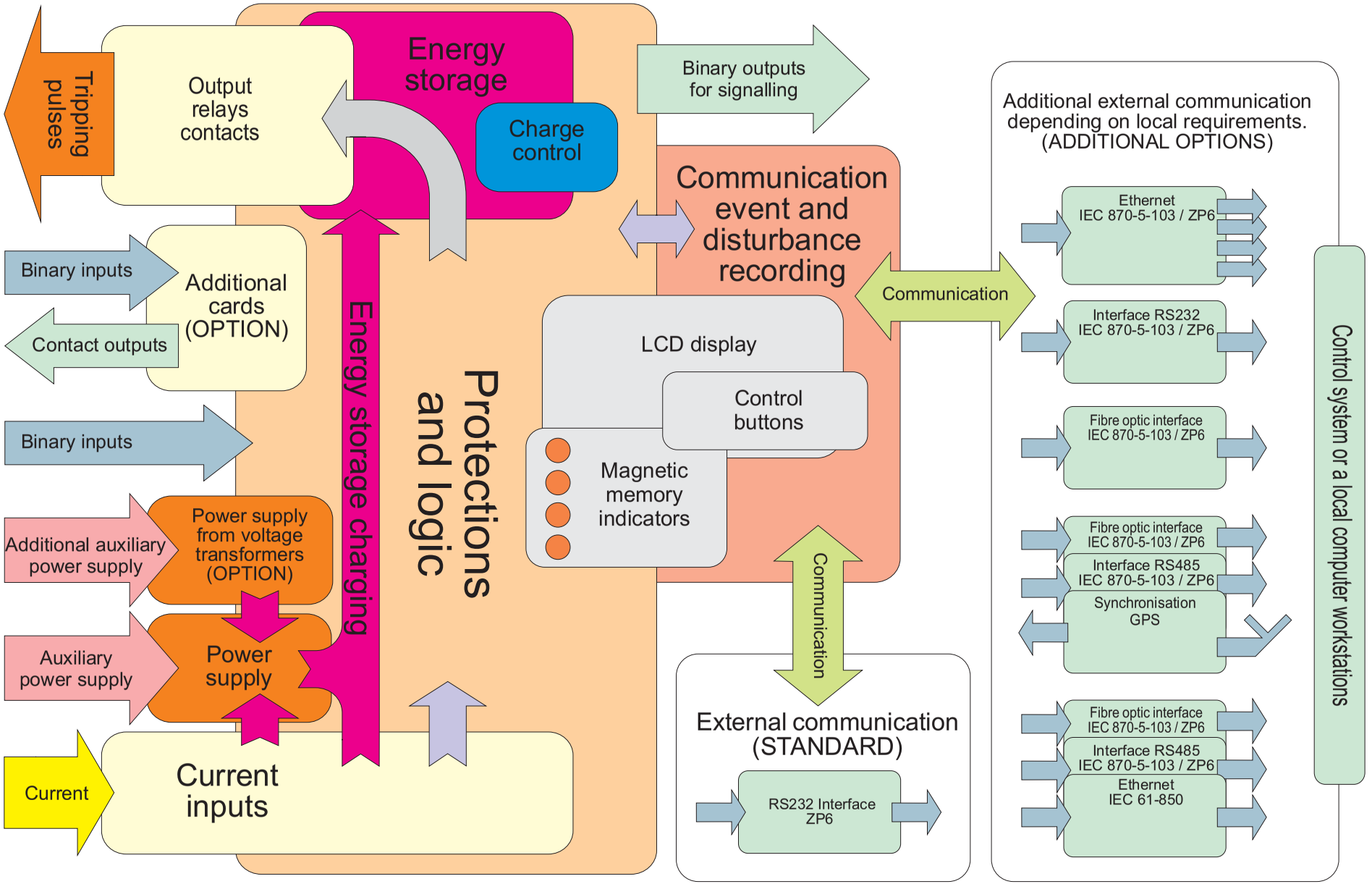
ZPrAE
Sp.z o.o.

AZT-9

AUTONOMOUS TRANSFORMER PROTECTION



Structural diagram of the AZT-9.

1. APPLICATIONS.

Autonomous AZT-9 protection device is dedicated to safeguard a transformer in emergencies, especially when primary protections of the transformer fail to operate due to loss of auxiliary voltage. It is possible since independent power supply circuits are used:

- power supply provided by current transformers for both the basic logic functions (protection, disturbance recorder, binary inputs, relay outputs, basic communication) and for energy storages used to generate an impulse for a switch off coil,
- external AC/DC power supply allowing for extension of the device's functionality with additional binary input cards, relay outputs and extended external communication (Ethernet, optical cable, …).
- optional auxiliary power supply provided by circuits of voltage transformers.

Application of this power supply solution allows it to work even in case of a loss of primary power supply. If AZT-9 detects a fault requiring the transformer to be switched off in order to protect it against destruction, the device sends a switch off impulse from an independent, internal, capacitor energy storage.

1.1. Basic features of the AZT-9 protection device:

- Overcurrent and earth-fault protections with one, two or three stages, with independent or dependent characteristics.
- Protection against asymmetric power supply and loss of phase.
- Undercurrent protection.
- Input of an external trigger of storages acting as breaker failure protection.
- Protection against oversaturation of instrument transformers (SAT).
- Twin energy storages allowing for operation with two circuit breakers (two coils) or in case of parallel collection allowing for increasing the impulse energy or sending two impulses within a set time interval (so-called re-trip).
- Internal event and disturbance recorder.
- Circuit breaker diagnostics: control of operation time, number of trip outs and a sum of currents tripped out.
- Device locking input.
- Communication with a monitoring system via IEC 61850 and 870-5-103 protocols, over optical cables or other method specified by the customer.
- Set of 8 configurable multicolour LEDs displaying information selected by the user from an internal list.
- Set of 4 configurable operation indicators with magnetic memory.
- Front panel with buttons and an LCD display for overview of operating parameters and setting basic configurations from the device's front panel.
- Optional power supply module for supplying additional power to the device from voltage transformers.
- Optional module of a test socket for device testing.
- Set of relay outputs for signalling operation and disturbance in operation of the device.
- Set of universal binary inputs
- The AZT-9 protection device is supplied with necessary software ( ) and full documentation in Polish required to design, perform independent configuration and facilitate device operation.

2. CONSTRUCTION.

The device was designed according to state of the art technology. The internal current and voltage elements, as well as the logic circuit of the protection device are fully digital.

The AZT-9 has a casing suitable for installation in 19” swing frames of cubicles. External circuits can be connected via connectors on the rear panel of the unit. An LCD display, signal LEDs and operation indicators with magnetic memory (allowing for reading of basic information even in case of complete lack of power supply to the device) are located on the front panel. Furthermore, on one side of the casing there is room for installation of an optional test switch with inspection sockets. Software supplied with the device makes configuration of the AZT-9 and its following operation easier. It provides the ability to monitor current status of the protection device on a computer screen, read data from the event and disturbance recorder and change the configuration of the AZT-9 if required. A 19”/3U/240 (483×133.5×245 mm) EURO housing made of chromate plated aluminium provides higher resistance to EMC interference. Additional space, approximately 55 mm deep, should be available behind the device for installation cables to be connected with multipin connectors.

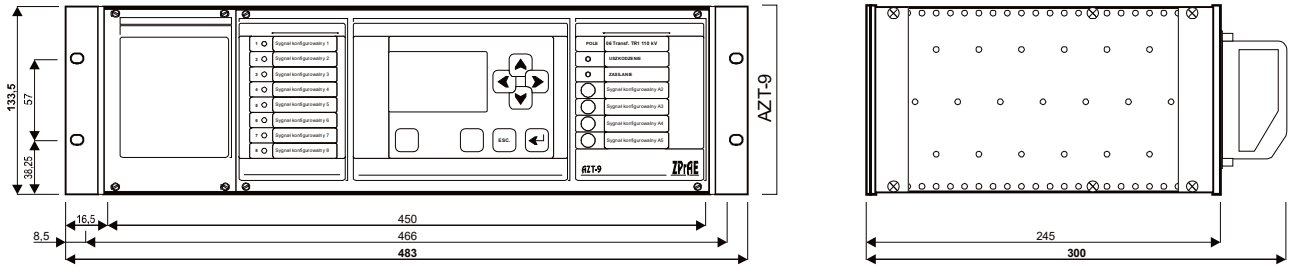


Fig. 2.1. External dimensions of the AZT-9 protection device.

2.1. Front panel.

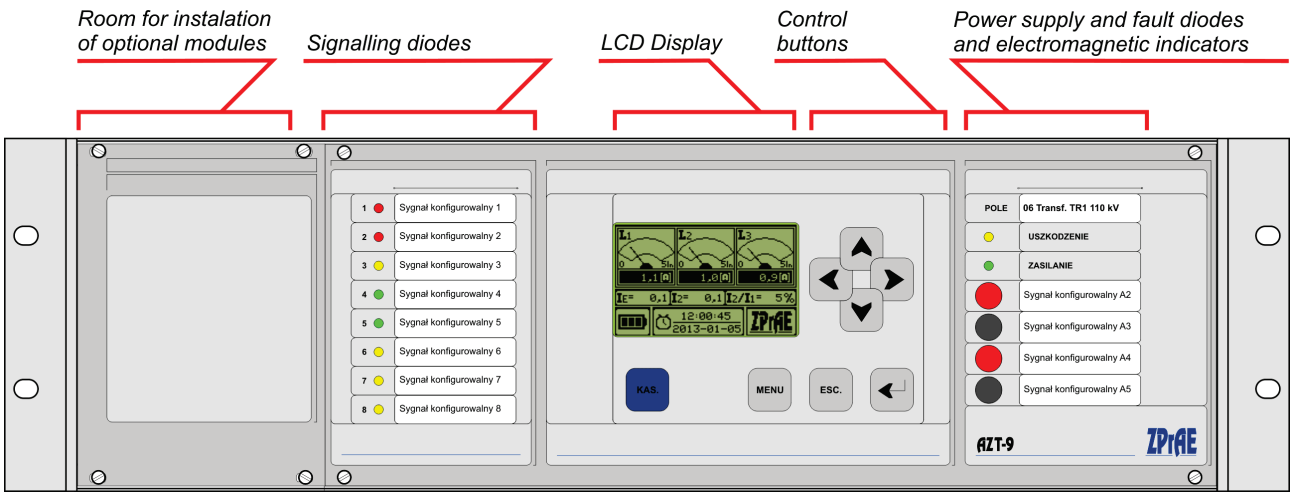


Fig. 2.2. Front panel.

2.2. LCD screen.

In the centre of the AZT-9 front panel there is a screen with overview of present values of measured currents, energy storage level and basic settings.

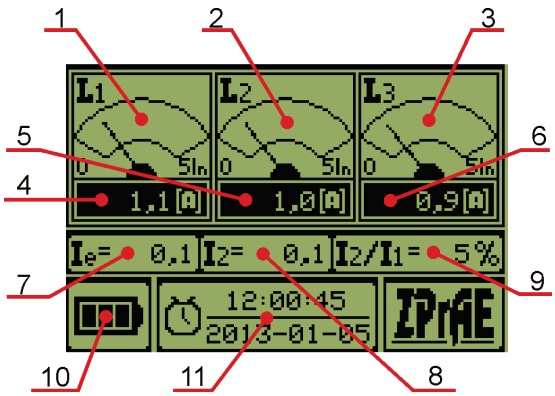


Fig. 2.3. Main screen overview

[1,2,3] - L1, L2, L3 current measurement tilt indicator
[4,5,6] - Present values of measured L1, L2, L3 currents
[7] - Present I_e ground fault current value
[8] - Present current value of the I2 negative sequence component
[9] - Percentage value of the negative sequence component to the positive sequence component I2/I1 ratio
[10] - Energy storage charge level
[11] - Present date and recorder time

2.3. Control buttons.

Buttons for control of the AZT-9 protection from the front panel are located next to the LCD display. Four buttons to the right are used to control an on-screen pointer; confirmation, menu access (MENU) and cancellation buttons (ESC.) are located below.

A separate blue button (DEL.) can be used to confirm the AZT-9 protection device is working and to delete alarms.

2.4. Power and fault LEDs.

On the right side of the housing there are two LEDs indicating the status:

- ***FAULT*** – yellow light in case of an internal fault of the protection device.
- ***POWER*** – green light if the device is powered from an auxiliary source, blue light if it is powered only from instrument transformers.

2.5. Operation indicators with magnetic memory.

Below the two signalling LEDs there are four indicators with magnetic memory allowing for reading recorded information even if there is completely no power supply to the device. The software provided with the AZT-9 protection device (or the control buttons) allow for selection of signals from the list available in the program. There is a description field next to the indicators. A signal description field of a single indicator is 42 mm × 10 mm (W×H). Signal descriptions can be printed on foil or paper and inserted under the transparent part of the front panel.

2.6. Signalling LEDs and signal description fields.

In this part of the front panel there are 8 signalling LEDs with description fields for identification with a suitable signal name. Multicolour super-bright RGB LEDs function as optical indicators. It is possible to use the software supplied with the AZT-9 protection device (or the control buttons) to select the signals from the list available in the program. The LED colour can also be selected from the available range: yellow, red, green, blue, purple. Next to the LEDs there are description fields. A description field for one LED is 42 mm × 10 mm (W×H). Signal descriptions can be printed on foil or paper and inserted under the transparent part of the front panel.

2.7. Rear panel and modules.

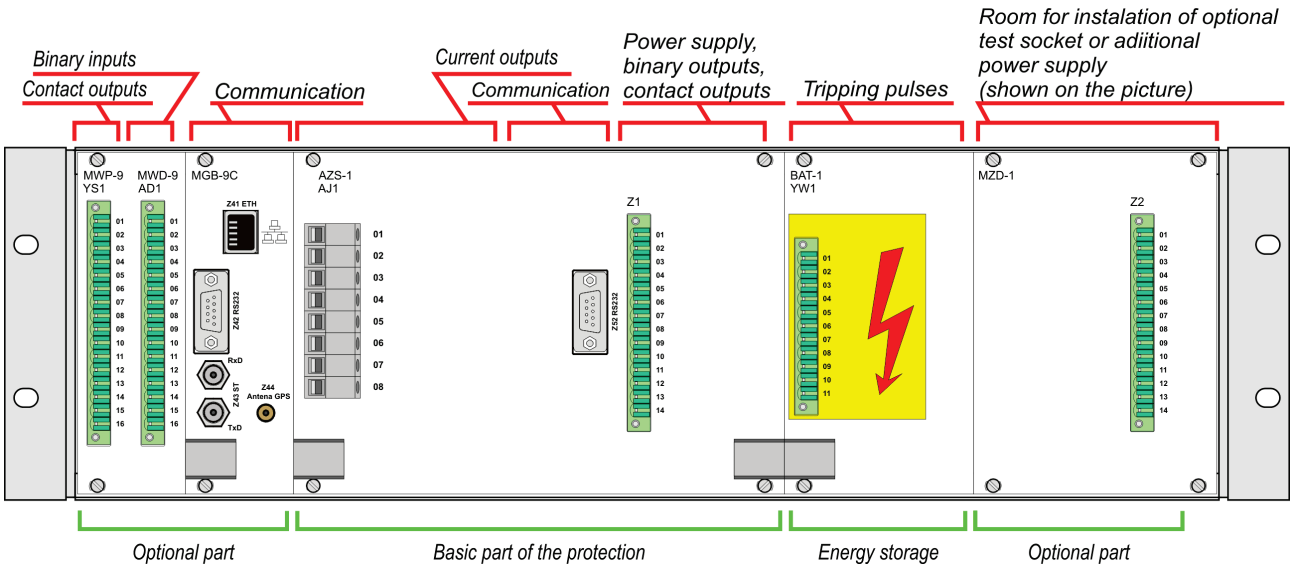


Fig. 2.4. Rear panel.

Card connectors for external connections are located on the rear panel. LgY cables are recommended for external connections. The protection device has current and binary inputs, contact outputs, power supply and external communication connectors. The output sending the impulse to the switch off coil is separate and specially marked. The impulse is generated with the energy from the energy storage.

WARNING! The energy storage is normally fully charged; therefore the module can be energized with 300 V DC even when the device is not connected to any power supply!

3. OPERATING PRINCIPLE.

The device is to be used for protecting transformers, outgoing feeders and busbars as a backup for primary protection devices.

The core function of AZT-9 is to provide delayed overcurrent phase (51P) and earth-fault protection (51N). In emergencies, if the primary protection devices do not shut off the overcurrent, the AZT-9 will generate a shutdown impulse using its own energy storage after a set delay. The AZT-9 does not require an additional auxiliary power supply to initiate the shut off impulse because it can be powered by measuring current transformers. The BAT-1 energy storage can store energy for several weeks allowing the device to be ready quickly in case of emergencies. If the energy storage is charged before a disturbance occurs the time required to start up the device and prepare it for operation is

less than 250 ms. "Cold start" (discharged energy storage) requires additional time (ca. 40 s) to charge energy storage before initiation of the shut off impulse.

3.1. Current inputs.

The current inputs module is divided into two sections: the measurement section with measuring current transformers and precise analogue-to-digital converters, and the power supply section with current transformers supplying power to the device.

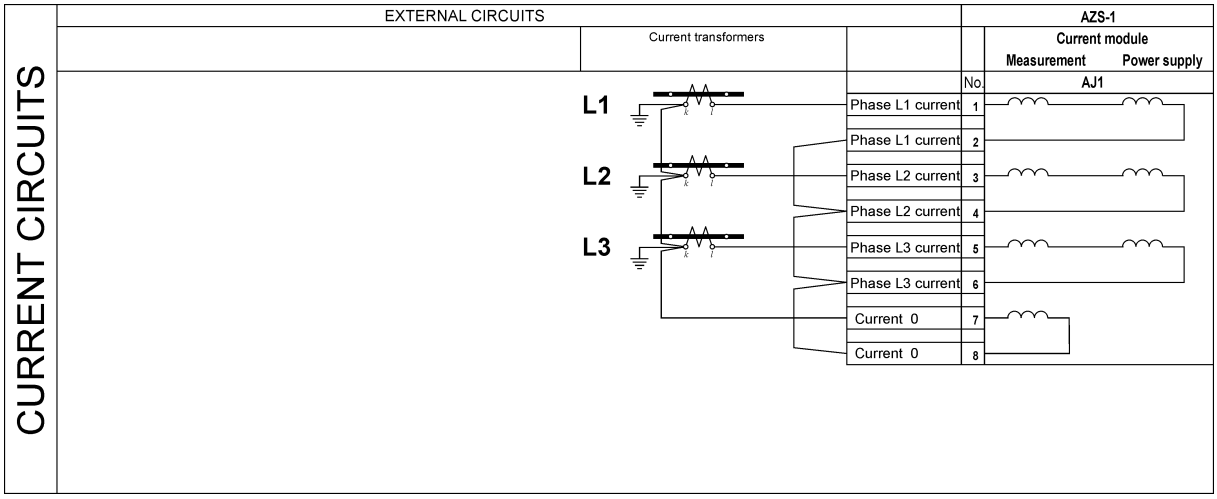


Fig. 3.1. Current circuits.

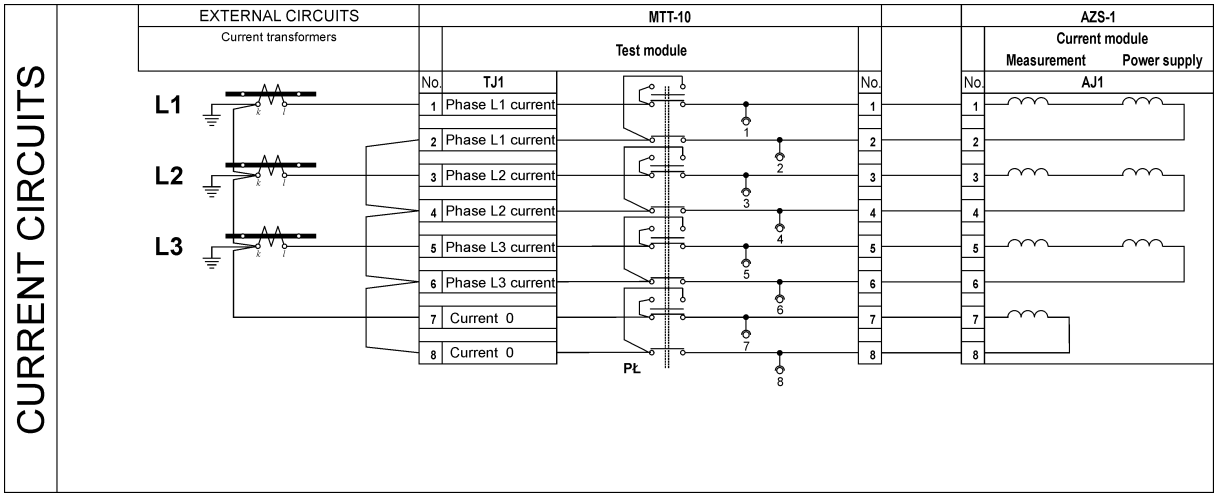


Fig. 3.2. Current circuits in a protection device fitted with a test module.

3.2. Shut off circuits.

To send shut off impulse the AZT-9 uses energy stored in twin energy storage. Combined with independent power supply from current circuits (powering the protection device, as well as charging the energy storage) this allows for operation of the protection even in case of complete lack of auxiliary power supply. The recommended setup consists of two switch off circuits working with a separate third switch off coil. However, shut off circuits sending impulses to CW1 or CW2 coils can be installed. That case requires all activation impulses to be separated with depletion diodes. Since the protection device has two energy storages and two shut off impulse outputs the energy can be increased, double tripping pulse (re-trip) is possible or impulses can be sent to two independent circuit breakers.

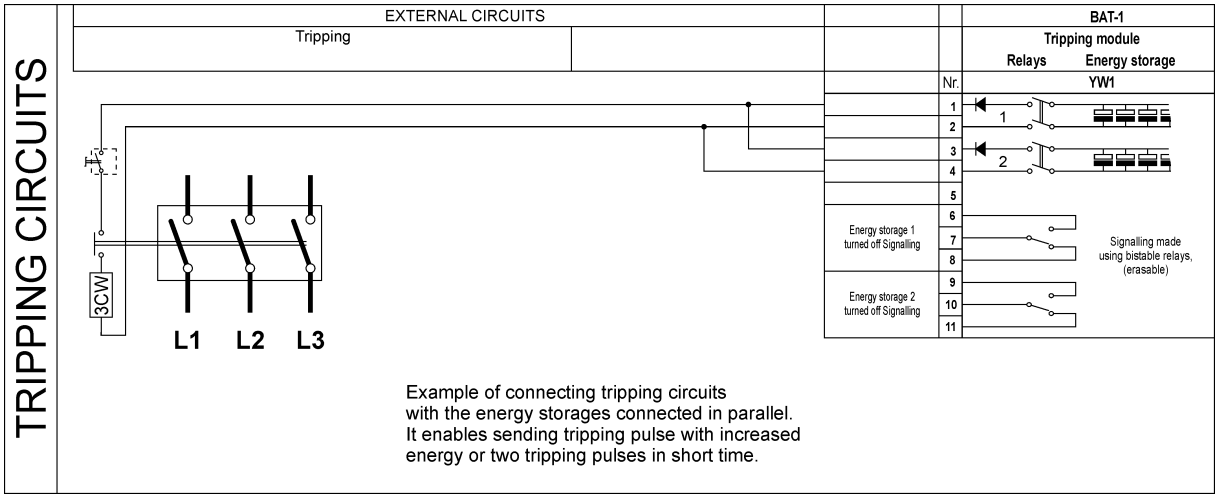


Fig. 3.3. Tripping circuits with the energy storages connected in parallel.

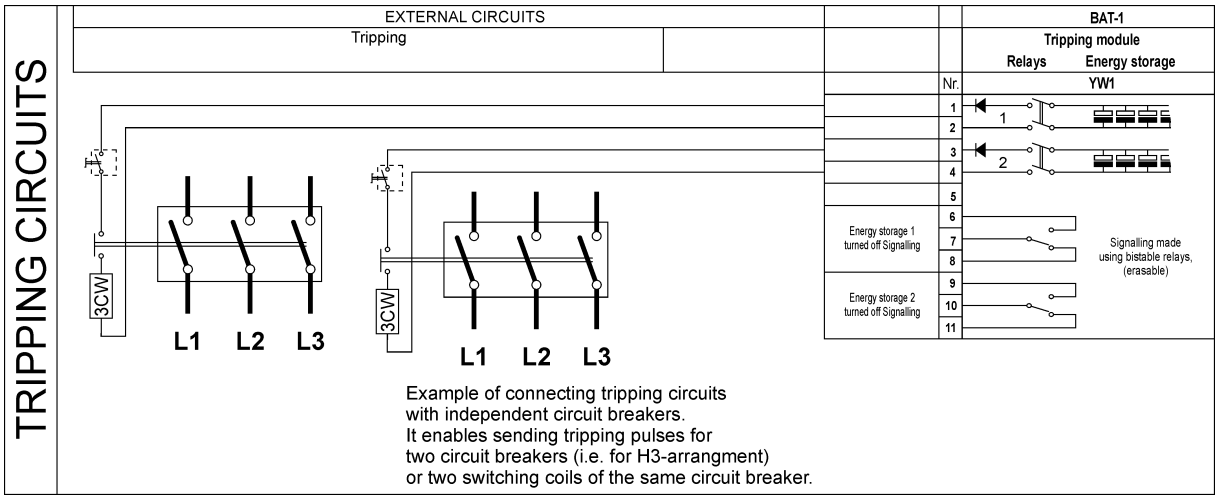


Fig. 3.4. Tripping circuits of two independent circuit breakers.

The BAT-1 shut off module has two outputs of relays switching when shut off impulses from energy storage No. 1 and no. 2 are sent. Use of latching relays makes them independent of any power supply after operation of the protection device. The signal can be reset after auxiliary voltage or current transformer power reappears.

If the optional test module is used, the shut off circuits are switched from external circuits to the external test module checking correct operation of energy storage during the test.

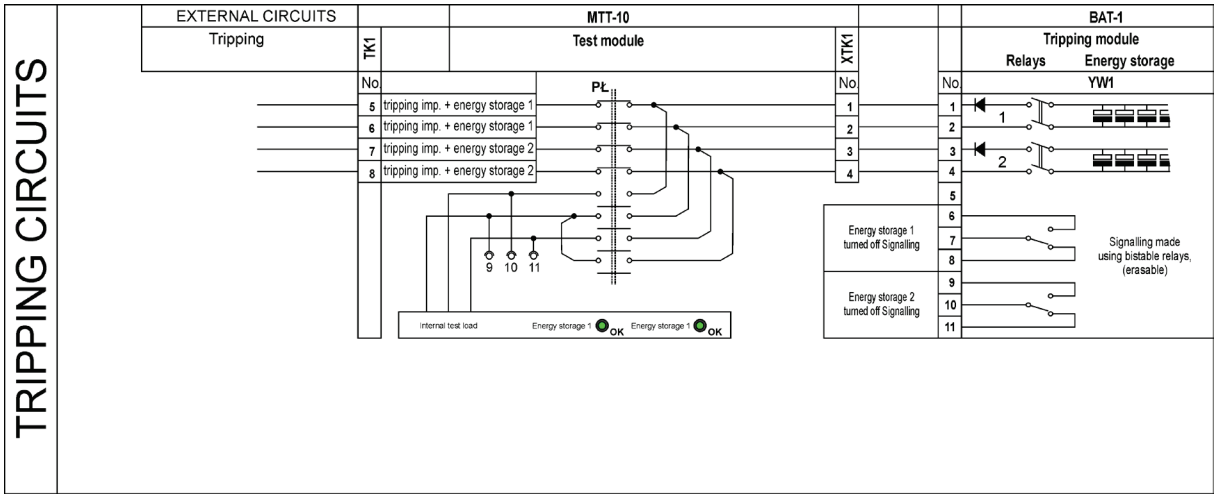


Fig. 3.5. Shut off circuits in the protection device with the test module.
External circuits as in figures 3.3. or 3.4.

3.3. Test of the protection device.

The AZT-9 protection device can be additionally equipped with the MTT-10 test module. It can be used for periodical testing of the AZT-9 protection device and condition of energy storage elements without modification of the device's cabling. Initiating the testing procedure results in sending shut off impulses to the internal load elements of the MTT-10 module equivalent to load provided by 2 × 300 W coils. Time of the shut off signals is used to determine condition of particular sections of the storage. If the storages are operational "Storage 1 OK" and "Storage 2 OK" LEDs will light up for ca. 7 s after completion of the procedure. If the storages are damaged or their capacity falls below 70% of the nominal capacity the LEDs confirming good condition of the storages will not light up after completion of the test procedure.

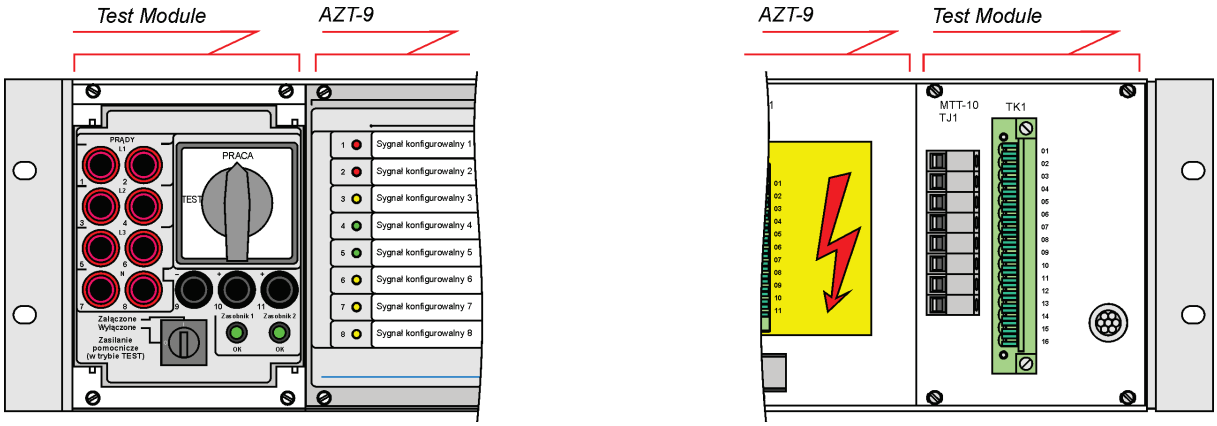


Fig. 3.6. Front and rear panels of the MTT-10 module

3.4. Auxiliary power supply, contact outputs and binary inputs.

The AZT-9 device was designed assuming prioritization of power consumption limitation to the minimum so it can work while it is powered only from the circuits of current transformers. Therefore the number of inputs and outputs integrated on a single card with a power supply unit is limited to the necessary minimum. Connector Z1 is used to connect auxiliary power and includes:

contact outputs:

- AZT working / AZT defective,
- AZT energized / AZT unenergized,

and binary inputs:

- shut off lock (if voltage is connected the AZT will not send shut off impulses),
- external energize signal P_{BFP} (e.g. by a breaker failure protection or the transformer's temperature breaker)

The last function acts as a local breaker failure protection of the specific feeder. Sending shut off impulses from primary protection and elapse of delay time t_{BFP} if the I_{BFP} criterion is met will cause the AZT-9 protection device to operate and send a shut off impulse from energy storage. This can be compared to the so called re-trip of breaker failure protection circuits.

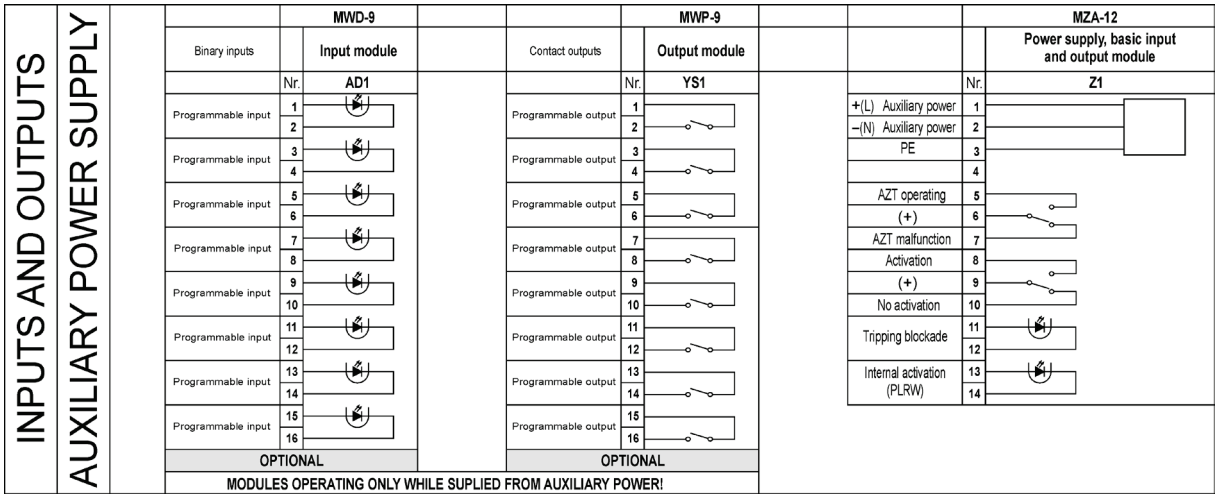


Fig. 3.7. Auxiliary power supply, contact outputs and binary inputs.

To expand capabilities of the AZT-9 protection device beyond the basic functions additional AD1 input card and YZ1 output card have to be added. However, they need auxiliary power supply to work. Both the inputs and the outputs can be configured with the software supplied with the AZT-9.

An optional MZD-1 card provides the possibility of connecting additional power supply to the device; it allows the device to be powered from circuits of voltage relays.

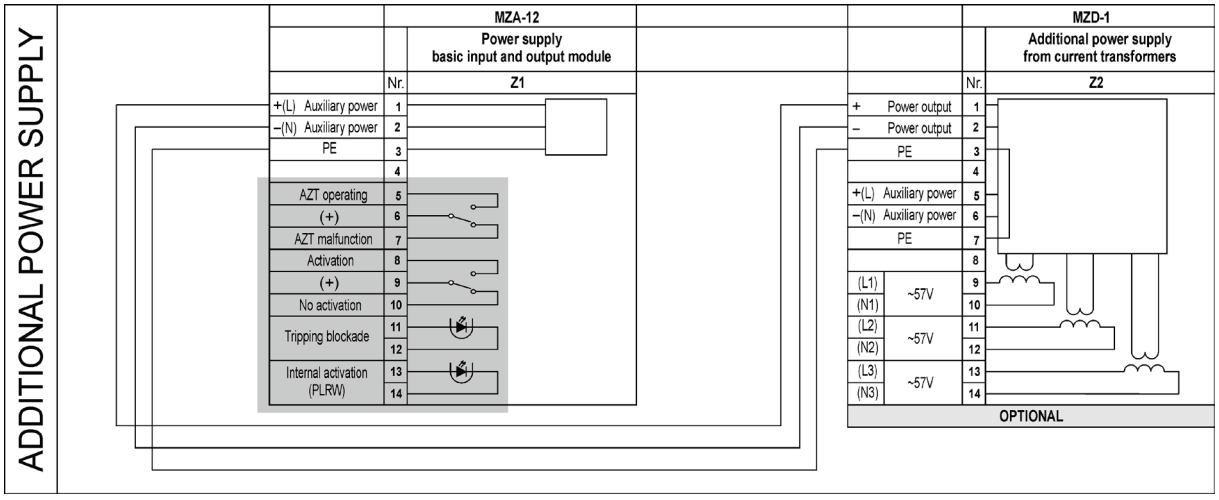


Fig. 3.8. Additional auxiliary power supply.

If the optional test module is used auxiliary power supply can be disconnected from the device during the test to check autonomous power supply provided to the device from current circuits.

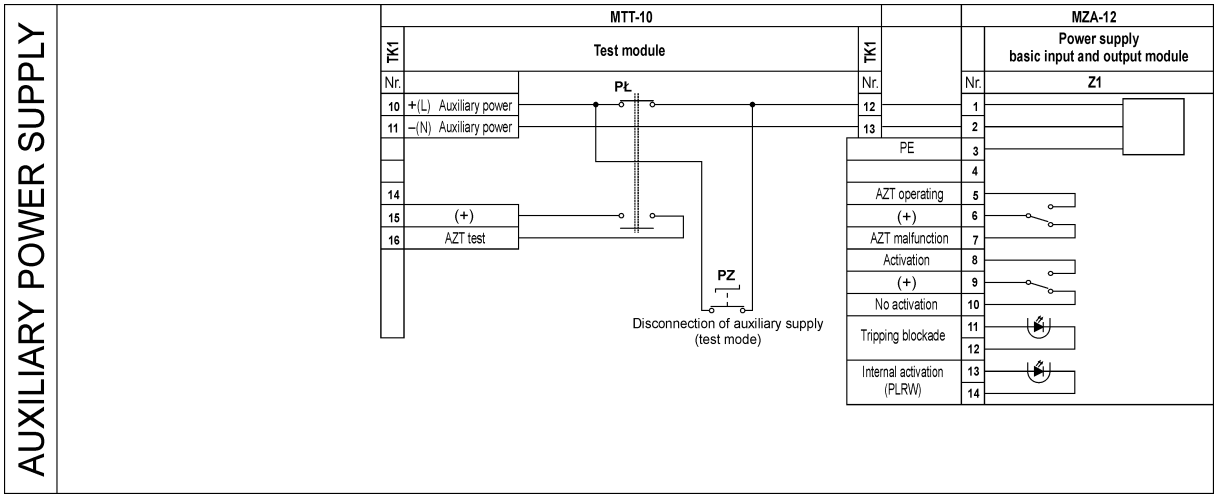


Fig. 3.9. Auxiliary power supply in a protection device with the test module.

3.5. External communication.

Configuration can be performed and monitored via a RS232 (Z52) connector included as standard. A proprietary protocol is used for communication from the level of software provided with the AZT-9. External communication capabilities can be expanded through installation of the MGB-9 hub module available in several versions. Depending on requirements it comes with RS232, RS485, optical or Ethernet ports (see the table below). As standard each communication channel simultaneously supports the following protocols: proprietary ZPrAE (ZP6) and IEC-60870-103. The F1 version of the MGB-9 module allows for communication over the IEC-61850 protocol. The MGB module requires auxiliary voltage to work.

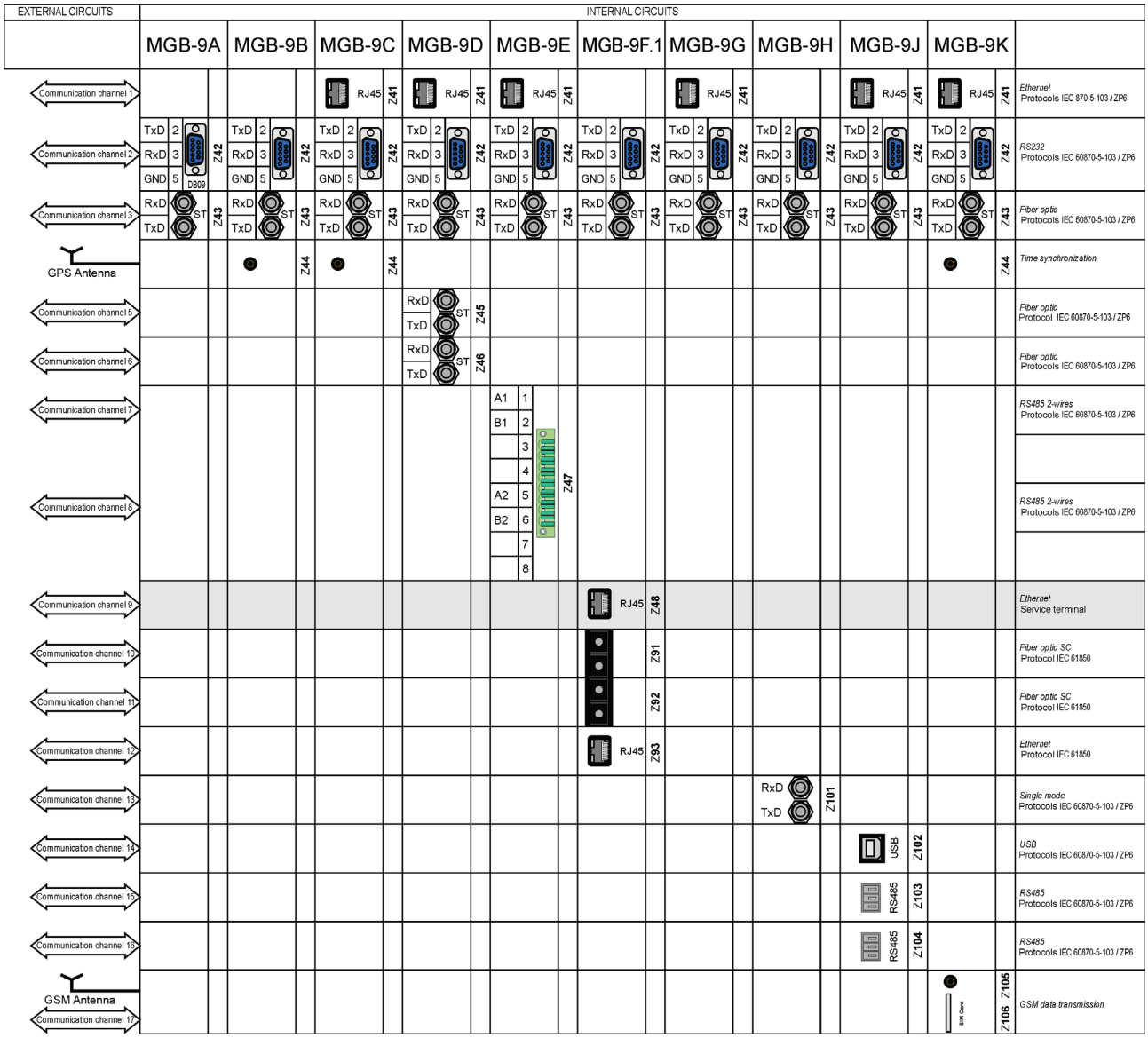


Fig. 3.10. Communication.

3.6. Event recorder

Cache memory of the recorder allows for archiving up to 1000 events at 5 ms resolution. Events are generated by the AZT logic module and stored in non-volatile memory. If the AZT device is equipped with an MGB concentrator module, generated events are rewritten into concentrator's main memory. The MGB concentrator allows for saving 10000 events. In case of too many recorded events the oldest data will be overwritten.

Data from the recorder can be sent to a primary control and monitoring system.

3.7. Disturbance recorder

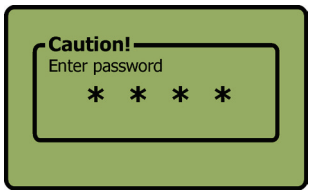
The AZT-9 protection device is equipped with a disturbance recorder recording analogue data, protection status and binary states from all input and output modules of the device at the frequency of 1 kHz. It enables in-depth analysis of the cause and working conditions in case of operation. When the recording is triggered an impulse is generated by one of 8 configurable channels of the recorder. Each channel can send the signal from the logic of the AZT-9 device directly or as a negated signal. Total time of single recording and post-trigger time of recording can be configured in a range from 0.6 to 60 s. The recorder has a non-volatile memory that allows for saving 1- 210 records depending on the time of a single recording. Trigger time and proper pre- and post-trigger operation time of the device is saved when the recording is triggered. If the recorder runs out of space it starts overwriting the oldest records. Records are saved in a universal COMTRADE format. The device is supplied with software for viewing and analysing the records.

4. CONFIGURATION OF THE DEVICE FROM FRONT PANEL

All settings of the AZT-9 protection device can be remotely configured with proper ZPrAE Edit software or using function buttons on a front panel. To view or change the current settings go to main menu by pressing MENU button. The following groups of settings are available in the main menu:

Use the direction buttons ◄,► to switch between particular groups. To select a function that is in a given group of settings place the cursor (a frame) using ◄, ► buttons and confirm with ↵ button. When the parameters of a selected function of the AZT-9 protection device are displayed, select a given parameter by placing the cursor on it using ▲, ▼ buttons and press ↵. The frame showing the selected parameter will start blinking. It indicates that the value can be changed. By using direction buttons set a proper value of the selected parameter. To confirm the changes press ↵ button. To cancel the change press ESC. In this case the frame will stop blinking and the selected parameter will be set to the value that was previously saved. To go to the other group of the settings go back to the main menu using ESC. button. To save new values of parameters press ESC. button in the main menu. You will then be prompted to save the changes.

After pressing ↵ button a screen for entering the password will be displayed.



Use ◄, ► arrows to move between the password characters; to change the value of a given character use ▲, ▼ buttons. Confirm the password using ↵ button. If you do not want to save the changes press ESC. button or leave the device and do not press any buttons for 60 s.

4.1. Configuration of phase, earth-fault and negative sequence protection

Phase, earth-fault and negative sequence protections have three independently configured stages I, II, III.
The following parameters can be set for each stage:

- **Mode:** - protection mode (switched off, undercurrent, overcurrent, overcurrent with independent DMT characteristics, overcurrent with dependent IDMT characteristics),
- **Energising threshold**: - value of trigger current activating selected threshold,
- **Time tdel:** - time delay between energizing of protection and activation of a given threshold,
- **Time tres:** - reset time, time to the reset of operation time delay after energising signal disappears. In case of operation and disappearance of energising signal – release time.

If the selected protection stage operates with DMT characteristics independent from the value of current, the delay time “tdel” and reset time “tres” is given directly in seconds.

For a selected mode with dependent IDMT characteristics delay time is calculated based on the following mathematical equation:

$$t = TMS * \{ k/[(I/I_S)^{\alpha} -1] + c \}$$

where:
t – time between energising and trigger of selected protection stage,
I – present value of measured current,
I_S – set energising current of a given stage,
α, k, c – constants defining a given characteristic,
TMS = tdel [s] – multiplier of a given characteristic.

Table below shows the values of constant α, k and c for available IDMT characteristics. Values of constants, except for the first characteristic, are defined in accordance with the requirements of IEC, IEEE and C0 standards.

IDMT characteristics	k	α	c
Extremely Inverse ZPrAE	80	3	0
Standard Inverse IEC	0.14	0,02	0
Very Inverse IEC	13.5	1	0
Extremely Inverse IEC	80	2	0
Long Time Inverse IEC	120	1	0
Moderately Inverse IEEE	0.0515	0.02	0.114
Very Inverse IEEE	19.61	2	0.491
Extremely Inverse IEEE	28.2	2	0.1217
Inverse C08	5.95	2	0.18
Short Timer Inverse C02	0.02394	0.02	0.01694

Reset time for characteristics that comply with IEC standard is defined the same as for DMT independent mode. For characteristics that comply with IEEE and CO standards reset time is calculated based on the following equation:

$$t = RTMS * \{ t_r/[(1-(I/I_S)^{\alpha}]\}$$

where:
t – time between the disappearance of energising signal and resetting of the calculated delay time,
I – present value of measured current,
I_S – set energising current of a given stage
α, t_r – constants defining a given characteristics,
RTMS = tres [s] – multiplier of a given characteristics.

Table below shows the values of constant α and t_r for available IDMT characteristics to be applied in the equation for reset time.

IDMT characteristics	t_r	α
Moderately Inverse IEEE	4.85	2
Very Inverse IEEE	21.6	2
Extremely Inverse IEEE	29.1	2
Inverse C08	5.95	2
Short Timer Inverse C02	2.261	2

4.2. Control of current circuit continuity (CTS)

Control of current circuit continuity is performed by measuring negative sequence to positive sequence ratio. This solution makes the measurement result insusceptible to the values of current in measuring circuits. When values of current in three phases are similar the ratio of negative sequence I2 to positive sequence is close to 0. In case of conductor damage (current loss in one of the phases) this ratio increases rapidly. It makes it possible to find the conductor damage and generate an alarm on a properly configured relay or trigger the protection.
The following parameters can be set to execute CTS:

- **Threshold I2/I1** – energising threshold for negative sequence component expressed as a percentage of positive sequence component.
- **Time tdel** – time delay between energising and activation of protection.

4.3. Breaker failure protection.

The AZT-9 protection device is equipped with an input that enables triggering of energy storages by an external signal. The input is active irrespective of the supply mode (by instrument transformers, auxiliary power supply). Thanks to the additional current criterion and configuration of delay time the input can perform a function of breaker failure protection.
Breaker failure protection can be set to the following values:
- Energising threshold – current value from current criterion necessary to activate breaker failure protection,
- Time tdel – time delay between energising the input (when the current criterion is met) and activation of protection,
- Time tres – reset time, time to the reset of operation time delay after energising signal fades out. In case of operation and disappearance of energising signal – release time.

4.4. Detection of oversaturation of an instrument transformer (SAT)

Detection of oversaturation of an instrument transformer operates based on the change of curve shape at the instrument transformer output in case of oversaturation. After 3 ms from the detection of maximum amplitude of a signal a window of oversaturation detection is activated. Detection of oversaturation of the instrument transformer starts if the oversaturation detection window is below the half of the maximum value of amplitude and when the change of a signal in the oversaturation detection window is lower than ¼ of the maximum value of amplitude.

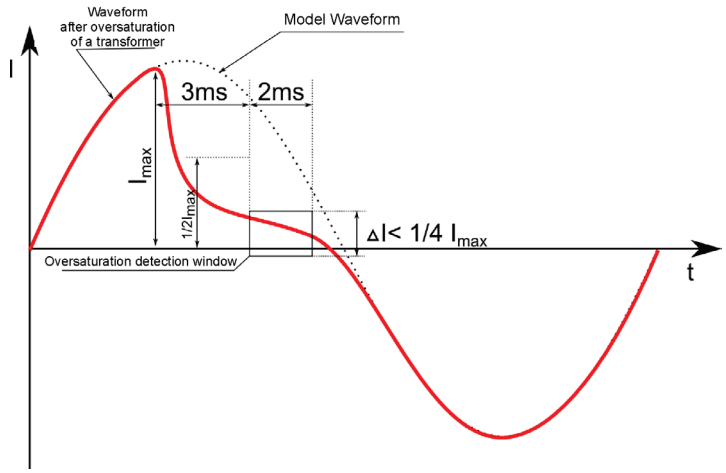


Fig. 4.1. Example of instrument transformer oversaturation curve.

Detection of instrument transformer oversaturation has hard-set parameters:
- Minimum level of oversaturarion detection - $I > 2\ I_N$,
- Delay time – 150 ms,
- Length of an output impulse– t > 20 ms.

4.5. Configuration of energy storage cards (BAT) and a power supply unit card (MZA)

Each of the protections and its individual thresholds can be used to trigger main energy storage and/or as an information signal for configured relays of an optional MWP card.
Group of settings for BAT, MZA cards allows for selecting particular protections triggering the energy storages or activating the relay of an energised AZT.
Trigger of section 1 and trigger of section 2 may be activated by the following signals:
- Operation of phase protection stage I,
- Operation of phase protection stage II,
- Operation of phase protection stage III,
- Operation of earth-fault protection stage I,
- Operation of earth-fault protection stage II,
- Operation of earth-fault protection stage III,
- Operation of negative sequence protection stage I,
- Operation of negative sequence protection stage II,
- Operation of negative sequence protection stage III,
- Logic gate output 1 active,
- Logic gate output 2 active,
- Operation of protection due to exceeded temperature (option),
- Operation of protection due to lack of continuity of current circuits (CTS),
- Operation of protection by breaker failure protection input (when the current criterion is met),
- Operation of detection of oversaturation of the instrument transformer (SAT).

The PK-1 relay in the MZA module (AZT-energised) can be activated by one of the following signals:
- Energising of phase protection stage I,
- Energising of phase protection stage II,
- Energising of phase protection stage III,
- Energising of earth-fault protection stage I,
- Energising of earth-fault protection stage II,
- Energising of earth-fault protection stage III,
- Energising of negative sequence protection stage I,
- Energising of negative sequence protection stage II,
- Energising of negative sequence protection stage III,
- Logic gate output 1 active,
- Logic gate output 2 active,
- Energising of protection due to exceeded temperature (option),
- Energising of protection due to lack of continuity of current circuits (CTS),
- Energising of protection by breaker failure protection input,
- Energising of detection of oversaturation of the instrument transformer (SAT).

For section 2 of the energy storage additional delay time can be defined, allowing for generating two switch-off impulses in defined time intervals.

Detection of instrument transformer oversaturation has a fixed time delay of 150 ms between energising and operation that allows for filtering accidental disturbances that may occur during switching the transformer on.

4.6. Configuration of an MWD input card

The following parameters can be set for the binary input card, MWD:

- **Time t_on**: delay time from the moment a signal is sent to the input until activation of its logic,
- **Time t_off**: hold time from the disappearance of energising signal until deactivation of logic,
- **Input type**: input mode AC or DC (for AC mode additional filtering time needs to be taken into account – 20 ms).

The binary input card (MWD) is active only when auxiliary power supply is connected. Logic signals from the MWD card may be used to introduce various types of additional signalling functions or to trigger the energy storages by external signal. Each of the inputs can be used to introduce additional control functions (continuity of circuits, read of circuit breaker status, etc.) by sending a logic signal from a binary input to the relevant configurable LED, magnetic indicator or configurable relay.

4.7. Configuration of a relay card (MWP)

Group “MWP relays” settings allows for configuring the operation mode of each available relay of the MWP card. The following parameters can be set for individual relays:

- **Active:** allows for switching the selected relay on or off,
- **Reset:** defines a way of releasing the relay after the energising signal disappears (after selecting ”manual” the relay is sustained until the operator resets it, in case of “automatic” the relay is released when the energising signal disappears),
- **Negated signal: :** allows for negating the status of the signal energising the relay,
- **Signal No.:** allows for selecting a signal from the list of available logic signals that is used to energise the configurable relay.

List of available logic signals is described in section 7.

The relay output card (MWP) is active only when auxiliary power supply is connected to the device.

4.8. LEDs.

Group “LEDs” settings allows for setting 8 configurable LEDs fitted on the front panel of the device. The following parameters can be set for each LED:

- **Active:** allows for switching the selected LED on or off,
- **Colour:** allows for selecting the LED colour,
- **Type:** allows for setting light modes: continuous, pulsating,
- **Reset:** defines a way of turning off the LED after the energising signal disappears (after selecting “manual” LED will be turned on until the operator resets it, in case of “automatic” LED is reset when the energising signal disappears),
- **Negated signal:** allows for negating the status of the signal energising the LED,
- **Signal No.:** allows for selecting a signal from the list of available logic signals that is used to light the LED.

List of available logic signals is described in section 7.

4.9. Configuration of magnetic indicators (WSM)

Group “WSM indicators” settings allows for setting of 4 magnetic indicators fitted on the front panel of the device. The following parameters can be set for each indicator:

- **Active:** allows for switching off the selected indicator on or,
- **Reset:** defines a way of “switching off” the indicator after the energising signal disappears (after selecting “manual” the indicator will be switched on until the operator resets it, in case of “automatic” the indicator is reset when the energising signal disappears),
- **Negated signal:** allows for negating the status of the signal energising the indicator,
- **Signal No.:** allows for selecting a signal from the list of available logic signals that is used to set the indicator.

List of available logic signals is described in section 7.

4.10. Configuration of logic gates

The AZT-9 protection device has two 8-input logic gates enabling the extension of protection functionality. Each of the gates can work as a sum or conjunction and gate input can be used as a trigger of energy storage, energiser of relays, LEDs, magnetic indicators or as a signal to the input of the second gate. The following parameters are used to configure the gates:

- **Type:** defines the logic function carried out by the gate (OR, AND),
- **Number of inputs:** enables determining the number of active gate inputs (max. 8),
- **Negated input:** allows for negating individual gate inputs,
- **Signal No.:** allows for selecting a signal from the list of available logic signals that is sent to the individual gate inputs.

List of available logic signals is described in section 7.

4.11. Configuration of a disturbance recorder

Group of “Recorder” settings is used to configure the operation of a fast changing curves’ recorder. The recorder allows for recording samples of measured currents L1, L2, L3, N, and 64 states of internal logic at sampling frequency of 1 kHz. It enables a detailed analysis of the disturbance and identification of the device status when the disturbance occurred, before the disturbance and after ATZ-9 operation. The following parameters are used to configure the recorder:

- Total time of recording,
- Post-trigger recording time.

8 configurable channels can be used to trigger the recorder. For each channel the following parameters can be set:

- **Active:** activates or deactivates the channel,
- **Negated signal:** allows for negating the status of the signal triggering a given channel,
- **Signal No.:** allows for selecting a signal from the list of available logic signals used to trigger a given channel.

List of available logic signals is described in section 7.

Number of recorded disturbances depends on the recording time set. For 0.6 s setting a maximum number of recorded curves is 210. One record is possible in case of 60 s.

WARNING! Change in the recording time deletes automatically the previous records.

4.12. Signalling of circuit breaker inspection

The AZT-9 protection device makes it possible to maintain the state of full readiness of the circuit breaker thanks to the built-in control functions that improve its maintenance. Maintenance functions of the circuit breaker include: counting of the number of trip outs, measurement of circuit breaker time, cumulative sum of the values of tripped out currents for individual phases, cumulative sum of the square of the values of tripped out currents for individual phases.
The following parameters can be set in the group of settings related to the maintenance of the circuit breaker:

- Maximum number of trip outs,
- Maximum time of circuit breaker opening,
- Maximum sum of currents in a given phase,
- Maximum sum of the square of the currents in a given phase.

Internal logic signal is assigned to each setting. It is activated when the controlled parameter exceeds the set value.

Generated logic signal can be sent to a configurable relay, LED, magnetic indicator or logic gate input to warn about a malfunction of the circuit breaker or required maintenance.

4.13. Configuration of the AZT device system.

Group of “AZT configuration” settings allows for setting of the following parameters:

- **Change password** – allows for entering a password that limits the access to the device configuration function,
- **Set time** – allows for setting a local time of the AZT-9. If an MGB module is connected relay time is synchronised automatically with the time set in the MGB module.
- **Optional modules** – enables support for optionally connected modules.

4.14. Energy storage test.

If the AZT-9 device is equipped with an optional MTT-10 test module it is possible to check the energy storage condition directly from the device panel.

To perform the test change the position of the main MTT-10 module switch into the "TEST" position. In this position the outputs of energy storages are disconnected from the switch off coil of the circuit breaker and switched over to an external load of MTT-10 module which prevents accidental operation of the circuit breaker during the test.

After selecting the "Perform storage test" option and pressing ↵ button a message will be displayed which indicates that it is necessary to change the position of the main MTT-10 module switch into TEST position and enter the password. A window asking to confirm the energy storage test will then be displayed. Activation of storages takes place after confirming the message and holding down ↵ button for 5 seconds. If the condition of storages is good "Storage 1 OK" and "Storage 2 OK" LEDs will be on after the test is completed. If the condition of any storage is bad a respective LED will remain off.

Thanks to the test connectors on the front panel which are connected to current inputs (connector no. 1…8) and storage outputs (connector no. 9…11) the MTT-10 module enables performance of extensive tests of protection functions without the need to modify cabling of ATZ-9 device. In the "TEST" position external current circuits are closed and the test terminals of MTT-10 module are connected to the measurement current inputs of the protection device. Thanks to the additional switch "auxiliary power supply" at the bottom part of the MTT-10 module it is possible to disconnect the auxiliary power supply to check the autonomous power supply of the device using current circuit of the testing device.

Warning!

Execution of energy storage test without the MTT-10 module installed or its execution in the "OPERATION" position will lead to the actuation of the main circuit breaker.

5. UTILITY SOFTWARE

Together with the AZT-9 protection device the user receives **ZPrAE-EDIT** software for its configuration and operation as well as **iREC** software for presenting and analysing the records of disturbances in electrical power systems. Installation software is provided on CD.
Software allows for:

- reading and previewing recorded events (binary signals),
- reading and presenting recorded events (analogue and binary signals),
- displaying the device status,
- previewing and editing protection settings,
- configuring device's signalling LEDs and reading their current status,
- configuring signalling and auxiliary relays in the device and reading their present status.

5.1. Installation and launching the software

To start the installation launch the SETUP.EXE file and then follow the instructions given by the installation program. Files necessary for the program to work will be copied to the computer and a default folder for the events in a given facility (it can be selected during installation), where data files copied from device memory will be saved (with *.ZP6 extension) will be created. Depending of the Windows version the default folder will be located as follows:
- for Windows XP the folder in the following location:
C:\Documents and Settings\All Users\Dane aplikacji\ZPrAE\Dane
- for Windows Vista/7 the folder in the following location:
C:\ProgramData\ZPrAE\

After installation is complete a shortcut to ZPrAE EDIT software will be added in the **Programs** menu in the **ZPrAE Sp. z o.o.** folder.

5.2. Start working with the ZPrAE - EDIT software

Software can be launched from the **ZPrAE Sp. z o.o.** folder in the START menu by selecting the **ZPrAE EDIT** file or by launching the **ZPrAE EDIT.exe** executable file (in the installation folder). After the software is launched the main window will be displayed; it can be used to view event recorder contents or to access more windows to view operating status or to configure the AZT-9 protection device.

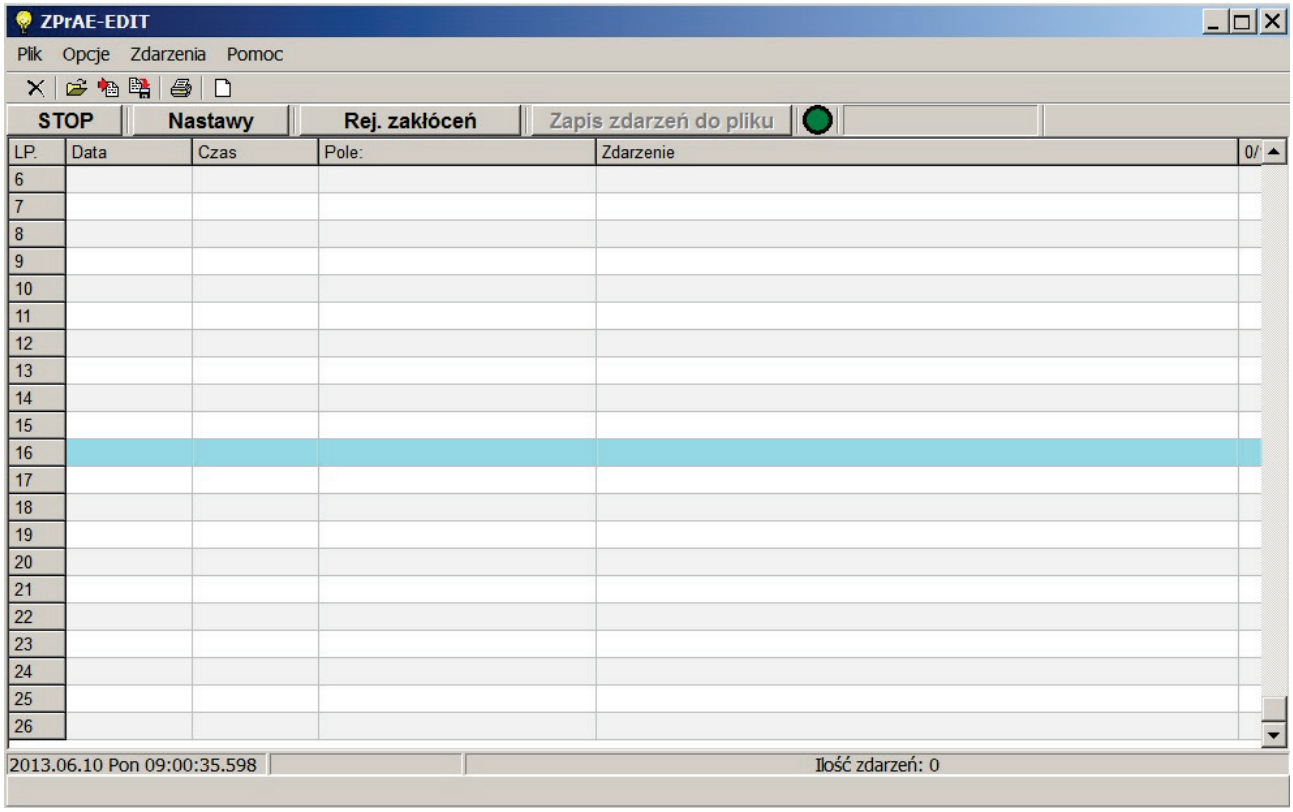


Fig. 5.1. Main window of the program.

Before work with the software is started a connection to the device should be properly configured, unless the program had been used before and the configuration was saved. In order to introduce changes make the following selection in the main menu: OPTIONS and then CONNECTION PARAMETERS, and a port and connection speed selection window will appear.

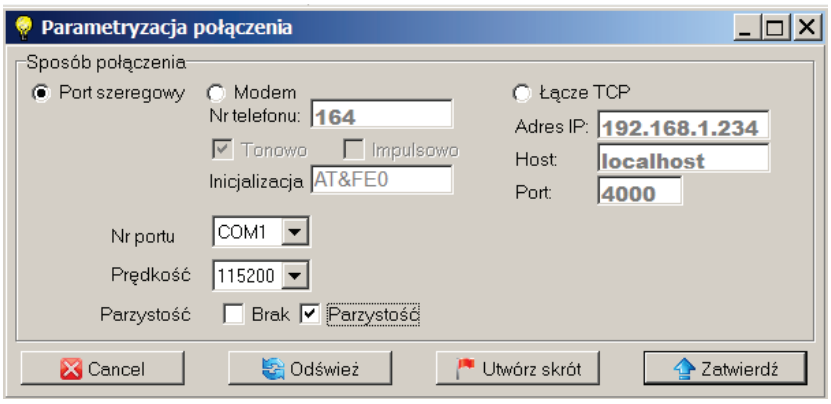


Fig. 5.2. Connection parameters window.

Depending on the version of the MGB concentrator the user can send data over various physical interfaces: RS232, RS485, Ethernet.

If a serial port is to be used select: "serial port", then select an “even” value, then select the correct COM port number and transmission speed, which is by default set to 115200 bps.

In case of an Ethernet connection the configuration requires an IP address of the device and a port number, and the TCP connection option to be selected.

If a traditional external dial-up modem is used select type of dialling (tone or pulse) and enter relevant start-up sequence, telephone number of the modem and select Modem option. Transmission speed is by default set to 115200 bps. Other speed is also possible but it needs to be agreed in advance. Change of speed is possible only in software maintenance mode.

After selecting all the transmission parameters press CONFIRM to save the device configuration. Additionally, it is possible to create a shortcut to such configured connection e.g. in case of several devices using the same TCP connection a shortcut (icon) for AZT-9 Bay No. 1 and AZT-9 Bay No. 2 can be created.

To initiate the connection press the START button which can be found in the group of the main buttons of the program. The software will then search for available devices on the transmission channel; select INITIATE SCANNING to begin. Other devices may use the same connection; therefore it is necessary to select the device to connect to. If there is one device on the channel the software displays the name of the device it is assigned to (e.g. AZT-9 Bay No. 1 under address No. 1), and if there are more devices it displays a corresponding number of device names. Next, highlight the right device and press CONNECT TO THE SELECTED DEVICE. The software initiates communication with the selected device and closes the selection window.

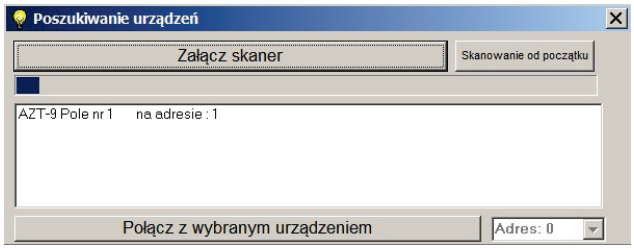


Fig. 5.3. Device scanner window.

In case of correct operation, i.e. after connection to the device and uninterrupted data transfer the round indicator in the top bar of the main window will flash yellow. In case of a transmission error the indicator will turn red.

The top part of the main window contains program icons:

-  - close the program,
-  - open a recorded data file,
-  - save events to a *.ZP6 file,
-  - save events to a *.TXT text file,
-  - print events (preview),
-  - clear event tables.

Below the icons there are five large program buttons:

- **START (STOP)** – connect to (disconnect from) a device,
- **Settings** – change device settings, preview device status,
- **Disturbance recorder** – access disturbance recorder,
- **Save events to a file** – save a file with current events to the default folder.

5.3. Range of user rights for specific logging levels and change of password

There are four levels of user rights: level 0 without any rights and three other levels which enable access to device functions.

- Level 0 – no password, preview of recorded events and disturbances, saving to the file, preview of device operation, settings preview.
- Level 1 – default password: “password1” gives rights to delete.
- Level 2 – default password: “password2” gives right to set the device time synchronised with computer system time.
- Level 3 – default password: „password3” gives rights to send the settings to the device, change configuration, etc.

To access a specific level of user rights select OPTIONS>PASSWORD in program menu and enter a password relevant for a given level. The program will inform the user about the level they logged on e.g. “Logged on level 1”.

To change the password select OPTIONS> CHANGE YOUR PASSWORD >LEVEL x. After selecting the aforementioned option a pop-up window will appear where it is necessary to enter the old password and the new password for the given level twice. If you are sure that you want to change the password click CONFIRM button and the program should inform the user that the password has been changed.

5.4. Read from the event recorder

The main program screen does not only contain the icons and buttons enabling the access to other functions but it is also the main screen of the event recorder and includes a table with the following columns:

- No. – event number,
- Date – date on which the event was recorded by the device,
- Time – time when the event was recorded by the device (with accuracy of 5 ms),
- General description – general name of a signal,
- Event – detailed description of a signal, the beginnings of an event are highlighted in bold,
- 1/0 – beginning and end of an event,

Program enables ON-LINE downloading of events (after selecting DOWNLOAD EVENTS option in the EVENTS menu). After this option is selected, the program will download the archived events that have not been downloaded yet from the device and then will switch to downloading the events in ON-LINE mode. Progress bar in the main program window shows progress of downloading the events from the device (full bar represents 100 events). It is also possible to download a specific number of events by selecting DOWNLOAD A SPECIFIED NUMBER OF EVENTS in menu events. A window will be displayed where it is necessary to enter a required number of events to be downloaded and press ENTER.

An AUTO SAVE AFTER 1000 EVENTS option is also available in the menu. If this option is enabled during ON-LINE download of events, the events will be automatically saved to a file after 1000 events. File name consists of the word EVENTS and date and time when the file was saved:

“Events 2013_03_26 13_03_42_749. ZP6”

The file will be saved in a folder relevant for a given device and created during software installation.

The “Save events to file” button on the toolbar in the main program window enables saving of last events received and shown in a table of events to a file with a default name described above, and clearing the table of events. When closing the program all unsaved events are saved to a file with a default name in a relevant folder.

5.5. Change of AZT-9 setups.

To change the settings of the AZT-9 protection device select SETTINGS button once the connection with the device is established. Upon selection of this option a window indicating operating condition of the AZT-9 protection DEVICE pops-up, as shown in fig. 5.4.

In the first tab the user can check the device status i.e. status of LEDs, indicators and present current measurements. On the left side of the window there are 8 configurable LEDs. Their colour and signal source can be assigned by the user. On the right there is a general signalling with 2 LEDs assigned to FAILURE and SUPPLY signal. Indicators with magnetic storage are shown below. User can assign any signal to the indicator but it is recommended to use them to indicate operation.

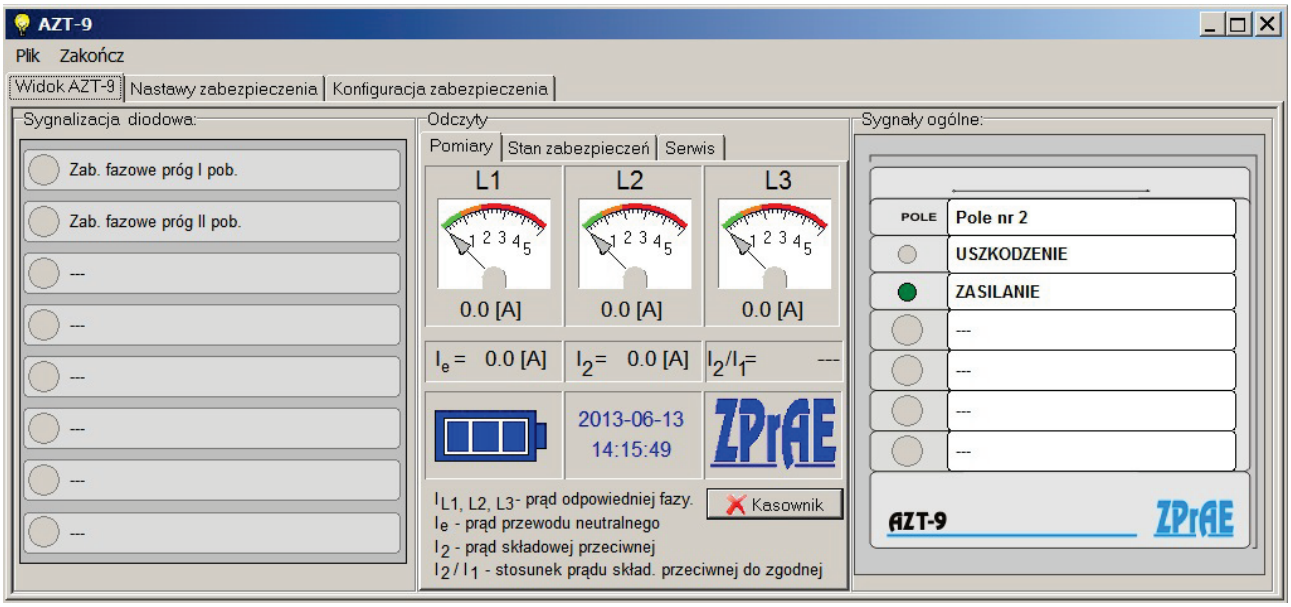


Fig. 5.4. General settings window.

In the middle of the window there are phase current measurements with additional analogue indicators. Below there are also additional measurements:

- I_e – measured earth-fault current,
- I_2 – calculated negative sequence current,
- I_2/I_1 – negative sequence current to positive sequence current ratio.

At the bottom there is an energy storage charge indicator. Three bars indicate that the energy storage is fully charged. RESET button is used do cancel/confirm the signalling. This operation can be performed after entering the correct level 1 password.

In the middle of the window, which is described as readouts, there are three tabs as shown in fig. 5.5: measurements, protection status and maintenance. Protection status indicates if functional block is energised, in operation or e.g. if the time of a given protection stage is elapsing. Circuit breaker parameters are displayed under maintenance i.e. circuit breaker operation counter, operation time and a sum of currents tripped out by the circuit breaker.

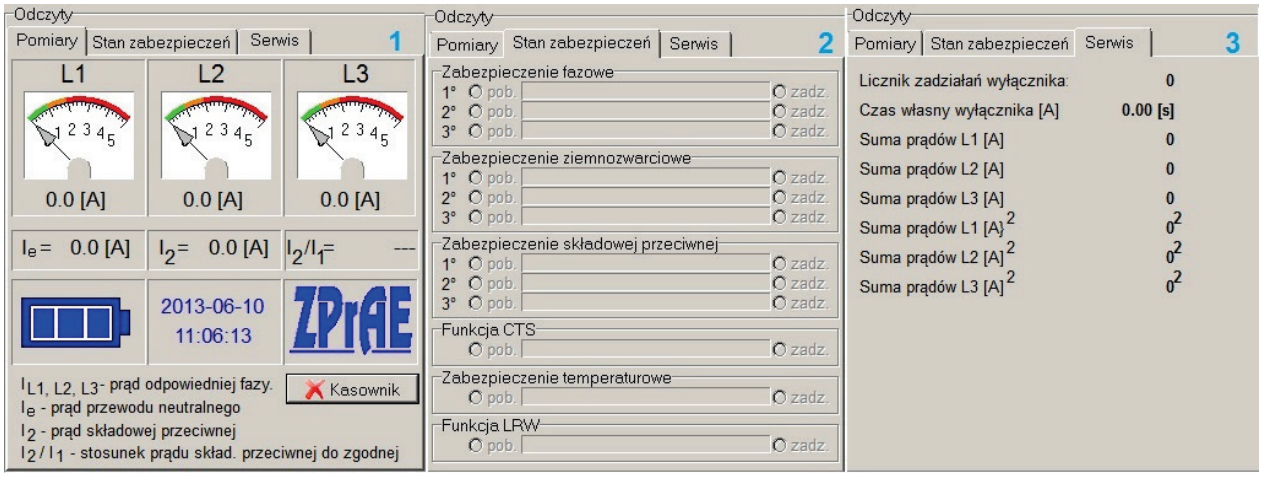


Fig. 5.5. General overview of AZT-9 readouts/measurements tabs.

Next tab of the window allows the user to set up the protection device. It is shown in fig. 5.6. In this tab the user sets up:

- device ID – device name or name of the supported facility (factory number and year of manufacture is available as read-only),
- phase protection – three operation stages,
- earth-fault protection – three operation stages,
- negative sequence protection – three operation stages,
- current circuit monitoring (CTS),
- breaker failure protection,
- configuration of group signalling relay,
- configuration of signal sources triggering the energy storage for two sections,
- operation delay of section No. 2 of energy storage,
- signal configuration for two logic gates.

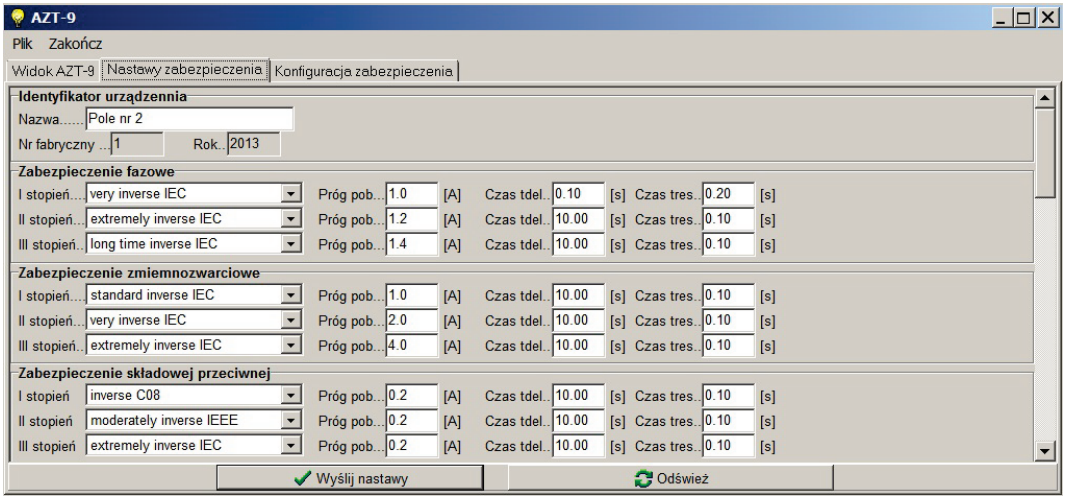


Fig. 5.6. Setups of the AZT-9 protection device.

Next tab of the window allows the user to configure the protection. It is shown in fig. 5.7. In this tab the user configures:

- delay time of input signals,
- source of signals energising the configurable relays (the list of signals described in section 7),
- source of signals turning the LED (one of eight) on (the list of signals described in section 7),
- source of signals switching the magnetic indicator (one of four) on with memory (the list of signals described in section 7),
- parameters' limits for the circuit breaker maintenance indicator.

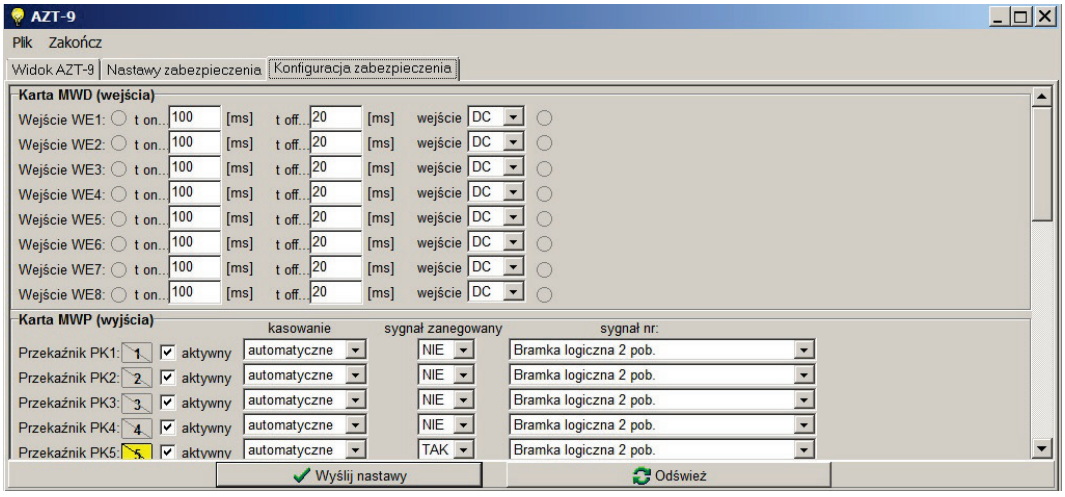


Fig. 5.7. Configuration of the AZT-9 protection device.

6. DISTURBANCE RECORDER.

The function of the disturbance recorder is performed by a module with battery-backed RAM memory. The memory storage capacity is sufficient for saving the last 210 records of 600 ms. When the memory is full the oldest disturbance records are „overwritten" by the latest ones.

The data is collected, while mutual sync is maintained, and stored in a circular buffer of cache RAM. When the recorder is triggered (started) the data from the specified (pre-set) time before the trigger is stored in the non-volatile memory. The data after the trigger is saved for as long as it reaches the total length of recording. The so-called pre-trigger time and post-trigger time can be configured using ZPrAE-EDIT software.

The recorder is triggered by one of the eight configurable signals. User can set them in the parameter window of disturbance recorder as shown in fig. 6.1. Select the RECORDER option in the program main window and go to the second tab, RECORDER SETTINGS.

Signals are linked by an OR gate – activation of one of them triggers the recorder. User sets the maximal time of recording and post-trigger time. Maximal time of single recording is 60 s.

Recorder parameters:

- sampling frequency - 1 kHz,
- resolution of analogue-to-digital converter – 12 bits,
- time of single recording – from 600 ms to 60 s
- number of available records – from 1 to 210 depending on the recording time set.

WARNING! Change in the recording time automatically deletes the previous records.

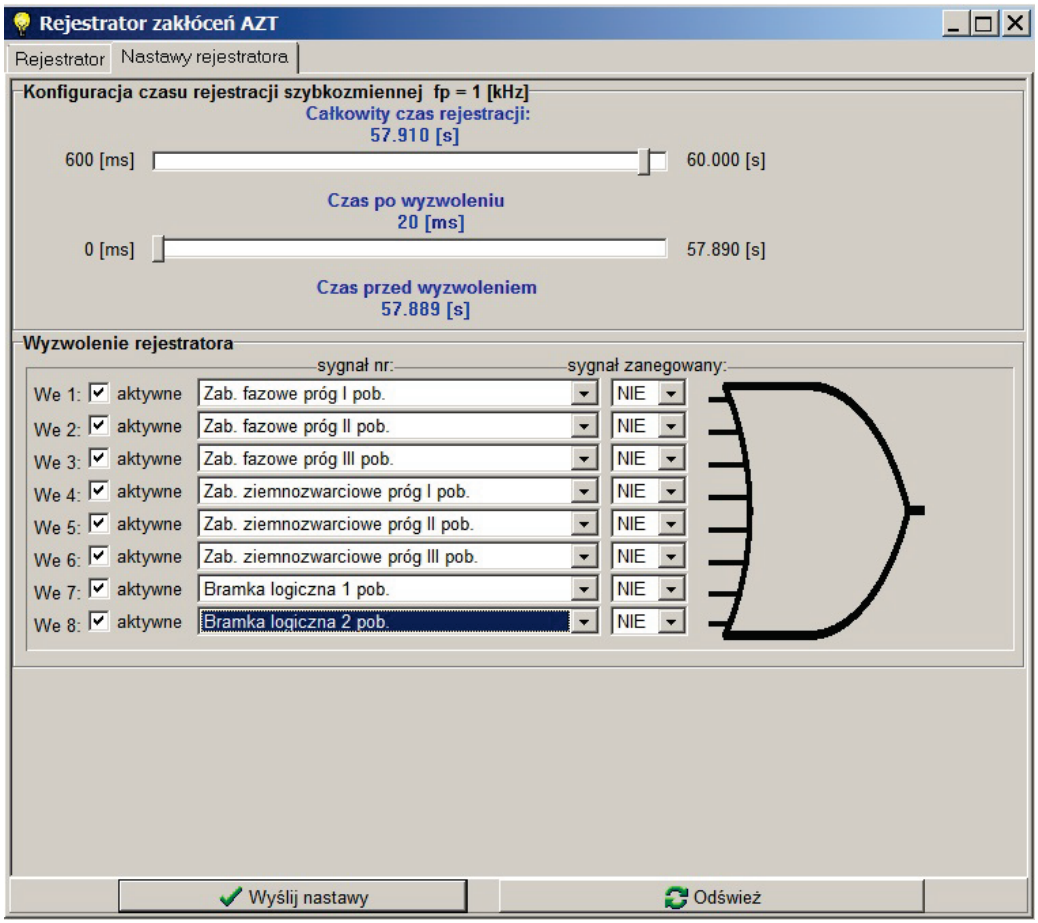
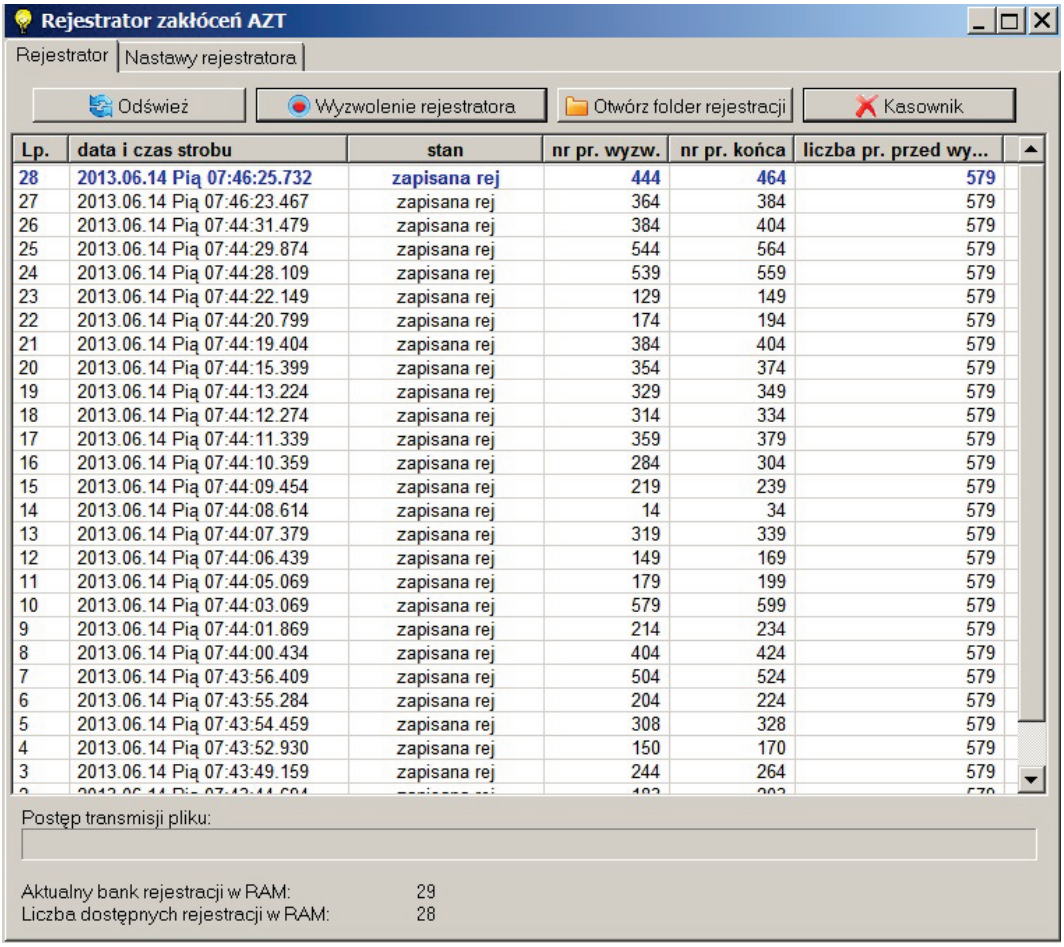


Fig. 6.1. Configuration of the disturbance recorder in the AZT-9.

6.1. Read from disturbance recorder

To check the list of recorded disturbances select RECORDER option in the main program window. A window as shown in fig. 6.2 will be displayed. A table with the records saved in the device is displayed in the main part of the window. Records are saved following the circular buffer principle. Depending on the time set for a single recording the buffer can store from 1 to 210 records in non-volatile memory. In the upper part of the window there is a REFRESH button which queries the recorder and refreshes the record table. In addition, it is possible to trigger the recording manually by RECORDER TRIGGER. To download a record from the device, choose the record line in the table and select the DOWNLOAD RECORD option by clicking the right mouse button.



Lp.	data i czas strobu	stan	nr pr. wyzw.	nr pr. końca	liczba pr. przed wy...
28	2013.06.14 Pią 07:46:25.732	zapisana rej	444	464	579
27	2013.06.14 Pią 07:46:23.467	zapisana rej	364	384	579
26	2013.06.14 Pią 07:44:31.479	zapisana rej	384	404	579
25	2013.06.14 Pią 07:44:29.874	zapisana rej	544	564	579
24	2013.06.14 Pią 07:44:28.109	zapisana rej	539	559	579
23	2013.06.14 Pią 07:44:22.149	zapisana rej	129	149	579
22	2013.06.14 Pią 07:44:20.799	zapisana rej	174	194	579
21	2013.06.14 Pią 07:44:19.404	zapisana rej	384	404	579
20	2013.06.14 Pią 07:44:15.399	zapisana rej	354	374	579
19	2013.06.14 Pią 07:44:13.224	zapisana rej	329	349	579
18	2013.06.14 Pią 07:44:12.274	zapisana rej	314	334	579
17	2013.06.14 Pią 07:44:11.339	zapisana rej	359	379	579
16	2013.06.14 Pią 07:44:10.359	zapisana rej	284	304	579
15	2013.06.14 Pią 07:44:09.454	zapisana rej	219	239	579
14	2013.06.14 Pią 07:44:08.614	zapisana rej	14	34	579
13	2013.06.14 Pią 07:44:07.379	zapisana rej	319	339	579
12	2013.06.14 Pią 07:44:06.439	zapisana rej	149	169	579
11	2013.06.14 Pią 07:44:05.069	zapisana rej	179	199	579
10	2013.06.14 Pią 07:44:03.069	zapisana rej	579	599	579
9	2013.06.14 Pią 07:44:01.869	zapisana rej	214	234	579
8	2013.06.14 Pią 07:44:00.434	zapisana rej	404	424	579
7	2013.06.14 Pią 07:43:56.409	zapisana rej	504	524	579
6	2013.06.14 Pią 07:43:55.284	zapisana rej	204	224	579
5	2013.06.14 Pią 07:43:54.459	zapisana rej	308	328	579
4	2013.06.14 Pią 07:43:52.930	zapisana rej	150	170	579
3	2013.06.14 Pią 07:43:49.159	zapisana rej	244	264	579

Fig. 6.2. Record list window.

After the transmission, program asks where the record should be saved, by default it is the default folder for a given device. The files are saved in COMTRADE format. Record files *.cfg *.dat can be opened in iREC viewer supplied with ZPrAE-EDIT software. After default installation the iREC software should run automatically once the record is saved. It is possible to view the records saved on the PC drive, select the OPEN RECORD FOLDER and run a given file.

6.2. Graphic presentation and disturbance analysis module, iREC.

iREC software is a separate program installed with ZPrAE-EDIT package. It can be used to visualise a given record file saved in COMTRADE format. It is launched from the start menu by selecting the iREC shortcut or by selecting the file from record folder in ZPrAE-EDIT software. When iREC is launched, open a selected record file. First, find a folder with saved records (folder location will be saved) and then select the record, confirm and go to the window shown in fig. 6.3.
A detailed instruction in electronic format is supplied with iREC software. In this instruction only few options of the program, which are helpful when analysing disturbances recorded by AZT-9 protection device, are presented.

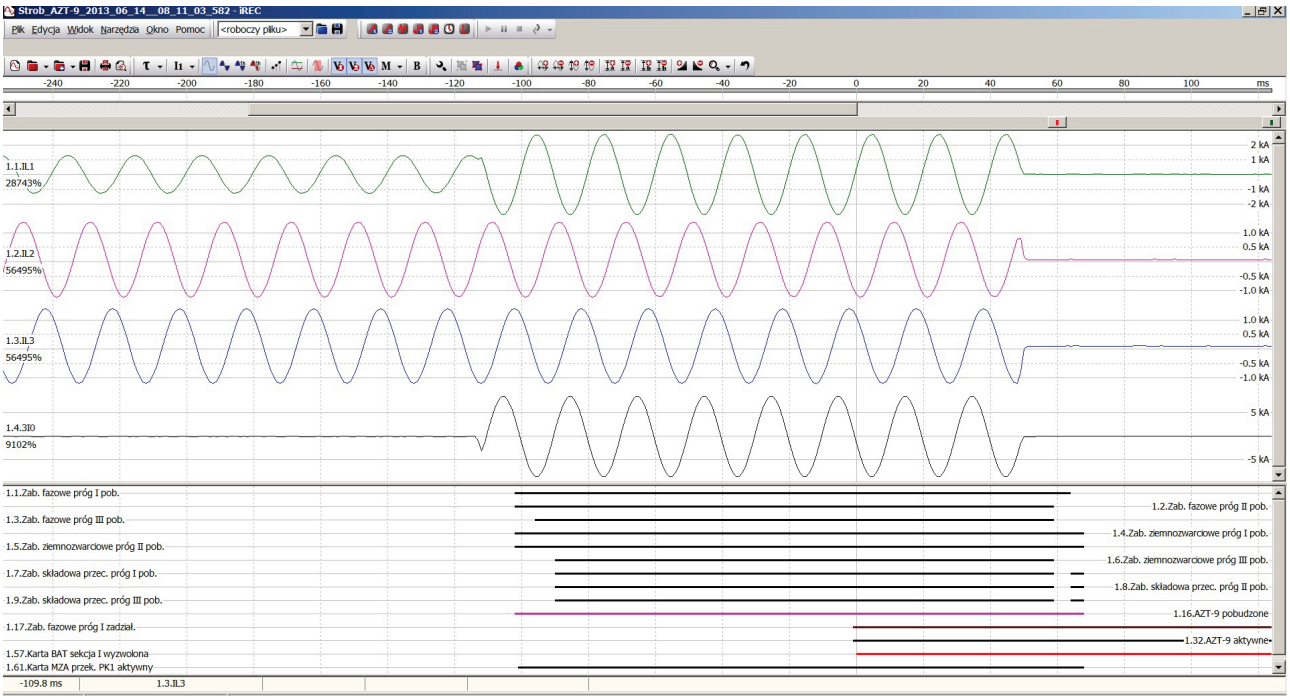


Fig. 6.3. iREC main window.

Currents can be displayed in values of primary as well as secondary side of relays. They can also be displayed in a standardised way. An option which is useful when analysing disturbances is a possibility to create virtual channels i.e. sum of channels, symmetrical components. After first readout of record file from the AZT-9, the bay's currents and binary signals i.e. logic, input and output, can be seen.

It is possible to filter only given curves, i.e. phase that was the cause of operation can be left in the analogue channels. Active channels, i.e. those which changed their status during recording can be left in digital channels. To do this, click the right mouse button on binary channels and select Show only active option.

In addition, a given record can be printed out or exported as a picture to PNG format.

Additional options include:

- creation of virtual channels e.g. calculation of symmetrical components,
- drawing 3-phase vector diagrams,
- determining harmonic components of curves,
- combining analogue channels, etc.

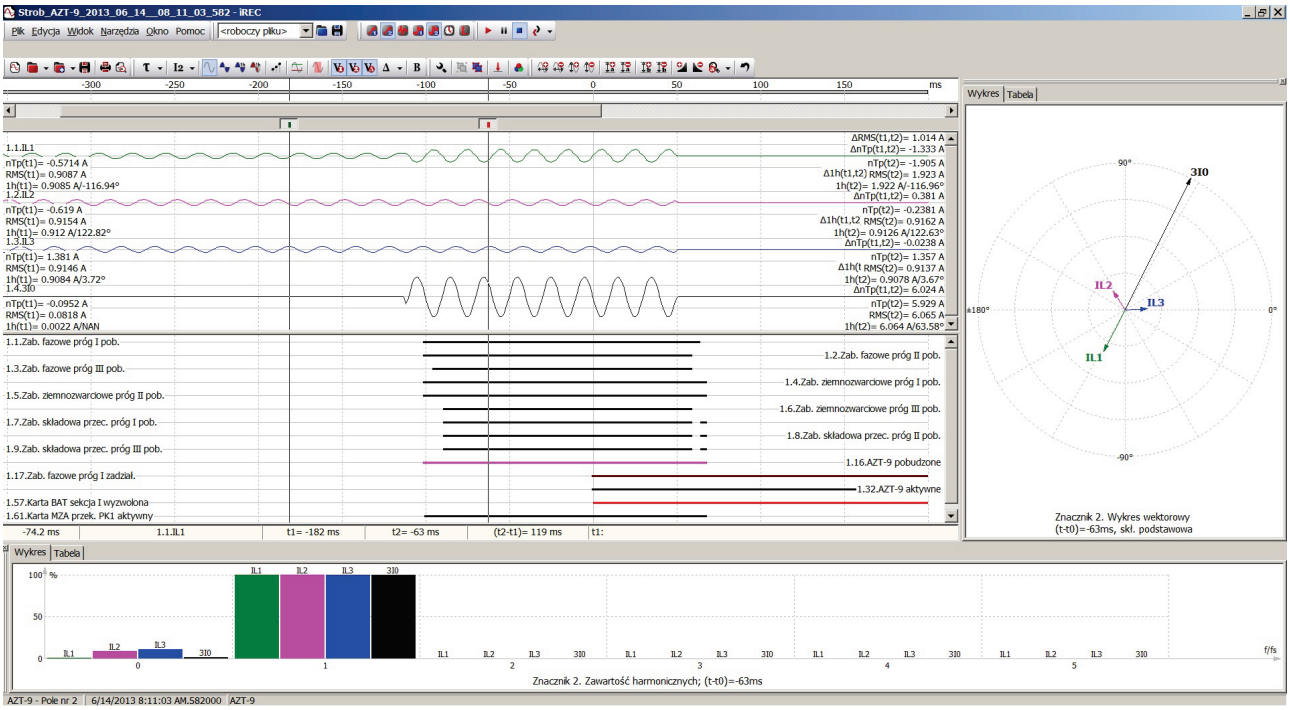


Fig. 6.4. Advanced options of record visualisation.

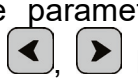
7. AZT-9 signal list

List of signals available in the AZT-9 device is presented below. The signals can be used to configure LEDs, relay cards, recorder triggers, etc.

No.	Signal description
1	Phase protection threshold I energised
2	Phase protection threshold II energised
3	Phase protection threshold III energised
4	Earth-fault protection threshold I energised
5	Earth-fault protection threshold II energised
6	Earth-fault protection threshold III energised
7	Negative sequence protection threshold I energised
8	Negative sequence protection threshold II energised
9	Negative sequence protection threshold III energised
10	Logic gate 1 energised
11	Logic gate 2 energised
12	Temperature protection energised
13	Detection of cable damage CTS - energised
14	External trigger of breaker failure protection energised
15	Instrument transformer saturation SAT - energised
16	AZT-9 energised
17	Phase protection threshold I operation
18	Phase protection threshold II operation
19	Phase protection threshold III operation
20	Earth-fault protection threshold I operation
21	Earth-fault protection threshold II operation
22	Earth-fault protection threshold III operation
23	Negative sequence protection threshold I operation
24	Negative sequence protection threshold II operation
25	Negative sequence protection threshold III operation
26	Logic gate 1 operation
27	Logic gate 1 operation
28	Transformer temperature protection active

29	Detection of cable damage CTS - operation
30	External trigger of breaker failure protection - operation
31	Instrument transformer saturation SAT - operation
32	AZT-9 active
33	MWD card WE-1 energised
34	MWD card WE-2 energised
35	MWD card WE-3 energised
36	MWD card WE-4 energised
37	MWD card WE-5 energised
38	MWD card WE-6 energised
39	MWD card WE-7 energised
40	MWD card WE-8 energised
41	MWD card WE-1 active
42	MWD card WE-2 active
43	MWD card WE-3 active
44	MWD card WE-4 active
45	MWD card WE-5 active
46	MWD card WE-6 active
47	MWD card WE-7 active
48	MWD card WE-8 active
49	MWP card PK1 relay active
50	MWP card PK2 relay active
51	MWP card PK3 relay active
52	MWP card PK4 relay active
53	MWP card PK5 relay active
54	MWP card PK6 relay active
55	MWP card PK7 relay active
56	MWP card PK8 relay active
57	BAT card section I triggered
58	BAT card section II triggered
59	BAT card BI-I relay active
60	BAT card BI-II relay active
61	MZA card PK1 relay active
62	MZA card PK2 relay active
63	Lock
64	Power supply OK
65	Maintenance sum of trip outs phase L1
66	Maintenance sum of trip outs phase L2
67	Maintenance sum of trip outs phase L3
68	Maintenance sum of trip outs phase L1^2
69	Maintenance sum of trip outs phase L2^2
70	Maintenance sum of trip outs phase L3^2
71	Maintenance number of trip outs
72	Maintenance trip out time
73	Section I charged
74	Section II charged
78	MZA input - breaker failure protection
79	Maintenance recorder battery LOW
81	Reset flag
82	Manual trigger of recorder
83	New recording
84	Energy storage test

8. PREVIEW OF AZT-9 STATUS ON LCD SCREEN

On LCD screen of AZT-9 device it is possible to view the current status of protections, binary inputs, relay outputs and maintenance parameters of the circuit breaker. To enter the preview mode of AZT-9 status press  , button in the main window.

When previewing the status of protection there are two indicators showing the energising status (energised, active) and a progress bar indicating elapsing time delay.
Preview of the status of binary inputs and relays is available for the MZA card.
Preview of the status of relay outputs is available for BAT and MWP cards.
Preview of the status at binary inputs and logic state including time delay set is available for the MWD card.

9. SCOPE OF SERVICES PROVIDED BY THE MANUFACTURER

The manufacturer provides support in designing transformer protection systems using the AZT-9 device. We have ready-to-use **project outlines**. The manufacturer supplies the AZT-9 protection device configured as agreed, takes care of the equipment during the warranty period and provides full service after its expiry.

Should you have any questions or doubts, please call us.

10. TECHNICAL PARAMETERS OF AZT-9 PROTECTION DEVICE

Auxiliary power supply	Rated auxiliary voltage U_{pn}:	220 V DC or 110 V DC Or other as agreed.
	Permissible range of auxiliary voltage change	(0,8 ÷ 1,15) U_{pn}
	Power consumption	< 15 W
Power supply from current transformers	Miminal current allowing for operation	3-phase = 3×0,2 I_n 1 phase = 1×0,6 I_n
	Ready-to-operate time while fed from current transformers	< 250 ms – if energy storage were supplied before power decay < 40 s – with empty Energy storage and current from transformers $I_{L1} + I_{L2} + I_{L3} \geq 1,0\ I_n$
Tripping circuits	Number of energy storages	2
	Energy storage capacity	1320 uF
	Rated output voltage	300 V DC
	Energy cumulated in storages	118 J (2 × 59 J)
	Loading time of energy storages (auxiliary supply)	< 40 s
	Overshoot time	≤ 40 ms
	Delay of tripping channels	15 ms ÷ 45 ms
Analogue – current inputs	Number of measuring inputs in AZS module	4 inputs
	Rated current I_n	1 A lub 5 A
	Measuring range	40 I_n
	Starting current setup range	0,2 I_n ÷ 40 I_n, co 0,1 I_n
	Guaranteed error of starting current setup	± (0,5% $I_{nastawy}$ + 5 mA) – dla I_n = 1 A ± (0,5% $I_{nastawy}$ + 25 mA) – dla I_n = 5 A
	Power consumption of measuring circuits for I_n without auxiliary power supply	< 8 VA / (phase input) – supply from one phase < 6 VA / (phase input) – 3-phase supply
	Power consumption of measuring circuits for I_n with auxiliary power supply	< 1,3 VA / (phase input)
	Power consumption for I_n in earth-fault circuit	< 0,25 VA
	Permissible permanent current	2,5 I_n
	Thermal strength 1s	100 I_n
	Dynamic strength of current circuits	200 I_n
Binary inputs	***MZA module***	
	Number of signal inputs	2 inputs
	Rated voltage U_{wn}	220 V DC / 230 V AC or other as agreed
	Time delay	30 ms
	Power consumption of signalling circuits	< 0,5 W / input
	Starting threshold	0,7 U_{wn} ± 5%
	WD module (option)	
	Number of signal inputs	8 inputs (active only with auxiliary power supply)
	Rated voltage U_{wn}	220 V/230 V r other as agreed, AC/DC configurable
	Power consumption of signalling circuits	< 0,5 W / input
	Starting threshold	0,7 U_{pn} ± 5%
	Operation mode	AC or DC
	Turn-on time t_on	0…60 s
	Shut-off time t_off	0…60 s
	Setup range	1 ms

Signalling outputs	Current strength of contacts	4 A
	Making capacity of contacts	3 A / 250 V AC 0,15 A / 250 V DC; L/R=40 ms
	MZA and BAT modules	
	Number of output channels in MZA module	2 (change-over)
	Number of output channels in BAT module	2 (change-over - bistable)
	Delay of signalling channels	15 ms ÷ 45 ms
	MWP module (option)	
	Number of output channels	8 (active with auxiliary power supply)
	Delay of signalling channels	10 ms ÷ 15 ms
Recorder	Procesing resolution A/C	12-bitów
	Recording frequency	1 kHz
	Single recording time of a disturbance	600 ms ÷ 60 s
	Number of disturbance records	1 – 210 – (depending on time set)
	Number of event records	1000
	Number of event records for MGB module (option)	10000 (active with auxiliary power supply)
Phase, earth-fault, negative sequence component protections	Number of operation stages	3
	Operating modes of each stage	OFF, OVER-CURR 50/51, UNDER-CURR 37 (required auxiliary power supply), IDMT EI ZPrAE, IDMT SI IEC, IDMT VI IEC, IDMT EI IEC, IDMT LTI IEC, IDMT MI IEEE, IDMT VI IEEE, IDMT EI IEEE, IDMT I C08, IDMT STI C02
	Setup resolution	0,1 I_n
	Protections with independent characteristics	
	Starting threshold	0,2 I_n ÷ 40 I_n
	Return ratio for overcurrent protection	0,95 ± 0,03
	Return ratio for undercurrent protection	1,05 ± 0,03
	Delay time tdel	0 ÷ 300 s
	Reset time tres	0 ÷ 300 s
	Time setup resolution	10 ms
	Time setup guaranteed error	± (0,1% $t_{nastawy}$ + 5 ms)
	Protections with dependent characteristics	
	Starting threshold	0,2 I_n ÷ 4 I_n
	Multiplier of TMS characteristic = tdel	0,01 s ÷ 10 s
	Reset time tres (for IEC characteristics, ZPrAE)	0 ÷ 300 s
	Multiplier of RTMS characteristics = tres (for IEEE/C02/C08 characteristics)	0,01 s ÷ 5 s
	Time setup resolution	10 ms
	Time setup guaranteed error	± (0,5% $t_{theoretical}$ + 5 ms) for: –operation delay: I / $I_{nastawy}$ > 10 – return delay: 0,1< I / $I_{nastawy}$ <0,2 (accordingly with PN-EN 60255-151:2010)
CTS Function	Starting threshold I_2/I_1	20 % ÷ 90 %
	Setup resolution	5 p. p.
	Setup guaranteed error	± 3 p. p.
	Return ratio	0,95 ± 0,04
	Delay time	0 ÷ 300 s
	Time setup resolution	10 ms
	Time setup guaranteed error	± (0,1% $t_{nastawy}$ + 5 ms)

LRW Function	Current criterion range		0,2 I_n ÷ 40 I_n
	Return ratio		0,95 ± 0,03
	Current setup resolution		0,1 I_n
	Delay time tdel		0 ÷ 300 s
	Time setup resolution		10 ms
	Time setup guaranteed error		± (0,1% $t_{nastawy}$ + 5 ms)
SAT Funciton	Minimal level of detection of oversaturation		> 2 I_n
	Time delay from oversaturation detection to operation\		150 ms
Communication	Basic communication RS-232 / ZP-6		
	Number of communication channels on the back panel (options depend on version of the MGB module):		
	Channel 1	MGB-9 A / B / C / D / E / F1 / G	RS232 – IEC870-5-103 / ZP-6
	Channel 2	MGB-9 A / B / C / D / E / F1 / G	ST fibre optic connector – IEC870-5-103 / ZP-6
	Channel 3	MGB-9 D	ST fibre optic connector – IEC870-5-103 / ZP-6
		MGB-9 E	RS485 - Phoenix 8-pin-IEC 870-5-103 / ZP-6 connector
	Channel 4	MGB-9 D	ST fibre optic connector – IEC870-5-103 / ZP-6
		MGB-9 E	RS485 - Phoenix 8-pin-IEC 870-5-103 / ZP-6 connector
		MGB-9 B / C	GPS – antenna connector SMA - NMEA
	Channel 5	MGB-9 C / D / E / G	Ethernet - RJ-45 connector - IEC 870-5-103 / ZP-6
		MGB-9 F1	Ethernet - RJ-45 connector, 2 × SC connector - IEC 61850
Insulation	Rated voltage of insulation:		250 V
	Proof impulse voltage:		4 kV (1,2/50 μs)
	Overvoltage category:		III
	Insulation electrical strength:		2,5 kV; 50 Hz; 1 min.
	Insulation electrical strength between output sections of battery capacitors.		1,5 kV; 50 Hz; 1 min.
	Enclosure protection degree		Front panel: IP50 Sidewalls and terminals: IP20
General	Ambient temperature range for storage		248 K ÷ 343 K (od -25 °C do +70 °C)
	Ambient temperature range for operation		263 K ÷ 328 K (od -10 °C do +55 °C)
	Ambient humidity (with no water vapour condensation or ice):		95 %
	Ambient pressure		70 kPa ÷ 110 kPa (0 – 3000 m npm)
	Mechanical strength accordingly to PN-EN 60255-21-(1,2,3)		class 1
	K Electromagnetic compatibility accordingly to PN-EN 60255-26		class A
	Dimensions: (one chassis) Another chassis multiply dimension		19”/3U/240 (483×133,5×245 mm), W×H×D
	Weight (one chassis)		Ca. 4 kg (depending on number of odules)
Addidional Power supply (option)	***Additional power supply from current transformers (option)***		
	Rated input voltage U_{Wn}		57 V AC
	Permissable input voltage range		(0,7 ÷ 1,15) U_{Wn}
	Power consumption of voltage input circuits without auxiliary power supply		< 8 VA / (phase input) – 3-phase power supply < 15 VA / (phase input) – 1-phase power supply
MTT-10 TEST Module (option)	Activating threshold for indication LEDs		Storage level > 70% of nominal capacity
	Available test inputs and outputs		sockets 1 to 8, measuring inputs – current
			sockets 9 to 11, BAT-1 storage outputs
	Test load for energy storages		2 × 160 Ω

11. HOW TO ORDER

When placing the order please use the device code specified in the „**Order form”**.

Example of an order code: **AZT-9-52-00K-1-0**

5 – Rated current **5A**

2 – Auxiliary power supply voltage **220 V DC**

-

0 – Without an **MWD-9** binary input card

0 – Without an **MWP-9** relay output card

K – **MGB-9K** communication module

-

1 –**MTT-10** test module installed

-

0 – Without non-standard equipment

Order form:

Ordering Code: AZT-9 - [ ][ ] - [ ][ ][ ] - [ ] - [ ]

Rated current

In = 1 A	1
In = 5 A	5

Auxiliary supply voltage

Un = 110 V DC - (special version)	1
Un = 220 V DC / 230 V AC	2

Customizable binary outputs

No customizable outputs	0
8 binary inputs card MWD-9	1

Customizable contact outputs

No customizable outputs	0
8 contact inputs card MWP-9	1

Communication

Basic only

RS232 terminal, DB 9 terminal / ZP-6 protocol	0

Version A

RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol fibre optic terminal, ST terminal - IEC 870-5-103 / ZP-6 protocol.	A

Version B

RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol. fibre optic terminal, ST terminal - IEC 870-5-103 / ZP-6 protocol GPS – antenna terminal SMA.	B

Version C

Ethernet terminal, RJ45 terminal - IEC 870-5-103 / ZP-6 protocol. RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol. fibre optic terminal, ST terminal - IEC 870-5-103 / ZP-6 protocol. GPS – antenna terminal SMA.	C

Version D

Ethernet terminal, RJ45 terminal - IEC 870-5-103 / ZP-6 protocol. RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol. 3 sets of fibre optic terminals, ST terminals - IEC 870-5-103 / ZP-6 protocol.	D

Version E

Ethernet terminal, RJ45 terminal - IEC 870-5-103 / ZP-6 protocol. RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol. Fibre optic terminal, ST terminal - IEC 870-5-103 / ZP-6 protocol. 2 sets of RS485 terminals, Phoenix 8×5.08 - IEC 870-5-103 / ZP-6 protocol.	E

Version F1

RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol. fibre optic terminal, ST terminal - IEC 870-5-103 / ZP-6 protocol. Ethernet terminal, RJ45 terminal - IEC 870-5-103 / ZP-6 protocol. 2 sets of RS485 terminals, SC terminal - IEC 61850 protocol.	F1

Version G

Ethernet terminal, RJ45 terminal - IEC 870-5-103 / ZP-6 protocol. RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol. Fibre optic terminal, ST terminal - IEC 870-5-103 / ZP-6 protocol.	G

Version H

RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol. fibre optic terminal, ST terminal - IEC 870-5-103 / ZP-6 protocol. Single-mode fiber optic, ST terminal - IEC 870-5-103 / ZP-6 protocol.	H

Version J

Ethernet terminal, RJ45 terminal - IEC 870-5-103 / ZP-6 protocol. RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol. fibre optic terminal, ST terminal - IEC 870-5-103 / ZP-6 protocol. USB-B RS232 terminal - IEC 870-5-103 / ZP-6 protocol. 2 sets of RS485 terminals, Wago 3x3.5 conection-IEC 870-5-103 / ZP-6 protocol.	J

Wersja K

Ethernet terminal, RJ45 terminal - IEC 870-5-103 / ZP-6 protocol. RS232 terminal, DB 9 terminal - IEC 870-5-103 / ZP-6 protocol. fibre optic terminal, ST terminal - IEC 870-5-103 / ZP-6 protocol. GPS antenna SMA connector. GSM antenna, SMA connector, SIM card.	K

Optional modules

No optional modules	0
Test module MTT-10	1
Additional power supply module MZD-1	2

Additional requirements

no additional requirements	0
accordingly to the Attachment	1

AZT-9

OFFER

RE line® ENERGETIC STANDARDS

- RSH-3, RSH-3S - tripping
- RS-6, RPD-2, RPP-4, RPP-6 - interposing
- RMS-2 - signalling
- RCW-3, RCDW-1 - circuit continuity monitoring
- RKO-3 - power supply circuit continuity monitoring
- RB-1, RBS-1, RBS-2 - bistable
- RT-22 - time
- RUT-2, RUT-3 - time-voltage
- RJT-1, RJT-3 - time-current
- RKU-1, RKS-1 - final controlling
- LZ-1, LZ-2 - operation counters
- RPZ-1 - supply source switching
- GPS-1 - time synchronisation
- MDD-6, MDS-12 - Diode modules
- PH-XX, PS-XX - Modules of switches, pushbuttons and control lamps
- Relay racks

- Busbar protections and breaker failure protections type TSL-9r, TSL-11
- Auxiliary and signalization relays
- Reserve Central Signalling System type MSA-9, MSA-12, MSA-24
- Protection relays type AZT-9, APP-9
- Disturbance recorder RZS-9
- Energy measurement system and event recorder ZRZ-28
- Load Resistors for measuring transformers
- DC and AC auxiliary power supply switchgears
- Cubicle-contained sets of control and supervision protections
- Modular power supplies, measuring suitcases, measuring and registering system RFQ-8
- PROFIL-L cubicles
- Periodical and post-failure tests, as well as repairs and overhauls of busbar protections TSL
- Servicing, strting-up and post assembly tests

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