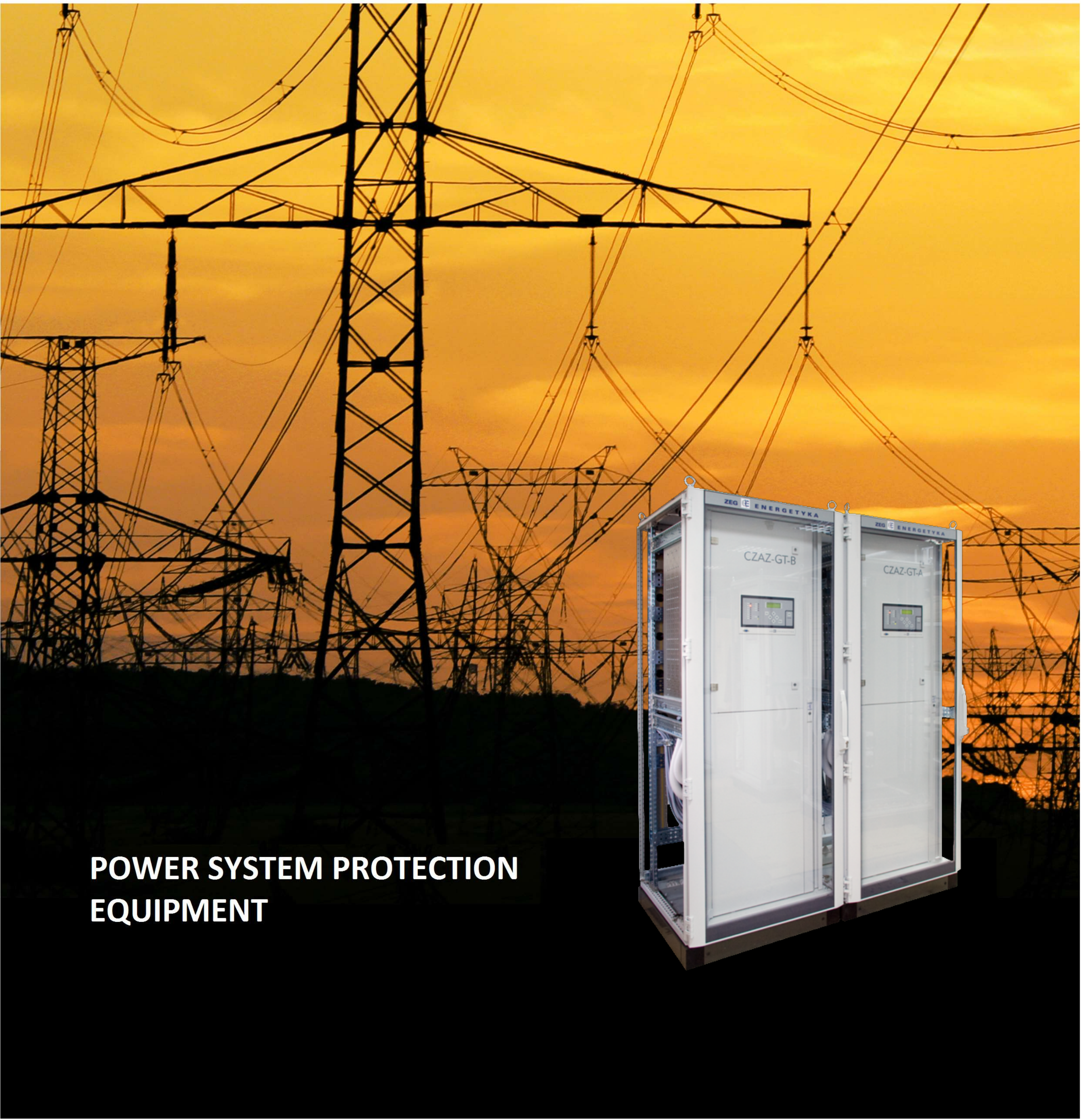
ZEG-ENERGETYKA

CZAZ-GT

DIGITAL PROTECTION SET DEDICATED TO LARGE POWER GENERATOR-TRANSFORMER OR GENERATOR UNIT

PRODUCT DATASHEET



POWER SYSTEM PROTECTION EQUIPMENT

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1. GENERAL CHARACTERISTICS

1.1. APPLICATION

The digital protection set of CZAZ-GT type is intended for protecting large power generator - transformer or generator units. The relay protects all heavy-duty devices of the power unit and cooperates with external recording and signalling devices.

CZAZ-GT-type relay ensures correct response to all types of faults or improper working condition and meets all functional requirements of the generator-transformer unit protection system.

The typical construction is a two-cabinet system, designed as the CZAZ-GT-A and CZAZ-GT-B cabinets. Each of these cabinets is supplied with an independent auxiliary voltage source and is provided with a set of protections ensuring full redundancy for the latter (examples of the application – see Figs. 1 and 2). The possibility to house two mutually redundant sets of protections in a single cabinet (example of use – see Fig. 3) is also available.

1.2. MAIN FEATURES

- Digital design ensures high stability of characteristics as well as high operating accuracy and reliability of the relay
- Optimal set of protection functions configurable by the manufacturer in compliance with requirements of the protected object
- Free-programmable logic and time characteristics of the protections
- Sufficient number of trigger inputs as well as control and signalling output modes for each application
- Trip outputs allowing direct control of unit breakers
- Expanded self-control system and failure signalling
- Measuring of electrical values (current, voltage, active and reactive power, frequency, phase shift, resistance, reactance, apparent impedance)
- Events and disturbance recorders
- Autonomic communication with local HMI
- Remote serial communication with PC computer or SCADA system

1.3. CONFORMITY WITH THE REQUIREMENTS OF POLISH STANDARDS - TEST RESULTS

The CZAZ-GT digital multifunction relay has passed with positive result a complex testing procedure for conformity to the requirements of the following Polish Standards and their international equivalents:

- PN-EN 60255-5:2005
- PN-EN 50263:2004
- PN-93/E-88641
- PN-EN 60255-6:2000
- PN-IEC 255-11:1994
- PN-IEC 255-12:1994
- PN-IEC 255-13:1994
- PN-IEC 255-16:1997
- PN-EN 61000-4-3:2003/AI :2004{U)
- PN-EN 61000-4-4:2005
- PN-EN 61000-4-5:1998/A1:2003
- PN-EN 61000-4-6:1999/A1:2003
- PN-EN 55011:2001
- PN-EN 60529:2003
- PN-EN 61000-4-11:1997/A1:2003
- PN-EN 60255-22-2:1999

- PN-EN 60255-21 -1:1999
- PN-EN 60255-21-2:2000
- PN-EN 60255-21-3:1999
- PN-EN 61000-4-2:1999/A2:2003
- PN-EN 60255-22-3:2002
- PN-EN 60255-22-4:2003(U)
- PN-EN 60255-22-6:2004
- PN-EN 55022:2000/A1:2003+A2:2004

The above mentioned tests were carried out by the following laboratories:

- “PUE Energotest – Energopomiar” in Gliwice
- “ZPBE Energopomiar in Gliwice - Zakład Techniki i Gospodarki Cieplnej i Elektroenergetycznej” (Establishment for Power and Thermal Engineering and Economy)
- “ZPBE Energopomiar – Elektryka” in Gliwice.
- Institute of Electrical Engineering, Branch in Gdańsk

2. CONSTRUCTION

CZAZ-GT-type multifunction relay is accessible in two constructional versions, wall mountable or free-standing (see Fig. 14). 19-inch EURO cassettes comprising power supply module (or two power supply units working simultaneously), A/C module, multiprocessor modules realizing main function of the device, binary inputs modules and relay output modules. The module set is installed on the deflectable frame of the case.

The idea of versatile modules allows to adapt in a flexible way the functions of the relay to the requirements of the protected object and to extend functionality according experience gained during power unit operation.

The local operator control board equipped with LCD display, keyboard and LED indicators is located on the front wall side.

The remaining equipment is situated on rails or assembly plates situated inside the cabinet. They are, first of all, current and voltage measuring transformers, presence of auxiliary supply voltages checking relays as well as testing sockets and terminals.

3. PRINCIPLE OF OPERATION

The following two kinds of input magnitudes are supplied to the relay:

- analog magnitudes (i. e. currents, voltages and non-electrical values provided by 4-20 mA circuits),
- binary signals (i. e. information about the position of unit breakers and operation of external protections).

The analog magnitudes (via measuring current and voltage transformers) and the binary ones (via optoisolator circuits) are supplied to the digital modules.

The digital modules carry out initial analog-to-digital data transformation, digital filtration, protection algorithms, electrical values measurement, logical operations and time delays

The number of digital modules in a given multifunction relay depends on the computational power, which is indispensable to the realization of the complete set of protection and other operating functions. The set of protection functions, logic and timers, trip and signalling outputs are configured by the manufacturer on the basis of the unit design. A freely programmable structure of the relay ensures its flexible adaptation to the requirements of the protected object at the production and setup stages.

The logic and time block containing the library of approx. 20 kinds of logical operators allows to build up to 400 logical and time circuits. The basic logical lines can be freely multiplied and combined, which enables to configure advanced automation circuits in accordance with the requirements of the protected unit.

The number of available emergency control signals and signalling pulses can be adapted to the requirements of the protected object. Using universal I / O modules, allows realization up to 320 trigger inputs as well as controlling and signalling outputs.

The controlling outputs enable direct control of the unit breakers. If required, the signals controlling unit main CB, excitation system CB, the generator CB are configured. The Control of the unit auxiliaries, valves cutting off turbines can also be realized. The same concerns operating drop-out of the generator, emergency power drop, boiler automation and other control modes as required by automation of the unit technological part.

The programmable pulses dedicated to be used in external signalling systems enable signalling of the functions such as:

- Pick-up of particular protection functions of CZAZ-GT relay,
- Control mode realized by CZAZ-GT relay,
- Failure of the auxiliary supply voltage,
- Improper operation of CZAZ-GT-type relay caused by internal or external factors.

4. TECHNICAL DATA

Rated current I_n	1 A or 5 A
Rated voltage U_n	100 V
Rated frequency f_n	50 Hz
Auxiliary voltage U_p	DC 85 to 270 V; AC 230 V
Burden in current standard measuring inputs	≤ 1.0 VA / phase
Burden in current high-precision measuring inputs	≤ 3.5 VA / phase
Burden in voltage measuring circuits	≤ 0.1 VA / phase
Burden in power supply circuit	≤ 70 W
Continuously thermal withstand of:	
– standard current inputs	2.2 In
– high precision current inputs	1.2 In
Continuously voltage withstand voltage inputs	2 Un
One-second thermal withstand of current inputs	80 In
Dynamic withstand (10 ms)	200 In
One-minute insulation strength	2 kV / 50 Hz
Relay outputs data	
a. control and trip purpose outputs:	
– breaking capacity	DC / AC 5A
– continuous contact carry	5 A
b. Redundant control outputs:	
– breaking capacity	DC / AC 3.15A
– continuous contact carry	3.15 A
c. Signalling relays:	
– breaking capacity	DC 0.3 A / 250 V at resistance load DC 0.12 A / 220 V at L/R = 40 ms AC 3 A / 220 V at cos. φ = 0.4

– continuous contact carry	3 A
Ambient temperature range	268 ÷ 313 K (-5 ÷ +40°C)
Relative humidity	≤ 80%
Ingress protection degree	IP40
Weight (1 cabinet)	< 250 kg

4.1. PROTECTION FUNCTION LIST

Protection functions available in CZAZ-GT are specified in Table 1. The Protection functions are supported by logic circuits, which are designed using available measuring functions, Boolean operators and timers. It allows to configure advanced automation.

Table 1. Protection function list

Func. No.	Protection function	Setting ranges and functions parameters
1.	**Differential current protection, stabilized** (see Fig. 4) **Application:** • **Generator differential protection 87G** Differential current, longitudinal, stabilized protection against effects of phase-to-phase faults of the stator winding; enables selective detection of such faults within the zone covered by its operation.	I_{ro} = (0.1 ÷ 1.0) I_n in step of 0.05 I_n k_h = (0.0 ÷ 0.5) in step of 0.05
2.	**Instantaneous overcurrent protection** Time delays realized by a free-programmable logic. **Application:** • **Generator stator overload protection 51G** Generator stator protection against effects of operating overloads. • **Generator over-current protection 51V I>** Overcurrent protection dedicated to co-operation with voltage restrain (see item 7) applied as redundancy protection of the generator. • **Step-up transformer overload protection 51TOp and pick-up transformer overload protection 51TWp** Overcurrent protection of the step-up transformer against the effects of operating overloads. • **Step-up transformer overcurrent protection 51TO and excitation transformer overcurrent protection 51TW** Protection of the step-up transformers against the	I_r = (0.02 ÷ 20.0) I_n in step of 0.01 I_n

Func. No.	Protection function	Setting ranges and functions parameters
	effects of overcurrent condition caused by external faults. • **Step-up transformer short-circuit protection 50TO and excitation transformer short-circuit protection 50TW** Protection against the effects of internal faults and short-circuits occurring at transformer taps. • **Protection against phase-to-phase faults within the stator winding 51Z** Protection applicable to generators where the stator winding consists of two parallel branches.	
3.	**Inverse-time overcurrent protection (see Fig. 9)** **Application:** • **Protection against generator rotor overloads 49R** Protection of the generator rotor against thermal effects of overloads. Its operating characteristics matches the criterion of admissible rotor winding overload determined by the generator manufacturer.	I_r = (0.50 ÷ 1.50) I_b in step of 0.01 I_b I_b = (0.10 ÷ 2,50) I_n in step of 0.01 I_n k = (1.0 ÷ 50.0) s in step of 0.1 s t_{min} = (1.0 ÷ 100.0) s in step of 0.1 s t_{max} = (100 ÷ 2000) s in step of 10 s t_{pow} = (5÷ 1000) s in step of 5 s
4.	**Zero-sequence overcurrent protection** • **Ground-fault protection of the unit circuits 51TN** Inverse-time protection against effects of ground faults occurring within the power unit.	I_r = (0.02 ÷ 1.0) I_n in step of 0.01 I_n
5.	**Negative sequence overcurrent protection, instantaneous** **Application:** • **Definite-time protection against generator load unbalance 46** Protection of the generator against the effects of load unbalance. The protection operates usually onto the signalling and reacts when the permanently admissible unbalanced load value is being exceeded.	I_r = (0.02 ÷ 0.50) I_n in step of 0.01 I_n

Func. No.	Protection function	Setting ranges and functions parameters
6.	**Negative sequence overcurrent protection, inverse-time (see Fig. 10)** **Application:** • **Inverse-time protection against generator load unbalance 46 inv** Protection of the generator against effects of load unbalance. Its operating characteristics matches the criterion of admissible unbalance load value determined by the generator manufacturer. It operates usually onto trip and reacts when the admissible duration of unbalanced load is being exceeded.	I_r = (0.02 ÷ 0.50) I_n in step of 0.01 I_n I_b = (0.2 ÷ 2.5) I_n in step of 0.01 I_n k_1 = (1.0 ÷ 50.0) s in step of 0.1 s k_2 = (0.01 ÷ 1.00) s in step of 0.01 s t_{min} = (1.0 ÷ 120.0) s in step of 0.1 s t_{max} = (1.0 ÷ 2000) s in step of 1 s
7.	**Undervoltage protection** **Application:** • **Generator under-voltage protection reacting to the generator excitation loss 27** The protection is dedicated to immediate generator turn off in case of loss of excitation and generator voltage drop occurring simultaneously • **Generator under-voltage protection 51V U<** Undervoltage function dedicated as restrain signal to be used in overcurrent protection of generator stator (voltage restrain characteristic of overcurrent protection, see item 2).	U_r = (0.020 ÷ 2.000) U_n in step of 0.001 U_n
8.	**Instantaneous overvoltage protection** **Application:** • **Power unit overvoltage protection 59** Protection of the generator and unit transformer against effects of excessive voltage rise caused by sudden loss of load of the generator, increase of excitation voltage, false manual regulation or damage of voltage regulator.	U_r = (0.020 ÷ 2.000) U_n in step of 0.001 U_n

Func. No.	Protection function	Setting ranges and functions parameters
9.	**Zero sequence overvoltage protection** **Application:** • **Generator protection against ground faults occurring within stator winding 59GN** Protection of the generator against effects of ground-faults occurring within the generator stator windings as well as within the unit primary circuits galvanically connected with the generator stator. Covers 85% of the generator stator windings. • **Ground-fault protection of the unit circuits 59TN** Reaction to ground-faults occurring within the power unit.	$U_r = (0.020 \div 2.000)\ U_n$ in step of $0.001\ U_n$
10.	**100% ground-fault protection mode, overvoltage 3rd harmonic based** **Application:** • **Generator protection against ground faults occurring within stator windings (100%) 64S** Detection of ground faults and resistance drops nearby the generator star point (predominant third harmonic in zero sequence voltage) using criterion of inducing third harmonic sequence voltage within the generator stator winding. Covers 100% of generator stator windings.	$U_r = (0.001 \div 0.200)\ U_n$ in step of $0.001\ U_n$ $U_z = (0.001 \div 0.200)\ U_n$ in step of $0.001\ U_n$

Func. No.	Protection function	Setting ranges and functions parameters
11.	**Active power overload protection, three-phase (see Fig. 6)** **Application:** • **Generator protection against reverse power flow 32R** Two-stage protection of the generator against the effects of motor operation condition. Its first stage operates under a short time-delay when the generator enters the motor operation condition (due to loss of mechanical energy) confirmed by a signal of the turbine cut-off valves activation. The operation of its second stage under a time-delay insensitive to unstable conditions of the power network (power swinging). Does not depend on the position of the turbine cutting-off valves . • **Power under-load protection 32L** Protection reacts to active power drop caused by power drop-off automation system activation (see item 20).	$P_r = (0.000 \div 1.200)\ P_n$ in step of $0.005\ P_n$ $\varphi_m = (0.0 \div 360.0)^\circ$ in step of 0.1°
12.	**Slipping pole protection (see Fig. 8)** **Application:** • **Generator protection against rotor slipping pole 78** Protection of the excited generator against the effects of out of step event. It reacts to asynchronous swinging occurring within the power network. When the generator is falling out of step, this disturbance is identified by using a change of impedance run (within specific time period) measured on the generator terminals.	$X_T = (0.0 \div 100.0)\ \Omega$ in step of $0.2\ \Omega$ $X_S = (0.0 \div 100.0)\ \Omega$ in step of $0.2\ \Omega$ $X_d = (2.0 \div 150.0)\ \Omega$ in step of $0.02\ \Omega$ $\delta_{s1} = (0 \div 180)^\circ$ in step of 5° $\delta_{s2} = (0 \div 180)^\circ$ in step of 5° $\delta_{w1} = (0 \div 180)^\circ$ in step of 5°

Func. No.	Protection function	Setting ranges and functions parameters
13.	**Impedance based on straight-line cut-off characteristics (see Fig. 5)** **Application:** • **Generator excitation loss protection 40** Protection of the generator against asynchronous operation mode and effects of unstable condition of the power network due to partial or full excitation loss. It operates on the basis of the criterion of operating impedance oscillations (power swinging) which is typical of insufficient excitation of the generator. The function operates with preset time-delay In case of simultaneously occurence of generator voltage drop, the function generates immediate trip signal.	$I_{bl} = (0.08 \div 0.10)\ I_n$ in step of $0.01\ I_n$ $X_1 = (-50.00 \div 50.00)\ \Omega$ in step of $0.02\ \Omega$ $X_2 = (-50.00 \div 50.00)\ \Omega$ in step of $0.02\ \Omega$ $X_3 = (-150.00 \div 0.00)\ \Omega$ in step of $0.02\ \Omega$
14.	**Impedance-based protection (see Fig. 7)** **Application:** • **Generator protection against ground faults occurring within rotor windings 64R** This two-stage protection of the generator against the effects of insulation faults of an excitation system. Its first stage (signalling) operates in case of drop of resistance between excitation circuits and earth potential. The operation characteristics is determined by the characteristic 1 (see Fig. 7). Its second stage (trip stage) operates at ground-faults (determined by the characteristic 2 – see Fig. 7) occurring within the excitation circuit. Function measuring circuit requires to be supplied by 230 V AC voltage.	$R_1 = (0 \div 15{,}000)\ \Omega$ in step of $1\ \Omega$ $R_2 = (-1000 \div 0.0)\ \Omega$ in step of $0.1\ \Omega$

Func. No.	Protection function	Setting ranges and functions parameters
15.	**Under-impedance protection (see Fig. 12)** **Application:** • **Power unit (generator) impedance protection 21B** Protection of the power unit (generator) against the effects of unsuccessful clearance of external phase-to-phase faults. The function is also back-up protection against internal phase-to-phase faults. Its operating characteristics ensures its correct operation at low value short-circuit currents typical of generators equipped with static excitation system.	$I_{bl} = (0.08 \div 0.10)\ I_n$ in step of $0.01\ I_n$ $Z_r = (0.10 \div 150.00)\ \Omega$ in step of $0.02\ \Omega$
16.	**Volts per Hertz protection (see Fig. 13)** **Application:** • **Generator stator and block transformer over-excitation protection 24** Protection of the unit transformer against the effects of excessive rise of magnetic flux intensity (the effect of the decrease of frequency during nominal voltage condition). Function operates on the basis of the criterion of relative value of the voltage and frequency quotient.	$(U/f)_r = (0.20 \div 2.00)\ U_n/f_n$ in step of $0.01\ U_n/f_n$ $U_{bl} = 0{,}2\ U_n$ $f_{bl} = 0{,}4\ f_n$
17.	**Underfrequency protection** **Application:** • **Unit underfrequency protection 81L** Function operates under disturbance conditions caused by power shortfall in power system. It protects the generator against effects of oscillations caused by induction rise and eddy currents and unit motors against stalls.	$U_{bl} = (0.2 \div 0.8)\ U_n$ in step of $0.1\ U_n$ $I_{bl} = (0.1 \div 0.5)\ I_n$ in step of $0.1\ I_n$ $f_r = (0.8000 \div 1.000)\ f_n$ in step of $0.0002\ f_n$
18.	**Overfrequency protection** **Application:** • **Unit overfrequency protection 81H** Function operates at sudden load drops occurring along with a damage of turbine rotation speed regulator. It protects the unit against additional mechanical stresses.	$U_{bl} = (0.2 \div 0.8)\ U_n$ in step of $0.1\ U_n$ $I_{bl} = (0.1 \div 0.5)\ I_n$ in step of $0.1\ I_n$ $f_r = (1.0000 \div 1.3000)\ f_n$ in step of $0.0002\ f_n$

Func. No.	Protection function	Setting ranges and functions parameters
19.	**Stabilized differential protection restrained by 2nd harmonic (see Fig. 11)** **Application:** The function provides selective detection of phase-to-phase faults within the covered zone. The restrain mode using the second harmonic sequence current prevents operation of the protection at magnetizing current surges. • **Unit differential protection 87B** Prevents effects of ground-faults occurring within windings of the generator stator and the unit transformer. • **Unit transformer differential protection 87TB** Prevention against the effects of ground-faults occurring within windings of the unit transformer • **Step-up transformer differential protection 87TO** Prevention against the effects of ground-faults occurring within windings of the step-up transformer.	I_{ro} = (0.10 ÷ 1.00) I_n in step of 0.05 I_n I_{hg} = (5 ÷ 15) I_n in step of 1 I_n I_{rg} = (5 ÷ 15) I_n in step of 1 k_h = (0.2 ÷ 0.8) in step of 0.1 k_b = (0.01 ÷ 0.50) in step of 0.01
20.	**Unit power dump protective automation 67** **Application:** Function operates on the basis of the rate of change of power criterion which indicates the power dump case. In function logic, underpower criterion 32L is also used. (see item 11).	
21.	**Protection against accidental turning the generator on the power network 81GL** **Application:** Function operates using the overcurrent and undervoltage protection functions as well as elements of free programmable logical and time unit.	

Legend:

U_n	- rated voltage
I_n	- rated current
P_n	- rated active power
f_n	- rated frequency
φ	- phase shift angle
φ_m	- maximum sensitivity angle
$k_h=I_r/I_h$	- stabilization coefficient
k_b	- restrain coefficient 2h
U_r	- starting voltage
U_{bl}	- voltage blocking against the operation in case of lack of measuring values
U/f	- unit transformer over-excitation coefficient
U_z	- resetting voltage
f_r	- starting frequency
f_{bl}	- interlocking frequency
I_r	- starting current
I_{ro}	- initial starting current
I_h	- stabilizing current
I_{hg}	- stabilizing current threshold
I_{bl}	- current blocking against the operation in case of lack of measuring values
I_b	- base current
P	- active power
P_r	- starting active power
R_1	- right resistance limit
R_2	- left resistance limit
X_1	- upper reactance limit
X_2	- cut-off reactance
X_3	- bottom reactance limit
X_T	- unit transformer reactance
X_S	- system transfer reactance
X_d	- generator transient reactance
Z_r or r	- circle radius
δs_1	- rotor angle for S1 unit
δs_2	- rotor angle for S2 unit
δw	- rotor angle for W unit

5. NON-PROTECTION FUNCTIONS

5.1. INTERNAL SIGNALLING SYSTEM

Internal signalling system is realized on the HMI of the protection unit. Each of twelve LED diodes can be freely assigned to any particular event at the configuration file creation stage.
In particular, these LEDs can be used for signalling trip operations, specific operation modes of the unit or protection functions pick-ups. Moreover, the HMI is equipped with a LED diode signalling the presence of supply voltage and another LED diode intended for signalling correct operation of the device.

5.2. MEASUREMENT MODES

CZAZ-GT set measures currents and voltages input signals as well as tens of advanced criteria magnitudes calculated based on these signals. The measurement of input signals determine rms. value of the current or voltage basic component, frequency and phase shift in relation to any signal selected by the user. According to the user's choice, all measuring results can be shown as primary, secondary or relative magnitudes.
All criteria magnitudes: directly measured or calculated can be constantly previewed. I.e. it can be: currents (e.g. amplitude of fundamental component of differential current or its average rms. value), voltages (e.g. amplitude of the voltage fundamental component or amplitude of the differential voltage third harmonic), resistance, impedance, active and reactive power, frequency, phase shift angle.
The repetition time of these measurements is 1 second, and the visualization of their results is enabled either via HMI or via utility software of the relay in the local / remote communication mode with PC-type host.

5.3. RECORDERS

CZAZ-GT set contains two independently operating digital recorders - one for the events (event recorder) and another for measuring and binary signals (disturbance recorder)

Event recorder
The event recorder can memorize not less than 5,000 events. Its capacity increases in case of simultaneous occurrence of several events that are at the same time memorized by it. The recorder enables to write up to 256 events (distinguished by means of textual descriptions) along with their occurrence date and time (hour, minutes and seconds). This recorder memorizes information about pick-up and operation of protections, as well as about unit breakers, external signals and any logical modes configurable within the logic module.

System event recorder
Moreover, the relay memorizes all the so-called system events, resulting from operation of the relay itself, i.e. supply voltage ON and OFF, configuration changes made by the user, as well as its operating errors. The system events are not programmable and their

register cannot be turned off. The system event recorder capacity amounts to above 1,000 events.
The time resolution of the recording of events is 1 ms. In case of the recorder overflow, the device writes according to first-in-first-out (FIFO) rule.
If the relay is used by external software, the next registered events are transferred in step of 10 seconds to the file stored by the host computer.

Disturbance recorder

The recorder of signals records selected analog and binary signals when a pre-defined situation (i. e. trip) occurs, enabling to reproduce any disturbance and the response to this disturbance afterwards. The sampling frequency of the recorder is 1,800 Hz.
The recording mode is released by a change of selected binary signal or by the logical sum of selected binary signals. All the activated binary signals release the recording of disturbances and are recorded as well.
The disturbance recorder records up to 40 analog channels selected from the configuration of currents and voltage channels, and up to 128 binary signals. All input currents and voltages, input binary signals and control and signalling output signals are accessible for recording. The values resulting from the processing of input signals (e.g. fundamental component amplitude of the differential current and stabilizing current in case of the generator stator protection against phase-to-phase faults) by internal procedures of protections can also be recorded.
There is a possibility to select recording mode (the static mode - recording stops after a predefined time, the dynamic mode – recording ends after vanishing of recording trigger signal) and to form the recording process by means of the appropriate software utility. Each record contains a section projecting runs occurred before the release moment, the so-called pre-run section.
The maximum recording time amounts up to 500 seconds for a single analog run. The number of signals and the recording time are determined by the recorder capacity. For example, the recording duration of 40 analog and 128 binary channels amounts to approx. 10 seconds. Function provides the information abour percentage of memory usage.
If disturbance recorder is set to static mode, the saving process operates according to FIFO rule. In case of dynamic mode, further recording is blocked if the memory is full.

5.4. TESTING MODES

All digital modules of the relay are equipped with correct operation checking system. Checking system covers: hardware protection against loss of control and embedded software protection checking the correctness of control process and data transfer between relay modules.
Both the internal software of CZAZ-GT multifunction relay and the SMiS utility allows to control I/O circuits. Optionally, operation of particular protection functions can also be blocked.
Along with the configuration file, the user can obtain a file containing test configuration dedicated to conduct the test of input/output modules.

6. COMMUNICATION

Two following communication modes with CZAZ-GT- relay are possible
- local communication mode via HMI, and
- remote communication mode by single PC host or by the supervision system

In the local communication mode, the keyboard and LCD display situated on the front panel of the CZAZ-GT are used. Due to high complexity of the relay, this mode enables only basic operations (ON/OFF, CONFIGURATION), settings of particular protections (starting values, delays) and preview of magnitudes measured by the relay or contents of events and system recorders.
The communication with the operator is realized by PC-type host via RS 232 interface. It allows complete communication with the device: creating and editing configuration file, carrying out the device tests, reviewing measured values, reviewing all records (events and disturbances)
The remote communication with the supervision system is executed via RS 485 interface by use of MODBUS communication protocol. Two RS 485 channels (one replaceable by RS 232) are foreseen in the relay.
CZAZ-GT set can also co-operate with a monitoring and control point situated within a widespread network (Internet) via a communication hub meeting requirements of the whole CZAZ family of digital multifunction relays manufactured by the ZEG-ENERGETYKA, as well as with any higher-level control and visualization system.
Due to high configurability of the multifunction relay, in the range of communication protocols, the communication system must be discussed with the manufacturer.
In order to prevent access by any incompetent persons, several operating levels assigned to particular users (where each of the users has their own access password to the device) have been foreseen. The lowest operating level (i.e. monitoring) enables the user only to monitor the relay operation mode, measuring values and recorded events, whereas the highest one (configuration) enables to introduce some essential setting changes and relay configuration file.

7. CZAZ-GT CONFIGURATION

In order to meet specific requirements of the protected object, the following details need to be specified within the framework of brief foredesign:
- number and kind of measuring inputs (single-phase, three-phase signals) measured on the protected object,
- binary signals originating by external devices,
- binary signals supervising position of the unit breakers,
- protection functions and their starting values,
- time-delays of particular protections,
- logical and time dependencies (interlocks);
- trip signals,
- output signals transmitted to external signalling system (max. 128 contact outputs and max. 256 digital transferred by the serial transmission mode),
- mimic diagram situated on the relay front panel;
- measuring signals;
- measuring and binary signals to be memorized by the recorders

Basing on the above requirements as well as on necessary hardware configuration, software configuration works are carried out especially the edition of the configuration file. The configuration file determines all the operation modes to be realized, their parameters and settings, particularly: structure of protections, logical and time dependencies, control and signalling system, measurements, data recording structure.
The creation of configuration file and its upload to CZAZ-GT relay is carried out by the manufacturer using dedicated software.
The upload of the configuration file to CZAZ-GT relay set all the modules and allows to start its operation. Thanks to such a possibility, the relay is characterized by a huge flexibility, thus enabling the users to adapt it to their individual requirements.

8. SOFTWARE

According to the user's requirements, the manufacturer delivers a monitoring and control point enabling full service of the relay. Such a point is designed basing on PC-type host delivered depending on the local working conditions, in the standard, semi-industrial or industrial version. The software of the monitoring and control point works under the control of MS Windows operating system. In co-operation with the monitoring and control point connected with CZAZ-GT relay, the software enables to:

- read, edit and upload the settings;
- read and change the relay operation mode,
- read measuring values;
- read and review the content of the event recorder;
- read and review the content of the system event recorder,
- read and review the content of the disturbance recorder,
- handle additional tasks for the recorder module;
- test operation correctness of the relay.

With the communication kept continuously between the supervision system and the relay following operations are possible:

- the relay's pick-up and drop-out time synchronization continuously via the monitoring and control point or network,
- the list of indicated events automatic update,
- event and disturbance recorders records automatic download (thus relieving some amount of its memory)

The records of disturbance runs read from the relay can be recorded in the COMTRADE standard. The procedure handling the recorders of events enables data filtering and sorting modes. The manner of visualization of recorded runs allows to preview them in many visualization options and allows to precisely read the measured values by user-friendly interface.
The monitoring and control point software contains also functions enabling configuration the system by means of a remote computer, enabling access to the CZAZ-GT relay via a widespread network. In such a case, however, the CZAZ relay must be equipped with communication hub offered by the ZEG-ENERGETYKA Company.

9. WARRANTY AND SERVICE CONDITIONS

All end-users of CZAZ-G/CZAZ-GT- relays are granted 24-month warranty period commencing from their purchase date. The manufacturer ensures the warranty service under generally acceptable conditions as well as past-warranty service within the range of commissioning and periodical maintenance tests of the relays.

Phone numbers:
- technical information **+48 (32) 775 07 98**

10. HOW TO ORDER

Please place your orders at:

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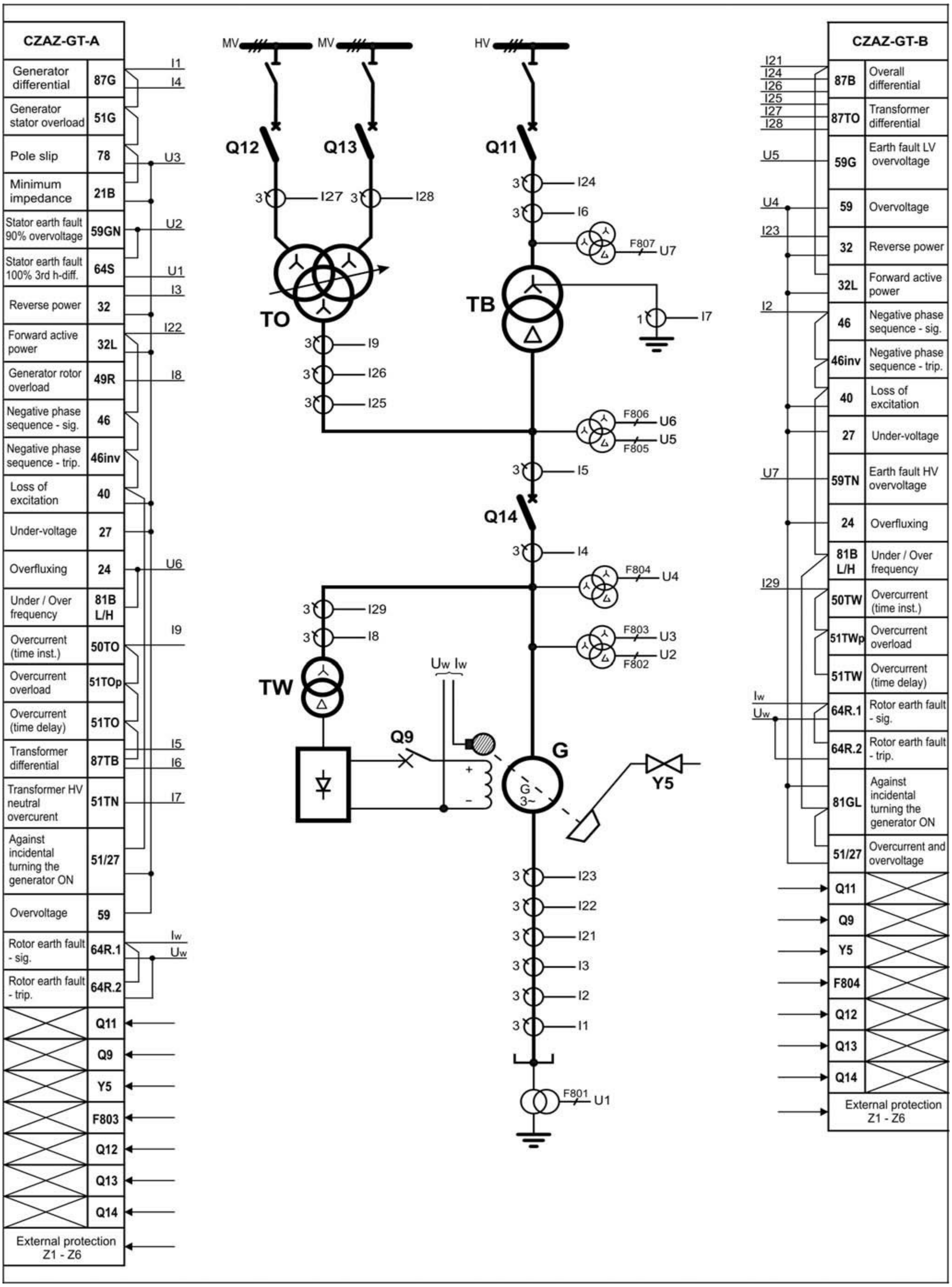


Fig.1. Hypothetical connection diagram of measuring circuits for protections comprised by CZAZ-GT sets intended for generator-transformer unit provided with generator circuit breaker

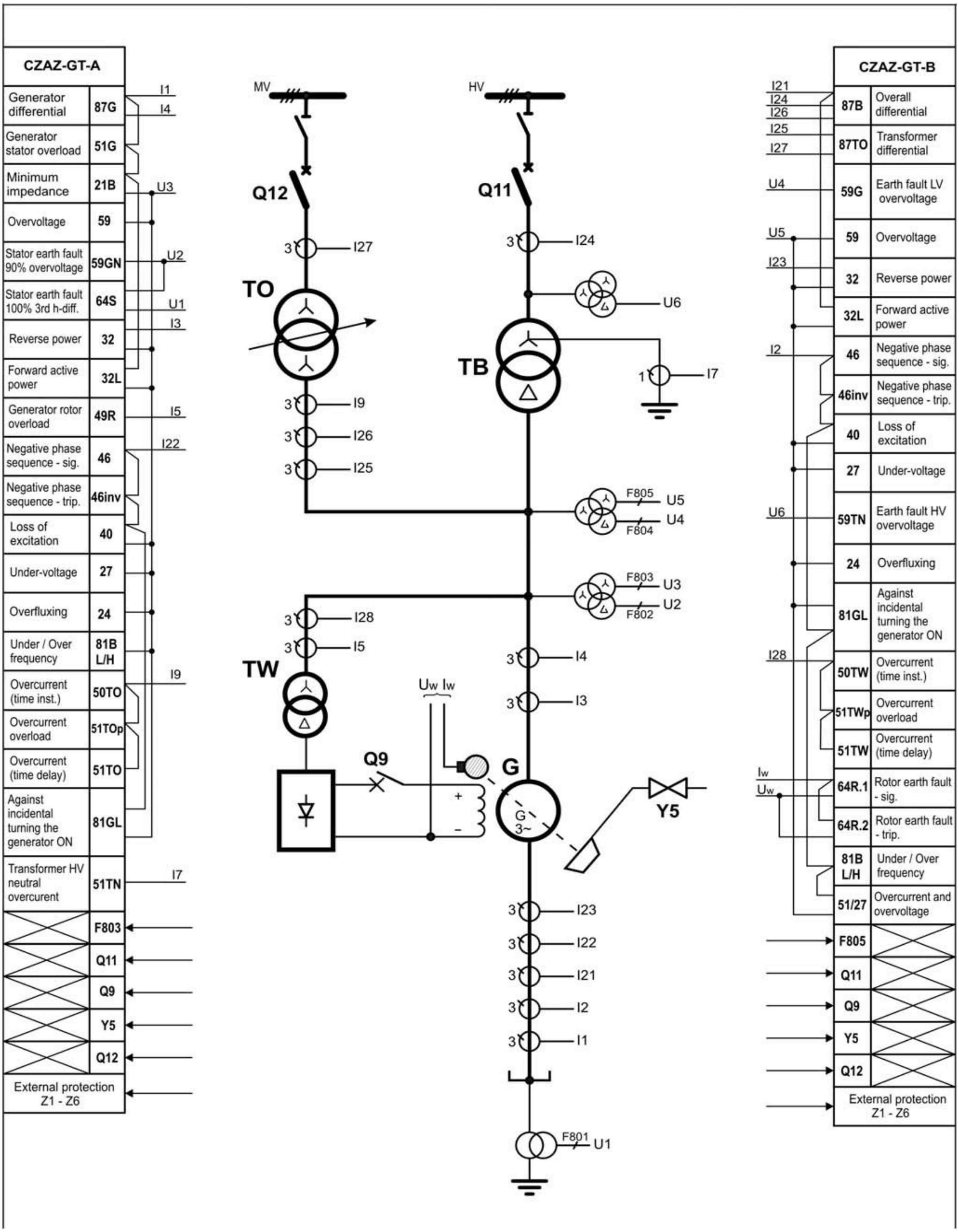


Fig.2. Hypothetical connection diagram of measuring circuits for protections comprised by CZAZ-GT relay intended for generator-transformer block without generator circuit breaker

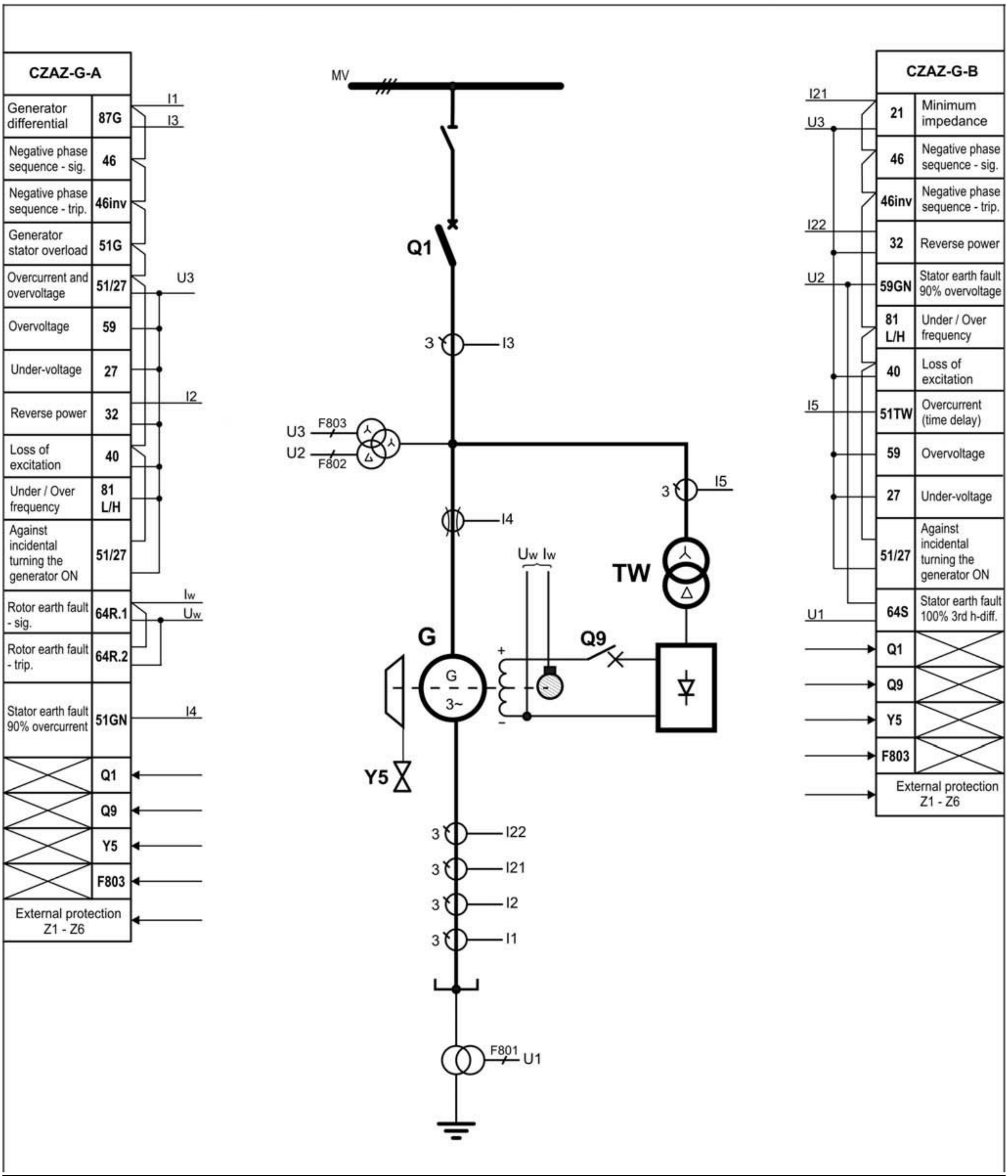


Fig.3. Hypothetical connection diagram of measuring circuits for protections comprised by **CZAZ-G** relay intended for generators

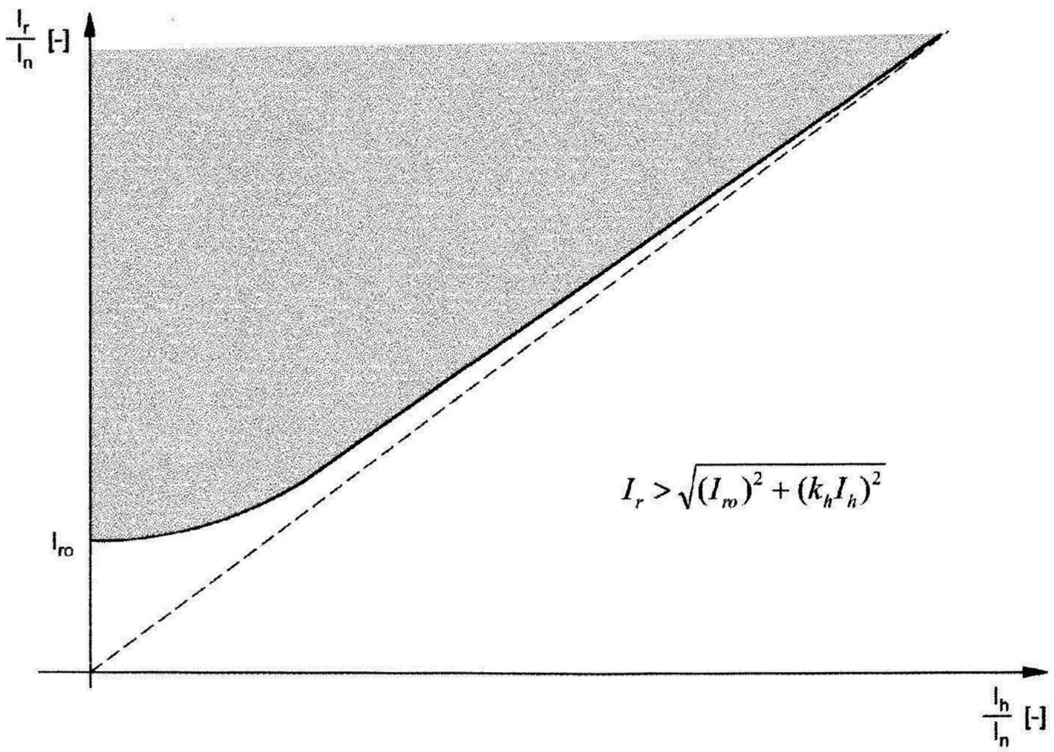


Fig.4. Operating characteristics of **87G** generator differential protection

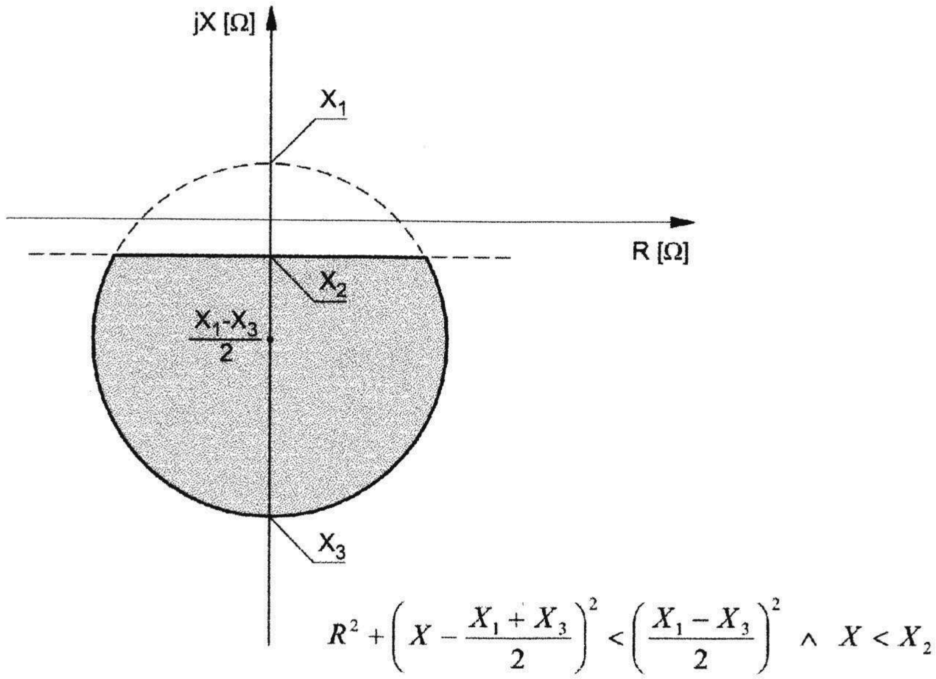


Fig.5. Operating characteristics of **40** protection against generator excitation loss

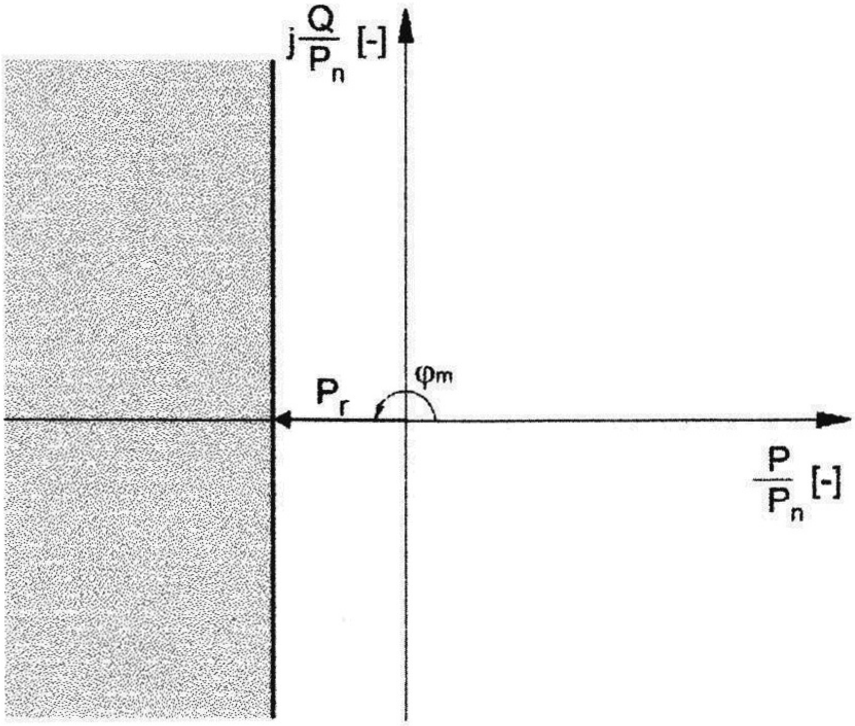
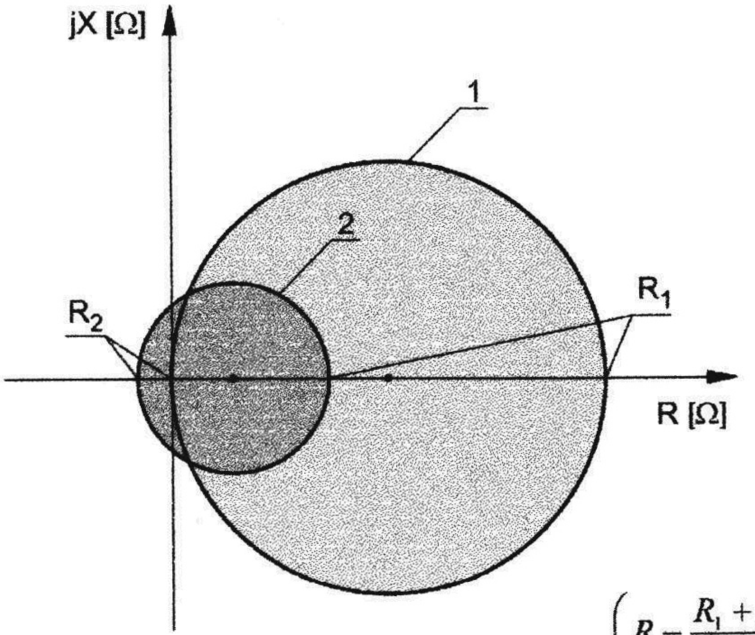


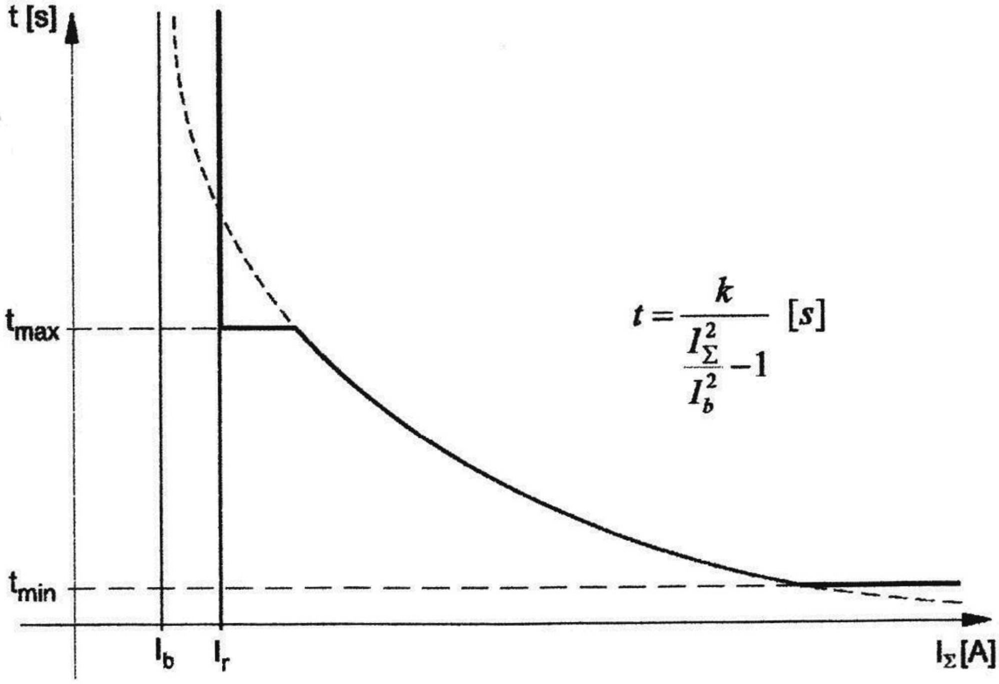
Fig.6. Operating characteristics of **32** generator protection against reverse power condition



1 – signalling stage
2 – tripping stage

$$\left(R-\frac{R_1+R_2}{2}\right)^2+X^2<\left(\frac{R_1-R_2}{2}\right)^2$$

Fig.7. Operating characteristics of **64R** ground-fault protection of the excitation circuit



$$t=\frac{k}{\frac{I_{\Sigma}^2}{I_b^2}-1}\ [s]$$

Fig 8. Operating characteristics of **49R** protection against rotor overloads

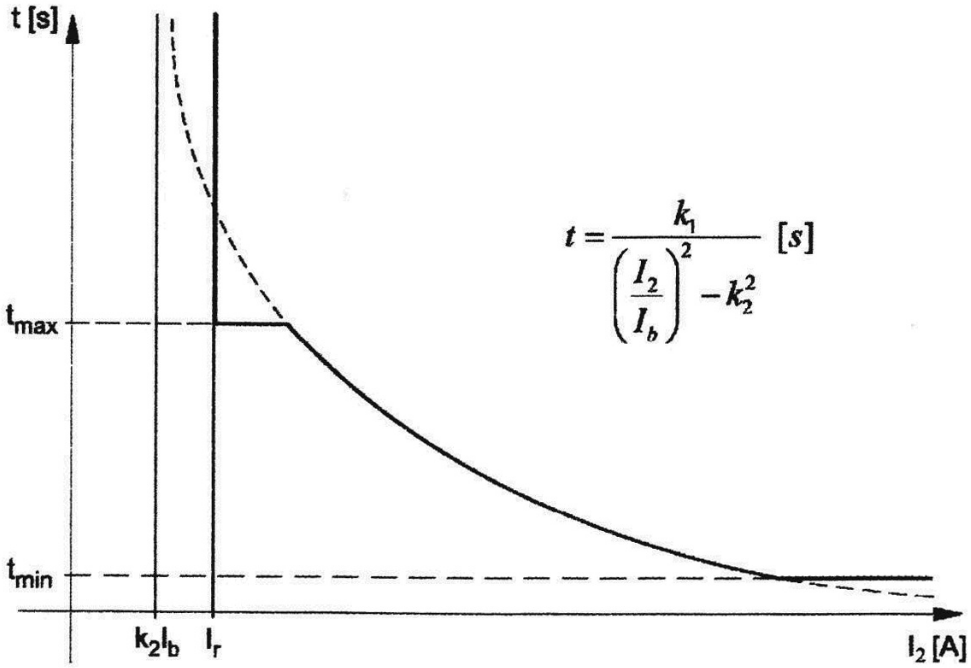


Fig.9. Operating characteristics of **46inv** generator protection against load unbalance

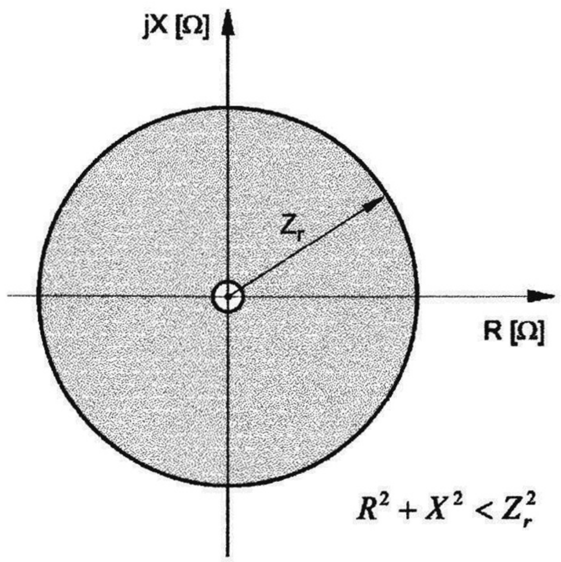


Fig.10. Operating characteristics of **21B** unit impedance protection

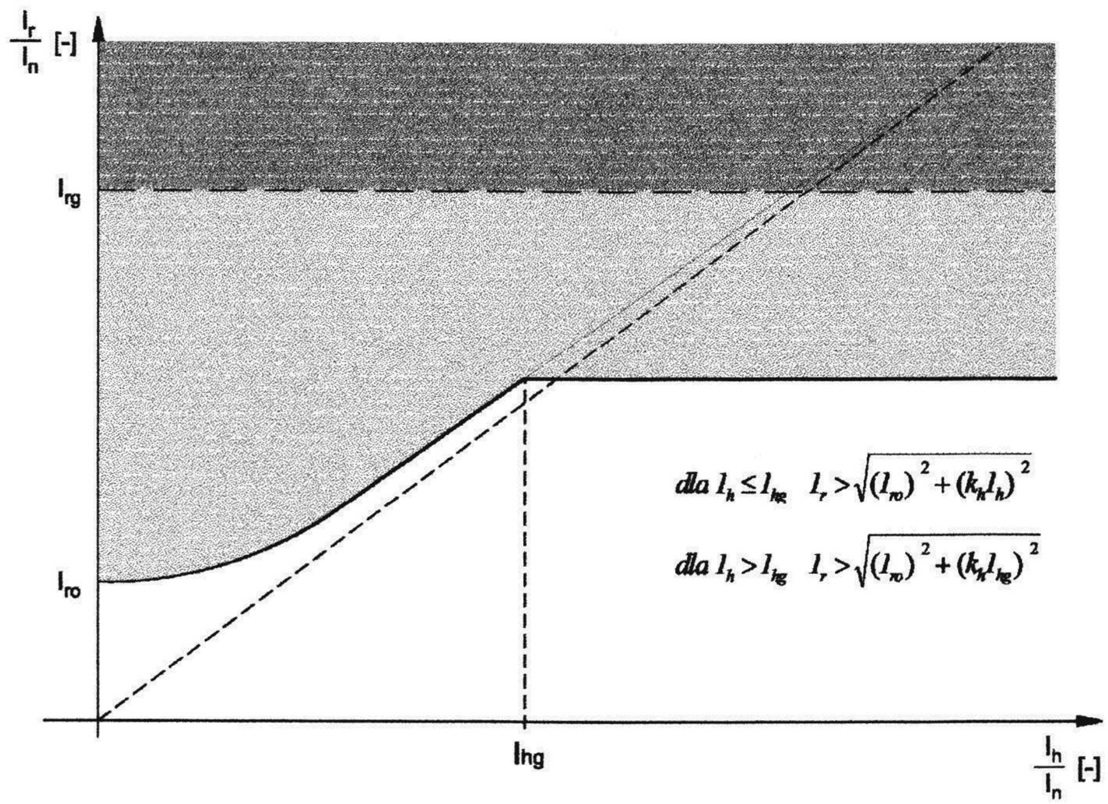


Fig.11. Operating characteristics of: **87B** unit differential protection, **87TB** unit transformer differential protection, **87TO** step-up transformer differential protection

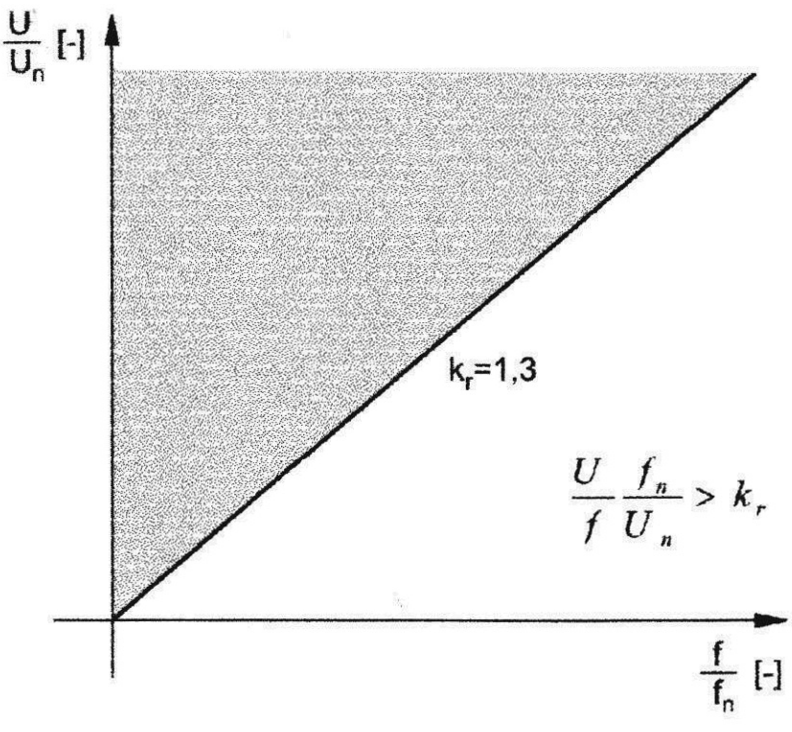


Fig.12. Operating characteristics of **24** protection against unit transformer over-excitation

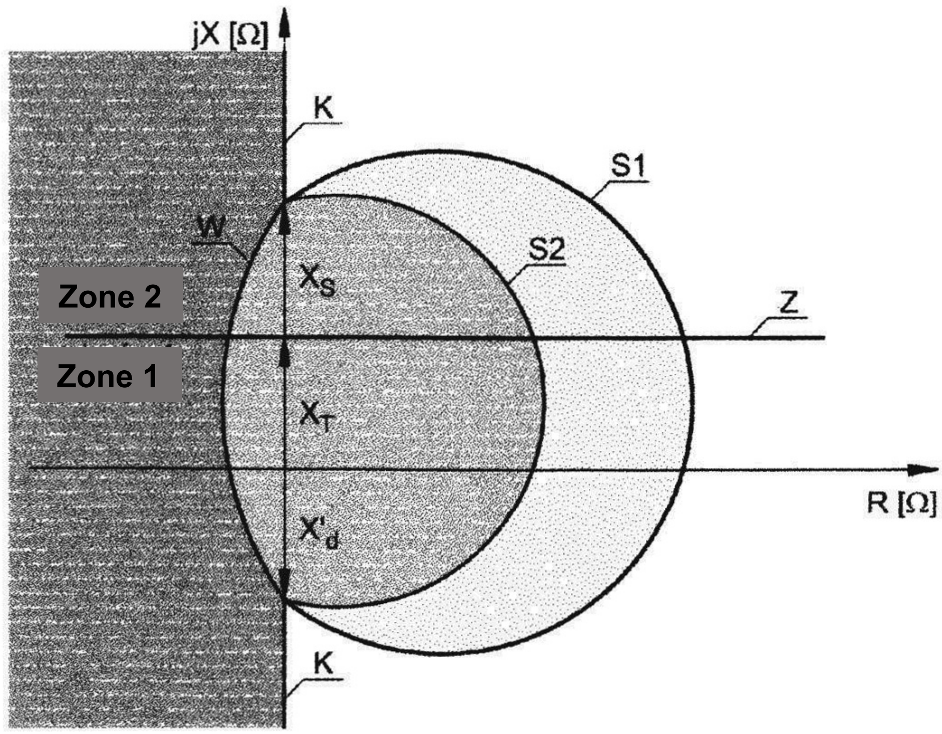


Fig.13. Operating characteristics of **78** generator protection against generator slipping poles

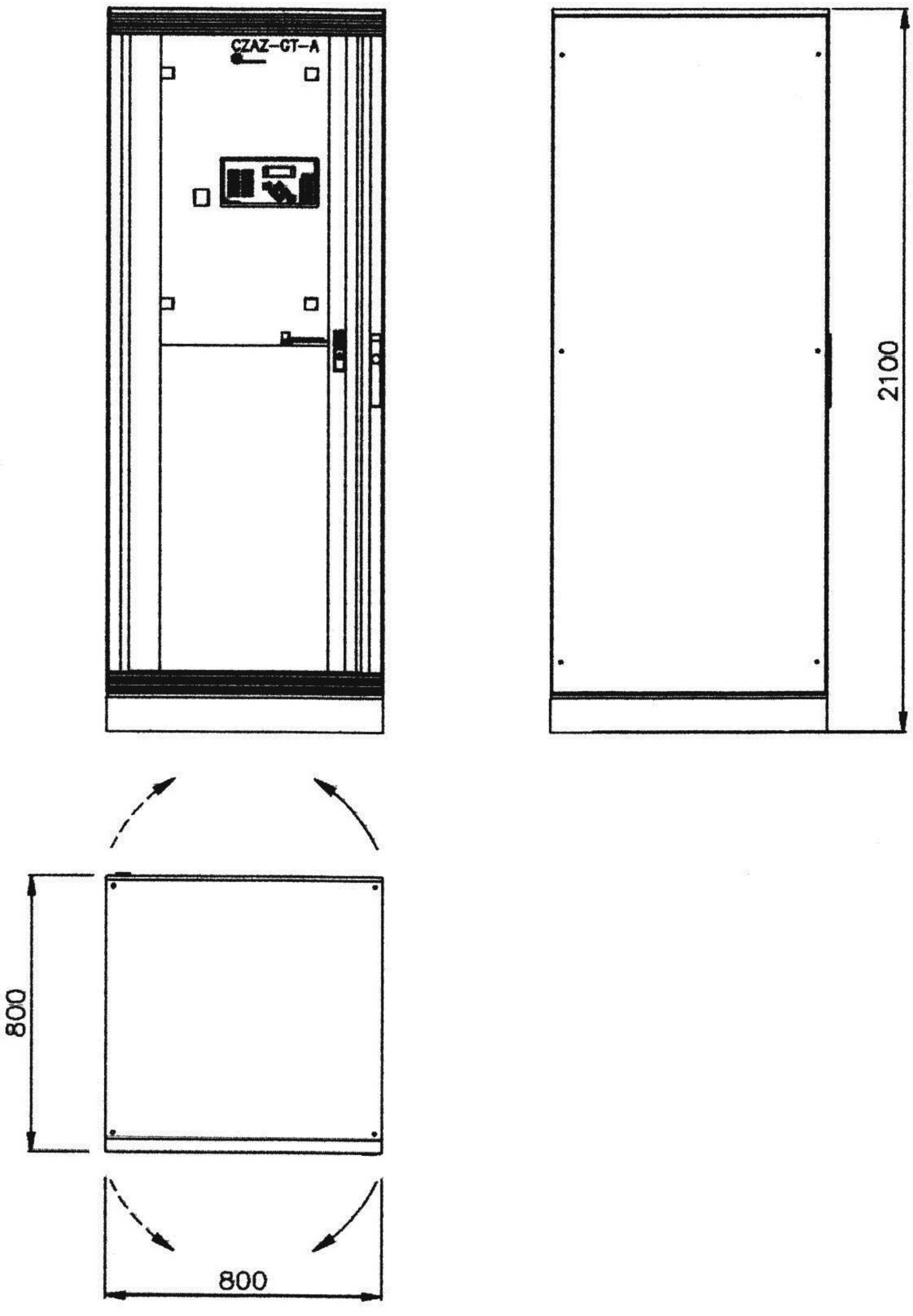


Fig. 14. CZAZ-GT multifunction relay (housed in the RITTAL DK 7080235 cabinet) – front, side and top view

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