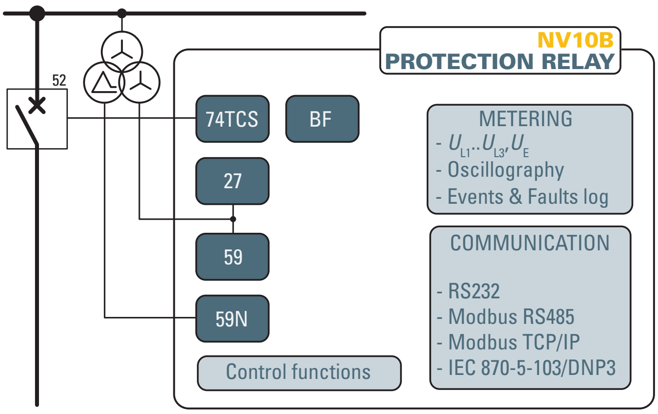
NV10

LoM PROTECTION RELAY

THE COMPREHENSIVE SOLUTION FOR VOLTAGE AND FREQUENCY PROTECTION

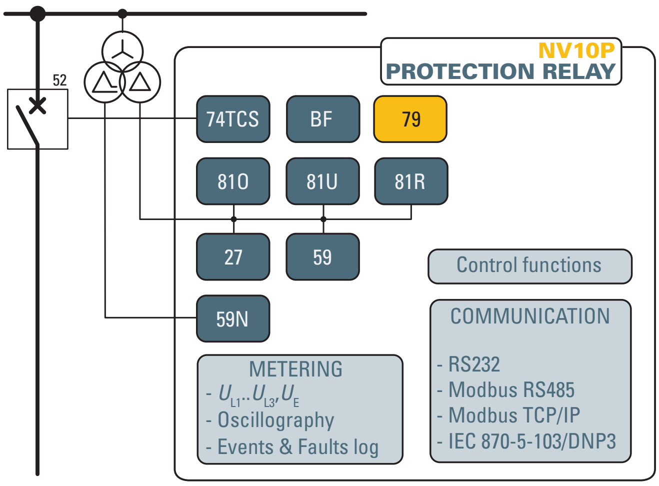
Application

The relay type NV10 can be typically used in HV, MV and LV distribution systems, on transformers or for electrical machines.
It can be used for system decoupling, load shedding and loss of main (islanding) protection.



- Protective & control functions NV10B

27	Phase undervoltage
59	Phase overvoltage
59N	Residual overvoltage
BF	Circuit breaker failure
74TCS	Trip circuit supervision



- Protective & control functions NV10P

27	Phase undervoltage
59	Phase overvoltage
59N	Residual overvoltage
81O	Overfrequency
81U	Underfrequency
81R	Frequency rate of change
BF	Circuit breaker failure
74TCS	Trip circuit supervision

— Measuring inputs
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).

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

— Construction
According to the hardware configurations, the 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 NV10 hardware can be customized through external auxiliary modules:
- MRI - Output relays and LEDs
- MID16 - Binary inputs
- MCI - 4...20 mA converters
- MPT - Pt100 probe inputs.

— 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.

— 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.

— 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 - 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.
Two session level (User or Administrator) with password for sensible data access are provided.

— 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.

— 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,...)
- Circuit breaker faults.

— Control and monitoring
Several predefined functions are implemented:
- Trip circuit supervision (74TCS)
- Remote tripping
- Automatic reclosure for photovoltaic plants (optional)
- Circuit Breaker commands and diagnostic

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

— Metering
NV10 provides metering values for phase, residual voltages and frequency, making them available for reading on a display or to communication interfaces. Voltages 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. The measured voltages can be displayed with reference to nominal values or directly expressed in volts.
With DFT the RMS value some harmonic are also measured.

— 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, 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

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)

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 selectable by 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 selectable by 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

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

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 nominal voltage (U_n) 50...130 V or 200...520 V
Relay residual nominal voltage (direct measure) (U_{En}) 50...130 V
Relay residual nominal voltage (calculated) (U_{ECN})=U_n· √3 50...130 V
Line VT primary nominal voltage (U_{np}) 50 V..500 kV
Residual primary nominal voltage (phase-to-phase) · √3 (U_{Enp})
50 V...500 kV

Binary input timers
ON delay time (IN1 t_{ON}, IN2 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

Undervoltage - 27

Common configuration:
- 27 Operating logic (*Logic*27) — AND/OR

U< Element
- $U<$ Curve type ($U<$Curve) — DEFINITE, INVERSE [1]

Definite time
- 27 First threshold definite time ($U_{<def}$) — 0.05...1.10 U_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
- $U_{<inv}$ 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
- $U_{<<def}$ Operating time ($t_{U<<def}$) — 0.03...100.0 s

Note [1] - 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

Overvoltage - 59

Common configuration:
- 59 Operating logic (*Logic*59) — AND/OR

U> Element
- $U>$ Curve type ($U>$Curve) — DEFINITE, INVERSE [1]

Definite time
- 59 First threshold definite time ($U_{>def}$) — 0.50...1.50 U_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
- $U_{>inv}$ 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
- $U_{>>def}$ Operating time ($t_{U>>def}$) — 0.03...100.0 s

Note [1] - The mathematical formula for INVERSE curves is:

$$t = 0.5 \cdot t_{U>inv} / [(U/U_{>inv})-1]$$

where:

t = trip time (in seconds)
$t_{U>inv}$ = operating time setting (in seconds)
U = input voltage
$U_{>inv}$ = threshold

Residual overvoltage - 59N

Common configuration:
- Residual voltage measurement for 59N - direct/calculated (*3V0Type*59N) — U_E / U_{EC}
- 59N Operation from 74VT external (*74VText*59N) — *OFF / Block*

$U_E>$ Element
- $U_E>$ Curve type ($U_E>$Curve) — DEFINITE, INVERSE [1]
- $U_E>$ 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:

$$t = 0.5 \cdot t_{UE>inv} / [(U/U_{E>inv})-1]$$

where:

t = trip time (in seconds)
$t_{UE>inv}$ = operating time setting (in seconds)
U_E = residual input voltage
$U_{E>inv}$ = threshold

Underfrequency - 81U

f< Element

Definite time
- 81U First threshold definite time ($f_{<def}$) — 0.800...1.000 f_n
- $f_{<def}$ Operating time ($t_{f<def}$) — 0.05...100.0 s

f<< Element

Definite time
- 81U Second threshold definite time ($f_{<<def}$) — 0.800...1.000 f_n
- $f_{<<def}$ Operating time ($t_{f<<def}$) — 0.05...100.0 s

f<<< Element

Definite time
- 81U Third threshold definite time ($f_{<<<def}$) — 0.800...1.000 f_n
- $f_{<<<def}$ Operating time ($t_{f<<<def}$) — 0.05...100.0 s

f<<<< Element

Definite time
- 81U Fourth threshold definite time ($f_{<<<<def}$) — 0.800...1.000 f_n
- $f_{<<<<def}$ Operating time ($t_{f<<<<def}$) — 0.05...100.0 s

Overfrequency - 81O

f> Element

Definite time
- 81O First threshold definite time ($f_{>def}$) — 1.000....1.200 f_n
- $f_{>def}$ Operating time ($t_{f>def}$) — 0.05...100.0 s

f>> Element>

Definite time
- 81O Second threshold definite time ($f_{>>def}$) — 1.000....1.200 f_n
- $f_{>>def}$ Operating time ($t_{f>>def}$) — 0.05...100.0 s

Frequency rate of change - 81R

df> Element
- Operating mode (*df>*mode) — Module/Positive/Negative

Definite time
- 81R First threshold definite time ($df_{>def}$) — 0.1...10.0 Hz/s
- $df_{>def}$ Operating time ($tdf_{>def}$) — 0.00...100.0 s

df>> Element
- Operating mode (*df>>*mode) — Module/Positive/Negative

Definite time
- 81R Second threshold definite time ($df_{>>def}$) — 0.1...10.0 Hz/s
- $df_{>>def}$ Operating time ($tdf_{>>def}$) — 0.00...100.0 s

df>>> Element
- Operating mode (*df>>>*mode) — Module/Positive/Negative

Definite time
- 81R Third threshold definite time ($df_{>>>def}$) — 0.1...10.0 Hz/s
- $df_{>>>def}$ Operating time ($tdf_{>>>def}$) — 0.00...100.0 s

df>>>> Element
- Operating mode (*df>>>>*mode) — Module/Positive/Negative

Definite time
- 81R Fourth threshold definite time ($df_{>>>>def}$) — 0.1...10.0 Hz/s
- $df_{>>>>def}$ Operating time ($tdf_{>>>>def}$) — 0.00...100.0 s

Breaker failure - BF

BF Time delay (t_{BF}) — 0.06...10.00 s

Circuit Breaker supervision

Number of CB trips (*N.Open*) — 0...10000
CB max allowed opening time ($t_{break>}$) — 0.05...1.00 s

METERING & RECORDING

Measured parameters

Direct:	
• Frequency	f
• Input voltages	U_{L1}, U_{L2}, U_{L3}
• Residual voltage	U_E
Calculated:	
• Calculated residual voltage	U_{EC}
• Maximum voltage between U_{L1}-U_{L2}-U_{L3}	U_{Lmax}
• Average voltage between U_{L1}-U_{L2}-U_{L3}	U_L
Sequence:	
• Negative sequence voltage	U_2
3rd harmonic:	
• Third harmonic residual voltage	$U_{E\text{-}3rd}$
Frequency rate of change:	
• Frequency rate of change	df/dt

Event recording (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

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)	$0...10^9$
• Input voltages	U_{L1r}, U_{L2r}, U_{L3r}
• Residual voltages (measured and calculated)	U_{Er}, U_{ECr}
• Frequency	f_r
• Frequency rate of change	df_r
• Binary inputs state	IN1, IN2...INx
• Output relays state	K1...K6...K10
• Fault cause info (operating phase)	L1, L2, L3

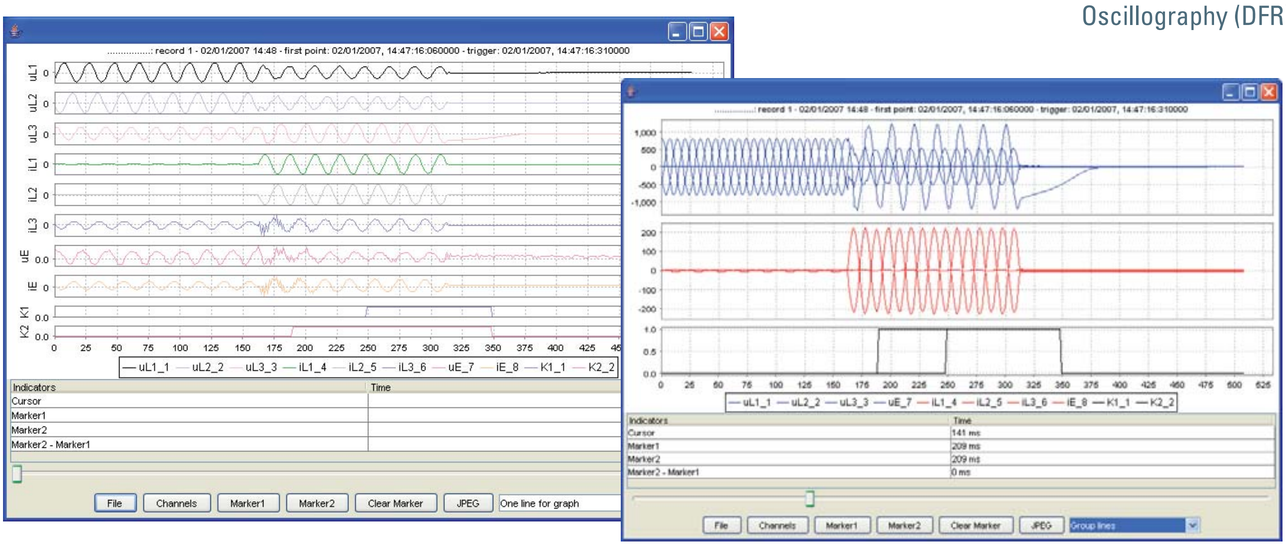
Digital Fault Recorder (Oscillography)

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...INx
• Trigger from outputs	K1...K6...K10
• Communication	ThySetter
Set sample channels:	
• Instantaneous voltages	u_{L1}, u_{L2}, u_{L3}, u_E
Set analog channels (Analog 1...12):	
• Frequency	f
• Input voltages	U_{L1}, U_{L2}, U_{L3}
• Residual voltage (measured and calculated)	U_E, U_{EC}
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:

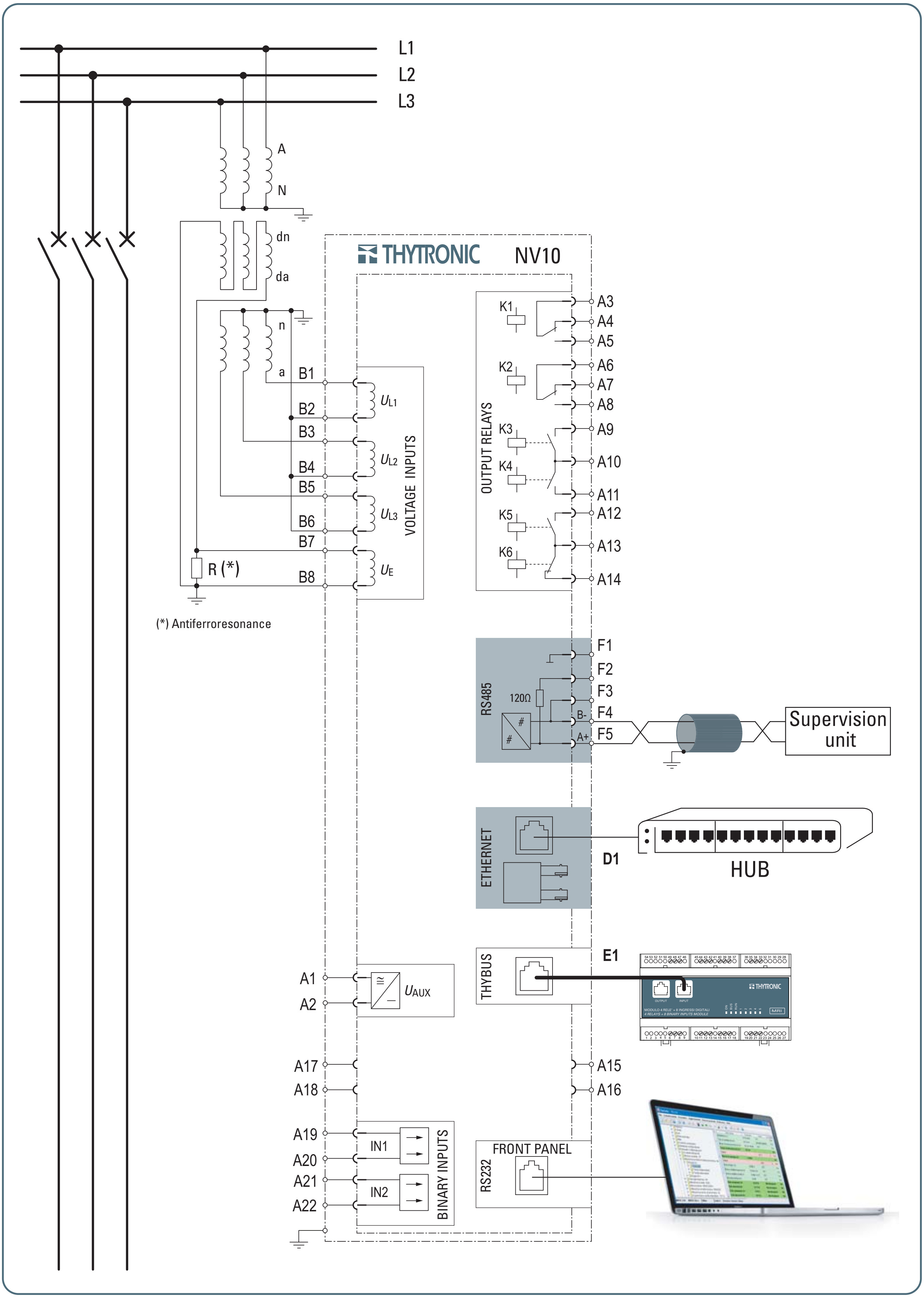
• *Pre-trigger time*	*0.25 s*
• *Post-trigger time*	*0.25 s*
• *Sampled channels*	u_{L1}, u_{L2}, u_{L3}, u_E
• *Analog channels*	U_{L1}, U_{L2}, U_{L3}, U_E
• *Digital channels*	*K1, K2, K3, K4, K5, K6, IN1, IN2*

More than three hundred records can be stored

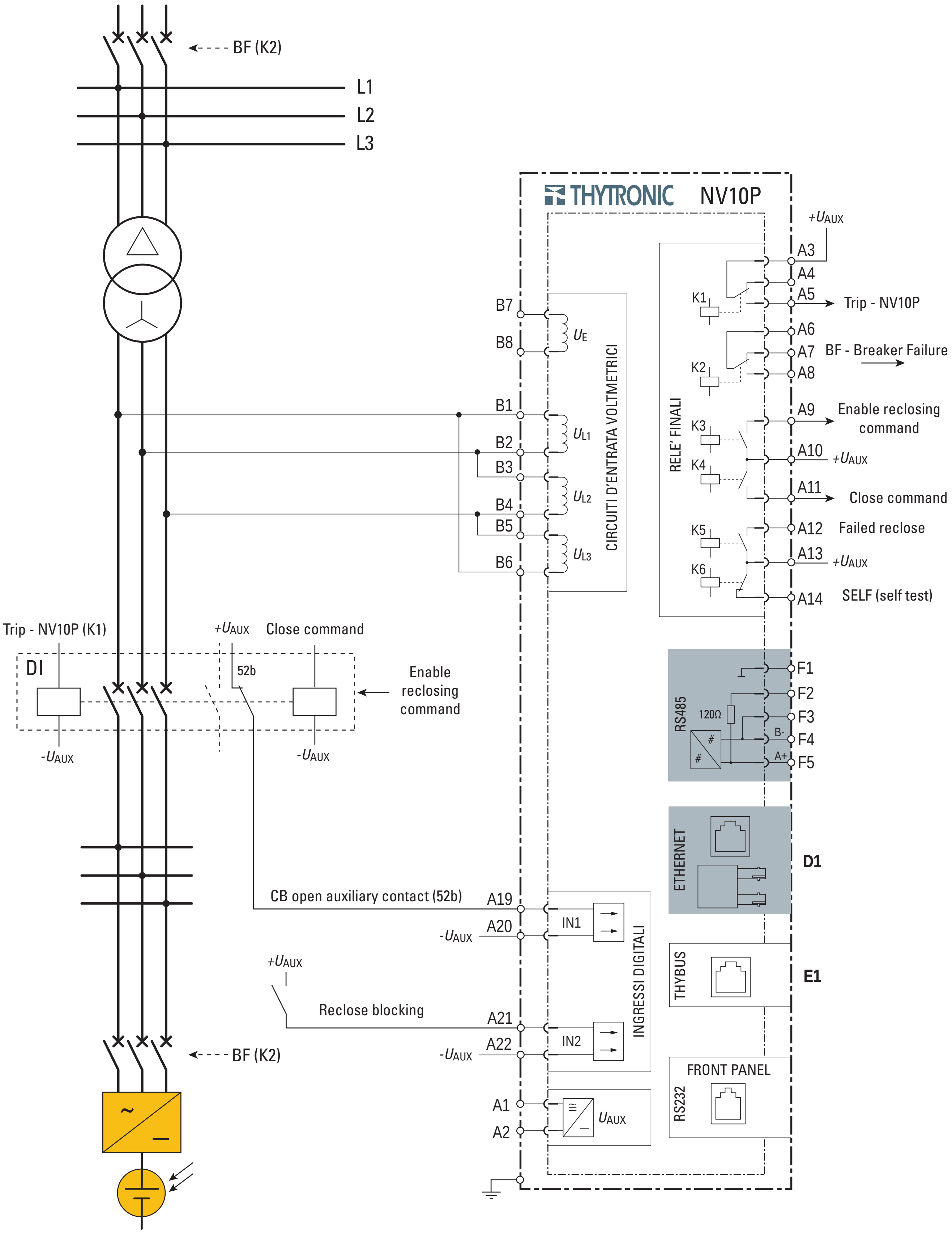


Oscillography (DFR)

Connection diagram example



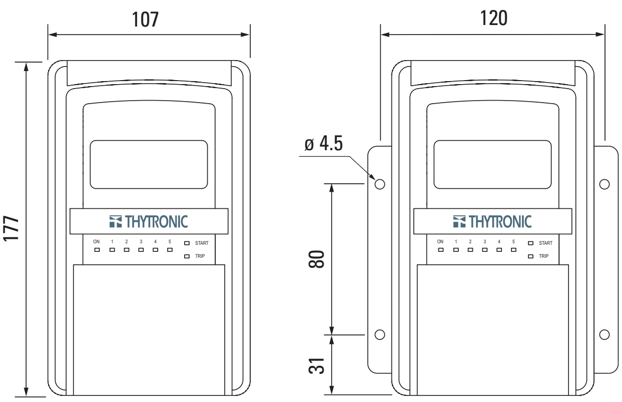
Connection diagram example for active users (photovoltaic plant with low voltage interface) with reclosing function



Digital input and output relays connections for automatic reclosing function (PLC)
Phase-phase input voltages with direct connection to the LV side (U_R = 400 V versions)

DIMENSIONS

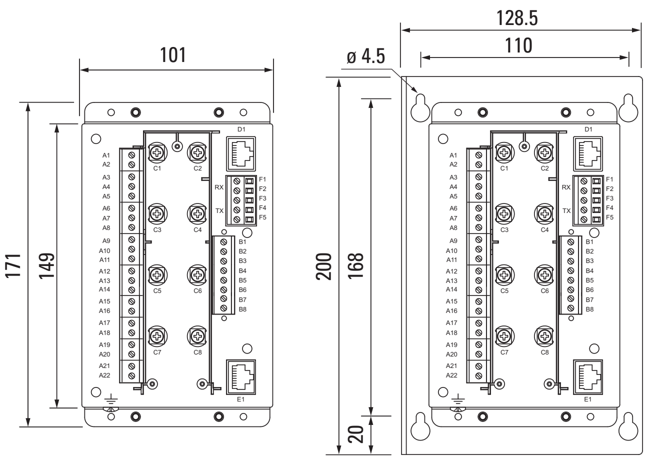
FRONT VIEW



FLUSH MOUNTING

PROJECTING MOUNTING

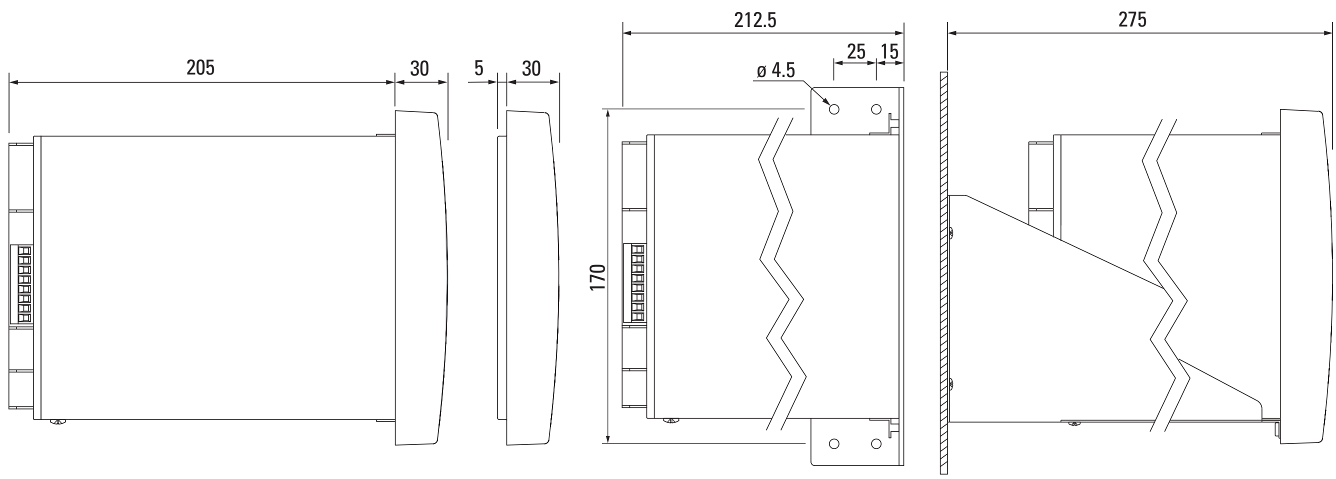
REAR VIEW



FLUSH MOUNTING

PROJECTING MOUNTING
(Separate operator panel)

SIDE VIEW



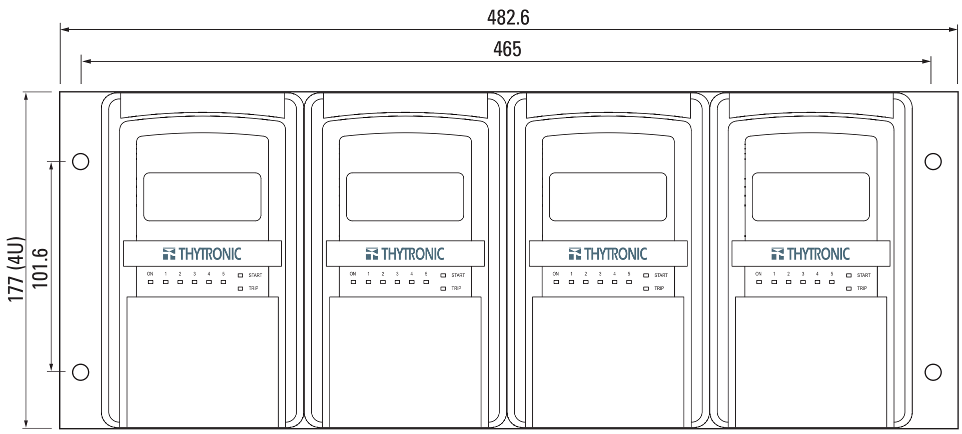
FLUSH MOUNTING

SEPARATE
OPERATOR PANEL

PROJECTING MOUNTING
(Separate operator panel)

PROJECTING MOUNTING
(Stand alone)

RACK MOUNTING



FLUSH MOUNTING CUTOUT