



# SEL-421 Relay Guideform Specification

The microprocessor-based relay shall provide protection, monitoring, control, fault locating, and automation. Relay self-checking functions shall be included. Specific requirements are as follows:

**Phase Distance Protection.** The relay shall incorporate five zones of mho distance protection for detection of phase faults. Three zones shall be settable for either forward or reverse direction. Positive-sequence memory polarization shall be used to provide stable reach and reliable operation for zero voltage faults.

**Optional.** High-speed elements shall be included to provide tripping in less than one cycle. Relay shall prevent Zone 1 overreaching or loss of directionality for faults on series-compensated lines.

**Ground Distance Protection.** The relay shall incorporate five zones of mho and quadrilateral distance protection for detection of faults involving ground. Three zones shall be settable for either forward or reverse direction. Ground elements shall not overreach on multiphase faults and shall not be affected by load flow.

**Optional.** High-speed elements shall be included to provide tripping in less than one cycle.

**CCVT Transient Blocking.** The relay shall detect CCVT transients and block the operation of Zone 1 distance elements during the transient time.

**Out-of-Step Characteristics.** The relay shall detect stable and unstable power swings. User settings shall determine whether the relay trips or blocks tripping.

**High-Accuracy Timing.** The relay shall time-tag COMTRADE event reports to an absolute accuracy of  $\pm 10 \mu\text{s}$ . Relays at different system locations shall have the same absolute timing accuracy.

**Overcurrent Fault Protection.** The relay shall incorporate selectable input overcurrent elements. Torque control capability (internal and external) shall be provided.

**Combined CT Current.** The relay shall monitor the current from two CTs separately while using the combined current for line protection functions.

**Voltage Transfer Capability.** The relay shall change protection voltage source upon detection of loss of potential (LOP). Voltage shall be capable of changing to a second source connected to the relay.

**Breaker Failure Logic.** The relay shall incorporate breaker failure logic for single- and three-pole tripping and reclosing. Retrip and transfer trip initiate contacts shall be provided. Pole discordance logic shall be included. Dropout time of the current detection circuit shall be less than  $5/8$  cycle, even in cases with residual dc current in the CT secondary.

**Auto-Reclosing Control.** The relay shall incorporate both single- and three-pole reclosing with four separately-set open time intervals for three-pole and two intervals for single-pole reclosing. Separately-set reset times from reclose cycle and from lockout shall be available. Recloser shall be selectable for one or two breakers.

**Synchronism Check.** The relay shall include two synchronism check elements with separate maximum angle settings. The synchronism check function shall incorporate slip frequency and close angle settings and allow different sources of synchronizing voltage (VA, VB, VC, VAB, VBC, VCA).

**Event Reporting and Sequential Events Recorder.** The relay shall automatically record disturbance events of up to 2 seconds at 8 kHz sampling rate and 5 seconds at 1 kHz sampling rate. Events shall be stored in nonvolatile memory. The relay shall also include a Sequential Events Recorder (SER) that stores the latest 1000 entries.

**Operator Controls.** The relay shall include operator control pushbuttons on the relay front panel. Each pushbutton shall be programmable and accessible in the relay control logic.

**Independent Trip/Close Pushbuttons.** The relay shall include independently operated breaker trip/close switches and indicating lamps. The switches and breaker status lamps shall be functional regardless of the relay status.

**Configurable Labels.** The relay shall include configurable labels to customize the targets and operator control pushbuttons.

**Password Protection.** The relay shall have multilevel passwords to safeguard protection and automation settings.

**Dual Circuit Breaker Monitor.** The relay shall include a breaker wear monitor function for two circuit breakers with a programmable breaker monitor curve. Electrical and mechanical operating times, with comparison between last and average times, shall be monitored and reported.

**Dual Substation Battery Monitor.** The relay shall measure and report the substation battery voltages both at steady-state conditions and during trip operations. Two sets of selectable threshold parameters shall be provided for alarm and control purposes at each battery voltage. DC ground detection for two systems shall be included.



**Fault Locator.** The relay shall include a fault locating algorithm to provide an accurate estimate of fault location without communications channels or special instrument transformers.

**Digital Relay-to-Relay Communications.** The relay shall have send and receive logic elements, and analog and virtual terminal elements in each of two communications ports for dedicated relay-to-relay communications.

**Automation.** The relay shall include 32 local control switches, 32 remote control switches, 32 latching switches, and programmable display messages in conjunction with a local display panel in the relay. The relay shall be capable of displaying custom messages. Input signals to the relay shall have settable assertion levels.

**Relay Logic.** The relay shall include programmable logic functions for a wide range of user-configurable protection, monitoring, and control schemes. Logic shall have the ability to use relay elements, math functions, comparison functions, and Boolean logic functions.

**IEC 61850 Ethernet Communications.** The relay shall provide IEC 61850-compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data points.

**Distributed Network Protocol (DNP).** The relay shall incorporate certified DNP3 Level 2 Slave protocol and Ethernet DNP3 LAN/WAN communications capability.

**Terminal Connectors.** The relay shall include the ability to remove the screw terminal block connectors from the back of the relay to disconnect I/O, dc battery monitor, and power without removing each wire connection.

**Communications.** The relay shall include four independent EIA-232 serial ports for external communications.

**PC Interface.** The relay shall be capable of being set by Windows<sup>®</sup>-based graphical and ASCII terminal interfaces.

**IRIG-B Time Input.** The relay shall include an interface port for either a standard or high-accuracy demodulated IRIG-B time synchronization input signal.

**HMI Display.** The relay shall include custom configurable display information to display status, analog quantities, text, and alarm information.

**Synchrophasors.** The relay shall include operation as a phasor measurement unit (PMU) following the IEEE C37.118-2005 Standard for Synchrophasors for Power Systems.

**Environment.** The relay shall be suitable for continuous operation over a temperature range of  $-40^{\circ}$  to  $+85^{\circ}\text{C}$ .

**Warranty.** The relay shall have a minimum 10-year worldwide warranty.

