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# Feeder Protection REF615 ANSI

## Product Guide



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# 1. Description

The REF615 is the most powerful, most advanced and simplest feeder protection relay it is class suited for the protection, control, measurement and monitoring of utility substations and industrial power systems. Engineered from the ground up, the relay has been guided by the IEC 61850 standard for communication and interoperability of substation automation devices.

The relay provides main protection for overhead lines, cable feeders and busbar systems in distribution substations. The relay is also used as back-up protection in applications, where an independent and redundant protection system is required such as in transformer protection.

Depending on the preconfiguration made, the relay is adapted for the protection of overhead line and cable feeders in grounded and ungrounded distribution systems.. Once the standard configuration relay has been given the application-specific settings, it can directly be put into service.

The 615 series relays support a range of communication protocols including IEC 61850 with GOOSE messaging, DNP3.0 Level 2+ and Modbus®.

## Standard Configurations

| Functions | | Analog Inputs | 3 CT | 3 CT + Ground CT | 3 CT + SEF/HIZ CT |
|---|---|---|---|---|---|
| | | Order Code | AA | AB | AC |
| **Protection** | **ANSI** | | | | |
| Phase overcurrent protection, 4 elements | 51P, 50P-1, 50P-2, 50P-3 | | • | • | • |
| Phase long time overcurrent protection | 51LT | | • | • | • |
| Neutral overcurrent protection, 4 elements | 51N, 50N-1, 50N-2, 50N-3 | | • | • | • |
| Ground overcurrent protection, 4 elements | 51G, 50G-1, 50G-2, 50G-3 | | | • | |
| Sensitive earth fault protection | 50SEF | | | | • |
| Negative sequence overcurrent protection, 2 elements | 46-1, 46-2 | | • | • | • |
| High impedance fault protection | HIZ | | | | • |
| Thermal overload protection | 49F | | • | • | • |
| Phase discontinuity protection | 46PD | | • | • | • |
| Cold load inrush detection, 2 elements | 62CLD-1, 62CLD-2 | | • | • | • |
| Circuit breaker failure protection | 50BF | | • | • | • |
| Electrically latched/self-resetting trip outputs | 86/94-1, 86/94-2 | | • | • | • |
| Arc flash detection via three lens sensors | AFD-1, AFD-2, AFD-3 | | o | o | o |
| **Control** | | | | | |
| Circuit breaker control | 52-1 | | • | • | • |
| Autoreclose | 79 | | | o | o |
| **Monitoring and Supervision** | | | | | |
| Trip circuit monitoring | TCM | | • | • | • |
| Breaker condition monitoring | 52CM | | • | • | • |
| **Measurement** | | | | | |
| Three-phase currents | IA, IB, IC | | • | • | • |
| Sequence currents | I1, I2, I0 | | • | • | • |
| Ground current | IG | | | • | |
| Demand phase currents | | | • | • | • |
| Maximum demand phase currents | | | • | • | • |
| **Automation & Communications** | | | | | |
| 10/100BaseT 'RJ45' Ethernet(DNP3.0 Level 2+, Modbus, IEC61850, SNTP, FTP) + IRIG-B | | | o | o | o |
| 100BaseFL 'LC' Ethernet (DNP3.0 Level 2+, Modbus, IEC61850, SNTP, FTP) + IRIG-B | | | o | o | o |
| 10/100BaseT 'RJ45' Ethernet(DNP3.0 Level 2+, Modbus, IEC61850, SNTP, FTP) + RS-485 (DNP3.0 Level 2+ or Modbus) + IRIG-B | | | o | o | o |
| 100BaseFL 'LC' Ethernet (DNP3.0 Level 2+, Modbus, IEC61850, SNTP, FTP) + RS-485 (DNP3.0 Level 2+ or Modbus) + IRIG-B | | | o | o | o |
| **Records** | | | | | |
| Sequence of events recorder | SER | | • | • | • |
| Fault recorder | FLR | | • | • | • |
| Digital fault (waveform) recorder | DFR | | • | • | • |

• = Included,
o = Optional

# 2. Standard configurations

The feeder protection relay REF615 is available with three alternative standard configurations. The table below indicates the functions supported by the different relay configurations.

** The DNP3.0 Level 2+ implementation includes some Level 3 functionality.*

### Unique features

The REF615 ANSI version offers all of these unique features and functions unavailable with competitive relays in its class:

- High impedance (HIZ) fault detection
- Arc flash detection (AFD)
- Thermal overload protection of feeder cable
- Ring-lug terminals for all inputs and outputs
- Large LCD screen with clearly visible font
- Environmentally friendly design with RoHS compliance

# 3. Protection functions

The REF615 offers time and instantaneous overcurrent, negative sequence overcurrent, phase discontinuity, breaker failure and thermal overload protection. Optional features include high impedance fault (HIZ) detection and sensitive earth fault (SEF) protection. The relay also offers an optional three-phase multi-reclose function for automatic feeder restoration with temporary faults on overhead lines.

Enhanced with an arc flash detection (AFD), the relay also features three light detection channels for arc fault detection of the circuit breaker, busbar and cable compartment of metal-enclosed switchgear.

The AFD sensor interface is available on the optional communication module. Fast tripping increases personal safety and limits material damage within the switchgear in an arc fault situation.

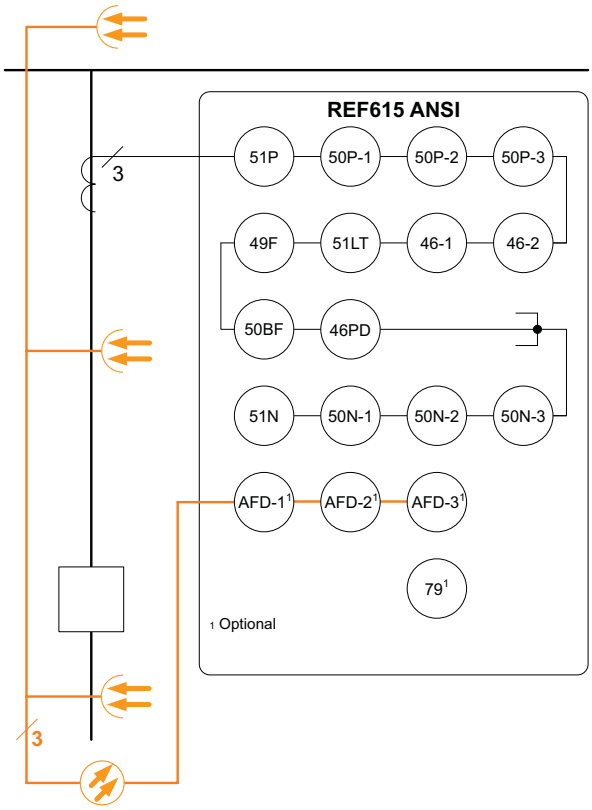



Fig. 1 Protection function overview of the "3 CT" configuration

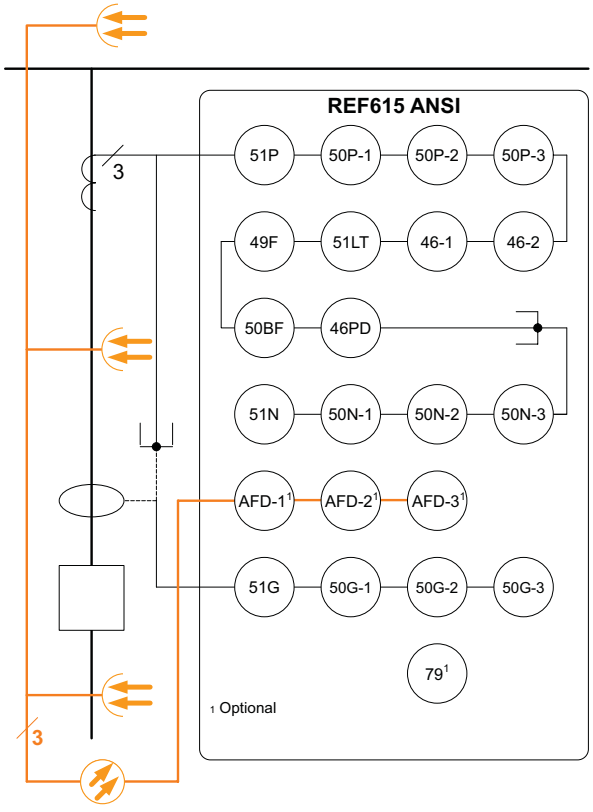



Fig. 2: Protection function overview of "3CT + Ground CT" configuration

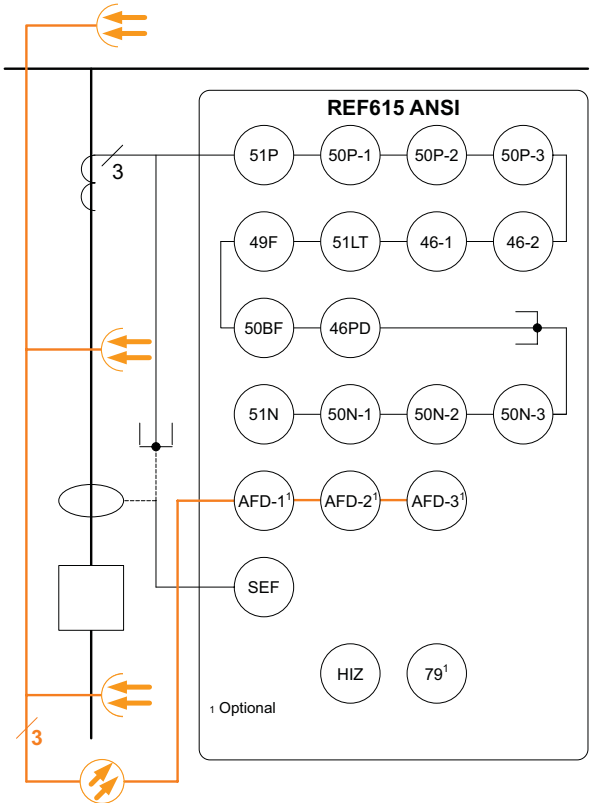



Fig 3: Protection overview of "3CT + SEF CT/HIZ CT" configuration

# 4. Application

The REF615 ANSI version feeder protection relay can be conveniently ordered with or without a dedicated ground or sensitive earth ct input. For those protection schemes where a ground ct is unavailable or undesirable, the three-phase ct inputs-only model eliminates additional wiring associated with an external residual connection. This model performs an internal neutral (IN) calculation using the three phase ct inputs and provides numerous neutral overcurrent protection elements for ground fault protection.

Where a dedicated ground ct, sensitive earth fault (SEF) protection and high impedance fault (HIZ) detection is required, additional models can be ordered that include a fourth ct input. The dedicated ground ct affords ground overcurrent protection via an external residual connection or window ct while the SEF/HIZ ct option provides both SEF and HIZ protection.

Including a HIZ protective function incorporating ABB's patented high impedance fault detection alogorithms in the SEF/HIZ option enables the REF615 to be applied as a stand-alone HIZ detector wired with any existing feeder protection relay from any vendor.

Figures 4-6 show protection application examples possible with the various REF615 ANSI model options. Its simple design and small size makes for a convenient solution for primary feeder and backup overcurrent protection schemes.

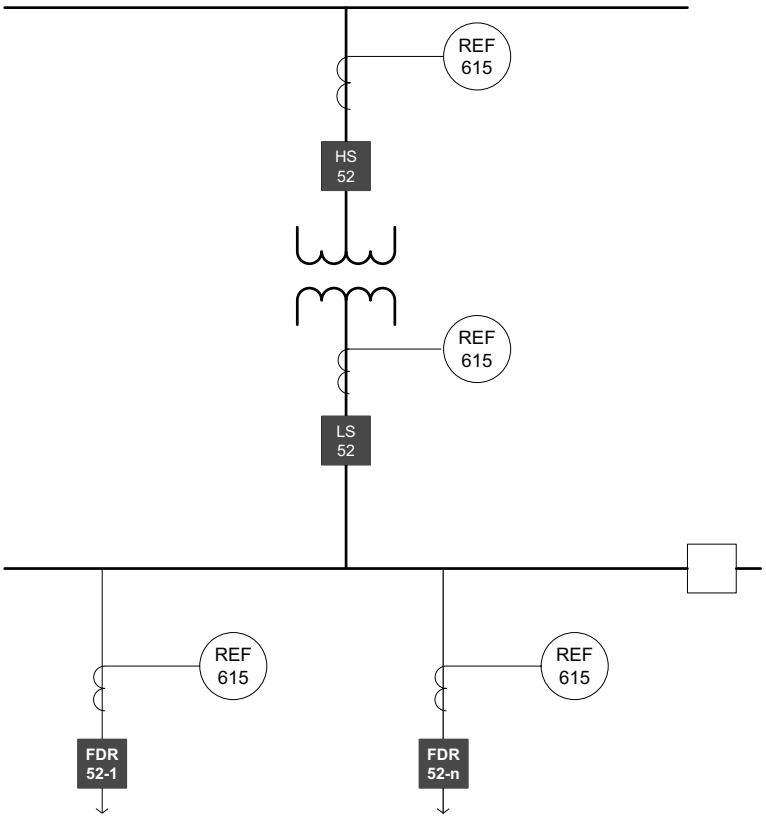



Fig. 4 Substation feeder, bus and backup overcurrent protection with the REF615 ANSI configurations with optional reclosing, SEF, HIZ and arc protection.

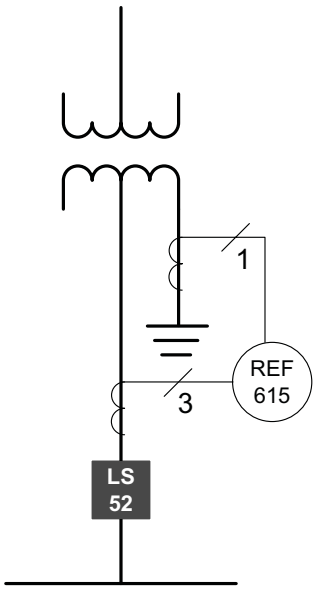



Fig. 5a

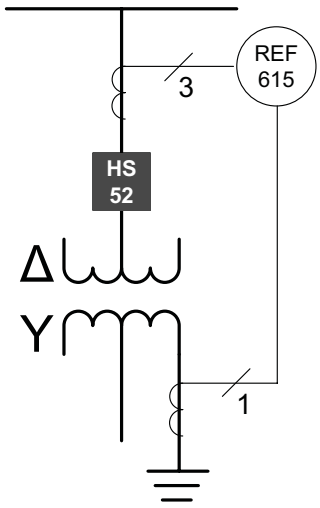



Fig. 5b

Fig. 5 Backup protection a) bus and transformer and b) transformer.

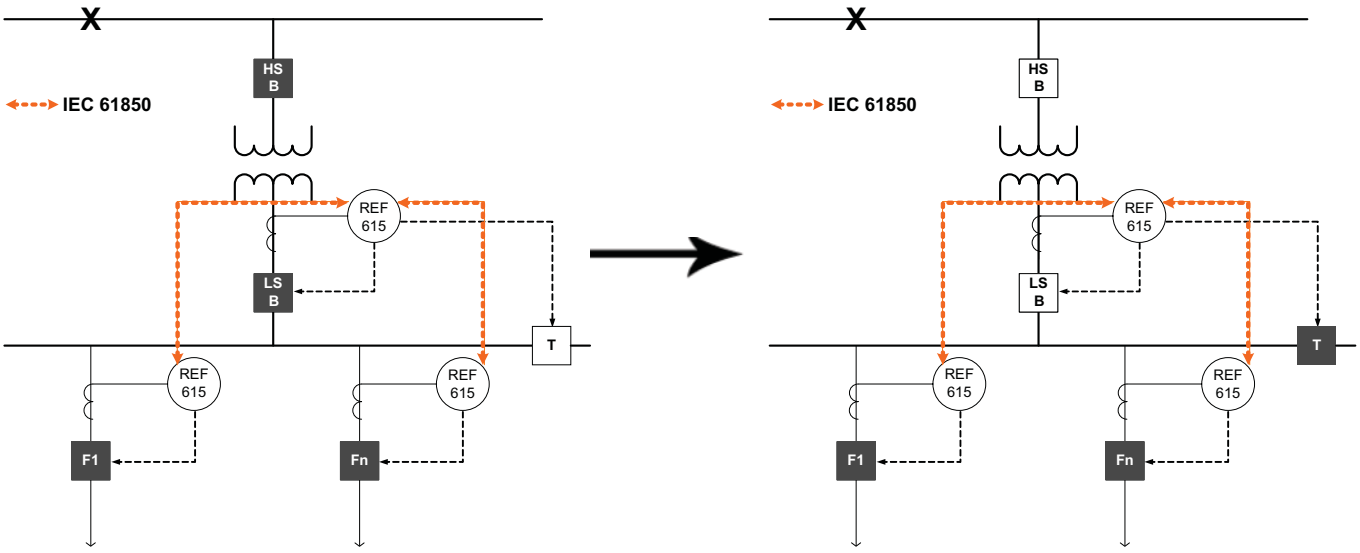



Fig. 6 Peer-to-peer relay control via IEC 61850 GOOSE messaging and Cat 5 or fiber optic communications.

## 5. Control

The relay offers status and control of one circuit breaker with dedicated push-buttons on the front panel local human machine interface (LHMI) for opening and closing of that breaker. Flexible remote breaker control of select-before-operate (SBO) or direct operate is also available with each of the supported DNP3.0 Level 2+, Modbus and IEC 61850 communication protocols. Interlocking schemes required by the application are configured with the signal matrix tool in PCM600 by the application are configured with the Signal Matrix Tool (SMT) of the REF615 user tool PCM600.

## 6. Measurement

The relay continuously measures the phase currents, the sequence components of the currents and the residual current. If the relay includes the ground ct option, it also measures the ground current, IG. In addition, the relay calculates the demand phase currents over a user-selectable pre-set time frame, the thermal overload of the protected object, and the phase unbalance value as a ratio between the negative sequence and positive sequence currents.

The values measured can be accessed locally via the user interface on the relay front panel or remotely via the communication interface of the relay. The values can also be accessed locally or remotely using the web-browser based user interface.

## 7. Digital fault recorder

The relay is provided with a digital fault recorder (DFR) featuring up to four analog and 64 binary signal channels. The analog channels record either the waveform or the trend of the currents measured.

The analog channels can be set to trigger the recording function when the measured value falls below or exceeds the set values. The binary signal channels can be set to start a recording on the rising or the falling edge of the binary signal or both.

By default, the binary channels are set to record external or internal relay signals, e.g. the pickup or trip signals of the relay stages, or external blocking or control signals. Binary relay signals such as a protection pickup or trip signal, or an external relay control signal over a binary input can be set to trigger the recording.

## 8. Events recorder

The IED includes a sequence of events recorder (SER) that logs important event activity. To collect sequence-of-events (SER) information, the relay incorporates a memory with a capacity of storing 50 event codes with associated time stamps with associated date and time stamps.. The event log facilitates detailed pre- and post-fault analyses of feeder faults and disturbances.

The SER information can be accessed locally via the user interface on the relay front panel or remotely via the communication interface of the relay. The information can further be accessed, either locally or remotely, using the web-browser based user interface.

## 9. Fault recorder

The relay has the capacity to store the records of 100 fault events. The records enable the user to analyze the four most recent power system events. Each record includes the current values, the start times of the protection blocks, time stamp, etc. The fault recording can be triggered by the pickup signal or the trip signal of a protection block, or by both. The available measurement modes include DFT, RMS and peak-to-peak. In addition, the maximum demand phase currents with date and time stamp are separately stored as recorded data. All 100 records are remotely retrievable via DNP3.0 Level 2+ and Modbus protocols and the four most recent fault records are retrievable and viewable using the front panel HMI, WMHI and PCM600 interfaces using the front panel HMI, web-based WHMI and PCM600 interfaces.

## 10. Circuit-breaker condition monitoring

For continuous knowledge of the operational availability of the REF615 features, a comprehensive set of monitoring functions to supervise the relay health, the trip circuit and the circuit breaker health is included. The breaker monitoring can include checking the wear and tear of the circuit breaker, the spring charging time of the breaker operating mechanism and the gas pressure of the breaker chambers. The relay also monitors the breaker travel time and the number of circuit breaker (CB) operations to provide basic information for scheduling CB maintenance.

# 11. Trip-circuit monitoring

The trip-circuit monitoring continuously supervises the availability and operability of the trip circuit. It provides open-circuit monitoring both when the circuit breaker is in its closed and in its open position. It also detects loss of circuit-breaker control voltage.

**Local and remote indication are programmable to ensure immediate notification so the necessary steps can be established to correct before the next fault event occurs.**

# 12. Self-supervision

The relay's built-in self-supervision system continuously monitors the state of the relay hardware and the operation of the relay software. Any fault or malfunction detected will be used for alerting the operator. A permanent relay fault will block the protection functions of the relay to prevent incorrect relay operation.

# 13. Access control

To protect the relay from unauthorized access and to maintain information integrity, the relay is provided with a four-level, role-based authentication system with administrator-programmable individual passwords for the viewer, operator, engineer and administrator levels. The access control applies to the front-panel user interface, the web-browser based user interface and the PCM600 user interface tool.

# 14. Inputs and outputs

Depending on the standard configuration selected, the relay is equipped with three-phase ct inputs for basic phase and neutral overcurrent backup protection, three-phase and ground ct inputs for phase and ground overcurrent protection or three-phase and sensitive earth fault ct inputs for phase, neutral, SEF and HIZ protection.

The phase-current inputs are user programmable for 5 A or 1 A ct secondary nominal rating. The ground ct option is programmable for 5/1 A nominal rating, the SEF ct option has a fixed 0.2 A nominal rating. The sensitive earth fault ct option provides SEF protection and includes a separate, independent HIZ protective function for detecting downed conductors..

The phase-current and ground current nominal rating of 5 A or 1 A are selected in the relay software.

The binary input turn-on thresholds are programmable from 18…176 V DC by adjusting the relay's parameter settings.

All binary input and output contacts are freely programmable with the signal matrix tool in PCM600 software user tool.

Relay analog input and binary input/output overview:

- Three phase-current inputs
- Optional ground current or SEF/HIZ ct current input
- Programmable four binary inputs and six binary outputs standard
- Two normally-open (NO) output contacts with embedded TCM circuitry
- Three NO output contacts
- One normally-closed (NC) output contact
- One Form C self-check alarm output contact

I/O extension module:

- Seven programmable binary inputs
- Three programmable signal-output contacts

# 15. Communication

The relay supports three different communication protocols: IEC 61850 , DNP3.0 Level 2+ and Modbus®. Operational information and controls are available through these protocols. Unique communication functionality, for example, peer-to-peer communication between relays is available via the IEC 61850 communication protocol.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter setting and disturbance file records can be accessed using the IEC 61850-8-1 protocol. Further, the relay can send and receive binary signals from other relays (peer-to-peer communication) using the IEC61850-8-1 GOOSE profile, where the highest performance class with a total transmission time of 3 ms is supported. The relay can simultaneously report to five different clients - maximum five IEC 61850-8-1 clients, maximum five Modbus clients and maximum one DNP3.0 Level 2+ client with total number not exceeding five.

All communication connectors, except for the front RJ45 connector, are located in the back of the unit on the leftmost card slot. This slot remains in the case when the drawout unit is removed eliminating the need to disconnect communication connections. The relay can be connected to an Ethernet-based communications network via a copper RJ45 (100Base TX) or fiberoptic LC (100Base FX) connector or serial network via the RS-485 option that provides one 4-wire or two 2-wire ports.

Modbus over TCP/IP is supported with the Ethernet communications option selected. Besides standard Modbus functionality such as status and control operations, the relay supports retrieval of time-stamped events, uploading of disturbance files and storing of the latest fault records. For the Modbus TCP connection, a maximum of , five clients can be connected to the relay simultaneously.

DNP3.0 Level 2+ over TCP/IP is also supported with the Ethernet communications card option. Status and control, including breaker trip/close control, operations are supported in the Level 2+ implementation.

Optional serial communications via one or two RS-485 ports is available that supports a user programmable protocol of Modbus RTU or DNP3.0 Level 2+. This option also includes an Ethernet communications port and an IRIG-B port for dedicated time synchronization network connections.

The relay supports the time synchronization with a time-stamping resolution of +/-1 ms:

Ethernet based:

- SNTP (primary and secondary server support)

| | | Communication Interface | | |
|---|---|---|---|---|
| | | 100Base TX (RJ45) | 100Base FX (LC) | RS-485 |
| Protocol Support | DNP3.0 over TCP/IP | • | • | |
| | Modbus over TCP/IP | • | • | |
| | IEC 61850-8-1 | • | • | |
| | SNTP | • | • | |
| | FTP | • | • | |
| | DNP3.0 Level 2+ serial | | | • |
| | Modbus RTU serial | | | • |
| | IRIG-B time synchronization | o | o | • |

• = Included, o = Optional

• = Supported

# 16. Technical data

**Dimensions**

| | | |
|---|---|---|
| Width | frame<br>case | 6.97” (177 mm)<br>6.57” (165 mm) |
| Height | frame<br>case | 6.97 (177 mm), 4U<br>6.30” (160 mm) |
| Depth | case | 6.10” (155 mm) |
| Weight | relay<br>draw-out unit | 7.72 lbs. (3.5 kg)<br>3.97 lbs. (1.8 kg) |

**Power Supply**

| **Type:** | **Type 1** | **Type 2** |
|---|---|---|
| V nominal ($V_n$) | 100, 110, 120, 220, 240 V AC,<br>60 and 50 Hz<br>48, 60, 110, 125, 220, 250 V DC | 24, 30, 48, 60 V DC |
| $V_n$ variation | 38...110% of $V_n$ (38...264 V AC)<br>80...120% of $V_n$ (38.4...300 V DC) | 50...120% of $V_n$<br>(12...72 V DC) |
| Start-up threshold | | 19.2 V DC<br>(24 V DC * 80%) |
| Burden of auxiliary voltage supply under quiescent (Pq)/operating condition | <8.4 W/13 W | |
| Ripple in the DC auxiliary voltage | Max 12% of the DC value (at frequency of 100 Hz) | |
| Maximum interruption time in the auxiliary DC voltage without resetting the relay | 50 ms at $V_n$ rated | |
| Fuse type | T4A/250 V | |

### Analog inputs

| | | | |
|---|---|---|---|
| Rated frequency | | 60/50 Hz ± 5 Hz | |
| Current inputs | Rated current, $I_n$ | 5/1 A [1] | 0.2 A [2] |
| | Thermal withstand capability:<br>• Continuously<br>• For 1 s<br>• For 10 s | <br>20 A<br>500 A<br>100 A | <br>4 A<br>100 A<br>25 A |
| | Dynamic current withstand:<br>• Half-wave value | <br>1250 A | <br>250 A |
| | Input impedance | <20 mΩ | <100 mΩ |

1) Phase and ground current inputs
2) Sensitive earth fault (SEF)/high impedance (HIZ) detection current input

### Measuring range

| | |
|---|---|
| Measured currents on phases IA, IB and IC as multiples of the rated currents of the energizing inputs | 0... 50 x $I_n$ |
| Ground current as a multiple of the rated current of the energizing input | 0... 50 x $I_n$ |

### Binary inputs

| | |
|---|---|
| Operating range | ±20 % of the rated voltage |
| Rated voltage | 24...250 V DC |
| Current drain | 2...18 mA |
| Power consumption/input | <0.9 W |
| Threshold voltage | 18...176 V DC |

### Signal outputs (SO) [Typical operation time is 5-8 ms.]

| | |
|---|---|
| Rated voltage | 250 V AC/DC |
| Continuous carry | 5 A |
| Make and carry for 3.0 s | 8 A |
| Make and carry 0.5 s | 10 A |
| Breaking capacity when the control-circuit time constant L/R<40 ms | 1 A/0.25 A/0.15 A |
| Minimum contact load | 100 mA at 24 V AC/DC |

| Self-check alarm relay change over - type signal output relay [Typical operation time is 5-8 ms.] | |
|---|---|
| Rated voltage | 250 V AC/DC |
| Continuous contact carry | 5 A |
| Make and carry for 3.0 s | 15 A |
| Make and carry 0.5 s | 30 A |
| Breaking capacity when the control-circuit time constant L/R<40 ms | 1 A/0.25 A/0.15 A |
| Minimum contact load | 100 mA at 24 V AC/DC |

**Heavy-duty output contacts [Typical operation time is 8-11 ms.]**

| Double-pole power output with trip-circuit monitoring function | |
|---|---|
| Rated voltage | 250 V AC/DC |
| Continuous contact carry | 8 A |
| Make and carry for 3.0 s | 15 A |
| Make and carry 0.5 s | 30 A |
| Breaking capacity when the control-circuit time constant L/R<40 ms, at 48/110/220 V DC (two contacts connected in series) | 5 A/3 A/1 A |
| Minimum contact load | 100 mA at 24 V AC/DC |
| Trip-circuit monitoring (TCM):<br>• Control voltage range<br>• Current drain through the monitoring circuit<br>• Minimum voltage over the TCM contact | <br>20...250 V AC/DC<br>~1.5 mA<br>20 V AC/DC (15...20 V) |

| Single-pole power output | |
|---|---|
| Rated voltage | 250 V AC/DC |
| Continuous contact carry | 8 A |
| Make and carry for 3.0 s | 15 A |
| Make and carry 0.5 s | 30 A |
| Breaking capacity when the control-circuit time constant L/R<40 ms, at 48/110/220 V DC | 5 A/3 A/1 A |
| Minimum contact load | 100 mA at 24 V AC/DC |

**Lens sensor and optic fiber for arc flash detection (AFD)**

| | |
|---|---|
| Fibre-optic cable including lens | 1.5 m, 3.0 m or 5.0 m |
| Normal service temperature range of the lens | -40° to +212° F (-40° to 100° C) |
| Maximum service temperature range of the lens, max 1 h | +284° F (+140° C) |
| Minimum permissible bending radius of the connection fibre | 3.94" (100 mm) |

**Degree of protection of flush-mounted relay**

| | |
|---|---|
| Front side | IP 54 |
| Top side | IP 40 |
| Back side, connection terminals | IP 20 |

**Environmental conditions and tests**

| **Environmental conditions** | |
|---|---|
| Operating temperature range | -40° to +85° C (-20 C to +55° C continuous) |
| HMI LCD temperature range | Some degradation in LCD performance outside the temperature range of -25...+55ºC |
| Relative humidity | <93%, non-condensing |
| Atmospheric pressure | 12.47 - 15.37 psi (86 - 106 kPa) |
| Altitude | up to 6561 ft. (2000 m) |
| Transport and storage temperature range | -40...+85ºC |

| **Environmental tests** | |
|---|---|
| Dry heat test (humidity <50%) | According to IEC 60068-2-2<br>Test values:<br>• 96 h at +55ºC<br>• 16 h at +85ºC |
| Cold test | According to IEC 60068-2-1<br>Test values:<br>• 96 h at -25ºC<br>• 16 h at -40ºC |
| Damp heat test, cyclic | According to IEC 60068-2-30<br>Test values:<br>• 6 cycles at +25…55°C, humidity 93…95% |
| Storage test | According to IEC 60068-2-48<br>Test values:<br>• 96 h at -40ºC<br>• 16 h at +85ºC |

**Electromagnetic compatibility tests**

| The EMC immunity test level meets the requirements listed below: | |
|---|---|
| 1 MHz burst disturbance test, class III<br><br>• Common mode<br>• Differential mode | According to IEC 61000-4-18 and IEC 60255-22-1, level 3<br>2.5 kV<br>1.0 kV |
| Electrostatic discharge test<br><br><br>• Contact discharge<br>• Air discharge | According to IEC 61000-4-2, IEC 60255-22-2, level 3, and IEEE 37.90.3-2001<br>6 kV<br>8 kV |

(continued)

| | |
|---|---|
| Radio frequency interference tests: | |
| • Conducted, common mode | According to IEC 61000-4-6 and IEC 60255-22-6, level 3 10 V (emf), f = 150 kHz...80 MHz |
| • Radiated, amplitude-modulated | According to IEC 61000-4-3 and IEC 60255-22-3, level 3 10 V/m (rms), f=80...1000 MHz and f=1.4...2.7 GHz |
| • Radiated, pulse-modulated | According to the ENV 50204 and IEC 60255-22-3,level 3 10 V/m, f=900 MHz |
| Fast transient disturbance tests: | According to IEC 61000-4-4 and IEC 60255-22-4, class B |
| • Signal and self-check alarm outputs, binary inputs | 2 kV |
| • Other ports | 4 kV |
| Surge immunity test: | According to IEC 61000-4-5 and IEC 60255-22-5, level 4/3 |
| • All ports | 2 kV, line-to-ground, 1kV, line-to-line |
| • Communication | 1 kV, line-to-ground |
| Power frequency (50 Hz) magnetic field: | According to IEC 61000-4-8, level 5 |
| • Continuous | 300 A/m |
| Power frequency immunity test: | According to IEC 60255-22-7, class A |
| • Common mode | 300 V rms |
| • Differential mode | 150 V rms |
| Voltage dips and short interruptions | According to IEC 61000-4-11<br>30%/10 ms<br>60%/100 ms<br>60%/1000 ms<br>>95%/5000 ms |
| Electromagnetic emission tests: | According to the EN 55011, class A and IEC60255-25 |
| • Conducted, RF emission (mains terminal) | |
| 0.15...0.50 MHz | < 79 dB(µV) quasi peak<br>< 66 dB(µV) average |
| 0.5...30 MHz | < 73 dB(µV) quasi peak<br>< 60 dB(µV) average |
| • Radiated RF emission | |
| 0...230 MHz | < 40 dB(µV/m) quasi peak, measured at 32.81 ft (10 m) distance |
| 230...1000 MHz | < 47 dB(µV/m) quasi peak, measured at 32.81 ft (10 m) distance |

**Insulation and mechanical tests**

| **Insulation tests** | |
|---|---|
| Dielectric tests: | According to IEC 60255-5 |
| • Test voltage | 2 kV, 50 Hz, 1 min<br>500 V, 50 Hz, 1min, communication |
| Impulse voltage test: | According to IEC 60255-5 |
| • Test voltage | 5 kV, unipolar impulses, waveform 1.2/50 µs, source energy 0.5 J<br>1 kV, unipolar impulses, waveform 1.2/50 µs, source energy 0.5 J, communication |
| Insulation resistance measurements | According to IEC 60255-5 |
| • Isolation resistance | >100 MΩ, 500 V DC |
| Protective bonding resistance<br>• Resistance | According to IEC 60255-27<br><0.1 Ω (60 s) |

| **Mechanical tests** | |
|---|---|
| Vibration tests (sinusoidal) | According to IEC 60255-21-1, class 2 |
| Shock and bump test | According to IEC 60255-21-2, class 2 |

**EMC compliance**

| | |
|---|---|
| Complies with the LV directive 2006/95/EC | |
| Standards | EN 60255-27 (2005),<br>EN 60255-6 (1994) |

**RoHS compliance**

| |
|---|
| Complies with the RoHS directive 2002/95/EC |

**Product safety**

| | |
|---|---|
| Complies with the LV directive 2006/95/EC | |
| Standards | EN 60255-27 (2005),<br>EN 60255-6 (1994) |

**Data communication for front interface**

| |
|---|
| Front interface:<br>• TCP/IP protocol<br>• Standard CAT 5 Ethernet cable<br>• 10 MBits/s |

## Protection functions

### Three-phase non-directional overcurrent protection (50/51)

| | | | | |
|---|---|---|---|---|
| Basic settings | 51P Pickup | 0.05 - 5.00 x In, step 0.01 x In | | |
| | 50P-1, 50P-2, 50P-3 Pickup | 0.01 - 40.00 x In | | |
| | 50P/51P Curves | Selectable ANSI and IEC Inverse-time (IDMT) and Definite time (DT) curves | | |
| | 50P/51P Time multiple | 0.05 - 15.00, step 0.01 | | |
| | 50P/51P Time delay | 0.020 - 200.000 s, step 0.001 s | | |
| | 50P/51P Curve reset mode | Immediate, Inverse or definite time | | |
| | 51P, 50P-1, 50P-2 Operate mode | DFT, RMS or Peak-to-Peak | | |
| | 50P-3 Operate mode | Peak-to-Peak (fixed) | | |
| Pickup accuracy | Depending on the frequency of the current measured: $f_n$ ±2Hz | | | |
| | 51P | ±1.5% of the set value or ±0.002 x $I_n$ | | |
| | 50P-1, 50P-2 and 50P-3 | ±1.5% of set value or ±0.002 x $I_n$ (at currents in the range of 0.1…10 x $I_n$) ±5.0% of the set value (at currents in the range of 10…40 x $I_n$) | | |
| Pickup time [1) 2)] | | Minimum | Typical | Maximum |
| | 50P-3: $I_{Fault}$ = 2 x set Pickup value | 16 ms | 19 ms | 23 ms |
| | $I_{Fault}$ = 10 x set Pickup value | 11 ms | 12 ms | 14 ms |
| | 51P, 50P-1 and 50P-2: $I_{Fault}$ = 2 x set Pickup value | 22 ms | 24 ms | 25 ms |
| Instantaneous operate time [1) 3)] | | Minimum | Typical | Maximum |
| | 50P-3: $I_{Fault}$ = 2 x set Pickup value | 17 ms | 21 ms | 25 ms |
| | $I_{Fault}$ = 10 x set Pickup value | 12 ms | 15 ms | 16 ms |
| | 50P-1, 50P-2 and 51P: $I_{Fault}$ = 2 x set Pickup value | 25 ms | 27 ms | 29 ms |
| Reset time | | < 40 ms | | |
| Reset ratio | | Typical 0.96 | | |
| Retardation time | | < 30 ms | | |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms | | |
| Operate time accuracy in inverse time mode | | ±5.0% of the theoretical value or ±20 ms [4)] | | |
| Suppression of harmonics | | RMS: No suppression DFT: -50dB at f = n x $f_n$, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression P-to-P+backup: No suppression | | |

1) Set Operate delay time = 0.02 s, Operate curve type = ANSI definite time, Measurement mode = default (depends on element), current before fault = 0.0 x $I_n$, $f_n$ = 60 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements.

2) Includes the delay of the signal output contact

3) Includes the delay of the heavy-duty output contact

4) Maximum Pickup value = 2.5 x $I_n$, Pickup value multiples in range of 1.5 to 20

## Protection functions

### Three-phase non-directional long time overcurrent protection (51LT)

| | | | | |
|---|---|---|---|---|
| Basic settings | 51LT Pickup | 0.05 - 5.00 x In, step 0.01 x In | | |
| | 51LT Curves | Selectable ANSI and IEC long-time Inverse-time (IDMT) and Definite time (DT) curves | | |
| | 51LT Time multiple | 0.05 - 15.00, step 0.01 | | |
| | 51LT Time delay | 0.020 - 200.000 s, step 0.001 s | | |
| | 51LT Curve reset mode | Immediate, Inverse or definite time | | |
| | 51LT Operate mode | DFT, RMS or Peak-to-Peak | | |
| Pickup accuracy | Depending on the frequency of the current measured: $f_n$ ±2Hz | | | |
| | 51LT | ±1.5% of the set value or ±0.002 x $I_n$ | | |
| Pickup time [1) 2)] | | Minimum | Typical | Maximum |
| | 51LT: $I_{Fault}$ = 2 x set Pickup value | 22 ms | 24 ms | 25 ms |
| Reset time | | < 40 ms | | |
| Reset ratio | | Typical 0.96 | | |
| Retardation time | | < 30 ms | | |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms | | |
| Operate time accuracy in inverse time mode | | ±5.0% of the theoretical value or ±20 ms [4)] | | |
| Suppression of harmonics | | RMS: No suppression DFT: -50dB at f = n x $f_n$, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression P-to-P+backup: No suppression | | |

1) Set Operate delay time = 0.02 s, Operate curve type = ANSI definite time, Measurement mode = default (depends on element), current before fault = 0.0 x $I_n$, $f_n$ = 60 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements.
2) Includes the delay of the signal output contact
3) Includes the delay of the heavy-duty output contact
4) Maximum Pickup value = 2.5 x $I_n$, Pickup value multiples in range of 1.5 to 20

**Non-directional neutral and ground overcurrent protection (50N/51N, 50G/51G)**

| | | | | |
|---|---|---|---|---|
| Basic settings | 51N(G) Pickup | 0.05 - 5.00 x In, step 0.01 x In | | |
| | 50N(G)-1, 50N(G)-2, 50N(G)-3 Pickup | 0.01 - 40.00 x In | | |
| | 50N(G)/51N(G) Curves | Selectable ANSI and IEC Inverse-time (IDMT) and Definite time (DT) curves | | |
| | 50N(G)/51N(G) Time multiple | 0.05 - 15.00, step 0.01 | | |
| | 50N(G)/51N(G) Time delay | 0.020 - 200.000 s, step 0.001 s | | |
| | 50N(G)/51N(G) Curve reset mode | Immediate, Inverse or definite time | | |
| | 51N(G), 50N(G)-1, 50N(G)-2 Operate mode | DFT, RMS or Peak-to-Peak | | |
| | 50N(G)-3 Operate mode | Peak-to-Peak (fixed) | | |
| Operation accuracy | Depending on the frequency of the current measured: $f_n$ ±2Hz | | | |
| | 51N/51G | ±1.5% of the set value or ±0.002 x $I_n$ | | |
| | 50N-1, 50N-2, 50G-1 and 50G-2 and 50N-3 and 50G-3 | ±1.5% of set value or ±0.002 x $I_n$ (at currents in the range of 0.1…10 x $I_n$) ±5.0% of the set value (at currents in the range of 10…40 x $I_n$) | | |
| Pickup time [1) 2)] | | Minimum | Typical | Maximum |
| | 50N-3, 50G-3: $I_{Fault}$ = 2 x set Pickup value | 16 ms | 19 ms | 23 ms |
| | $I_{Fault}$ = 10 x set Pickup value | 11 ms | 12 ms | 14 ms |
| | 51N, 50N-1, 50N-2, 51G, 50G-1 and 50G-2: $I_{Fault}$ = 2 x set Pickup value | 22 ms | 24 ms | 25 ms |
| Instantaneous operate time [1) 3)] | | Minimum | Typical | Maximum |
| | 50N-3, 50G-3: $I_{Fault}$ = 2 x set Pickup value | 19 ms | 23 ms | 27 ms |
| | $I_{Fault}$ = 10 x set Pickup value | 14 ms | 16 ms | 17 ms |
| | 51N, 50N-1, 50N-2, 51G, 50G-1 and 50G-2: $I_{Fault}$ = 2 x set Pickup value | 24 ms | 27 ms | 29 ms |
| Reset time | | < 40 ms | | |
| Reset ratio | | Typical 0.96 | | |
| Retardation time | | < 30 ms | | |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms | | |
| Operate time accuracy in inverse time mode | | ±5.0% of the theoretical value or ±20 ms [4)] | | |
| Suppression of harmonics | | RMS: No suppression DFT: -50dB at f = n x $f_n$, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression | | |

1) Set Operate delay time = 0.02 s, Operate curve type = ANSI definite time, Measurement mode = default (depends on element), current before fault = 0.0 x $I_n$, $f_n$ = 60 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

3) Includes the delay of the heavy-duty output contact

4) Maximum Pickup value = 2.5 x $I_n$, Pickup value multiples in range of 1.5 to 20

**Non-directional sensitive earth fault protection (50SEF)**

| | | | | |
|---|---|---|---|---|
| Basic settings | 50SEF Pickup | 0.10 - 40.00 x In, step 0.01 x In | | |
| | 50SEF Time delay | 0.020 - 200.000 s, step 0.001 s | | |
| Pickup accuracy | Depending on the frequency of the current measured: $f_n$ ±2Hz | | | |
| | 50SEF | ±1.5% of set value or ±0.002 x $I_n$<br>(at currents in the range of 0.1…10 x $I_n$)<br>±5.0% of the set value<br>(at currents in the range of 10…40 x $I_n$) | | |
| Pickup time [1) 2)] | | Minimum | Typical | Maximum |
| | 50SEF:<br>$I_{Fault}$ = 2 x set Pickup value<br>$I_{Fault}$ = 10 x set Pickup value | <br>16 ms<br>11 ms | <br>19 ms<br>12 ms | <br>23 ms<br>14 ms |
| Instantaneous operate time [1) 3)] | | Minimum | Typical | Maximum |
| | 550SEF:<br>$I_{Fault}$ = 2 x set Pickup value<br>$I_{Fault}$ = 10 x set Pickup value | <br>19 ms<br>14 ms | <br>23 ms<br>16 ms | <br>27 ms<br>17 ms |
| Reset time | | < 40 ms | | |
| Reset ratio | | Typical 0.96 | | |
| Retardation time | | < 30 ms | | |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms | | |
| Operate time accuracy in inverse time mode | | ±5.0% of the theoretical value or ±20 ms [4)] | | |
| Suppression of harmonics | | RMS: No suppression DFT: -50dB at f = n x $f_n$, where n = 2, 3, 4, 5,…<br>Peak-to-Peak: No suppression | | |

1) Set Operate delay time = 0.02 s, Operate curve type = ANSI definite time, Measurement mode = default (depends on element), current before fault = 0.0 x $I_n$, $f_n$ = 60 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

3) Includes the delay of the heavy-duty output contact

4) Maximum Pickup value = 2.5 x $I_n$, Pickup value multiples in range of 1.5 to 20

**Negative phase-sequence current protection (46-1, 46-2)**

| | | | | |
|---|---|---|---|---|
| Basic Settings | 46 Pickup | 0.05 - 5.00 x In, step 0.01 x In | | |
| | 46 Curves | Selectable ANSI and IEC Inverse-time (IDMT) and Definite time (DT) curves | | |
| | 46 Time multiple | 0.05 - 15.00, step 0.01 | | |
| | 46 Time delay | 0.020 - 200.000 s, step 0.001 s | | |
| | 46 Reset mode | Immediate, Inverse or definite time | | |
| Pickup accuracy | | Depending on the frequency of the current measured: $f_n$ = ±2Hz | | |
| | | ±1.5% of the set value or ±0.002 x $I_n$ | | |
| Pickup time [1) 2)] | | Minimum | Typical | Maximum |
| | $I_{Fault}$ = 2 x set Pickup value | 22 ms | 24 ms | 25 ms |
| | $I_{Fault}$ = 10 x set Pickup value | 14 ms | 16 ms | 17 ms |
| Instantaneous operate time [1) 3)] | | Minimum | Typical | Maximum |
| | $I_{Fault}$ = 2 x set Pickup value | 24 ms | 26 ms | 28 ms |
| Reset time | | < 40 ms | | |
| Reset ratio | | Typical 0.96 | | |
| Retardation time | | < 35 ms | | |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms | | |
| Operate time accuracy in inverse time mode | | ±5.0% of the theoretical value or ±20 ms [4)] | | |
| Suppression of harmonics | | DFT: -50dB at f = n x $f_n$, where n = 2, 3, 4, 5,… | | |

**Phase discontinuity protection (46PD)**

| | | |
|---|---|---|
| Basic Settings | 46PD Pickup | 10 - 100%, step 1% |
| | 46PD Time delay | 0.100 - 30.000 sec, step 0.001 sec |
| Pickup accuracy | | Depending on the frequency of the current measured: fn ±2Hz |
| | | ±2% of the set value |
| Pickup time | | < 70 ms |
| Reset time | | < 40 ms |
| Reset ratio | | Typical 0.96 |
| Retardation time | | < 35 ms |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms |
| Suppression of harmonics | | DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,… |

**Three-phase thermal overload (49F)**

| | | |
|---|---|---|
| Basic Settings | 49F Current reference | 0.05 - 4.00 x In, step 0.01 x In |
| | 49F Temperature rise | 0.0 - 200.0 °C, step 0.1 °C |
| | 49F Time constant | 60 - 60000 s, step 1 s |
| | 49F Maximum temperature | 20.0 - 200.0 °C, step 0.1 °C |
| | 49F Alarm value | 20.0 - 150.0 °C, step 0.1 °C |
| | Reclose temperature | 20.0 - 150.0 °C, step 0.1 °C |
| Pickup accuracy | | Depending on the frequency of the current measured: fn ±2Hz |
| | | Current measurement: ±0.5% or ±0.002 x $I_n$ (at currents in the range of 0.01…4.00 x $I_n$) |
| Operate time accuracy | | ±2.0% or ±0.50 s |

### Circuit breaker failure protection (50BF)

| | | |
|---|---|---|
| Basic Settings | 50BF failure mode | Current, Breaker status or Both |
| | 50BF retrip mode | Disabled, Current check or Without check |
| | 50BF retrip time | 0.000 - 60.000 s, step 0.001 s |
| | 50BF failure delay | 0.000 - 60.000 s, step 0.001 s |
| | 50BF measurement mod | DFT or Peak-to-peak |
| Pickup accuracy | | Depending on the frequency of the current measured: fn ±2Hz |
| | | ±1.5% of the set value or ±0.002 x $I_n$ |
| Operate time accuracy | | ±1.0% of the set value or ±20 ms |

### Three-phase inrush current detection (INR)

| | | |
|---|---|---|
| Basic Settings | INR Pickup | 5 - 100%, step 1% |
| | INR Trip delay | 0.020 - 60.000 s, step 0.001 s |
| | 62CLD-1 time | 0 - 300 s, step 1 s |
| | 62CLD-2 time | 0 - 300 m, step 1 m |
| Pickup accuracy | | At the frequency f=$f_n$ |
| | | Current measurement:<br>±1.5% of set value or ±0.002 x In<br>Ratio I2f/I1f measurement: ±5.0% of set value |
| Reset time | | +35 ms / -0 ms |
| Reset ratio | | Typical 0.96 |
| Operate time accuracy | | +35 ms / -0 ms |

### Arc flash detection (AFD)

| | | | | |
|---|---|---|---|---|
| Basic settings | | ±3% of the set value or ±0.01 x $I_n$ | | |
| | Phase pickup value (operate phase current) | 0.50 - 40.00 x IN, step 0.01 x In | | |
| | Ground pickup value (operate ground current) | 0.05 - 8.00 x In, step 0.01 x In | | |
| | Operate mode | 1 = Light + current 2 = Light only 3 = BI controlled | | |
| Pickup accuracy | | ±3% of the set value or ±0.01 x $I_n$ | | |
| Operate time | | Minimum | Typical | Maximum |
| | Operation mode = “Light+current” [1) 2)] | 9 ms | 12 ms | 15 ms |
| | Operation mode = “Light only” [2)] | 9 ms | 10 ms | 12 ms |
| Reset time | | < 40 ms | | |
| Reset ratio | | Typical 0.96 | | |

1) Phase pickup value = 1.0 x In, current before fault = 2.0 x set Phase pickup value, fn = 60Hz, fault with nominal frequency, results based on statistical distribution 200 measurements

2) Includes the delay of the heavy-duty output contact

### Control functions

### Autoreclosure (79)

| | | |
|---|---|---|
| Basic Settings | Reset time | 0.100 - 1800.000 s, step 0.001 s |
| | Number of reclose attempts | 7 |
| | Reclose time | 0.000 - 300.000 s, step 0.001 s |
| | Enable/Disable functions | All overcurrent functions per reclose |
| Pickup accuracy | | ±1.0% of the set value or ±20 ms |

# 17. Display

The relay's local HMI includes a large LCD screen standard. The large LCD display offers full front-panel user-interface functionality with menu navigation and menu views.

The large display offers increased front-panel usability with less menu scrolling and improved information overview than with smaller LCD screens. The large display is well-suited for all relay installations providing an easy viewing interface.




Fig. 6: Large display standard

| Large display | | |
|---|---|---|
| **Character size** | **Rows in the view** | **Characters per row** |
| Large, variable width (13x14pixels) | 10 | 20 or more |

# 18. Mounting methods

By means of appropriate mounting accessories the standard relay case for the 615 series relays can be flush mounted, semi-flush mounted or wall mounted. The flush mounted and wall mounted relay cases can also be mounted in a tilted position (25°) using special accessories.

Further, the relays can be mounted in any standard 19" instrument cabinet by means of 19" mounting panels available with cut-outs for one or two relays.

For the routine testing purposes, the relay cases can be equipped with Flexitest (FT) test switches, type FT-1 or FT-19R, which can be mounted side by side or below the relay cases.

Mounting methods:

- Flush mounting
- Semi-flush mounting
- Semi-flush mounting in a 25° tilt
- Rack mounting
- Wall mounting
- Mounting to a 19" equipment frame
- Mounting with Flexitest (FT) test switches to a 19"rack

Panel cut-out for flush mounting:

- Height: 6.36" ± 0.04" (161.5±1 mm)
- Width: 6.52" ± 0.04" ( 165.5±1 mm)

# 19. Relay case and relay plug-in unit

For safety reasons, the relay cases are provided with automatically operating contacts for short-circuiting the CT secondary circuits when a relay unit is withdrawn from its case. The relay case is further provided with a mechanical coding system preventing current measuring relay units from being inserted into a relay case for a voltage measuring relay unit and vice versa, i.e. the relay cases are assigned to a certain type of relay draw-out unit.

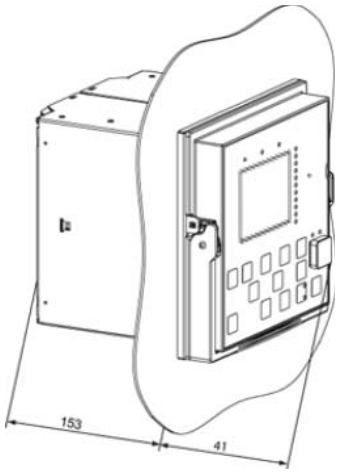



Fig. 7: Flush mounting

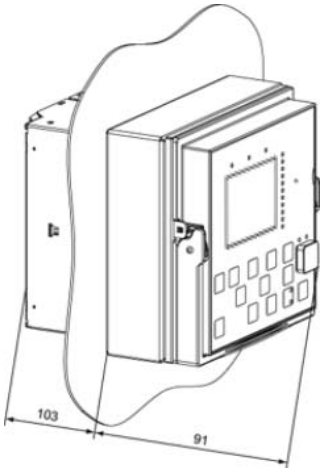



Fig. 8: Semi-flush mounting

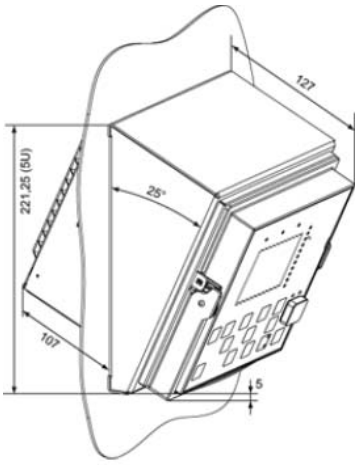



Fig. 9: Semi-flush with a 25° tilt

# 20. Selection and ordering data

The relay type and serial number label identifies the protection relay. The label is placed above the HMI on the upper part of the draw-out unit. An order number label is placed on the side of the draw-out unit as well as inside the case.

The order number consists of a string of alphanumeric characters generated from the hardware and software modules of the relay.

Use the ordering key information in Fig. 10 to generate the order number when ordering complete protection relays.

**REF615 Ordering Code**

| Code Character | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ex.: HAFAACADNAE1BAN1XB | H | A | F | A | A | C | A | D | N | A | E | 1 | B | A | N | 1 | X | B | Notes |
| 1) Product Series | H: 615 (Draw-out unit with case) | H | | | | | | | | | | | | | | | | | | |
| 2) Standard | A: ANSI | | A | | | | | | | | | | | | | | | | | |
| 3) Main Application | F: Feeder protection and control | | | F | | | | | | | | | | | | | | | | |
| 4) Functional Application | A: Single breaker (CT Inputs only) | | | | A | | | | | | | | | | | | | | | |
| 5-6) Analog Inputs | 3 CT | | | | | A | A | | | | | | | | | | | | | |
| | 3 CT + Ground CT | | | | | A | B | | | | | | | | | | | | | |
| | 3 CT + SEF/HIZ CT | | | | | A | C | | | | | | | | | | | | | |
| 7-8) Binary I/O | 4 BI + 6 BO | | | | | | | A | A | | | | | | | | | | | |
| | 11 BI + 9 BO | | | | | | | A | D | | | | | | | | | | | |
| 9-11) Communications | One Port: Ethernet 100Base FX (LC) | | | | | | | | | N | A | E | | | | | | | | |
| | One Port: Ethernet 100Base TX (RJ45) | | | | | | | | | N | B | E | | | | | | | | |
| | Two/three ports: [Ethernet 100Base FX (LC) + RS-485 (1x4-wire or 2x2-wire)] + IRIG-B | | | | | | | | | A | A | E | | | | | | | | |
| | Two/three ports: [Ethernet 100Base TX (RJ45) + RS-485 (1x4-wire or 2x2-wire)] + IRIG-B | | | | | | | | | A | B | E | | | | | | | | |
| Includes Arc Flash Detection (AFD) | One Port: Ethernet 100Base FX (LC) | | | | | | | | | N | F | E | | | | | | | | 1 |
| | One Port: Ethernet 100Base TX (RJ45) | | | | | | | | | N | G | E | | | | | | | | 1 |
| | Two/three ports: [Ethernet 100Base FX (LC) + RS-485 (1x4-wire or 2x2- | | | | | | | | | F | F | E | | | | | | | | 1 |
| | Two/three ports: [Ethernet 100Base TX (RJ45) + RS-485 (1x4-wire or 2x2- | | | | | | | | | F | G | E | | | | | | | | 1 |
| 12) Language | English | | | | | | | | | | | | 1 | | | | | | | |
| 13) Front Panel | Large LCD (standard) | | | | | | | | | | | | | B | | | | | | |
| 14) Option 1 | Reclosing | | | | | | | | | | | | | | A | | | | | |
| | None | | | | | | | | | | | | | | N | | | | | |
| 15) Option 2 | None | | | | | | | | | | | | | | | N | | | | |
| 16) Power Supply | 48-250 Vdc; 48-240 Vac | | | | | | | | | | | | | | | | 1 | | | |
| | 24-60 Vdc | | | | | | | | | | | | | | | | 2 | | | |
| 17) Reserved | Reserved | | | | | | | | | | | | | | | | | X | | |
| 18) Version | Version 1.1 | | | | | | | | | | | | | | | | | | B | |

Note 1: When the Arc Flash Detection option is selected then fiber lens must be quoted and ordered separately.

**Example code:** **H A F A A C A D N A E 1 B A N 1 X B**

**Your ordering code:**

| **Digit (#)** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Code** | | | | | | | | | | | | | | | | | | |

Fig. 10: Ordering key for complete relays

# 21. Accessories and ordering data

| Item | Order Number |
|---|---|
| **Tools** | |
| PCM600 V2.0 user tool | PCM600-20 |
| **Cables** | |
| Cable for optical sensors for arc protection 1.5 m | 1MRS120534-1.5 |
| Cable for optical sensors for arc protection 3.0 m | 1MRS120534-3.0 |
| Cable for optical sensors for arc protection 5.0 m | 1MRS120534-5.0 |
| **Mounting accessories** | |
| Semi-flush mounting kit | 1MRS050696 |
| Wall mounting kit | 1MRS050697 |
| Inclined semi-flush mounting kit | 1MRS050831 |
| 19 ” rack mounting kit with cutout for one relay, ANSI 61 | 604539-K1 |
| 19 ” rack mounting kit with cutout for one relay, ANSI 70 | 604539-K3 |
| 19 ” rack mounting kit with cutout for two relays , ANSI 61 | 604540-K1 |
| 19 ” rack mounting kit with cutout for two relays , ANSI 70 | 604540-K3 |
| **Test switches:** | |
| FT-1, FT-14, and FT-19 Flexitest switches | See Descriptive bulletins DB 41-077 and DB 41-078 on www.abb.com/substationautomation |

# 22. Tools

The relay is delivered as a pre-configured unit. The default parameter setting values can be changed from the front-panel user interface, the web-browser based user interface (WHMI) or the PCM600 tool in combination with the relay specific connectivity package (CP).

PCM600 offers extensive relay configuration functions such as relay signal configuration using the signal matrix tool, and IEC 61850 communication configuration including horizontal relay-to-relay communication, GOOSE.

When the web-browser based user interface is used, the relay can be accessed either locally or remotely using a web browser (IE 6.0 or later). For security reasons, the web-browser based user interface is disabled by default. The interface can be enabled with the PCM600 tool or from the front panel user interface. The functionality of the interface can be limited to read-only access by means of PCM600.

**Tools**

| Configuration, setting and SA system tools | Version |
|---|---|
| PCM600 | 2.0 SP1 or later |
| Web-browser based user interface | IE 6.0 or later |
| REF615 Connectivity Package | 1.2 or later |
| MicroSCADA Pro Substation Automation system | 9.2 SP1 or later |

| Function | WebHMI | PCM600 |
|---|---|---|
| Relay signal configuration via Signal Matrix Tool (SMT) | – | • |
| IEC 61850 communication configuration, GOOSE via Communication Configuration Tool (CCT) | – | • |
| DNP3.0 Level 2+ point mapping and scaling | – | • |
| Relay paramter setting | • | • |
| Saving of relay parameter settings in the relay | • | • |
| Saving of relay parameter settings in the tool | • | • |
| Signal monitoring | – | • |
| Digital fault recorder (DFR) handling | • | • |
| Digital fault recorder (DFR) analysis | – | • |
| Event viewing | – | • |
| Saving of event data on the user's PC | • | • |
| Alarm LED viewing | • | – |
| Phasor diagram viewing | • | – |
| Access control management | • | • |

• = Supported

# 23. Terminal diagrams

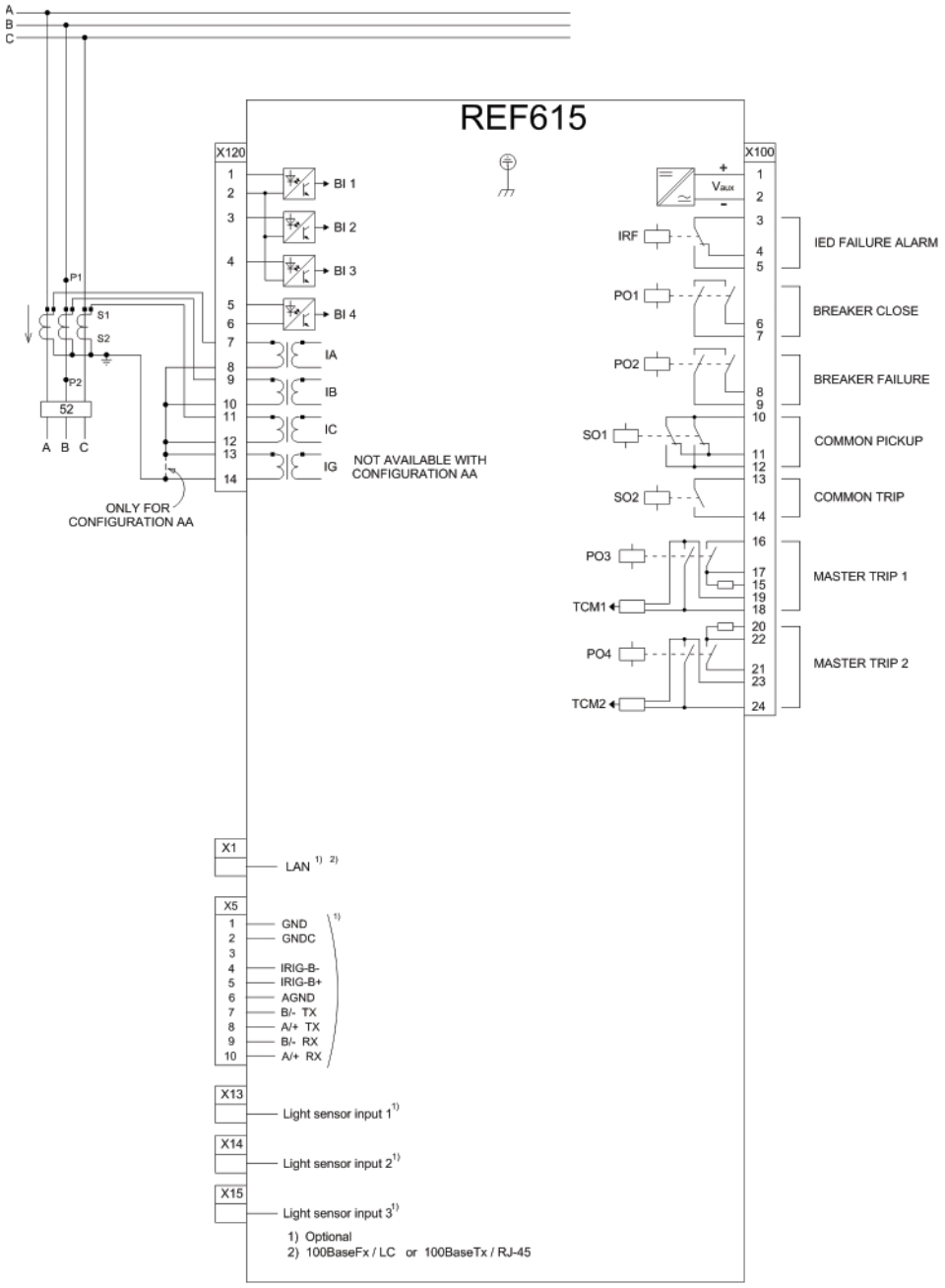



Fig. 11: Terminal diagram of "3CT" analog inputs with standard and optional Binary I/O and without optional reclosing

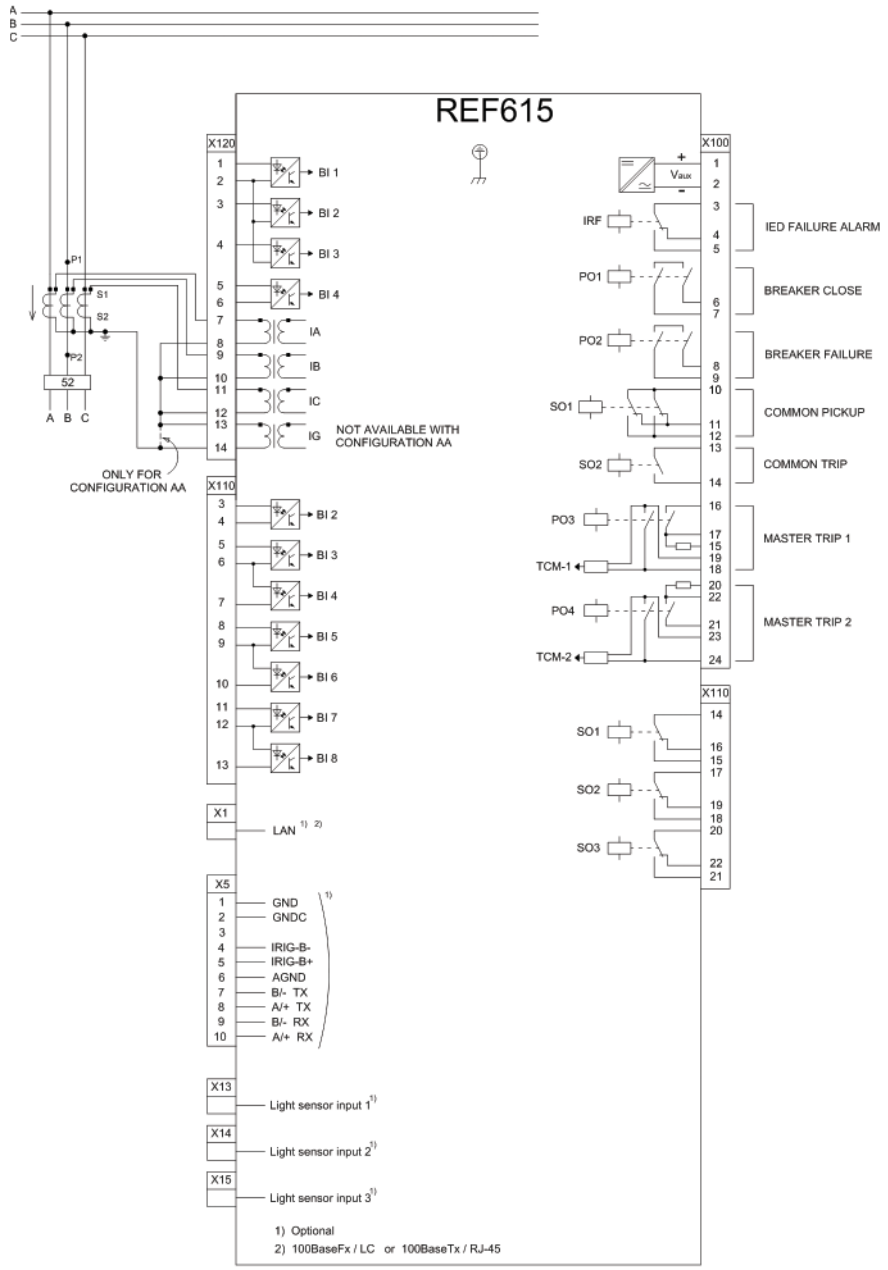



Fig. 12: Terminal diagram of “3CT + Ground CT” and “3CT + SEF CT” analog inputs with standard and optional Binary I/O and optional reclosing

# 24. Certificates

KEMA has issued an IEC 61850 Certificate Level A1 for REF615. Certificate number: 30710144-Consulting 08-0115

The download area on the right hand side of the web page contains the latest product documentation, such as technical reference manual, installation manual, operators manual,etc. The selection tool on the web page helps you find the documents by the document category and language.

The Features and Application tabs contain product related information in a compact format.

# 25. References

The www.abb.com/substationautomation portal offers you information about the distribution automation product and service range.

You will find the latest relevant information on the REF615 protection relay on the product page.

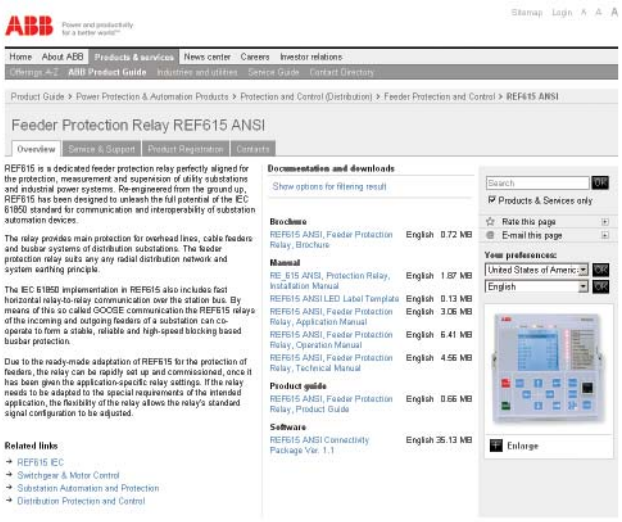



Fig 13. Product page

# 26. Functions, codes and symbols

| Function | IEC 61850 | ANSI |
|---|---|---|
| **Standard functions:** | | |
| Three-phase current measurement | CMMXU1 | IA, IB, IC |
| Sequence current measurement | CSMSQI | I1, I2, I0 |
| Three-phase transformer inrush detector | INRPHAR1 | INR |
| Cold load timer 1 (Seconds) | TPSGAPC1 | 62CLD-1 |
| Cold load timer 2 (Minutes) | TPMGAPC1 | 62CLD-2 |
| Three-phase non-directional time overcurrent protection, low stage | PHLPTOC1 | 51P |
| Three-phase non-directional time overcurrent protection, high stage 1 | PHHPTOC1 | 50P-1 |
| Three-phase non-directional time overcurrent protection, high stage 2 | PHHPTOC2 | 50P-2 |
| Three-phase non-directional instantaneous overcurrent protection | PHIPTOC1 | 50P-3 |
| Three-phase non-directional long time overcurrent protection | PHLTPTOC1 | 51LT |
| Neutral non-directional time overcurrent protection, low stage (Calculated 3I0) | EFLPTOC2 | 51N |
| Neutral non-directional time overcurrent protection, high stage 1 (Calculated 3I0) | EFHPTOC3 | 50N-1 |
| Neutral non-directional time overcurrent protection, high stage 2 (Calculated 3I0) | EFHPTOC4 | 50N-2 |
| Neutral non-directional instantaneous overcurrent protection (Calculated 3I0) | EFIPTOC2 | 50N-3 |
| Negative sequence time overcurrent protection 1 | NSPTOC1 | 46-1 |
| Negative sequence time overcurrent protection 2 | NSPTOC2 | 46-2 |
| Phase discontinuity protection | PDNSPTOC1 | 46PD |
| Three-phase thermal overload protection for feeders | T1PTTR1 | 49F |
| Circuit breaker failure protection | CCBRBRF1 | 50BF |
| Trip circuit monitoring 1 | TCSSCBR1 | TCM-1 |
| Trip circuit monitoring 2 | TCSSCBR2 | TCM-2 |
| Electrically latched/self-resetting trip output 1 | TRPPTRC1 | 86/94-1 |
| Electrically latched/self-resetting trip output 2 | TRPPTRC2 | 86/94-2 |
| Digital fault recorder | DREC | DFR |
| Sequence of events recorder | SoE | SER |
| Fault recorder | FLTMSTA | FLR |
| CB control | CBXCBR1 | 52-1 |
| Optional functions: | | |
| Ground current measurement | RESCMMXU1 | IG |
| Ground non-directional time overcurrent, low stage (Measured 3I0) | EFLPTOC1 | 51G |
| Ground non-directional time overcurrent, high stage 1 (Measured 3I0) | EFHPTOC1 | 50G-1 |
| Ground non-directional time overcurrent, high stage 2 (Measured 3I0) | EFHPTOC2 | 50G-2 |
| Ground non-directional instantaneous overcurrent (Measured 3I0) | EFIPTOC1 | 50G-3 |
| Non-directional sensitive earth-fault protection | EFIPTOC3 | 50SEF |
| Autoreclosing | DARREC1 | 79 |
| Arc flash detector 1 | ARCPSARC1 | AFD-1 |
| Arc flash detector 2 | ARCPSARC2 | AFD-2 |
| Arc flash detector 3 | ARCPSARC3 | AFD-3 |
| High impedance fault detector | PHIZ1 | HIZ |

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