Multilin 350

Intuitive and Innovative Feeder Protection

The Multilin™ 350 is a member of the Multilin 3 Series protective relay platform and has been designed for the protection, control and management of feeders or related applications as a primary or backup protection device. This cost-effective protective device is used to perform advanced feeder protection, control and monitoring in a draw-out or non draw-out design for low, medium and high voltage applications. The 350 also offers enhanced features such as metering, monitoring and diagnostics, preventative maintenance, advanced communications and security.

Key Benefits

- Cost-effective and flexible protection and control for distribution and industrial feeder applications
- Ease of use and setup in one simple step
- Environmental monitoring system to monitor operating conditions and plan preventive maintenance
- Advanced power system diagnostics
- Flexible communications with multiple ports and protocols allowing seamless integration
- Arc flash mitigation via zone inter-tripping, flex curves, and multiple settings group
- Powerful Security Audit Trail tool to increase security and minimize system risks
- Application flexibility with the use of programmable logic elements
- Effortless draw-out construction eliminates requirement for test switches
- Draw-out or non draw-out options available
- Increase network availability by reducing failover time to zero through IEC® 62439-3 PRP and HSR support
- Provide precise time synchronization by support for IEEE® 1588 (Precise Time Protocol (PTP))
- Accelerated life cycle testing for high reliability

Applications

- Primary protection and control for medium and high voltage distribution utility and industrial overhead or cable feeder applications
- Protection of small and medium size distribution transformers
- Back-up protection of various HV applications
- Capacitor bank protection
- Advanced control applications including Cold Load Pickup, multi-shot recloser and multiple setting groups

Protection & Control

- Comprehensive overcurrent, voltage and frequency functions
- Synchrocheck and breaker failure
- Wide variety of protection curves
- Thermal model protection

Metering & Monitoring

- Comprehensive metering
- Event Recorder: 256 events with 1ms time stamping
- 32 samples per cycle oscillography
- IRIG-B or IEEE 1588 time synchronization
- Security audit trail and password control
- Relay health diagnostics

Communications

- Front USB and rear serial, Ethernet, Fiber and dual port options for seamless redundancy (IEC 62439-3, PRP & HSR)
- Multiple communication protocols including IEC 61850, IEC 61850 GOOSE, Modbus® TCP/ IP, Modbus RTU, DNP 3.0, IEC 60870-5-104, IEC 60870-5-103 & OPC-UA (IEC 62541)

EnerVista Software

- Simplify setup and configuration
- Strong document archive and management system
- Full featured monitoring and data recording
- Maintenance and troubleshooting tool
- Seamless integration toolkit

imagination at work

Overview

The 350 relay is a member of the 3 Series family of Multilin relays. This protective device is used to perform primary or back-up circuit protection on medium or high voltage feeders and down stream protection for distribution utilities. The 350 can be used for a wide variety of protection applications in power system such as MV/LV transfomer protection and capacitor bank protection.

The basic protection function of this relay includes multiple phase, ground, and neutral time and instantaneous overcurrent elements for coordination with upstream and downstream devices. Additionally, the device provides essential feeder breaker control features such as cold load pick up blocking, breaker failure, synchrocheck and autoreclose.

The robust 350 streamlines user work flow processes and simplifies engineering tasks such as configuration, wiring, testing, commissioning, and maintenance. This cost-effective relay also offers enhanced features such as diagnostics, preventative maintenance, arc flash mitigation and security.

Easy to Use

Drawout Construction

The 350 offers a complete drawout feature eliminating the need for rewiring after testing has been concluded. The withdrawable feature also eliminates the need to open the switch gear door and disconnect communication cables, eg. Ethernet fiber, copper, RJ45, etc prior to removing the relay from the chasis.

Effortless Retrofit

The small and compact 350 enables multiple relays to be mounted side by side on medium voltage panels. It also allows easy retrofit into existing S1 and S2 cutouts with adapter plates. The 350 can be used with reducing collars when the depth of LV compartment is limited.

Easy to Configure

Fast & Simple Configuration

The 350 requires minimal settings for configuring standard feeder protection applications. The entire feeder protection setup can be completed in one easy step.

Advanced Communications

Easy Integration Into New or Existing Infrastructure

With several Ethernet and serial port options, and a variety of protocols, the 350 provides advanced and flexible communication selections for new and existing energy management, SCADA, and DCS systems. The 350 also provides the industry leading protocols such as PRP and HSR when any failover time in communication system is not tolerated.

Enhanced Diagnostics

Preventative Maintenance

The 350 allows users to track relay exposure to extreme environmental conditions by monitoring and alarming at high ambient temperatures. This data allows users to proactively schedule regular maintenance work and schedule upgrade activities. The diagnostics data enables the user to understand degradation of electronics due to extreme conditions.

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350 Relay Features
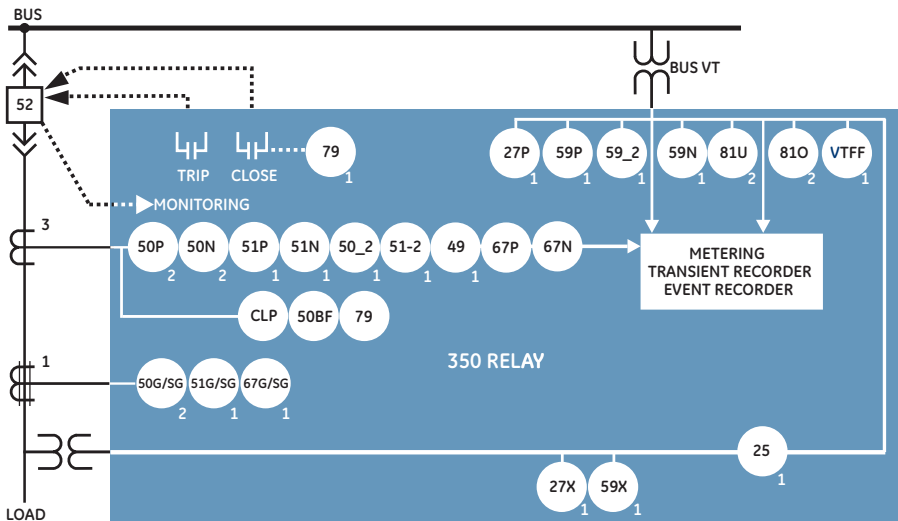
✓ Easy to Configure- 1 Simple Step
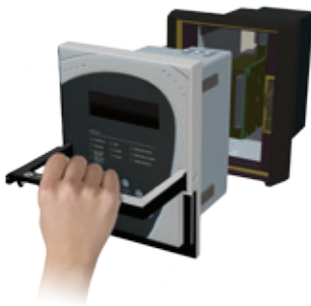
✓ Advanced & Flexible Communication Options

✓ Easy to Use - Draw-out Case

✓ Diagnostic Alarms

Functional Block Diagram

ANSI® Device Numbers & Functions

DEVICE NUMBER	FUNCTION
25	Function Synchrocheck
27X	Auxiliary Undervoltage
49	Thermal Model
50P	Phase Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent
50G	Ground/Sensitive Ground Instantaneous Overcurrent
50BF	Breaker Failure
50_2	Negative Sequence Overcurrent
51P	Phase Timed Overcurrent
51G	Ground Timed Overcurrent
51N	Neutral Timed Overcurrent
67P	Phase Directional Overcurrent
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59N	Neutral Overvoltage
59_2	Negative Sequence Overvoltage
67G	Ground Directional Overcurrent
67N	Neutral Directional Overcurrent
79	Autoreclose
81U	Underfrequency
81O	Overfrequency
CLP	Cold Load Pickup
VTFF	Voltage Transformer Fuse Failure

Latched Lockout available as a standard feature

Cost Effective

Robust Design

The 350 is subjected to Accelerated Life Testing (ALT) to validate accurate relay function under specified normal conditions. The device is further tested for durability through Highly Accelerated Life Testing (HALT) where it undergoes extreme operating conditions. The robust 350 design ensures long term operation.

Reduced Life Cycle Cost

The 350 is designed to reduce total installation and life cycle cost for feeder protection. The draw-out construction of the device reduces downtime during maintenance and decreases extra wiring needed for relay testing and commissioning.

Multiple Options

Several option for protection & communications are provided to match basic to high end application requirements.

Protection

The 350 feeder protection system offers protection, control and monitoring in one integrated, economical and compact package.

Timed Overcurrent (Phase, Ground, Neutral)

The 350 has three-phase TOC elements which enable coordination with upstream and downstream protection devices such as fuses, overload relays, etc to maximize fault selectivity and minimize interruptions and downtime.

Multiple time current curves are available including IAC, IEC, ANSI and IEEE curves. Additional user programmable flex curves can be used to customize and meet specific coordination requirements. The TOC has both linear and instantaneous reset timing function to coordinate with electro-mechanical relays.

Instantaneous Overcurrent (Phase, Ground, Neutral)

The instantaneous element provides fast clearance of high magnitude faults to prevent damage to the power infrastructure and the equipment connected to it.

Neutral Overcurrent

The neutral signal is derived as the residual sum of the three phase CTs eliminating the need for an additional ground sensor.

Sensitive Ground Overcurrent

Sensitive ground protection feature detects ground faults on high impedance grounded systems in order to limit damage to conductors and equipment. Special low ratio CT's are used for this purpose to detect low magnitude ground faults.

Directional Overcurrent (Phase)

This element is intended to send a directional signal to an overcurrent element to prevent an operation when current is flowing in a particular direction.

The direction of current flow is determined by measuring the phase angle between the current from the phase CTs and the line-line voltage from the other two phases. The Maximum Torque Angle (MTA) can be set from 0º to 359º in steps of 1°.

Logic Designer
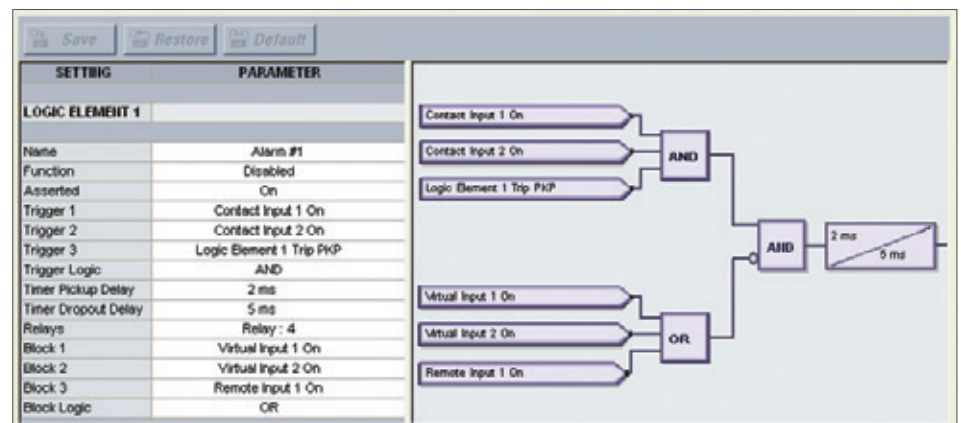
Sixteen logic elements available for applications such as manual control, interlocking, and peer to peer tripping.

Ground Directional

The Ground Directional element is used to discriminate whether a fault occurs in a forward or in a reverse direction, and it can be used either individually or as a part of the Ground Time, or Instantaneous over-current elements.

Neutral Directional

The Neutral Directional element is used to discriminate between faults that occur in the forward direction, and faults that occur in the reverse direction. The Neutral Directional element can be used either individually for control or alarm by energizing the auxiliary output relays, or as a part of the Neutral Time, or Instantaneous, over-current elements to define the tripping direction.

Over/Under Voltage Protection

Overvoltage/Undervoltage protection features can cause a trip or generate an alarm when the voltage exceeds a specified voltage setting for a specified time.

Frequency Protection

The 350 offers overfrequency and underfrequency elements to improve network (grid) stability using voltage or frequency based load shedding techniques.

It also provides back up protection when protecting feeders and other frequency sensitive power equipment.

Thermal Model

The cable thermal model element protects power apparatus like feeder cables against overheating due to excessive load. It estimates the temperature rise of current carrying conductors based on the amount of current flow (I2R) and alarms when temperature rise exceeds a threshold value. This protection feature is essential to ensure the longevity of electrical feeders; particularly important to prevent premature cable failures, expensive repair costs and system down time.

Neutral/Ground Directional Overcurrent

The directional ground overcurrent isolates faulted feeders in ring bus or parallel feeder arrangements. It also allows detection of back feed of fault current from feeders with motors.

Control

Synchronism Check

The Synchrocheck element is used for monitoring the connection of two parts of the circuit by the close of a breaker. Breaker closing can be supervised by ΔV, Δf and ΔHz setpoints. This element verifies that voltages at both sides of the breaker are within the magnitude, angle and frequency limits set by the user before closing the breaker, in order to minimize internal damage that could occur due to the voltage difference, both in magnitude and angle.

Cold Load Pick Up

Cold Load Pick up allows automatic or manual blocking or raising of trip settings for a period after the breaker has been closed. This feature adapts the pick up of overcurrent elements to override the higher overload currents resulting from re-energization of feeder after a long period of time.

Breaker Failure

The Breaker Failure function is used 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 350 will issue an additional signal to trip the breakers connected to the same busbar or signal the trip of upstream breakers.

Autoreclose

Reclose can be initiated externally or from an overcurrent protection. Up to four reclose operations are available, each with a programmable dead time. For each reclose shot, the relay can be programmed to block any overcurrent element.

Automation and Integration

Inputs & Outputs

The 350 features the following inputs and outputs for monitoring and control of typical feeder applications:
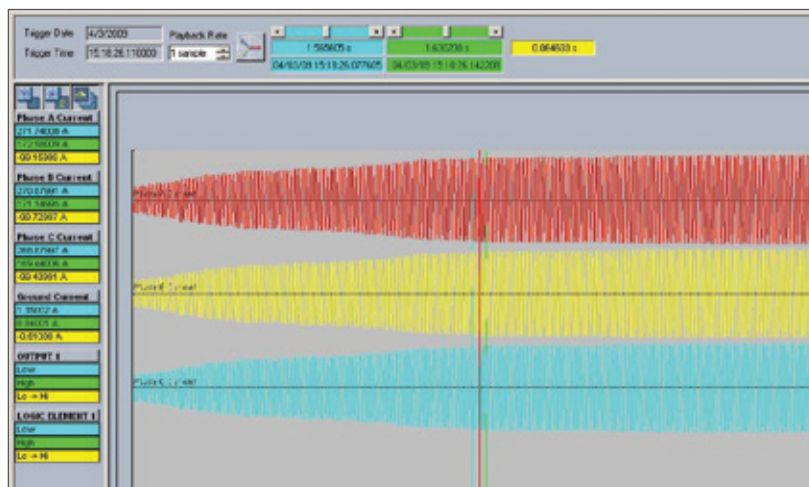
- 10 contact Inputs with programmable thresholds
- 2 Form A output relays for breaker trip and close with coil monitoring
- 5 Form C output relays

IEC 61850 GOOSE

The 350 supports IEC 61850 Logical Nodes which allows for digital communications to DCS, SCADA and higher level control systems. In addition, the 350 also supports IEC 61850 GOOSE communication, providing a means of sharing digital point state information between 350's or other IEC 61850 compliant IED's.

Power System Troubleshooting

Analyze power system disturbances with transient fault recorder and event records

- Eliminates the need for hardwiring contact inputs to contact outputs via communication messaging.
- Transmits information from one relay to the next in as fast as 8 ms.
- Enables sequence coordination with upstream and downstream devices.
- When Breaker Open operation malfunctions, GOOSE messaging sends a signal to the upstream breaker to trip and clear the fault.

Logic Elements

The 350 relay has sixteen Logic Elements available for the user to build simple logic using the state of any programmed contact, virtual, remote input or the output operand of a protection or control element.

The logic provides for assigning up to three triggering inputs in an "AND/OR" gate for the logic element operation and up to three blocking inputs in an "AND/OR" gate for defining the block signal. Pickup and dropout timers are available for delaying the logic element operation and reset respectively.

Virtual Inputs

Virtual inputs allow communication devices the ability to write digital commands to the 350 relay. These commands could be open/close the breaker, changing setting groups, or blocking protection elements.

Multiple Settings Group

Two separate settings groups are stored in nonvolatile memory, with only one group active at a given time. Switching between setting groups 1 and 2 can be done by means of a setting, a communication command or contact input activation.

The two settings groups allow users to store seasonal settings – such as for summer and winter or alternate profiles such as settings during maintenance operations.

Monitoring & Diagnostics

Event Recording

Events consist of a broad range of change of state occurrences, including pickups, trips, contact operations, alarms and self test status. The 350 relay stores up to 256 events time tagged to the nearest millisecond. This provides the information required to determine sequence of events which facilitates diagnosis of relay operation. Event types are individually maskable in order to avoid the generation of undesired

events, and includes the metered values at the moment of the event.

Oscillography/ Transient Fault Recorder

The 350 captures current and voltage waveforms and digital channels at 32 samples per cycle. Multiple records can be stored in the relay at any given time with a maximum length of 192 cycles Oscillography is triggered either by internal signals or an external contact.

Trip/Close Coil Monitoring

The 350 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: Ia, Ib, Ic, In, Ig, Isg
- Phase-to-phase and phase-to-ground voltages for bus and line: Van, Vbn, Vcn, Vab, Vbc, Vca
- Active power (3-Phase)
- Reactive power (3-Phase)
- Frequency

Advanced Device Health Diagnostics

The 350 performs comprehensive device health diagnostic tests during startup and continuously at runtime to test its own major functions and critical hardware. These diagnostic tests monitor for conditions that could impact system reliability. Device status is communicated via SCADA communications and the front panel

display. This continuous monitoring and early detection of possible issues helps improve system availability by employing predictive maintenance.

IEEE 1588 (Precise Time Protocol)

The IEEE 1588 Precision Time Protocol (PTP) is to synchronize the time between different nodes on an Ethernet network and it is used when very precise time synchronization is required.

It is possible to synchronize distributed clocks with an accuracy of less than 1 microsecond via Ethernet networks. PTP enables clock redundancy and reduces wiring and testing. It can operate over a complete facility and has the ability to compensate for lead length.

IRIG-B

IRIG-B is a standard time code format that allows time stamping of events to be synchronized among connected devices within 1 millisecond. An IRIG-B input is provided in the 350 to allow time synchronization using a GPS clock over a wide area. The 350 IRIG-B supports both AM and DC time synchronization with an auto detect feature that removes the requirement for manual selection.

Temperature Monitoring

The 350 continually monitors ambient temperature around the relay and alarms when the device is exposed to extreme temperatures and undesirable conditions such as air-conditioning unit or station heater failures.

The EnerVista Viewpoint maintenance tool allows users to review and analyze the time period a 350 relay is exposed to certain temperature ranges.

Trace any setting changes with security audit trail

Example of Redundant HSR and PRP Architecture
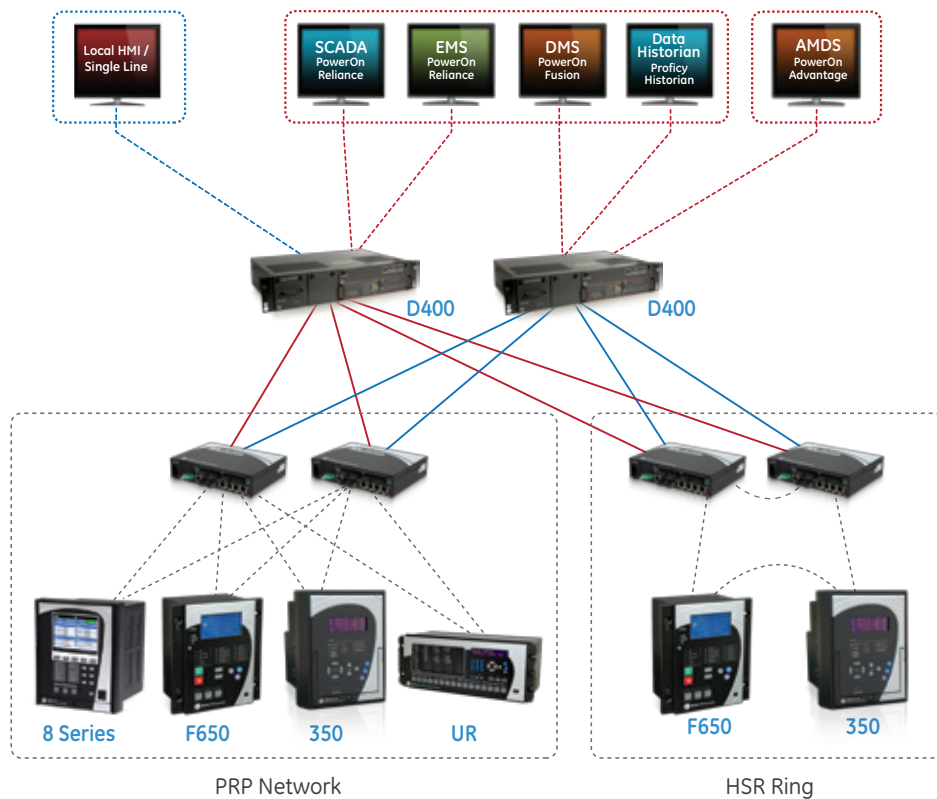
Redundancy protocols (PRP and HSR) can be used for various networking architectures including combined PRP/HSR topologies.

Security

Security Audit Trail

The Security Audit Trail feature provides complete traceability of relay setting changes at any given time and is NERC® CIP compliant. The 350 maintains a history of the last 10 changes made to the 350 configuration, including modifications to settings and firmware upgrades.

Security Setting Reports include the following information:

- If Password was required to change settings
- MAC address of user making setting changes
- Listing of modified changes
- Method of setting changes - Keypad, Front serial port, Ethernet, etc.

Password Control

With the implementation of the Password Security feature in the 350 relay, extra measures have been taken to ensure unauthorized changes are not made to the relay. When

password security is enabled, changing of setpoints or issuing of commands will require passwords to be entered. Separate passwords are supported for remote and local operators, and separate access levels support changing of setpoints or sending commands.

Advanced Communications

The 350 incorporates the latest communication technologies making it the easiest and the most flexible feeder protection relay for use and integration into new and existing infrastructures. The 350 relay provides the user with one front USB and one rear RS485 communication port. Also available with the 350 is a rear communication port with Ethernet Fiber and Copper. In case of implementing PRP and HSR redundancy protocols, the 350 provides two rear Fiber ports. Through the use of these ports, continuous monitoring and control from a remote computer, SCADA system or PLC is possible.

The 350 provides optional Parallel Redundancy Protocol (PRP) and High Availability Seamless Ring (HSR) according to the IEC 62439-3

standard that defines two protocols to increase network availability by reducing failover time to zero. Both ports are capable of simultaneously supporting the following protocols: Modbus TCP/IP, IEC 61850, DNP3 or IEC 60870-5-104, IEEE 1588, SNTP and OPC-UA.

The basic concept of both protocols, PRP and HSR, is to send identical frames over different paths and discard one of the copies in reception, at best. If an error occurs or one of the paths goes down, the frame travelling through that path will not reach its destination, but its copy remains intact and will reach the desired destination. This technology ensures high reliability and availability of communication networks by providing redundancy and zero reconfiguration time in the event of a failure. Failsafe communications systems are crucial for industries and utilities with critical applications where no recovery time is tolerated.

The 350 supports popular industry leading standard protocols enabling easy, direct integration into electrical SCADA and HMI systems. The protocols supported by the 350 include:

- IEC 61850
- IEC 61850 GOOSE
- DNP 3.0
- Modbus RTU
- Modbus TCP/IP
- IEC 60870-5-103
- IEC 60870-5-104
- PRP & HSR (IEC 62439-3)
- OPC-UA
- IEEE 1588 for time synchronization

The 350 relay provides Precision Time Protocol (PTP) based on IEEE 1588 for precise time synchronization throughout a network. OPC-UA is another feature based on IEC 62541 that the 350 relay offers.

These protocols make it easy to connect to a Utility or Industrial automation system, eliminating the need for external protocol converter devices.

EnerVista Software

The EnerVista suite is an industry leading set of software programs that simplifies every aspect of using the 350 relay. The EnerVista suite provides all the tools to monitor the status of the protected asset, maintain the relay, and integrate the information measured into DCS or SCADA monitoring systems. Convenient COMTRADE and sequence of event viewers are an integral part of the 350 set up software and are included to ensure proper protection and system operation.

Simplified Feeder Setup

The 350 Feeder Protection System includes a simplified setup process. This simplified feeder

setup consists of minimal settings and can be accessed through the relay front panel or via the EnerVista Setup software. Once the information is entered, the simplified setup will generate a settings file, provide documentation indicating which settings are enabled, and an explanation of the parameters entered.

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 and play device monitoring

• System single line monitoring and control

• Annunciator alarm screens

• Trending reports

• Automatic event retrieval

• Automatic waveform retrieval

Display

A 4 line liquid crystal display (LCD) allows visibility under varied lighting conditions. When the keypad and display are not being used, the metering summary page is displayed to show critical metered values.

LEDs

The 350 relay has twelve* LED's (8 programmable) that provide status indication for various conditions of the relay and the system. The LED indications are color coded to indicate the type of event.

10 non programmable LEDs for the non draw-out design

User Interface

SETPOINT GROUP 1, 2:
Trip, Alarm and Pick Up indicators are continuously on for protection elements.

DISPLAY:
4 line text for easy viewing of key data

LEDs:
10/12 LED indicators for quick diagnostics

KEYPAD:
Ten button keypad for access to device interrogation and change of settings.

FRONT PORT:
Electrically isolated front USB communication port

USER INTERFACE OPTIONS:
Draw-out and non draw-out options available

Feeder protection settings in one easy step

Fast and accurate configuration in one simple screen.

3 Series setup software protection summary for viewing a summary of Protection & Control configuration.

Dimensions

Draw-out version

3.96"
[100.6mm]

1.087"
[27.6 mm]

7.89"
[200.4 mm]

1.73"
[43.8mm]

7.93"
[201.5mm]

6.62"
[168.2mm]

6.82"
[173.2mm]

Non draw-out version

3.96"
[100.6mm]

0.755"
[19.17mm]

7.88"
[200.2mm]

1.47"
[37.3mm]

7.98"
[202.7mm]

6.23"
[158.2mm]

6.82"
[173.2mm]

Mounting

5.350" ±0.010"
(131.1 mm ±0.25mm)

4.100" ±0.010"
(104.1 mm ±0.25 mm)

Φ 0.200"
(5.1 mm)

6.900" ±0.010"
(175.3 mm ±0.25 mm)

6.000" ±0.010"
(152.4 mm ±0.25 mm)

4.000" ±0.010"
(101.6 mm ±0.25 mm)
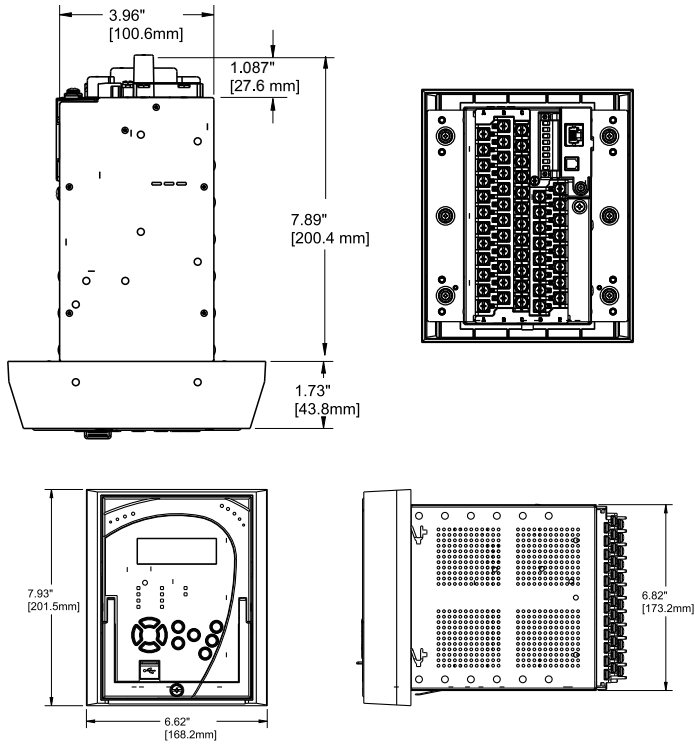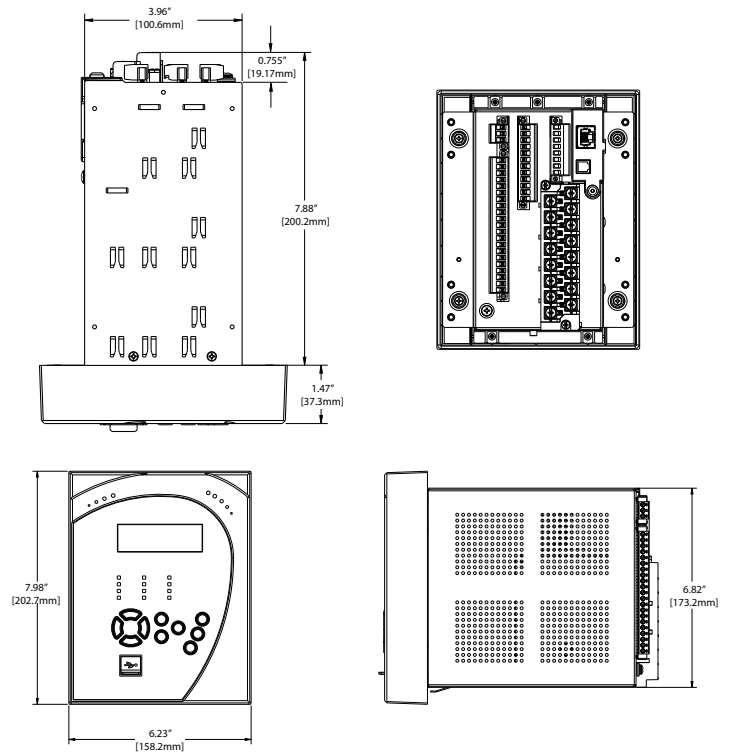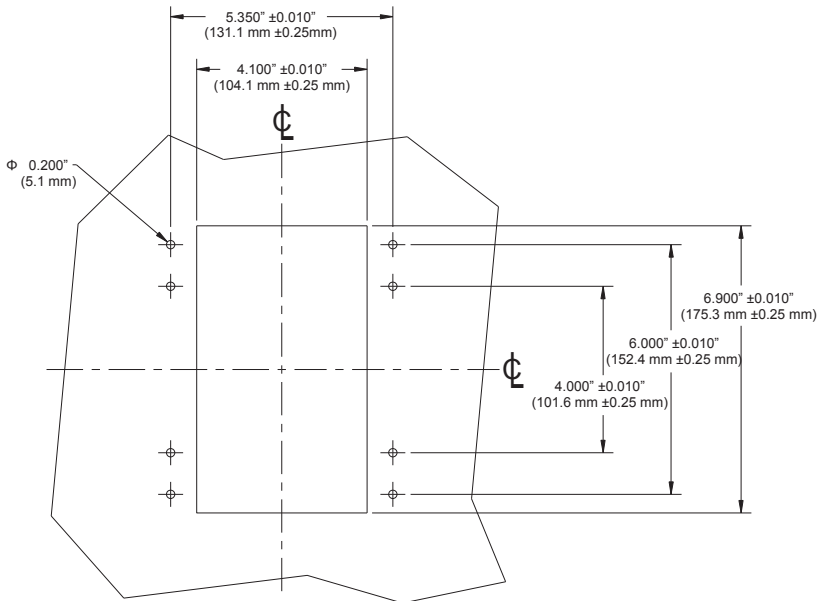
3 Series Depth Reducing Collar

'L'

SCALE 0.500

'L' (in)
3.000
1.375
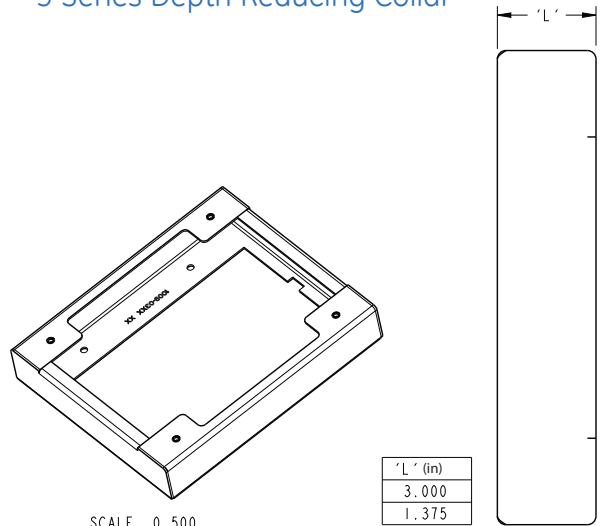
Typical Wiring Diagram - Draw-out

898728.CDR
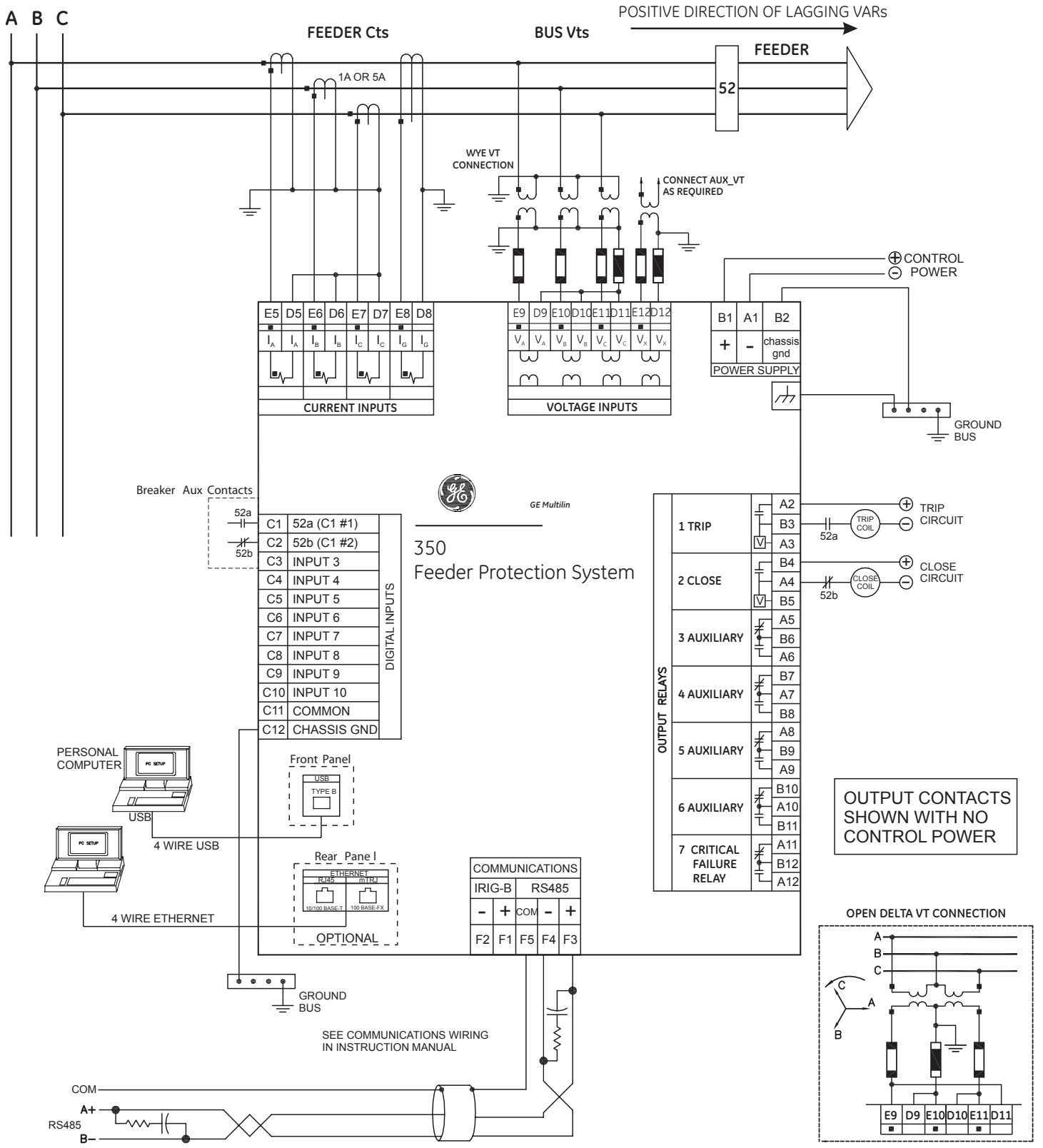
Technical Specifications

PHASE/NEUTRAL/GROUND TIME OVERCURRENT (51P/51N/51G)

Pickup Level:	0.05 to 20.00 × CT in steps of 0.01 × CT
Dropout Level:	97 to 99% of Pickup @ I > 1 × CT Pickup - 0.02 × CT @ I < 1 × CT
Curve Shape:	ANSI Extremely/Very/Moderately/ Normally Inverse Definite Time (0.05 s base curve) IEC Curve A/B/C/Short IAC Extreme/Very/Inverse/Short User Curve, FlexCurve™ A/B (programmable curves)
Curve Multiplier:	0.05 to 50.00 in steps of 0.01
Reset Time:	Instantaneous, Linear
Time Delay Accuracy:	±3% of expected inverse time or 1 cycle, whichever is greater
Level Accuracy:	per CT input

SENSITIVE GROUND TIME OVERCURRENT (51SG)

Pickup Level:	0.005 to 3 × CT in steps of 0.001 × CT
Dropout Level:	97 to 99% of Pickup @ I > 0.1 × CT Pickup - 0.002 × CT @ I < 0.1 × CT
Curve Shape:	ANSI Extremely/Very/Moderately/ Normally Inverse DefiniteTime IEC Curve A/B/C/Short Inverse IAC Extreme/Very/Inverse/Short Inverse User Curve, FlexCurve™ A/B
Curve Multiplier:	0.05 to 50.00 in steps of 0.01
Reset Time:	Instantaneous, Linear
Time Delay Accuracy:	±3% of expected inverse time or 1 cycle, whichever is greater
Level Accuracy:	per CT input

PHASE/NEUTRAL/GROUND NEGATIVE SEQUENCE INSTANTANEOUS OVERCURRENT (50P/50N/50G/50_2)

Pickup Level:	0.05 to 20 × CT in steps of 0.01 × CT
Dropout Level:	97 to 99% of Pickup @ I > 1 × CT Pickup - 0.02 × CT @ I <1 × CT
Time delay:	0.00 to 300.00 sec in steps of 0.01
Operate Time:	<30 ms @ 60Hz (I > 2.0 × PKP, No time delay) <35 ms @ 50Hz (I > 2.0 × PKP, No time delay)
Time Delay Accuracy:	0 to 1 cycle (Time Delay selected)
Level Accuracy:	per CT input

SENSITIVE GROUND INSTANTANEOUS OVERCURRENT (50SG)

Pickup Level:	0.005 to 3 × CT in steps of 0.001 × CT
Dropout Level:	97 to 99% of Pickup @ I > 0.1 × CT Pickup - 0.002 × CT @ I < 0.1 × CT
Time delay:	0.00 to 300.00 sec in steps of 0.01
Operate Time:	<30 ms @ 60Hz (I > 2.0 × PKP, No time delay) <35 ms @ 50Hz (I > 2.0 × PKP, No time delay)
Time Delay Accuracy:	0 to 1 cycle (Time Delay selected)
Level Accuracy:	per CT input

PHASE DIRECTIONAL (67P)

Directionality:	Co-existing forward and reverse
Operating:	Phase Current (Ia, Ib, Ic)
Polarizing Voltage:	Quadrature Voltage (ABC phase sequence: Vbc, Vca, Vab) (CBA phase sequence: Vcb, Vac, Vba)
Polarizing Voltage Threshold	0.05 to 1.25 × VT in steps of 0.01
MTA	From 0º to 359º in steps of 1°
Angle Accuracy:	±4º
Operation Delay:	20 to 30 ms

GROUND DIRECTIONAL (67G)

Directionality:	Co-existing forward and reverse
Operating:	Ground Current (Ig)
Polarizing Voltage:	V_0 calculated using phase voltages (VTs must be connected in "Wye") - $3V_0$ measured from Vaux input. ($3V_0$ provided by an external open delta connection).
MTA:	From 0° to 359° in steps of 1°
Angle Accuracy:	±4º
Operation Delay:	20 to 30 ms

METERING SPECIFICATIONS

Parameter	Accuracy	Resolution	Range
3-Phase Real Power (MW)	±1% of full scale	0.1 MW	±3000 MW
3-Phase Reactive Power (Mvar)	±1% of full scale	0.1 Mvar	±3000 Mvar
3-Phase Apparent Power (MVA)	±1% of full scale	0.1 MVA	3000 MVA
Power Factor	±0.05	0.01	-0.99 to 1.00
Frequency	±0.05 Hz	0.01 Hz	40.00 to 70.00 Hz

NEUTRAL DIRECTIONAL (67N)

Directionality:	Co-existing forward and reverse
Polarizing:	Voltage, Current, Dual
Polarizing Voltage:	V_0 calculated using phase voltages (VTs must be connected in "Wye") - $3V_0$ measured by Vaux input ($3V_0$ provided by an external open delta connection).
Polarizing Current:	Ig
MTA:	From 0° to 359° in steps of 1°
Angle Accuracy:	±4º
Operation Delay:	20 to 30 ms

PHASE/AUXILIARY UNDERVOLTAGE (27P/27X)

Minimum Voltage:	Programmable from 0.00 to 1.25 × VT in steps of 0.01
Pickup Level:	0.00 to 1.25 × VT in steps of 0.01
Dropout Level:	101 to 104% of pickup
Curve:	Definite Time, Inverse Time
Time Delay:	0.0 to 600.0 s in steps of 0.1
Operate Time:	Time delay ±30 ms @ 60Hz (V < 0.85 × PKP) Time delay ±40 ms @ 50Hz (V < 0.85 × PKP)
Time Delay Accuracy:	±3% of expected inverse time or 1 cycle, whichever is greater
Level Accuracy:	Per voltage input

PHASE/AUXILIARY/NEUTRAL/NEG SEQ OVERVOLTAGE (59P/59X/59N/59_2)

Minimum Voltage:	Programmable from 0.00 to 1.25 × VT in steps of 0.01
Pickup Level:	0.00 to 1.25 × VT in steps of 0.01
Dropout Level:	96 to 99% of pickup
Time Delay:	0.0 to 600.0 s in steps of 0.1
Operate Time:	Time delay ±35 ms @ 60Hz (V > 1.1 × PKP) Time delay ±40 ms @ 50Hz (V > 1.1 × PKP)
Time Delay Accuracy:	0 to 1 cycle (Time Delay selected)
Level Accuracy:	Per voltage input

UNDERFREQUENCY (81U)

Minimum Voltage:	0.00 to 1.25 × VT in steps of 0.01
Pickup Level:	40.00 to 70.00 Hz in steps of 0.01
Dropout Level:	Pickup +0.03 Hz
Time Delay:	0.0 to 600.0 s in steps of 0.1
Time Delay Accuracy:	0 to 6 cycles (Time Delay selected)
Operate Time:	Typically 10 cycles @ 0.1Hz/s change
Level Accuracy:	±0.01 Hz

OVERFREQUENCY (81O)

Pickup Level:	40.00 to 70.00 Hz in steps of 0.01
Dropout Level:	Pickup -0.03 Hz
Time Delay:	0.0 to 600.0 s in steps of 0.1
Time Delay Accuracy:	0 to 6 cycles (Time Delay selected)
Operate Time:	Typically 10 cycles @ 0.1Hz/s change
Level Accuracy:	±0.01 Hz

TRANSIENT RECORDER

Buffer size:	3 s
No. of buffers:	1x192, 3x64, 6x32
No. of channels:	14
Sampling rate:	32 samples per cycle
Triggers:	Manual Command Contact Input Virtual Input Logic Element Element Pickup/Trip/Dropout/Alarm
Data:	AC input channels Contact input state Contact output state Virtual input state Logic element state
Data storage:	RAM - battery backed-up

EVENT RECORDER

Number of events:	256
Header:	relay name, order code, firmware revision
Content:	event number, date of event, cause of event, per-phase current, ground current, sensitive ground current, neutral current, per-phase voltage (VTs connected in "Wye"), or phase-phase voltages (VTs connected in "Delta"), system frequency, power, power factor, thermal capacity
Data Storage:	Retained for 3 days

CLOCK

Setup:	Date and time Daylight Saving Time
IRIG-B:	Auto-detect (DC shift or Amplitude Modulated) Amplitude modulated: 1 to 10 V pk-pk DC shift: TTL Input impedance: 40kOhm ± 10% RTC Accuracy: ± 1 min / month

LOGIC ELEMENTS

Number of logic elements:	8
Trigger source inputs per element:	3
Block inputs per element:	3
Supported operations:	AND, OR, NOT, Pickup / Dropout timers
Pickup timer:	0 to 6000 ms in steps of 1 ms
Dropout timer:	0 to 6000 ms in steps of 1 ms

BREAKER CONTROL

Operation:	Asserted Contact Input, Logic Element, Virtual Input, Manual Command
Function:	Opens / closes the feeder breaker

SYNCHROCHECK (25)

Dead/Live levels for Line and Bus:	0 to 1.25 × VT in steps of 0.01
Maximum voltage difference:	0.02 to 1.25 × VT in steps of 0.01
Maximum angle difference	2° to 80° in steps of 1°
Maximum frequency slip	0.01 to 5.00 Hz in steps of 0.01 Hz
Breaker Closing time	0.01 to 600.00 s in steps of 0.01 s
Dead Source function:	None (DL-DB) Dead Line-Dead Bus (LL-DB) Live Line-Dead Bus (DL-LB) Dead Line-Live Bus (AL-DB) Any Line-Dead Bus (DL-AB) Dead Line-Any Bus (OL-OD) One Live-Other Dead (NBL) Not Both Live

AUTORECLOSE (79)

Reclose attempts:	Up to 4 shots
Time Delay Accuracy:	0 to 3 cycles (AR Dead Time selected)
Elements:	Inputs, Outputs, Breaker Status (52 status)

BREAKER FAILURE (50BF)

Pickup Level:	0.05 to 20.00 × CT in steps of 0.01
Dropout Level:	97 to 98% of pickup
Time Delay Accuracy:	0 to 1 cycle (Timer 1, Timer 2)
Level Accuracy:	per CT input

BREAKER TRIP COUNTER

Trip Counter Limit (Pickup):	1 to 10000 in steps of 1

COLD LOAD PICKUP BLOCKING

Operation:	Automatically (current level), or by command (asserted input)
Function:	Block IOC functions, raise TOC pickup, for selected period of time
Time Delay Accuracy:	0 to 1 cycle (block Time) ±50 ms (outage time? ≤?5 min) ±1 s (outage time > 5 min)

AMBIENT TEMPERATURE

High Temperature Pickup:	20°C to 80°C in steps of 1°C
Low Temperature Pickup:	-40°C to 20°C in steps of 1°C
Time Delay:	1 to 60 min in steps of 1 min ±50 ms (outage time? ≤?5 min) ±1 s (outage time > 5 min)
Temperature Dropout:	Configurable 90 to 98% of pickup
Temperature Accuracy:	±10°C
Timing Accuracy:	±1 second

CONTACT INPUTS

Inputs:	8
Selectable thresholds:	17, 33, 84, 166 VDC
Recognition time:	1/2 cycle
Debounce time:	1 to 64 ms, selectable, in steps of 1 ms
Continuous current draw:	2 mA
Type:	opto-isolated inputs
External switch:	wet contact
Maximum input voltage:	300 VDC

PHASE & GROUND CURRENT INPUTS

CT Primary:	1 to 6000 A
Range:	0.02 to 20 × CT
Input type:	1 A or 5 A (must be specified with order)
Nominal frequency:	50/60 Hz
Burden:	<0.1 VA at rated load
Accuracy:	±1% of reading at 1× CT ±3% of reading from 0.2 to 20 × CT ±20% of reading from 0.02 to 0.19 × CT
CT withstand:	1 second at 100 × rated current 2 seconds at 40 × rated current continuous at 3 × rated current

SENSITIVE GROUND CURRENT INPUT

CT Primary:	1 to 600 A
Range:	0.002 to 3 × CT
Input type:	1 A or 5 A (must be specified with order)
Nominal frequency:	50/60 Hz
Burden:	<0.1 VA at rated load
Accuracy:	±1% of reading at 0.1× CT ±3% of reading from 0.02 to 3 × CT ±20% of reading from 0.002 to 0.019 × CT
CT withstand:	1 second at 100 × rated current 2 seconds at 40 × rated current continuous at 3 × rated current

PHASE/AUX VOLTAGE INPUTS

Source VT:	0.12 to 65 kV / 50 to 220 V
VT secondary:	50 to 240 V
VT ratio:	1 to 5000 in steps of 1
Nominal frequency:	50/60 Hz
Accuracy:	±1.0% of reading
Voltage withstand:	260 VAC continuous

FORM-A RELAYS

Configuration:	2 (two) electromechanical
Contact material:	silver-alloy
Operate time:	<8 ms
Continuous current:	10 A
Make and carry for 0.2s:	30 A per ANSI C37.90
Break (DC inductive, L/R=40 ms):	24 V / 1 A 48 V / 0.5 A 125 V / 0.3 A 250 V / 0.2 A
Break (DC resistive):	24 V / 10 A 48 V / 6 A 125 V / 0.5 A 250 V / 0.3 A
Break (AC inductive):	720 VA @ 250 VAC Pilot duty A300
Break (AC resistive):	277 VAC / 10 A

FORM-A VOLTAGE MONITOR

Applicable voltage:	20 to 250 VDC
Trickle current:	1 to 2.5 mA

FORM-C RELAYS

Configuration:	5 (five) electromechanical
Contact material:	silver-alloy
Operate time:	<8 ms
Continuous current:	10 A
Make and carry for 0.2s:	30 A per ANSI C37.90
Break (DC inductive, L/R=40 ms):	24 V / 1 A 48 V / 0.5 A 125 V / 0.3 A 250 V / 0.2 A
Break (DC resistive):	24 V / 10 A 48 V / 6 A 125 V / 0.5 A 250 V / 0.3 A
Break (AC inductive):	720 VA @ 250 VAC Pilot duty A300
Break (AC resistive):	277 VAC / 10 A

TRIP / CLOSE SEAL-IN

Relay 1 trip seal-in:	0.00 to 9.99 s in steps of 0.01
Relay 2 close seal-in:	0.00 to 9.99 s in steps of 0.01

HIGH RANGE POWER SUPPLY

Nominal:	120 to 240 VAC 125 to 250 VDC
Range:	60 to 300 VAC (50 and 60 Hz) 84 to 250 VDC
Ride-through time:	35 ms

LOW RANGE POWER SUPPLY

Nominal:	24 to 48 VDC
Range:	20 to 60 VDC

ALL RANGES

Voltage withstand:	2 × highest nominal voltage for 10 ms
Power consumption:	15 W nominal, 20 W maximum 20 VA nominal, 28 VA maximum

SERIAL

RS485 port:	Opto-coupled
Baud rates:	up to 115 kbps
Response time:	1 ms typical
Parity:	None, Odd, Even
Maximum Distance:	1200 m (4000 feet)
Isolation:	2 kV
Protocol:	Modbus RTU, DNP 3.0, IEC 60870-5-103

ETHERNET (COPPER)

Modes:	10/100 MB (auto-detect)
Connector:	RJ-45
Protocol:	Modbus TCP/IP, DNP 3.0, IEC 60870-5-104, IEC 61850 GOOSE

ETHERNET (FIBER)

Fiber type:	100 MB Multi-mode
Wavelength:	1300 nm
Connector:	MTRJ
Transmit power:	-20 dBm
Receiver sensitivity:	-31 dBm
Power budget:	9 dB
Maximum input power:	-11.8 dBm
Typical distance:	2 km (1.25 miles)
Duplex:	half/full
Protocol:	Modbus TCP/IP, DNP 3.0, IEC 60870-5-104, IEC 61850 GOOSE

USB

Standard specification:	Compliant with USB 2.0
Data transfer rate:	115 kbps

CERTIFICATION

CE:	Low voltage directive EN60255-5 / EN60255-27 / EN61010-1 EMC Directive EN60255-26/EN50263, EN61000-6-2, UL508
North America:	cULus UL1053, C22.2.No 14
ISO:	Manufactured under a registered quality program ISO9001

TYPE TESTS

Dielectric voltage withstand:		2.3KV
Impulse voltage withstand:	EN60255-5	5KV
Damped Oscillatory:	IEC 61000-4-18 IEC 60255-22-1	2.5KV CM, 1KV DM
Electrostatic Discharge:	EN61000-4-2/ IEC 60255-22-2	Level 4
RF immunity:	EN61000-4-3/ IEC 60255-22-3	Level 3
Fast Transient Disturbance:	EN61000-4-4/ IEC 60255-22-4	Class A and B
Surge Immunity:	EN61000-4-5/ IEC 60255-22-5	Level 3 & 4
Conducted RF Immunity:	EN61000-4-6/ IEC 60255-22-6	Level 3
Power Frequency Immunity:	EN61000-4-7/ IEC 60255-22-7	Class A & B
Voltage interruption and Ripple DC:	IEC 60255-11	15% ripple, 200ms interupts
Radiated & Conducted Emissions:	CISPR11 /CISPR22/ IEC 60255-25	Class A
Sinusoidal Vibration:	IEC 60255-21-1	Class 1
Shock & Bump:	IEC 60255-21-2	Class 1
Siesmic:	IEC 60255-21-3	Class 2
Power magnetic Immunity:	IEC 61000-4-8	Level 5
Pulse Magnetic Immunity:	IEC 61000-4-9	Level 4
Damped Magnetic Immunity:	IEC 61000-4-10	Level 4
Voltage Dip & interruption:	IEC 61000-4-11	0, 40, 70, 80% dips, 250/ 300 cycle interrupts
Damped Oscillatory:	IEC 61000-4-12	2.5KV CM, 1KV DM
Conducted RF Immunity 0-150khz:	IEC 61000-4-16	Level 4
Voltage Ripple:	IEC 61000-4-17	15% ripple
Ingress Protection:	IEC 60529	IP40 front , IP10 Back
Environmental (Cold):	IEC 60068-2-1	-40C 16 hrs
Environmental (Dry heat):	IEC 60068-2-2	85C 16hrs
Relative Humidity Cyclic:	IEC 60068-2-30	6day variant 2
EFT:	IEEE/ANSI C37.90.1	4KV, 2.5Khz
Damped Oscillatrory:	IEEE/ANSI C37.90.1	2.5KV,1Mhz
RF Immunity:	IEEE/ANSIC37.90.2	20V/m 80-1Ghz
ESD:	IEEE/ANSIC37.90.3	8KV CD/ 15KV AD e83849 NKCR
Safety:	UL508 UL C22.2-14 UL1053	e83849 NKCR7 e83849 NKCR

DIMENSIONS

Size:	Refer to Dimensions Chapter
Weight:	4.1 kg [9.0 lb]

OPERATING ENVIRONMENT

Ambient operating temperature:	−40°C to +60°C [-40°F to +140°F]
Ambient storage / shipping temperature:	−40°C to +85°C [-40°F to +185°F]
Humidity:	Operating up to 95% (non condensing) @ 55C (As per IEC 60068-2-30 Variant 2, 6days)
Pollution degree:	II
Overvoltage category:	III
Ingress Protection:	IP40 Front , IP10 back

Ordering

350	*	**	**	*	E	*	*	*	**	*	*	Description
Base Unit	350											
Language	E											English (without programmable LEDs)
	L											English (with programmable LEDs) for Draw-out option only
Phase Currents		P1										1A three phase current inputs
		P5										5A three phase current inputs
Ground Currents			G1									1A ground current input
			G5									5A ground current input
			S1									1A sensitive ground current input
			S5									5A sensitive ground current input
Power Supply				L								24 - 48 Vdc
				H								125 - 250 Vdc/120 - 240Vac
Faceplate					E							Standard faceplate (LCD, full menu, actual values and setpoints) with 10 Inputs, 7 Outputs (2 Form A, 5 Form C)
Current Protection						S						Standard Overcurrent Protection - 50P(1), 50G(1), 50N(1), 51P(1), 51G(1), 51N(1)
						E						Extended Overcurrent Protection - 49, 50P(2), 50G(2), 50N(2), 51P(1), 51G(1), 51N(1)
						M						Advanced overcurrent protection - 49, 50P(2), 50G(2), 50N(2), 51P(1), 51G(1), 51N(1), 50_2 (46)
Control							N					No Selection
							C					CLP, 50BF, Autoreclose (79), Lockout (86)
Options								N				No Selection
								D				Directional Neutral Overcurrent Protection 67N(1), 67G(1)
								M				Voltage Metering
								R				Phase, Neutral and Ground Directional elements 67P(1), 67N(1), 67G(1) + Voltage Metering
								P				Voltage Protection, Phase, Neutral and Ground Directional elements - 27P(1), 27X(1), 59P(1), 59N(1), 59X(1), 59_2(1), 81O(2), 81U(2), 67P(1), 67N(1), 67G(1), VTFF(1), 25(1)
Communications									SN			Standard :Front USB, Rear RS485 : Modbus RTU, DNP3.0, IEC 60870-5-103
									1E			Standard + Ethernet (Copper & Fiber - MTRJ) Modbus TCP/IP, DNP3.0, IEC 60870-5-104
									2E			Standard + Ethernet (Copper & Fiber - MTRJ) Modbus TCP/IP, DNP3.0, IEC 60870-5-104, IEC 61850 GOOSE
									3E			Standard + Ethernet (Copper & Fiber - MTRJ) Modbus TCP/IP, DNP3.0, IEC 60870-5-104, IEC 61850
									4E			Standard + Ethernet (Copper & Fiber - MTRJ) Modbus TCP/IP, DNP3.0, IEC 60870-5-104, IEC 61850, OPC-UA
									5E			Standard + Ethernet PRP/HSR/1588(Fiber- MTRJ) Modbus TCP/IP, DNP3.0, IEC 60870-5-104, IEC 61850, OPC-UA
Case Design										D		Draw-out Design
										N		Non Draw-out Design
Harsh Environment											N	None
											H	Harsh Environment Conformal coating

Ordering Notes:
1. G1/G5 and S1/S5 must match corresponding P1/P5 - there cannot be 5A and 1A mixing
2. "4E" and "5E" communication options are available only on draw-out version

Related Products / Accessories

• MultiSync 100 - GPS Clock	MultiSync100-P
• 350 Retrofit Kit For 735	1819-0103
• 350 Retrofit Kit For IAC Relay	1819-0102
• 350 Retrofit Kit For MDP Relay	1819-0101
• 350 Retrofit Kit For S1/S2 Cut-Out	1819-0100
• SR3 Depth reducing collar - 1.375"	1009-0314
• SR3 Depth reducing collar - 3.00"	1009-0313

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