THYTRONIC

SMART line
Protection Relays

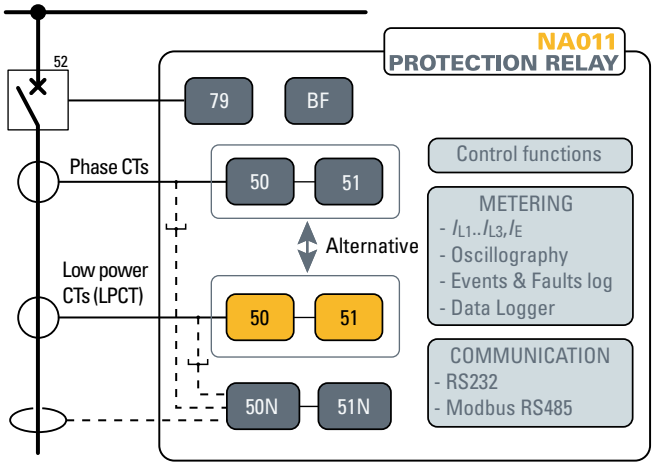
NA011

FEEDER PROTECTION RELAY

THE ECONOMICAL SOLUTION FOR THE PROTECTION OF LINES AND TRANSFORMERS WITH AUTOMATIC RECLOSER

— Application

The relay type NA011 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 NA011 protection relay may be shipped with traditional CTs or low power (LPCT) current inputs; for both versions, the residual overcurrent protection can use the measured (CTs or balanced transformer) or the calculated residual current.



- Protective & control functions

50/51	Phase overcurrent
50N/51N	Residual overcurrent
79	Automatic recloser
BF	Breaker failure

— Phase current inputs

Traditional CTs

Three phase current inputs with secondary nominal currents independently selectable at 1 A or 5 A through DIP-switches.

Low power CTs

Three phase current inputs with primary nominal currents independently selectable through DIP-switches and software.

— Residual current input

Measured residual current

One residual current input with secondary nominal current selectable at 1 A or 5 A through DIP-switches.

Calculated residual current

Residual current is calculated by the vector sum of the three phase currents, measured by three 1A or 5A CTs or by three LPCT type sensors.

— Binary inputs

Three binary inputs are available with predefined functions:

- IN1 - 52b acquisition or external trip
- IN2 - 52a acquisition, external trip or CB Open command
- IN3 - 79 (Enable or Remote), external trip or CB Close command

— Output relays

Four output relays are available (one changeover contact); each relay may be individually programmed as normal state (normally energized or de-energized) 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.

— Construction

The NA011 protection relay case is suitable for flush or rack mounting.

— 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,
- The yellow LED START, no-latched, indicates Start of the I>, I>>, I>>>, IE>, IE>> elements
- The red LED TRIP, no-latched, indicates Trip of the I>, I>>, I>>>, IE>, IE>> elements
- The red LED 1, latched, indicates Trip of the I>, I>>, I>>> elements
- The red LED 2, latched, indicates Trip of the IE>, IE>> elements
- The red LED 3, no-latched, indicates the CB state (CB open)
- The red LED 4, no-latched, indicates the CB state (CB closed)
- The red LED 5, no-latched, indicates the 79 (Reclosure) state:

- ○ LED off = 79 disabled
- ● LED on = 79 enabled
- ◐ LED slow blink = cycle in progress
- ⊗ LED fast blink = reclosure fail

By means of the ○ (Open) and I (Close) keys, the circuit breaker commands may be issued.

— 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.

— Control and monitoring

Several predefined functions are implemented:

- Cold load pickup (CLP) with block or setting change
- Circuit Breaker diagnostic.

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.

— Firmware updating

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

— Communication

Two communication interfaces are implemented:

- One RS232 local communication front-end interface for communication with ThyVisor setup software
- One RS485 port using ModBus® RTU or IEC 60870-5-103 for communication with remote monitoring and control systems.

— 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, ...).
- Sw faults (boot and run time tests for data base, EEPROM memory checksum failure, data BUS,...).

— Metering

NA011 provides metering values for phase and residual currents, making them available for reading on a display or to communication interfaces.
Input signals are sampled 64 times per period and the RMS value of the fundamental component is measured using the DFT (Discrete Fourier Transform) algorithm and digital filtering.
The measured signals can be displayed with reference to nominal values or directly expressed in amperes.

— Data storage

Several useful data are stored into a non volatile memory.

- Sequence of Event Recorder
  The event recorder runs continuously capturing in circular mode the last one hundred events upon trigger of binary input/output.
- Sequence of Fault Recorder
  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).
- Counters

— Digital Fault Recorder (Oscillography)[1]

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

SPECIFICATIONS

GENERAL

— Mechanical data

Mounting:	flush, rack
Mass (flush mounting case)	1.2 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	2004/108/EC
• Low Voltage Directive	2006/95/EC
Type tests	IEC 60255-6

COMMUNICATION INTERFACES

Local PC RS232	19200 bps
RS485 port	1200...57600 bps
Protocol	ModBus® RTU/IEC 60870-5-103

INPUT CIRCUITS

— Auxiliary power supply Uaux

Nominal value (range)	24...230 Vac/dc
Operative range	19...265 Vac / 19...300 Vdc
Power consumption (max)	6 W (9 VA)

— Phase current inputs

Traditional CTs:

• Nominal current I_n	1 A or 5 A selectable by DIP Switches
• Permanent overload	25 A
• Thermal overload (1 s)	500 A
• Rated consumption (for any phase)	≤ 0.002 VA (I_n = 1 A) ≤ 0.04 VA (I_n = 5 A)
• Connections	4 mm ring lugs suitable for M4 screws

Low power CTs (according to IEC 60044-8 standard):

• Nominal primary current I_{pn}	100 A
• Extended primary current (selectable via DIP Switches and sw)	50...1250 A
• Maximum primary current	12.5 kA
• Nominal secondary voltage (I_{np} = 100 A)	22.5 mV
• Connections	RJ45 plug

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

OUTPUT CIRCUITS

— Output relays K1...K4

Quantity	4
Command relays K1, K2, K4	
Type of contacts	changeover (SPDT, type C)
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
Signalling relays K3	
Type of contacts	changeover (SPDT, type C)
Nominal current	8 A
Nominal voltage/max switching voltage	250 Vac/400 Vac

— LEDs

Quantity	8
• ON/fail (green)	1
• Start (yellow)	1
• Trip (red)	1
• Trip I>, I>>, I>>> (red)	1
• Trip IE>, IE>> (red)	1
• 52a - CB position (red)	1
• 52b - CB position (red)	1
• 79 - Auto recloser (red)	1

GENERAL SETTINGS

— Rated values

Phase CT nominal primary current (I_{np})	1 A...5000 A
Residual CT nominal primary current (I_{Enp})	1 A...5000 A
Reading	Direct / Relative

— Relay output timers

Minimum pulse width (K_1t_{TR}... K_4t_{TR})	0.01...0.50 s

PROTECTIVE FUNCTIONS

— Phase overcurrent - 50/51

I> Element

- *I>* Curve type (*I>*Curve) — DEFINITE, IEC/BS A, B, C, ANSI/IEEE MI, VI, EI, I2T
- CLP activation time ($t_{CLP>}$) — 0.00...100.0 s
- *I>* Reset time ($t_{>RES}$) — 0.00...100.0 s

Definite time

- 50/51 First threshold definite time ($I_{>def}$) — 0.100...20.0 I_n
- $I_{>def}$ within CLP ($I_{CLP>def}$) — 0.100...20.0 I_n
- $I_{>def}$ Operating time ($t_{>def}$) — 0.03...10.00 s

Inverse time

- 50/51 First threshold inverse time ($I_{>inv}$) — 0.100...2.50 I_n
- $I_{>inv}$ within CLP ($I_{CLP>inv}$) — 0.100...10.0 I_n
- $I_{>inv}$ Operating time ($t_{>inv}$) — 0.02...60.0 s

I>> Element

- CLP activation time ($t_{CLP>>}$) — 0.00...100.0 s
- *I>>* Reset time ($t_{>>RES}$) — 0.00...100.0 s

Definite time

- 50/51 Second threshold definite time ($I_{>>def}$) — 0.100...20.0 I_n
- $I_{>>def}$ within CLP ($I_{CLP>>def}$) — 0.100...20.0 I_n
- $I_{>>def}$ Operating time ($t_{>>def}$) — 0.03...10.00 s

I>>> Element

- CLP activation time ($t_{CLP>>>def}$) — 0.00...100.0 s
- *I>>>* Reset time ($t_{>>>RES}$) — 0.00...100.0 s

Definite time

- 50/51 Third threshold definite time ($I_{>>>def}$) — 0.100...20.0 I_n
- $I_{>>>def}$ within CLP ($I_{CLP>>>def}$) — 0.100...20.0 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, I2T
- CLP activation time ($t_{ECLP>}$) — 0.00...100.0 s
- I_E> Reset time delay ($t_{E>RES}$) — 0.00...1.00 s

Definite time

- 50N/51N First threshold definite time ($I_{E>def}$) — 0.005...5.00 I_{En}
- $I_{E>def}$ within CLP ($I_{ECLP>def}$) — 0.005...5.00 I_{En}
- $I_{E>def}$ Operating time ($t_{E>def}$) — 0.03...10.00 s

Inverse time

- 50N/51N First threshold inverse time ($I_{E>inv}$) — 0.005...2.00 I_{En}
- $I_{E>inv}$ within CLP ($I_{ECLP>inv}$) — 0.005...2.00 I_{En}
- $I_{E>inv}$ Operating time ($t_{E>inv}$) — 0.02...60.0 s

I_E>> *Element*

- I_E>> Curve type (I_E>>Curve) — DEFINITE, IEC/BS A, B, C, ANSI/IEEE MI, VI, EI, I2T
- CLP activation time ($t_{ECLP>>def}$) — 0.00...100.0 s
- I_E>> Reset time delay ($t_{E>>RES}$) — 0.00...1.00 s

Definite time

- 50N/51N Second threshold definite time ($I_{E>>def}$) — 0.005...5.00 I_{En}
- $I_{E>>def}$ within CLP ($I_{ECLP>>def}$) — 0.005...5.00 I_{En}
- I$_{E>>def}$ Operating time ($t_{E>>def}$) — 0.03...10.00 s

Inverse time

- 50N/51N First threshold inverse time ($I_{E>inv}$) — 0.005...2.00 I_{En}
- $I_{E>>inv}$ within CLP ($I_{ECLP>>inv}$) — 0.005...2.00 I_{En}
- $I_{E>>inv}$ Operating time ($t_{E>>inv}$) — 0.02...60.0 s

— AutoReclose - 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_d)	0...10 s

METERING & RECORDING

— Measured parameters

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

— Digital inputs

- IN1 — OFF - 52b -Trip EXT
- IN2 — OFF - 52a - Trip EXT - CB Open
- IN3 — OFF - 79 Enable - 79 Remote - Trip EXT - CB Close

— AutoReclose - 79

- 79 ActiveMode — On - Off
- 79 CycleState — Reset - On - Off
- 79 Run — On - Off
- 79 Residual-time
- 79 LastEvent

— Counters

- Counter Start I>, Counter Start I>>, Counter Start I>>>
- Counter Start IE>,Counter Start IE>>
- Counter Trip I>, Counter Trip I>>, Counter Trip I>>>
- Counter Trip IE>, Counter Trip IE>>
- Counter 79 RR
- Counter 79 SR
- Counter 79 RDR
- Counter 79 FR P
- Counter 79 FR E
- Counter 79 FR X

— Events recorder

Number of events — 100

Trigger: — K1...K4, IN1, IN2, IN3 switching

Data recorded:

- Event counter — 0...10^9
- Event cause info (operating phase) — L1, L2, L3
- Time stamp — Date and time

— Faults recorder

Number of faults — 20

Trigger:

- Output relays activation (OFF-ON transition) — K1...K4
- External trigger (binary inputs) — IN1, IN2, IN3
- Element pickup (OFF-ON transition) — Start/Trip

Data recorded:

- Fault counter (F-Number) — 0...10^9
- Fundamental RMS phase currents — I_{L1}, I_{L2}, I_{L3}
- Fundamental RMS residual current — I_E
- Fault cause (F-Cause) — start, trip
- Time stamp — Date and time

— Digital Fault Recorder (Oscillography)[1]

File format	COMTRADE
Number of records	2 [2]
Recording mode	circular
Sampling rate	16 per power frequency cycle

Trigger setup

- Pre-trigger time — 0...63 T [3]
- Trigger from inputs — IN1, IN2, IN3
- Trigger from outputs — K1...K4
- General trigger from start / trip — Start, Trip
- Manual trigger — ThyVisor
- Trigger from start / trip — Start I>, I>>, ...Trip I>...

Data recorded on analog channels (Analog channel 1...4)

- Instantaneous currents — i_{L1}, i_{L2}, i_{L3}, i_E
- Fundamental RMS phase currents — I_{L1}, I_{L2}, I_{L3}
- Fundamental RMS residual current — I_E

Data recorded on digital channel

- Binary inputs state — IN1, IN2, IN3
- Output relays state — K1...K4
- General trigger from start / trip — General Start, General Trip

Note 1 - The oscillography records are stored in non-volatile memory

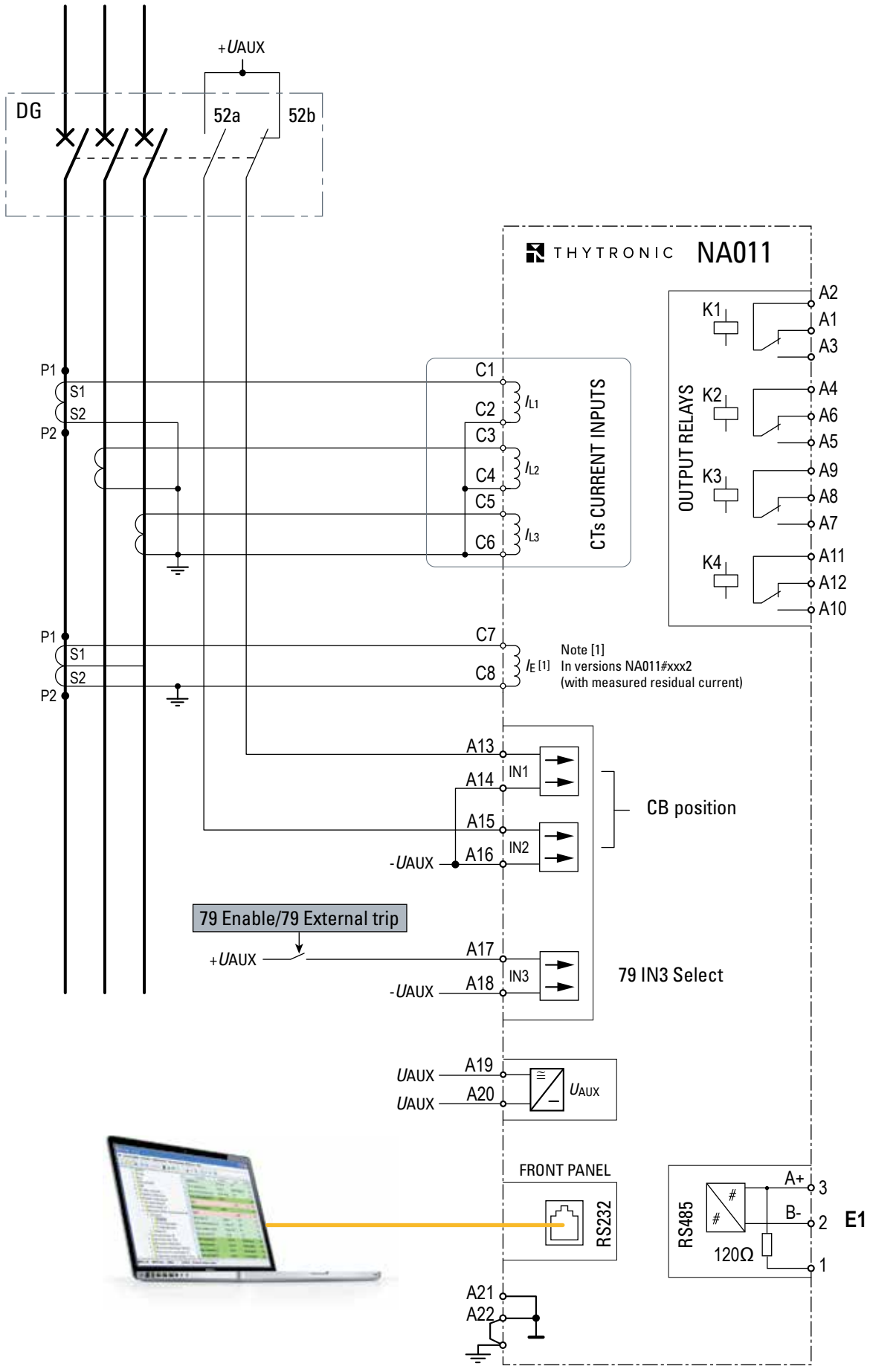
Note 2 - The time duration of the two records is dependent of settings; e.g. the record duration with f = 50 Hz is 240 ms with following settings:

- *Instantaneous i_{L1} current into "Analog channel 1"* — i_{L1}
- *Instantaneous i_{L2} current into "Analog channel 2"* — i_{L2}
- *Instantaneous i_{L3} current into "Analog channel 3"* — i_{L3}
- *Instantaneous i_E current into " Analog channel 4"* — i_E
- *Digital channels* — *K1*

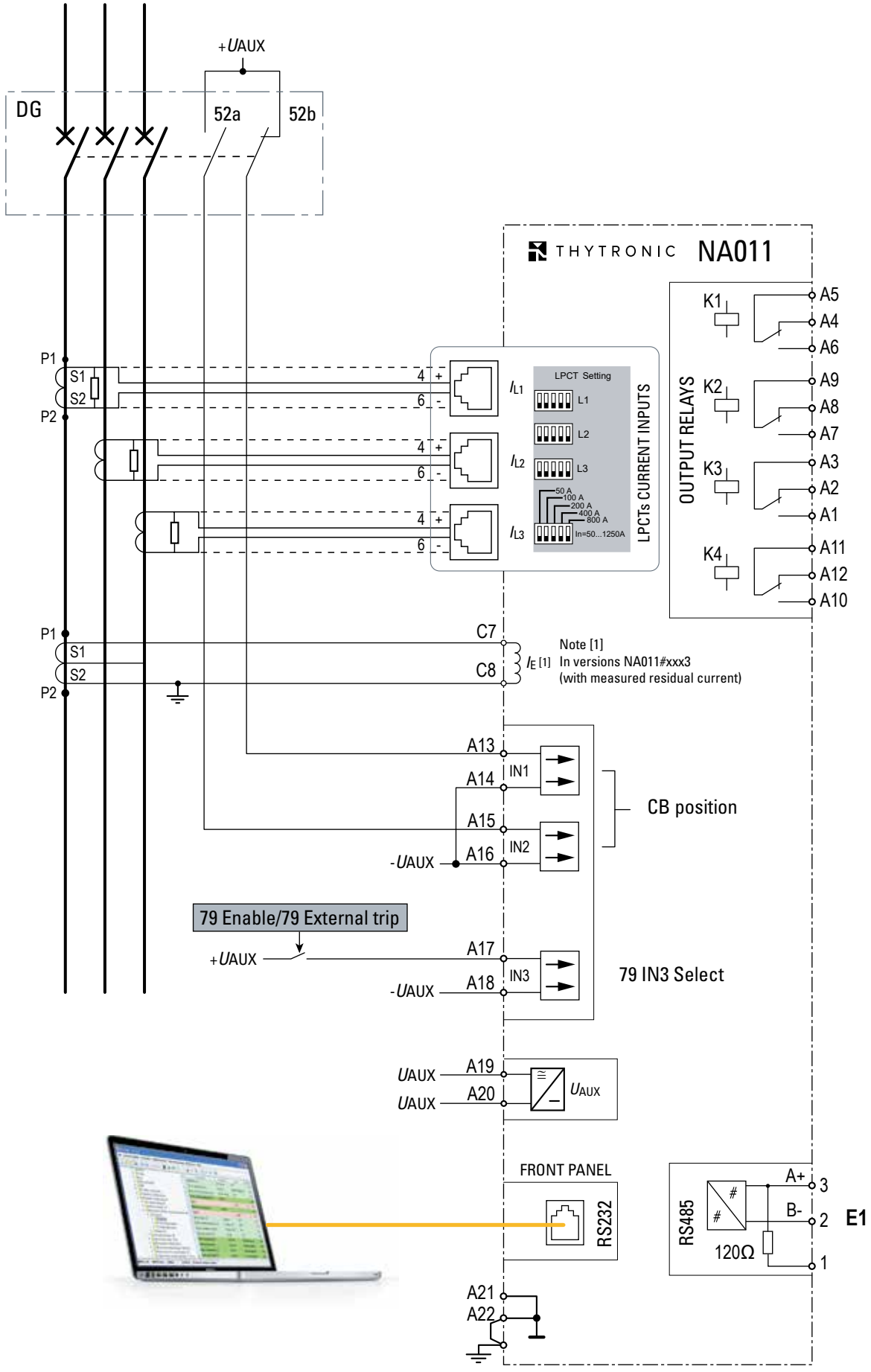
Note 3 - T = number of power cycles

Example, with settings T= 4 the pre-trigger time is 80 ms with f = 50 Hz

— Example of connection diagram with traditional CT inputs and acquisition of CB states and Auto Reclose enable/start

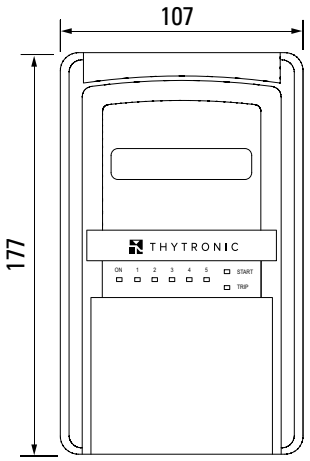


— Example of connection diagram with low power CT inputs and acquisition of CB states and Auto Reclose enable/start

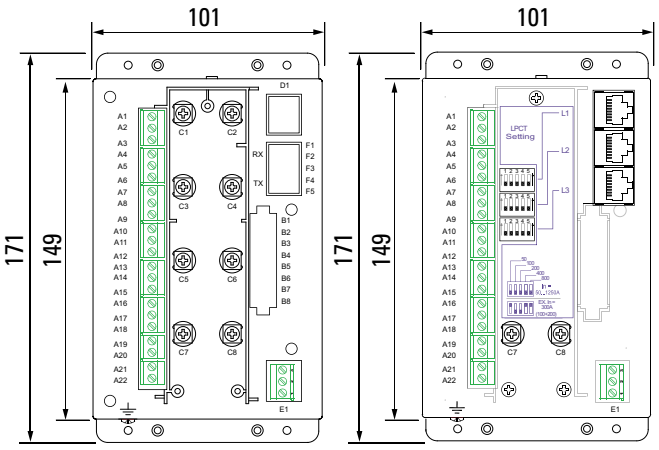


DIMENSIONS

FRONT VIEW



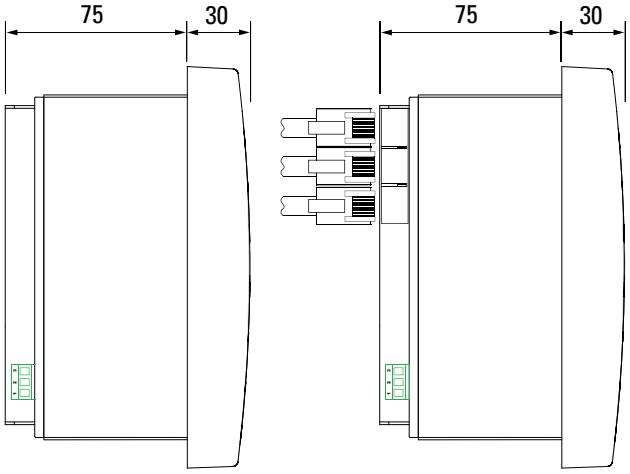
REAR VIEW



Traditional CT inputs

Low power CT inputs

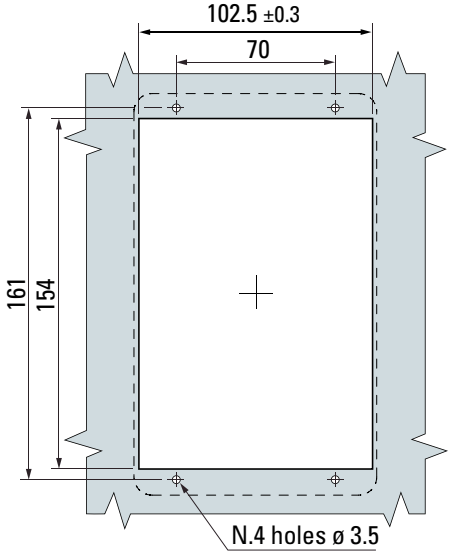
SIDE VIEW



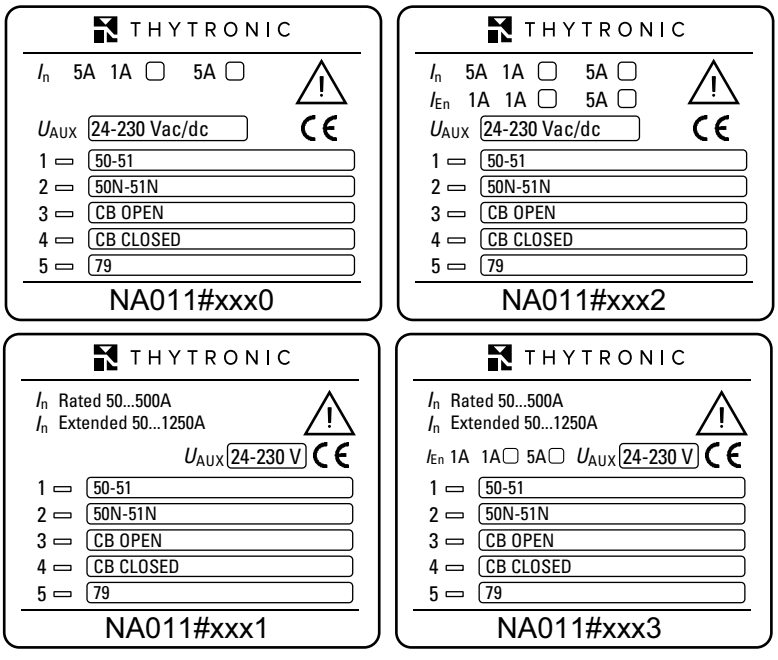
Traditional CT inputs

Low power CT inputs

FLUSH MOUNTING CUTOUT



IDENTIFICATION LABEL



LEDS

Keys O (CB open) and I (CB close) are enabled