

# Conventional Control Systems

## Value Added Solutions for Protection, Control and Automation Applications

GE's Conventional Control Systems provide fully integrated, modular solution sets comprising of engineering, design, manufacturing assembly, wiring, testing and commissioning support for protection, control and automation of power system applications. Adhering to the world class quality control standards, GE's Conventional Control Systems are built on an advanced GE product base, and feature seamless integration with legacy and multi-vendor devices and systems.

### Key Benefits

- Provides overall project cost savings, potentially up to 15% of the total CapEx spend including engineering and site acceptance costs, resulting in substantial economic benefits for the project
- Reduces cycle time driving accelerated customer acceptance and project turnaround period
- Integrates multi-vendor legacy protection relays, devices and automation sub-systems
- Provides integrated platforms for additional levels of automation, cost optimization and enhanced process efficiency
- Enables faster service restoration and improves system reliability by providing improved visibility and control of the power infrastructure

### Application Specific Solutions

#### Generation

Conventional Control Systems offer fully integrated sub-system solutions for protection and control of generators with sizes ranging from tens of KWs to hundreds of MWs

#### Transmission

Pre-designed modular protection, control and automation solutions for transmission system assets such as transmission lines, bus-bars, large transformers and capacitor banks

#### Distribution

Expandable modular solutions for assets within a distribution substation, e.g. transformers, breakers, cap-banks, as well as assets outside of the 'substation fence', e.g. reclosers and switches

#### Power Utilization & Automation

Conventional Control Systems offer a wide variety of modular metering, automation, industrial process protection and control solutions for commercial and industrial customers



## Flexible and Expandable

- Pre-designed modular solutions for ease of expansion, installation and testing
- Accelerated delivery cycle for protection, control and automation applications by leveraging modularity and standardization

## Total Quality Solution

- Use of standardized manufacturing processes, resulting in reduced variability and high quality solutions
- Designed, engineered, manufactured and tested in a strict ISO 9001 and Lean 6-Sigma quality controlled environment to provide enhanced system reliability

## Cost Effective Solutions

- Fully validated and factory tested solutions, helping in reducing the commissioning and site acceptance costs
- Leverage GE's advanced multi-function devices to improve application convergence and reduce device redundancies

## Comprehensive Solution

- Featuring state-of-the-art GE protection, control, automation technology with advanced communications, security and interoperability
- Suitable to interface legacy multi-vendor products and subsystems



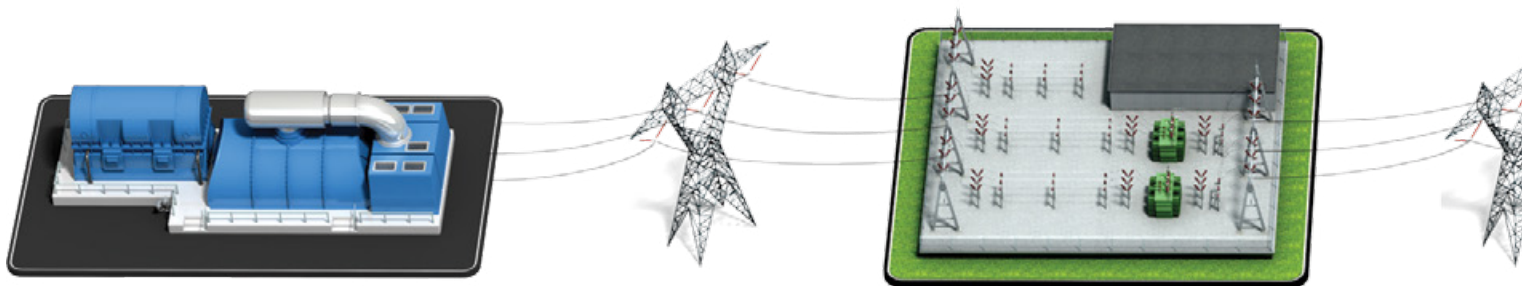
# Conventional Control Systems for the

## Generation

GE provides fully integrated protection, control and automation engineered panels and systems for a range of small to large size generators, ensuring safe operation, and protecting these key power system assets from a variety of fault conditions and anomalies. GE's Packaged Solution's generator protection and control solution features ANSI and IEC compliant main protection devices and auxiliary components and subsystems.

## Transmission

GE provides protection, control and automation conventional control systems for variety of power transmission applications such as HV/EHV line protection, large transformer protection, and high or low impedance bus protection systems to name a few. These solutions are designed and manufactured to address a multitude of customer challenges ranging from installation constraints to rugged environmental applications.



### Generator Protection and Control Solution

- Leverages advanced GE protection relays
- Fully integrated, tested packaged solution
- High quality workmanship and accelerated delivery cycles

### Advanced Bus Protection and Control Solution

- Pre-designed, configurable advanced protection schemes
- Bus differential protection and control package
- Engineered solutions for custom transmission applications



Advanced GE Generator Protection and Control panel used for protection of large gas and steam turbines.



Advanced Low Impedance Bus Protection and Control Solutions used for complex bus topologies.

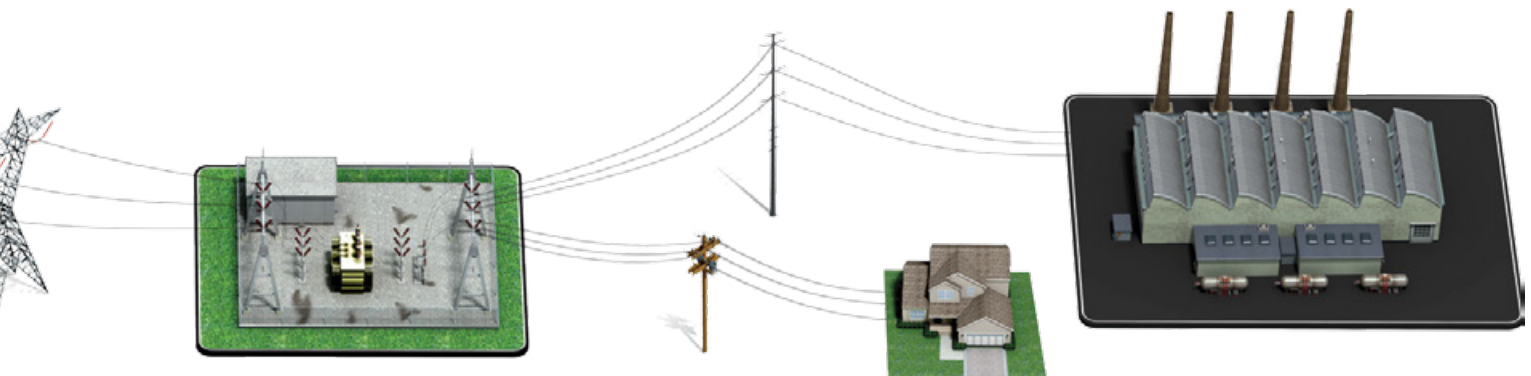
# Full Range of Smart Grid Applications

## Distribution

GE's Conventional Control Systems offer smart distribution solutions, minimizing customer downtime and improving safety and reliability in power distribution networks. The standard pre-designed modular control panel solutions reduce the total solution cost while providing state-of-the-art protection, control and automation capabilities.

## Automation & Industrial

GE provides a range of RTU automation and industrial protection and control solutions for medium to large industrial and utility applications. These solutions are provided as indoor, outdoor or pole-top solutions and are used for green-field and brown-field installations.



### Pre-designed Distribution Solutions

- Pre-configured modular protection and control solutions for distribution applications such as feeder, transformer and breaker
- Designed for indoor (NEMA 1) or outdoor (NEMA 4 or NEMA 12) applications
- Library of modular designs for common distribution applications to pick from

### Automation and Industrial Solutions

- Customized RTU solutions for variety of applications
- Supported by large host and IED protocol libraries
- Fully configured, factory tested solutions reducing installation and commissioning time at site



Distribution Protection and Control Solutions.



Industrial RTU Automation and Protection Solutions examples.

## Conventional Control Solution Offerings

Extending value by offering value add solutions and services

### Modular Panels & Cubicles

- Library of repetitive pre-configured, pre-wired and tested modular solutions
- Ideal for simple repetitive applications , e.g. Feeder Protection and Control, Transformer Monitoring Solution and Generator Protection



### Engineered Solutions

- Engineered Solutions for complex Generation, Transmission, Distribution and Automation applications
- Fully engineered, wired, tested, integrated solutions ready for site testing and commissioning



### Retrofit Solutions

- Pre-engineered retrofit solutions for legacy and automation Protection and Control devices such as DGP, ALPS, LPS, DLP and other legacy multi-vendor P&C products
- Pre-wired, pre-terminated modules ready to integrate, test and commission



### Project Solutions

- Protection and Control engineering and design
- Engineered conventional control solutions
- Special project requirements including commissioning and site testing support for protection, control and automation applications



## Modular Protection, Control and Automation Solutions

GE's conventional control systems are a comprehensive set of pre-designed, fully integrated protection, control and automation modules for generation, transmission and distribution applications.

These solutions are well suited to provide optimization of protection, control and automation designs for green field and brownfield substations. GE's module design philosophy allows for flexibility in design, engineering, installation, commissioning and upgrades throughout the life of your protection and control system.

### Key Benefits

#### Reduced Total Cost of Ownership and Maintenance

- Predesigned, modular solution for ease of panel design, expansion, installation and testing
- Reduced total cost of ownership by using the modular designs, significantly lower than custom panel design

#### Quality Solutions

- Designed, assembled, wired and tested under high assurance and quality control standards
- Each solution is provided with complete documentation for ease of site installation and testing

#### Scalable, Flexible and Quick Turnaround

- Choose protection, metering and control modules from a wide selection of designs
- Standard module offerings with quick turnaround lead-time in range of 6-8 weeks from order to shipment for common applications
- Simple selection of modules and enclosures/racks for panel design
- Factory tested and verified to help expedite the field testing and commissioning

## Steps to design your own protection panel using MPS assemblies

### Step 1

#### Select pre-designed, configurable modules for your application

Select the modules from the following typical application library to best fit your application needs. Configure your panels with one or more (typically up to three) modules for your application and desired functionality.

### Step 2

#### Select auxiliaries from extensive GE device libraries

Select auxiliary devices such as Ethernet switches, RTU gateways, meters, etc to best fit your needs. GE provides a typical range of the above mentioned devices, but more options and devices are available for your protection and automation applications.

### Step 3

#### Select an enclosure for your panel from variety of available options

Select the enclosure from typical protection panel enclosures and racks to best fit your application. The selection below provides a typical range, but we can also support more types/designs as needed.

## Step 1: Select Pre-designed, Configurable Modules

### Generator Protection Applications

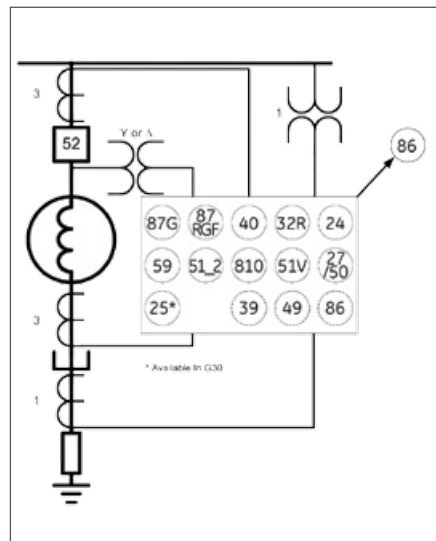
#### Generator Protection Panels

##### Applications

- Small to medium generator applications
- Pumped storage generators
- DG interconnect protection per IEEE 1547

##### 19" rack-mount MPS assembly featuring:

- Multilin™ G30 based advanced modules with typical functions e.g. Generator Stator Differential, Restricted Ground fault, Reverse power and optional vibration and thermal overload
- Built-in one Breaker Control Switch and one Lock Out Relay (option to add more)
- Built-in 19" rack-mount test-switch assembly for relay testing
- Pre-wired, fully tested module ready to be installed in a P&C panel
- Built-in advanced communications and optional IEC 61850 and advanced cyber security
- Available in IEC designs (with IEC auxiliary devices)



Typical Small/Medium Generator Scheme with Low Impedance Grounding



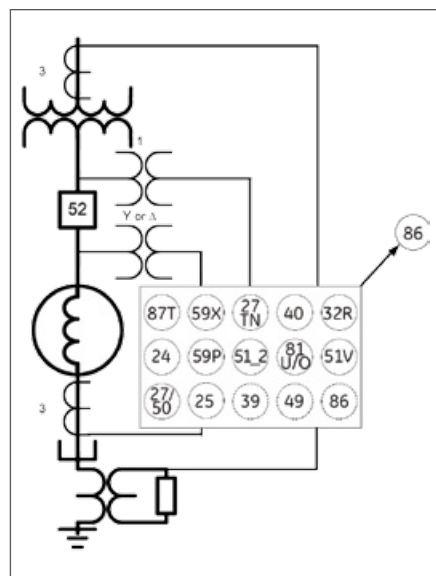
### Advanced Generator Protection Panels

##### Applications

- Large Generators typically driven by gas/ stream turbines
- Pumped storage generators used as pumping motors

##### 19" rack-mount pre-wired assembly featuring:

- Multilin G60 based advanced generator protection modules with typical functions e.g. Generator Transformer differential, 3rd Harmonic Neutral Under-voltage, Loss of excitation, Phase distance and optional 100% Stator Ground fault
- Built-in EPM 9900 meter, with option to add bus metering
- Built-in one Breaker Control Switch and one Lock out relay (option to add more)
- Built-in 19" rack-mount test-switch assembly for relay testing, with option to add more, as required
- Pre-wired, fully tested module ready to be installed in a P&C panel
- Built-in advanced communications and optional IEC 61850 and advanced cyber security
- Available in IEC designs (with IEC auxiliary devices)



Typical In-zone Transformer Generator Scheme for Large Generators



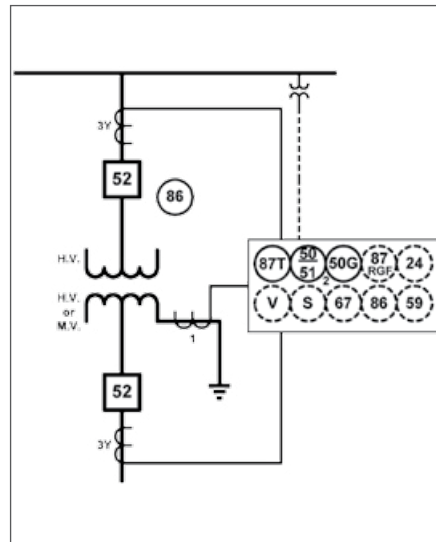
## Transformer Protection Applications Advanced Transformer Protection Panels

### Applications

- Power Transformer, HV windings protection and control
- Transformers in ring bus or break-and-a-half schemes
- Transformer asset monitoring using Hottest Spot, Loss-of-Life and Aging factor

### 19" rack-mount assembly featuring:

- Multilin T60 based advanced modules with typical transformer functions e.g. Differential, over current and short circuit, ground fault, directional overcurrent, Volts per Hertz, overvoltage, power swing blocking and optional synchrocheck
- Built-in one Breaker Control Switch and one Lock out relay (option to add more)
- Built-in 19" rack-mount test-switch assembly for relay testing
- Option to add EPM energy meter as needed
- Pre-wired, fully tested MPS module ready to be installed in a P&C panel
- Built-in advanced communications and optional IEC 61850 and advanced cyber security
- Available in IEC designs (with IEC auxiliary devices)



Typical Transformer Protection Scheme for Large Transformers



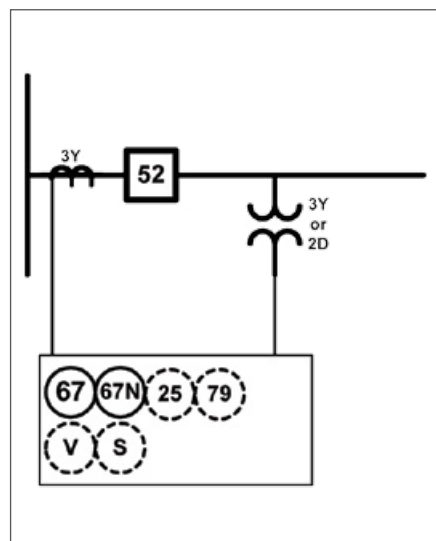
## Distribution Feeder Protection Applications Basic Feeder and Bay Control Unit

### Applications

- Primary feeder protection on solidly grounded, high impedance grounded or resonant grounded systems
- Bus blocking/interlocking, and bus transfer schemes
- Simple utility and industrial feeder topologies

### 19" rack-mount modules assembly featuring:

- Multilin F650 with typical functions e.g. Phase directional overcurrent, Neutral directional overcurrent, synchrocheck, reclosing and voltage/power metering
- Option to add redundant meter, if needed
- Built-in one Breaker Control Switch and one Lock out relay
- Built-in 19" rack-mount test-switch assembly for relay testing
- Pre-wired, fully tested module, ready to be installed in a P&C panel
- Can be provided in an enclosed NEMA 4 rated outdoor enclosure
- Available in IEC designs (with IEC auxiliary devices)



Typical Single Feeder Protection Application



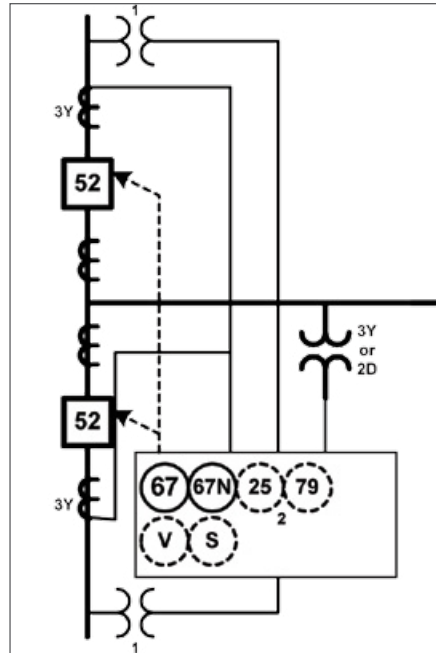
## Advanced Feeder Protection Panels

### Applications

- Primary feeder protection on solidly grounded, high impedance grounded or resonant grounded systems
- Back-up protection for transmission lines, feeders and transformers
- DG interconnect protection

### 19" rack-mount assembly featuring:

- GE Multilin F60 based advanced module with typical functions e.g. Phase directional overcurrent, Neutral directional overcurrent, synchrocheck, reclosing and built-in voltage and power metering, Voltage and frequency elements for transfer schemes
- Built-in one Breaker Control Switch and one Lock out relay (option to add more)
- Built-in 19" rack-mount test-switch assembly for relay testing
- Option to add EPM energy meters as needed
- Pre-wired, fully tested MPS module ready to be installed in a P&C panel
- Built-in advanced communications and optional IEC 61850 and advanced cyber security
- Available in IEC designs (with IEC auxiliary devices)



Typical Directional Overcurrent - Dual Breaker Protection Scheme



## Transmission Line Protection Applications

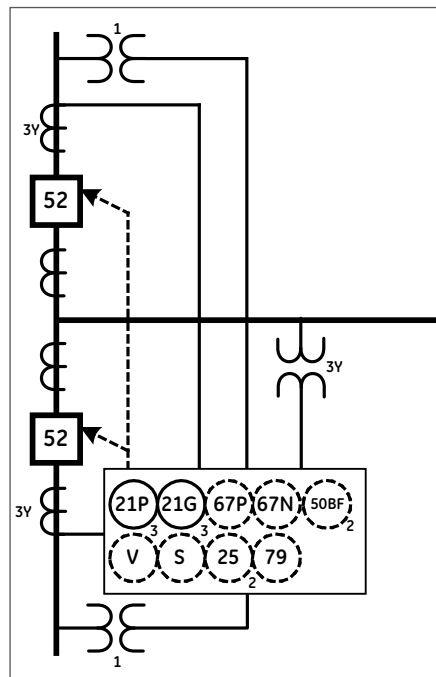
### Distance Protection

### Applications

- Overhead lines including series compensated lines and underground cables
- Single and dual-breaker circuits, with single/three pole auto-reclosing
- Backup protection for generators, transformers and reactors

### 19" rack-mount assembly featuring:

- Multilin D60 with advanced functions e.g. Power swing detection, single-pole tripping, synchrocheck and reclosing
- Option to add meter(s) to the module, if needed
- Built-in one Breaker Control Switch and one Lock out relay
- Built-in 19" rack-mount test-switch assembly for relay testing
- Pre-wired, fully tested module ready to be installed in a P&C panel
- Available in IEC designs (with IEC auxiliary devices)



Typical Stepped Distance - Dual Breaker Protection Scheme



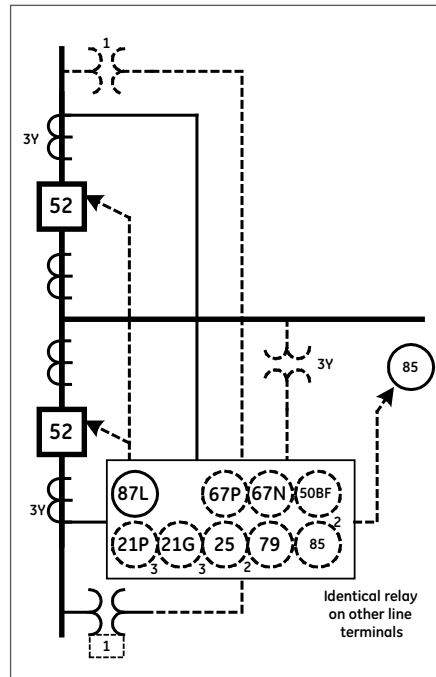
## Line Current Differential Protection

### Applications

- Overhead lines including series compensated lines and underground cables
- Single and dual-breaker circuits, with single/three pole auto-reclosing
- 3 terminal line configurations, with channel redundancy and DTT
- Wide area system monitoring and control

### 19" rack-mount assembly featuring:

- Multilin L90 based advanced module with typical functions e.g. Phaselet based Line differential and multiple communication options, 5 zone distance protection with pilot schemes, 2 and 3 terminal applications, optional breaker-and-a-half configuration, Peer-to-Peer or Master-Slave modes of operation, Direct Transfer Trip (DTT), Tapped transformer applications
- Built-in one Breaker Control Switch and one Lock out relay (option to add more)
- Built-in 19" rack-mount test-switch assembly for relay testing
- Option to add EPM energy meters as needed
- Pre-wired, fully tested MPS module ready to be installed in a P&C panel
- Built-in advanced communications and optional IEC 61850 and advanced cyber security
- Available in IEC designs (with IEC auxiliary devices)



Typical Line Current Differential - Dual Breaker Protection Scheme



## Bus Protection Applications

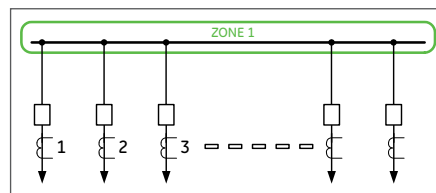
### Low Impedance Bus Protection

### Applications

- Single Bus, Breaker and half bus bar configurations, Double Bus and Triple Bus with and without bus couplers
- The Low Impedance Bus MPS supports up to 8 feeders; can be designed to support re-configurable multi-section bus-bars with up to 24 feeders

### 19" rack-mount assembly featuring:

- Multilin B90 with advanced bus protection functions e.g. Phase segregated scheme, 4 zones with dynamic bus replica, CT saturation detection, up to 8 feeders with one B90 (No Breaker Failure function)
- Built-in one Lock out relay
- Built-in 19" rack-mount test-switch assembly for relay testing; option to add more for more than 8 feeders
- Pre-wired, fully tested MPS module ready to be installed in a P&C panel
- Available in IEC designs (with IEC auxiliary devices)



Typical Single Bus Bar, 8 Feeders or less, 1 Zone Protection





## Step 2: Select Auxiliary Options from Extensive Libraries of GE Solutions

Substation Automation Devices



Metering Devices



Terminal Blocks & Test Switches

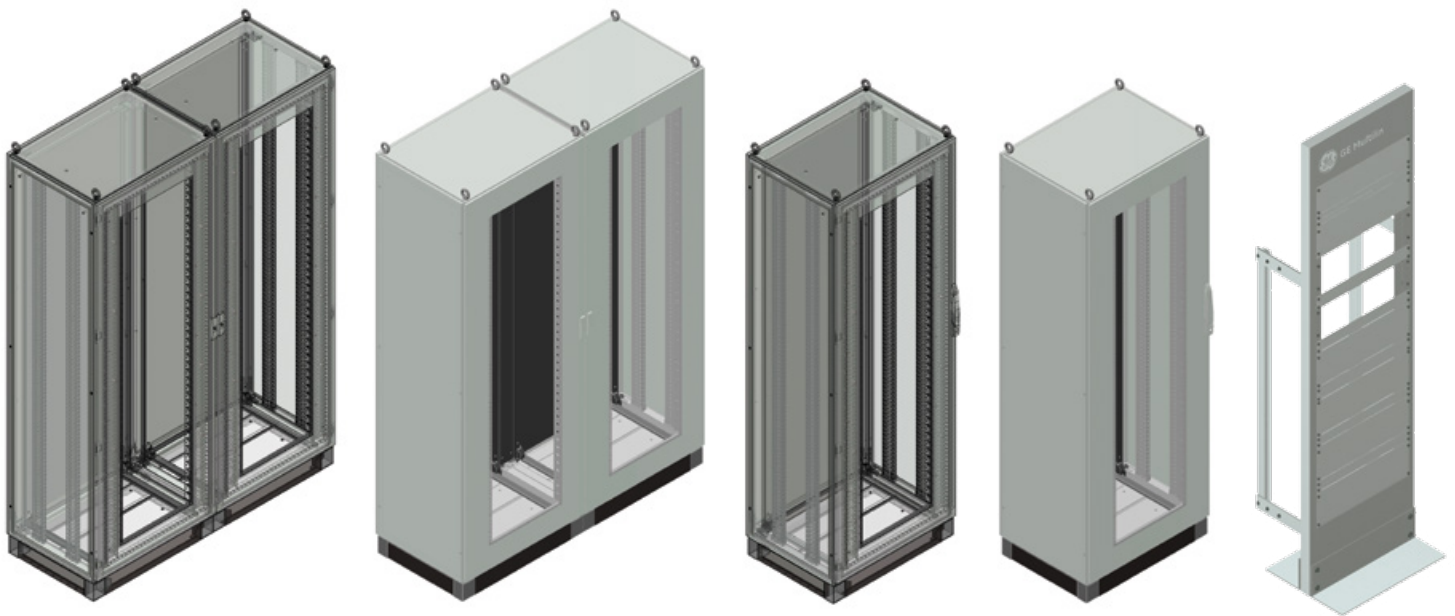


Ethernet Switches

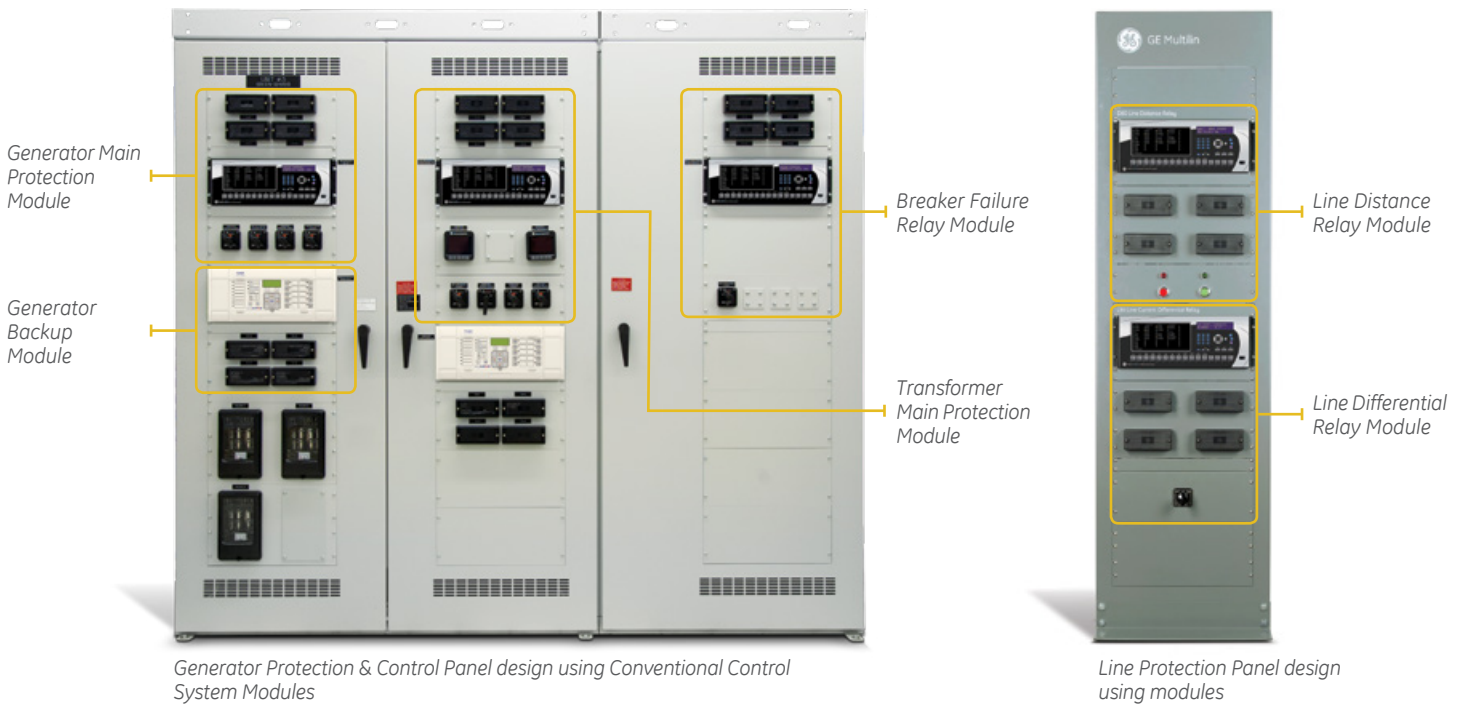


## Step 3: Select Enclosure Options

Variety of open racks and enclosures to pick from - featuring NEMA 1, NEMA 4 or NEMA 12 and Zone 3 or Zone 4 Seismic ratings



## Demonstration of Modular Conventional Control Systems for Protection Panel Design



## Engineered Solutions

Custom Engineered Solutions for Protection, Control and Automation Applications

### Engineered Solutions for Utility and Industrial Power Systems

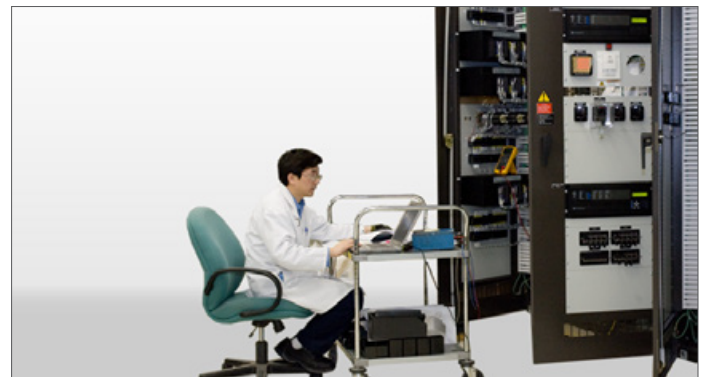
GE's Conventional Control System offerings include custom engineered protection, control and automation solutions for customer specific applications. These solutions leverage modular designs while providing full flexibility to integrate multi-vendor legacy products and technologies.

### Generator Protection and Control Solution

Suitable for medium to large sized generators, typically +100MW, generally driven by steam or gas turbines. This solution is built on an industry leading UR platform, and is a free-standing, fully integrated, pre-designed, assembled, wired and tested solution. Thorough in-house testing and pre-configurations enable accelerated site acceptance testing and commissioning.

#### Base Package Features:

- A standard NEMA 1 ANSI grey panel enclosure
- Multilin G60 based main and backup generator protection
- Multilin C60 Circuit Breaker management relay
- Multilin T60 based main transformer protection
- Advanced relays with built in powerful FlexLogic engine
- Modular design to expand protection functions as needed
- Digital Generator Metering (1% KW, 0.5% V, I)
- FT test switches and LORs for testing and local control
- Auxiliary devices and switches
- Panel design and engineering, assembly, wiring
- PTP and relay power-up functional testing



#### Optional Features:

- A NEMA 12 panel enclosure for harsh environment applications
- Seismic Z4 compliant enclosure for seismic sensitive areas
- Second GSU unit protection relay system
- Backup digital metering for critical applications
- Interfaces to multivendor legacy devices for retrofit applications
- Built-in fully integrated bus/feeder protection system
- Customized panel for customer specific applications
- Power system studies and relay settings design
- Factory Acceptance Testing and Site Testing assistance
- Generator protection commissioning support and training

## Low Impedance Bus Differential Protection and Control Solution

Suitable protection system for complex bus topologies with multiple feeders, sectionalizer and bus couplers. The solution features the Multilin B90 low impedance bus protection relay system standardized design libraries for application on a variety of bus topologies, and for indoor and outdoor applications.

## Distribution Protection & Control Solution

GE's Distribution Protection and Control Solution is suitable for feeder and breaker protection applications. This solution is modular and engineered with full protection and control logic implementation for outdoor switchyard applications.

### Key Features:

- Brushed Aluminum enclosure for outdoor applications
- Advanced Multilin F60 feeder protection relay with high impedance down conductor protection function
- Solution designed for extreme hot weather and seismic conditions
- Built-in communication to upstream SCADA system

## RTU Automation Solutions

RTU automation solutions for transmission and distribution SCADA applications. The solution features a direct interface to the SCADA Master Stations and provides effective communications between IEDs over multiple communication protocols. GE's solution features a direct interface to switchyard equipment and devices.

The automation solutions feature advanced Multilin D20/D20MX/D200/D400 RTU units. They are available for indoor, outdoor, and pole top applications.

These solutions provide the largest host and IED protocol library in the industry applications. The solutions are customizable and flexible to meet utility specific hardware termination requirements.



## Retrofit Solutions

### Pre-designed, Integrated Retrofit Solutions for Legacy Protection and Control

GE's Retrofit Solutions are comprehensive modernization and upgrade solution sets for a variety of legacy protection and control relays and sub-systems. GE's conventional control systems provide one-to-one retrofit upgrade solutions leveraging state-of-the-art microprocessor-based protection devices for advanced protection and control functionality.

These solutions are pre-designed, pre-wired and integrated to replace an older device in an existing panel without any changes in customer side wiring. The customer gets a substantial benefit of deploying these solutions by retaining their existing infrastructure and yet getting latest features and functionality.

### Key Benefits

#### Simplified Retrofit Designs:

Pre-designed, modular solution for ease of installation and testing in an existing protection panel

#### Convergence:

Ability to provide the protection and control functions required for large power system assets in one relay platform to replace multiple single function devices

#### Total Quality Solution:

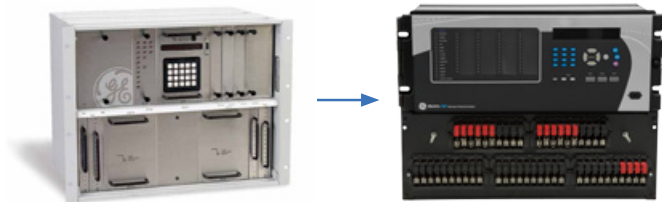
Designed, assembled, wired and tested under high quality assurance and quality control standards. Each retrofit solution type is provided with complete documentation with as-built drawings, wiring matchup details for ease of site installation and testing



### Retrofit Solution Example

#### Generator Protection: DGP Retrofit Solution - DGPR

The Multilin DGPR Solution is a pre-designed, fully integrated retrofit solution for a GE legacy Generator Protection DGP Relay. The DGPR Solution is designed for a one-to-one replacement of a DGP relay with a Multilin G60 based retrofit module. The DGPR Solution is well suited for large hydro, gas and steam turbine generators, providing state-of-the-art modern protection and control functionality for these critical power system assets.



DGP Generator Protection Relay

DGPR Retrofit Module

### Solution Features:

- A Multilin G60-UA4-HKH-F8M-H6P-M8M-P6M-U6C-WRH relay
- 5 FT switches for trip, CT and DC circuit isolation
- Gage 11 metal structure to mount G60 relay and test switches
- Integrated wiring to connect relay through the FT test switches and back of the module
- Installation documentation to assist with mounting in a generator protection panel and internal wiring and interconnection diagram provided
- Self-contained wiring between G60, FT switches and terminal blocks at the back of the module, to connect existing GPP wiring
- G60 relay settings, based on DGP settings

### DGPR Ordering:

|                                   | - XX | - XX | - XX   |
|-----------------------------------|------|------|--|
| DGPR                              |      |      | Base Module  |
| LPSO retrofit not required        | D0   |      | DGP retrofit only  |
| LPSO retrofit included            | D1   |      | Provided with a 3 RU plate to cover for LPSO             |
| G60 Settings not required         | S0   |      | G60 relay settings not provided                          |
| G60 settings required             | S1   |      | Settings converted from original DGP settings (optional) |
| Wiring Matchup table not required |      | W0   | No wiring match-up table provided                        |
| Wiring table included             |      | W1   | Derived from customer existing panel wiring diagram      |

### Notes:

\* Please contact your local sales channel for a custom design instead of the standard module proposed above

\*\* Visit our website for details on the UR G60 relay:  
<http://gegridsolutions.com/multilin/catalog/g60.htm>

## Project Solutions

### Comprehensive Protection, Control and Automation Projects

Offering projects in the area of Protection, Control and Automation. The typical scope for such a project would be to engineer a P&C and/or automation system, supply of pre-wired and tested panels or cubicles, assistance and support for site acceptance testing and commissioning.

### Features & Benefits

Complete engineering and design of protection, control and automation schemes for generation, transmission and/or distribution and industrial automation applications. Our team of P&C and automation experts will work with the customer in defining the complete project scope, protection, control and automation requirements, and finally a fully compliant design. Following are the key features and benefits of leveraging GE's comprehensive portfolio:

- Full capability for in-house design, engineering and development of conventional control systems for P&C and Automation
- Capability and proven experience in project management, sourcing and material procurement, construction, panel wiring and testing
- Available technical site support for commissioning and site acceptance testing
- Fully integrated Lean 6-Sigma and ISO 9001 quality standards and processes

We have successfully delivered a large number of P&C and automation projects in various geographies, and continue to support our customers for various state-of-the-art applications.



GE

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