F650

FEEDER PROTECTION AND BAY CONTROLLER SYSTEM

Cost effective solution for protection, automation and control of distribution feeders

KEY BENEFITS

• Flexible protection and control device for distribution feeder applications
• Advanced automation capabilities for providing customized protection and control solutions
• Human machine interface (HMI) - graphical LCD, programmable buttons, and easy keys for selecting setting menus, and submenus.
• Minimize replacement time - Modular with card draw-out construction
• Reduce troubleshooting time and maintenance costs - IRIG-B and SNTP time synchronization, event reports, waveform capture, data logger
• Advanced automation capabilities for providing customized protection and control solutions
• Voltage and frequency based load shedding and transfer schemes to increase system uptime and improve system stability
• Reduced relay to relay wiring and associated installation costs through high-speed inter-relay communications
• Simplified system integration with communications supporting serial and Ethernet interfaces and multiple protocols
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• Embedded IEC61850 Protocol (optional), IEC 60870-5-103 (optional)

APPLICATIONS

• Primary protection and control for distribution feeders on solidly grounded, high impedance grounded or resonant (Peterson Coil) grounded systems
• Bus blocking/Interlocking schemes
• High-speed fault detection for arc flash mitigation
• Throw over schemes (bus transfer scheme applications)

• Load shedding schemes based on voltage and frequency elements
• Back-up protection for transmission lines, feeders and transformers
• Distributed Generation (DG) interconnect protection, including active and passive anti-islanding

FEATURES

Protection and Control
• Time, instantaneous & directional phase, neutral, ground and sensitive ground overcurrent
• Manual close with cold load pickup control via PLC, Forward Power and Directional Power Units
• Load encroachment supervision
• Wattmetric ground fault detection
• Positive and negative sequence based over/under voltage elements
• Four-shot autorecloser with synchronism check
• Breaker control and breaker failure
• Abnormal frequency protection (Rate of change, under and over frequency)
• Broken conductor and locked rotor
• Synchrocheck - V, & Hz
• Up to 64 Programmable digital inputs and up to 16 digital outputs
• Trip Circuit Supervision

Monitoring & Metering
• Fault locator, record of last 10 faults -metering - current, voltage, power, energy, frequency and harmonics
• Breaker operation & trip failure
• Total breaker arcing current
• Event recorder - 479 Events
• High resolution oscillography and Data Logger, with programmable sampling rate
• Metering: V I Hz W VA PF
• Demand: Ia , Ib , Ic , Ig, Isg, I2, MW, MVA
• Configurable graphical HMI interface
• Alarm Panel

EnerVista™ Software
• Sophisticated software for configuration and commissioning
• Document and software archiving
• EnerVista™ Integrator providing easy integration of data in the F650 into new or existing monitoring and control systems

Digital Energy
Multilin
Protection and Control

The F650 provides high speed protection and control for feeder management and bay control applications, including:

Overcurrent Protection

Instantaneous and time overcurrent functions are available for phase, neutral, ground/sensitive ground and negative sequence currents. A variety of time curves are provided including IEEE/ANSI, IEC A/B/C/long time inverse / short time inverse, GE IAC, I²t, definite time, rectifier curve and four user-programmable curves.

Directional Elements

Directional supervision are available for phase, neutral, ground and sensitive ground currents. The neutral/ground directional elements can be programmed to work under zero-sequence voltage, ground sensitive current or dual polarization.

Over/Under Voltage Protection

The F650 includes the following voltage elements:

• Phase undervoltage/overvoltage elements (each element has three individual phase undervoltage/overvoltage components)
• Auxiliary undervoltage/overvoltage element
• Neutral overvoltage element

Following are some of the key applications where voltage elements can be used:

• Source transfer schemes.
• Load shedding schemes
• Back up capacitor bank protection and control
• Backup motor protection to prevent automatic restart.

Over/Under Frequency Protection

The F650 offers overfrequency and underfrequency elements to improve network (grid) stability using voltage or frequency based loadshedding techniques. It also allows to provide back up protection and trip breakers directly when protecting feeders and other frequency sensitive power equipment.

Frequency Rate of Change Protection

Frequency rate of change df/dt elements can be used:

• Backup motor protection to prevent automatic restart.

Wattmetric Zero-sequence Directional

Applications include ground fault protection in solidly grounded transmission networks, grounded/ungrounded/resistor-grounded/resonant-grounded distribution networks. The wattmetric zero-sequence directional element responds to power derived from zero-sequence voltage and current in a direction specified by the element characteristic angle. The angle can be set within all four quadrants and the power can be active or reactive. Therefore, the element may be used to sense either forward or reverse ground faults in either inductive, capacitive or resistive networks. The inverse time characteristic allows time coordination of elements across the network.

Breaker Failure and Control

Use the breaker failure function to determine when a trip command sent to a breaker has not been executed within a selectable time delay. In the event of a breaker failure, the unit will issue an additional signal to trip the breakers connected to the same busbar, potential sources of fault current.

The F650 incorporates 3 levels of current and time, together with a trip without current unit, and an internal arc detection unit. The breaker failure unit has three levels: “Retrip” or “Supervision” used to generate a second trip signal to the corresponding breaker on which the initial opening has been executed, “High Level”,

Functional Block Diagram

Wattmetric Zero-sequence Detection

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ANSI Device Numbers & Functions

<table>
<thead>
<tr>
<th>Device Number</th>
<th>Function</th>
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<td>50B</td>
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<td>Phase Instantaneous Overcurrent High/Low</td>
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<td>51N</td>
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<td>51G</td>
<td>Ground Time Overcurrent</td>
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<td>67F</td>
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and “Low Level” used to executing complex protection schemes. The function can be initiated/blocked via digital inputs as well as communications.

The relay also provides for control of one or two breakers from faceplate pushbuttons, remote communications or contact inputs. A breaker pole discrepancy is included in the breaker control scheme. Breaker position is indicated by LEDs on the faceplate.

**Load Encroachment**

Feeders may experience very heavy load increases due to various contingency situations. The Load Encroachment function in F650 provides the capability to manage such load growth in feeders. Load encroachment element can be set for the feeder’s expected maximum load, reducing the likelihood of false tripping for load conditions while maintaining dependability to trip for legitimate faults.

The load encroachment supervision in F650 based on positive-sequence voltage and current and applies a characteristic shown in the figure. It allows to set the phase overcurrent elements below peak load current to see end-offline phase faults in heavily loaded feeder applications.

**Autorecloser**

This function is applicable to three-pole tripping schemes and single breaker applications. Four reclosing “shots” are possible prior to locking out, each with an independent time setting. Autoreclosure outputs can be used to modify circuit protection settings between shots.

**Synchronism Check**

One synchronism check element is available. The algorithm allows breaker close time compensation to optimize close conditions. The element monitors maximum difference in voltage magnitudes (ΔV), phase angles (Δφ), and frequencies (Δf) as well as the dead source condition.

**Multiple Settings Groups**

Three separate groups of protection settings may be stored in the F650 non-volatile memory. The user can edit the active settings internally and externally via contact inputs and communications.

**Broken Conductor**

F650 incorporates a broken or fallen conductor detection function. The relay uses the ratio between the negative sequence current, i2, and the positive sequence current i1. In normal and balanced load situations, this ratio is zero, while in severe load fault conditions, an unbalance is produced and this ratio increases.

In order to avoid trips or pickup with very weak loads, there is a current level threshold (i2/i1) to inhibit the operation of the element when the three phase currents are below a fixed level.

**Locked Rotor**

F650 incorporates a locked rotor element. Protection element 48 produces a trip when current primary values exceed the set value. This current setting value is the product of the set Full Load Current by the pickup setting.

**Advanced Automation**

The F650 incorporates advanced automation features including powerful programmable logic, communication, and SCADA capabilities that far surpass what is found in the average feeder relay. The F650 integrates seamlessly with other GE Multilin relays for complete system protection.

**F650 Logic Configuration**

F650 Logic Configuration is the powerful programming logic engine that provides the ability of creating customized protection and control schemes thereby minimizing the need, and the associated costs, of auxiliary components and wiring. Using F650 Logic Configuration, the F650 can be programmed to provide required tripping logic along with custom scheme logic for auto transfer schemes (Main-Tie-Main), loadshedding based on frequency, voltage and communication, loop restoration schemes, other remedial action schemes and dynamic setting group changes.

**Inputs and Outputs**

A choice of 16 to 64 inputs and 0 to 16 outputs are available. Digital inputs may be user defined with a separate debounce and chatter time. Programmable “quasi” analog input levels allow the use of different voltage levels in the same model via setting the requested thresholds. EnerVista™ software allows easy configuration of all the interlocking and switching sequences. A graphic HMI interface provides access to monitoring, metering and alarm panel screens.

**Virtual Inputs/Outputs**

Traditionally, protective relay logic has been relatively limited. Use virtual inputs and outputs in conjunction with the programmable logic capabilities of the F650 for unusual applications involving interlocks, blocking, or supervisory functions, to minimize the requirement for auxiliary components and wiring while making more complex schemes possible.

The virtual inputs and outputs are digital signals associated with the F650 internal logic. Virtual inputs include signals generated remotely via communications. The virtual outputs are outputs of programmable logic equations used to customize the device. Virtual outputs can also serve as inputs to programmable logic equations.

**CAN BUS Remote I/O (CIO)**

The F650 can be ordered with up to two additional communication cards on the rear. Besides two identical ports, COM1 and COM2, the cards may incorporate a port for CAN BUS communications used to connect the Remote CAN BUS I/O module (CIO Module). Use the CIO Module to double the number of I/Os of the F650, when the maximum number of I/Os available inside the relay (up to 64 inputs and 16 outputs) is not sufficient to meet the needs of specific applications.

In addition to increasing the number of I/Os, the CIO Module allows the F650 to monitor signals located at a remote location with only a connection between both devices, resulting in significant savings in installation costs.

**Transducer Inputs**

dcmA inputs are available to monitor system parameters such as temperature, vibration, pressure, wind speed, and flow.

**Remote I/O**

The remote I/O feature provides a means of sharing digital point state information between F650s or other IEC61850 compliant IEDs or controllers. The remote outputs interface seamlessly to the remote inputs.
of other F650 devices via the IEC61850 GSSE messaging. User secure peer-to-peer communications to develop complex schemes in distributed logic and I/Os.

Monitoring and Metering
The F650 provides advanced monitoring and metering that includes:

VT Fuse Failure
Use the VT Fuse Failure feature to issue an alarm and/or to block voltage driven protection functions that can operate incorrectly due to an abrupt partial or total voltage loss. This loss is caused by the voltage transformers secondary circuit protection fuse failure. Different methods are used to detect the different types of VT fuse failure.

Trip Circuit Monitoring
F650 can be used to monitor the integrity of both the breaker trip and closing coils and circuits. The supervision inputs monitor both the battery voltage level, while the outputs monitor the continuity of the trip and/or closing circuits, by applying a small current through the circuits.

Basic Metering
Metered values include:

- Current: $I_a$, $I_b$, $I_c$, $I_n$, $I_{sg}$
- Phase-to-phase and phase-to-ground voltages for bus and line: $V_{an}$, $V_{bn}$, $V_{cn}$, $V_{bb}$, $V_{ab}$, $V_{bc}$, $V_{ca}$
- Active power (per-phase and total): $W_a$, $W_b$, $W_c$, $W$
- Reactive power (per-phase and total): $VA_a$, $VA_b$, $VA_c$, $VAR$
- Total active, reactive and apparent energy: MWh, MVArh, MVAh
- Power factor (per-phase and total)
- Frequency
- Demand
- l\text{a}, l\text{b}, l\text{c}, l\text{g}, l\text{sg}, V\text{a}, V\text{b}, V\text{c} and V\text{x} signals are available locally and remotely and can be stored in the oscillography record or data logger.

Event Recording and Oscillography
The F650 is capable of storing 479 time-tagged events (1 ms tagging), to help with troubleshooting. The trigger point, the channels, and sampling rate of the oscillography files are user programmable features. Up to five seconds at maximum sample rate can be stored.

Breaker Arcing Current ($I^2t$)
The relay estimates the total interrupted current as an accumulation of the RMS current measured during the time period taken to open the breaker after a trip. It calculates the per-phase wear on the breaker contacts to establish a threshold. When the breaker maintenance threshold is exceeded the relay can be set to trigger an alarm.

Communications
The F650 includes up to three communication ports that operate simultaneously. Redundant ports are also available for special applications. F650 features an RS232 front port (COM2) and a choice of rear RS485, plastic/glass fiber optics (COM1 and COM2). Additionally, this module may incorporate a port for CAN bus communications, used for the connection to the remote CAN BUS I/O module. F650 COM3 features 10/100 BaseTX and 100 Base FX single or redundant Ethernet ports.

Protocols supported by the F650 include IEC61850, DNP 3.0, Modbus RTU, Modbus TCP/IP and IEC 60870-5-104. These protocols make it easy to connect to a Utility automation system and are integrated into the F650, eliminating the need for external protocol converter devices.

Security
Independent passwords for protection and control allow restricting access via keypad and display, or EnerVista™ software.

Multi-Language
The F650 supports multiple languages. French, Chinese, Russian language options are available on the local display, front panel, and EnerVista™ setup software, as well as the product instruction manual. Easily switch between English and an additional user selectable language on the local display.

Interoperability With Embedded
IEC61850 Protocol
IEC61850 is the new international standard for information exchange and interoperability between intelligent devices within a substation. Use the F650 with IEC61850 to lower the costs and simplify the engineering, commissioning, operating, and maintenance associated with substation protection and control applications. IEC61850 is built on over 7 years of GE leadership in UCA 2.0 implementation.

IEC61850 allows for the seamless connection of IEDs from multiple vendors. In addition to device interoperability, these protocols are designed to control the substation via a LAN instead of through discrete wiring to an RTU. Peer-to-peer communication over Ethernet enables distributed control with several IEDs and eliminates the need for an RTU to remote SCADA master. High-speed message transfer eliminates the need for large and costly hard-wired interconnection.

EnerVista™ Software
The EnerVista™ Suite is an industry-leading set of software programs that simplifies every aspect of the F65 relay. The EnerVista™ suite provides all the tools to monitor the status of your protected asset, maintain the relay, and integrate information measured by the F650 into DCS or SCADA monitoring systems. Convenient COMTRADE and Sequence of Events viewers are an integral part of the 650 Setup software included with every F650 relay, to carry out postmortem event analysis to ensure proper protection system operation.

EnerVista™ Launchpad
EnerVista™ Launchpad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining GE Multilin products. The setup software within Launchpad allows configuring devices in real-time by communicating using serial, Ethernet, or modem connections, or offline by creating setting files to be sent to devices at a later time.

Included in Launchpad is a document archiving and management system that ensures critical documentation is up-to-date and available when needed. Documents made available include:

- Manuals
- Application Notes
- Guideform Specifications
- Brochures
- Wiring Diagrams
- FAQ’s
- Service Bulletins
Viewpoint Monitoring

Viewpoint Monitoring is a simple-to-use and full-featured monitoring and data recording software package for small systems. Viewpoint Monitoring provides a complete HMI package with the following functionality:

- Plug-&-Play Device Monitoring
- System Single-Line Monitoring & Control
- Annunciator Alarm Screens
- Trending Reports
- Automatic Event Retrieval
- Automatic Waveform Retrieval

User Interface

The F650 uses a “shuttle” control for ease of use. A choice of text or graphic display, and up to five configurable keys are available for frequently performed control functions. Up to 15 programmable LEDs are available. The F650 can incorporate option "N" for the second position of the ordering code a Graphical display with IEC Symbols.

Dimensions

SIDE VIEW  FRONT VIEW  CUTOUT
Typical Wiring Diagram
PHASE/NEUTRAL AND GROUND TIMED OVERCURRENT (15PH/5PH/5LN/5G)

Current: Fundamental Phasor (w/o harmonic) or RMS
Rated current: For connection to 1 or 5 A CTs
Pickup level: 0.00 to 160.0 A in steps of 0.01 A
Reset dropout level: 97.9% to 98.9% of the pickup level
Accuracy: ±3.5% of the reading or 50 ms (whichever is greater)

OPERATION CURRENTS
IC: extremely very/moderately inverse IEC Curve A/B/C/Long-Time Inverse Short-Time Inverse ANSI extremely very/normally/moderately inverse
IA: extremely very / moderately inverse Define time Rectifier curve User curve FlexCurve™ A/B/C/D
Reset time type: Instantaneous or time delayed according to IEC
Increment:
Voltage
Phases:
Frequency Rate of Change
Phase C (VBA)
AUXILIARY UNDERVOLTAGE (27A)
Pickup level: 3 to 300 in steps of 1 V
Reset dropout level: 97.9% to 98% of the pickup level
Accuracy: ±1% of the reading from 10 to 208 V

OPERATION CURVES
Plug level: 0 to 20 Hz in steps of 0.01 Hz
Reset delay: 0.00 to 900.00 s in steps of 0.01 s
Timing accuracy: ±1% of the reading from 10 to 208 V
Snapshot Events: Selectable by setting

PROTECTION
Minimum voltage threshold: 3 to 300 in steps of 1 V
Logic: Any two/all of phases logic selectable by setting
Supervised by breaker:
Timing accuracy: ±3.5% of operation time or 50 ms (whichever is greater)

FREQUENCY BEU (85A)
Pickup level: 20 to 100 Hz in steps of 0.01 Hz
Reset dropout level: 30 mHz higher/lower than the plug level
Rating:

NEUTRAL UNDERVOLTAGE (59S/5NL)
Voltage: Fundamental Phasor of the neutral voltage
Pickup level: 3 to 300 in steps of 1 V
Reset time delay: 97% of the pickup level
Accuracy: ±1% of the reading from 10 to 208 V
Snapshot Events: Selectable

SUGGESTED CONNECTIONS
Rated current: 0.00 to 900.00 s in steps of 0.01 s
Timing accuracy: ±3.5% of operation time or 50 ms (whichever is greater)

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Rated current: 0.00 to 900.00 s in steps of 0.01 s
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Voltage: Fundamental Phasor of the neutral voltage
Pickup level: 3 to 300 in steps of 1 V
Reset time delay: 97% of the pickup level
Accuracy: ±1% of the reading from 10 to 208 V
Snapshot Events: Selectable

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Pickup level: 20 to 100 Hz in steps of 0.01 Hz
Reset dropout level: 30 mHz higher/lower than the plug level
Rating:

NEUTRAL UNDERVOLTAGE (59S/5NL)
Voltage: Fundamental Phasor of the neutral voltage
Pickup level: 3 to 300 in steps of 1 V
Reset time delay: 97% of the pickup level
Accuracy: ±1% of the reading from 10 to 208 V
Snapshot Events: Selectable

SUGGESTED CONNECTIONS
Rated current: 0.00 to 900.00 s in steps of 0.01 s
Timing accuracy: ±3.5% of operation time or 50 ms (whichever is greater)

Minimum phase current threshold: 0.1% current inhi- bition level: 0.00-1.000 in steps of 0.001

FREQUENCY RATE OF CHANGE
df/dt trend: increasing, decreasing, bi-directional
df/dt pickup level: 0.10 to 100.00 Hz in steps of 0.01 s
df/dt level: 80 mHz or 3.5% whichever is greater

Overvoltage supervision: 0.00 to 110.00 % in steps of 0.01
95% settling time for df/dt: < 24 cycles

Phase/neutral and ground timed overcurrent (15PH/5PH/5LN/5G)
Current: Fundamental Phasor (w/o harmonic) or RMS
Rated current: For connection to 1 or 5 A CTs
Pickup level: 0.00 to 160.0 A in steps of 0.01 A
Reset dropout level: 97.9% to 98.9% of the pickup level
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OPERATION CURRENTS
IC: extremely very/moderately inverse IEC Curve A/B/C/Long-Time Inverse Short-Time Inverse ANSI extremely very/normally/moderately inverse
IA: extremely very / moderately inverse Define time Rectifier curve User curve FlexCurve™ A/B/C/D
Reset time type: Instantaneous or time delayed according to IEC
Increment:
Voltage
Phases:
Frequency Rate of Change
Phase C (VBA)
**Technical Specifications (cont’d)**

### Protection

- **Load Encroachment**
  - Responds to: Positive-sequence quantities
  - Minimum voltage: 0.0 to 300.0 V in steps of 0.01
  - Reach (sec, Q): 0.02 to 2500.0 Q in steps of 0.01

- **Impedance accuracy**: ±3%
  - Angle: 5 to 60° in steps of 1
  - Angle accuracy: ±3°

- **Pickup delay**: 0 to 65.35 s in steps of 0.001

- **Reset time**: 0 to 65.35 s in steps of 0.001

- **Time accuracy**: ±1.5% or ±60 ms, whichever is greater

### Control

- **Control Settings**
  - **Load calculation (4Q)**
  - Maximum: 0.0 to 2000.0 in steps of 0.01

- **Condition permission**: Reclaim time: each shot adjustable between 0 and 900 s

- **Maximum openings**: 0 to 9999 in steps of 1

### Automation Close (179)

- **Schemes**: Three-phase pole tripping schemes

- **No. of reclosing shots**: Up to 4 reclose attempts before lockout

- **Dead time**: Independent dead time setting before each shot adjustable between 0 and 900 s in steps of 1 s

- **Reclaim time**: 0 to 900.0 s in steps of 0.1 s

- **Condition permission**: Selectable by setting

### Synchronism Check (25)

- **Dead/live levels for line and bus**: 0.0 to 300.00 m steps of 0.1 V

- **Maximum voltage difference**: 2.0 to 300.0 V in steps of 0.01 V

- **Maximum angle difference**: 2.0° to 80.0° in steps of 0.1°

### Fuse Failure

- **Activation by Algorithm based on opposite sequence of voltage and current**: 100 mA

### Breaker Failure (50BF)

- **Current**: Fundamental phasor (without harmonics)

- **Rated current**: Valid for connection to 1 or 5 A CTs

- **Normal operation**: 0.0 to 160.0 A in steps of 0.01 A

- **Maximum operation**: 0.05 to 160.0 A in steps of 0.1 A

### breaker settings

- **Switchgear number**: 1 to 16

- **Maximum Kl**: 0.0 to 9999.99 in steps of 0.01 kA²

- **Kl time**: 0.03 to 0.25 s in steps of 0.01 s

- **Maximum opening**: 0 to 9999 in steps of 1

- **Maximum Openings in an hour**: 1 to 60 in steps of 1

### Monitoring

- **Open trip and close circuits**

- **Oscillography**
  - Records: Up to 20 oscillography records
  - Samples: Programmable to 4, 8, 16, 32 or 64

- **Trigger position**: 5% to 95% of total length

- **Data**: 5 current channels and 4 voltage channels

### Fault Locator

- **Method**: Single-ended

- **Positive sequence module**: 0.01 to 250.00 Ohm in steps of 0.01

- **Zero sequence angle**: 25 to 90° in steps of 3°

### Fault LD

- **Line length**: 0.0 to 2000.0 in steps of 0.1 miles or km

- **Display fault on HMI**: Possibility to show the fault report on HMI

### Settings

- **Accuracy angle**: 5% (typical)

- **SNAPSHOT EVENTS**
  - **Capacity**: 4.79 sampling events

### Synchronism

- **Synchronization time**: 0.6 to 200.00 ms in steps of 0.1 ms

- **Maximum frequency slip**: ±0.5% of the reading ± 10 mA from 0.05 to 10 A

- **Parameters**:
  - ±0.5% of the reading ± 10 mA from 0.05 to 10 A
  - ±3% of the reading ± 10 mA from 0.05 to 10 A
  - ±3.5% or ±60 ms, whichever is greater

### Switchgear

- **Switchgear number**: 1 to 16

- **Switchgear**: 1 to 16 (configurable).

### Metering

- **Apparent power**: ±2.5% of the reading ± 10 A from 0.1 to 10 A (for phases and ground)

- **Active power**: ±1.5% of the reading ± 1 mA from 0.005 to 5 A (for sensitive ground)

- **Volts**: ±2.5% of the reading from power factor x 0.8 to 1

### Inputs

- **Controller**: Appropriate for 1 or 5 A

### Analog Outputs (4mA)

- **Current inputs**: 0.0 to 1; 0 to +1; -1 to +1; 0 to 5; 0 to 20, 4 to 20

- **Accuracy**: ±2.5% of full scale

- **Type**: Passive

### IIRG-8 Time Synchronization Input

- **Type**: Demodulated input (no carrier)

- **Format**: B001, B001, B002 and B003

- **Level**: TTL

- **Load**: 1.5 mA

### Real Time Clock

- **Accuracy**: Typical 20 ppm

### Breaker Maintenance

- **KI²**: BKR Ph A, B, C Cnt

- **Kl**: 0.0 to 9999.99 in steps of 0.01 kA²

- **KI² Integ. Time**: 0.03 to 0.25 s in steps of 0.01 s

- **Maximum opening**: 0 to 9999 in steps of 1

- **Maximum Openings in an hour**: 1 to 60 in steps of 1

### Switchgear

- **Switchgear number**: 1 to 16

- **Switchgear**: 1 to 16 (configurable).
Technical Specifications (cont’d)

**POWER SUPPLY**
Options:
- F range LO, LOR: DC: 24 to 48 V
- H range HI, HIR: DC: 110 to 250 V
- Power: 25 VA nominal, maximum 45 VA
- Voltage loss hold-up time: 200 ms typical, worst case 100 ms without unit reset

**OUTPUTS**
TRIPPING CONTACTS/OUTPUT RELAYS
- Permanent current Carry continuous: 16 A
- Closing current Make and Carry for 1 second: 60 A during 1 second
- Opening current: 0.3 A with L/R = 40 ms at 125 Vdc
  - 0.25 A with L/R = 40 ms at 250 Vdc

REMOTE OUTPUTS
- Standard output points: 32
- User output points: 32

**COMMUNICATIONS**
FRONT PORT (COM2):
- Type: RS232
- Baude Rate: 300, 600, 1200, 2400, 4800, 9600, 38400, 57600 and 115200 bauds
- Default baud rate: 19200 bauds
- Protocol: ModBus® RTU / DNP 3.0

ASYNCHRONOUS REAR PORTS:
- Two COM1, COM2 (rear COM2 multiplexed with front port)
- Type: Depending on model
  - Two RS485 ports
  - Two multimode glass F.O. ports
  - With ST connectors
- PROTOCOLS:
  - IEC 60870-5-103 on COM1
  - DNP on COM1 & COM2
  - Serial Modbus® on COM1 & COM2

CAN PORT:
- Type: Cable or Multimode glass F.O. port with ST connectors
- Fiber Wave length: 1300 nm
- Isolation: 2kV

ETHERNET PORT:
- Model B: 10/100BaseTX self-negotiable
- Model C: 10/100BaseTX + 100BaseFX with ST connectors
- Model D: 10/100BaseTX + Double 100BaseFX with ST connectors (physical media redundancy)
- Model E: Redundant 10/100BaseTX
- Protocols: ModBus® TCP/IP
  - DNP over TCP/IP and UDP/IPv4
  - IEC 60870-5-104
  - IEC 61850
- Notes: Http, ftp, tftp (allow the use of a standard Internet browser)

NOTES:
In Models C and D, the 10/100BaseTX port is selected by an internal switch. Two indicating LEDs for transmission and reception are included.

**TYPE TESTS**

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<thead>
<tr>
<th>CATEGORY</th>
<th>STANDARD</th>
<th>CLASS</th>
<th>TEST</th>
</tr>
</thead>
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<td>EMC</td>
<td>IEC 60601-1</td>
<td>III</td>
<td>Conducted and radiated emissions</td>
</tr>
<tr>
<td></td>
<td>IEC 61000-4-5</td>
<td>I</td>
<td>Radiated electromagnetic field</td>
</tr>
<tr>
<td></td>
<td>IEC 61000-4-6</td>
<td>III</td>
<td>Immunity</td>
</tr>
<tr>
<td></td>
<td>IEC 61000-4-8</td>
<td>IV</td>
<td>Magnetic field</td>
</tr>
<tr>
<td></td>
<td>ENV 50204</td>
<td>III</td>
<td>Radiated electromagnetic field disturbance test - 1890 MHz</td>
</tr>
</tbody>
</table>

**EMERGENCY**
- Conducted and radiated emissions |
- Radiated electromagnetic field |
- Immunity |
- Magnetic field |
- Conducted and radiated emissions |
- Radiated electromagnetic field |
- Immunity |
- Magnetic field |
- Conducted and radiated emissions |
- Radiated electromagnetic field |
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- Conducted and radiated emissions |
### Ordering

<table>
<thead>
<tr>
<th>F650</th>
<th>Display</th>
<th>Rear Serial Communications Board 1</th>
<th>Rear Ethernet Communications Board 2</th>
<th>Rear I/O Board in Slot F</th>
<th>Rear I/O Board in Slot G</th>
<th>Auxiliary Voltage</th>
<th>Language</th>
<th>Communication Protocol</th>
<th>Environmental Protection</th>
<th>Enhanced Display</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Basic Alphanumeric Text Display</td>
<td>None</td>
<td>16 Digital Inputs + 8 Outputs</td>
<td>None</td>
<td>24-48 Vdc (range 19.2 - 57.6)</td>
<td>English/English</td>
<td>Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104</td>
<td>Without Harsh (Chemical) Environment Conformal Coating</td>
<td>Display with RS232</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>Basic Alphanumeric Text Display</td>
<td>Redundant RS485</td>
<td>8 Digital Inputs + 8 Outputs + 2 trip/close circuit supervision circuits</td>
<td>16 Digital Inputs + 8 Analog Inputs</td>
<td>110-250 Vdc (range 88 - 300)</td>
<td>Chinese/English (See Note 2)</td>
<td>IEC 60870-5-103, Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104</td>
<td>Harsh (Chemical) Environment Conformal Coating</td>
<td>Enhanced Display with Front USB port</td>
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<tr>
<td></td>
<td>N</td>
<td>Graphic Display with IEC symbols</td>
<td>Redundant plastic fiber optic</td>
<td>32 Digital Inputs</td>
<td>Redundant HI</td>
<td>120-230 Vdc (range 96 - 250)</td>
<td>French/English</td>
<td>Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104</td>
<td></td>
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<td>P</td>
<td>Graphic Display with IEC symbols</td>
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<td>Russian/English (See Note 2)</td>
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<tr>
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<td>X</td>
<td>Graphic Display with IEC symbols</td>
<td>Redundant plastic fiber optic + fiber remote CAN bus I/O</td>
<td>16 Digital Inputs + 8 Analog Inputs</td>
<td>Redundant HI</td>
<td></td>
<td>Spanish/English</td>
<td>Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104</td>
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<td>Redundant glass fiber optic + fiber remote CAN bus I/O</td>
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<td>Redundant HI</td>
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<tr>
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<td>Z</td>
<td>Graphic Display with IEC symbols</td>
<td>Redundant glass fiber optic + fiber remote CAN bus I/O</td>
<td>16 Digital Inputs + 8 Analog Inputs</td>
<td>Redundant HI</td>
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<td>Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104</td>
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<tr>
<td></td>
<td>C</td>
<td>Cable Remote CAN Bus I/O</td>
<td>Redundant glass fiber optic + fiber remote CAN bus I/O</td>
<td>16 Digital Inputs + 8 Analog Inputs</td>
<td>Redundant HI</td>
<td></td>
<td></td>
<td>Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104</td>
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<tr>
<td></td>
<td>M</td>
<td>Redundant glass fiber optic + fiber remote CAN bus I/O</td>
<td>Redundant glass fiber optic + fiber remote CAN bus I/O</td>
<td>16 Digital Inputs + 8 Analog Inputs</td>
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</tr>
</tbody>
</table>

**SPECIAL MODELS:**
- MOD001: 6A output contacts instead of 16A.
- (*) Notes:
  1. The number selected for option G must be equal or higher than the number selected for option F for models including boards 4 and 5.
  2. Display options with language selection:
     - Graphic display (M & N): available for English, French, Spanish and Chinese languages. For Chinese only IEC symbols option is available (N in ordering code).
     - Basic display (B): available for English, French, Spanish, Russian and Chinese languages

**Ordering Note:** This order code is valid for the latest version of F650 hardware and firmware version. The older hardware and previous firmware versions are still available and may be ordered through the usual channels.

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### Accessories for the F650

- Feeder Protection with the F650: TRCD-F650-C-S-1
- Multilink Ethernet Switch: ML2400-F-HI-HI-A2-A2-A6-G1
- Viewpoint Maintenance: VPM-1
- Viewpoint Monitoring: VP-1-61850

**Visit** [www.GEMultilin.com/F650](http://www.GEMultilin.com/F650) to:

- View Guideform specifications
- Download the instruction manual
- Review applications notes and support documents
- Buy a F650 online
- View the 650 Family brochure

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**Distribution/Feeder Protection**

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**Feeder Bay Protection System**

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**334**

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**www.GEDigitalEnergy.com**

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**090819 - V9**