THYTRONIC

TWO SET POINT GROUPS (A-B)

FREQUENCY TRACKING

BINARY INPUTS

CB SUPERVISION

EVENTS & DIGITAL FAULT RECORDING

MODBUS RS485 & TCP/IP REMOTE COMMUNICATION

ON-SITE FIRMWARE UPGRADE

LOCAL COMMUNICATION

NTGB MULTIFUNCTION GENERATOR PROTECTION RELAY

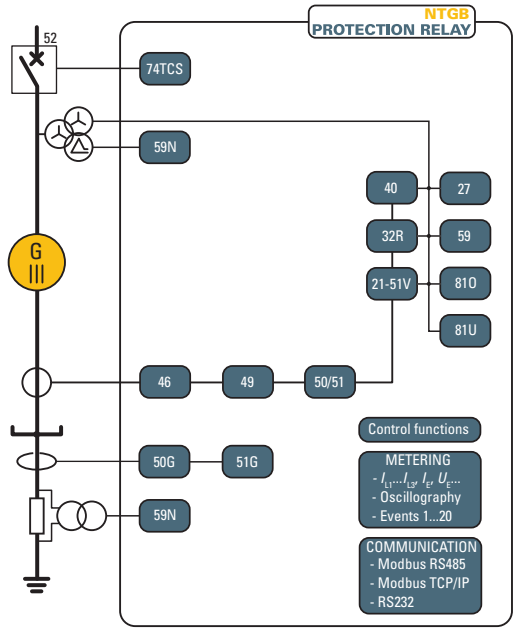
Application

The NTGB digital protection relay integrates a number of functions required for the protection of generators. It is used in power stations from gas, steam, hydraulic turbine, or diesel driven generators, operating in parallel with the public network and/or in island and with any neutral state and network layout.

Construction

Standard rack 19" 3U high case.
Plug-in terminals.

Protection elements



21-51V	Underimpedance or Voltage-controlled overcurrent protection
27	Undervoltage
32R	Active reverse power
40	Loss of field
46	Negative sequence overcurrent
49	Thermal image
50/51	Phase overcurrent
50G/51G-87N	Residual overcurrent (90% stator earth fault) or, alternatively, high impedance restricted earth fault.
59	Overvoltage
59N	Residual overvoltage (90% stator earth fault)
81O	Overfrequency
81U	Underfrequency
74TCS	Trip circuit supervision

Measuring inputs

- Three phase current and one residual current inputs with nominal currents independently selectable at 1 A or 5 A using jumpers
- Three voltage inputs software programmable within 50...130 V or 200...520 V ranges and one residual voltage software programmable within 50...130 V range
- Software selectable nominal frequency at 50 or 60 Hz.

Metering

The relay measures all the generators electrical quantities (currents, voltages, frequency, impedance, power, energies, flux, etc.) and the relay input/output logic states, making them available for reading on a display or to communication interfaces. Currents and voltages are sampled 16 times per period and measured in the effective value (RMS) of the fundamental component using the DFT (Discrete Fourier Transform) algorithm and digital filters.

Firmware updating

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

Binary inputs

Eight binary input are available which may be used for preset functions.

Output relays and LEDs

There are eight change-over contacts output relays and 16 indicator LEDs. Each output relay may be individually programmed in relation to resting state (normally energized- de-energized) and reset mode (manual or automatic). Each LED is programmable in relation to reset mode (manual or automatic). The user may program the function of each output relay and LED in accordance with a matrix (tripping matrix) structure.

MMI (Man Machine Interface)

The user interface comprises a membrane keyboard, a backlight LCD alphanumeric display and 16 LEDs. Regarding the LEDs, one are set aside to indicate auxiliary and self diagnostics power supply (green ON LED), whilst the remaining red LEDs are user assigned.

Frequency tracking

Within the generator frequency range 20...70 Hz, a frequency tracking algorithm alters the currents and voltages sampling frequency, so as to keep the number of samples in any given period constant.
The precision and availability of all relay functions are hence even guaranteed during generator start-up and shut-down.

Control and monitoring

Several predefined functions are implemented:

- Activation of two set point profiles
- Logic selectivity
- Sequential logic
- Trip circuit supervision (74TCS)
- Circuit Breaker diagnostic

Multiple setpoint profiles

The relay protection functions have two setting parameters configurations (BANK A or BANK B). Activation of the two data sets is controlled binary input or communications interfaces.

Circuit Breaker monitoring and diagnostics

The relay comprises the following functions for monitoring and controlling circuit breaker:

- Status monitoring (open, closed, anomalous)
- Monitoring the trip circuit (74TCS) for any indication of trip circuit anomalies prior to the tripping of the protective devices (interruptions or absence of auxiliary voltage, interruption or short-circuiting of the trip coil)
- Diagnostics: the relay provides a series of cumulative data (number of operations, cumulative value of the currents broken by each pole, cumulative I2t broken by each pole, duration of operations), to assist the user in the task of circuit breaker managing maintenance programmes.

Logic selectivity

With the aim of providing a selective protection system, some of the relay protective functions may be blocked by logic selectivity binary input (pilot wire accelerated logic).

Sequential trip logic

To avoid any over-speeding of the turbine-generator unit during shut-down of the unit or due to the delayed tripping of the protective devices, a binary input may be configured in order to open the machine circuit breaker as a result of tripping of the Low forward power (37P) or Reverse power (32R) functions, only after closure of the turbine intake valve.

Self diagnostics

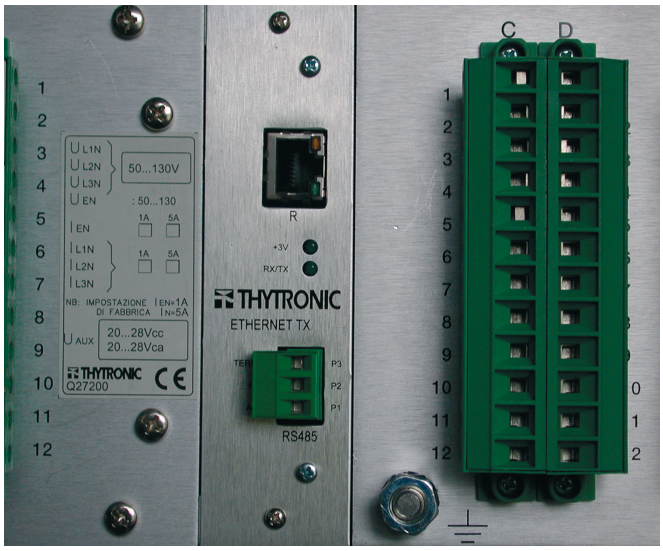
Anomalies may refer to:

- 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,...)
- Activation of trip circuit monitoring function
- Activation of CT and VT monitoring functions
- Circuit breaker faults.

Communication

Three communication interfaces are implemented:

- A RS232 local communication front-end interface, used for protection management, viewing and changing the relay programming, obtaining readings of the logic states, the chronological events, measuring, and for relay testing and resetting commands. The local interface is fitted as standard in all relay versions; a dedicated PC Software is provided.
- A RS485 port with Modbus RTU protocol for field bus communication.
- An optional back-end interface for communication with remote monitoring and control systems by 10/100 Ethernet using the Modbus TCP/IP protocol and copper (RJ45) or fiber-optic (FX) connections.



Event storage

Several useful data are stored for diagnostic purpose.

- The event recorder runs continuously capturing in circular mode the last twenty events upon trigger of binary input/output and/or element pickup (start-trip). They are graded from the newest to the older after the "Events reading" command (ThySetter) is issued
- 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 of the measured signals for long time periods analysis
- Logic states (binary inputs and output relays).

Programming and settings

All relay programming and adjustment operations may be performed through MMI (Keyboard and display) or using a Personal Computer with the aid of the ThySetter software.
The same PC setup software is required to set, monitor and configure all Pro_N devices.

Full access to the available data is provided:
- Read status and measures
- Read/edit settings (on-line or off-line edit)

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

ThySetter

SPECIFICATIONS

GENERAL

Mechanical data

Mounting:	rack 19", 3U high, 300 mm depth
Mass	7.0 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	IP31
• Rear side, connection terminals	IP20

Environmental conditions

Ambient temperature	-25...+55 °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 60255-66

INPUT CIRCUITS

Auxiliary power supply *U*aux

Nominal value (range)	24 Vac/dc
	48...110 Vac/dc
	230 Vac [1]
Operative range	24 Vac/dc ±15%
(each one of the above nominal values)	38...150 Vdc, 38...110 Vca
	165...275 Vca(1)
Max power consumption	25 VA

Note 1 By means DAC200 adapter

Phase current input circuits

Nominal current I_n	1 A or 5 A selectable by jumpers
Permanent overload	20 A
Thermal overload (1 s)	500 A
Rated consumption (for any phase)	≤ 0.1 VA with = I_n 1 A
	≤ 0.3 VA with = I_n 5 A

Residual current input circuit

Nominal current I_{En}	1 A or 5 A selectable by jumpers
Permanent overload	20 A
Thermal overload (1 s)	500 A
Rated consumption	≤ 0.1 VA with = I_{En} 1 A
	≤ 0.3 VA with = I_{En} 5 A

Phase voltage input circuits

Reference voltage U_R	100 V or 400 V
Nominal voltage U_n	50...130 V or 200...520 V selectable by sw
Overload (1 s)	2 U_R
Rated consumption	≤ 0.5 VA

Residual voltage input circuit

Reference voltage U_{ER}	100 V
Nominal voltage U_{En}	50...130 V selectable by sw
Overload (1 s)	2 U_{ER}
Rated consumption	≤ 0.5 VA

Binary input circuits

Quantity	8
Max permissible voltage	U_{aux}
Max consumption, energized	3 mA

OUTPUT CIRCUITS

Output relays

Quantity	8
Type of contacts	change-over (SPDT, type C)
Nominal current	8 A
Nominal voltage/max switching voltage	250 Vac/400 Vac
Breaking capacity:	
• Direct current	30 W (L/R = 40 ms)
• Alternating current	40 W (λ= 0,4)
Make	1000 W/VA
Short duration current	15 A (0,5 s)

COMMUNICATION INTERFACES

Local PC RS232	ModBus® RTU
Network:	
• RS485	ModBus® RTU
• Ethernet 100BaseT	100 Mbps - ModBus®-TCP/IP

GENERAL SETTINGS

Rated values

Relay nominal frequency f_n	50, 60 Hz
Relay phase nominal current I_n	1 A, 5 A
Primary phase CTs nominal current I_{np}	1 A...10 kA
Relay residual nominal current I_{En}	1 A o 5 A
Primary residual CT nominal current I_{Enp}	1 A...10 kA
Generator nominal current I_{ng}	1 A...10 kA
Relay phase to phase nominal voltage U_n	50...130 V (U_R=100V)
	200...520 V (U_R=400V)
Relay phase nominal voltage E_n	$E_n = U_n/\sqrt{3}$
Primary phase to phase VTs nominal voltage U_{np}	50 V...500 kV
Relay residual nominal voltage U_{En}	50...130 V
Residual primary nominal voltage (phase to phase) · √3	U_{Enp}
	50 V...500 kV
Generator nominal voltage U_{ng}	50 V...500 kV

Correlated values

Relay active nominal power	$P_n = \sqrt{3} \cdot U_n \cdot I_n = 3 \cdot E_n \cdot I_n$
Relay reactive nominal power	$Q_n = \sqrt{3} \cdot U_n \cdot I_n = 3 \cdot E_n \cdot I_n$
Relay apparent nominal power	$S_n = \sqrt{3} \cdot U_n \cdot I_n = 3 \cdot E_n \cdot I_n$
Relay nominal impedance (21 element)	$Z_n = U_n / I_n$
Relay phase nominal impedance (40 element)	$Z_{nf} = E_n / I_n$

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

Relay output timers

Minimum pulse width t_{TR}	0.00...500.0 s

Circuit Breaker supervision

CB operations	0...10000
Contact interrupting duty ΣI	0...5000 I_n
CB Trip delay (ΣI^2t computation)	0.05...1.00 s
Contact interrupting duty ΣI^2t	0...5000 $(I_n)^2 \cdot s$
Break time t_{break}	0.050...1.000 s

FUNCTIONS

Base current

I_B	0.40...1.50 I_n

Underimpedance (21

Pickups $Z<$, $Z<<$	0.02...3.00 Z_n
Time delays $t_{Z<}$, $t_{Z<<}$ (definite time)	0.07...100.0 s

Voltage restraint overcurrent - 51V

Characteristic	Voltage controlled/Voltage restraint
Reduction factor K	0.10...1.00
Voltage controlled settings:	
• Pickup $U_{\text{-}51CV<}$	0.10...1.00 U_n
Voltage restarint settings:	
• Pickup $U_{1\text{-}51AV<}$	0.10...1.00 U_n
• Pickup $U_{2\text{-}51AV<}$	0.10...1.00 U_n
• Pickup $I_{\text{-}51V>}$	0.20...10.00 I_n
• Time delay $t_{I\text{-}51V>}$ (definite time)	0.07...100.0 s
Pickup $I_{\text{-}51V>>}$	0.20...20.00 I_n
Time delay $t_{I\text{-}51V>>}$ (definite time)	0.07...100.0 s

Undervoltage - 27

Common settings:	
• Voltages	phase to earth or phase to phase [1]
• Logic	AND or OR
Pickups $U<$, $U<<$	0.05...1.10 U_n [1]
Time delays $t_{U<}$, $t_{U<<}$ (definite time)	0.07...100.0 s
Time delay $t_{U<}$ (inverse time)	0.10...60.0 s

Note 1 With phase to phase setting pickups are in p.u. Un
With phase to earth setting pickups are in p.u. En

Active reverse power - 32R

Pickups $P->$, $P->>$	-0.01...-1.00 P_n
Time delays $t_{P->}$, $t_{P->>}$ (definite time)	0.07...100.0 s

Loss of field - 40

Inclination angle α for the alarm pickup	10...75°
Undervoltage pickup $U_{SUP<}$	0.50...1.00 U_n
Offset thresholds X_{01}, X_{02}	-2.00...+2.00 Z_{nf}
Diameter thresholds X_{D1}, X_{D2}	0.20...+5.00 Z_{nf}
Time delays t_{AL}, $t_1<$, $t_2<$ (definite time)	0.07...100.0 s

Negative sequence overcurrent - 46

Pickup $I_{2AL>}$	0.03...0.50 I_B
Time delay $t_{2AL>}$ (definite time)	0.10...100.0 s
Pickup $I_{2>>}$ [1]	0.05...0.50 I_B
Heating time constant K_{heat}	0.1...40.0 s
Cooling time constant K_{cool}	0.1...40.0 s
Minimum operating time t_{2MIN}	0.07...100.0 s
Maximum operating time t_{2MAX}	500...2000 s

Note 1 Inverse time characteristic $t = K_{heat}/(I_2/I_B)^2$

Thermal image - 49

Heating time constant τ+	1...200 min
Cooling time constant τ-	1.0...6.0 τ+
Alarm pickup $\Delta\theta_{AL}$	0.3...1.1 $\Delta\theta_B$
Pickup $\Delta\theta>$	1.2 $\Delta\theta_B$
Thermal preset $\Delta\theta_{IN}$	0....1.0 $\Delta\theta_B$
Heating coefficient for negative sequence current K_2	0...10

☐ Phase overcurrent - 50/51

Pickup $I>$	0.100...5.00 I_n
Time delay $t>$ (definite time)	0.05...200.0 s
Time delay $t>$ (inverse time)	0.10...60.0 s
Pickups $I>>$, $I>>>$	0.100...20.0 I_n
Time delays $t>>$, $t>>>$ (definite time)	0.04...10.00 s

☐ Residual overcurrent - 50G/51G/Restricted earth fault - 87N

Pickup $I_E>$	0.010...2.00 I_{En}
Time delay $t_E>$ (definite time)	0.05...200 s
Time delay $t_E>$ (inverse time)	0.10...60.0 s
Pickups $I_E>>$, $I_E>>>$	0.010...10.00 I_{En}
Time delays $t_E>>$, $t_E>>>$ (definite time)	0.05...10.00 s

☐ Overvoltage - 59

Common settings:

• Voltages	phase to earth or phase to phase [1]
• Logic	AND or OR
Pickups $U>$, $U>>$	0.50...1.50 U_n
Time delays $t_U>$, $t_U>>$ (definite time)	0.07...100.0 s
Time delay $t_U>$ (inverse time)	0.10...100.0 s

Note 1 With phase to phase setting pickups are in p.u. Un
With phase to earth setting pickups are in p.u. En

☐ Residual overvoltage - 59N

Pickups $U_E>$, $U_E>>$	0.01...0.50 U_{En}
Time delays $t_{UE}>$, $t_{UE}>>$ (definite time)	0.07...100.0 s
Time delay $t_{UE}>$ (inverse time)	0.10...100.0 s

☐ Overfrequency - 81O

Pickups $f>$, $f>>$	1.000...1.200 f_n
Time delays $t_f>$, $t_f>>$ (definite time)	0.07...100.0 s

☐ Underfrequency - 81U

Pickups $f<$, $f<<$, $f<<<$, $f<<<<$	0.800...1.000 f_n
Time delays $t_f<$, $t_f<<$, $t_f<<<$, $t_f<<<<$ (definite time)	0.07...100.0 s

METERING

☐ Frequency

Power frequency	16.000...90.000 Hz

☐ Currents

Phase currents I_{L1}, I_{L2}, I_{L3}	0.000...30.000 I_n
Measure residual current I_E	0.000...15.000 I_{En}
Calculated residual current I_{ECAL}	0.000...15.000 I_{En}
Direct sequence current I_1	0.000...30.000 I_n
Inverse sequence current I_2	0.000...10.000 I_n
Thermal image D_{Theta}	0.00...1.20 $\Delta\theta_B$

☐ Voltages

Phase voltages U_{L1}, U_{L2}, U_{L3}	0.000...2.000 E_n
Phase to phase voltages U_{12}, U_{23}, U_{31}	0.000...2.000 U_n
Residual voltage U_E	0.000...2.000 U_{En}
Inverse sequence U_2	0.000...2.000 U_n
3rd harmonic residual voltage U_{E-3H}	0.000...2.000 U_{En}
Flux U_{MAX}/f	0.000...10.000 U_n/f_n

☐ Impedance

Impedance Z_{12}, Z_{23}, Z_{31} (21 element)	0.000...10.000 Z_n
Impedance Z_{40} (40 element)	0.000...10.000 Z_{nf}
Resistive component R_{40} (40 element)	-10.000...+10.000 Z_{nf}
Reactive component R_{40} (40 element)	-10.000...+10.000 Z_{nf}
Power factor $\cos\varphi$ Z_{40} (40 element)	-1.000...+1.000

☐ Power

Phase active power P_{L1}, P_{L2}, P_{L3}	-3.000...+3.000 P_n
Total active power P	-3.000...+3.000 P_n
Phase reactive power Q_{L1}, Q_{L2}, Q_{L3}	-3.000...+3.000 Q_n
Total reactive power Q	-3.000...+3.000 Q_n
Phase apparent power S_{L1}, S_{L2}, S_{L3}	0.000...3.000 S_n
Total apparent power S	0.000...3.000 S_n
Phase power factor $\cos\varphi_{L1}$, $\cos\varphi_{L2}$, $\cos\varphi_{L3}$	-1.000...+1.000

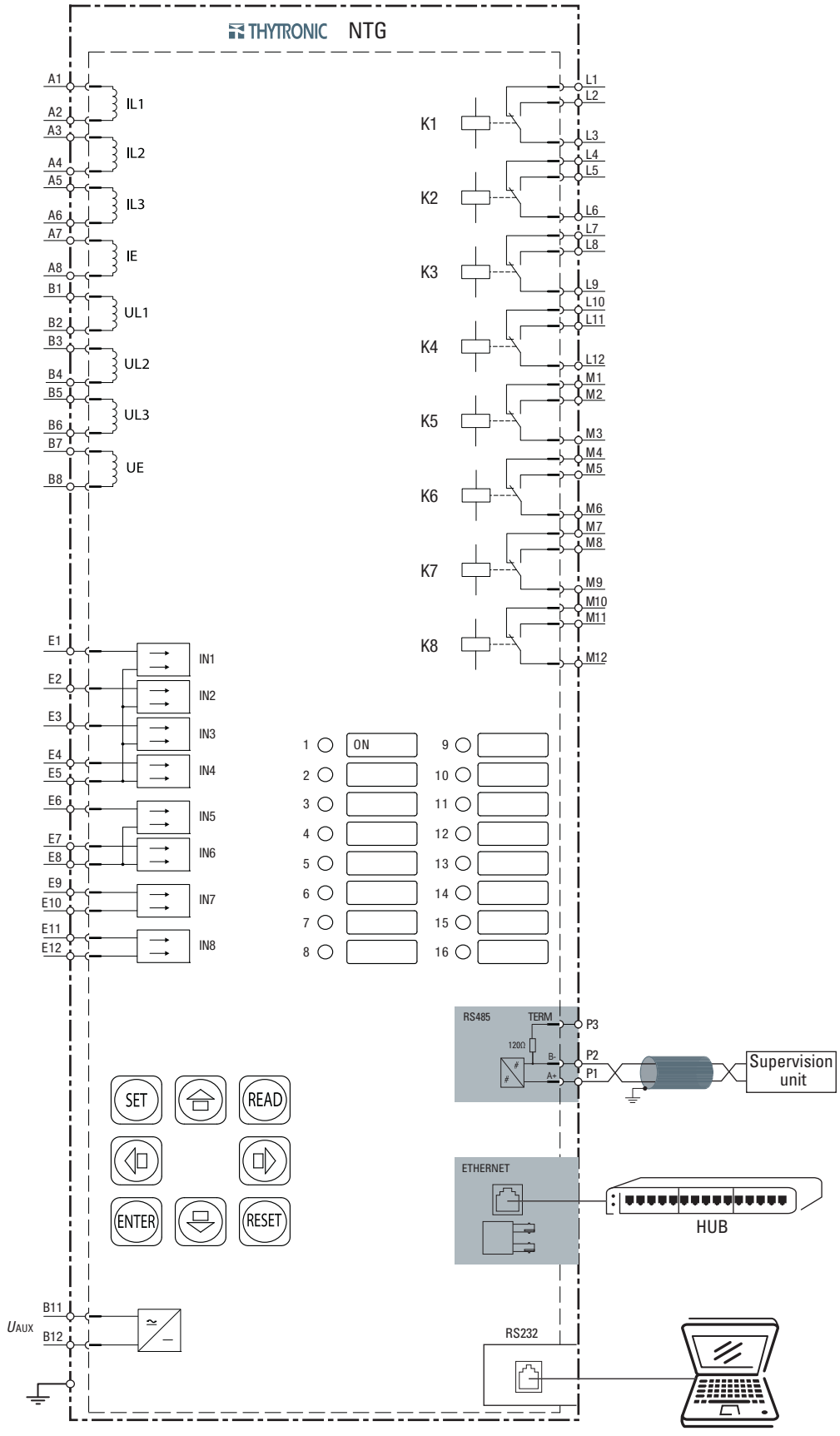
☐ Digital Fault Recorder (Oscillography)

File format	COMTRADE
Records	depending on setting
Recording mode	linear
Sampling rate	16 samples per period
Trigger setup:	
• Source	Binary inputs Communication (ThySetter) Output relays
• Pre-trigger time	0.05...1.00 s
• Post-trigger time	0.05...60.00 s
Data recorded on sampled channels:	
• Instantaneous currents	i_{L1}, i_{L2}, i_{L3}, i_E
• Instantaneous voltages	u_{L1}, u_{L2}, u_{L3}, u_E
Data recorded on analog channels:	
• Frequency	f
• RMS currents	I_{L1}, I_{L2}, I_{L3}, I_E
• RMS voltages	U_{L1}, U_{L2}, U_{L3}, U_{12}, U_{23}, U_{31}, U_E, U_2
• RMS sequence components	I_1, I_2, U_2
• Computed values	U_{MAX}/f, I_{ECALC}, D_{Theta}, U_{E-3rd}
• Active power	P_{tot}, P_{L1}, P_{L2}, P_{L3}
• Reactive power	Q, Q_{L1}, Q_{L2}, Q_{L3}
• Apparent power	S, S_{L1}, S_{L2}, S_{L3}
• Impedance	Z_{12}, Z_{23}, Z_{31}, R_{40}, X_{40}, Z_{40}, $CosPhiz_{40}$
• Power factor	$CosPhi_{L1}$, $CosPhi_{L2}$, $CosPhi_{L3}$
Data recorded on digital channels:	
• Output relays	K1...K8
• Binary inputs	IN1...IN8

☐ Events

Number of events	8
Recording mode	circular
Trigger:	Binary inputs Element pickup (start/trip)
Data recorded:	
• Frequency	f
• RMS currents	I_{L1}, I_{L2}, I_{L3}, I_E, I_1, I_2
• RMS voltages	U_{L1}, U_{L2}, U_{L3}, U_{L1}, U_{L2}, U_{L3}, U_E
• Computed values	U_{MAX}/f, D_{Theta}, U_{E-3rd}
• Active power	P
• Impedance	Min (Z_{12}-Z_{23}-Z_{31}), R_{40}, X_{40}, $CosPhiz_{40}$
• Insulation resistance	Z_F
• Event cause	start, trip, binary input
• Binary inputs	IN1..IN8
• Output relays	K1...K8
• Event cause info	operating phase (L1, L2, L3)
• Time stamp	Date and time

I/O Diagram


THYTRONIC NTG
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RS485
TERM
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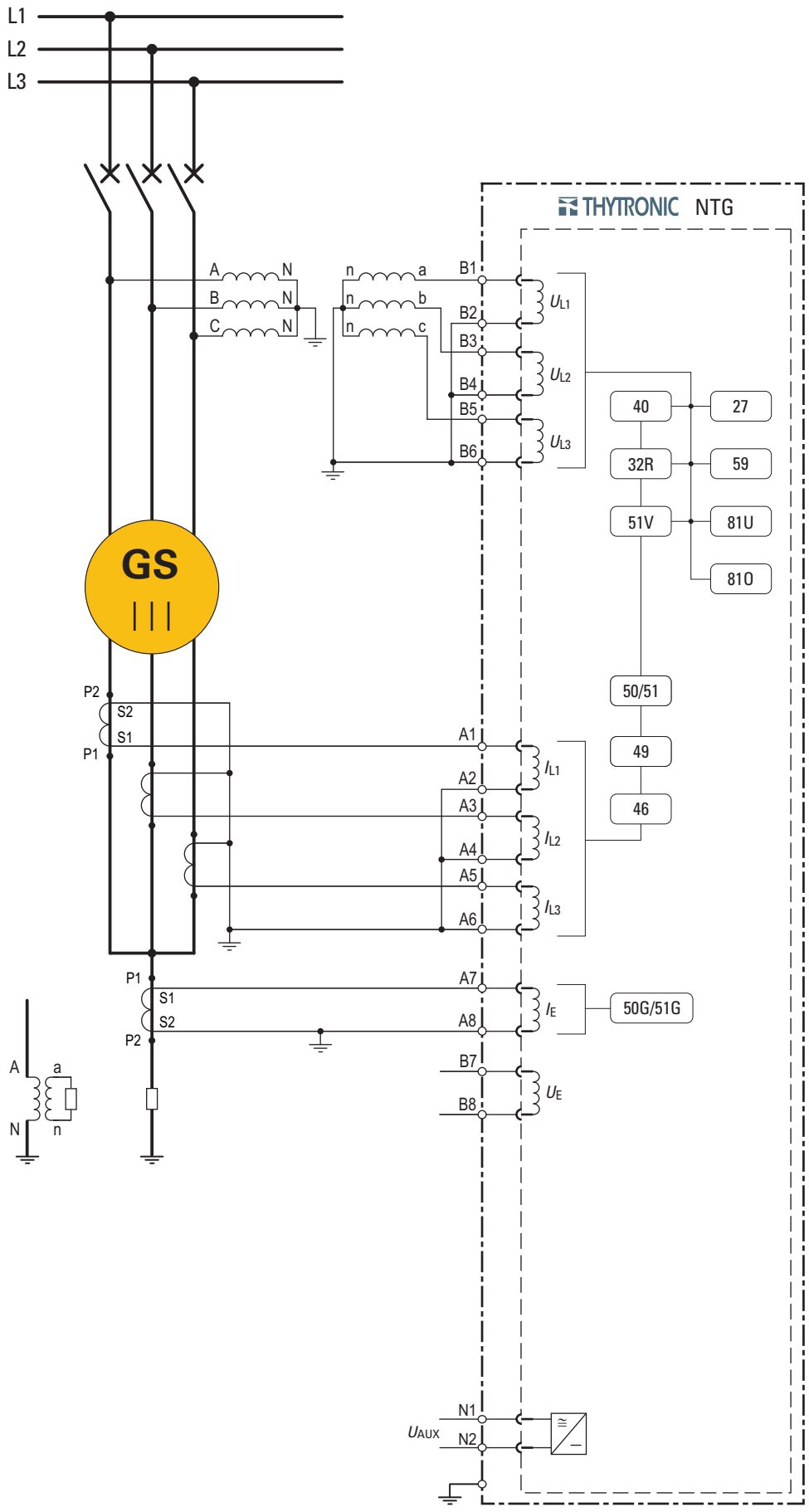
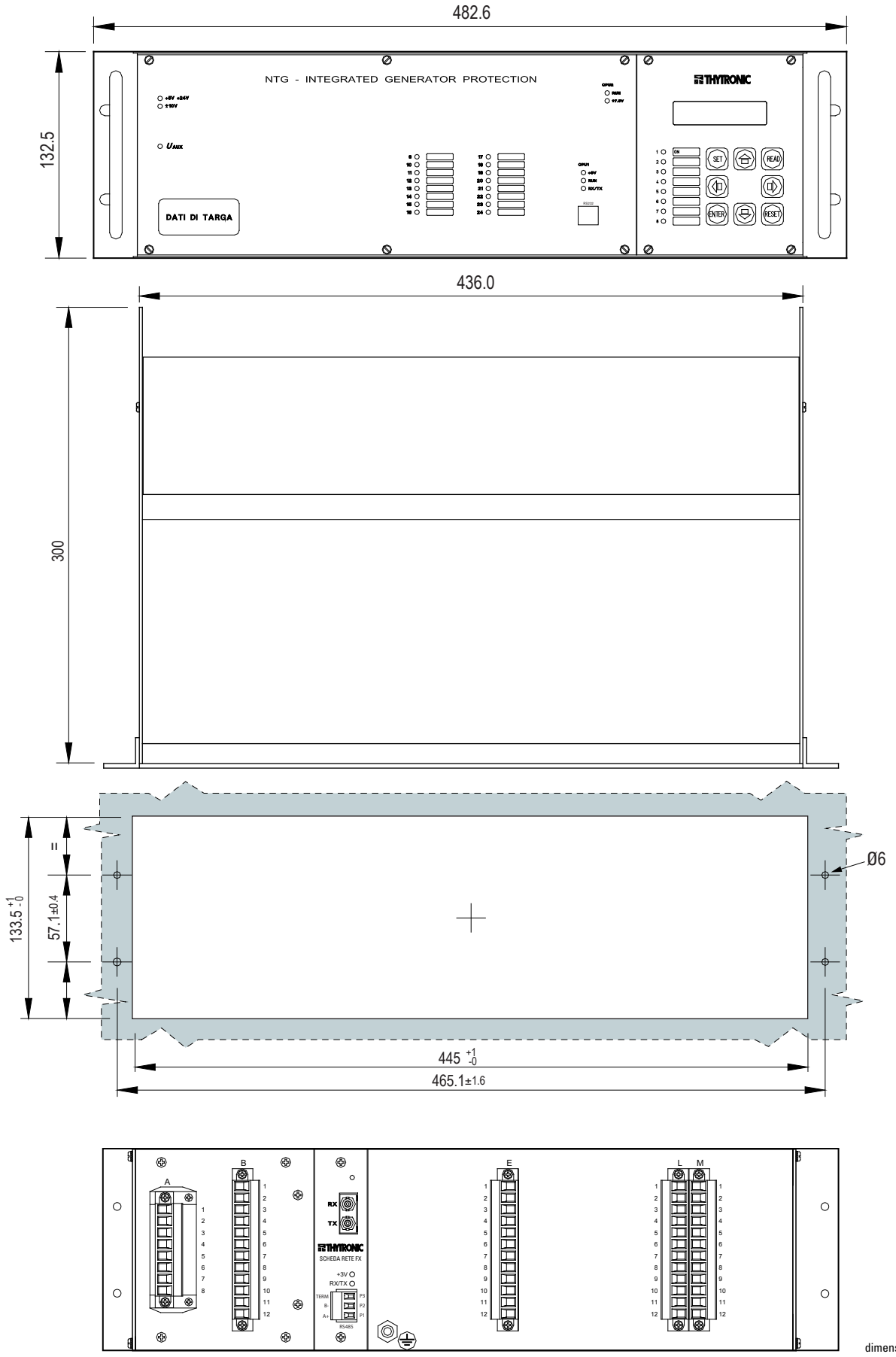
B-
A+
P3
P2
P1
Supervision unit
ETHERNET
HUB
B11
B12
UAUX
RS232
NTG-B.ai

Connection diagram example



Schematic diagram example (earthing resistor connected from generator star point or earthing TV secondary)

DIMENSIONS



Headquarters: 20139 Milano - Piazza Mistral, 7 - Tel. +39 02 574 957 01 ra - Fax +39 02 574 037 63
Factory: 35127 Padova - Z.I. Sud - Via dell'Artigianato, 48 - Tel. +39 049 894 770 1 ra - Fax +39 049 870 139 0

www.thytronic.it thytronic@thytronic.it www.pro-n.it