Feeder Protection Relay

REF 610

Buyer's Guide - ANSI version

Features

- Three-phase non-directional overcurrent protection with definite-time or IDMT (mode) characteristic, low-set element

- Three-phase non-directional overcurrent protection with definite-time or instantaneous characteristic, high-set element

- Three-phase non-directional overcurrent protection with definite-time or instantaneous characteristic, instantaneous element

- Non-directional ground fault protection with definite-time, IDMT (mode) or instantaneous characteristic, low-set element

- Non-directional ground-fault protection with definite-time or instantaneous characteristic, high-set element

- Three-phase thermal overload protection for cables

- Arc protection
  - two lens sensors for arc detection (optional)
  - automatic reference level adjustment based on backlight intensity
  - arc detection via a remote light signal

- Automatic reclosing 1...3 shots

- Circuit-breaker failure protection

- Trip counters for circuit-breaker condition monitoring

- Trip-circuit supervision with possibility to route the warning signal to a signal output

- Trip lockout function

- Four accurate current inputs

- User-selectable rated frequency 50/60 Hz

- Three normally open power output contacts

- Two change-over signal output contacts and three additional change-over signal output contacts on the optional I/O module

- Output contact functions freely configurable for desired operation

- Two galvanically isolated digital inputs and three additional galvanically isolated digital inputs on the optional I/O module

- Disturbance recorder
  - recording time up to 80 seconds
  - triggering by one or several internal or digital input signals
  - records four analog channels and up to eight user-selectable digital channels
  - adjustable sampling rate

- Non-volatile memory for
  - up to 100 event codes with time stamp
  - setting values
  - disturbance recorder data
  - recorded data of the five last events with time stamp
  - number of AR shots and pickups/trips for protection elements
  - target messages and LEDs showing the status at the moment of power failure

- HMI with an alphanumeric LCD and manoeuvring buttons
  - eight programmable LEDs

- Multi-language support

- User-selectable password protection for the HMI

- Display of primary current values

- Demand values

- All settings can be modified with a PC

- Optical front communication connection: wirelessly or via cable

- Optional rear communication module with plastic fibre-optic, combined fibre-optic (plastic and glass) or RS-485 connection for system communication using the SPA-bus, IEC 60870-5-103 or Modbus (RTU and ASCII) communication protocol

- Optional DNP 3.0 rear communication module with RS-485 connection for system communication using the DNP 3.0 communication protocol.

- Battery back-up for real-time clock

- Battery charge supervision

- Continuous self-supervision of electronics and software.

- Detachable plug-in unit

Application

REF 610 is a versatile multifunction protection relay mainly designed for protection of incoming and outgoing feeders in MV distribution substations. REF 610 can also be used as back-up protection for motors, transformers and generators, in industrial as well as in utility applications.

The large number of integrated protection functions, including three-element overcurrent protection, two-element, non-directional ground-fault protection as well as thermal protection, makes REF 610 a complete protection against overcurrent and ground faults.

The optional arc protection for detection of arc situations in air insulated metal-clad switchgears and the auto-reclose function for automatic clearing of overhead line faults increase the range of applications further.

The large number of digital inputs and output contacts allows a wide range of applications.

Design

REF 610 is based on a microprocessor environment. A self-supervision system continuously monitors the operation of the relay.

The HMI includes a Liquid Crystal Display (LCD) which makes the local use of the relay safe and easy.

Local control of the relay via serial communication can be carried out with a computer connected to the front communication port. Remote control can be carried out via the rear connector connected to the control and monitoring system through the serial communication bus.

Auxiliary voltage

REF 610 requires a secured auxiliary voltage supply to operate. The internal power supply of the relay forms the voltages required by the relay electronics. The power supply is a galvanically isolated (flyback-type) DC/DC converter. When the auxiliary voltage is connected, the green indicator LED (ready) on the front panel will be on. For detailed information on power supply, refer to Table 10.

The primary side of the power supply is protected with a fuse located on the PCB of the relay.

Technical data

Protection functions

Table 1: Elements 51P, 50P-1 and 50P-2

Feature	Element 51P	Element 50P-1	Element 50P-2
Set pickup value, 51P, 50P-1 and 50P-2			
• at definite-time characteristic	$0.30...5.00 \times I_{n\,(CT)}$	$0.50...35.0 \times I_{n\,(CT)}$	$0.50...35.0 \times I_{n\,(CT)}$
• at IDMT (mode) characteristic	$0.30...2.50x\ I_{n\,(CT)}$[1]		
Pickup time, typical	55 ms	30 ms	30 ms
Time/current characteristic			
• definite-time operate time, 51P TDLY, 50P-1 TDLY and 50P-2 TDLY	0.05...300 s	0.04...300 s	0.04...300 s
• IDMT (mode) according to IEC 60255-3	Extremely inverse Very inverse Normal inverse Long-time inverse		
time multiplier, 51P TD IEC	0.05...1.00		
• Special type of IDMT (mode) characteristic	RI-type inverse		
time multiplier, 51P TD IEC	0.05...1.00		
• IDMT (mode) according to IEEE C37.112	Extremely inverse Very inverse Moderately inverse		
time dial, 51P TD ANSI	1...15		
Resetting time, maximum	50 ms [2]	50 ms	50 ms
Retardation time, typical	30 ms	30 ms	30 ms
Set resetting time, 51P RSET	0.05...2.50 s		
Drop-off/pick-up ratio, typical	0.96	0.96	0.96
Operate time accuracy			
• at definite-time characteristic	±2% of the set operate time or ±25 ms	±2% of the set operate time or ±25 ms	±2% of the set operate time or ±25 ms
• at IDMT (mode) characteristic according to IEC 60255-3: accuracy class index E	5		
• at IDMT (mode) characteristic according to IEEE C37.112	±7% of the calculated operate time		
• at RI-type characteristic	±7% of the calculated operate time		
Operation accuracy			
• $0.3...0.5 \times I_n$ (CT)	±5% of the set pickup value or 0.05% I_n		
• $0.5...5.0 \times I_n$ (CT)	±3% of the set pickup value	±3% of the set pickup value	±3% of the set pickup value
• $5.0...35.0 \times I_n$ (CT)		±3% of the set pickup value	±3% of the set pickup value

[1] At IDMT (mode) characteristic, the relay allows settings above 2.5 x I_n for element 51P, but regards any setting >2.5 x I_n (CT) as equal to 2.5x I_n (CT).
[2] Resetting time of the trip signal.

Technical data (cont´d)

Table 2: Elements 51N and 50N

Feature	Element 51N	Element 50N
Set pickup value, 51N and 50N		
• at definite-time characteristic	1.0...100% I_n (CT)	5.0...400% I_n (CT)
• at IDMT (mode) characteristic	1.0...40% I_n (CT)[1]	
Pickup time, typical	60 ms	40 ms
Time/current characteristic		
• definite time operate time, 51N TDLY and 50N TDLY	0.05...300 s	0.04...300 s
• IDMT (mode) according to IEC 60255-3	Extremely inverse Very inverse Normal inverse Long-time inverse	
time multiplier, 51N TD IEC	0.05...1.00	
• Special type of IDMT (mode) characteristic	RI-type inverse	
time multiplier, 51N TD IEC	0.05...1.00	
• IDMT (mode) according to IEEE C37.112	Extremely inverse Very inverse Moderately inverse	
time dial, 51N TD ANSI	1...15	
Resetting time, maximum	50 ms [2]	50 ms
Retardation time, typical	30 ms	30 ms
Set resetting time, t_{r0}	0.05...2.50 s	
Drop-off/pick-up ratio, typical	0.96	0.96
Operate time accuracy		
• at definite-time characteristic	±2% of the set operate time or ±25 ms	±2% of the set operate time or ±25 ms
• at IDMT (mode) characteristic according to IEC 60255-3: accuracy class index E	5	
• at IDMT (mode) characteristic according to IEEE C37.112	±7% of the calculated operate time	
• at RI-type characteristic	±7% of the calculated operate time	
Operation accuracy		
• 1.0...10.0% I_n (CT)	±5% of the set pickup value or 0.05% I_n	±5% of the set pickup value or 0.05% I_n
• 10.0...100% I_n (CT)	±3% of the set pickup value	±3% of the set pickup value
• 100...400% I_n (CT)		±3% of the set pickup value

[1] At IDMT (mode) characteristic, the relay allows settings above 0.4 x I_n (CT) for element 51N, but regards any setting >0.4 x I_n (CT) as equal to 0.4 x I_n (CT).
[2] Resetting time of the trip signal.

Technical data (cont´d)

Table 3: Element 49

Feature	Value
Set full load current, FLA	0.30...1.50 x I_n (CT)
Set alarm level, 49 ALARM	50...100%
Trip level, 49 Trip	100%
Time constant, τ	1...200 min
Operate time accuracy I/FLA >1.2	±2% of the set operate time or ±1 s

Table 4: Element 46

Feature	Value
Set pickup value, 46 • at definite-time characteristic	10...100%
pickup time, typical	100 ms
Time/current characteristics • definite time operate time, 46 TDLY	1...300 s
Resetting time, maximum	70 ms
Drop-off/pick-up ratio, typical	0.90
Operate time accuracy • at definite-time characteristic	±2% of the set operate time or ±25 ms
Operation accuracy • 10...100%	±3% of the set pickup value and ±1 unit

Table 5: Element ARC and L>

Feature	Value
Element ARC	
Set current limit • Arc 50P • Arc 50N	0.5...35.0 x I_n (CT) 5.0...400% I_n (CT)
Operate time	< 15 ms [1]
Resetting time	30 ms
Operation accuracy	±7% of the set pickup value
L>	
Activation time of L>	< 15 ms
Resetting time	20 ms

[1] Applies only if a signal output contact (SO1...5) is used.
   If a power output contact (PO1...3) is used, 2...3 ms will be added.
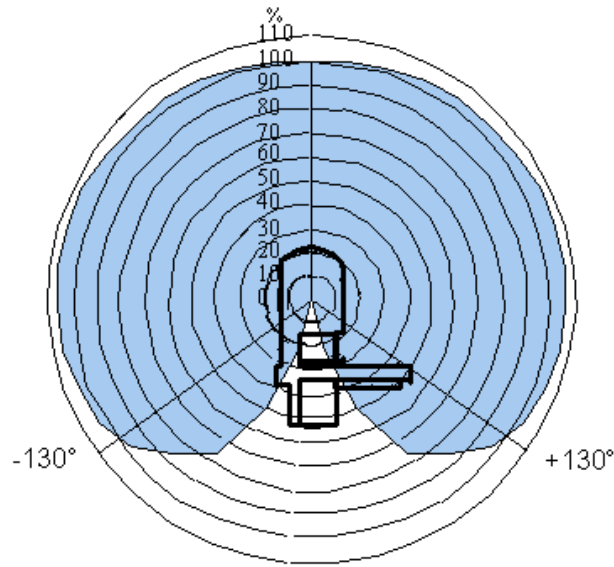
Technical data (cont´d)

ArcSensitREF610_a

Fig. 6   Relative sensitivity of lens sensors

Table 7: Auto-reclose function

Feature	Value
Number of shots	0...3
CB Closing time	0.1...10 s
pickup delay of element 51P	0...300 s
pickuppickup delay of element 51N	0...300 s
Reset time	3...300 s
Cutout time	0.1...300 s
Open time of shot 1	0.1...300 s
Open time of shot 2	0.1...300 s
Open time of shot 3	0.1...300 s
Operate time accuracy	±2% of the set time and ±25 ms

Table 8: CBFP

Feature	Value
Set operate time	0.10...60.0 s
Phase-current threshold for external triggering of the CBFAIL pick-up/drop-off	0.08/0.04 x I_n (CT)

Technical data (cont´d)

Technical data

Table 9: Dimensions

Width	frame 177 mm, case 164 mm
Height	frame 177 mm (4U), case 160 mm
Depth	case 149.3 mm
Weight of the relay	~3.5 kg
Weight of the spare unit	~1.8 kg
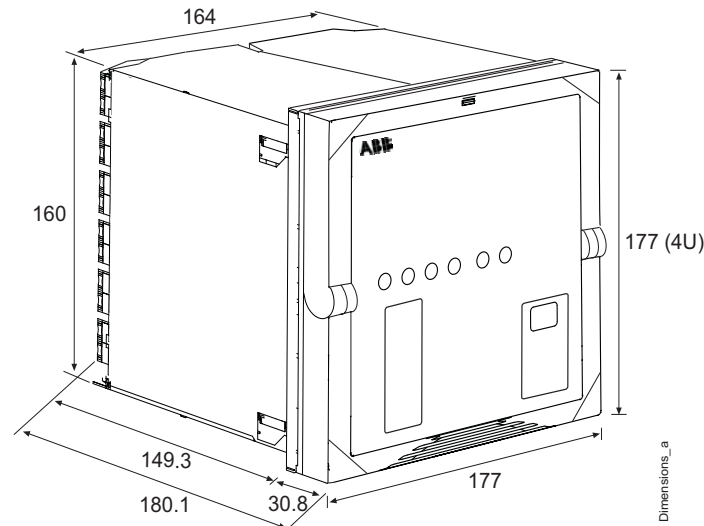
Fig. 1   Dimensions of the relay

Table 10: Power supply

REF610xxxHxxx	85...110% of U_r (ac) 80...120% of U_r (dc)
REF610xxxLxxx	80...120% of U_r (dc
Burden of auxiliary voltage supply under quiescent (P_q)/operating condition	<9 W/13 W
Ripple in the dc auxiliary voltage	Max 12% of the dc value
Interruption time in the auxiliary dc voltage without resetting the relay	<50 ms at U_{aux} rated
Time to trip from switching on the auxiliary voltage	<350 ms
Internal over temperature limit	+100°C (~212 °F)
Fuse type	T2A/250 V

Table 11: Energizing inputs

Rated frequency	50/60 Hz ± 5 Hz		
Rated current, I_n	0.2 A	1 A	5 A
Thermal withstand capability • continuously • for 1 s • for 10 s	1.5 A 20 A 5 A	4 A 100 A 25 A	20 A 500 A 100 A
Dynamic current withstand • half-wave value	50 A	250 A	1250 A
Input impedance	<750 mΩ	<100 mΩ	<20 mΩ

Technical data (cont´d)

Table 12: Measuring range

Measured currents on phases I_{L1}, I_{L2} and I_{L3} as multiples of the rated currents of the energizing inputs	0...50 x I_n
Ground fault current as a multiple of the rated current of the energizing input	0...8 x I_n

Table 13: Digital inputs

Operating range	±20% of the rated voltage
Rated voltage • DI1...DI2 REF610xxxHxxx • DI1...DI2 REF610xxxLxxx • DI3...DI5 (optional) REF610xxxxxHx • DI3...DI5 (optional) REF610xxxxxLx	110/125/220/250 V dc 24/48/60/110/125/220/250 V dc 110/125/220/250 V dc 24/48/60/110/125/220/250 V dc
Current drain	2...18 mA
Power consumption/input	≤0.9 W

Table 14: Non-trip output SO1 and optional SO4 and SO5

Rated voltage	250 V ac/dc
Continuous carry	5 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R <40 ms, at 48/110/220 V dc	1 A/0.25 A/0.15 A 5 A/3 A/1 A for series connection of SO4 and SO5
Minimum contact load	100 mA at 24 V ac/dc

Table 15: Non-trip output SO2, optional SO3 and IRF output

Rated voltage	250 V ac/dc
Continuous carry	5 A
Make and carry for 3.0 s	10 A
Make and carry for 0.5 s	15 A
Breaking capacity when the control-circuit time constant L/R <40 ms, at 48/110/220 V dc	1 A/0.25 A/0.15 A
Minimum contact load	100 mA at 24 V ac/dc

Table 16: Trip outputs PO1, PO2 and PO3

Rated voltage	250 V ac
Continuous carry	5 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R <40 ms, at 48/110/220 V dc (PO1 with both contacts connected in series)	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V ac/dc
TCS • Control voltage range • Current drain through the supervision circuit • Minimum voltage over a contact	20...265 V ac/dc ~1.5 mA 20 V ac/dc (15...20 V)

Technical data (cont´d)   **Table 17: Lens sensor and optic fibre for arc protection**

Normal service temperature range	-40°C...+100°C (~-40...~212°F)
Maximum service temperature, max. 1 hour	+140°C (~284°F)
Minimum permissible bending radius of the fibre cable	100 mm (~4")

Table 18: Enclosure class of the flush-mounted relay

Front side	IP 54 (NEMA 35)
Top of the relay	IP 40 (Protectec against solid objects grater than 1.0 mm)
Rear side, connection terminals	IP 20 (Protectec against solid objects grater than 12 mm)

Table 19: Environmental tests and conditions

Recommended service temperature range (continuous)	-10...+55°C (~-14...~131°F)
Limit temperature range (short-term)	-40...+70°C (~-40...~158°F)
Transport and storage temperature range	-40...+85°C according to IEC 60068-2-48
Dry heat test	According to IEC 60068-2-2
Dry cold test	According to IEC 60068-2-1
Damp heat test, cyclic	According to IEC 60068-2-30

Table 20: Electromagnetic compatibility tests

EMC immunity test level meets the requirements listed below	
1 MHz burst disturbance test, class III	According to IEC 60255-22-1
• Common mode	2.5 kV
• Differential mode	1.0 kV
Electrostatic discharge test, class IV	According to IEC 61000-4-2, IEC 60255-22-2 and ANSI C37.90.3-2001
• For contact discharge	8 kV
• For air discharge	15 kV
Radio frequency interference tests • Conducted, common mode	According to IEC 61000-4-6 and IEC 60255-22-6 (2000) 10 V (rms), f=150 kHz...80 MHz
• Radiated, amplitude-modulated	According to IEC 61000-4-3 and IEC 60255-22-3 (2000) 10 V/m (rms), f=80...1000 MHz
• Radiated, pulse-modulated	According to the ENV 50204 and IEC 60255-22-3 (2000) 10 V/m, f=900 MHz
Fast transient disturbance tests	According to IEC 60255-22-4, IEC 61000-4-4
• Trip outputs, energizing inputs, power supply	4 kV
• I/O ports	2 kV
Surge immunity test • Power outputs, energizing inputs, power supply	According to IEC 61000-4-5 4 kV, line-to-ground
	2 kV, line-to-line
• I/O ports	2 kV, line-to-ground
	1 kV, line-to-line

Technical data (cont´d)

Table 20: Electromagnetic compatibility tests

Power frequency (50 Hz) magnetic field IEC 61000-4-8	300 A/m continuous
Voltage dips and short interruptions	According to IEC 61000-4-11 30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms
Electromagnetic emission tests • Conducted, RF-emission (Mains terminal) • Radiated RF-emission	According to the EN 55011 EN 55011, class A, IEC 60255-25 EN 55011, class A, IEC 60255-25
CE approval	Complies with the EMC directive 89/336/EEC and the LV directive 73/23/EEC

Table 21: Standard tests

Insulation tests	
Dielectric tests • Test voltage	According to IEC 60255-5 2 kV, 50 Hz, 1 min
Impulse voltage test • Test voltage	According to IEC 60255-5 5 kV, unipolar impulses, waveform 1.2/50 µs, source energy 0.5 J
Insulation resistance measurements • Isolation resistance	According to IEC 60255-5 >100 MΩ, 500 V dc
Mechanical tests	
Vibration tests (sinusoidal)	According to IEC 60255-21-1, class I
Shock and bump test	According to IEC 60255-21-2, class I

Table 22: Data communication

| |
|---|
| Rear interface, connector X5.3, X5.4, X5.5 or X5.8 • Fibre-optic or RS-485 connection • SPA bus, IEC 60870-5-103 DNP3.0 or Modbus protocol • 9.6 or 4.8 kbps (additionally 2.4, 1.2 or 0.3 kbps for Modbus) |
| Front interface • Optical connection (infrared): wirelessly or via the front communication cable (1MRS050698) • SPA bus protocol • 9.6 or 4.8 kbps (9.6 kbps with front communication cable) |

Connection diagram
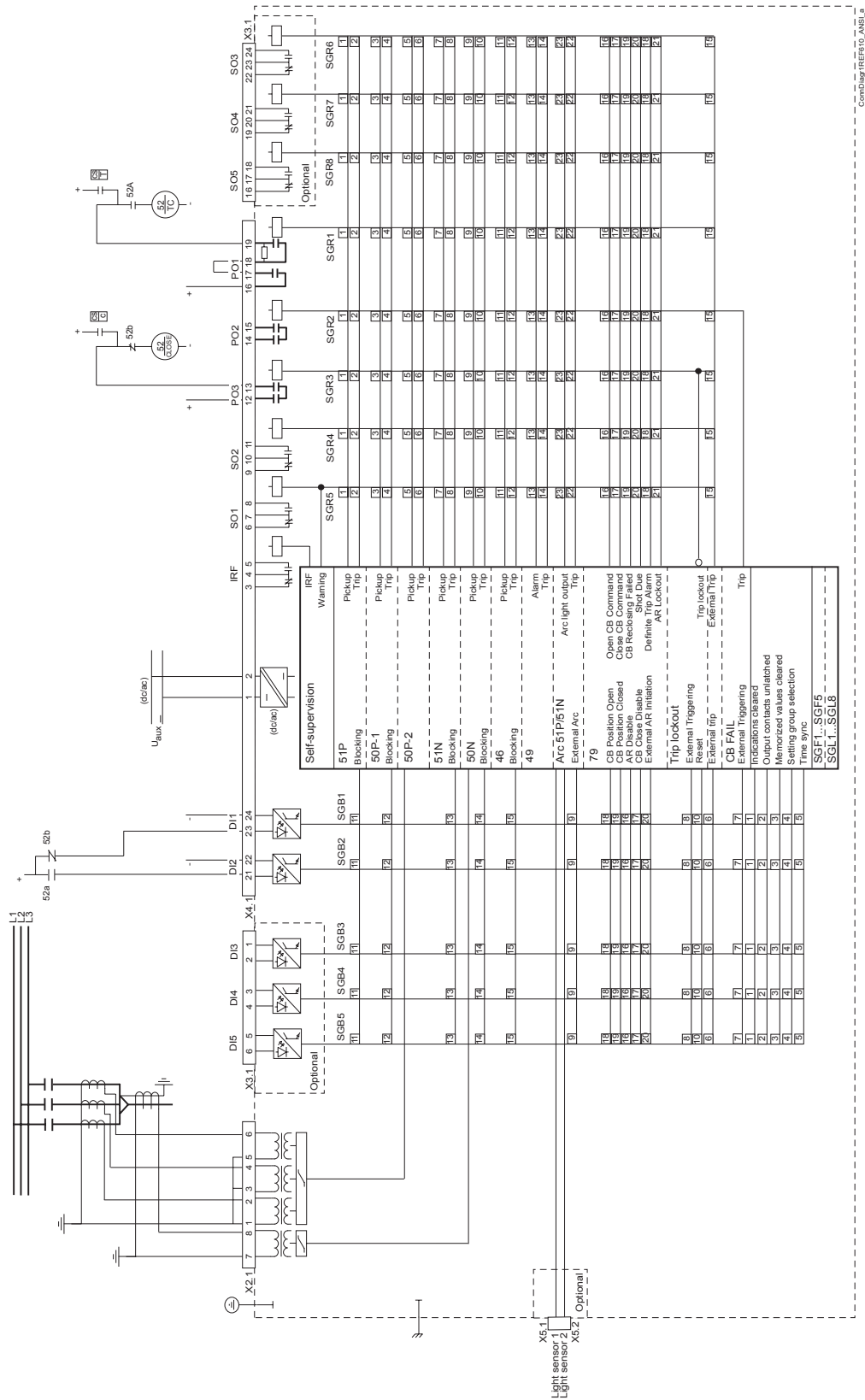
Fig. 2   Example connection

Ordering

When ordering REF 610 protection relays and/or accessories, please specify the following:

- Order number

- Quantity

The order number identifies the protection relay type and hardware as described in the figures below and is labelled on the marking strip under the lower handle of the relay.

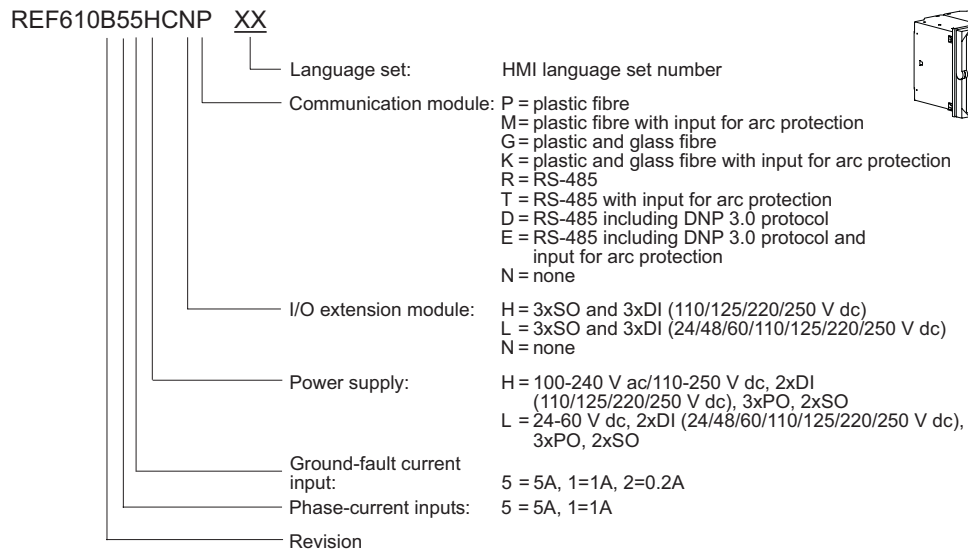Use the ordering key in Fig. 3 to generate the order number when ordering complete protection relays:

REF610B55HCNP XX

- Language set: HMI language set number
- Communication module: P = plastic fibre
  M = plastic fibre with input for arc protection
  G = plastic and glass fibre
  K = plastic and glass fibre with input for arc protection
  R = RS-485
  T = RS-485 with input for arc protection
  D = RS-485 including DNP 3.0 protocol
  E = RS-485 including DNP 3.0 protocol and input for arc protection
  N = none
- I/O extension module: H = 3xSO and 3xDI (110/125/220/250 V dc)
  L = 3xSO and 3xDI (24/48/60/110/125/220/250 V dc)
  N = none
- Power supply: H = 100-240 V ac/110-250 V dc, 2xDI (110/125/220/250 V dc), 3xPO, 2xSO
  L = 24-60 V dc, 2xDI (24/48/60/110/125/220/250 V dc), 3xPO, 2xSO
- Ground-fault current input: 5 = 5A, 1=1A, 2=0.2A
- Phase-current inputs: 5 = 5A, 1=1A
- Revision

Fig. 3   Ordering key for complete relays

HMI language set numbers, and corresponding terminology and languages included, are described in Table 15:

Table 23: HMI language codes

Language set number	Terminology	Languages
11	ANSI	English, Español, Portuguese

Use the ordering key in Fig. 4 to generate the order number when ordering spare units:

REF610B55HSNS XX
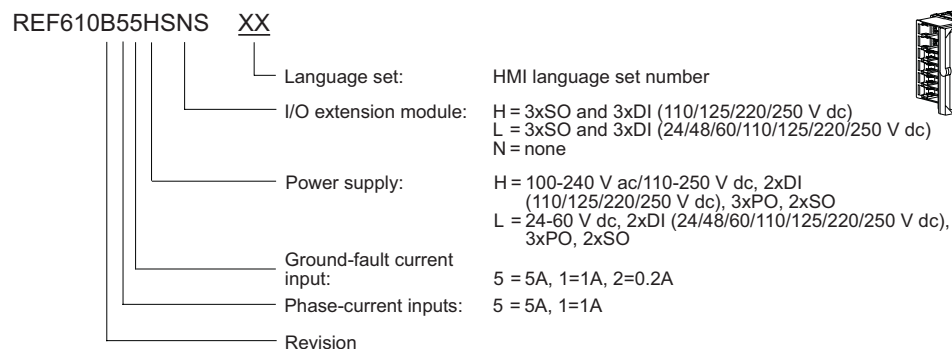
- Language set: HMI language set number
- I/O extension module: H = 3xSO and 3xDI (110/125/220/250 V dc)
  L = 3xSO and 3xDI (24/48/60/110/125/220/250 V dc)
  N = none
- Power supply: H = 100-240 V ac/110-250 V dc, 2xDI (110/125/220/250 V dc), 3xPO, 2xSO
  L = 24-60 V dc, 2xDI (24/48/60/110/125/220/250 V dc), 3xPO, 2xSO
- Ground-fault current input: 5 = 5A, 1=1A, 2=0.2A
- Phase-current inputs: 5 = 5A, 1=1A
- Revision

Fig. 4   Ordering key for spare units

The following accessories are available:

Item	Order number
Semi-flush mounting kit	1MRS050696
Inclined ($\underline{/}\,25^o$) semi-flush mounting kit	1MRS050831
Wall mounting kit	1MRS050697
19" Rack mounting kit, side-by-side	1MRS050695
19" Rack mounting kit, single relay	1MRS050694
19" Rack mounting kit for single relay and RTXP18	1MRS050783
19" equipment frame mounting (Combiflex), plain bracket	1MRS061208
19" equipment frame mounting (Combiflex), bracket for RTXP18	1MRS061207
Pre-manufactured lens sensor and optic fibre for arc protection:	
• 1.5 m $\pm3\%$	1MRS120534-1.5
• 3 m $\pm3\%$	1MRS120534-3.0
• 5 m $\pm3\%$	1MRS120534-5.0
Front communication cable	1MRS050698

References

Available manuals:

Item	Order number
Technical Reference Manual -ANSI version	1MRS 755535
Operator's Manual -ANSI version	1MRS 755539
Installation Manual	1MRS 752265-MUM (version B or later)

Configuration, setting and SA system tools:

The following tool versions are needed to support the new functions and features of REF 610 release B:

CAP 501 Relay Setting Tool	CAP 501 v. 2.2.0-3 or later
CAP 505 Relay Setting Tool	CAP 505 v. 2.2.0-3 or later
SMS 510 Substation Monitoring System	SMS 510 v. 1.2.0-1 or later
LIB 510 Library for MicroSCADA v. 8.4.4	LIB 510 v. 4.0.5-1 or later

ABB