

“Smart Grid Essentials”

The Potential of Beckwith Electric Controls

Beckwith Electric Company, Inc.



JSK
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Introduction to Beckwith Electric Knowledge Base for Smart Grid

There are theoretical and practical principal aspects related to Integrating Volt/VAr Management strategies that are consistent with Smart Grid objectives for Asset Management and Reliability in the distribution system. Integrated Volt/VAr Management (IVVM) of LTC transformer control, line regulator control along feeders, pole top capacitor bank control (remotely controlled and locally controlled), power quality issue mitigation for sags, swells, and harmonics, adherence to CBEMA voltage waveform criteria, as well as protection of the intertie with disbursed, alternative, or green energy sources, may all be part of a smart grid strategy. Beckwith Electric is a leader in implementing the components of such a strategy. With Beckwith's long standing history of IVVM, we have implemented system performance enhancements, such as the use of Autodaptive® techniques, VAr Biasing, Line Drop Compensation (LDC), flattening the voltage profile end to end and Conservation Voltage Control, as well as advanced techniques for paralleling of single bus, double bus and ring bus configurations. Beckwith has also developed SCADA heartbeat integrity checks, and automatic change over algorithms on loss of communications to enhance system reliability. Beckwith Electric has kept abreast of industry advances in communications, ports, protocols and media and the use of Ethernet over fiber optics, IEC 61850, mesh networks, reporting by exception and unsolicited reporting, broadcasting capabilities for voltage collapse mitigation, distribution VAr support to transmission side for voltage collapse mitigation, and much more.

Beckwith Electric is the premier leader in voltage and VAr management techniques and has the system elements that facilitate the solutions for strategies that our utility customers want. Our 42 years of experience in IVVM, coupled with thousands of man-hours of experience, instill confidence in the solutions that we provide. Let Beckwith Electric be your Smart Grid partner for implementing your integrated volt/VAr management strategy!

Benefits of Integrated Volt/VAr Management (IVVM)

- Improved system stability
- Reduced system-wide losses
- Increased power delivery capacity (kW)
- Minimized voltage variations, resulting in satisfactory delivery voltage to customers
- Reduced maintenance costs
- Reduced/deferred capital expenditure
- Reduced operating costs
- Flattened Voltage Profiles and Conservation Voltage Control (CVC)

Reduction Of Line Losses the Fundamental Key

Studies have shown that line losses in the distribution system approach 8 to 10%, and that correct and proper capacitor bank placement and operation can reduce line losses in the distribution system by as much as 1 to 2% at a minimum.

If the annual load of said distribution system is 35,000GWh/yr, 8% line losses would equate to 2800GWh/yr. At a cost of \$0.05/kWh, the 2800kWh/yr would be a gross \$140 million dollars loss annually!

If proper and correct placement and operation of switched capacitor banks in the distribution system can conservatively save 1% of those losses, then by rapid assessment it can be seen that annual savings from installing pole top cap banks approaches \$17 million. (1% of 2800GWh/yr = 350,000 kWh @ \$0.05 = \$17.5 million).

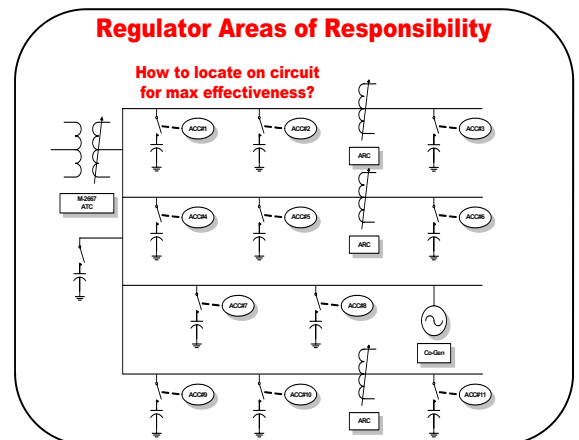
Savings like this can largely defer or offset the need for additional generation by freeing up delivery capacity.

With more capacitance in the system, the x/r ratio of the lines are reduced which can improve stability with less voltage fluctuations (with $x/r = 4$, 1kw produces a 1 volt drop while 1 kVAR produces a 4 volt drop).

With less voltage variations, better voltage delivery to customers can also be achieved.

With flatter voltage profiles, conservation voltage control can be utilized, which can reduce loading system-wide, which in turn also frees up delivery capacity and again can defer or offset capital expenditure.

It's a beautiful thing, let Beckwith Electric show you how...



Smart Grid Capacity-Relief, Additional Operational Technologies:

- Integrated volt/VAr management (IVVM)
- Substation Peak Load management
- Feeder Peak load management
- Integration with DG and Renewables

Conservation Voltage control

Maintain customer voltage levels to minimize power consumption on the system.

Immediately reduce the following:

- Energy usage,
- Generation emissions,
- Power system losses,
- Circuit VAr requirements,
- Power demand quantities.

M-6200 and M-6280 Dynamic Duo of Controls

The dynamic duo of regulator and capacitor control, coupled with our long experience in the control of LTC Transformers and Step-Voltage Regulators, provides a complete solution to system-wide Integrated Volt-VAr Management.

Some of the capabilities of the Capacitor/Regulator Control duo that lend these controls to total integration, include the following:

- Open architecture, non-proprietary protocols, based on standards – MODBUS, DNP3.0 and IEC61850
- Secure protocols with error checking
- True, fast Ethernet connection supporting multiple concurrent sessions and simultaneous multiple protocols
- Ethernet over fiber optic (ST Connector) driven by solid state lasers, good for up to 2000 meters transmission length
- Ethernet over fiber optic supports MODBUS, DNP 3.0 and IEC 61850 over TCP/IP – true peer-to-peer, high speed implementation 100Mbps
- Fiber optic loop-through, integrity AC/DC backup power capability
- Full Remote Operation, Automatic Voltage or VAr Capacitor Operation with Voltage Override, and Manual control
- Conventional or Autodaptive® Control algorithms switch selectable
- Remote Capacitor Control with Voltage Override and Auto backup upon loss of communications, SCADA Heartbeat
- Patented Autodaptive® algorithms are selectable to further enhance smart grid capabilities
- Patented VAr Bias algorithm for downstream cap control coordination with the regulator control.
- Patented VAr Exportation into the transmission system from the distribution system is facilitated.

The Dynamic Duo Supports Massive Data Collection and Storage

These devices with a powerful microprocessor and high sampling rate (64 samples/cycle) permit collection and storage of both Operational Data as well as the non-operational data. Events, oscillography, and logged data stored in non-volatile memory backed up by super capacitor. No battery required.

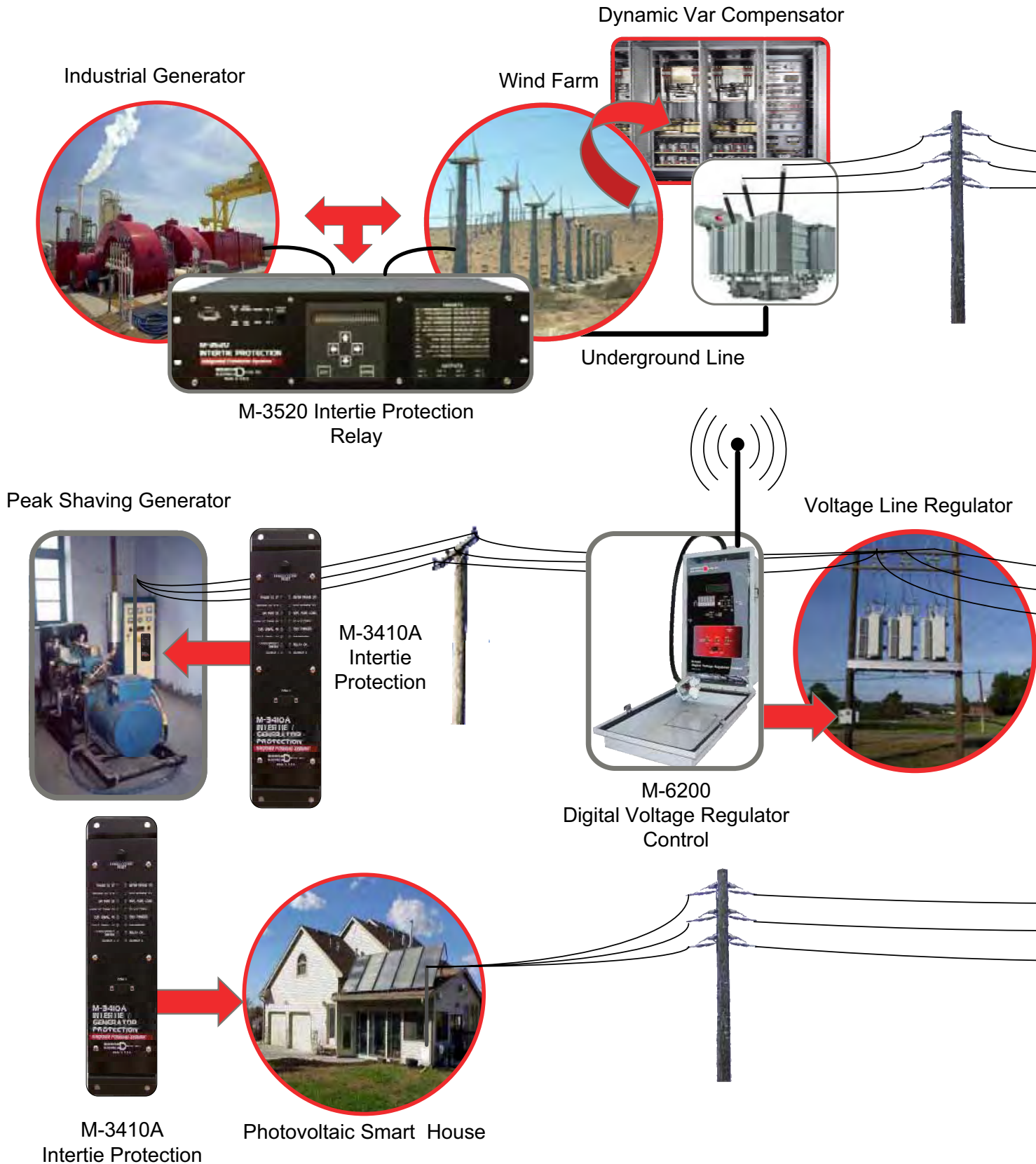
Operational Data

- Metered parameters and calculated values
- Sequence of Events (SOE) recording of 128 events each time-stamped to the millisecond with Graphic Logic Initiate from critical operational factors
- Oscillography, triggered from critical operational factors, with selectable sample rates up to 64 samples/cycle permits capture of sags, swells and sub synchronous transients. Recording configured for number of partitions from one to sixteen, with corresponding cycles per partition varying from 1638 to 192 respectively.
- With better class CT inputs, fault recording and location would be possible, providing specifics that cannot be captured with substation devices.
- Data Logging of critical parameters with extensive memory permitting weeks and even months of data capture with selectable downloading to target specific characteristics and time periods.

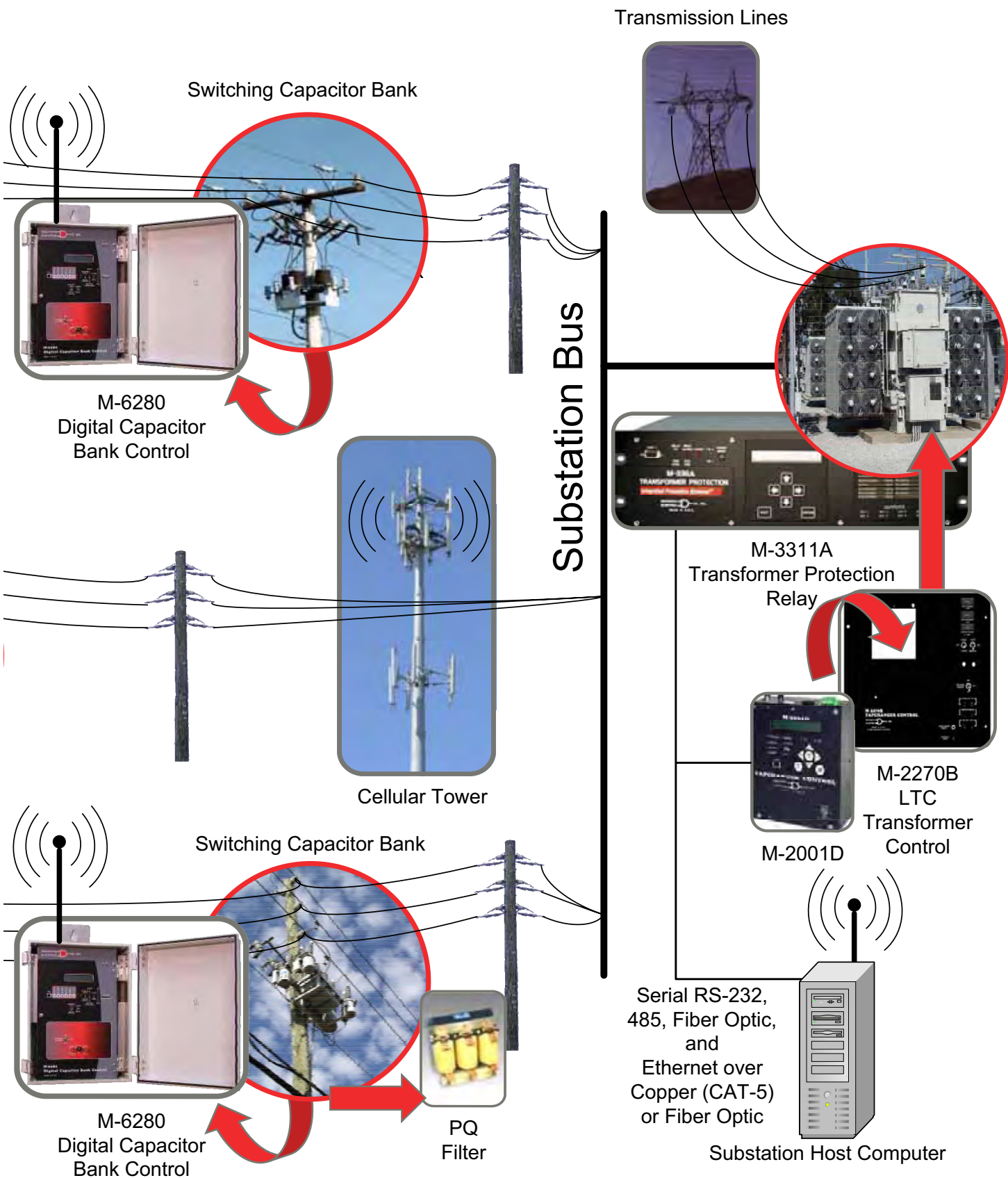
Non-Operational Data

- Equipment Condition
 - Neutral Current Detection of Capacitor Bank or Pack failure
 - Capacitor Bank Status Confirmation using Neutral Current and Bank Switch Status
- Fault Events
 - Programmable Alarms, Report By Exception, Unsolicited Reporting
- Power Quality
 - Voltage and Current (VAr Control) Harmonic Reporting to the 31st. Harmonic Thresholds permit real-time detection and recording of grid harmonic problems and could also be used to protect banks from damage

Integrated Volt/VAr



Management (IVVM)



M-2001C/D

It's the Longstanding standard for LTC transformer control!

Solves the Problems of Maintenance

- The Number of Manufacturers - GE, Westinghouse, Allis Chalmers, McGraw, FerrantiPackard, Prolec, Voltran, Asea, MR, Siemens, Cooper, etc.
- The number of different models for each manufacturer within the same technologies
- An evolution of technologies - balance beam, magnetic amplifier, solid-state, microprocessor...
- A lack of support of earlier designs by the manufacturers
- Inability to find spare parts for earlier controls

Reduces Maintenance Costs!

- Reduction of technician training on all the different types of old controls
- Reduction in inventory costs
- Use one control for all transformers and regulators!
- Reduce the number of controls on the shelf and stock less expensive Adapter Panels instead.

Reduces the Cost of Operations!

- Eliminates costly manual mode operation because of control failure
- Self test routines in the control report operating problems
- Metering, status and event reports permit more efficient system operation
- TAP Usage Monitor – How many times the transformers have been on specific Taps

Improves Power Quality!

- The ability to maintain a very precise voltage inside the desired band
- Prevent a Tapchanger runaway that would result in an extreme output voltage at full buck or full boost
- Built in First House Protection for excessive LDC operation
- Harmonic Analysis
- Reduction of voltage fluctuations by use of more intelligent algorithms that allow a faster response when needed

Extends Service Life!

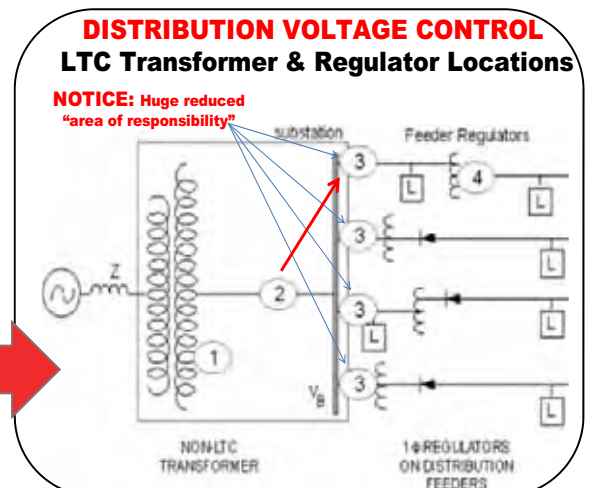
- Prolong the life of the LTC mechanism by eliminating unnecessary operations
- Can quickly return old transformers and regulators to service with modern controls
- Why buy a new one just because an adequate replacement control is no longer available from the original equipment manufacturer?

Provides Automation and Communications!

- Power transformers and voltage regulators can be included in modern automation philosophies
- Communications by Multiple On-board Protocols through RS232, RS485, fiber optics or Ethernet ports
- Automatic reconfiguration of voltage regulators during reverse power conditions (*without a source side PT*)
- Automatic voltage reduction to lower system energy requirements during overload



Protection



M-6200 Digital Line Regulator Control

Local intelligent control or remote automation, monitoring and control of voltage regulators.

- True Ethernet connection which supports unlimited concurrent sessions and simultaneous multiple protocols
- Patented Autodaptive[®] algorithms are selectable to further enhance smart grid capabilities
- Patented VAr Bias algorithm for downstream cap control coordination with the regulator control.
- Patented VAr Exportation into the transmission system from the distribution system is facilitated.
- Using a PC, the operator has real time, remote access to all functions for of the digital regulator control. The control can act as the monitoring point for all voltage, current, and related power quantities, thereby simplifying operating while avoiding transducers and multiple RTU analog inputs.
- Protocols implement half-duplex, 2-way communications to allow all functions which would normally require an operator at the control, to be performed remotely
- SD Memory card interface allows the user to transfer Setpoint files, DNP configuration file, data logger and oscillography files. It can also be used to accomplish firmware updates.
- Smart Grid enabled for Wired or Wireless networks with either DNP3.0 or MODBUS protocols.
- Elegantly simplistic, intuitive, and easy to use software



M-6280 Digital Capacitor Control

Local intelligent control or remote automation, monitoring, metering & control of distribution pole top capacitor banks

- Conventional or Autodaptive[®] operating characteristic available to fine tune system operation and optimize VAr flow
- SD Memory card interface allows the user to transfer Setpoint files, DNP configuration file, data logger and oscillography files. It can also be used to accomplish firmware updates.
- Smart Grid enabled for Wired or Wireless networks with either DNP3.0 or MODBUS protocols.
- Protocols implement half-duplex, 2-way communications to allow all functions which would normally require an operator at the control, to be performed remotely
- Real time remote access to all functions for monitoring of voltage, current and related power quantities
- Elegantly simplistic, intuitive, and easy to use software



3410A and 3520 Intertie Protection

Integration with Distributed Energy Resources

- Renewable (wind, solar PV)
- DGs with energy storage

Benefits:

- Reduce Project Costs
 - Standardization for most utility and power pool interconnection requirements
 - Commissioning tools to speed factory acceptance testing and field start-up
 - Trip dispute resolution and warranty investigation tools
 - Programmable I/O to meet different breaker trip assignment requirements
- Meet Utility and Power Pool Protection Requirements
 - Utility-grade relay passing pertinent ANSI and IEC specifications
 - Meets UL and CSA compliance standards; M-3410A is CE compliant
 - Ability to be applied with grounded or ungrounded primary interconnection transformer configurations
 - Configurable and selectable elements to meet protection challenges for different size, machine type, DG interconnection transformer arrangement and utility requirements





Contract Holder
Contract GS-07F-0208V

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