SMART line
Protection Relays

NA016 PHASE & RESIDUAL OVERCURRENT

☐ Application
The relay type NA016 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 functions
50/51	Phase overcurrent
50N/51N	Earth fault
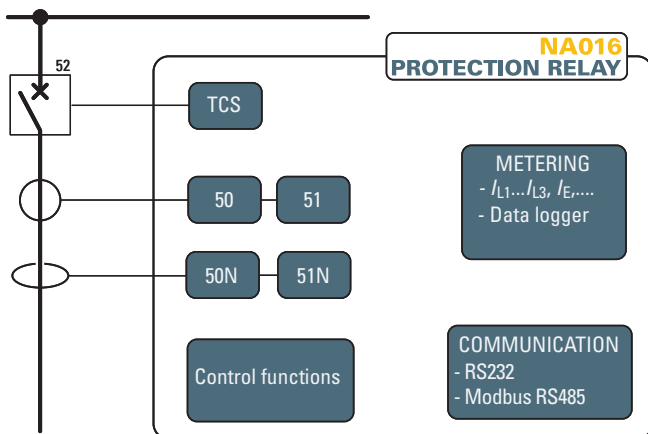
☐ Measuring inputs
Three phase current inputs and one residual current input, with nominal currents independently selectable at 1 A or 5 A through DIP-switches.

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

☐ Output relays
Four output relays are available (two changeover contacts); 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.

☐ Binary inputs
Three binary inputs are available with predefined functions:
• IN1 acquisition of 52b auxiliary contact for CB position capture
• IN2 acquisition of 52a auxiliary contact for CB position capture
• IN3 Trip circuit Supervision (TCS).

☐ Construction
The NA016 protection relay case is suitable for flush or rack mounting.

☐ Communication
Two communication interfaces are implemented:
• One RS232 local communication front-end interface for communication with ThySetter 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 interruptions, ...).
• Sw faults (boot and run time tests for data base, EEPROM memory checksum failure, data BUS,...).

☐ 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 52a state (CB position)
- The red LED 4, no-latched, indicates the 52a state (CB position)
- The red LED 5, no-latched, indicates the TCS state.

☐ 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.

☐ Metering

NA016 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).
- Settings recording
  Following some setting changes the last ten changes are recorded in circular mode (Data Logger CEI 0-16)
- 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.

ThySetter

SPECIFICATIONS

GENERAL

☐ **Mechanical data**
Mounting:	flush, rack
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	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**
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	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
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, K4
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
• TCS - Trip Circuit Supervision (red)	1

GENERAL SETTINGS

☐ **Rated values**
Phase CT nominal primary current (I_{np})	1 A...1000 A
Residual CT nominal primary current (I_{Enp})	1 A...1000 A
Reading	Direct / Relative

☐ **Relay output timers**
Minimum pulse width (t_{TR})	0.01...0.50 s

FUNCTIONS

☐ Phase overcurrent - 50/51

I> Element
- I> Curve type (I>Curve) — IEC/BS A, B, C
- 50/51 First threshold inverse time (I>$_{inv}$) — 0.100...2.50 I_n
- I>$_{inv}$ Operating time (t>$_{inv}$) — 0.02...60.0 s

I>> Element
- 50/51 Second threshold definite time (I>>$_{def}$) — 0.100...20.0 I_n
- I>>$_{def}$ Operating time (t>>$_{def}$) — 0.03...10.00 s
- I>> Reset time delay (t>>$_{RES}$) — 0.00...1.00 s

I>>> Element
Definite time
- 50/51 Third threshold definite time (I>>>$_{def}$) — 0.100...20.0 I_n
- I>>>$_{def}$ Operating time (t>>>$_{def}$) — 0.03...10.00 s
- I>>> Reset time delay (t>>>$_{RES}$) — 0.00...1.00 s

☐ Residual overcurrent - 50N/51N

I$_E$> Element
- 50N/51N First threshold definite time (I$_E$>$_{def}$) — 0.005...5.00 I_{En}
- I$_E$>$_{def}$ Operating time (t$_E$>$_{def}$) — 0.03...180 s
- I$_E$> Reset time delay (t$_E$>$_{RES}$) — 0.00...1.00 s

I$_E$>> Element
Definite time
- 50N/51N Second threshold definite time (I$_E$>>$_{def}$) — 0.005...5.00 I_{En}
- I$_E$>>$_{def}$ within CLP (I$_{ECLP}$>>$_{def}$) — 0.02...10.00 I_{En}
- I$_E$>>$_{def}$ Operating time (t$_E$>>$_{def}$) — 0.03...10.00 s
- I$_E$>> Reset time delay (t$_E$>>$_{RES}$) — 0.00...1.00 s

☐ Circuit Breaker
- BF diagnostic — On/Off
- Trip Circuit Supervision (74TCS) — On/Off

METERING

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

☐ Circuit Breaker
- Position — Open - Close - Unknown
- Trip Circuit Supervision 74TCS — On/Off
- IN1 - 52b state — On/Off
- IN2 - 52a state — On/Off
- IN3 - TCS state — On/Off

☐ Counters
- Start I> element
- Start I>> element
- Start I>>> element
- Start IE> element
- Start IE>> element
- Trip I> element
- Trip I>> element
- Trip I>>> element
- Trip IE> element
- Trip IE>> element

☐ Event storage

Sequence of Event Recorder (SER)
- Number of events — 100
- Recording mode — circular
Trigger:
- Output relays switching — K1...K4
- Binary inputs switching — IN1, IN2, IN3
- Setting changes
Data recorded:
- Event counter (resettable by ThySetter) — 0...10⁹
- Event cause — binary input/output relay/setting changes
- Time stamp — Date and time

Fault Recorder
- Number of events — 20
- Recording mode — circular
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:
- Event counter (resettable by ThySetter) — 0...10⁹
- Fundamental RMS phase currents — I_{L1}, I_{L2}, I_{L3}
- Fundamental RMS residual current — I_E
- Event cause — start, trip
- Binary inputs state — IN1, IN2, IN3
- Output relays state — K1...K4
- Event cause info (operating phase) — L1, L2, L3
- Time stamp — Date and time

Settings recording
- Number of setting changes — 10
- Recording mode — circular
Data recorded:
- Setting counter — 0...10⁹
- Setting data — description and parameter
- Time stamp — Date and time

☐ Digital Fault Recorder (Oscillography)

- File format — COMTRADE
- Records — 2 [1]
- Recording mode — circular
- Sampling rate — 16 per power frequency cycle

Trigger setup
- Pre-trigger time — 0...63 T [2]
- Trigger from inputs — IN1, IN2, IN3
- Trigger from outputs — K1...K4
- General trigger from start / trip — Start, Trip
- Manual trigger — ThySetter
- Trigger from start / trip — Start I>, I>>, ...Trip I>...

Data recorded on analog channels (Analog 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 channels (Digital 1...4)
- Binary inputs state — IN1, IN2, IN3
- Output relays state — K1...K4
- General trigger from start / trip — Start, Trip

For instance, with following setting:
Note 1 - the time duration of the two records is dependent of settings
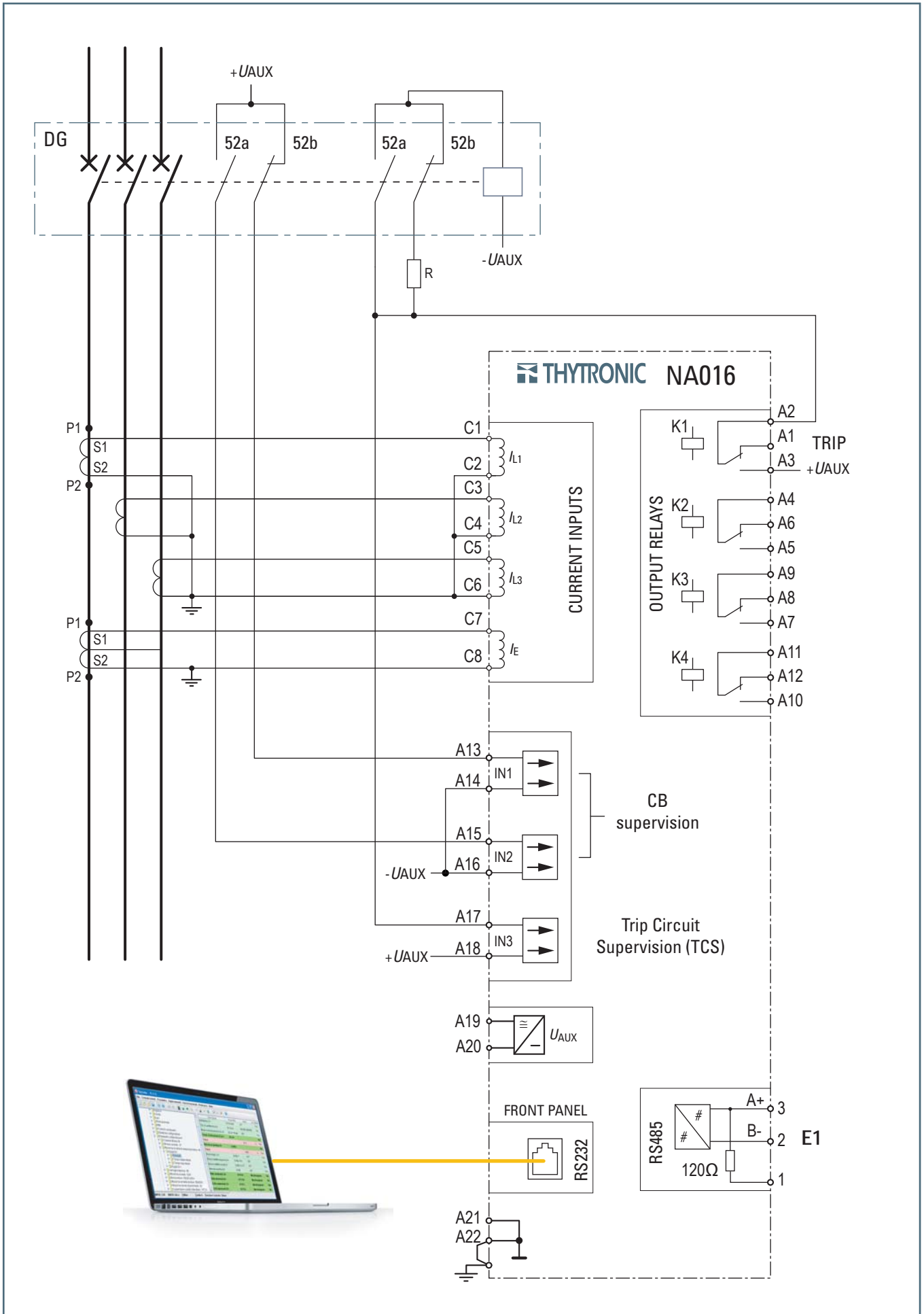*Example, with settings:*
- Instantaneous i_{L1} current into "Analog channel 1" — i_{L1}
- Instantaneous i_{L2} current into "Analog channel 2" — i_{L2}
- Instantaneous i_{L3} current into "Analog channel 3" — i_{L3}
- Instantaneous i_E current into "Analog channel 4" — i_E
- Diigital channel — K1
the stored record duration with f = 50 Hz is 240 ms
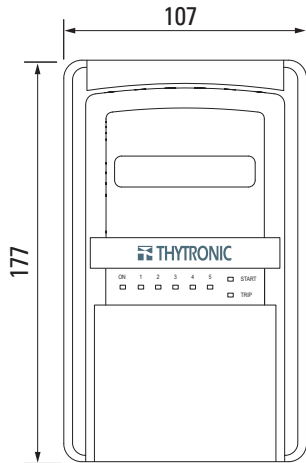
Note 2 - T = number of power cycles
Example, with settings T=4 the pre-trigger duration is 80 ms with f = 50 Hz

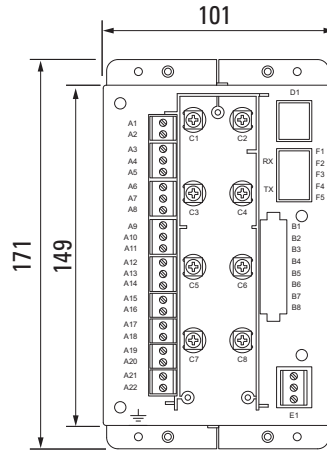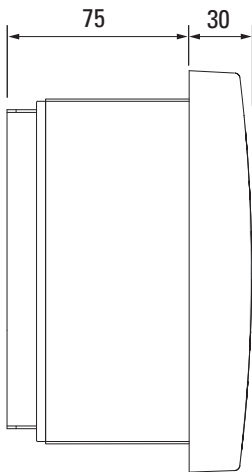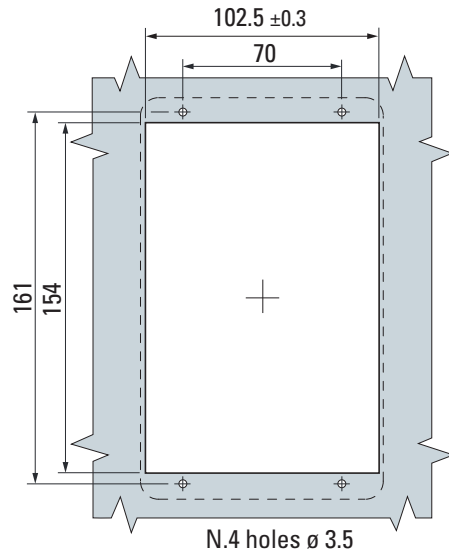☐ **Example of connection diagram with acquisition of CB inputs for Data Logger**

THYTRONIC

DIMENSIONS

FRONT VIEW

107

177

THYTRONIC

ON 1 2 3 4 5 START
                   TRIP

REAR VIEW

101

171

149

A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
A16
A17
A18
A19
A20
A21
A22

C1 C2
C3 C4
C5 C6
C7 C8

D1

RX
TX

F1
F2
F3
F4
F5

B1
B2
B3
B4
B5
B6
B7
B8

E1

SIDE VIEW

75   30

FLUSH MOUNTING CUTOUT

102.5 ±0.3

70

161

154

N.4 holes ø 3.5

IDENTIFICATION DATA

THYTRONIC

I_n	5A	1A ☐	5A ☐	⚠
I_{En}	5A	1A ☐	5A ☐	
U_{AUX}	24-230 Vac/dc			CE

1 ☐ 50-51
2 ☐ 50N-51N
3 ☐ CB OPEN
4 ☐ CB CLOSED
5 ☐ TCS

NA016#5M00

LEDs

ON e Diagnostic

THYTRONIC

ON 1 2 3 4 5 START
                   TRIP

← Start
← Trip

RESET