NA21

FEEDER PROTECTION RELAY

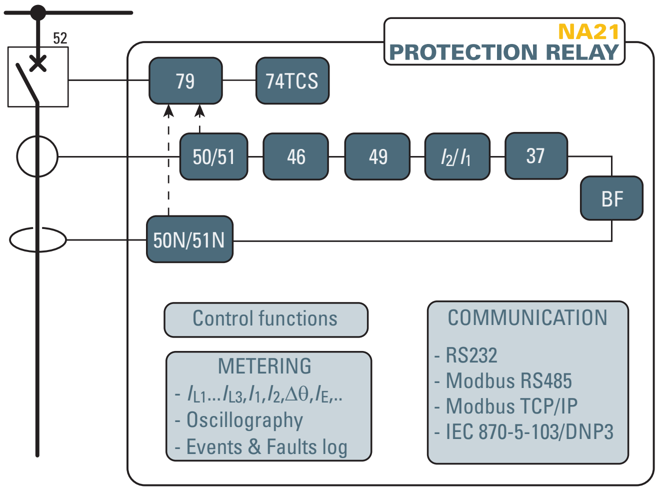
THE BASIC SOLUTION FOR FEEDERS AND TRANSFORMERS
PROTECTION WITH THERMAL IMAGE,
NEGATIVE SEQUENCE OVERCURRENT AND AUTOMATIC RECLOSURE

Application

The relay type NA21 is typically used in HV, MV and LV 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.

Beside to the phase and residual overcurrent protection, the following protective functions are provided:

- Thermal image protection of lines and power transformers
- Undercurrent protection for monitoring of CB opening
- Negative sequence protection against asymmetrical short circuits and unbalance loads
- I_2/I_1 protection against phase interruption under low-load condition
- Automatic reclosing.



- Protective & control functions

37	Undercurrent
46	Negative-sequence overcurrent
49	Thermal image
50/51	Phase overcurrent
50N/51N	Residual overcurrent
I2/I1	Phase interruption under low-load condition
BF	Circuit breaker failure
79	Automatic reclosing
74CT	CTs monitoring
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.

— 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.

— Construction

According to the hardware configurations, the NA21 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 NA21 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.

— 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.

— 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.

— 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.

— 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.

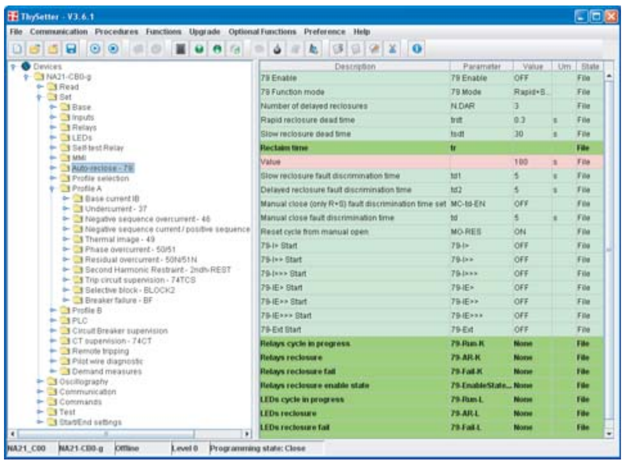
— Programming and settings

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:

- 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.
- Synchronization.
- Automatic reclosing

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.

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.

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)

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.

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

NA21 provides metering values for phase and residual currents, 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, the fundamental RMS value of the positive and negative sequence currents, 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 (ThySetter) is issued:

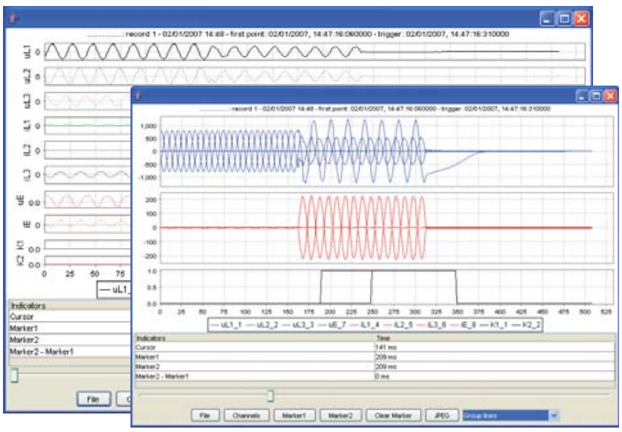
- Sequence of Event Recorder (SER).
  The event recorder runs continuously capturing in circular mode the last three hundred events upon trigger of binary input/output.
- Sequence of Fault Recorder (SFR).
  The fault recorder runs continuously capturing in circular mode the last twenty faults upon trigger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

Oscillography (DFR)



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 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_{OF},...IN5 t_{OFF}) 0.00...100.0 s

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

PROTECTIVE FUNCTIONS

Base current - IB

Base current (I_B) 0.10...2.50 I_n

Note 1: assuming that the secondary rated current of the line CT's equals the rated current of the NA21 relay, the I_B value is the ratio between the rated current of the protected component and the CT's primary rated current.

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

Undercurrent - 37

Common configuration:
- 37 Operating logic (*Logic*37) AND/OR

I< Element
Definite time
- 37 First threshold definite time ($I<_{def}$) 0.10...1.00 I_n
- $I<_{def}$ Operating time ($t<_{def}$) 0.04...200 s

Negative sequence - 46

I_2> Element
- I_2> Curve type DEFINITE IEC/BS A, B, C - ANSI/IEEE MI, VI, EI, I²t or EM
- I_{2CLP}> Activation time ($t_{2CLP>}$) 0.00...100.0 s
- I_2> Reset time delay ($t_{2>RES}$) 0.00...100.0 s

Definite time
- 46 First threshold definite time ($I_2>_{def}$) 0.100...10.00 I_n
- $I_2>_{def}$ within CLP ($I_{2CLP>def}$) 0.100...10.00 I_n
- $I_2>_{def}$ Operating time ($t_2>_{def}$) 0.03...200 s

Inverse time
- 46 First threshold inverse time ($I_2>_{inv}$) 0.100...10.00 I_n
- $I_2>_{inv}$ within CLP ($I_{2CLP>inv}$) 0.100...10.00 I_n
- $I_2>_{inv}$ Operating time ($t_2>_{inv}$) 0.02...60.0 s

I_2>> Element
- I_{2CLP}>> Activation time ($t_{2CLP>>}$) 0.00...100.0 s
- I_2>> Reset time delay ($t_{2>>RES}$) 0.00...100.0 s

Definite time
- 46 Second threshold definite time ($I>>_{def}$) 0.100...40.00 I_n
- $I_2>>_{def}$ within CLP ($I_{2CLP>>def}$) 0.100...40.00 I_n
- $I_2>>_{def}$ Operating time ($t_2>>_{def}$) 0.03...10.00 s

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
- DthCLP 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 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...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 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/51N

I_E> Element
- I_E> Curve type DEFINITE IEC/BS A, B, C - ANSI/IEEE MI, VI, EI or 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}
- $I_{ECLP>>>def}$ within CLP ($I_{ECLP>>>def}$) 0.002...10.00 I_{En}
- $I_{ECLP>>>def}$ Operating time ($t_{E>>>def}$) 0.03...10.00 s

Negative sequence current / positive sequence current ratio - I_2/I_1

I_{21}> Element
- I_{21CLP}> Activation time ($t_{21CLP>}$) 0.00...100.0 s

Definite time
- I_2/I_1 First threshold definite time ($I_{21>def}$) 0.10...1.00
- $I_{21>def}$ within CLP ($I_{21CLP>def}$) 0.10...1.00
- $I_{21>def}$ Operating time ($t_{21>def}$) 0.04...15000 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

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

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:

- BLOUT1 Dropout time delay for phase protections (t_{F-IPh}) 0.00...1.00 s
- BLOUT1 Drop-out time delay for phase protections (t_{F-IE}) 0.00...1.00 s
- BLOUT1 Drop-out time delay for phase and earth protections ($t_{F-IPh/IE}$) 0.00...1.00 s

Auto-reclose - 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

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

Circuit Breaker supervision

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

Measured parameters

Direct:

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

Calculated:

- Thermal image — DTheta
- 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

Sequence:

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

2nd harmonic:

- Second harmonic phase currents — I_{L1-2nd}, I_{L2-2nd}, I_{L3-2nd}
- 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 of 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}

Pt100:

- PT1...PT8 Temperature — T_1... T_8

Sequence of Event Recorder (SER)

Number of events	300
Recording mode	circular

Trigger:

- Output relays switching — K1...K6...K10
- 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 of measured residual current (CTs) — I_{Er}
- Thermal image — *DTheta*-r
- Negative sequence current / positive sequence current ratio — $(I_2/I_1)_r$
- Binary inputs state — IN1, IN2...INx
- Output relays state — K1...K6...K110
- Fault cause info (operating phase) — L1, L2, L3

Digital Fault Recorder (Oscillography) [1]

File format	COMTRADE
Records	depending on setting [2]
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 — ThySetter

Set sample channels:

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

Set analog channels (Analog 1...12):

- Frequency — *f*
- Phase current RMS values — I_{L1}, I_{L2}, I_{L3}
- Residual current RMS value — I_E
- Positive and negative sequence currents — I_1, I_2
- Negative sequence current/positive sequence current ratio — I_2/I_1
- Second harmonic 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
- Temperature — *T1...T8*

Set digital channels (Digital 1...12):

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

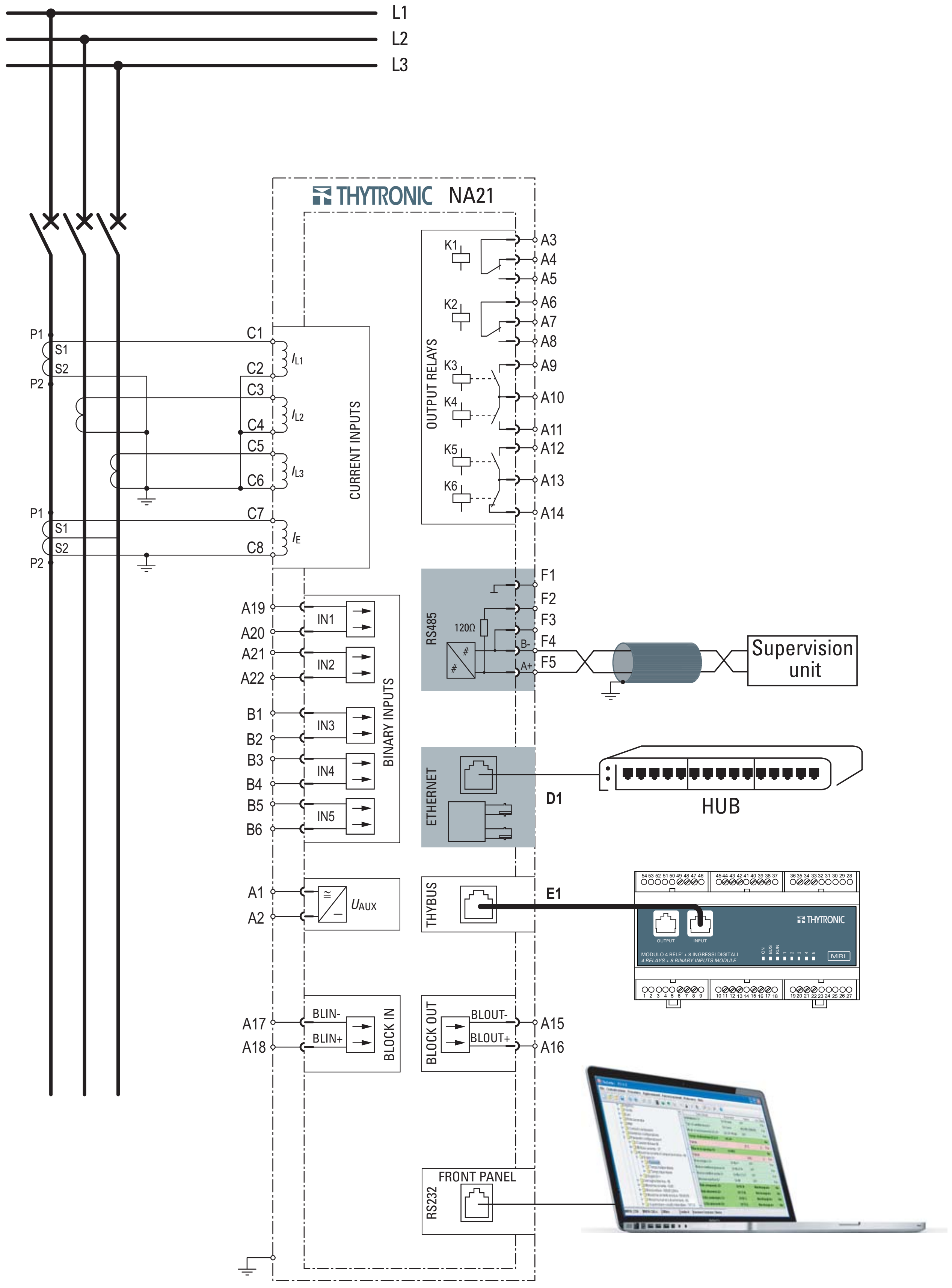
Note 1- A licence for the digital fault recorder function is required. The oscillography records are stored in non-volatile memory.

Note 2 - 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 five hundred records can be stored when f = 50 Hz

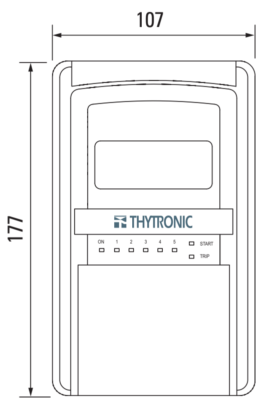
Connection diagram example



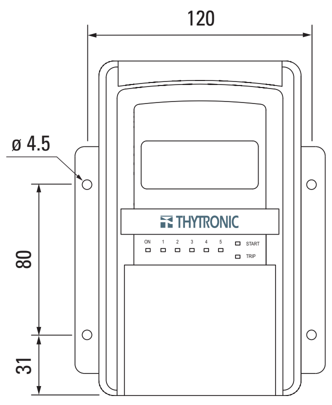
THYTRONIC

DIMENSIONS

FRONT VIEW

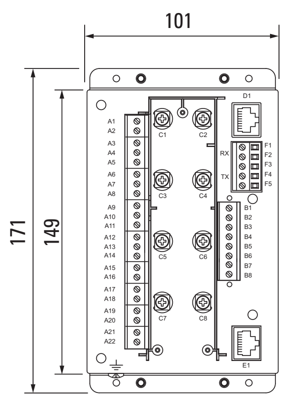


FLUSH MOUNTING



PROJECTING MOUNTING

REAR VIEW



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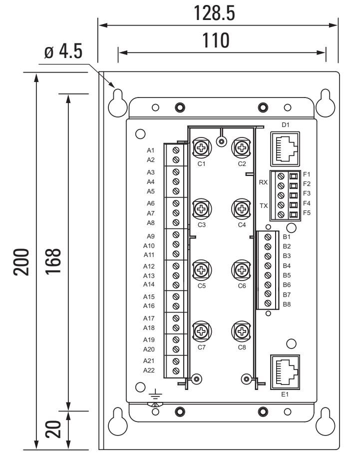
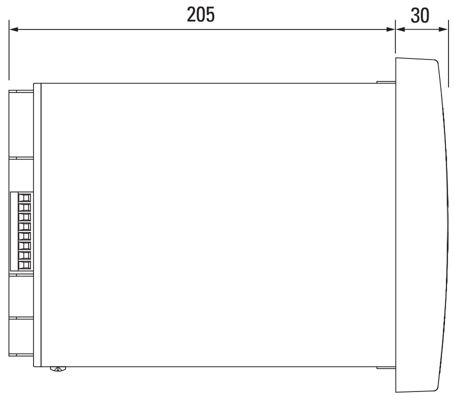
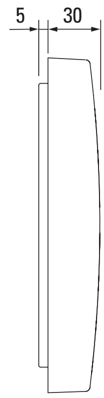


PROJECTING MOUNTING
(Separate operator panel)

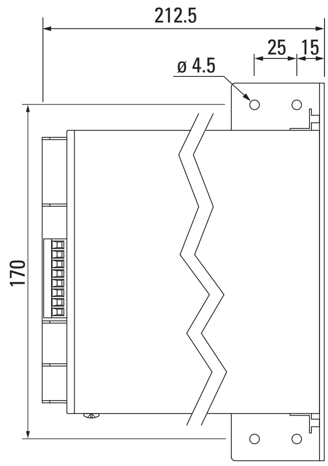
SIDE VIEW



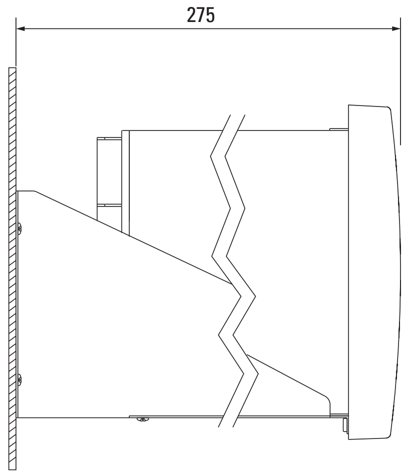
FLUSH MOUNTING



SEPARATE
OPERATOR PANEL

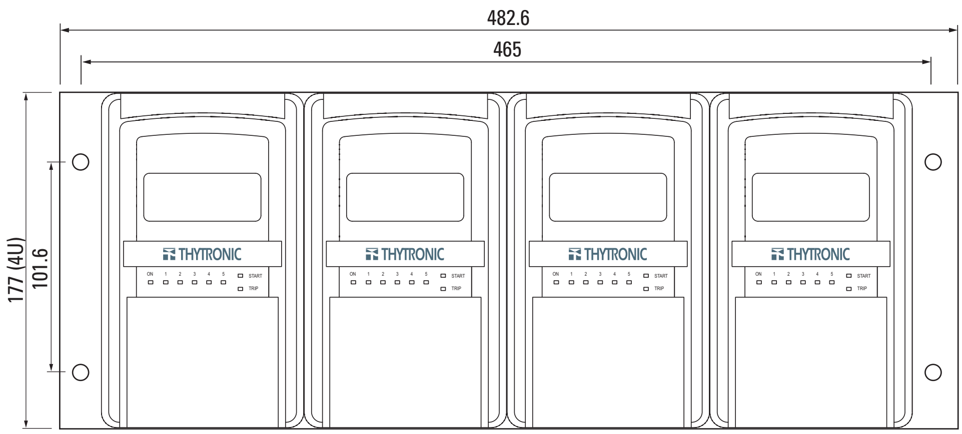


PROJECTING MOUNTING
(Separate operator panel)

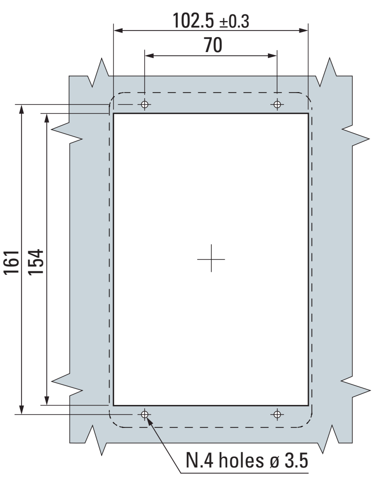


PROJECTING MOUNTING
(Stand alone)

RACK MOUNTING



FLUSH MOUNTING CUTOUT



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