



Guide Form Specification

BE1-11*d* DC Power Protection System

1. Objective

This specification describes requirements for a numeric multifunction Protection System (communicating microprocessor-based relay) for the protection of DC circuits. The relay system shall provide protection, monitoring, local and remote control, and standard automation protocols. Relay self-checking functions shall be included. Specific requirements are as follows.

2. Overcurrent Protection

2.1. Overcurrent Faults (76)

The relay shall include at least 13 overcurrent elements. Each of the overcurrent elements can be set to instantaneous or time delayed tripping characteristics. Each element shall have an adjustable definite time delay up to 600 seconds. Each overcurrent element shall have a selectable standard time characteristic. These shall consist of standard IEEE and IEC characteristics, as well as the ability to define a custom curve shape using either an equation or tabular format. The relay shall include forward, reverse and non-directional control for each overcurrent element.

2.2. Rate of Rise (RoR)

The relay shall include at least two rate-of-rise elements. Each RoR element shall include both a trigger and a minimum di/dt setting. Rate of rise elements shall include two parallel detection methods: Current Increment Detection and Time Delay Detection. Rate-of-Rise elements will operate if either detection method becomes TRUE.

3. Voltage Protection

3.1. Under/Overvoltage (27/59)

The relay shall include four undervoltage and four overvoltage elements for detecting voltage events. Each voltage element shall be independently configurable to monitor any voltage input channel. Undervoltage elements will include an inhibit setting to avoid nuisance operation when zero volts are present. Each instantaneous element shall have an adjustable definite time delay up to 60 seconds.

4. Power Protection

4.1. Directional Power (32)

The relay shall include two sensitive overpower or underpower elements that can be independently set for forward (positive) or reverse (negative) and overpower or underpower.

5. Thermal Protection

5.1. Thermal Overload (49)

The relay shall correspond to the IEC 60255-8 standard to provide thermal cable or catenary system protection. The overload model shall include time delay characteristic equations for hot and cold line conditions.

5.2. RTD Thermal (49RTD)

The protection system shall have the ability to monitor up to 24 RTDs optionally through isolated remotely-mounted RTD modules. RTD protection shall be individually selectable RTD types: 10-ohm copper, 100-ohm platinum, 100-ohm nickel, and 120-ohm nickel. The system shall provide metering of the individual RTD thermal values. RTD tripping shall include a logical provision to require more than one RTD to exceed its setpoint for RTD tripping. The relay shall alarm on open and shorted RTDs as well as loss of communications with the remote RTD module.

6. Sensing and I/O

6.1. Current Inputs

The system shall have one current sensing input fed from a nominal 25 to 100mV shunt. Current sensing inputs are fully isolated from the protective relay and user HMI via fiber optic communications.

6.2. Voltage Inputs

The system shall have three voltage sensing inputs capable of directly monitoring voltage levels up to $\pm 2,000$ Vdc. Voltage sensing inputs are fully isolated from the protective relay and user HMI via fiber optic communications.

6.3. Digital Inputs

The relay shall have seven optically isolated inputs. Each input shall be able to operate correctly with both dc and ac wetting voltages.

6.4. Output Contacts

The relay shall have eight general purpose output contacts and one failsafe alarm. The failsafe alarm shall be available in both normally open and normally closed output contact form. Each output shall be isolated and rated for tripping duty (30 A for 0.2 seconds, 7 A continuous).

6.5. Analog Inputs

The relay, through the remote RTD module, shall provide analog inputs. The remote module shall provide independent user settings selection of either 4 to 20 mAdc or 0 to 10 Vdc for inputs. Analog inputs shall be available for metering and tripping. Analog inputs shall be available for metering.

6.6. Analog Outputs

The relay through the remote RTD module shall provide analog outputs. The remote module shall provide independent user settings selection of either 4 to 20 mAdc or 0 to 10 Vdc for

outputs. Analog outputs shall be available for driving external meters and processes by providing scaled outputs of quantities metered by the relay.

7. Control and Logic

7.1. Automatic Reclosing Control (82)

The relay shall include a four-shot recloser. The relay shall include line test capabilities before closing to prevent the line dc circuit breaker closing onto an overload or a short-circuit condition. The element shall include four independent reclose timers, a timer for reset after a successful reclose, a maximum cycle timer, and a reclose fail timer.

7.2. Settings Groups

The relay shall have four user-programmable settings groups.

7.3. Virtual Control Switches (101, 43)

The relay shall include five virtual selector switches (x43) and one virtual breaker control switch (101), controllable from both the HMI and communication ports. Two virtual switches shall include a latch function (86).

7.4. Relay Logic

The relay shall include graphical programmable logic for all outputs, inputs, and device elements for user programming. The logic file shall generate a graphical logic file that is saved to the relay for output to printer or other destination. Relay logic shall have built in error checking and built in offline logic simulation.

7.5. Logic Timers (62)

The relay shall include eight logic timers (62) to aid in the development of custom logic.

8. Reporting and Alarms

8.1. Oscillography

The relay shall be capable of recording disturbance events of up to at least 8 seconds (user-adjustable lengths). The relay shall be capable of storing up to at least 32 seconds of total data.

8.2. Sequential Events Recorder (SER)

The relay shall include sequence of events recording (SER) that stores the latest 1,024 logic events.

8.3. Nonvolatile Status and Trip Target LEDs

The relay shall retain recent target and alarm information in nonvolatile memory and provide that information locally through the HMI/LEDs, and remotely via communication ports. The relay shall have three programmable alarm bits based upon relay logic states: major, minor, and logic.

8.4. Real-Time Metering

The relay shall include real-time metering that provides watt, watthour, thermal capacity, voltage, and current values for the protected circuit.

8.5. Demand Metering

The relay shall include user-settable current demands current, and positive and negative watts with magnitudes and time stamps.

8.6. Circuit Breaker Monitor

The relay shall include breaker status and operations counter reporting, fault current interruption duty monitoring, and trip-speed monitoring. A trip coil monitor circuit shall be internally connected across the trip output to provide trip circuit continuity monitoring.

9. Communications

9.1. Relay Interface

The relay shall include two or three independent general-purpose communication ports, including a front USB port, a rear RS-485 port, and an optional copper or fiber optic Ethernet port.

9.2. Modbus RTU Slave Communications

The relay shall optionally incorporate Modbus™ RTU slave protocol internally. External converters or adapters are not acceptable.

9.3. Distributed Network Protocol (DNP)

The relay shall optionally incorporate certified DNP 3.0 Level 2 Slave protocol communications capability internally. External converters or adapters are not acceptable.

9.4. IEC 61850 Protocol

The relay shall optionally incorporate IEC 61850 protocol communications capability internally. External converters or adapters are not acceptable.

9.5. IRIG-B

The relay shall include an interface port for a demodulated IRIG-B time synchronization input signal. IRIG-B connection shall be to a barrier terminal strip capable of accepting ring-lug-terminated wiring.

9.6. PC Interface

The relay shall be capable of being set by Windows®-based graphical user interface and included software.

9.7. Communications Security

The relay shall be capable of requiring username and passwords for at least six distinct, functional access levels. Up to 26 independent users with selectable password expiration shall be available. Complex passwords of up to 16 characters shall be supported.

10. Settings and Analysis Software

10.1. PC Software

PC software compatible with Windows® XP with SP3, Windows Vista 32, Windows 7, Windows 8, and Windows 10 shall be included at no charge. The software shall be freely reproducible within the end user's organization without additional charge. The software must include serial communications for settings upload and download, graphical programming and display of logic equations (including pictorial display of AND, OR and XOR gates), and the ability to display and print COMTRADE oscillography and event files without conversion tools. Free software shall be provided with the relay and with no limitation in the number of users who can install it on their laptop/computer for the same product. The software shall be accessible to the customer prior to purchase of the relay for trial and evaluation. The software shall integrate programmable logic with a drag and drop system that is easy to set up and modify. Setup of logic shall be graphical and not through typing of equations or formulas. The logic shall integrate an error checking function highlighting which tabs the errors are located. The logic shall integrate an offline simulator enabling checking of the logic by setting any of the logic inputs as a 0 or 1.

11. Case and Hardware

11.1. Panel Mount (S1 Case Cutout)

The relay shall be packaged in a case no larger than an S1 case relay. The relay shall have removable rear connectors for easy removal of the relay from in-service wiring.

11.2. Agency and Industry Standards

11.2.1. IEC Standards

- IEC 60068-1 – *Environmental Testing Part 1: General and Guidance. Temperature Test*
- IEC 60068-2-1 – *Basic Environmental Testing Procedures, Part 2: Tests - Test Ad: Cold (Type Test)*
- IEC 60068-2-2 – *Basic Environmental Testing Procedures, Part 2: Tests - Test Bd: Dry Heat (Type Test)*
- IEC 60068-2-28 – *Environmental Testing Part 2: Testing-Guidance for Damp Heat Tests*
- IEC 60068-2-38 – *Composite Temperature/Humidity Cyclic Test*
- IEC 60068-2-78 – *Environmental Testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*
- IEC 60255-4 – *Single Input Energizing Quantity Measuring Relays with Dependent Specified Time*
- IEC 60255-5 – *Electrical Insulation Tests for Electrical Relays. Dielectric Test and Impulse Test*
- IEC 60255-6 – *Electrical Relays - Measuring Relays and Protection Equipment*
- IEC 60255-21-1 – *Vibration, Shock, Bump, and Seismic Tests on Measuring Relays and Protective Equipment (Section 1 - Vibration Test - Sinusoidal). Class 1*
- IEC 60255-21-2 – *Vibration, Shock, Bump, and Seismic Tests on Measuring Relays and Protective Equipment (Section 2 - Shock and Bump Test - Sinusoidal). Class 1*
- IEC 60255-21-3 – *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section 3: Seismic tests*

11.2.2. IEEE Standards

- IEEE C37.90-2005 – *IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus*
- IEEE C37.90.1-2002 – *IEEE Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus*
- IEEE C37.90.2-2004 – *IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers*
- IEEE C37.90.3-2001 – *IEEE Standard Electrostatic Discharge Test for Protective Relays*

11.3. Terminal Blocks and Wiring

With the exception of the USB port and Ethernet and fiber optic connectors, all connections shall be made to barrier terminal strips capable of accepting ring-lugs. This requirement includes the RS-485 and IRIG-B wiring.

11.4. HMI/Display

A high-contrast 128-by-64 pixel liquid crystal display (LCD) shall be provided integral to the relay along with a four-key cursor/navigation keypad. Separate target/alarm reset and settings editing pushbuttons shall be included. All keypad pushbuttons shall be protected by a continuous, flexible, water-resistant membrane overlay. The relay shall have an optionally available style that provides an enhanced HMI with direct operation of internal virtual switches and user-configurable LEDs that can provide status indication for up to seven user-defined logic points.