G&W ELECTRIC VIPER®-HV
72.5kV SOLID DIELECTRIC RECLOSER

PART 1- GENERAL

1.1 DESCRIPTION

This specification covers the requirements for an electronically controlled, solid dielectric vacuum recloser with fault isolation and system restoration for use on sub-transmission systems up to 72.5kV. The three-phase recloser shall consist of three single phases and be designated as G&W Electric Viper-HV recloser.

1.2 QUALITY ASSURANCE

A . Manufacturer Qualifications:

The chosen manufacturer shall have at least 10 years of experience in manufacturing solid dielectric reclosers. The manufacturer of the reclosers shall be completely and solely responsible for the performance of the reclosers as well as the complete integrated assembly as rated.

B. The manufacturer shall furnish certification of ratings of the reclosers upon request.

C. The recloser shall comply with requirements of the applicable industry standards that include the following minimum requirements:

IEEE C37.60-2018 / IEC 62271-111:2019	Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems up to 38kV
IEEE C37.04-2018	IEEE Standard for Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000V
IEEE C37.06-2009	IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis-Preferred Ratings and Related Required Capabilities for Voltages Above 1000V
IEEE C37.09-2018	IEEE Standard Test Procedures for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000V
IEC 62217: 2012	Polymeric HV Insulators for Indoor and Outdoor Use - General Definitions, Test Methods and acceptance criteria
IEEE C37.90.1-2012	IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.90.2-2004	IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
IEEE C37.90.3-2001	IEEE Standard Electrostatic Discharge Tests for Protective Relays

D. The recloser manufacturer shall be ISO 9001 and ISO 14001 certified.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Reclosers shall be packaged and shipped in crating that has been appropriately validated through vibration testing. The recloser shall be pre-assembled as much as possible to minimize field assembly.

B. The contractor, if applicable, shall handle, transfer and move the reclosers in accordance with manufacturer's recommendations.

C. Storage of the recloser mechanism can be outdoor environment but the supplied control to be placed under cover and/or in an environment free from excessive moisture. This is to prevent damage to the control as it is shipped on its back and in a non-outdoor or extended outdoor rated shipping container.

PART 2- PRODUCTS

2.1 RECLOSER CONFIGURATION

Recloser shall have orderable options for the following configurations:

- Phase-over-phase mounting for vertical line construction
- Staggered phase-over-phase mounting for vertical line construction
- Cross arm style for horizontal line construction
- Mechanism capable of being mounted vertically, horizontally, and/or on a 45° angle

2.2 RECLOSER CONSTRUCTION

A. Mechanism Enclosure

The magnetic actuator and corresponding linkage assembly shall be housed within a high-impact, UV-stable, air-insulated, polycarbonate enclosure: a contact position indicator and housing designed with air vent. Lifting provisions shall be provided for each mechanism assembly.

B. Operating Mechanism

The operating mechanism shall utilize a magnetic actuator for opening and closing of the vacuum interrupters, one per phase, with the following design provisions:

1. The magnetic actuator shall be powered by a capacitive discharge system located in the control enclosure.

2. The manual trip and lockout handle that contains the following features and capabilities:

    a. The trip handle assembly shall be hotstick operable, yellow in color, made of stainless steel for maximum corrosion resistance and does not require any power to function.
    b. A physical mechanical block device shall be part of the assembly to mechanically prohibit accidental closing when the manual trip handle is used.
    c. The manual trip handle operation shall also block any electrical operation of the recloser.
    d. An auxiliary contact (69 device) shall be provided down to the control to provide position indication of the manual trip handle.

3. Vacuum interrupter contact position indication shall be accomplished using green (open) and red (closed) highly reflective indicators located on the bottom of each mechanism enclosure, and provide 360° viewing for the ground. Position indication shall also be provided through LEDs located in the control.

4. Operating mechanism to have capability for both synchronized three phase open and close operations and single-phase open and close operations.

C. Vacuum Interrupters

Interruption of the fault or load current shall be accomplished through vacuum interrupters located inside the solid dielectric modules with the following operating time requirements:

1. Interrupting Time (Maximum): 40 msec
2. Closing Time: 76 msec

D. Solid Dielectric Modules

The solid dielectric modules shall utilize a time-proven and essentially maintenance-free EPOX solid dielectric insulation to fully encapsulate the vacuum interrupter with no SF6, oil, foam, and/or porcelain insulating material utilized. Each module shall contain weather resistant molded silicone sheds on each module assembly with a 5,000-hour salt fog rating. Each module shall contain the following:

1. Multi-ratio current transformers (CTs) encapsulated within the solid dielectric insulation for exclusive use with the recloser control. The CTs shall be designed with overvoltage protection so that excessive voltage cannot be produced if the CTs are opened under load. The 5 wires for each CT shall be brought into the control for clear and easy selection of desired ratios. Accuracy class shall be *(choose one)* [C50 IEEE/ 10P20 IEC] [5P20 IEC] and per IEC 61869-2:2012

2. An integrated and internal 15,000:1 Low Energy Analog (LEA) voltage sensor shall be provided in the horizontal side bushing with +/- 2% accuracy from -20°C to +40°C.

E. High Voltage Terminals

The high voltage electrical terminals shall be equipped with four (4) NEMA pads with a total of six (6) terminal lugs provided for the three phase recloser.

F. Grounding Provisions

Grounding terminal pads shall be provided on both sides of the recloser frame.

G. Wildlife Protectors

A total of six (6) wildlife protectors shall be provided and designed appropriately for the recloser. The wildlife protector's electrical ratings shall be validated per testing based upon IEEE 1656, modified for the 72.5kV operating voltage of the recloser.

2.3 Electrical Ratings

The recloser shall contain the following electrical ratings and characteristics:

DESCRIPTION	RATING
Nominal Voltage Class (kV)	40 to 69
Maximum Rated Voltage (kV)	72.5
Power Frequency (Hz)	50/60
Lighting Impulse Withstand Voltage - BIL (kV)	350
Power-Frequency Withstand Voltage – 60 Seconds (kV)	160
Continuous Current (A)	1,200
Peak Withstand Current (kA_{peak})	82
Short-time Withstand Current (kA)	31.5
Short-circuit Making Current (kA_{peak})	82
Short-circuit Breaking Current (kA)	31.5
Duration of Short-Circuit (s)	3
First Pole-to-Clear Factor	1.5 and 1.3
Line-Charging Breaking Current (A)	20
Cable-Charging Breaking Current (A)	250
Top Terminal (Z-Side) to Ground Creepage Distance - Inches (mm)	160.0 (4,064)
Side Terminal (Y-Side) to Ground Creepage Distance - Inches (mm)	139.9 (3,553)
Terminal to Terminal Creepage Distance - Inches (mm)	135.5 (3,442)
Mechanical Endurance (Operations)	10,000
Ambient Temperature	-40°C to +65°C
Relative Humidity (RH)	0 – 95%
Ingress Protection	IPX6

Electrical ratings and design type testing shall be verified through DIRECT three-phase high power testing. NO synthetic circuit testing and/or single-phase validation testing shall be allowed. The recloser shall have successfully passed the SSAO testing requirements.

2.4 CONTROL CABLES

The recloser shall be supplied with a set of three (3) cables with the following requirements:

1. Weather tight environmental connectors on both ends that mate with the corresponding recloser mechanism and the control to allow easy and quick connection of the cables.
2. Cable length options shall have increments up to a maximum of 100 feet (30.5 meters) and contain a protective armor jacket.

2.4 CONTROL CABINET CHARACTERISTICS AND FUNCTIONALITY

The recloser shall be paired and validated under the requirements of IEEE C37.60-2018 / IEC 62271-111:2019. The following control and relay options shall be available as integral tested solutions under the IEEE/IEC noted standard: (*choose appropriate primary relay and redundant relay if required*)

A. Primary Control Package featuring the SEL 651R2 relay module

1. Control Package to include the following features:

Category	Description
Relay	0651R2AH1GA8AD13X3XXXX (MOT breakdown shown below)
Control Cable Interface	35 Pin Harting Connector Interface
Control Voltage	120 and 240Vac, auto-ranging, 50/60Hz
Enclosure	Single Door (Rear Mount), Painted Stainless Steel
Power Module	Viper-HV recloser various power supply voltages (125Vdc for relay and 24Vdc for battery charging)
Battery Backup	(2) 12Vdc, 68Ahr Battery
Test & Isolation Switches	ABB FT-19 switches
Communication Mounting	Standard mounting and powering provisions for future communication equipment

2. SEL Rack Mount Relay (MOT 0651R2AH1GA8AD13X3XXXX) features are as follows:

Category	Description
Firmware	Standard
Control Cable Interface	Part of G&W Electric's Package shown above
Enclosure	Part of G&W Electric's Package shown above
Conformal Coat	Conformal Coated Circuit Boards
Secondary Input Voltage	(6) 8 Vac Max LEA inputs
Secondary Input Current	1A Phase, 0.2 A Neutral
Extra Inputs/Outputs	(7) 12Vdc Inputs/(8) Standard Outputs
Communication Port	3 EIA-232, USB
Communication Interface	(1) 100BASE-FX, EIA-485
Communication Protocol	Standard
Power Supply	125Vdc
User Interface	Configurable Labels and Tri-Colored LED's

3. SEL-651R2 Relay Functionality:

    - 50 (P, N, G, Q) – Overcurrent *(Phase, Neutral, Ground, Negative Sequence)*
    - 51 (P,N,G,Q) – Time Overcurrent *(Phase, Neutral, Ground, Negative Sequence)*
    - 79 – Auto-reclosing
    - 21– Phase and Ground Distance
    - 25 – Synchronization Check
    - 27 – Undervoltage
    - 32 – Directional Power
    - 59 (P,G,Q) – Overvoltage *(Phase, Ground, Negative Sequence)*
    - 67 (P,G,Q) – Directional Overcurrent *(Phase, Ground, Negative Sequence)*
    - 78 -Vector Shift
    - 81 (O,U,R) – Frequency (Over, Under, Rate of Change)

4. Control Power Source Requirements: 2kVA @ 120Vac or 240Vac

B. Primary Control Package featuring the SE-421 relay module

1. Control Package to include the following features:

Category	Description
Relay	04215411XB0X4H744442X (MOT breakdown shown below)
Control Cable Interface	35 Pin Harting Connector Interface
Control Voltage	120 and 240Vac, auto-ranging, 50/60Hz
Enclosure	Single Door (Rear Mount), Painted Stainless Steel
Power Module	Viper-HV recloser various power supply voltages (125Vdc for relay and 24Vdc for battery charging)
Aux Operating Panel	Panel for Open/Close Pushbuttons, LEDs, Hot Line Switch with LED, Local/Remote Switch
Battery Backup	(2) 12Vdc, 68Ahr Battery
Test & Isolation Switches	ABB FT-19 switches (SEL-421 Relay and provision for Future SEL-T401L)
Communications Equipment	Included and wired in the control on communication panels are the following *(optional)* accessories: 1 - SEL-2401 Satellite Clock (Part No. 20410X1X2) 1 - SEL-3622 Security Gateway (Part No. 3622XDE111X1) Mounting and powering provisions for customer future communication equipment

2. SEL Rack Mount Relay (MOT 04215411XB0X4H744442X) features are as follows:

Category	Selection
Firmware	Plus, Sub-Cycle Elements, Series Compensation Logic, and Full Automation
Power Supply	125Vdc
Connector Type	Screw-Terminal Block
Secondary Inputs	300V Phase-Neutral Maximum (Wye), 1 A Phase
Ethernet Communication Protocols	FTP, Telnet, Synchrophasors, and DNP
Ethernet Connection Options	Ports 5C, 5D: Ethernet Card with Two 10/100Base-T Connectors
Mainboard Input Voltage	125Vdc
Mounting	Horizontal Rack Mount
Chassis	5U, Front Panel With 24 Target LEDs, 12 Operator Control Pushbuttons, and Tri-Color LEDs
I/O Board Position B For 4U or 5U Chassis	24 Opto-isolated Level-Sensitive Inputs, 8 Outputs
I/O Board Position B Input Voltage	125Vdc
I/O Board Position C For 5U Chassis Only	24 Opto-isolated Level-Sensitive Inputs, 8 Outputs
I/O Board Position C Input Voltage	125 Vdc
Conformal Coat	Conformal Coated Circuit Boards

3. SEL-421 Relay Functionality:

   - 50 (P, N, G, Q) – Overcurrent *(Phase, Neutral, Ground, Negative Sequence)*
   - 51 (P,N,G,Q) – Time Overcurrent *(Phase, Neutral, Ground, Negative Sequence)*
   - 79 – Auto-reclosing
   - 21– Phase and Ground Distance
   - 25 – Synchronization Check
   - 27 – Undervoltage
   - 32 – Directional Power

- 50BF – Breaker Failure Overcurrent
- 59 (P,G,Q) – Overvoltage *(Phase, Ground, Negative Sequence)*
- 67 (P,G,Q) – Directional Overcurrent *(Phase, Ground, Negative Sequence)*
- 68 – Out-of-Step Block/Trip
- 81 (O,U,R) – Frequency (Over, Under, Rate of Change)

4. Control Power Source Requirements: 2kVA @ 120Vac or 240Vac

C. Primary Control Package featuring the SEL-411L relay module

1. Control Package to include the following features:

Category	Description
Relay	0411L126C1B600XH54444XX (MOT breakdown shown below)
Control Cable Interface	35 Pin Harting Connector Interface
Control Voltage	120 and 240Vac, auto-ranging, 50/60Hz
Enclosure	Single Door (Rear Mount), Painted Stainless Steel
Power Module	Viper-HV recloser various power supply voltages (125Vdc for relay and 24Vdc for battery charging)
Aux Operating Panel	Panel for Open/Close Pushbuttons, LEDs, Hot Line Switch with LED, Local/Remote Switch Local control via SEL-411L front-panel HMI, digital inputs, and SELOGIC® control equations
Battery Backup	(2) 12Vdc, 68Ahr Battery
Test & Isolation Switches	ABB FT-19 switches (SEL 421 Relay and provision for Future SEL T401L)
Communications Equipment	Included and wired in the control on communication panels are the following *(optional)* accessories: 1 - SEL-2401 Satellite Clock (Part No. 20410X1X2) 1 - SEL-3622 Security Gateway (Part No. 3622XDE111X1) Mounting and powering provisions for customer future communication equipment

2. SEL Rack Mount Relay (MOT 0411L126C1B600XH54444XX) features are as follows:

Category	Selection
Firmware	Plus, Sub-Cycle Elements, Series Compensation Logic, and Full Automation
Power Supply	125Vdc
Connector Type	Screw-Terminal Block
Secondary Inputs	Voltage: 57.7–144.3 V Phase-Neutral (100–250 V Line-Line); Current: 1 A nominal
Ethernet Communication Protocols	FTP, Telnet, DNP3 (LAN/WAN), IEEE C37.118 Synchrophasors, IEC 61850 MMS/GOOSE (optional)
Ethernet Connection Options	Ports 5C, 5D: Ethernet Card with Two 10/100Base-T Connectors Optional Ethernet card with 10/100BASE-T copper and/or 100BASE-FX fiber ports
Mainboard Input Voltage	125Vdc
Mounting	Horizontal Rack Mount
Chassis	5U, Front Panel With 24 Target LEDs, 12 Operator Control Pushbuttons, and Tri-Color LEDs
I/O Board Position B For 4U or 5U Chassis	24 Opto-isolated Level-Sensitive Inputs, 8 Outputs
I/O Board Position B Input Voltage	125Vdc
I/O Board Position C For 5U Chassis Only	24 Opto-isolated Level-Sensitive Inputs, 8 Outputs
I/O Board Position C Input Voltage	125Vdc
Conformal Coat	Conformal Coated Circuit Boards

3. SEL-411L Relay Functionality:

   - 50 (P, N, G, Q) – Overcurrent *(Phase, Neutral, Ground, Negative Sequence)*
   - 51 (P,N,G,Q) – Time Overcurrent *(Phase, Neutral, Ground, Negative Sequence)*
   - 79 – Auto-reclosing
   - 21– Phase and Ground Distance
   - 25 – Synchronization Check
   - 27 – Undervoltage
   - 32 – Directional Power
   - 50BF – Breaker Failure Overcurrent
   - 59 (P,G,Q) – Overvoltage *(Phase, Ground, Negative Sequence)*
   - 67 (P,G,Q) – Directional Overcurrent *(Phase, Ground, Negative Sequence)*
   - 68 – Out-of-Step Block/Trip
   - 81 (O,U,R) – Frequency (Over, Under, Rate of Change)
   - 87 Current Differential

   Additional Functions:
   - 85 RIO – SEL Mirrored Bits® Communications
   - BCD – Broken Conductor Detection
   - BRM – Breaker Wear Monitor
   - DFR – Event Reports
   - ENV – SEL-2600 RTD Module
   - HMI – Operator Interface
   - LDE – Load Encroachment
   - LGC – Expanded SELogic® Control Equations
   - FL – Fault Locator (Impedance, Traveling-Wave)
   - MET – High-Accuracy Metering
   - PMU – Synchrophasors
   - SBM – Station Battery Monitor
   - SER – Sequential Events Recorder
   - SIP – Software-Invertible Polarities
   - SV – IEC 61850-9-2 or IEC 61869-9 Sampled Values
   - THM – IEC 60255-Compliant Thermal Model
   - TiDL – Time-Domain Link Technology

4. Control Power Source Requirements: 2kVA @ 120Vac or 240Vac

D. Primary Control Package featuring the Ingeteam INGEPAC EF LD relay module

1. Control Package to include the following features:

Category	Description
Relay	EF LD1BCACDFFXXFFB-AZD-A-A-6-D-A--- (breakdown shown below)
Control Cable Interface	35 Pin Harting Connector Interface
Control Voltage	120 and 240Vac, auto-ranging, 50/60Hz
Enclosure	Single Door (Rear Mount), Painted Stainless Steel
Power Module	Viper-HV recloser various power supply voltages (125Vdc for relay and 24Vdc for battery charging)
Aux Operating Panel	Integrated front-panel keypad, display, and LEDs; breaker control via digital inputs and programmable logic
Battery Backup	(2) 12Vdc, 68Ahr Battery
Test & Isolation Switches	Test and isolation provisions as required by panel design (not relay-specific)
Communications Equipment	EF-LD supports: Line differential fiber channels (C37.94, direct fiber) Ethernet (IEC 61850, DNP3) Optional GPS / IRIG-B via accessories

2. Ingeteam Rack Mount Relay (EF-LD1BCACDFFXXFFB-AZD-A-A-6-D-A---) features are as follows:

Category	Selection
Firmware	Standard
Power Supply	125Vdc
Connector Type	Screw-Terminal Block
Secondary Inputs	Phase current inputs 1 A , neutral/ground current inputs, and phase and neutral voltage inputs per EF-LD configuration
Ethernet Communication Protocols	IEC 61850, DNP3, FTP, Telnet
Ethernet Connection Options	Ethernet copper or fiber interfaces (model dependent), with optional PRP/HSR redundancy
Mainboard Input Voltage	Not applicable (single DC auxiliary power supply architecture)
Mounting	Horizontal Rack Mount
Chassis	19-inch rack-mount chassis 5U with front keypad, display, and LED indicators
Digital I/O	Modular digital I/O boards available with configurable combinations of opto-isolated inputs and output contacts (model dependent)
Conformal Coat	Conformal Coated Circuit Boards

3. EF-LD Relay Functionality:

   - 87L – Line Current Differential Protection
   - 87LG / 87N – Ground and Neutral Differential Protection
   - 21 – Phase and Ground Distance Protection (Multiple Zones)
   - 50 (P, N, G, Q) – Instantaneous Overcurrent (Phase, Neutral, Ground, Negative Sequence)
   - 51 (P, N, G, Q) – Time Overcurrent (Phase, Neutral, Ground, Negative Sequence)
   - 67 (P, G, Q) – Directional Overcurrent (Phase, Ground, Negative Sequence)
   - 50BF – Breaker Failure Protection
   - 59 (P, G, Q) – Overvoltage (Phase, Ground, Negative Sequence)
   - 27 – Undervoltage
   - 68 – Power Swing Detection / Blocking
   - 68LE – Load Encroachment
   - 78 – Out-of-Step Tripping
   - 81 (O, U, R) – Frequency Protection (Over, Under, Rate of Change)

- 25 – Synchronization Check (configuration dependent)
- SOTF – Switch-Onto-Fault Logic
- FL – Fault Locator
- SB – Stub Bus Protection
- POTT / Blocking / Permissive – Teleprotection Schemes (via differential or distance elements)

4. Control Power Source Requirements: 2kVA @ 120Vac or 240Vac

E. Dual Relay Control Package featuring the SEL-T401L relay module (must be in addition to SEL 651R2, SEL-421, or SEL-411L)

1. Control Package to include the following features:

Category	Description
Relay	(T401L#0002 breakdown shown below)
Control Cable Interface	35 Pin Harting Connector Interface
Control Voltage	120 and 240Vac, auto-ranging, 50/60Hz
Enclosure	Single Door (Rear Mount), Painted Stainless Steel
Power Module	Viper-HV recloser various power supply voltages (125Vdc for relay and 24Vdc for battery charging)
Aux Operating Panel	Panel for Open/Close Pushbuttons, LEDs, Hot Line Switch with LED, Local/Remote Switch
Battery Backup	(2) 12Vdc, 68Ahr Battery
Test & Isolation Switches	ABB FT-19 switches (SEL-421 Relay and provision for Future SEL-T401L)
Communications Equipment	Included and wired in the control on communication panels are the following *(optional)* accessories: GPS Clock Communication Switch Mounting and powering provisions for customer future communication equipment

2. SEL Rack Mount Relay (T401L#0002) features are as follows:

Category	Selection
Firmware	Plus, Sub-Cycle Elements, Series Compensation Logic, and Full Automation
Power Supply	48–125 Vdc or 110–120 Vac **and** 125–250 Vdc or 110–240 Vac (model dependent), auto-ranging
Connector Type	Screw-Terminal Block
Secondary Inputs	300V Phase-Neutral Maximum (Wye), 1 A Phase Six AC current inputs 1 A six AC voltage inputs, 57.7–144.3 V Phase-Neutral (100–250 V Line-Line)
Ethernet Communication Protocols	FTP, Telnet, DNP3 (Ethernet), IEEE C37.118 Synchrophasors
Ethernet Connection Options	Ports 5C, 5D: Ethernet Card with Two 10/100Base-T Connectors 100 Mbps or 1 Gbps SFP fiber-optic Ethernet port (LC connector)
Mainboard Input Voltage	125Vdc
Mounting	Horizontal Rack Mount
Chassis	5U, Front Panel With 24 Target LEDs, 12 Operator Control Pushbuttons, and Tri-Color LEDs
Digital I/O	Fixed digital I/O: five shared-common opto-isolated inputs, eight isolated opto-isolated inputs, six high-speed trip outputs, eight standard outputs, and one alarm output
Conformal Coat	Conformal Coated Circuit Boards

3. SEL-T401L Relay Functionality:
   - 50 (P, N, G, Q) – Overcurrent *(Phase, Neutral, Ground, Negative Sequence)*
   - 51 (P,N,G,Q) – Time Overcurrent *(Phase, Neutral, Ground, Negative Sequence)*
   - 21 – Phase and Ground Distance
   - 27 – Undervoltage
   - 32 – Directional Power
   - 59 (P, G, Q) – Overvoltage (Phase, Ground, Negative Sequence)
   - 67 (P, G, Q) – Directional Overcurrent (Phase, Ground, Negative Sequence)
   - 68 – Out-of-Step Block/Trip
   - 78 – Out-of-Step Tripping
   - 85 – SEL Mirrored Bits® Communications
   - 94 – High-Speed Trip-Rated Outputs

   Additional Functions:
   - TD21 – Incremental-Quantity Phase and Ground Distance
   - TD32 – Incremental-Quantity Directional
   - TW32 – Traveling-Wave Directional
   - TW87 – Traveling-Wave Differential
   - POTT – Permissive Overreaching Transfer Trip Logic
   - CBECHO – Open-Breaker Echo Logic
   - WI – Weak-Infeed Logic
   - DCB – Directional Comparison Blocking Logic
   - SOTF – Switch-Onto-Fault Logic
   - DTT – Direct Transfer Trip Logic (Intertripping)
   - LOP – Loss-of-Potential Logic
   - OP – Open-Pole Detection Logic
   - LE – Load Encroachment Logic
   - DFR – Digital Fault Recorder
   - SER – Sequential Events Recorder
   - FL – Fault Locator
   - LM – Line Monitor
   - MET – Metering
   - LGC – SELogic® Equations
   - ARC – Adaptive Autoreclose Cancel Logic
   - HMI – Local Operator Interface
   - DNP3 – Distributed Network Protocol 3.0 (Ethernet)
   - LB – Local Control Bits (Operated Through Front-Panel HMI)
   - RB – Remote Control Bits (Operated Through DNP3 and SEL Fast Operate Protocols)
   - FTP – File Transfer Protocol
   - FTDV – Fast Time-Domain Values
   - EMI – Electromagnetic Interference Monitoring for Traveling-Wave Functions
   - TEST – Event Playback and Traveling-Wave Test Mode

4. Control Power Source Requirements: 2kVA @ 120Vac or 240Vac

Please review the following chart for Dual-Relay Options:

Dual Relay Compatibility Chart

Secondary Relay	Primary Relay: SEL-651R2	SEL-421	SEL-411L	IngePac EF LD
SEL-651R2	☑	☑	☐	☑
SEL-421	☑	☑	☐	☑
SEL-411L	☑	☑	☑	☑
SEL-T401L	☑	☑	☑	☑
IngePac EF LD	☑	☑	☐	☑
Gateway(any)	☑	☑	☑	☑

2.5 FACTORY PRODUCTION TESTS

Each individual recloser shall undergo a mechanical operation check verifying contact:

- Trip/close velocity,
- Travel profile,
- Timing and phase synchronicity.

The recloser shall be AC hi-pot tested for one minute in the closed position and across the open contacts. Circuit resistance shall be checked on all phases.

Timing tests shall be conducted to verify TCC performance.

Voltage sensors to be calibrated and accuracy confirmed.

2.6 STANDARD COMPONENTS

The following shall be included as standard:

- Galvanized mounting bracket
- Lifting provisions
- Grounding provisions
- UV stable wildlife protectors for both source and load terminals

2.7 LABELING

A. Hazard Alerting Signs
Appropriate hazard signs shall be applied to each unit, frame, or enclosure (if applicable). A Danger sign shall warn of hazardous voltage and the need for qualified operating personnel. Warning signs shall warn of moving components inside the mechanism housing. Caution signs shall warn of harmful X-ray potential and warn against product misapplication more than fault ratings and the hazards when accessing hi-potential voltage testing.

B. Nameplates, Ratings Labels, and Connection Diagrams
Each recloser shall be provided with a nameplate label. Ratings and information listed on nameplate shall indicate the following: Rated Voltage (Maximum), Impulse Level (BIL), Continuous Current RMS, Interrupting Current RMS, Duration of Short Circuit, Catalog Number, Serial Number, Manufacturing Date, and Weight per Phase.