



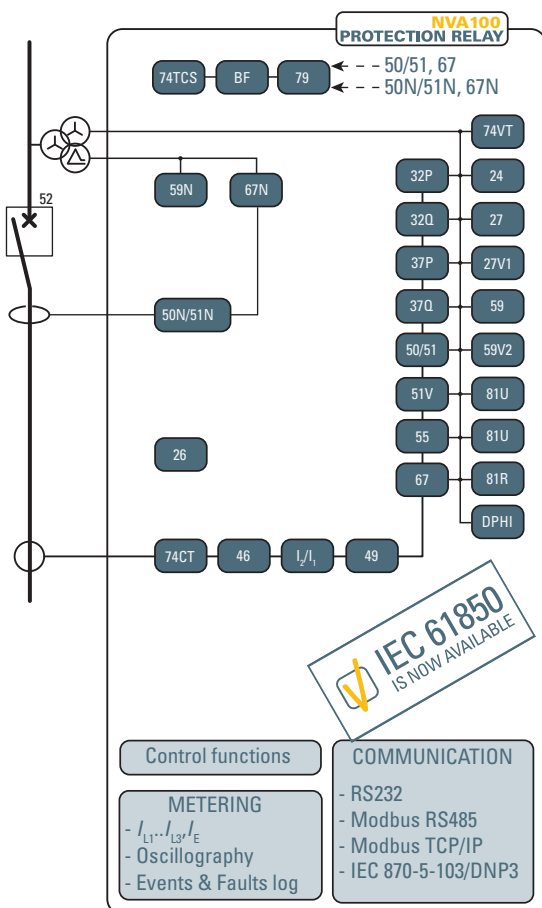
NVA100

FEEDER, LoM & POWER PROTECTION RELAY
THE COMPREHENSIVE SOLUTION FOR FEEDERS
AND LOSS OF MAIN PROTECTION

— Application

The relay type NVA100 can be typically used in radial or meshed MV and LV networks as feeder or power transformer protection:

- On radial, ring and parallel feeders of any length in solidly grounded, ungrounded, Petersen coil and/or resistance grounded systems.
- On parallel connected generators and transformer on the same Busbar.
- In HV, MV and LV electrical machines and network, load shedding and separation of active users from the grid.



- Protective & control functions

24	Overflux (V/Hz)
26	Thermal protection with Pt100 probes (MPT optional)
27	Undervoltage
27V1	Positive sequence undervoltage
32P	Directional active overpower
32Q	Directional reactive overpower
37P	Directional active underpower
37Q	Directional reactive underpower
46	Negative sequence overcurrent
I2/I1	Negative/positive sequence current ratio
49	Thermal image (for lines and transformers)
50/51	Phase overcurrent
50N/51N	Residual overcurrent
51V	Voltage-controlled overcurrent
55	Minimum power factor
59	Overvoltage
59N	Residual overvoltage
59V2	Negative sequence overvoltage
67	Phase directional overcurrent
67N	Ground directional overcurrent
810/81U	Overfrequency and underfrequency
81R	Frequency rate of change
DPHI	Vector jump
BF	Circuit breaker failure
79	Automatic reclosing
74CT	CT supervision
74VT	VT supervision
74TCS	Trip circuit supervision

— 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.

— 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.
- 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).

— Construction

According to the hardware configurations, the NVA100 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 NVA100 hardware can be customized through external auxiliary modules:

- MRI - Output relays and LEDs (provided with NVA100)
- 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.

— 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 upstream in the electric plant. The output circuit works as a simple contact, whose condition is detected by the input circuit of the upstream protection relay. Use of suitable pilot wire to fiber optic converters (BFO) allows to perform fast and reliable accelerated logic selectivity on radial and closed ring networks.

— 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 according to a matrix (tripping matrix) structure.

— MMI (Man Machine Interface)

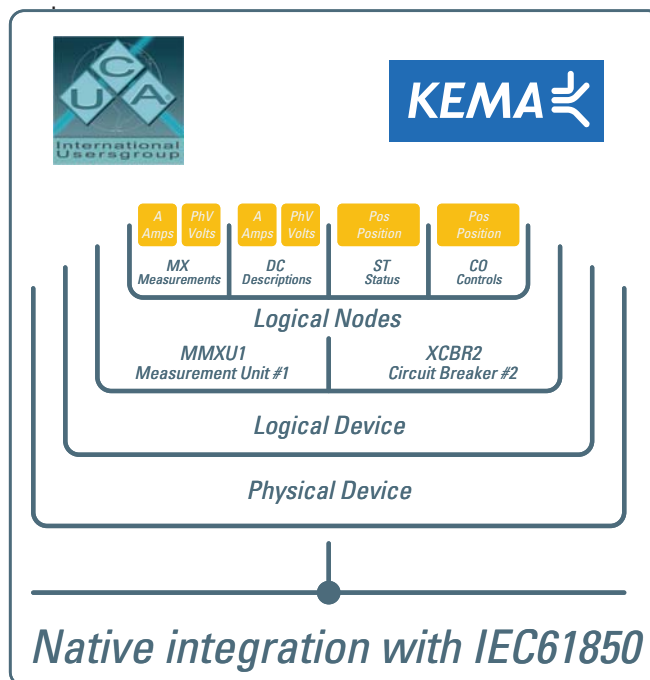
The user interface comprises a membrane keyboard, a backlight LCD alphanumeric display and eight LEDs.

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), ModBus/TCP or IEC61850 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.

— Metering

NVA100 provides metering values for phase and residual currents, phase and residual voltage, 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, several calculated (min, max, average,...), phase, sequence, power, harmonic, demand and energy measures are processed.

Measures can be displayed with reference to nominal values or directly expressed in amperes and volts.

— Control and monitoring

Several predefined functions are implemented:

- Activation of two set point profiles.
- Phase CTs and VTs monitoring (74CT and 74VT).
- 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.

Moreover user defined logic must be customized in accordance with IEC 61131-3 protocol by means programmable logic controller (PLC).

Circuit Breaker

Several diagnostic, monitoring and control functions are provided:

- Health thresholds can be set; when the accumulated duty (ΣI or $\Sigma I^2 t$), 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.

Virtual I/O

Through ThySetter and ThyVisor tools the type of operation and links between eight outputs (Virtual Output - VOUT1 ... 8) and ten virtual inputs (Virtual Inputs - VIN1 ... VIN10) may be defined using RPC or IEC 61850 communication protocols over Ethernet network.

The system allows:

- Availability of eight inputs and ten outputs independently programmable by the user
- Simplify wiring using one channel as the Ethernet
- Eliminate the need to install communication devices and / or external conversion
- Significantly reduce costs
- Dynamically change from sw connections and associated functions.

The virtual I / O can be usefully employed for:

- Transmit information between protections installed in distance
- Achieve accelerated logic discrimination in which some protection elements can be blocked by the activation of the downstream protection start
- Circuit Breaker commands, Selection of setting profiles, Remote trip, etc...

Logic selectivity

With the aim of providing a fast selective protection system some protective functions may be blocked.

The selectivity logic may be accomplished by:

- input and output block circuits,
- output relays and logic inputs,
- virtual input and output with messages on Ethernet network.

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, with small width in order to be ignored as an effective blocking signal by the input blocking circuit of the upstream protection, but suitable to prove 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.

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 setting time.
- Each threshold can be increased for a setting time.

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 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.

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.

— 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.

— 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, for purchase procedure please contact Thytronic.

The records are stored in non-volatile 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 μ s) 5 kV
Insulation resistance >100 M Ω
- **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
- Network:
• RS485 1200...57600 bps
• Ethernet 100BaseT 100 Mbps
- Protocol ModBus® RTU/IEC 60870-5-103/DNP3, TCP/IP, IEC61850

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)
- **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 adjustable via 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 adjustable via 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
- **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)
• K3, K4, K5 make (SPST-NO, type A)
• 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 ($\lambda = 0,4$) 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
Relay nominal voltage (phase-to-phase) (U_n)	50...130 V or 200...520 V
Relay nominal voltage (phase-to-ground) ($E_n = U_n/\sqrt{3}$)	-
Line VT primary nominal voltage (phase-to-phase) (U_{np})	50 V...500 kV
Relay residual nominal voltage (direct measure) (U_{En})	50...130 V
Residual primary nominal voltage (phase-to-phase) ($\sqrt{3} (U_{Enp})$)	50 V...500 kV
Relay nominal active power (P_n)	$P_n = \sqrt{3} \cdot U_n \cdot I_n = 3 \cdot E_n \cdot I_n$
Relay nominal reactive power (Q_n)	$Q_n = \sqrt{3} \cdot U_n \cdot I_n = 3 \cdot E_n \cdot I_n$
Relay nominal apparent power (S_n)	$S_n = \sqrt{3} \cdot U_n \cdot I_n = 3 \cdot E_n \cdot I_n$

Binary input timers

ON delay time (IN1 t_{ON} ...IN10 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
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PROTECTIVE FUNCTIONS

Base current I_B ⁽¹⁾

Base current (I_B)	0.10...2.50 I_n
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Note - The basic current I_B represents the nominal current of the line or transformer, referred to the nominal current of the CT's for thermal image protection. If the secondary rated current of the line CT's equals the rated current of the relay, as usually happens, the I_B value is the ratio between the rated current of the protected element and the primary rated current of the CT's

Overexcitation (24)

<i>(U/f)_{AL} Element</i>	
• Alarm threshold definite time ($(U/f)_{ALdef}$)	0.50...2.00 U_n/f_n
• Operating time (definite time) $t_{(U/f)_{ALdef}}$	0.10...100.0 s
<i>(U/f)> Element</i>	
• Curve type ($(U/f)>Curve$)	DEFINITE, IEC/BS A, B, C
<i>Definite time</i>	
• ($(U/f)>$ threshold definite time ($(U/f)>_{def}$)	0.50...2.00 U_n/f_n
• ($(U/f)>_{def}$ Operating time (definite time) ($t_{(U/f)>_{def}}$)	0.10...100.0 s
<i>Inverse time</i>	
• ($(U/f)>$ threshold inverse time ($(U/f)>_{inv}$)	0.50...2.00 U_n/f_n
• ($(U/f)>_{inv}$ Operating time (inverse time) ($t_{(U/f)>_{inv}}$)	0.10...100.0 s
<i>(U/f)>> Element</i>	
• ($(U/f)>$ threshold definite time ($(U/f)>>_{def}$)	0.50...2.00 U_n/f_n
• Soglia ($(U/f)>>_{def}$)	0.50...2.00 U_n/f_n
• ($(U/f)>>_{def}$ Operating time (definite time) ($t_{(U/f)>>_{def}}$)	0.10...100.0 s

Thermal protection with RTD thermometric probes - 26

<i>Alarm</i>	
• Alarm threshold θ_{ALx} ($x=1...8$)	0...200 °C
• Operating time $t_{\theta_{ALx}}$ ($x=1...8$)	0...100 s
<i>Trip</i>	
• 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

Undervoltage - 27

Common configuration:

- Voltage measurement type for 27 (U_{type27}) ⁽¹⁾ U_{ph-ph}/U_{ph-n}
- 27 Operating logic ($Logic27$) AND/OR

U< Element

- $U<$ Curve type ($U<Curve$) DEFINITE, INVERSE ⁽²⁾

Definite time

- 27 First threshold definite time ($U<_{def}$) 0.05...1.10 U_n/E_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/E_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/E_n
- $U<<_{def}$ Operating time ($t_{U<<_{def}}$) 0.03...100.0 s

Note 1: With U_{ph-ph} setting all threshold are in p.u. U_n

With U_{ph-n} setting all threshold are in p.u. E_n

Note 2: 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 setting

Positive sequence undervoltage - 27V1

U1< Element

- 27V1 First threshold definite time ($U1<_{def}$) 0.05...1.10 E_n
- 27V1 Operating time ($t_{U1<_{def}}$) 0.07...100.0 s

Directional active overpower 32P

P1> Element

- P1> Tripping direction ($P1>_{DIR}$) P Forward/P Reverse/P Fw/Rv
- P1> Reset time delay ($t_{P1>RES}$) 0.00...100.0 s
- 32P First threshold definite time ($P1>_{def}$) 0.01...1.50 P_n
- $P1>_{def}$ Operating time ($t_{P1>_{def}}$) 0.07...100.0 s

P2> Element

- P2> Tripping direction ($P2>_{DIR}$) P Forward/P Reverse/P Fw/Rv
- P2> Reset time delay ($t_{P2>RES}$) 0.00...100.0 s
- 32P Second threshold definite time ($P2>_{def}$) 0.01...1.50 P_n
- P2> Operating time ($t_{P2>_{def}}$) 0.07...100.0 s

Directional reactive overpower 32Q

Q1> Element

- Q1> Tripping direction ($Q1>_{DIR}$) Q Forward/Q Reverse/Q Fw/Rv
- Q1> Reset time delay ($t_{Q1>RES}$) 0.00...100.0 s
- 32Q First threshold definite time ($Q1>_{def}$) 0.01...1.50 Q_n
- Q1> Operating time ($t_{Q1>_{def}}$) 0.07...100.0 s

Q2> Element

- Q2> Tripping direction ($Q2>_{DIR}$) Q Forward/Q Reverse/Q Fw/Rv
- Q2> Reset time delay ($t_{Q2>RES}$) 0.00...100.0 s
- 32Q Second threshold definite time ($Q2>_{def}$) 0.01...1.50 Q_n
- Q2> Operating time ($t_{Q2>_{def}}$) 0.07...100.0 s

Directional active underpower 37P

Common configuration:

- CB-37P Enable ($CB-37P$) ON/OFF
- CB-37P Delay ($t_{ARM-P<}$) 0.07...300 s

P1< Element

- 37P First threshold definite time ($P1<_{def}$) 0.01...1.50 P_n
- P1< Operating time ($t_{P1<_{def}}$) 0.07...100.0 s

P2< Element

- 37P Second threshold definite time ($P2<_{def}$) 0.01...1.50 P_n
- P2< Operating time ($t_{P2<_{def}}$) 0.07...100.0 s

Directional reactive underpower 37Q

Common configuration:

- CB-37Q Enable ($CB-37Q$) ON/OFF
- CB-37Q Delay ($t_{ARM-Q<}$) 0.07...300 s

Q1< Element

- 37Q First threshold definite time ($Q1<_{def}$) 0.01...1.50 Q_n
- Q1< Operating time ($t_{Q1<_{def}}$) 0.07...100.0 s

Q2< Element

- 37Q Second threshold definite time ($Q2<_{def}$) 0.01...1.50 Q_n
- Q1< Operating time ($t_{Q2<_{def}}$) 0.07...100.0 s

Negative sequence - 46

I2> Element

- $I2>$ Curve type DEFINITE
- $I2>$ IEC/BS A, B, C - ANSI/IEEE MI, VI, EI, I_{2t}, EM
- $I2CLP>$ Activation time ($t_{2CLP>}$) 0.00...100.0 s
- $I2>$ Reset time delay ($t_{2>RES}$) 0.00...100.0 s
- *Definite time*
- 46 First threshold definite time ($I2>_{def}$) 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
<i>Inverse time</i>	
• 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>$I_{2>>}$ Element</i>	
• $I_{2CLP>>}$ Activation time ($t_{2CLP>>}$)	0.00...100.0 s
• $I_{2>>}$ Reset time delay ($t_{2>>RES}$)	0.00...100.0 s
<i>Definite time</i>	
• 46 Second threshold definite time ($I_{>def}$)	0.100...40.00 I_n
• $I_{>def}$ within CLP ($I_{2CLP>>def}$)	0.100...40.00 I_n
• $I_{>>def}$ Operating time ($t_{>>def}$)	0.03...10.00 s

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

<i>$I_{21>}$ Element</i>	
• $I_{21CLP>}$ Activation time ($t_{21CLP>}$)	0.00...100.0 s
<i>Definite time</i>	
• 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

— 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
• Dth_{IN} Activation time (t_{dthCLP})	0.00...100.0 s
• 49 Second harmonic restraint ($Dth_{2ndh-REST}$)	OFF/ON

Dth_{AL1} Element

• 49 First alarm threshold $\Delta\theta_{AL1}$ (Dth_{AL1})	0.3...1.0 $\Delta\theta_B$
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Dth_{AL2} Element

• 49 Second alarm threshold $\Delta\theta_{AL2}$ (Dth_{AL2})	0.5...1.2 $\Delta\theta_B$
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$Dth>$ Element

• 49 Trip threshold $\Delta\theta$ ($Dth>$)	1.100...1.300 $\Delta\theta_B$
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— Phase overcurrent - 50/51

$I>$ Element

• $I>$ Curve type ($I>Curve$)	DEFINITE, IEC/BS A, B, C, ANSI/IEEE MI, VI, E, RECTIFIER, I^2t , 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
• $I>>>$ Voltage-controlled by $U<<$	OFF-ON

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, ANSI/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 ($I_E>inv$)	0.010...2.00 I_{En}
• $I_E>inv$ within CLP ($I_{ECLP>inv}$)	0.010...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 ($I_{ECLP>>def}$)	0.002...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
• $I_E>>>$ 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

— Minimum power factor - 55

Common configuration:

• CB-55 Delay ($t_{ARM-CPhi<}$)	0.07...300 s
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$CPhi1<$ Element

• $CPhi1<$ Tripping direction ($CPhi1<DIR$)	CosPhi Lag/CosPhi Lead/Lag/CosPhi Lag-Lead
• 55 First threshold definite time ($CPhi1<def$)	0.10...0.99

• $CPhi1<$ Operating time ($t_{CPhi1<def}$)	0.04...100.0 s
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$CPhi2<$ Element

• $CPhi2<$ Tripping direction ($CPhi2<DIR$)	CosPhi Lag/CosPhi Lead/Lag/CosPhi Lag-Lead
• 55 Second threshold definite time ($CPhi2<def$)	0.10...0.99

• $CPhi2<$ Operating time ($t_{CPhi2<def}$)	0.04...100.0 s
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— Overvoltage - 59

Common configuration:

• Voltage measurement type for 59 ($Utype59$) ^[1]	U_{ph-ph}/U_{ph-n}
• 59 Operating logic ($Logic59$)	AND/OR

$U>$ Element

• $U>$ Curve type ($U>Curve$)	DEFINITE, INVERSE ^[2]
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Definite time

• 59 First threshold definite time ($U>def$)	0.50...1.50 U_n/E_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/E_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/E_n
• $U>>def$ Operating time ($t_{U>>def}$)	0.03...100.0 s

Note 1: With U_{ph-ph} setting all threshold are in p.u. U_n

With U_{ph-n} setting all threshold are in p.u. E_n

Note 2: The mathematical formula for INVERSE curves is:

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

t = trip time (in seconds), $t_{U>inv}$ = operating time setting (in seconds)

U = input voltage, $U_{>inv}$ = threshold setting

— Residual overvoltage - 59N

Common configuration:

• Residual voltage measurement for 59N- direct/calc.	U_E/U_{EC}
• 59N Operating mode from 74VT internal ($74VTint59N$)	OFF/Block
• 59N Operating mode from 74VT external ($74VTtext59N$)	OFF/Block

$U_E>$ Element

• $U_E>$ Curve type ($U_E>Curve$)	DEFINITE, INVERSE ^[3]
• $U_E>$ Reset time delay ($t_{U_E>RES}$)	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 formula for INVERSE curves is: $t = 0.5 \cdot t_{UE>inv} / [(U_E/U_{E>inv}) - 1]$

t = trip time (in seconds)

$t_{UE>inv}$ = operating time setting (in seconds)

U_E = residual input voltage, $U_{E>inv}$ = threshold setting

— Negative sequence overvoltage - 59V2

$U_2>$ Element

Definite time

- $U_2>def$ Operating time ($t_{U2>def}$) 0.07...100.0 s

— Directional phase overcurrent - 67

Common configuration:

- 67 Operating mode (Mode67) $I/I \cdot \cos$
- 67 Operating logic (Logic67) 1/3 / 2/3
- 67 Operating mode from 74VT internal (74VTint67) OFF/Block/Not directional
- 67 Operating mode from 74VT external (74VText67) OFF/Block/Not directional

$I_{PD}>$ Element

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

Definite time

- 67 First threshold definite time ($I_{PD}>def$) 0.100...40.0 I_n
- $I_{PD}>def$ characteristic angle ($\Theta_{\theta_{PD}>def}$) 0...359°
- $I_{PD}>def$ within CLP ($I_{PDCLP}>def$) 0.100...40.0 I_n
- $I_{PD}>def$ Operating time ($t_{PD}>def$) 0.05...200 s

Inverse time

- 67 First threshold inverse time ($I_{PD}>inv$) 0.100...10.0 I_n
- $I_{PD}>inv$ characteristic angle ($\Theta_{\theta_{PD}>inv}$) 0...359°
- $I_{PD}>inv$ within CLP ($I_{PDCLP}>inv$) 0.100...10.0 I_n
- $I_{PD}>inv$ Operating time ($t_{PD}>inv$) 0.02...60.0 s

$I_{PD}>>$ Element

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

Definite time

- 67 Second threshold definite time ($I_{PD}>>def$) 0.100...40.0 I_n
- $I_{PD}>>def$ characteristic angle ($\Theta_{\theta_{PD}>>def}$) 0...359°
- $I_{PD}>>def$ within CLP ($I_{PDCLP}>>def$) 0.100...40.0 I_n
- $I_{PD}>>def$ Operating time ($t_{PD}>>def$) 0.04...200 s

Inverse time

- 67 Second threshold inverse time ($I_{PD}>>inv$) 0.100...10.0 I_n
- $I_{PD}>>inv$ characteristic angle ($\Theta_{\theta_{PD}>>inv}$) 0...359°
- $I_{PD}>>inv$ within CLP ($I_{PDCLP}>>inv$) 0.100...10.0 I_n
- $I_{PD}>>inv$ Operating time ($t_{PD}>>inv$) 0.02...60.0 s

$I_{PD}>>>$ Element

- $I_{PDCLP}>>>$ Activation time ($t_{PDCLP}>>>$) 0.00...100.0 s
- $I_{PD}>>>$ Reset time delay ($t_{PD}>>>RES$) 0.00...100.0 s

Definite time

- 67 Third threshold definite time ($I_{PD}>>>def$) 0.100...40.0 I_n
- $I_{PD}>>>def$ characteristic angle ($\Theta_{\theta_{PD}>>>def}$) 0...359°
- $I_{PD}>>>def$ within CLP ($I_{PDCLP}>>>def$) 0.100...40.0 I_n
- $I_{PD}>>>def$ Operating time ($t_{PD}>>>def$) 0.04...10.00 s

$I_{PD}>>>>$ Element

- $I_{PDCLP}>>>>$ Activation time ($t_{PDCLP}>>>>$) 0.00...100.0 s
- $I_{PD}>>>>$ Reset time delay ($t_{PD}>>>>RES$) 0.00...100.0 s

Definite time

- 67 Fourth threshold definite time ($I_{PD}>>>>def$) 0.100...40.0 I_n
- $I_{PD}>>>>def$ characteristic angle ($\Theta_{\theta_{PD}>>>>def}$) 0...359°
- $I_{PD}>>>>def$ within CLP ($I_{PDCLP}>>>>def$) 0.100...40.0 I_n
- $I_{PD}>>>>def$ Operating time ($t_{PD}>>>>def$) 0.04...10.00 s

— Directional earth fault overcurrent - 67N

Common configuration:

- 67N Operating mode (Mode67N) $I/I \cdot \cos$
- Residual voltage measurement type for 67N - direct/calculated ($3VoType67N$) U_E / U_{EC}
- 67N Multiplier of threshold for insensitive zone (M) 1.5...10.0
- 67N Operating mode from 74VT internal (74VTint67N) OFF/Block/Not directional
- 67N Operating mode from 74VT external (74VText67N) OFF/Block/Not directional

$I_{ED}>$ Element

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

Definite time

- 67N First threshold definite time ($I_{ED}>def - U_{ED}>def$)
- Residual current pickup value 0.002...10.00 I_{En}
- Residual voltage pickup value 0.004...0.500 U_{En}
- Characteristic angle 0...359°
- Half operating sector 1...180°
- $I_{ED}>def$ within CLP ($I_{EDCLP}>def$) 0.002...10.00 I_{En}
- $I_{ED}>def$ Operating time ($t_{ED}>def$) 0.05...200 s

Inverse time

- 67N First threshold inverse time ($I_{ED}>inv - U_{ED}>inv$)
- Residual current pickup value 0.002...2.00 I_{En}
- Residual voltage pickup value 0.004...0.500 U_{En}
- Characteristic angle 0...359°
- Half operating sector 1...180°
- $I_{ED}>inv$ within CLP ($I_{EDCLP}>inv$) 0.002...2.00 I_{En}
- $I_{ED}>inv$ Operating time ($t_{ED}>inv$) 0.02...60.0 s

$I_{ED}>>$ Element

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

Definite time

- 67N Second threshold definite time ($I_{ED}>>def - U_{ED}>>def$)
- Residual current pickup value 0.002...10.00 I_{En}
- Residual voltage pickup value 0.004...0.500 U_{En}
- Characteristic angle 0...359°
- Half operating sector 1...180°
- $I_{ED}>>def$ within CLP ($I_{EDCLP}>>def$) 0.002...10.00 I_{En}
- $I_{ED}>>def$ Operating time ($t_{ED}>>def$) 0.05...10.00 s

Inverse time

- 67N Second threshold inverse time ($I_{ED}>>inv - U_{ED}>>inv$)
- Residual current pickup value 0.002...2.00 I_{En}
- Residual voltage pickup value 0.004...0.500 U_{En}
- Characteristic angle 0...359°
- Half operating sector 1...180°
- $I_{ED}>>inv$ within CLP ($I_{EDCLP}>>inv$) 0.002...2.00 I_{En}
- $I_{ED}>>inv$ Operating time ($t_{ED}>>inv$) 0.02...10.00 s

$I_{ED}>>>$ Element

- $I_{EDCLP}>>>$ Activation time ($t_{EDCLP}>>>$) 0.00...100.0 s
- $I_{ED}>>>$ Reset time delay ($t_{ED}>>>RES$) 0.00...100.0 s

Definite time

- 67N Third threshold definite time ($I_{ED}>>>def - U_{ED}>>>def$)
- Residual current pickup value 0.002...10.00 I_{En}
- Residual voltage pickup value 0.004...0.500 U_{En}
- Characteristic angle 0...359°
- Half operating sector 1...180°
- $I_{ED}>>>def$ within CLP ($I_{EDCLP}>>>def$) 0.002...10.00 I_{En}
- $I_{ED}>>>def$ Operating time ($t_{ED}>>>def$) 0.05...10.00 s

$I_{ED}>>>>$ Element

- $I_{EDCLP}>>>>$ Activation time ($t_{EDCLP}>>>>$) 0.00...100.0 s
- $I_{ED}>>>>$ Reset time delay ($t_{ED}>>>>RES$) 0.00...100.0 s

Definite time

- 67N Fourth threshold definite time ($I_{ED}>>>>def - U_{ED}>>>>def$)
- Residual current pickup value 0.002...10.00 I_{En}
- Residual voltage pickup value 0.004...0.500 U_{En}
- Characteristic angle 0...359°
- Half operating sector 1...180°
- $I_{ED}>>>>def$ within CLP ($I_{EDCLP}>>>>def$) 0.002...10.00 I_{En}
- $I_{ED}>>>>def$ Operating time ($t_{ED}>>>>def$) 0.05...10.00 s

— 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

- $df>$ 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 ($t_{df>def}$) 0.00...100.0 s

df>> Element

- $df>>$ 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 ($t_{df>>def}$) 0.00...100.0 s

df>>> Element

- $df>>>$ 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 ($t_{df>>>def}$) 0.00...100.0 s

df>>>> Element

- $df>>>>$ 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 ($t_{df>>>>def}$) 0.00...100.0 s

— Vector jump

dPHI> Element

- $dphi>$ Operating mode (Mode- $dphi>$) Module/Positive/Negative

Definite time

- $dphi>$ First threshold ($d_{PHI>def}$) 1...30 °
- $dphi>$ Reset time delay ($d_{PHI>RES}$) 0.00...100.0 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

— Selective block - BLOCK2

Selective block IN:

- BLIN Max activation time for phase prot. (t_{B-IPH}) 0.10...10.00 s
- BLIN Max activation time for ground prot. (t_{B-IE}) 0.10...10.00 s

Selective block OUT:

- BLOUT Dropout time delay for phase elements (t_{F-IPH}) 0.00...1.00 s
- BLOUT Dropout time delay for ground elements (t_{F-IE}) 0.00...1.00 s
- BLOUT Dropout time delay for all elements ($t_{F-IPH/IE}$) 0.00...1.00 s

— Internal selective block - BLOCK4

- Output internal selective block dropout time for phase protections (t_{F-IPH}) 0.00...10.00 s
- Output internal selective block dropout time for ground protections (t_{F-IE}) 0.00...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

— 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

— VT supervision - 74VT

- 74VT Negative sequence overvoltage threshold ($U_{2VT>}$) 0.05...0.50 E_n
- 74VT Negative sequence overvoltage threshold ($I_{2VT>}$) 0.05...0.50 I_n
- 74VT Phase undervoltage threshold ($U_{VT<}$) 0.05...0.50 E_n
- 74VT Minimum change of current threshold 74VT ($D_{IVT<}$) 0.05...0.50 I_n
- 74VT Undercurrent inhibition threshold ($I_{VT<}$) 0.100...40.0 I_n
- 74VT Alarm time delay (t_{VT-AL}) 0.0...10.0 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

— 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 $I_n^2.s$
- CB max 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

— Demand measures

- Fixed demand period (t_{FIX}) 1...60 min
- Rolling demand period (t_{ROL}) 1...60 min
- Number of cycles for rolling on demand ($N.ROL$) 1...24

METERING & RECORDING

— Measured parameters

Direct:

- Frequency f
- Fundamental RMS phase currents I_{L1}, I_{L2}, I_{L3}
- Fundamental RMS phase voltages U_{L1}, U_{L2}, U_{L3}
- Fundamental RMS residual current and voltage I_E, U_E

Calculated:

- Thermal image $D\theta$
- Flux U_{max}/f
- Fundamental RMS phase-to-phase voltages U_{12}, U_{23}, U_{31}
- Fundamental RMS calculated residual voltage U_{EC}
- 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
- Maximum voltage between $U_{L1}-U_{L2}-U_{L3}$ U_{Lmax}
- Average voltage between $U_{L1}-U_{L2}-U_{L3}$ U_L
- Maximum voltage between $U_{12}-U_{23}-U_{31}$ U_{max}
- Average voltage between $U_{12}-U_{23}-U_{31}$ U
- Frequency rate of change df/dt

Displacement:

- Displacement angle of I_{L1} respect to U_{L1} $PhiL1$
- Displacement angle of I_{L2} respect to U_{L2} $PhiL2$
- Displacement angle of I_{L3} respect to U_{L3} $PhiL3$
- Displacement angle of I_{L1} respect to U_{23} $Alpha1$
- Displacement angle of I_{L2} respect to U_{31} $Alpha2$
- Displacement angle of I_{L3} respect to U_{12} $Alpha3$
- Displacement angle of U_E respect to I_E $PhiE$
- Displacement angle of U_{EC} respect to I_E $PhiEC$

Sequence:

• Positive sequence current	I_1
• Negative sequence current	I_2
• Negative sequence current/positive sequence current ratio	I_2/I_1
• Positive sequence voltage	U_1
• Negative sequence voltage	U_2

Power:

• Total active power	P
• Total reactive power	Q
• Total apparent power	S
• Power factor	$\cos\Phi$
• Phase active powers	P_{L1}, P_{L2}, P_{L3}
• Phase reactive powers	Q_{L1}, Q_{L2}, Q_{L3}
• Power factors	$\cos\Phi_{L1}, \cos\Phi_{L2}, \cos\Phi_{L3}$

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}
• Third harmonic residual voltage	U_{E-3rd}

4th harmonic:

• Fourth harmonic phase currents	$I_{L1-4th}, I_{L2-4th}, I_{L3-4th}$
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5th harmonic:

• Fifth harmonic phase currents	$I_{L1-5th}, I_{L2-5th}, I_{L3-5th}$
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Demand phase:

• 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	$I_{L1MIN}, I_{L2MIN}, I_{L3MIN}$

Demand power:

• Fixed active power demand	P_{FIX}
• Fixed reactive power demand	Q_{FIX}
• Rolling active power demand	P_{ROL}
• Rolling reactive power demand	Q_{ROL}
• Peak active power demand	P_{MAX}
• Peak reactive power demand	Q_{MAX}
• Minimum active power demand	P_{MIN}
• Minimum reactive power demand	Q_{MIN}

Energy:

• Positive active energy	E_{A+}
• Negative active energy	E_{A-}
• Total active energy	E_A
• Positive reactive energy	E_{Q+}
• Negative reactive energy	E_{Q-}
• Total reactive energy	E_Q

— 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 ThySetter)	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 ThySetter)	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}
• Fundamental RMS phase voltages	$U_{L1r}, U_{L2r}, U_{L3r}$
• Fundamental RMS phase-to-phase voltages	$U_{12r}, U_{23r}, U_{31r}$
• Fundamental RMS residual voltages	U_{Er}, U_{ECr}
• Displacement angles ($I_{L1}-U_{L1}, I_{L2}-U_{L2}, I_{L3}-U_{L3}$)	$\Phi_{iL1r}, \Phi_{iL2r}, \Phi_{iL3r}$
• Displacement angles ($I_{L1}-U_{23}, I_{L2}-U_{31}, I_{L3}-U_{12}$)	$\Phi_{iL1r}, \Phi_{iL2r}, \Phi_{iL3r}$
• Displacement angle ($U_{E}-I_E$)	Φ_{iE}
• Displacement angle ($U_{EC}-I_E$)	Φ_{iECr}
• Negative sequence current	I_{2r}
• Negative sequence current/positive sequence current ratio	I_2/I_1
• Positive sequence voltage	U_{1r}
• Negative sequence voltage	U_{2r}
• Thermal image	$D\Theta_{r-\theta}$
• Flux U_{max}/f	U/f_r
• Total active power	P_r
• Total reactive power	Q_r
• Power factor	$\cos\Phi$
• Frequency	f_r
• Frequency rate of change	df/dt_r
• Binary inputs state	IN1, IN2...INx
• Output relays state	K1...K6...K10
• Fault cause info (operating phase)	L1, L2, L3

— Digital Fault Recorder (DFR)

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
• Manual trigger	ThySetter

Set sample channels:

• Instantaneous currents	$i_{L1}, i_{L2}, i_{L3}, i_E$
• Instantaneous voltages	$u_{L1}, u_{L2}, u_{L3}, u_E$

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

• Frequency	f
• Fundamental RMS phase currents	I_{L1}, I_{L2}, I_{L3}
• Fundamental RMS residual current	I_E
• Fundamental RMS phase voltages	U_{L1}, U_{L2}, U_{L3}
• Fundamental RMS residual voltage	U_E
• Fundamental RMS phase-to-phase voltages	U_{12}, U_{23}, U_{31}
• Fundamental RMS calculated residual voltage	U_{EC}
• Displacement angles ($I_{L1}-U_{L1}, I_{L2}-U_{L2}, I_{L3}-U_{L3}$)	$\Phi_{iL1}, \Phi_{iL2}, \Phi_{iL3}$
• Displacement angles ($I_{L1}-U_{23}, I_{L2}-U_{31}, I_{L3}-U_{12}$)	$\Phi_{iL1}, \Phi_{iL2}, \Phi_{iL3}$
• Displacement angle (U_E-I_E)	Φ_{iE}
• Displacement angle ($U_{EC}-I_E$)	Φ_{iEC}
• Positive sequence current	I_1
• Negative sequence current	I_2
• Negative sequence current/positive sequence current ratio	I_2/I_1
• Positive sequence voltage	U_1
• Negative sequence voltage	U_2
• Total active power	P
• Total reactive power	Q
• Total apparent power	S
• Total power factor	$\cos\Phi$
• 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
• Frequency rate of change	df/dt
• Temperature	$T1...T8$

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

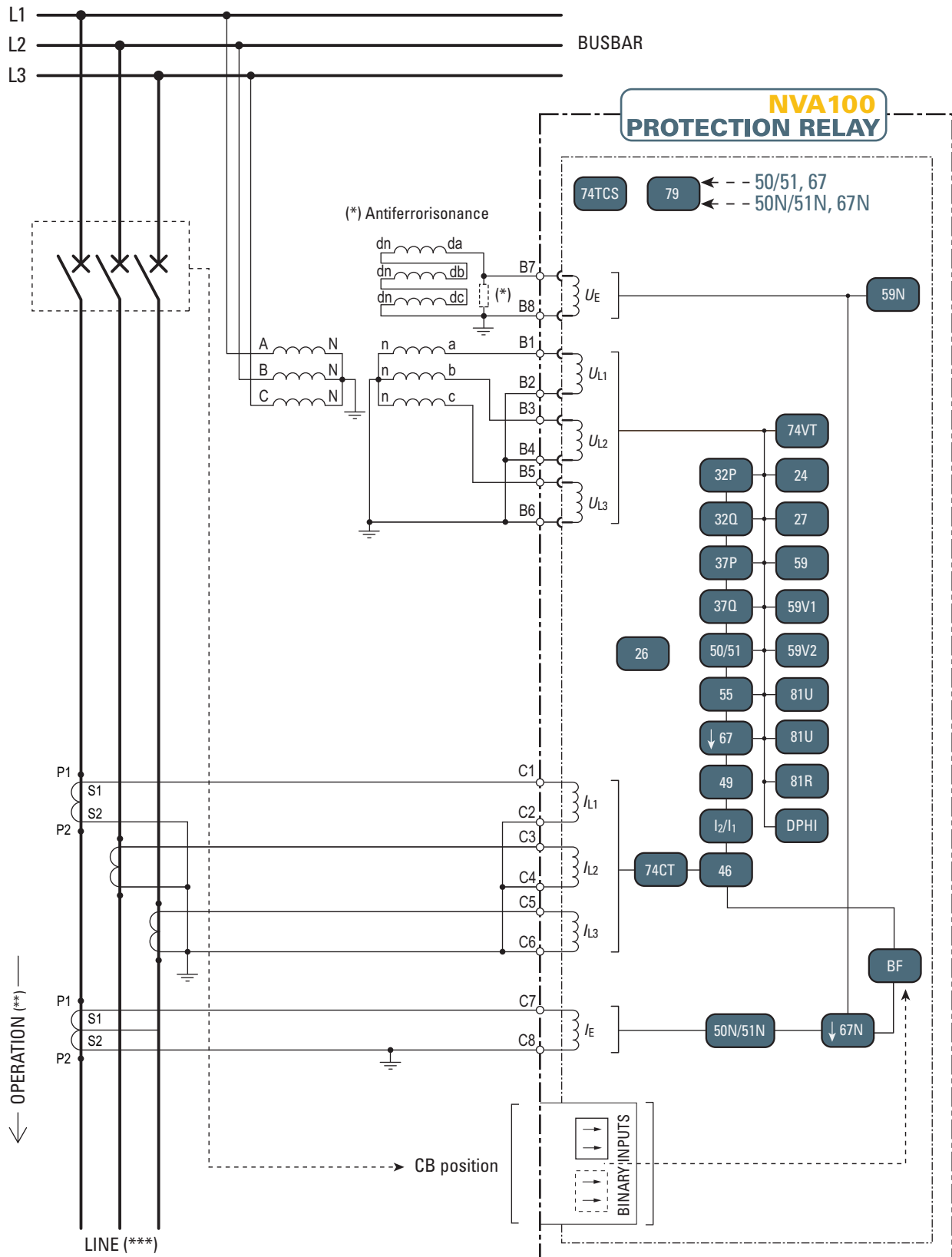
• Output relays state	K1...K6...K10
• Binary inputs state	IN1, IN2...INx

Note 1 - For instance, with following setting:

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

about 100 records can be stored with $f=50$ Hz

— Protective functions



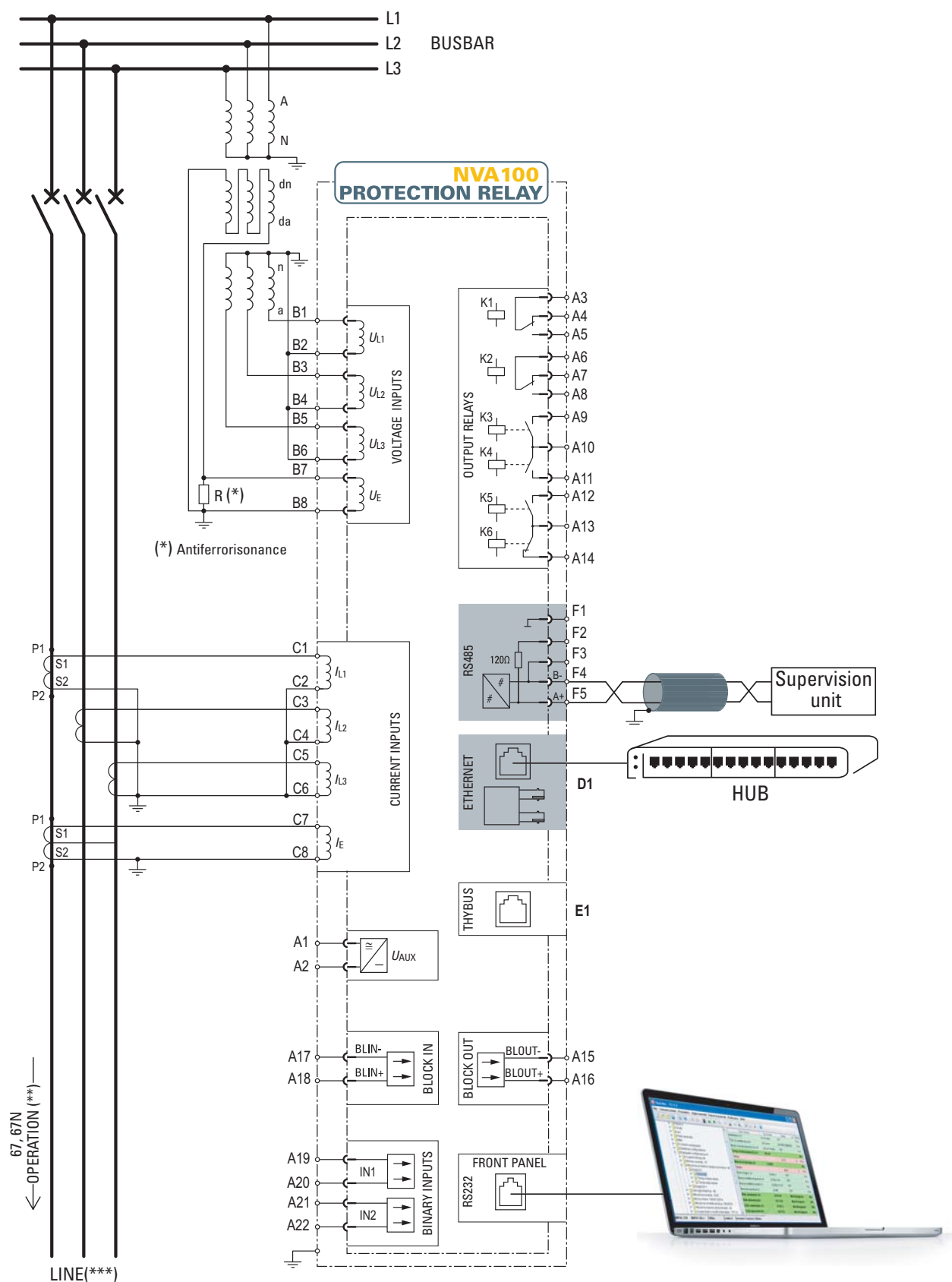
(**) OPERATION FOR:

- 67 elements with characteristic angle adjusted within $0^\circ \dots 90^\circ$ or $270^\circ \dots 359^\circ$ ranges
- 67N elements for insulated neutral systems and characteristic angle setting = 90°

(***) MEASUREMENTS:

- Positive sign for measurement of active power and energy with passive load
- Negative sign for measurement of active power and energy with generators

— Connection diagram example



(**) OPERATION FOR:

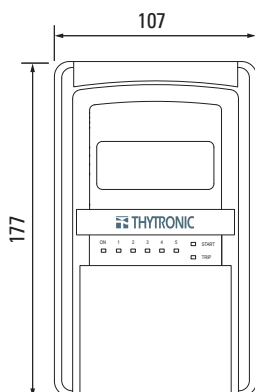
- 67 elements with characteristic angle adjusted within 0°... 90° or 270° ...359° ranges
- 67N elements for insulated neutral systems and characteristic angle setting = 90°

(***) MEASUREMENTS:

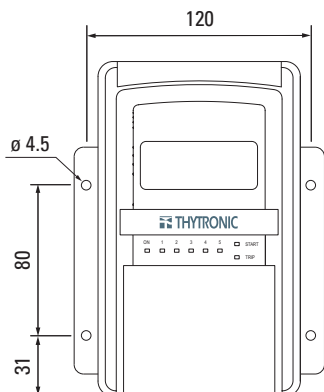
- Positive sign for measurement of active power and energy with passive load
- Negative sign for measurement of active power and energy with generators

DIMENSIONS

FRONT VIEW

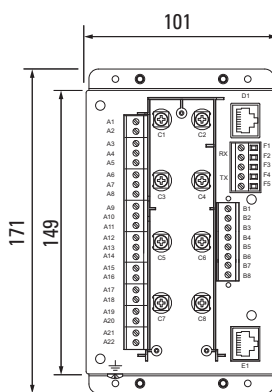


FLUSH MOUNTING

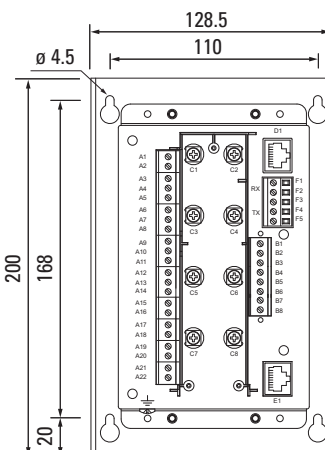


PROJECTING MOUNTING

REAR VIEW

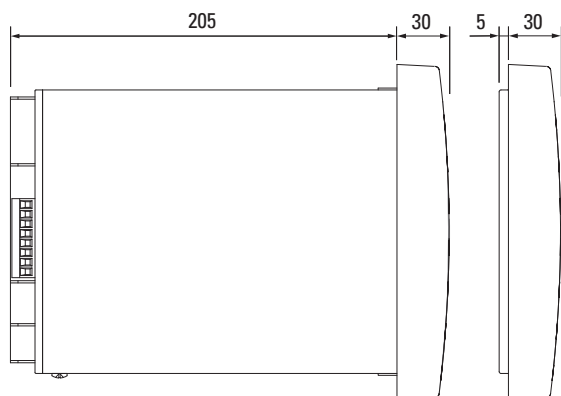


FLUSH MOUNTING



PROJECTING MOUNTING
(Separate operator panel)

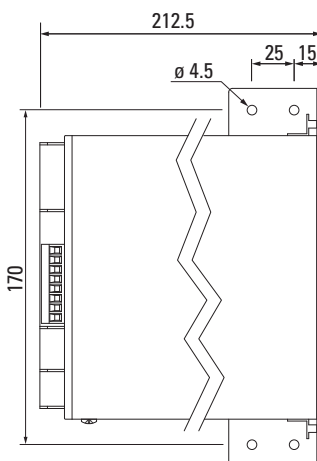
SIDE VIEW



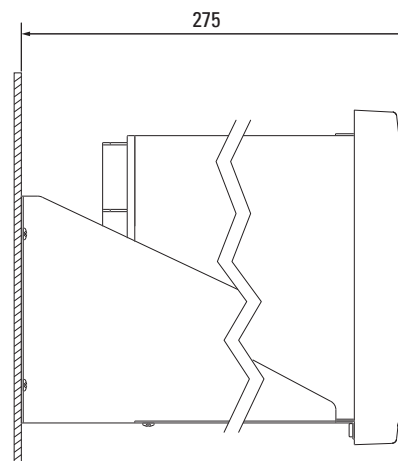
FLUSH MOUNTING



SEPARATE
OPERATOR PANEL

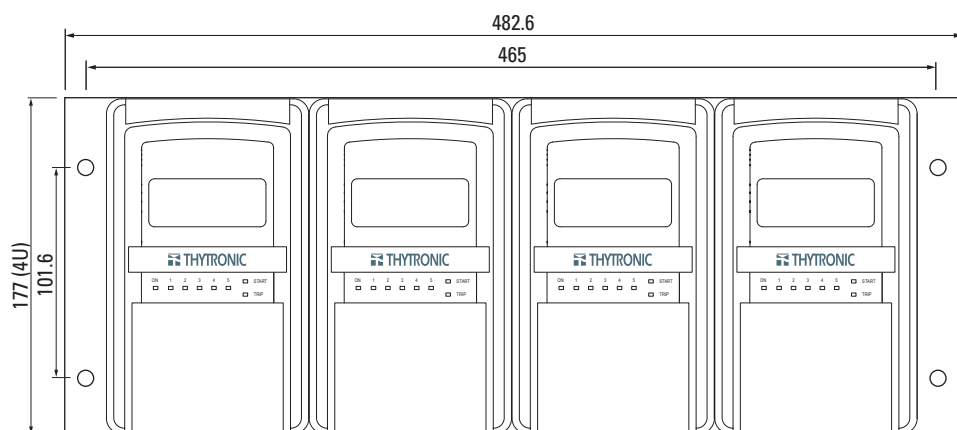


PROJECTING MOUNTING
(Separate operator panel)



PROJECTING MOUNTING
(Stand alone)

RACK MOUNTING



FLUSH MOUNTING CUTOUT

