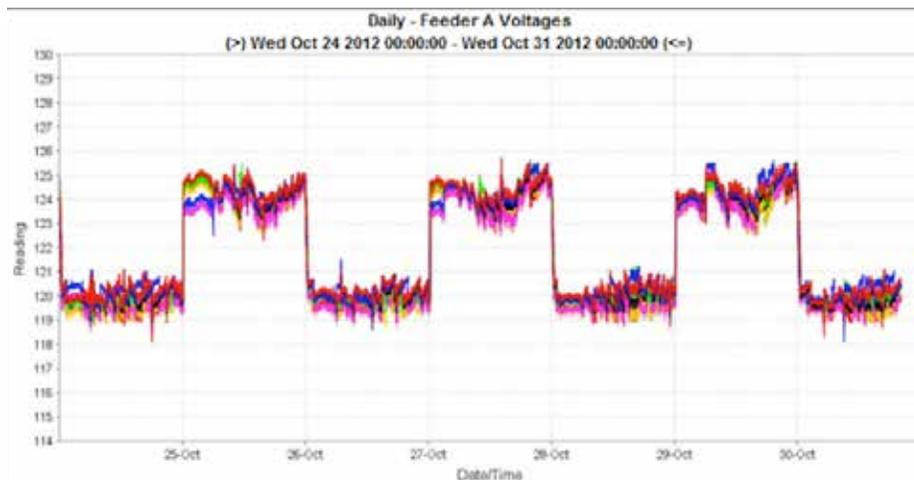


Figure 4. Historical trending to assess IVVC performance and compare to other strategies

Eaton's Cooper Power Systems Volt/VAR Management solution integrate to power quality distribution hardware control devices—industry leading in quality and innovation. Eaton's Cooper Power Systems Volt/VAR Management solution hardware can include power quality distribution devices like feeders, regulators, capacitors, and any additional monitoring points, such as customer meters or medium voltage sensors.



Figure 5. CYMDIST distribution analysis software

Working with CYME™ software development experts, our services team can help implement or improve study processes, provide coaching, and build templates for studies. By combining the knowledge acquired while developing the CYME software with field expertise, our services team can rapidly identify the parameters critical when designing either specific installations or complete networks.



Figure 6. Capacitor banks

Eaton's Cooper Power Systems lightweight, all-aluminum construction of the Series A and cantilever-mount capacitor bank racks makes for easy handling, fast installation, and low maintenance. These racks, with a clean uncluttered profile for blending into today's urban, suburban, and rural environments, are standouts among pole-mounted capacitor assemblies.



Figure 7. CBC-8000 Capacitor bank control

Eaton's Cooper Power Systems CBC-8000 Capacitor Bank Control (CBC) is specifically designed to operate utility distribution feeder capacitors. This highly flexible control can be deployed using a variety of control strategies: voltage, VARs, current, temperature, and time control configurations.



Figure 8. Voltage regulator

Eaton's Cooper Power Systems voltage regulators are available with a full complement of standard features for routine applications, as well as a full line of optional accessories for unique applications. In addition, the voltage regulator offers desirable features that enhance operation and service.



Figure 9. CL-7 multi-phase voltage regulator control

Eaton's Cooper Power Systems offers reliable voltage regulator controls that incorporate the latest in digital technology to provide accurate, rapid, and dependable control of a step-voltage regulator. Available as a single- or multi-phase device, the CL-7 control is designed with a full suite of deployment options to enhance grid efficiency and power quality.

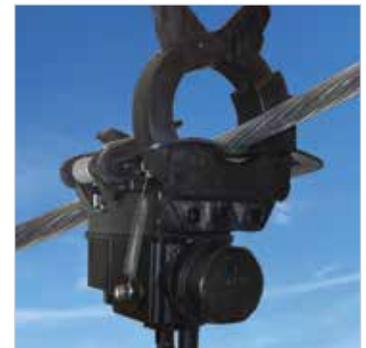
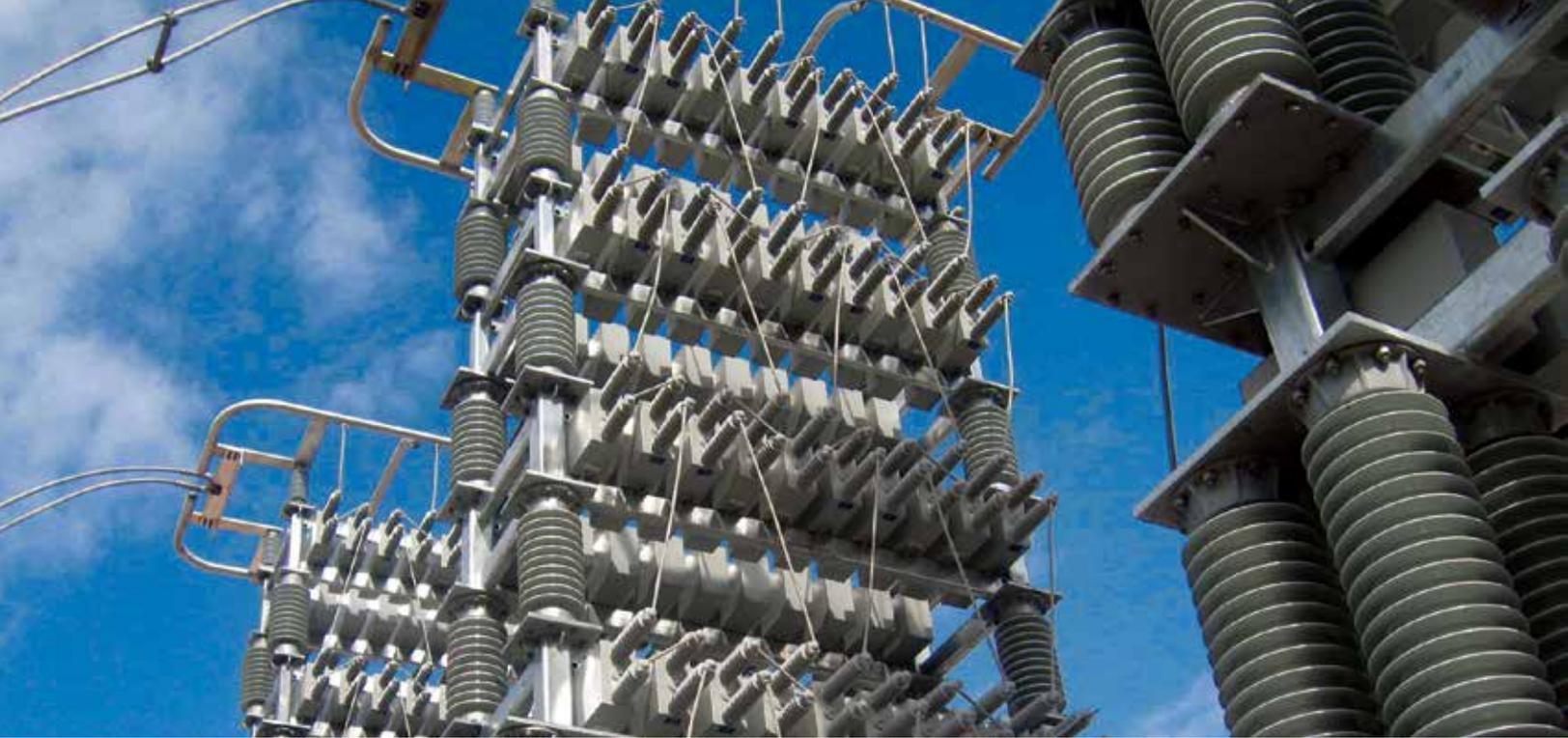


Figure 10. Smart sensor

As a capacitor bank monitoring sensor, the GridAdvisor Series II smart sensor measures current levels on the common neutral conductor and uses cellular communications networks to transmit readings. High neutral current readings may indicate blown capacitor bank fuses or other bank failure. Once it identifies such unexpected current levels, the sensor issues alerts to operation and maintenance personnel.



FIELD-PROVEN APPLICATION

The Eaton's Cooper Power Systems Volt/VAR management solution began as a centralized capacitor bank control management application. The Yukon Intelligent Capacitor Control application was first deployed in 2001 for substation and feeder VAR management. In 2004, the Capacitor Control application functionality was broadened to support substation and feeder voltage management. In 2009, the Yukon Integrated Volt/VAR Control application was added to the Volt/VAR management solution to support substation load tap changers (LTCs), voltage regulators, and CVR.

Yukon Volt/VAR management software applications installed at a number of utilities across North America presently control more than 20,000 capacitor banks. Eaton's Cooper Power Systems Yukon Volt/VAR management application is field-proven, supporting not just

automation analysis and control, but also an easy-to-use graphical user interface with maintenance, administration, and reporting functionality.

Smart Grid team puts Yukon IVVC application to the test

A southwestern utility conducted a pilot program in two large feeder networks. They used an 80/20 mix of residential and commercial customers, a feeder network with existing substation and line regulators, and a combination of overhead and underground power delivery of varying lengths. One area was ideal for the automation test because it not only had a history of customer complaints, but also had high projected future growth.

Representatives from Eaton's Cooper Power Systems, the utility's Smart Grid technology leader, and a third-party test verification consultant collaborated on the project. The team determined that a valid test required all of the

components to be supplied by Eaton's Cooper Power Systems, so a number of regulators, controllers, and end-of-line monitors were swapped out prior to implementation.

Results

The team found that the IVVC application successfully flattened the utility's voltage profile at the project sites, compared with averages at other sites. Voltage spikes and valleys were smoothed out—both in everyday readings and at peak demand. The power factor is now near an optimal 1.0 and CVR has demonstrated the potential to reduce feeder demand by at least 2% (at 3% voltage reduction) during system peaks.

Third party testing

A detailed test plan was devised by the third-party consultant that compared IVVC-on days with IVVC-off days. The testing validated that Eaton's Cooper Power Systems Yukon software operated as intended,

maintaining a power factor of 0.98 or greater. Whenever the power factor dipped lower, the software swiftly intervened to improve it. In terms of voltage management, the Yukon control successfully managed voltage toward the lower threshold on the IVVC-on days, often two to four volts below the IVVC-off days.

"Yukon is performing as advertised, which is excellent because that's a prerequisite for us to get demand reduction."

Third-party consultant who verified test results



Yukon Volt/VAR management—low cost of ownership with easy implementation and maintenance

Eaton's Cooper Power Systems Yukon Volt/VAR management solution can be configured to meet each utility's operational objectives, whether the objectives is reduction of system losses or conservation voltage reduction.

Benefits of IVVC with Eaton's Cooper Power Systems

- Requires limited device data that is easily imported
- Allows for more streamlined start-up of project
- Follows industry integration standards and protocols
- Reduces need for additional man hours when implementing the system
- Supports different types of communication networks and third-party LTCs, regulators, and capacitor banks
- Compatibility reduces any need for further capital expenditures
- Validates the operation of the communications message through command response analysis
- Allows for confirmation so deploying a truck/crew on-site to the device is not necessary



For more information about how Eaton's Cooper Power Systems Integrated Volt/VAR solution and products can optimize your electrical power transmission and distribution system, we invite you to contact **877-277-4636** or visit **www.cooperpower.com/IVVC**

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