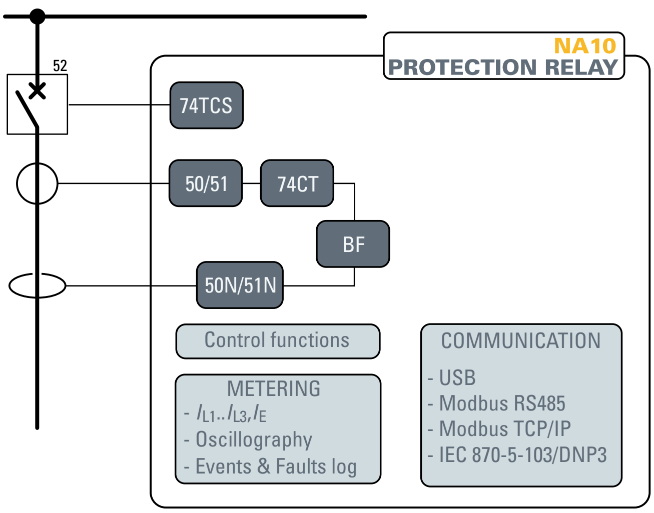
NA10

FEEDER PROTECTION RELAY

THE BASIC SOLUTION FOR FEEDERS AND TRANSFORMERS PROTECTION

— Application

The relay type NA10 can be used in radial networks as feeder or power transformer protection.
In solidly grounded systems the residual overcurrent protection can be used on feeders of any length, while in ungrounded or Petersen coil and/or resistance grounded systems, the residual overcurrent protection can be used on feeders of small length in order to avoid unwanted trippings due to the capacitive current contribution of the feeder on external ground fault.
The relay complies with CEI 0-16 requirements.



- Protective & control functions

50/51	Phase overcurrent
50N/51N	Residual overcurrent
BF	Breaker failure
74CT	CT supervision
74TCS	Trip circuit supervision

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.

Binary inputs
Two or five 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.

Construction
According to the hardware configurations, the NA10 protection relay can be shipped in various case styles depending on the required mounting options (flush, projecting mounting, rack or with separate operator panel).

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 in accordance with a matrix (tripping matrix) structure.

Modular design
In order to extend I/O capability, the hardware can be customized through external auxiliary modules:
- MRI - Output relays and LEDs
- MID16 - Binary inputs
- MCI - 4...20 mA converter
- MPT - Pt100 probe inputs.

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 upwards in the electric plant. The output circuit works as a simple contact, whose condition is detected by the input circuit of the upwards protection relay.
For long distances, when high insulation and high EMC immunity is essential, a suitable pilot wire to fiber optic converter (BFO) is available.

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

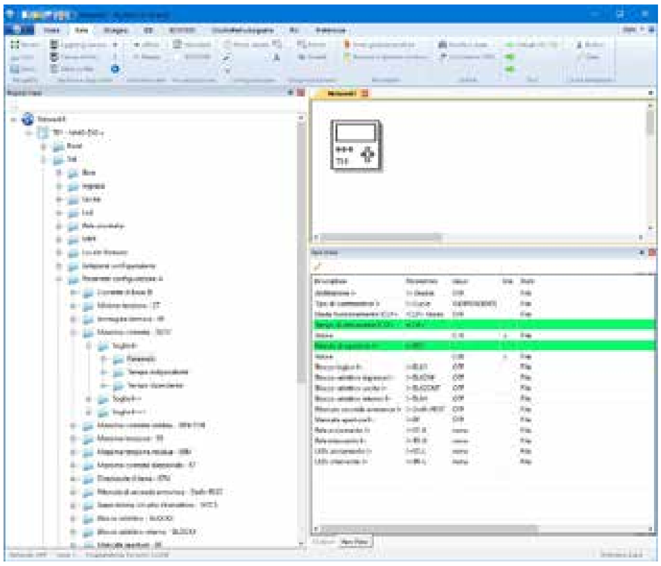
Two set point profiles (A,B)
Two independent groups of settings are provided. Switching from profiles may be operated by means of MMI, binary input and communication.

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 USB local communication front-end interface for communication with ThyVisor setup software
- Two back-end interfaces for communication with remote monitoring and control systems by:
  - RS485 port - 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 ThyVisor 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.



Control and monitoring

Several predefined functions are implemented:

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

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

Circuit Breaker commands and diagnostic

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)

The Cold Load Pickup feature can operate in two following modes:

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

It is triggered by the circuit breaker closing.

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 upwards 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.
The logic selectivity function can be realized through any combination of binary inputs, output relays and/or committed pilot wires circuits.

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

Metering values for phase and residual currents arev 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, the minimum-peak-fixed-rolling demand, mean-minimum-maximum absolute phase currents are processed.
The measured signals can be displayed with reference to nominal values or directly expressed in amperes.

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 (ThyVisor) is issued:

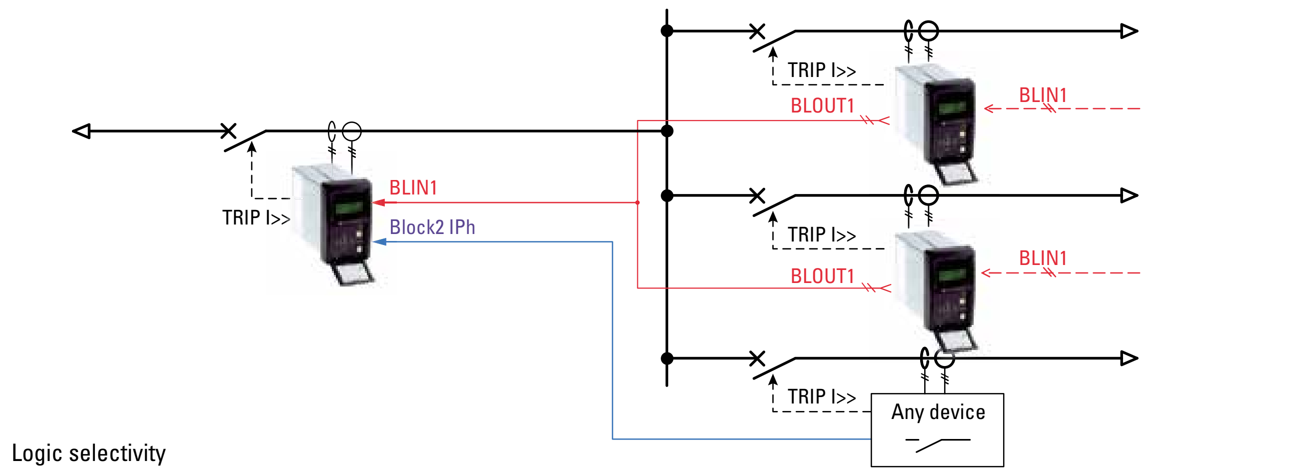
- Sequence of Event Recorder (SER)
  The event recorder runs continuously capturing in circular mode the last three hundred events upon trigger of binary input/output.
- Sequence of Fault Recorder (SFR)
  The fault recorder runs continuously capturing in circular mode the last twenty faults upon trigger of binary input/output and/or element pickup (start-trip).
- Settings recording
  Following some setting changes the last eight changes are recorded in circular mode (Data Logger CEI 0-16)
- 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



Logic selectivity

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 USB	Type B
Network:	
• RS485	1200...57600 bps
• Ethernet 100BaseT	100 Mbps
Protocol	ModBus® RTU/IEC 60870-5-103/DNP3, TCP/IP

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
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)

Binary inputs

Quantity	2 or 5
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_{En})	1 A, 5 A
Residual CT nominal primary current (I_{Enp})	1 A...10 kA

Binary input timers

ON delay time (IN1 t_{ON}, IN2 t_{ON},...IN5 t_{ON})	0.00...100.0 s
OFF delay time (IN1 t_{OFF}, IN2 t_{OFF},...IN5 t_{OFF})	0.00...100.0 s
Logic	Active-ON/Active-OFF

— Relay output timers
Minimum pulse width (t_{TR}) 0.000...0.500 s

PROTECTIVE FUNCTIONS

— Thermal protection with RTD thermometric probes - 26
Alarm
- Alarm threshold θ_{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

— 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, NSI/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 ($I_{E>inv}$) 0.002...2.00 I_{En}
- $I_{E>inv}$ within CLP ($I_{ECLP>inv}$) 0.002...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 ($I_{ECLP>>def}$) 0.02...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}
- $I_{E>>>def}$ within CLP ($I_{ECLP>>>def}$) 0.002...10.00 I_{En}
- $I_{E>>>def}$ Operating time ($t_{E>>>def}$) 0.03...10.00 s

— 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

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

— 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

— CT supervision - 74CT
74CT Threshold (*S<*) 0.10...0.95
74CT Overcurrent threshold (I^*) 0.10..1.00 I_n
S< Operate time ($t_{S<}$) 0.03...200 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 & RECORDING

— Measured parameters
Direct:
- Frequency *f*
- Fundamental RMS phase currents I_{L1}, I_{L2}, I_{L3}
- Fundamental RMS residual current I_E

Calculated:
- 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

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 residual current I_{E-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}

On demand:
- 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}

Event recording (SER)

Number of events 300
Recording mode circular

Trigger:

- Start/Trip of enabled protection or control element
- Binary inputs switching (OFF/ON or ON/OFF) IN1...INx
- Setting changes
- Auxiliary supply Power UP/Power DOWN

Data recorded:

- Counter (resettable by ThyVisor) $0...10^9$
- Cause binary input/trip/setting change/Power ON/OFF
- Time stamp Date and time

Fault recording (SFR)

Number of faults 20
Recording mode circular

Trigger:

- Output relays of enabled protection or control element (OFF-ON)
- External trigger (binary inputs) IN1...INx

Data recorded:

- Counter (resettable by ThyVisor) $0...10^9$
- Time stamp Date and time
- Cause tripped element
- Fundamental RMS phase currents I_{L1r}, I_{L2r}, I_{L3r}
- Fundamental RMS residual current I_{Er}
- Binary inputs state IN1...INx
- Output relays state K1...Kx
- Fault cause info (operating phase) L1, L2, L3

Settings recording

Number of setting changes 8
Recording mode circular

Data recorded:

- Setting counter $0...10^9$
- Setting data description and parameter
- Time stamp Date and time

Digital Fault Recorder (Oscillography)

File format COMTRADE
Records depending on setting [1]
Recording mode circular
Sampling rate 24 per power frequency cycle

Trigger setup:

- Pre-trigger time 0.05...1.00 s
- Post-trigger time 0.05...60.00 s
- Trigger from inputs IN1, IN2...INx
- Trigger from outputs K1...K6...K10
- Manual trigger

Data recorded on sampled channels:

- Instantaneous currents i_{L1}, i_{L2}, i_{L3}, i_E

Data recorded on analog channels (Analog 1...12):

- Frequency f
- Fundamental RMS phase currents I_{L1r}, I_{L2r}, I_{L3r}
- Fundamental RMS residual current I_{Er}

Data recorded on digital channels (Digital 1...12):

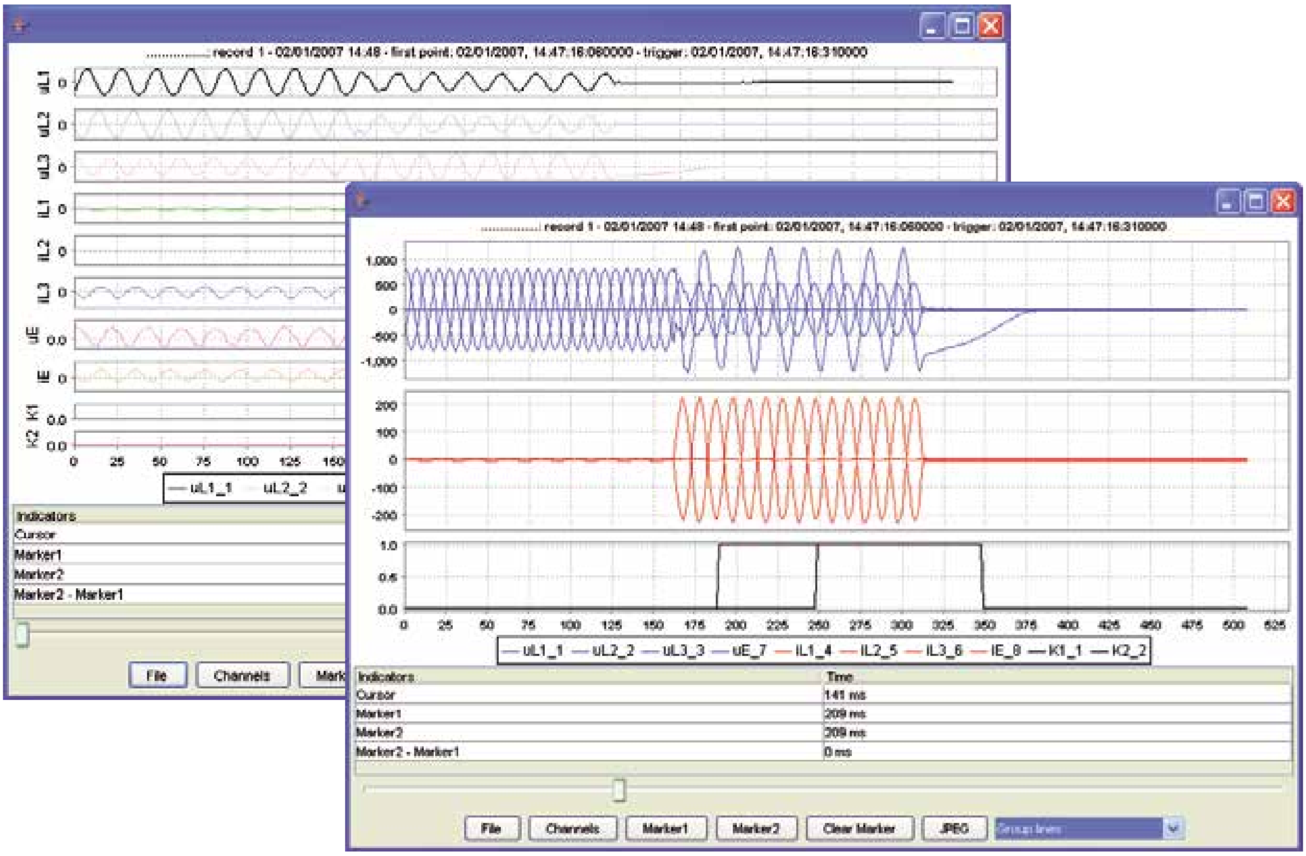
- Output relays state K1...K6...K10
- Binary inputs state IN1, IN2...INx

For instance, with following setting:

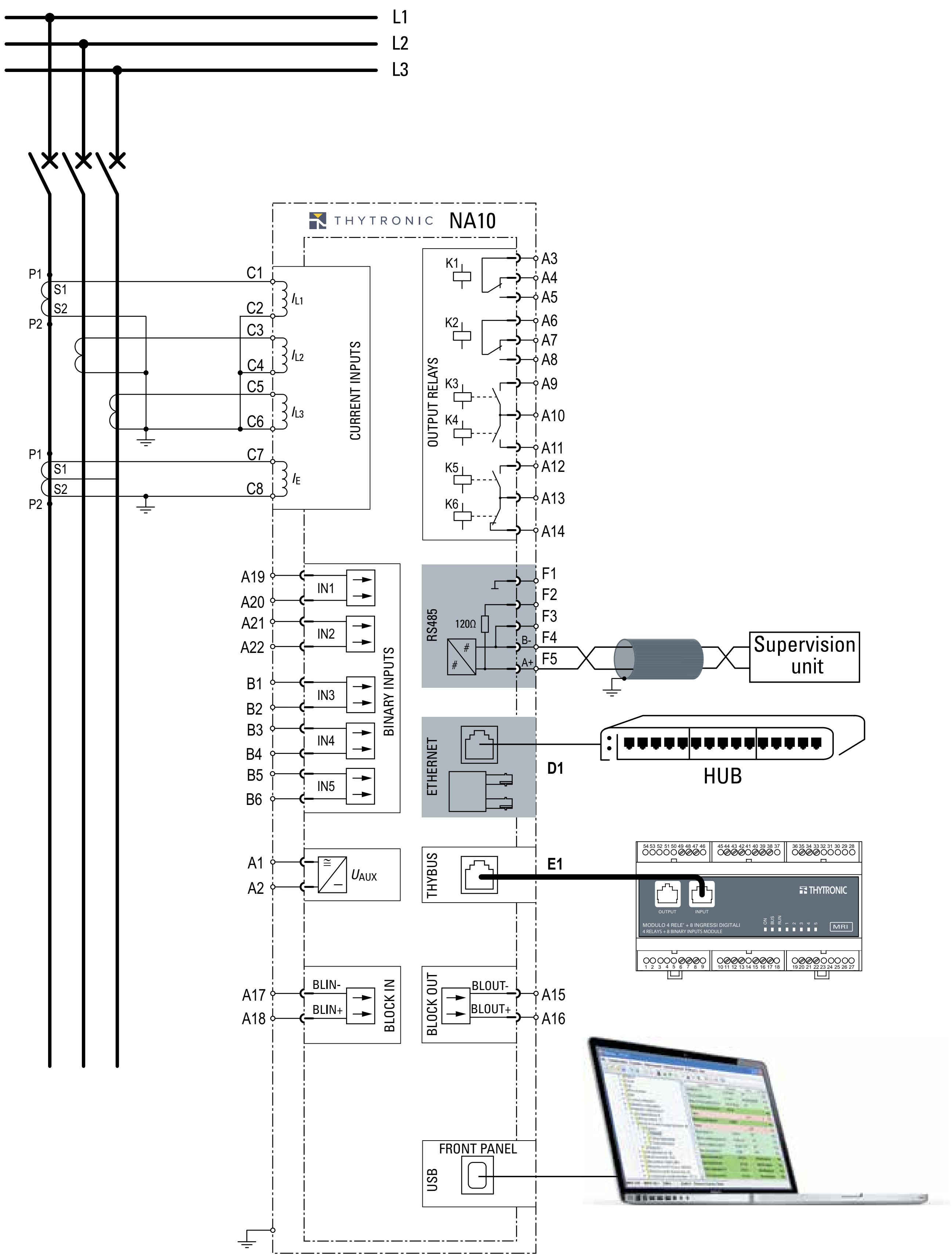
- *Pre-trigger time 0.25 s*
- *Post-trigger time 0.25 s*
- *Sampled channels* i_{L1}, i_{L2}, i_{L3}, i_E
- *Analog channels* I_{L1}, I_{L2}, I_{L3}, I_E
- *Digital channels K1, K2, K3, K4, K5, K6, IN1, IN2*

up to 180 records can be stored when f = 50 Hz

Oscillography (DFR)

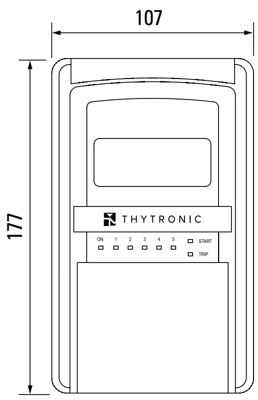


Connection diagram example

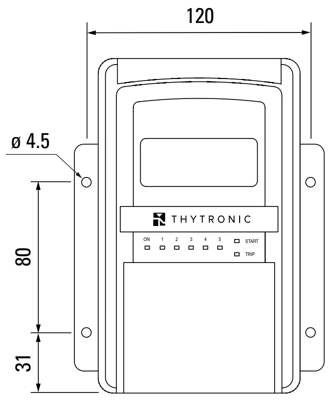


DIMENSIONS

FRONT VIEW

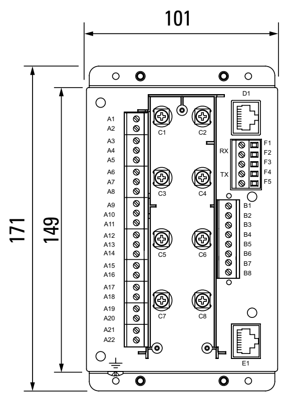


FLUSH MOUNTING

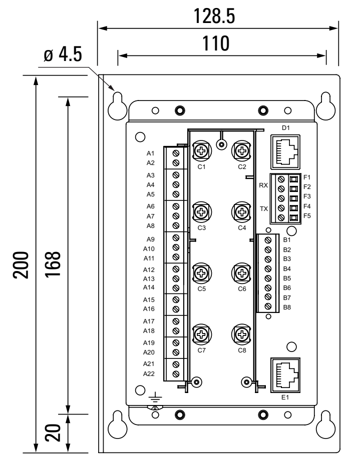


PROJECTING MOUNTING

REAR VIEW

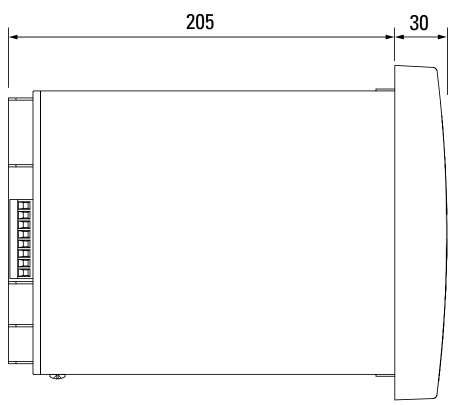


FLUSH MOUNTING

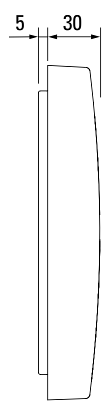


PROJECTING MOUNTING
(Separate operator panel)

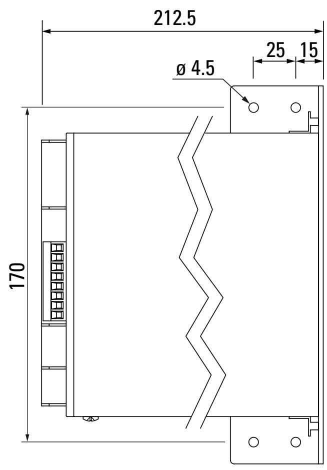
SIDE VIEW



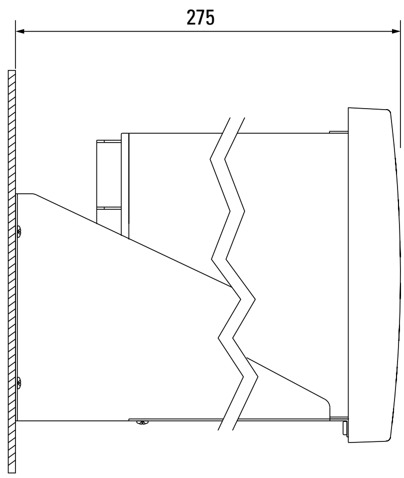
FLUSH MOUNTING



SEPARATE
OPERATOR PANEL

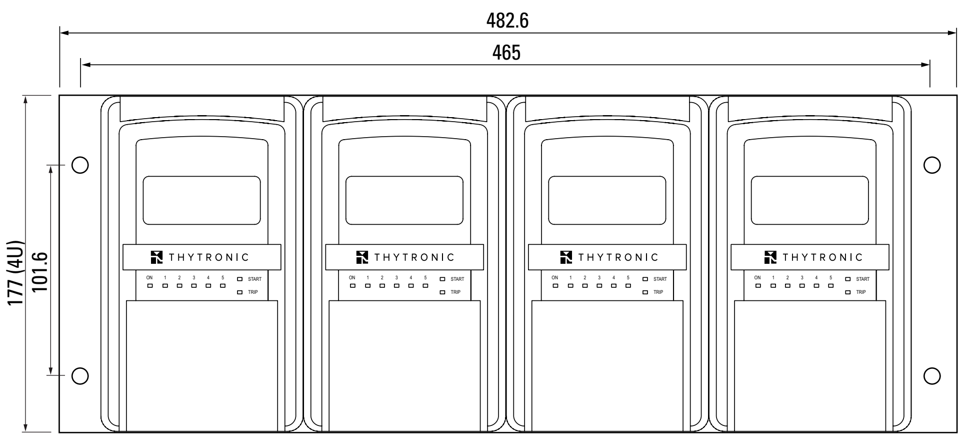


PROJECTING MOUNTING
(Separate operator panel)



PROJECTING MOUNTING
(Stand alone)

RACK MOUNTING



FLUSH MOUNTING CUTOUT