THYTRONIC

PRO N

# NA80

*FEEDER PROTECTION RELAY*

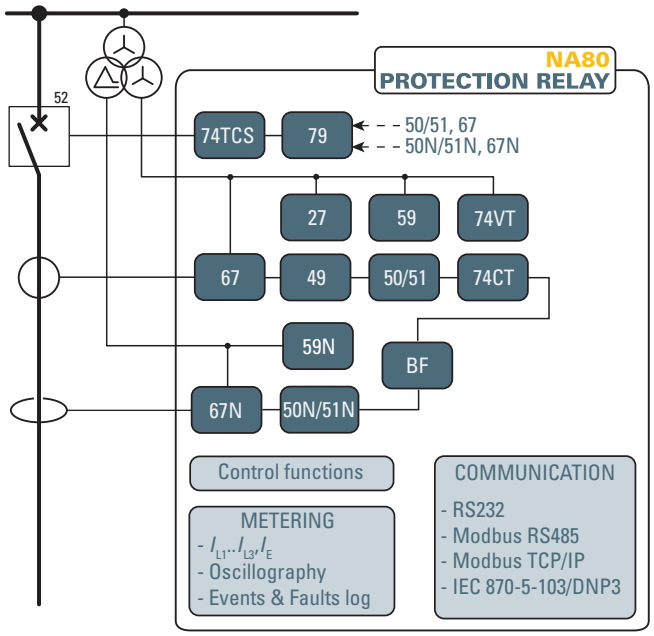
THE COMPREHENSIVE SOLUTION FOR FEEDERS AND TRANSFORMERS PROTECTION WITH AUTOMATIC RECLOSE

## — Application

The relay type NA80 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.

Moreover, undervoltage, overvoltage and automatic reclosing functions are provided.




### - Protective & control functions

| | |
|---|---|
| 27 | Undervoltage |
| 49 | Thermal image (for lines and transformers) |
| 50/51 | Phase overcurrent |
| 50N/51N | Residual overcurrent |
| 59 | Overvoltage |
| 59N | Residual overvoltage |
| 67 | Phase directional overcurrent |
| 67N | Ground directional overcurrent |
| BF | Circuit breaker failure |
| 79 | Automatic reclosing |
| 74CT | CT supervision |
| 74TCS | Trip circuit supervision |

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

## — Two set point profiles (A,B)
Two independent groups of settings are provided. Switching from profiles may be operated by means of MMI, binary input and communication.

## — Measuring inputs
- Three phase current inputs and one residual current input, with nominal currents independently selectable at 1 A or 5 A through DIP-switches.
- 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) and one residual voltage input, with programmable nominal voltage within range 50...130 V ($U_{ER}$ =100 V).

## — Construction
According to the hardware configurations, the NA80 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 NA80 hardware can be customized through external auxiliary modules:
- MRI - Output relays and LEDs (provided with NA80)
- MID16 - Binary inputs
- MCI - 4...20 mA converters
- MPT - Pt100 probe inputs.
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## — 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.

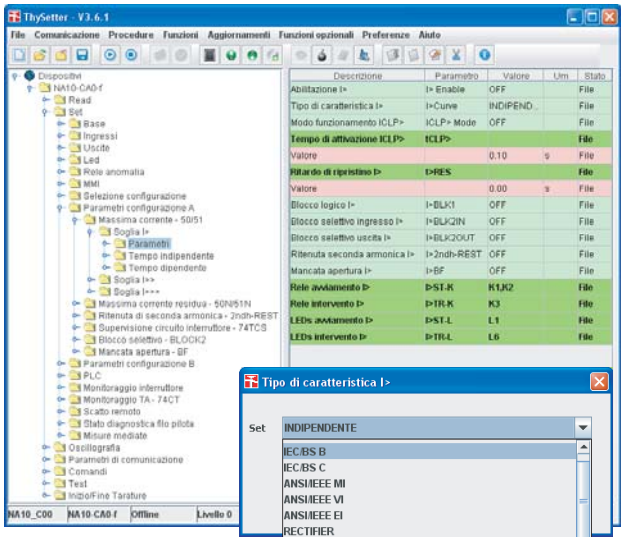
## — Output relays
Six output relays are available (two changeover, three make and one break contacts); each relay may be individually programmed as normal state (normally energized, de-energized or pulse) and reset mode (manual or automatic).
A programmable timer is provided for each relay (minimum 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), 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.
- Synchronization.
- Automatic reclosing
- Circuit Breaker commands and diagnostic.

Moreover user defined logic must be customized in accordance with IEC 61131-3 protocol by means programmable logic controller (PLC).

***Circuit Breaker***

Several diagnostic, monitoring and control functions are provided:
- Health thresholds can be set; when the accumulated duty ($\Sigma I$ or $\Sigma I^2t$), 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.

***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.

***Automatic reclosing***

The automatic reclosure function is well-used on overhead lines (when faults are self-extinguish after tripping of protection relays).
The following sequences may be selected:
- Rapid reclosure,
- Rapid reclosure followed by one slow reclosure,
- Rapid reclosure followed by one slow reclosure and one or more delayed reclosures (1...5).

Starting of the automatic reclosing function can be raised by internal protective elements or externally by means binary input signals (eg: external protection device contacts or operating switches).
The following logics may be set (binary inputs allocation):
- 52a - 52b (Circuit breaker state); the CB position is indispensable for the auto reclosure function.
- Blocking; exclusion command (pulse),
- Enabling; activation command (pulse).
- The following output functions may be coupled to the output relays:
- CB reclosing command;
- Reclosure fail.
- Cycle in progress.

***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 can be blocked for a programmable time.
- Each threshold can be increased for a programmable time.

## — 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

NA80 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).

*Note - A license for Digital Fault Recorder function is required, for purchase procedure please contact Thytronic.*
*The records are stored in nonvolatile memory*

# 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 IEC61850 |

## INPUT CIRCUITS

### — Auxiliary power supply Uaux

| | |
|---|---|
| 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<br>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)<br>≤ 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)<br>≤ 0.012 VA ($I_{En}$ = 5 A) |

### — 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 |

### — Residual voltage input

| | |
|---|---|
| Reference voltage $U_{ER}$ | 100 V |
| Nominal voltage $U_{En}$ | 50...130 V adjustable via sw |
| Permanent overload | 1.3 $U_{ER}$ |
| 1s overload | 2 $U_{ER}$ |
| Rated consumption | ≤ 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) |
| • K3, K4, K5 | make (SPST-NO, type A) |
| • 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 ($I_{En}$) | 1 A, 5 A |
| Residual CT nominal primary current ($I_{Enp}$) | 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 (direct measure) ($U_{En}$) | 50...130 V |
| 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 $t_{ON}$...IN10 $t_{ON}$) | 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 |

## PROTECTIVE FUNCTIONS

### — Base current IB [1]

| | |
|---|---|
| Base current ($I_B$) | 0.10...2.50 $I_n$ |

*Note - The basic current $I_B$ 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 oft he relay, as usually happens, the $I_B$ value is the ratio between therated current of the protected element and the primary rated current of the CT's*

### — Thermal protection with RTD thermometric probes - 26

*Alarm*

| | |
|---|---|
| • Alarm threshold $\theta_{ALx}$ (x=1...8) | 0...200 °C |
| • Operating time $t_{\theta ALx}$ (x=1...8) | 0....100 s |

*Trip*

| | |
|---|---|
| • Trip threshold $\theta>_x$ (x=1...8) | 0...200 °C |
| • Operating time $t_{\theta>x}$ (x=1...8) | 0....100 s |

*Note: The element becomes available when the MPT module is enabled and connected to Thybus*

### — Undervoltage - 27

*Common configuration:*

| | |
|---|---|
| • Voltage measurement type for 27 ($U$type27) [1] | $U_{ph-ph}/U_{ph-n}$ |
| • 27 Operating logic ($Logic$27) | 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 = trip 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 $\tau$ ($T$) | 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 $\Delta\theta_{AL2}$ ($Dth_{AL2}$) | 0.5...1.2 $\Delta\theta_B$ |

*Dth> Element*

| | |
|---|---|
| • 49 Trip threshold $\Delta\theta$ ($Dth>$) | 1.100...1.300 $\Delta\theta_B$ |

### — Phase overcurrent - 50/51

*I> Element*

| | |
|---|---|
| • $I>$ Curve type ($I>$Curve) | DEFINITE IEC/BS A, B, C, ANSI/IEEE MI, VI, EI RECTIFIER, $I^2t$ 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...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...60.0 s |

*I>> Element*

| | |
|---|---|
| • Type characteristic | DEFINITE or $I^2t$ |
| • $I_{CLP}>>$ 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/51N

*$I_E>$ Element*

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

*Definite time*

| | |
|---|---|
| • 50N/51N First threshold definite time ($I_E>_{def}$) | 0.002...10.00 $I_{En}$ |
| • $I_E>_{def}$ within CLP ($I_{ECLP>def}$) | 0.002...10.00 $I_{En}$ |
| • $I_E>_{def}$ Operating time ($t_{E>def}$) | 0.04...200 s |

*Inverse time*

| | |
|---|---|
| • 50N/51N First threshold inverse time ($I_E>_{inv}$) | 0.010...2.00 $I_{En}$ |
| • $I_E>_{inv}$ within CLP ($I_{ECLP>inv}$) | 0.010...2.00 $I_{En}$ |
| • $I_E>_{inv}$ Operating time ($t_{E>inv}$) | 0.02...60.0 s |

*$I_E>>$ Element*

| | |
|---|---|
| • $I_{ECLP}>>$ Activation time ($t_{ECLP>>}$) | 0.00...100.0 s |
| • $I_E>>$ Reset time delay ($t_{E>>RES}$) | 0.00...100.0 s |

*Definite time*

| | |
|---|---|
| • 50N/51N Second threshold definite time ($I_E>>_{def}$) | 0.002...10.00 $I_{En}$ |
| • $I_E>>_{def}$ within CLP ($I_{ECLP>>def}$) | 0.002...10.00 $I_{En}$ |
| • $I_E>>_{def}$ Operating time ($t_{E>>def}$) | 0.03...10.00 s |

*$I_E$>>> Element*
- $I_{ECLP}$>>> Activation time ($t_{ECLP>>>}$) 0.00...100.0 s
- $I_{ECLP}$>>> Reset time delay ($t_{E>>>RES}$) 0.00...100.0 s

*Definite time*
- 50N/51N Third threshold definite time ($I_{E>>>def}$) 0.002...10.00 $I_{En}$
- $I_{ECLP>>>def}$ within CLP ($I_{ECLP>>>def}$) 0.002...10.00 $I_{En}$
- $I_{ECLP>>>def}$ Operating time ($t_{E>>>def}$) 0.03...10.00 s

## — Overvoltage - 59

*Common configuration:*
- Voltage measurement type for 59 ($U$type59) [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 = trip time (in seconds)*

$t_{U>inv}$ *= operating time setting (in seconds)*

*U = input voltage*

$U_{>inv}$ *= threshold setting*

## — Residual overvoltage - 59N

*Common configuration:*
- Residual voltage measurement for 59N- direct/calc. $U_E/U_{EC}$
- 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 [3]
- $U_E$> 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 mathematical formula for INVERSE curves is:*

$t = 0.5 \cdot t_{UE>inv} / [(U_E/U_{E>inv}) - 1]$, *where:*

*t = trip time (in seconds)*

$t_{UE>inv}$ *= operating time setting (in seconds)*

$U_E$ *= residual input voltage*

$U_{E>inv}$ *= threshold setting*

## — Directional phase overcurrent - 67

*Common configuration:*
- 67 Operating mode (*Mode67*) *I*/*I*·*cos*
- 67 Operating logic (*Logic*67) 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, $I^2t$, 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

*Common configuration:*
- 67N Operating mode (*Mode67N*) *I*/*I*·*cos*
- Residual voltage measurement type for 67N - direct/calculated (*3VoType67N*) $U_E$ / $U_{EC}$
- 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 $I_{En}$
- Residual voltage pickup value 0.004...0.500 $U_{En}$
- 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...200 s

*Inverse time*

67N First threshold inverse time ($I_{ED>inv}$ - $U_{ED>inv}$)
- Residual current pickup value 0.002...2.00 $I_{En}$
- Residual voltage pickup value 0.004...0.500 $U_{En}$
- Characteristic angle 0...359°
- Half operating sector 1...180°
- $I_{ED>inv}$ within CLP ($I_{EDCLP>inv}$) 0.002...2.00 $I_{En}$
- $I_{ED>inv}$ 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 $I_{En}$
- Residual voltage pickup value 0.004...0.500 $U_{En}$
- 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 $I_{En}$
- Residual voltage pickup value 0.004...0.500 $U_{En}$
- Characteristic angle 0...359°
- Half operating sector 1...180°
- $I_{ED>inv}$ within CLP ($I_{EDCLP>>inv}$) 0.002...2.00 $I_{En}$
- $I_{ED>inv}$ Operating time ($t_{ED>>inv}$) 0.02...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 Third threshold definite time ($I_{ED>>>def}$ - $U_{ED>>>def}$)
- Residual current pickup value 0.002...10.00 $I_{En}$
- Residual voltage pickup value 0.004...0.500 $U_{En}$
- 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

*$I_{ED}$>>>> 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 $I_{En}$
- Residual voltage pickup value 0.004...0.500 $U_{En}$
- 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

## — Automatic reclosing - 79

| | |
|---|---|
| 79 Function mode (*79 Mode*) | Rapid/Rapid+Slow |
| Number of delayed reclosures (*N.DAR*) | 0...5 |
| Rapid reclosure dead time ($t_{rdt}$) | 0.1...60 s |
| Slow reclosure dead time ($t_{sdt}$) | 1...200 s |
| Reclaim time ($t_r$) | 1...200 s |
| Slow reclosure fault discrimination time ($t_{d1}$) | 0...10 s |
| Delayed reclosure fault discrimination time ($t_{d2}$) | 0...10 s |
| Manual close (R+S only) fault discrimination time ($t_d$) | 1...10 s |

## — 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 elements ($t_{F-IPh}$)0.00...1.00 s
- BLOUT Drop-out time delay for ground elements ($t_{F-IE}$) 0.00...1.00 s
- BLOUT Drop-out time delay for phase and ground elements ($t_{F-IPh/IE}$) 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 ($I_{EBF}$>) | 0.01..2.00 $I_{En}$ |
| 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 $I_n^2$·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

## — Demand measures

| | |
|---|---|
| Fixed demand period ($t_{FIX}$) | 1...60 min |
| Rolling demand period ($t_{ROL}$) | 1...60 min |
| Number of cycles for rolling on demand ($N._{ROL}$) | 1...24 |

# METERING & RECORDING

## — 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 current $I_E$
- Fundamental RMS residual voltage $U_E$

*Calculated:*
- Thermal image *DTheta*
- Fundamental RMS phase-to-phase voltages $U_{12}$, $U_{23}$, $U_{31}$
- Fundamental RMS calculated residual voltage $U_{EC}$
- 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 $U_E$ respect to $I_E$ *PhiE*
- Displacement angle of $U_{EC}$ respect to $I_E$ *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 $I_{L1\text{-}2nd}$, $I_{L2\text{-}2nd}$, $I_{L3\text{-}2nd}$
- Maximum of the second harmonic phase currents/fundamental component percentage ratio $I_{\text{-}2nd}/I_L$

*3rd harmonic:*
- Third harmonic phase currents $I_{L1\text{-}3rd}$, $I_{L2\text{-}3rd}$, $I_{L3\text{-}3rd}$
- Third harmonic residual current $I_{E\text{-}3rd}$
- Third harmonic residual voltage $U_{E\text{-}3rd}$

*4th harmonic:*
- Fourth harmonic phase currents $I_{L1\text{-}4th}$, $I_{L2\text{-}4th}$, $I_{L3\text{-}4th}$

*5th harmonic:*
- Fifth harmonic phase currents $I_{L1\text{-}5th}$, $I_{L2\text{-}5th}$, $I_{L3\text{-}5th}$

*Demand phase:*
- 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:*
- PT1...PT8 Temperature $T_1$... $T_8$

## — Event recording (SER)

Number of events 300
Recording mode circular

*Trigger:*
- Output relays switching K1...K6
- Binary inputs switching IN1, IN2
- 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

## — Fault recording (SFR)

Number of faults 20
Recording mode circular

*Trigger:*
- External trigger (binary inputs) IN1, IN2
- 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 current $I_{Er}$
- 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 (measured and calculated) $U_{Er}$, $U_{ECr}$
- 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 ($U_E$-$I_E$) $Phi_{Er}$
- Displacement angle ($U_{EC}$-$I_E$) $Phi_{ECr}$
- Thermal image *DTheta*-r
- Binary inputs state IN1,IN2
- Output relays state K1...K6
- Fault cause info (operating phase) L1, L2, L3

## — Digital Fault Recorder (DFR)

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, IN2
- Trigger from outputs K1...K6
- Manual trigger ThySetter

*Set sample channels:*
- Instantaneous currents $i_{L1}$, $i_{L2}$, $i_{L3}$, $i_E$
- Instantaneous voltages $u_{L1}$, $u_{L2}$, $u_{L3}$, $u_E$

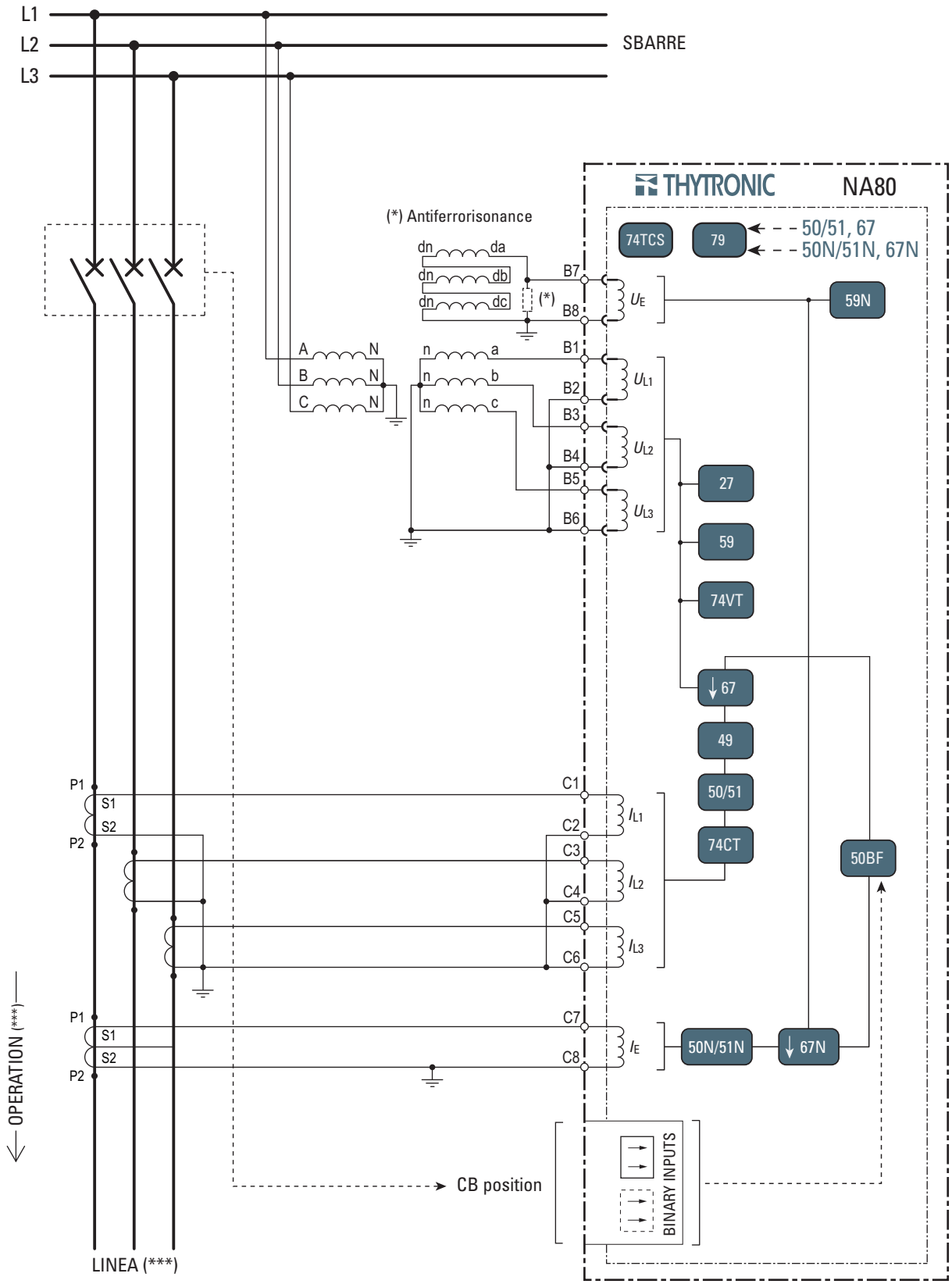
*Set analog channels (Analog 1...12):*
- Frequency $f$
- Fundamental RMS phase currents $I_{L1}$, $I_{L2}$, $I_{L3}$
- Fundamental RMS residual current $I_E$
- Fundamental RMS phase voltages $U_{L1}$, $U_{L2}$, $U_{L3}$
- Fundamental RMS residual voltage $U_E$
- Fundamental RMS phase-to-phase voltages $U_{12}$, $U_{23}$, $U_{31}$
- Fundamental RMS calculated residual voltage $U_{EC}$
- 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 ($U_E$-$I_E$) $Phi_E$
- Displacement angle ($U_{EC}$-$I_E$) $Phi_{EC}$
- 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 $I_{\text{-}2nd}/I_L$
- Temperature *T1...T8*

*Set digital channels (Digital 1...12):*
- Output relays state K1...K6...K10
- Binary inputs state IN1, IN2...INx

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

*about 260 records can be stored with f=50 Hz*

## — Protective functions

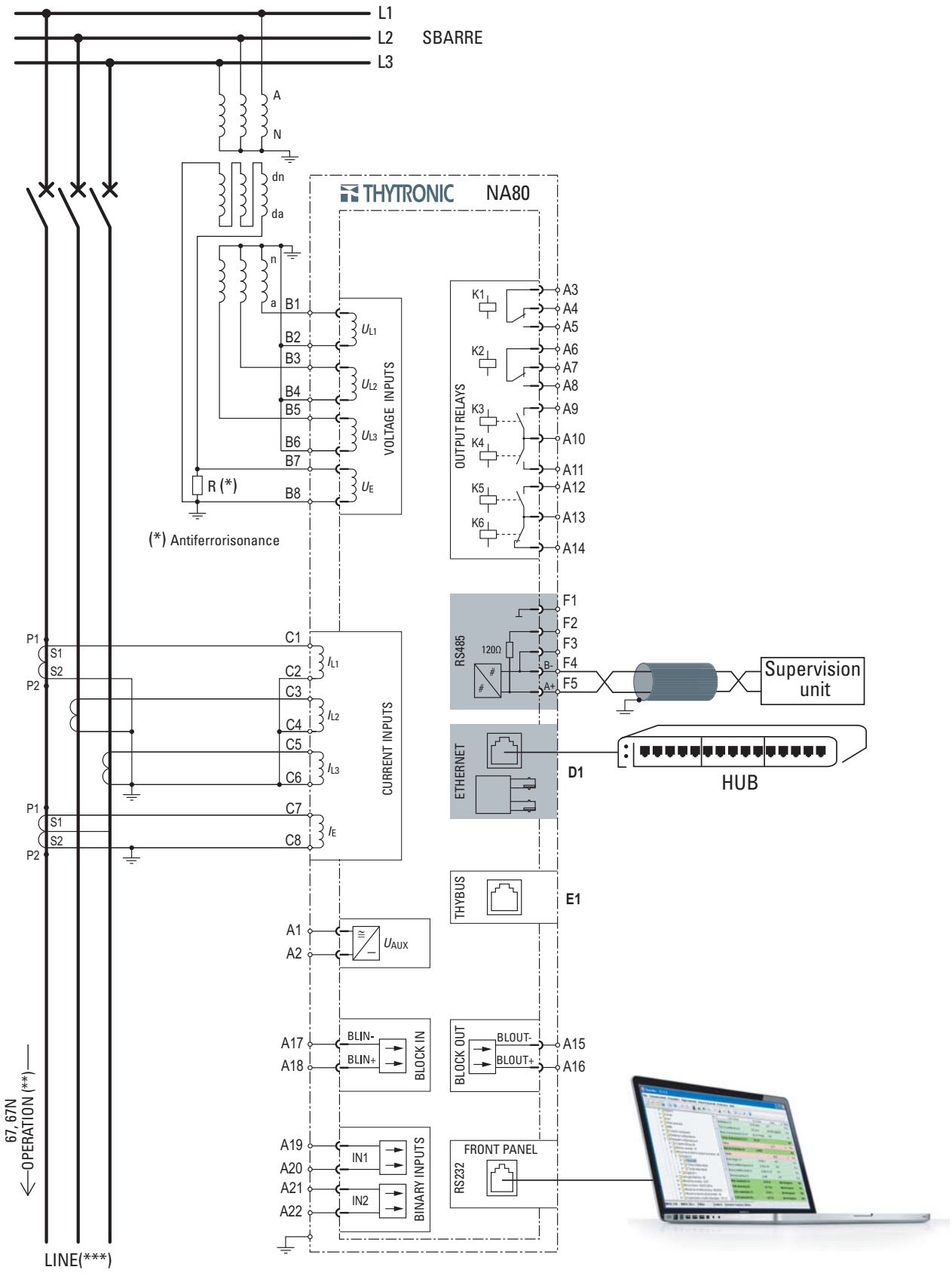



(**) OPERATION FOR:
- 67 elements with characteristic angle adjusted within 0°... 90° or 270° ...359° ranges
- 67N elements for insulated neutral systems and characteristic angle setting = 90°

(***) MEASUREMENTS:
- Positive sign for measurement of active power and energy with passive load
- Negative sign for measurement of active power and energy with generators

NA60-fun.ai

## — Connection diagram example

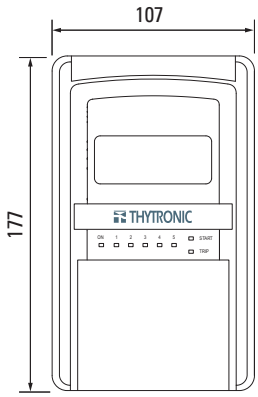



(**) OPERATION FOR:
- 67 elements with characteristic angle adjusted within 0°... 90° or 270° ...359° ranges
- 67N elements for insulated neutral systems and characteristic angle setting = 90°

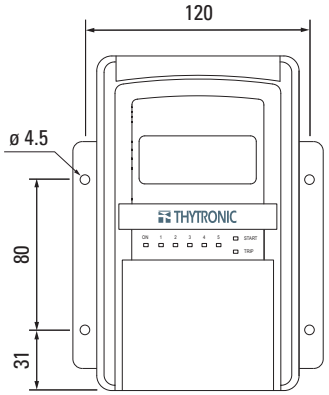
(***) MEASUREMENTS:
- Positive sign for measurement of active power and energy with passive load
- Negative sign for measurement of active power and energy with generators

# DIMENSIONS

## FRONT VIEW

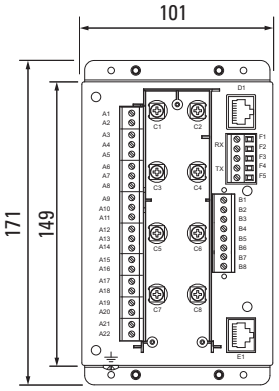



FLUSH MOUNTING

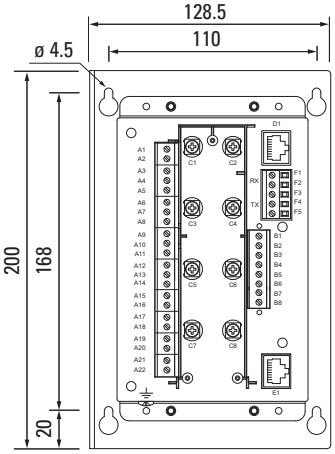



PROJECTING MOUNTING

## REAR VIEW

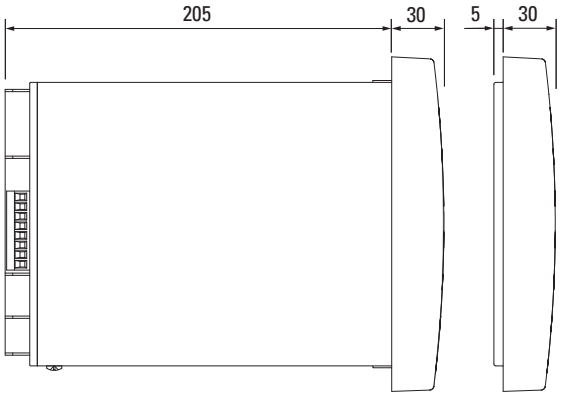



FLUSH MOUNTING



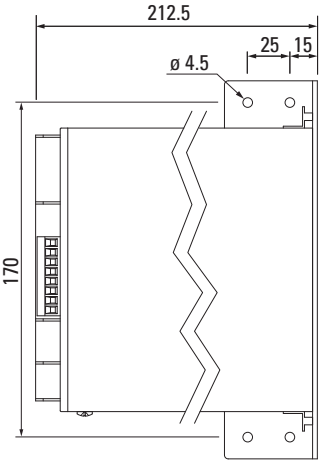

PROJECTING MOUNTING
(Separate operator panel)

## SIDE VIEW

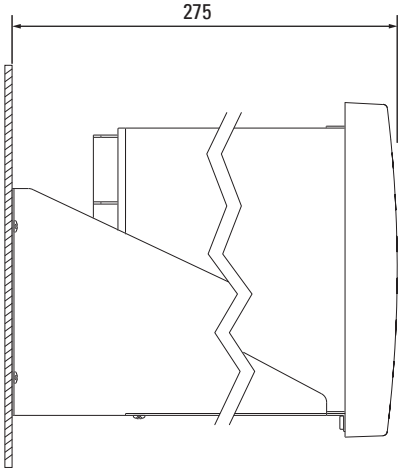



FLUSH MOUNTING

SEPARATE
OPERATOR PANEL

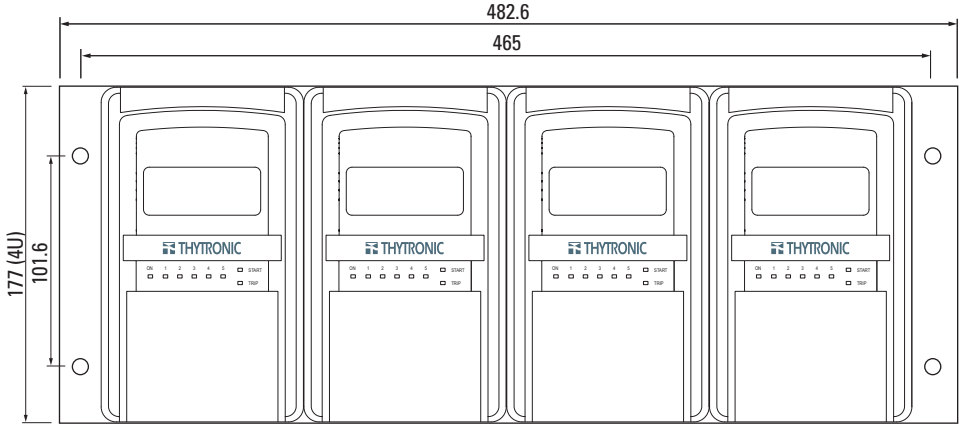



PROJECTING MOUNTING
(Separate operator panel)

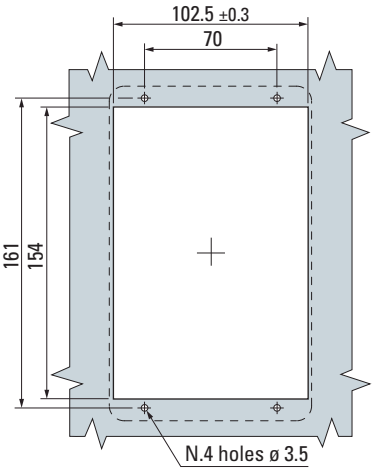



PROJECTING MOUNTING
(Stand alone)

## RACK MOUNTING




## FLUSH MOUNTING CUTOUT



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