NA90 PHASE & RESIDUAL OVERCURRENT, PHASE & GROUND DIRECTIONAL, THERMAL IMAGE, PHASE UNDER/OVERVOLTAGE, RESIDUAL OVERVOLTAGE WITH TWO INDEPENDENT RESIDUAL CURRENT INPUTS

Application

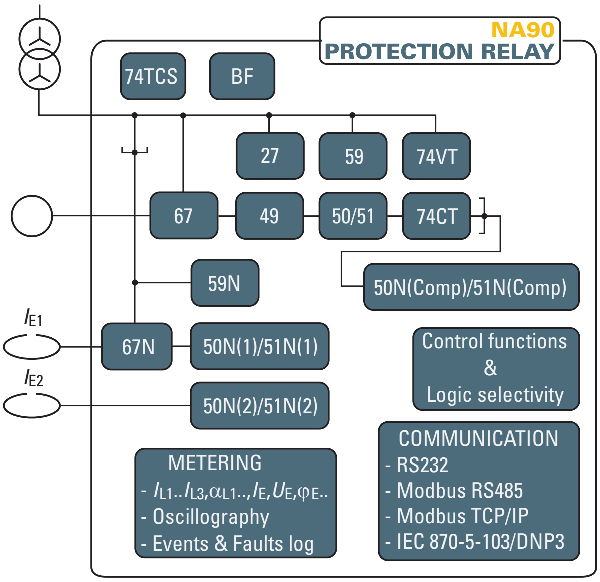
The relay type NA90 can be typically used in radial or meshed MV and LV networks as feeder or power transformer protection:

- On radial, ring and parallel feeders of any length in solidly grounded, ungrounded, Petersen coil and/or resistance grounded systems.
- On parallel connected generators and transformer on the same busbar.
- For ground fault protection on both sides of power MV-LV transformers.

Moreover undervoltage, overvoltage and automatic reclosing functions are provided.

Protective functions

27	Undervoltage
49	Thermal image (for lines and transformers)
50/51	Phase overcurrent
50N(1)/51N(1)	Measured residual overcurrent
50N(2)/51N(2)	Measured residual overcurrent
50N(Comp)/51N(Comp)	Computed residual overcurrent
59	Overvoltage
59N	Residual overvoltage
67	Directional phase overcurrent
67N	Directional earth fault overcurrent
79	Automatic reclosing
BF	Circuit breaker failure



Firmware updating

The use of flash memory units allows on-site firmware updating.

Measuring inputs

- Three phase current inputs and one residual current input (I_{E1}), with nominal currents independently selectable at 1 A or 5 A through DIP-switches.
- One residual current input (I_{E2}), with nominal current at 1 A.
- Three phase voltage inputs with programmable nominal voltages within range 50...130 V (U_R = 100 V) or 200...520 V (U_R = 400 V).

Construction

According to the hardware configurations, the NA90 protection relay can be shipped in various case styles depending on the required mounting options (flush, projecting mounting, rack or with separate operator panel).

Modular design

In order to extend I/O capability, the NA90 hardware can be customized through external auxiliary modules:

- MRI - Output relays and LEDs
- MID16 - Binary inputs
- MCI - 4...20 mA converters
- MPT - Pt100 thermal probes.

Binary inputs

Two binary inputs are available with programmable active state (active-ON/active-OFF) and programmable timer (active to OFF/ON or ON/OFF transitions).
Several presettable functions can be associated to each input.

Blocking input/outputs

One output blocking circuit and one input blocking circuit are provided.
The output blocking circuits of one or several Pro_N relays, shunted together, must be connected to the input blocking circuit of the protection relay, which is installed upstream in the electric plant. The output circuit works as a simple contact, whose condition is detected by the input circuit of the upstream protection relay.
Use of suitable pilot wire to fiber optic converters (BFO) allows to perform fast and reliable accelerated logic selectivity on radial and closed ring networks.

Output relays

Six output relays are available (two changeover, three make and one break contacts); each relay may be individually programmed as normal state (normally energized, de-energized or pulse) and reset mode (manual or automatic).

A programmable timer is provided for each relay (minimum pulse width). The user may program the function of each relay according to a matrix (tripping matrix) structure.

MMI (Man Machine Interface)

The user interface comprises a membrane keyboard, a backlight LCD alphanumeric display and eight LEDs.
The green ON LED indicates auxiliary power supply and self diagnostics, two LEDs are dedicated to the Start and Trip (yellow for Start, red for Trip) and five red LEDs are user assignable.

Communication

Multiple communication interfaces are implemented:

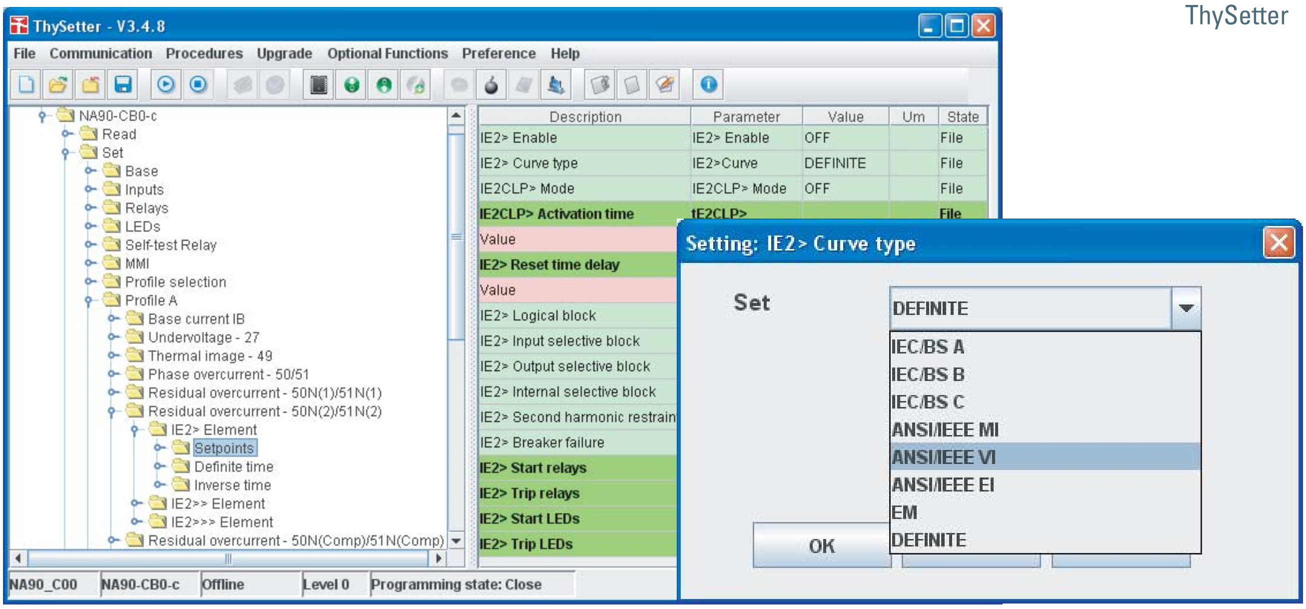
- One RS232 local communication front-end interface for communication with ThySetter setup software.
- Two back-end interfaces for communication with remote monitoring and control systems by:
  - RS485 port using ModBus® RTU, IEC 60870-5-103 or DNP3 protocol.
  - Ethernet port (RJ45 or optical fiber) using ModBus/TCP protocol.

Programming and settings

All relay programming and adjustment operations may be performed through MMI (Keyboard and display) or using a Personal Computer with the aid of the ThySetter software.
The same PC setup software is required to set, monitor and configure all Pro_N devices.
Full access to the available data is provided:

- Read status and measures.
- Read/edit settings (on-line or off-line edit).

Two session level (User or Administrator) with password for sensible data access are provided.



ThySetter

Control and monitoring

Several predefined functions are implemented:

- Activation of two set point profiles.
- Phase CTs and VTs monitoring (74CT and 74VT).
- Logic selectivity.
- Cold load pickup (CLP) with block or setting change.
- Trip circuit supervision (74TCS).
- Second harmonic restraint (inrush).
- Remote tripping.
- Circuit Breaker commands and diagnostic.

User defined logic may be customized according to IEC 61131-3 standard protocol (PLC).

Circuit Breaker

Several diagnostic, monitoring and control functions are provided:

- Health thresholds can be set; when the accumulated duty (ΣI or ΣI^2t), the number of operations or the opening time exceeds the threshold an alarm is activated.
- Breaker failure (BF); breaker status is monitored by means 52a-52b and/or through line current measurements.
- Trip circuit supervision (74TCS).
- Breaker control; opening and closing commands can be carried out locally or remotely.

Cold Load Pickup (CLP)

Cold load pickup element prevents unwanted tripping in case of temporary overcurrents produced when a feeder is being connected after an extended outage (e.g. motor starting).
Two different operating modes are provided:

- Each protective element may be blocked for a programmable time.
- Each threshold can be increased for a programmable time.

Second harmonic restraint

To prevent unwanted tripping of the protective functions on transformer inrush current, the protective elements can be blocked when the ratio between the second harmonic current and the relative fundamental current is larger than a user programmable threshold.
The function can be programmed to switch an output relay so as to cause a blocking protection relays lacking in second harmonic restraint.

Logic selectivity

With the aim of providing a fast selective protection system some protective functions may be blocked (pilot wire accelerated logic). To guarantee maximum fail-safety, the relay performs a run time monitoring for pilot wire continuity and pilot wire shorting. Exactly the output blocking circuit periodically produces a pulse, having a small enough width in order to be ignored as an effective blocking signal by the input blocking circuit of the upstream protection, but suitable to prove the continuity of the pilot wire.
Furthermore a permanent activation (or better, with a duration longer than a preset time) of the blocking signal is identified, as a warning for a possible short circuit in the pilot wire or in the output circuit of the downstream protection.

Self diagnostics

All hardware and software functions are repeatedly checked and any anomalies reported via display messages, communication interfaces, LEDs and output relays.
Anomalies may refer to:

- Hw faults (auxiliary power supply, output relay coil interruptions, MMI board...).
- Sw faults (boot and run time tests for data base, EEPROM memory checksum failure, data BUS,...).
- Pilot wire faults (break or short in the wire).
- Circuit breaker faults.

Metering

NA90 provides metering values for phase and residual currents, phase and residual voltage, making them available for reading on a display or to communication interfaces.
Input signals are sampled 24 times per period and the RMS value of the fundamental component is measured using the DFT (Discrete Fourier Transform) algorithm and digital filtering.
With DFT the RMS value of 2nd, 3rd, 4th and 5th harmonic of phase current are also measured.
On the base of the direct measurements, several calculated (min, max, average,...), phase, sequence, power, harmonic, demand and energy measures are processed.
Measures can be displayed with reference to nominal values or directly expressed in amperes and volts.

Event storage

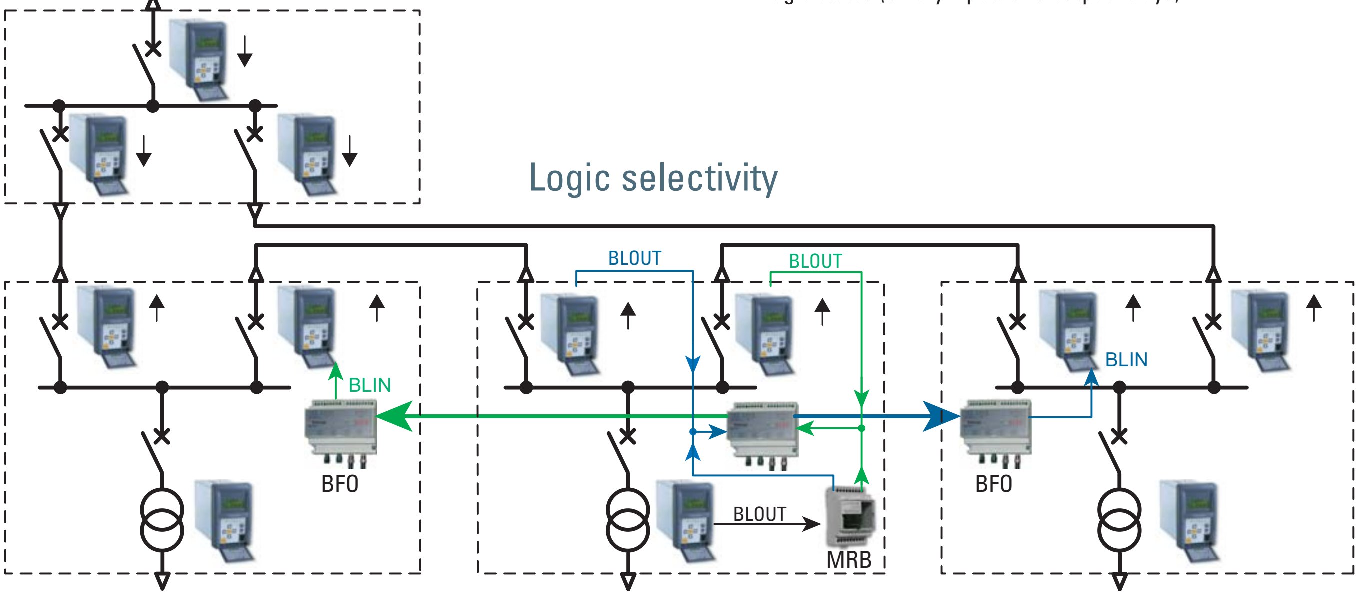
Several useful data are stored for diagnostic purpose; the events are stored into a non volatile memory.
They are graded from the newest to the older after the "Events reading" command (ThySetter) is issued:

- Sequence of Event Recorder (SER).
  The event recorder runs continuously capturing in circular mode the last three hundred events upon trigger of binary input/output.
- Sequence of Fault Recorder (SFR).
  The fault recorder runs continuously capturing in circular mode the last twenty faults upon trigger of binary input/output and/or element pickup (start-trip).
- Trip counters.

Digital Fault Recorder (Oscillography)

Upon trigger of tripping/starting of each function or external signals, the relay records in COMTRADE format:

- Oscillography with instantaneous values for transient analysis.
- RMS values for long time periods analysis.
- Logic states (binary inputs and output relays).



SPECIFICATIONS

GENERAL

☐ Mechanical data

Mounting:	flush, projecting, rack or separated operator panel
Mass (flush mounting case)	2.0 kg

☐ Insulation tests

Reference standards	EN 60255-5
High voltage test 50Hz	2 kV 60 s
Impulse voltage withstand (1.2/50 µs)	5 kV
Insulation resistance	>100 MΩ

☐ Voltage dip and interruption

Reference standards	EN 61000-4-29

☐ EMC tests for interference immunity

1 MHz damped oscillatory wave	EN 60255-22-1	1 kV-2.5 kV
Electrostatic discharge	EN 60255-22-2	8 kV
Fast transient burst (5/50 ns)	EN 60255-22-4	4 kV
Conducted radio-frequency fields	EN 60255-22-6	10 V
Radiated radio-frequency fields	EN 60255-4-3	10 V/m
High energy pulse	EN 61000-4-5	2 kV
Magnetic field 50 Hz	EN 61000-4-8	1 kA/m
Damped oscillatory wave	EN 61000-4-12	2.5 kV
Ring wave	EN 61000-4-12	2 kV
Conducted common mode (0...150 kHz)	EN 61000-4-16	10 V

☐ Emission

Reference standards	EN 61000-6-4 (ex EN 50081-2)
Conducted emission 0.15...30 MHz	Class A
Radiated emission 30...1000 MHz	Class A

☐ Climatic tests

Reference standards	IEC 60068-x, ENEL R CLI 01, CEI 50

☐ Mechanical tests

Reference standards	EN 60255-21-1, 21-2, 21-3

☐ Safety requirements

Reference standards	EN 61010-1
Pollution degree	3
Reference voltage	250 V
Overvoltage	III
Pulse voltage	5 kV
Reference standards	EN 60529
Protection degree:	
• Front side	IP52
• Rear side, connection terminals	IP20

☐ Environmental conditions

Ambient temperature	-25...+70 °C
Storage temperature	-40...+85 °C
Relative humidity	10...95 %
Atmospheric pressure	70...110 kPa

☐ Certifications

Product standard for measuring relays	EN 50263
CE conformity	
• EMC Directive	89/336/EEC
• Low Voltage Directive	73/23/EEC
Type tests	IEC 60255-6

COMMUNICATION INTERFACES

Local PC RS232	19200 bps
Network:	
• RS485	1200...57600 bps
• Ethernet 100BaseT	100 Mbps
Protocol	ModBus® RTU/IEC 60870-5-103/DNP3-TCP/IP

INPUT CIRCUITS

☐ Auxiliary power supply U_{AUX}

Nominal value (range)	24...48 Vac/dc
	115...230 Vac/110...220 Vdc
Operative range (each one of the above nominal values)	19...60 Vac/dc
	85...265 Vac/75...300 Vdc
Power consumption:	
• Maximum (energized relays, Ethernet TX)	10 W (20 VA)
• Maximum (energized relays, Ethernet FX)	15 W (25 VA)

☐ Phase current inputs

Nominal current I_n	1 A or 5 A selectable by DIP Switches
Permanent overload	25 A
Thermal overload (1s)	500 A
Rated consumption (for any phase)	≤ 0.002 VA (I_n = 1 A)
	≤ 0.04 VA (I_n = 5 A)

☐ Residual current input

Nominal current I_{En}	1 A or 5 A selectable by DIP Switch
Permanent overload	25 A
Thermal overload (1s)	500 A
Rated consumption	≤ 0.006 VA (I_{En} = 1 A)
	≤ 0.012 VA (I_{En} = 5 A)

☐ Residual current input I_{E2}

Nominal current I_{En}	1 A
Permanent overload	5 A
Thermal overload (1s)	100 A
Rated consumption	≤ 0.006 VA

☐ Voltage inputs

Reference voltage U_R	100 V or 400 V selectable on order
Nominal voltage U_n	50...130 V or 200...520 V adjustable via sw
Permanent overload	1.3 U_R
1s overload	2 U_R
Rated consumption (for any phase)	≤ 0.5 VA

☐ Binary inputs

Quantity	2
Type	dry inputs
Max permissible voltage	19...265 Vac/19...300 Vdc
Max consumption, energized	3 mA

☐ Block input (Logic selectivity)

Quantity	1
Type	polarized wet input (powered by internal isolated supply)
Max consumption, energized	5 mA

OUTPUT CIRCUITS

☐ Output relays K1...K6

Quantity	6
• Type of contacts K1, K2	changeover (SPDT, type C)
• Type of contacts K3, K4, K5	make (SPST-NO, type A)
• Type of contacts K6	break (SPST-NC, type B)
Nominal current	8 A
Nominal voltage/max switching voltage	250 Vac/400 Vac
Breaking capacity:	
• Direct current (L/R = 40 ms)	50 W
• Alternating current (λ = 0,4)	1250 VA
Make	1000 W/VA
Short duration current (0,5 s)	30 A

☐ Block output (Logic selectivity)

Quantity	1
Type	optocoupler

☐ LEDs

Quantity	8
• ON/fail (green)	1
• Start (yellow)	1
• Trip (red)	1
• Allocatable (red)	5

GENERAL SETTINGS

☐ Rated values

Relay nominal frequency (f_n)	50, 60 Hz
Relay phase nominal current (I_n)	1 A, 5 A
Phase CT nominal primary current (I_{np})	1 A...10 kA
Relay residual nominal current (I_{E1n})	1 A, 5 A
Relay residual nominal current (I_{E2n})	1 A
Residual CT nominal primary current (I_{E1np})	1 A...10 kA
Residual CT nominal primary current (I_{E2np})	1 A...10 kA
Relay nominal voltage (phase-to-phase) (U_n)	50...130 V or 200...520 V
Relay nominal voltage (phase-to-ground)	$E_n = U_n/\sqrt{3}$
Line VT primary nominal voltage (phase-to-phase) (U_{np})	50 V..500 kV
Relay residual nominal voltage (computed measure) (U_{ECn})	$U_{ECn} = \sqrt{3} \cdot U_n = 3 \cdot E_n$
Residual primary nominal voltage (phase-to-phase) $\cdot \sqrt{3}$ (U_{Enp})	50 V...500 kV
Relay nominal active power (P_n)	$P_n = \sqrt{3} \cdot U_n \cdot I_n = 3 \cdot E_n \cdot I_n$
Relay nominal reactive power (Q_n)	$Q_n = \sqrt{3} \cdot U_n \cdot I_n = 3 \cdot E_n \cdot I_n$
Relay nominal apparent power (S_n)	$S_n = \sqrt{3} \cdot U_n \cdot I_n = 3 \cdot E_n \cdot I_n$

☐ Binary input timers

ON delay time (IN1 t_{ON}, IN2 t_{ON})	0.00...100.0 s
OFF delay time (IN1 t_{OFF}, IN2 t_{OFF})	0.00...100.0 s
Logic	Active-ON/Active-OFF

☐ Relay output timers

Minimum pulse width	0.000...0.500 s

FUNCTIONS

☐ Base current IB [1]

Base current (I_B)	0.10...2.50 I_n

Note 1: the basic current IB represents the nominal current of the line or transformer, referred to the nominal current of the CT's for thermal image protection. If the secondary rated current of the line CT's equals the rated current ofthe relay, as usually happens, the IB value is the ratio between therated current of the protected element and the primary rated current of the CT's

☐ Thermal with PT100 thermometric probes - 26 [2]

PT1 probe:

ThAL1 Alarm

• PT1 Alarm threshold (*ThAL1*)	0...200 °C
• *ThAL1* Operating time (t_{ThAL1})	0...100 s

Th>1 Trip

• PT1 Trip threshold (*Th>1*)	0...200 °C
• *Th>1* Operating time ($t_{Th>1}$)	0...100 s

PT2...8: probe

ThAL2...8 Alarm

• PT2...8 Alarm threshold (*ThAL2...8*)	0...200 °C
• *ThAL2...8* Operating time ($t_{ThAL2...8}$)	0...100 s

Th>2...8 Trip

• PT2...8 Trip threshold (*Th>2...8*)	0...200 °C
• *Th>2...8* Operating time ($t_{Th>2...8}$)	0...100 s

Note 2: the element is available when the MPT module, connected to the Thybus, is enabled

☐ Undervoltage - 27

Common configuration:

• Voltage measurement type for 27 (*Utype27*) [1]	U_{ph-ph}/U_{ph-n}
• 27 Operating logic (*Logic27*)	AND/OR

U< Element

• *U<* Curve type (*U<Curve*)	DEFINITE INVERSE [2]

Definite time

• 27 First threshold definite time ($U_{<def}$)	0.05...1.10 U_n/E_n
• $U_{<def}$ Operating time ($t_{U<def}$)	0.03...100.0 s

Inverse time

• 27 First threshold inverse time ($U_{<inv}$)	0.05...1.10 U_n/E_n
• $U_{<inv}$ Operating time ($t_{U<inv}$)	0.10...100.0 s

U<< Element

Definite time

• 27 Second threshold definite time ($U_{<<def}$)	0.05...1.10 U_n/E_n
• $U_{<<def}$ Operating time ($t_{U<<def}$)	0.03...100.0 s

Note 1: With U_{ph-ph} setting all threshold are in p.u. U_n
with U_{ph-n} setting all threshold are in p.u. E_n

Note 2: The mathematical formula for INVERSE curves is::

$t = 0.75 \cdot t_{U<inv} / [1 - (U/U_{<inv})]$

where:

t = operating time (in seconds)
$t_{U<inv}$ = operating time setting (in seconds)
U = input voltage
$U_{<inv}$ = threshold setting

☐ Thermal image - 49

Common configuration:

• Initial thermal image $\Delta\theta_{IN}$ (Dth_{IN})	0.0...1.0 $\Delta\theta_B$
• Reduction factor at inrush (K_{INR})	1.0...3.0
• Thermal time constant τ (T)	1...200 min
• DthIN Activation time (t_{dthCLP})	0.00...100.0 s

DthAL1 Element

49 First alarm threshold $\Delta\theta_{AL1}$ (Dth_{AL1})	0.3...1.0 $\Delta\theta_B$

DthAL2 Element

49 Second alarm threshold $\Delta\theta_{AL2}$ (Dth_{AL2})	0.3...1.0 $\Delta\theta_B$

Dth> Element

49 Trip threshold $\Delta\theta$ (*Dth>*)	1.2 $\Delta\theta_B$

☐ Phase overcurrent - 50/51

I> Element

• *I>* Curve type (*I>Curve*)	DEFINITE IEC/BS A, B, C ANSI/IEEE MI, VI, EI RECTIFIER, I²t or EM
• $I_{CLP>}$ Activation time ($t_{CLP>}$)	0.00...100.0 s
• *I>* Reset time delay ($t_{>RES}$)	0.00...100.0 s

Definite time

• 50/51 First threshold definite time ($I_{>def}$)	0.100...40.0 I_n
• $I_{>def}$ within CLP ($I_{CLP>def}$)	0.100...40.0 I_n
• $I_{>def}$ Operating time ($t_{>def}$)	0.04...200 s

Inverse time

• 50/51 First threshold inverse time ($I_{>inv}$)	0.100...40.0 I_n
• $I_{>inv}$ within CLP ($I_{CLP>inv}$)	0.100...40.0 I_n
• $I_{>inv}$ Operating time ($t_{>inv}$)	0.02...60.0 s

I>> Element

• Type characteristic (*I>>Curve*)	DEFINITE I²t
• $I_{CLP>>}$ Activation time ($t_{CLP>>}$)	0.00...100.0 s
• *I>>* Reset time delay ($t_{>>RES}$)	0.00...100.0 s

Definite time

• 50/51 Second threshold definite time ($I_{>>def}$)	0.100...40.0 I_n
• $I_{>>def}$ within CLP ($I_{CLP>>def}$)	0.100...40.0 I_n
• $I_{>>def}$ Operating time ($t_{>>def}$)	0.03...10.00 s

Inverse time

• 50/51 Second threshold inverse time ($I_{>>inv}$)	0.100...20.00 I_n
• $I_{>>inv}$ within CLP ($I_{CLP>>inv}$)	0.100...20.00 I_n
• $I_{>>inv}$ Operating time ($t_{>>inv}$)	0.02...10.00 s

I>>> Element

• $I_{CLP>>>}$ Activation time ($t_{CLP>>>}$)	0.00...100.0 s
• *I>>>* Reset time delay ($t_{>>>RES}$)	0.00...100.0 s

Definite time

• 50/51 Third threshold definite time ($I_{>>>def}$)	0.100...40.0 I_n
• $I_{>>>def}$ within CLP ($I_{CLP>>>def}$)	0.100...40.0 I_n
• $I_{>>>def}$ Operating time ($t_{>>>def}$)	0.03...10.00 s

☐ Residual overcurrent - 50N(1)/51N(1)

I_{E1}> Element

• I_{E1}> Curve type (I_{E1}>Curve)	DEFINITE IEC/BS A, B, C ANSI/IEEE MI, VI, EI EM

- I_{E1CLP}> Activation time ($t_{E1CLP>}$) 0.00...100.0 s
- I_{E1}> Reset time delay ($t_{E1>RES}$) 0.00...100.0 s

Definite time
- 50N(1)/51N(1) First threshold definite time ($I_{E1>def}$) 0.002...10.00 I_{E1n}
- $I_{E1>def}$ within CLP ($I_{E1CLP>def}$) 0.002...10.00 I_{E1n}
- $I_{E1>def}$ Operating time ($t_{E1>def}$) 0.04...200 s

Inverse time
- 50N(1)/51N(1) First threshold inverse time ($I_{E1>inv}$) 0.002...2.00 I_{E1n}
- $I_{E1>inv}$ within CLP ($I_{E1CLP>inv}$) 0.002...2.00 I_{E1n}
- $I_{E1>inv}$ Operating time ($t_{E1>inv}$) 0.02...60.0 s

I_{E1}>> Element
- I_{E1CLP}>> Activation time ($t_{E1CLP>>}$) 0.00...100.0 s
- I_{E1}>> Reset time delay ($t_{E1>>RES}$) 0.00...100.0 s

Definite time
- 50N(1)/51N(1) Second threshold def. time ($I_{E1>>def}$) 0.002...10.00 I_{E1n}
- $I_{E1>>def}$ within CLP ($I_{E1CLP>>def}$) 0.002...10.00 I_{E1n}
- $I_{E1>>def}$ Operating time ($t_{E1>>def}$) 0.03...10.00 s

I_{E1}>>> Element
- I_{E1CLP}>>> Activation time ($t_{E1CLP>>>}$) 0.00...100.0 s
- I_{E1CLP}>>> Reset time delay ($t_{E1>>>RES}$) 0.00...100.0 s

Definite time
- 50N(1)/51N(1) Third threshold def. time ($I_{E>>>def}$) 0.002...10.00 I_{E1n}
- $I_{E1CLP>>>def}$ within CLP ($I_{E1CLP>>>def}$) 0.002...10.00 I_{E1n}
- $I_{E1CLP>>>def}$ Operating time ($t_{E1>>>def}$) 0.03...10.00 s

☐ Residual overcurrent - 50N(2)/51N(2)

I_{E2}> Element
- I_{E2}> Curve type (I_{E2}>Curve) DEFINITE / IEC/BS A, B, C / ANSI/IEEE MI, VI, EI / EM
- I_{E2CLP}> Activation time ($t_{E2CLP>}$) 0.00...100.0 s
- I_{E2}> Reset time delay ($t_{E2>RES}$) 0.00...100.0 s

Definite time
- 50N(2)/51N(2) First threshold definite time ($I_{E2>def}$) 0.002...10.00 I_{E2n}
- $I_{E2>def}$ within CLP ($I_{E2CLP>def}$) 0.002...10.00 I_{E2n}
- $I_{E2>def}$ Operating time ($t_{E2>def}$) 0.04...200 s

Inverse time
- 50N(2)/51N(2) First threshold inverse time ($I_{E2>inv}$) 0.002...2.00 I_{E2n}
- $I_{E2>inv}$ within CLP ($I_{E2CLP>inv}$) 0.002...2.00 I_{E2n}
- $I_{E2>inv}$ Operating time ($t_{E2>inv}$) 0.02...60.0 s

I_{E2}>> Element
- I_{E2CLP}>> Activation time ($t_{E2CLP>>}$) 0.00...100.0 s
- I_{E2}>> Reset time delay ($t_{E2>>RES}$) 0.00...100.0 s

Definite time
- 50N(2)/51N(2) Second threshold def. time ($I_{E2>>def}$) 0.002...10.00 I_{E2n}
- $I_{E2>>def}$ within CLP ($I_{E2CLP>>def}$) 0.002...10.00 I_{E2n}
- $I_{E2>>def}$ Operating time ($t_{E2>>def}$) 0.03...10.00 s

I_{E2}>>> Element
- I_{E2CLP}>>> Activation time ($t_{E2CLP>>>}$) 0.00...100.0 s
- I_{E2CLP}>>> Reset time delay ($t_{E2>>>RES}$) 0.00...100.0 s

Definite time
- 50N(1)/51N(1) Third threshold def. time ($I_{E2>>>def}$) 0.002...10.00 I_{E2n}
- $I_{E2CLP>>>def}$ within CLP ($I_{E2CLP>>>def}$) 0.002...10.00 I_{E2n}
- $I_{E2CLP>>>def}$ Operating time ($t_{E2>>>def}$) 0.03...10.00 s

☐ Residual overcurrent - 50N(Comp)/51N(Comp)

I_{EC}> Element [1]
- I_{EC}> Curve type (I_{EC}>Curve) DEFINITE / IEC/BS A, B, C / ANSI/IEEE MI, VI, EI / EM
- I_{ECCLP}> Activation time ($t_{ECCLP>}$) 0.00...100.0 s
- I_{EC}> Reset time delay ($t_{EC>RES}$) 0.00...100.0 s

Definite time
- 50N(Comp)/51N(Comp) First threshold def. time ($I_{E2>def}$) 0.100...40.0 I_n
- $I_{EC>def}$ within CLP ($I_{ECCLP>def}$) 0.100...40.0 I_n
- $I_{EC>def}$ Operating time ($t_{EC>def}$) 0.04...200 s

Inverse time
- 50N(Comp)/51N(Comp) First threshold inv. time ($I_{EC>inv}$) 0.100...20.00 I_n
- $I_{EC>inv}$ within CLP ($I_{ECCLP>inv}$) 0.100...20.00 I_n
- Operating time ($t_{EC>inv}$) 0.02...60.0 s

I_{EC}>> Element
- I_{ECCLP}>> Activation time ($t_{ECCLP>>}$) 0.00...100.0 s
- I_{EC}>> Reset time delay ($t_{EC>>RES}$) 0.00...100.0 s

Definite time
- 50N(Comp)/51N(Comp) Second thres. def. time ($I_{E2>>def}$) 0.100...40.0 I_n
- $I_{E2>>def}$ within CLP ($I_{E2CLP>>def}$) 0.100...40.0 I_n
- $I_{E2>>def}$ Operating time ($t_{E2>>def}$) 0.03...10.00 s

I_{E2}>>> Element
- I_{E2CLP}>>> Activation time ($t_{E2CLP>>>}$) 0.00...100.0 s
- I_{E2CLP}>>> Reset time delay ($t_{E2>>>RES}$) 0.00...100.0 s

Definite time
- 50N(Comp)/51N(Comp) Third thres. def. time ($I_{E2>>>def}$) 0.100...40.0 I_n
- $I_{E2CLP>>>def}$ within CLP ($I_{E2CLP>>>def}$) 0.100...40.0 I_n
- $I_{E2CLP>>>def}$ Operating time ($t_{E2>>>def}$) 0.03...10.00 s

Note 1: the computed residual current I_{EC} is employed (vectorial sum of the phase currents)

☐ Overvoltage - 59

Common configuration:
- Voltage measurement type for 59 (Utype59) [1] U_{ph-ph}/U_{ph-n}
- 59 Operating logic ($Logic$59) AND/OR

U> Element
- U> Curve type (U>Curve) DEFINITE / INVERSE [2]

Definite time
- 59 First threshold definite time ($U_{>def}$) 0.50...1.50 U_n/E_n
- $U_{>def}$ Operating time ($t_{U>def}$) 0.03...100.0 s

Inverse time
- 59 First threshold inverse time ($U_{>inv}$) 0.50...1.50 U_n/E_n
- $U_{>inv}$ Operating time ($t_{U>inv}$) 0.10...100.0 s

U>> Element

Definite time
- 59 Second threshold definite time ($U_{>>def}$) 0.50...1.50 U_n/E_n
- $U_{>>def}$ Operating time ($t_{U>>def}$) 0.03...100.0 s

Note 1: With U_{ph-ph} setting all threshold are in p.u. U_n
with U_{ph-n} setting all threshold are in p.u. E_n

Note 2: The mathematical formula for INVERSE curves is:

$t = 0.5 \cdot t_{U>inv} / [1 - (U/U_{>inv})]$

where:

t = operating time (in seconds)
$t_{U>inv}$ = operating time setting (in seconds)
U = input voltage
$U_{>inv}$ = threshold setting

☐ Residual overvoltage - 59N [1]

Common configuration:
- Residual voltage measurement for 59N - computed U_{EC}
- 59N Operating mode from 74VT internal (*74VTint59N*) OFF/Block
- 59N Operating mode from 74VT external (*74VText59N*) OFF/Block

U_E> Element
- U_E> Curve type (U_E>Curve) DEFINITE / INVERSE [2]
- U_E> Reset time delay ($t_{UE>RES}$) 0.00...100.0 s

Definite time
- 59N First threshold definite time ($U_{E>def}$) 0.01...0.70 U_{En}
- $U_{E>def}$ Operating time ($t_{UE>def}$) 0.07...100.0 s

Inverse time
- 59N First threshold inverse time ($U_{E>inv}$) 0.01...0.50 U_{En}
- $U_{E>inv}$ Operating time ($t_{UE>inv}$) 0.10...100.0 s

U_E>> Element
- U_E>> Reset time delay ($t_{UE>>RES}$) 0.00...100.0 s
- 59N Second threshold definite time ($U_{E>>def}$) 0.01...0.70 U_{En}
- $U_{E>>def}$ Operating time ($t_{UE>>def}$) 0.07...100.0 s

Note 1: The computed residual voltage U_{EC} is employed (vectorial sum of the phase voltages

Note 2: The mathematical formula for INVERSE curves is:

$t = 0.5 \cdot t_{UE>inv} / [(U_{EC}/U_{E>inv}) - 1]$

where:

t = operating time (in seconds)
$t_{UE>inv}$ = operating time setting (in seconds)
U_{EC}= computed residual voltage
$U_{E>inv}$ = threshold setting

Directional phase overcurrent - 67

Common configuration:

- 67 Operating mode (*Mode67*) — *I/I·cos*
- 67 Operating logic (*Logic67*) — 1/3 / 2/3
- 67 Operating mode from 74VT internal (*74VTint67*) — OFF/Block/Not directional
- 67 Operating mode from 74VT external (*74VText67*) — OFF/Block/Not directional

$I_{PD>}$ Element

- $I_{PD>}$ Curve type ($I_{PD>}$Curve) — DEFINITE, IEC/BS A, B, C, ANSI/IEEE MI, VI, EI, RECTIFIER, I^2t or EM
- $I_{PDCLP>}$ Activation time ($t_{PDCLP>}$) — 0.00...100.0 s
- $I_{PD>}$ Reset time delay ($t_{PD>RES}$) — 0.00...100.0 s

Definite time

- 67 First threshold definite time ($I_{PD>def}$) — 0.100...40.0 I_n
- $I_{PD>def}$ characteristic angle ($Theta_{PD>def}$) — 0...359°
- $I_{PD>def}$ within CLP ($I_{PDCLP>def}$) — 0.100...40.0 I_n
- $I_{PD>def}$ Operating time ($t_{PD>def}$) — 0.05...200 s

Inverse time

- 67 First threshold inverse time ($I_{PD>inv}$) — 0.100...10.0 I_n
- $I_{PD>inv}$ characteristic angle ($Theta_{PD>inv}$) — 0...359°
- $I_{PD>inv}$ within CLP ($I_{PDCLP>inv}$) — 0.100...10.0 I_n
- $I_{PD>inv}$ Operating time ($t_{PD>inv}$) — 0.02...60.0 s

$I_{PD>>}$ Element

- $I_{PD>}$ Curve type ($I_{PD>>}$Curve) — DEFINITE, IEC/BS A, B, C, ANSI/IEEE MI, VI, EI, RECTIFIER, I^2t or EM
- $I_{PDCLP>>}$ Activation time ($t_{PDCLP>>}$) — 0.00...100.0 s
- $I_{PD>>}$ Reset time delay ($t_{PD>>RES}$) — 0.00...100.0 s

Definite time

- 67 Second threshold definite time ($I_{PD>>def}$) — 0.100...40.0 I_n
- $I_{PD>>def}$ characteristic angle ($Theta_{PD>>def}$) — 0...359°
- $I_{PD>>def}$ within CLP ($I_{PDCLP>>def}$) — 0.100...40.0 I_n
- $I_{PD>>def}$ Operating time ($t_{PD>>def}$) — 0.04...200 s

Inverse time

- 67 Second threshold inverse time ($I_{PD>>inv}$) — 0.100...10.0 I_n
- $I_{PD>>inv}$ characteristic angle ($Theta_{PD>>inv}$) — 0...359°
- $I_{PD>>inv}$ within CLP ($I_{PDCLP>>inv}$) — 0.100...10.0 I_n
- $I_{PD>>inv}$ Operating time ($t_{PD>>inv}$) — 0.02...60.0 s

$I_{PD>>>}$ Element

- $I_{PDCLP>>>}$ Activation time ($t_{PDCLP>>>}$) — 0.00...100.0 s
- $I_{PD>>>}$ Reset time delay ($t_{PD>>>RES}$) — 0.00...100.0 s

Definite time

- 67 Third threshold definite time ($I_{PD>>>def}$) — 0.100...40.0 I_n
- $I_{PD>>>def}$ characteristic angle ($Theta_{PD>>>def}$) — 0...359°
- $I_{PD>>>def}$ within CLP ($I_{PDCLP>>>def}$) — 0.100...40.0 I_n
- $I_{PD>>>def}$ Operating time ($t_{PD>>>def}$) — 0.04...10.00 s

$I_{PD>>>>}$ Element

- $I_{PDCLP>>>>}$ Activation time ($t_{PDCLP>>>>}$) — 0.00...100.0 s
- $I_{PD>>>>}$ Reset time delay ($t_{PD>>>>RES}$) — 0.00...100.0 s

Definite time

- 67 Fourth threshold definite time ($I_{PD>>>>def}$) — 0.100...40.0 I_n
- $I_{PD>>>>def}$ characteristic angle ($Theta_{PD>>>>def}$) — 0...359°
- $I_{PD>>>>def}$ within CLP ($I_{PDCLP>>>>def}$) — 0.100...40.0 I_n
- $I_{PD>>>>def}$ Operating time ($t_{PD>>>>def}$) — 0.04...10.00 s

Directional earth fault overcurrent - 67N [1]

Common configuration:

- 67N Operating mode (*Mode67N*) — *I/I·cos*
- Residual voltage measurement type for 67N - direct/calculated (*3VoType67N*) — U_{EC}
- 67N Multiplier of threshold for insensitive zone (*M*) — 1.5...10.0
- 67N Operating mode from 74VT internal (*74VTint67N*) — OFF/Block/Not directional
- 67N Operating mode from 74VT external (*74VText67N*) — OFF/Block/Not directional

$I_{ED>}$ Element

- $I_{ED>}$ Curve type — DEFINITE, IEC/BS A, B, C, ANSI/IEEE MI, VI, EI, EM
- $I_{EDCLP>}$ Activation time ($t_{EDCLP>}$) — 0.00...100.0 s
- $I_{ED>}$ Reset time delay ($t_{ED>RES}$) — 0.00...100.0 s

Definite time

67N First threshold definite time ($I_{ED>def}$ - $U_{ED>def}$)

- Residual current pickup value — 0.002...10.00 I_{E1n}
- Residual voltage pickup value — 0.004...0.500 U_{ECn}
- Characteristic angle — 0...359°
- Half operating sector — 1...180°
- $I_{ED>def}$ within CLP ($I_{EDCLP>def}$) — 0.002...10.00 I_{E1n}
- $I_{ED>def}$ Operating time ($t_{ED>def}$) — 0.05...200 s

Inverse time

67N First threshold inverse time ($I_{ED>inv}$ - $U_{ED>inv}$)

- Residual current pickup value — 0.002...2.00 I_{E1n}
- Residual voltage pickup value — 0.004...0.500 U_{ECn}
- Characteristic angle — 0...359°
- Half operating sector — 1...180°
- $I_{ED>inv}$ within CLP ($I_{EDCLP>inv}$) — 0.002...2.00 I_{E1n}
- $I_{ED>inv}$ Operating time ($t_{ED>inv}$) — 0.02...60.0 s

$I_{ED>>}$ Element

- $I_{ED>}$ Curve type ($I_{ED>>}$Curve) — DEFINITE, IEC/BS A, B, C, ANSI/IEEE MI, VI, EI, EM
- $I_{EDCLP>>}$ Activation time ($t_{EDCLP>>}$) — 0.00...100.0 s
- $I_{ED>>}$ Reset time delay ($t_{ED>>RES}$) — 0.00...100.0 s

Definite time

67N Second threshold definite time ($I_{ED>>def}$ - $U_{ED>>def}$)

- Residual current pickup value — 0.002...10.00 I_{E1n}
- Residual voltage pickup value — 0.004...0.500 U_{ECn}
- Characteristic angle — 0...359°
- Half operating sector — 1...180°
- $I_{ED>>def}$ within CLP ($I_{EDCLP>>def}$) — 0.002...10.00 I_{En}
- $I_{ED>>def}$ Operating time ($t_{ED>>def}$) — 0.05...10.00 s

Inverse time

67N Second threshold inverse time ($I_{ED>>inv}$ - $U_{ED>>inv}$)

- Residual current pickup value — 0.002...2.00 I_{E1n}
- Residual voltage pickup value — 0.004...0.500 U_{ECn}
- Characteristic angle — 0...359°
- Half operating sector — 1...180°
- $I_{ED>inv}$ within CLP ($I_{EDCLP>>inv}$) — 0.002...2.00 I_{E1n}
- $I_{ED>inv}$ Operating time ($t_{ED>>inv}$) — 0.02...60.0 s

$I_{ED>>>}$ Element

- $I_{EDCLP>>>}$ Activation time ($t_{EDCLP>>>}$) — 0.00...100.0 s
- $I_{ED>>>}$ Reset time delay ($t_{ED>>>RES}$) — 0.00...100.0 s

Definite time

67N Third threshold definite time ($I_{ED>>>def}$ - $U_{ED>>>def}$)

- Residual current pickup value — 0.002...10.00 I_{E1n}
- Residual voltage pickup value — 0.004...0.500 U_{ECn}
- Characteristic angle — 0...359°
- Half operating sector — 1...180°
- $I_{ED>>>def}$ within CLP ($I_{EDCLP>>>def}$) — 0.002...10.00 I_{E1n}
- $I_{ED>>>def}$ Operating time ($t_{ED>>>def}$) — 0.05...10.00 s

$I_{ED>>>>}$ Element

- $I_{EDCLP>>>>}$ Activation time ($t_{EDCLP>>>>}$) — 0.00...100.0 s
- $I_{ED>>>>}$ Reset time delay ($t_{ED>>>>RES}$) — 0.00...100.0 s

Definite time

67N Fourth threshold definite time ($I_{ED>>>>def}$ - $U_{ED>>>>def}$)

- Residual current pickup value — 0.002...10.00 I_{E1n}
- Residual voltage pickup value — 0.004...0.500 U_{ECn}
- Characteristic angle — 0...359°
- Half operating sector — 1...180°
- $I_{ED>>>>def}$ within CLP ($I_{EDCLP>>>>def}$) — 0.002...10.00 I_{E1n}
- $I_{ED>>>>def}$ Operating time ($t_{ED>>>>def}$) — 0.05...10.00 s

Note 1: the computed residual voltage U_{EC} (vectorial sum of the phase voltages) and measured residual current I_{E1} are employed

Selective block - BLOCK2

Selective block IN:

- BLIN Max activation time for phase protections (t_{B-IPh}) — 0.10...10.00 s
- BLIN Max activation time for ground protections (t_{B-IE}) — 0.10...10.00 s

Selective block OUT:

- BLOUT Dropout time delay for phase protections (t_{F-IPh}) 0.00...1.00 s
- BLOUT Drop-out time delay for ground protections (t_{F-IE}) 0.00...1.00 s
- BLOUT Drop-out time delay for phase and ground protections ($t_{F-IPh/IE}$) 0.00...1.00 s

☐ Internal selective block - BLOCK4

- Output internal selective block dropout time for phase protections (t_{F-IPh}) 0.00...10.00 s
- Output internal selective block dropout time for ground protections (t_{F-IE}) 0.00...10.00 s

☐ Breaker failure - BF

BF Phase current threshold ($I_{BF}>$)	0.05...1.00 I_n
BF Residual current threshold from I_{E1} input ($I_{E1BF}>$)	0.01..2.00 I_{E1n}
BF Residual current threshold from I_{E2} input ($I_{E2BF}>$)	0.01..2.00 I_{E2n}
BF Time delay (t_{BF})	0.06...10.00 s

☐ Second Harmonic Restraint - 2ndh-REST

Second harmonic restraint threshold ($I_{2ndh}>$)	10...50 %
$I_{2ndh}>$ Reset time delay ($t_{2ndh>RES}$)	0.00...100.0 s

☐ VT supervision - 74VT

74VT Negative sequence overvoltage threshold ($U_{2VT>}$)	0.05...0.50 E_n
74VT Negative sequence overvoltage threshold ($I_{2VT>}$)	0.05...0.50 I_n
74VT Phase undervoltage threshold ($U_{VT<}$)	0.05...0.50 E_n
74VT Minimum change of current threshold 74VT ($D_{IVT<}$)	0.05...0.50 I_n
74VT Undercurrent inhibition threshold ($I_{VT<}$)	0.100...40.0 I_n
74VT Alarm time delay (t_{VT-AL})	0.0...10.0 s

☐ CT supervision - 74CT

74CT Threshold ($S<$)	0.10...0.95
74CT Overcurrent threshold ($I*$)	0.10...1.00 I_n
$S<$ Operating time ($t_{S}<$)	0.03...200 s

☐ Circuit Breaker supervision

Number of CB trips (*N.Open*)	0...10000
Cumulative CB tripping currents (*SumI*)	0...5000 I_n
CB opening time for I^2t calculation (t_{break})	0.05...1.00 s
Cumulative CB tripping I^2t (*SumI^2t*)	0...5000 $I_n^2 \cdot s$
CB max allowed opening time ($t_{break}>$)	0.05...1.00 s

☐ Pilot wire diagnostic

BLOUT1 Diagnostic pulses period (*PulseBLOUT1*) OFF - 0.1-1-5-10-60-120 s

BLIN1 Diagnostic pulses control time interval (*PulseBLIN1*) OFF - 0.1-1-5-10-60-120 s

METERING

☐ Measured parameters

Direct:

- Frequency — f
- Fundamental RMS phase currents — I_{L1}, I_{L2}, I_{L3}
- Fundamental RMS phase voltages — U_{L1}, U_{L2}, U_{L3}
- Fundamental RMS residual currents — I_{E1}, I_{E2}

Calculated:

- Thermal image — *DTheta*
- Fundamental RMS phase-to-phase voltages — U_{12}, U_{23}, U_{31}
- Fundamental RMS calculated residual voltage — U_{EC}
- Fundamental RMS calculated residual current — I_{EC}
- Maximum current between I_{L1}-I_{L2}-I_{L3} — I_{Lmax}
- Minimum current between I_{L1}-I_{L2}-I_{L3} — I_{Lmin}
- Average current between I_{L1}-I_{L2}-I_{L3} — I_L
- Maximum voltage between U_{L1}-U_{L2}-U_{L3} — U_{Lmax}
- Average voltage between U_{L1}-U_{L2}-U_{L3} — U_L
- Maximum voltage between U_{12}-U_{23}-U_{31} — U_{max}
- Average voltage between U_{12}-U_{23}-U_{31} — U

Phase:

- Displacement angle of I_{L1} respect to U_{L1} — *PhiL1*
- Displacement angle of I_{L2} respect to U_{L2} — *PhiL2*
- Displacement angle of I_{L3} respect to U_{L3} — *PhiL3*
- Displacement angle of I_{L1} respect to U_{23} — *Alpha1*
- Displacement angle of I_{L2} respect to U_{31} — *Alpha2*
- Displacement angle of I_{L3} respect to U_{12} — *Alpha3*
- Displacement angle of U_{EC} respect to I_{E1} — *PhiEC*

Sequence:

- Positive sequence current — I_1
- Negative sequence current — I_2
- Negative sequence current/positive sequence current ratio — I_2/I_1
- Negative sequence voltage — U_2

Power:

- Total active power — P
- Total reactive power — Q
- Total apparent power — S
- Power factor — *cosPhi*
- Phase active powers — P_{L1}, P_{L2}, P_{L3}
- Phase reactive powers — Q_{L1}, Q_{L2}, Q_{L3}
- Power factors — *cosPhiL1, cosPhiL2, cosPhiL3*

2nd harmonic:

- Second harmonic phase currents — I_{L1-2nd}, I_{L2-2nd}, I_{L3-2nd}
- Maximum of the second harmonic phase currents/fundamental component percentage ratio — I_{-2nd}/I_L

3rd harmonic:

- Third harmonic phase currents — I_{L1-3rd}, I_{L2-3rd}, I_{L3-3rd}
- Third harmonic I_{E1} residual current — I_{E1-3rd}

4th harmonic:

- Fourth harmonic phase currents — I_{L1-4th}, I_{L2-4th}, I_{L3-4th}

5th harmonic:

- Fifth harmonic phase currents — I_{L1-5th}, I_{L2-5th}, I_{L3-5th}

Demand phase currents:

- Phase fixed currents demand — I_{L1FIX}, I_{L2FIX}, I_{L3FIX}
- Phase rolling currents demand — I_{L1ROL}, I_{L2ROL}, I_{L3ROL}
- Phase peak currents demand — I_{L1MAX}, I_{L2MAX}, I_{L3MAX}
- Phase minimum currents demand — I_{L1MIN}, I_{L2MIN}, I_{L3MIN}

Demand power:

- Fixed active power demand — P_{FIX}
- Fixed reactive power demand — Q_{FIX}
- Rolling active power demand — P_{ROL}
- Rolling reactive power demand — Q_{ROL}
- Peak active power demand — P_{MAX}
- Peak reactive power demand — Q_{MAX}
- Minimum active power demand — P_{MIN}
- Minimum reactive power demand — Q_{MIN}

Energy:

- Positive active energy — $E_{A}+$
- Negative active energy — $E_{A}-$
- Total active energy — E_A
- Positive reactive energy — $E_{Q}+$
- Negative reactive energy — $E_{Q}-$
- Total reactive energy — E_Q

PT100:

- Temperature PT1...PT8 — T_1... T_8

☐ Event storage

Sequence of Event Recorder (SER)

Number of events	300
Recording mode	circular

Trigger:

- Output relays switching — K1...K6...Kx
- Binary inputs switching — IN1, IN2...INx
- Setting changes

Data recorded:
- Event counter (resettable by ThySetter) 0...10^9
- Event cause binary input/output relay/setting changes
- Time stamp Date and time

Sequence of Fault Recorder (SFR)

Number of faults 20

Recording mode circular

Trigger:
- External trigger (binary inputs) IN1, IN2...INx
- Element pickup (OFF-ON transition) Start/Trip

Data recorded:
- Time stamp Date and time
- Fault cause start, trip, binary input
- Fault counter (resettable by ThySetter) 0...10^9
- Fundamental RMS phase currents I_{L1r}, I_{L2r}, I_{L3r}
- Fundamental RMS residual currents I_{E1r}, I_{E2r}, I_{ECr}
- Fundamental RMS phase voltages U_{L1r}, U_{L2r}, U_{L3r}
- Fundamental RMS phase-to-phase voltages U_{12r}, U_{23r}, U_{31r}
- Fundamental RMS residual voltages (calculated) U_{ECr}
- Displacement angles (I_{L1}-U_{L1}, I_{L2}-U_{L2}, I_{L3}-U_{L3}) Phi_{L1r}, Phi_{L2r}, Phi_{L3r}
- Displacement angles (I_{L1}-U_{23}, I_{L2}-U_{31}, I_{L3}-U_{L3}) $Alpha_{1r}$, $Alpha_{2r}$, $Alpha_{3r}$
- Displacement angle (U_{EC}-I_{E12}) Phi_{ECr}
- Thermal image *DTheta-r*
- Binary inputs state IN1, IN2...INx
- Output relays state K1...K6...Kx
- Fault cause info (operating phase) L1, L2, L3

☐ Digital Fault Recorder (Oscillography)

File format COMTRADE

Records depending on setting [1]

Recording mode circular

Sampling rate 24 samples per cycle

Trigger setup:
- Pre-trigger time 0.05...1.00 s
- Post-trigger time 0.05...60.00 s
- Trigger from inputs IN1, INx
- Trigger from outputs K1...Kx
- Manual command ThySetter

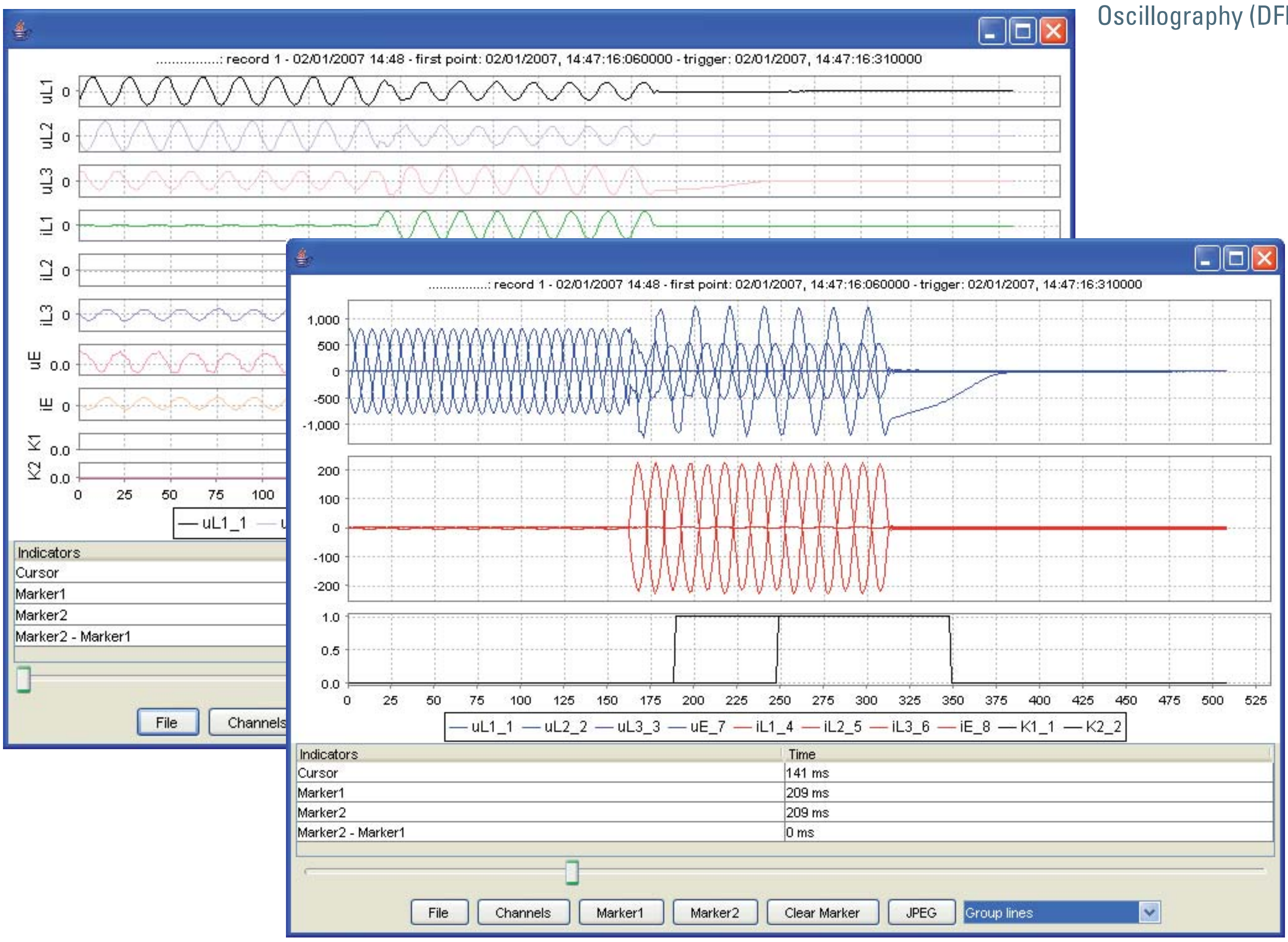
Set sample channels:
- Instantaneous currents i_{L1}, i_{L2}, i_{L3}, i_{E1}, i_{E2}
- Instantaneous voltages u_{L1}, u_{L2}, u_{L3}

Set analog channels (Analog 1...12):
- Frequency f
- Fundamental RMS phase currents I_{L1}, I_{L2}, I_{L3}
- Fundamental RMS residual current I_{E1}, I_{E2}
- Fundamental RMS phase voltages U_{L1}, U_{L2}, U_{L3}
- Fundamental RMS calculated residual current I_{EC}
- Fundamental RMS computed residual voltage U_{EC}
- Fundamental RMS phase-to-phase voltages U_{12}, U_{23}, U_{31}
- Displacement angles (I_{L1}-U_{L1}, I_{L2}-U_{L2}, I_{L3}-U_{L3}) Phi_{L1}, Phi_{L2}, Phi_{L3}
- Displacement angles (I_{L1}-U_{23}, I_{L2}-U_{31}, I_{L3}-U_{L3}) $Alpha_1$, $Alpha_2$, $Alpha_3$
- Displacement angle (U_{EC}-I_{E1}) Phi_{EC}
- Second harmonic phase currents $I_{L1\text{-}2nd}$, $I_{L2\text{-}2nd}$, $I_{L3\text{-}2nd}$
- Maximum of the second harmonic phase currents/fundamental component percentage ratio I_{-2nd}/I_L
- Temperature *T1...T8*

Set digital channels (Digital 1...12):
- Output relays state K1...Kx
- Binary inputs state IN1, INx

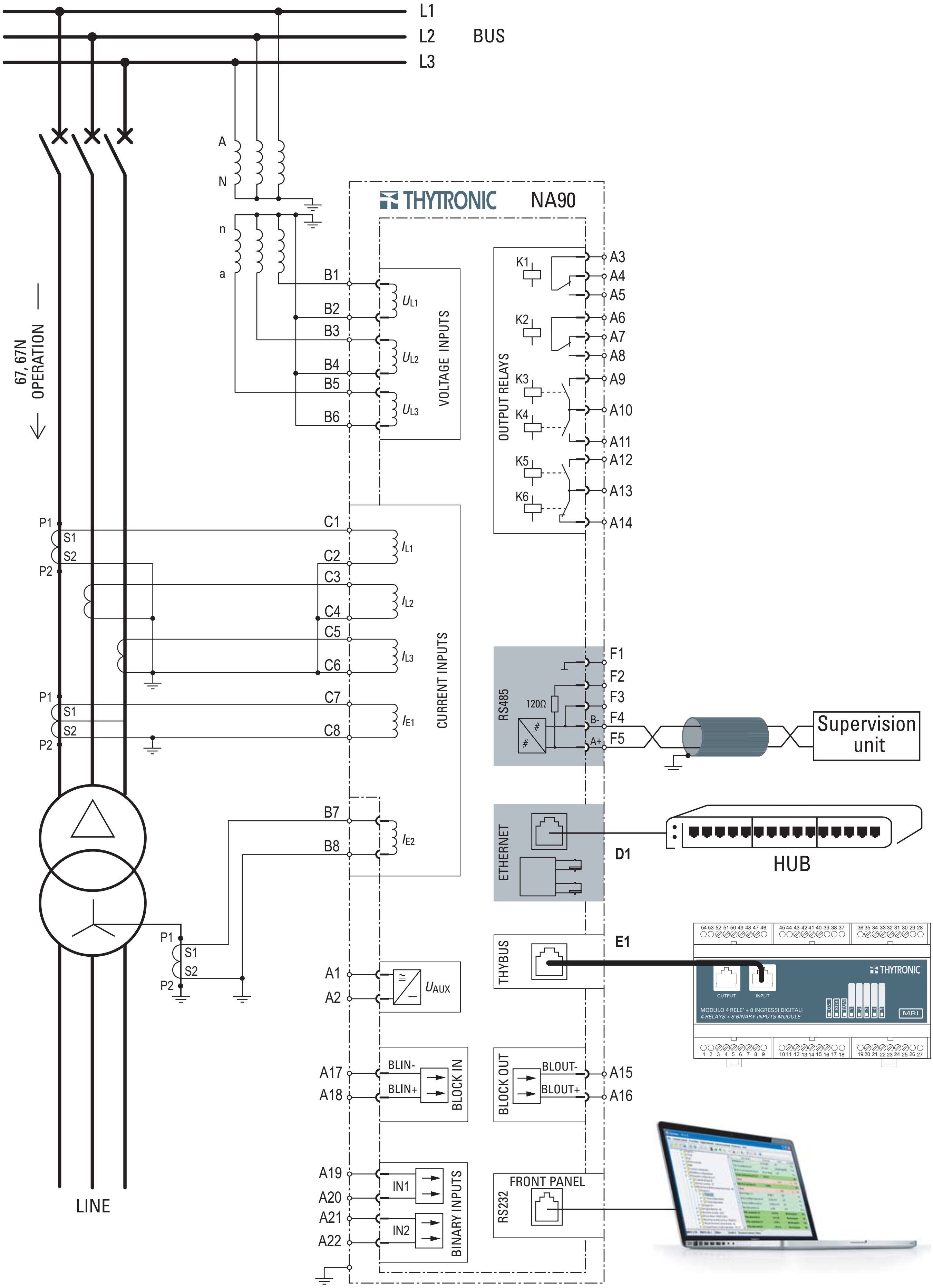
Note 1 - For instance, with following setting:
- *Pre-trigger time 0.25 s*
- *Post-trigger time 0.25 s*
- *Sampled channels* i_{L1}, i_{L2}, i_{L3}, i_{E1}, i_{E2}, u_{L1}, u_{L2}, u_{L3}
- *Analog channels* I_{L1}, I_{L2}, I_{L3}, I_{E1}, I_{E2}, U_{L1}, U_{L2}, U_{L3}, U_{EC}
- *Digital channels* K1, K2, K3, K4, K5, K6, IN1, IN2

More than 270 records can be stored with f = 50 Hz



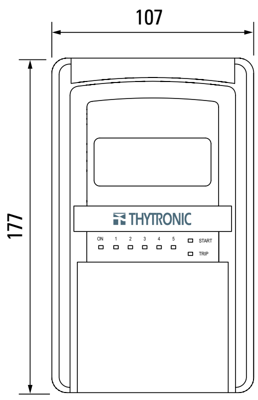
Oscillography (DFR)

Connection diagram example

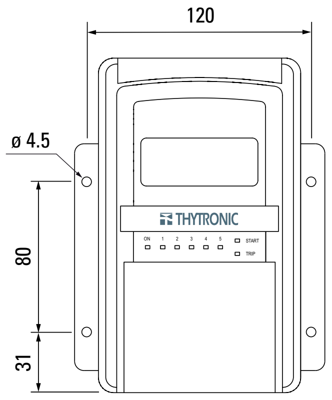


DIMENSIONS

FRONT VIEWS

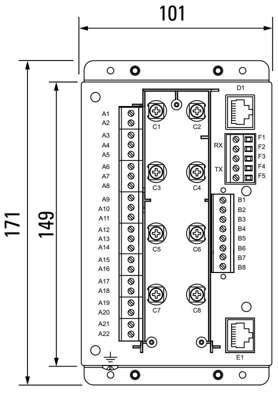


FLUSH MOUNTING

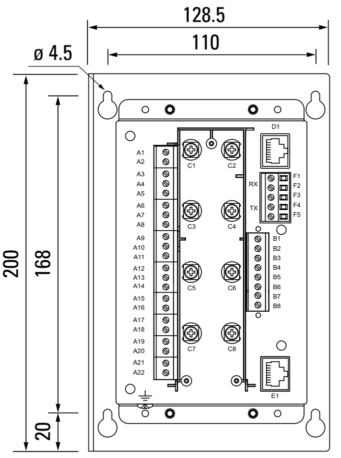


PROJECTING MOUNTING

REAR VIEWS

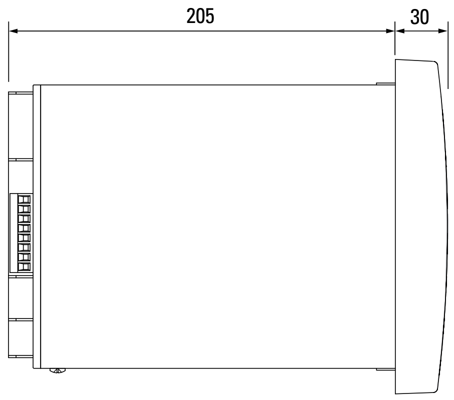


FLUSH MOUNTING

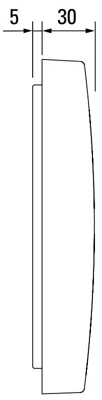


PROJECTING MOUNTING
(Separate operator panel)

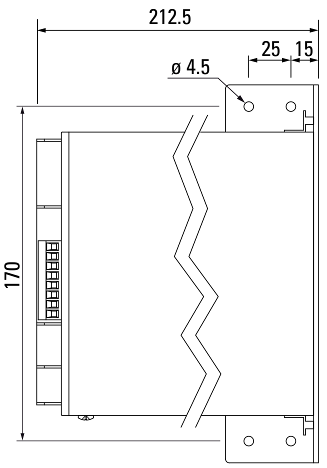
SIDE VIEWS



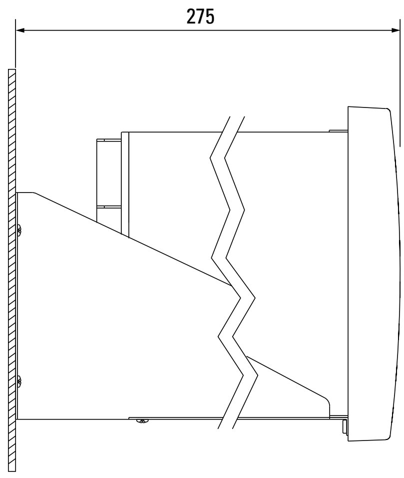
FLUSH MOUNTING



SEPARATE
OPERATOR PANEL

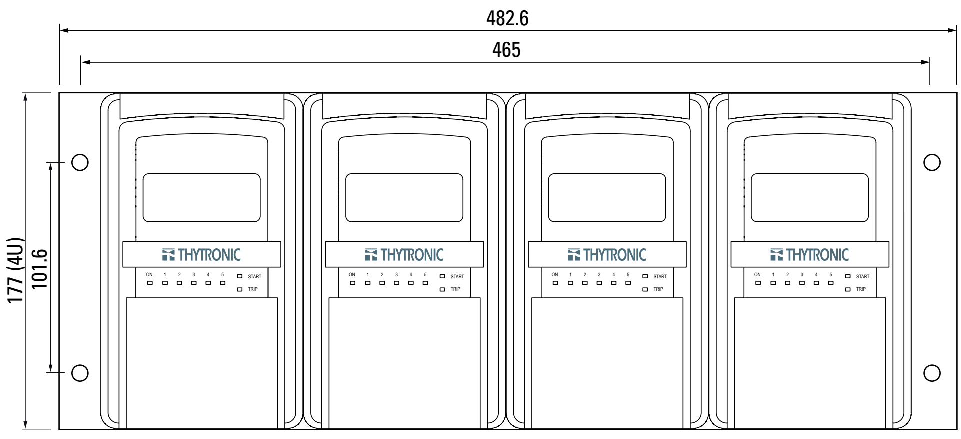


PROJECTING MOUNTING
(Separate operator panel)

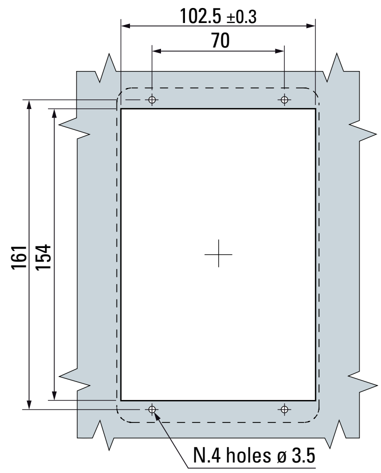


PROJECTING MOUNTING
(Stand alone)

RACK MOUNTING



FLUSH MOUNTING CUTOUT



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A PERSONALISED SERVICE OF THE PRODUCTION, A RAPID DELIVERY, A COMPETITIVE PRICE AND AN ATTENTIVE EVALUATION OF OUR CUSTOMERS NEEDS, HAVE ALL CONTRIBUTED IN MAKING US ONE OF THE BEST AND MOST RELIABLE PRODUCERS OF PROTECTIVE RELAYS. FORTY YEARS OF EXPERIENCE HAS MADE STANDARD THESE ADVANTAGES THAT ARE GREATLY APPRECIATED BY LARGE COMPANIES THAT DEAL ON THE INTERNATIONAL MARKET. A HIGHLY QUALIFIED AND MOTIVATED STAFF PERMITS US TO OFFER AN AVANT-GARDE PRODUCT AND SERVICE WHICH MEET ALL SAFETY AND CONTINUITY DEMANDS, VITAL IN THE GENERATION OF ELECTRIC POWER. OUR COMPANY PHILOSOPHY HAS HAD A POSITIVE REACTION FROM THE MARKET BY BACKING OUR COMMITMENT AND HENCE STIMULATING OUR GROWTH.

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