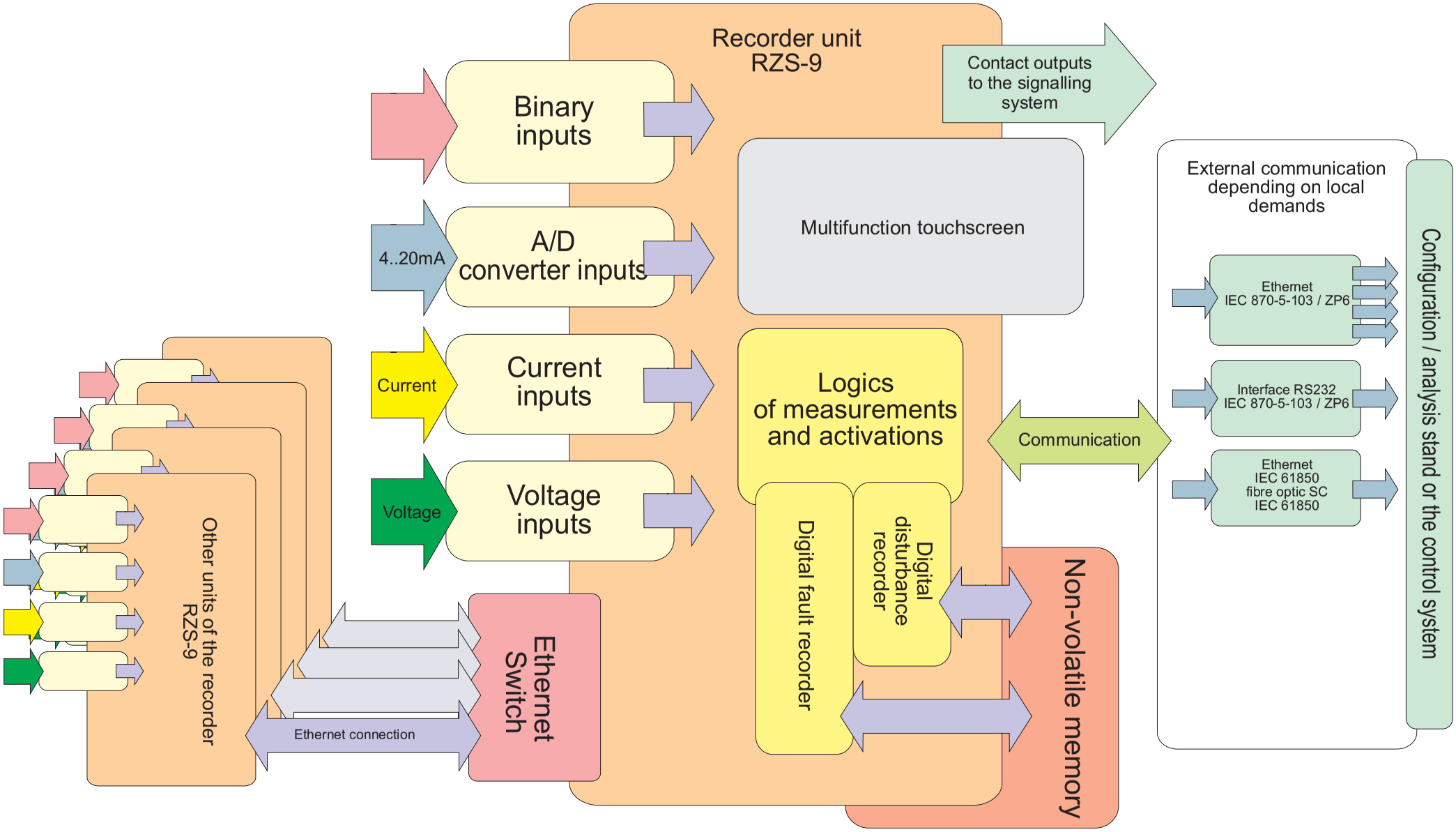
ZPrAE Sp.z o.o.

SZAFY ZABEZPIECZEŃ DLA ENERGETYKI
ISO 9001
ZPrAE Sp.z o.o.
20-letnie doświadczenie
* POLSKA *

RZS-9

DISTURBANCE RECORDER



Structural diagram of the disturbance recorder RZS-9

1. APPLICATION.

Disturbances in operation or breakdowns of electrical power facilities usually lead to substantial financial losses and other negative technical consequences. Analysis of previous incidents enables determining causes of malfunctions, drawing conclusions and avoiding similar problems in future. A breakdown at a facility unleashes an avalanche of different signals, which appeared directly before and just after the signal initiating recording. A disturbance recorder is an invaluable tool in such cases, as it registers current and voltage values, and statuses of binary signals from a switchgear at the time of the disturbance. It also makes it possible to check operating conditions before the disturbance and after it disappears, including correct operation of automatic protection systems. Software supplied with the device makes analysis of all recorded curves possible.

1.1. Basic features of the RZS-9 recorder:

- This microprocessor device records analogue and binary measurement signals from specific connected equipment of the substation.
- It records data before, during and after the disturbance
- It is equipped with two embedded independent software recorder modules:
    - digital fault recorder - *DFR* (for fast changing disturbances, which can occur for only a very brief time, e.g. all types of short-circuits)
    - dynamic disturbance recorder - *DDR* (for slow changing disturbances, which can last for a few minutes and cause substantial risk to the system due to their scope. Power swings are one example of such problem).
- A disturbance is recorded in a way enabling proper observation and analysis, i.e. analogue signals (currents and voltages from instrument transformers) can be recorded at sampling rate up to 10 kHz, for more than 20 seconds in standard configuration. The dynamic disturbance recorder can be set to record for even a few hours.
- Ability to create virtual channels, with curves calculated based on measurements from actual channels (e.g. a virtual channel can be created to record active and reactive power, positive and negative component etc.).
- Ability to record 4-20 mA signals from measuring transducers (e.g. pressure and temperature transducers).
- Coordination between digital and dynamic recorders. An option to activate one or both recorders based on a specific criterion.
- Recorded sampled and calculated values can be visualized simultaneously to analyze interdependencies between fast and slow changing disturbances.
- Easy recorder installation, testing and configuration.
- Electrical Ethernet or optical 100Base-FX can be used for external communication. Other connectivity options are available at request; however, the aforementioned solutions are recommended due to their speed.
- Optional communication with a monitoring system based on IEC 61850 protocol over optical fibre or according to other client requirements.
- Ability to easily increase the number of recorded channels without deterioration of recording quality.
- Supplied software enables configuration of recorders and full analysis of recorded data.
- Ability to record up to 32 analogue signals and up to 64 binary signals in a single unit (standard configuration enables recording of 8 analogue signals and 32 binary signals, the system can be expanded with additional modules in the unit at the client's request).
- Guaranteed cooperation of a number of units in the recording system with simultaneous sampling and precise time synchronization.
- Expansion of the recording system does not cause deterioration of operating parameters.

- Cooperation and synchronization of multiple units is based on optical fibres and Ethernet network.
- A recorder is a multitasking device. It is possible to download data and record simultaneously.
- A front panel is fitted with a colour touchscreen displaying current status of the recorder, notifications about full memory or malfunctions and displaying the last time each recorder was activated. It is also possible to preview measurements, status of binary inputs, set an interlock and change the device operating mode (see more details below).
- The front panel is also fitted with a set of 8 configurable multicolour LEDs displaying information selected by the user from a list (logic signals).
- Memory is sufficient to store disturbance data for 1 year (100 fast changing and 75 slow changing disturbances) without data compression.
- Can be powered from two independent sources.
- Two recorder modes to chose from:
  - *run-till-full* – when memory is full the recorder is locked and notifies it is out of memory until there is a permission to overwrite data
  - *circular* – the memory works in circular mode; if it runs out of memory the oldest records are overwritten.
- Configurable sampling frequency of the digital fault recorder: 1, 2, 5, 10 kHz.
- Configurable sampling frequency of the dynamic disturbance recorder: 0.1 Hz, 0.5 Hz, 1 Hz, 5 Hz, 10 Hz, 20 Hz, 50 Hz.
- Maximal sampling frequency difference between channels in a single unit or one distributed recording system is 5 μs. The features described above ensure negligibly small phase displacement in calculating values from analogue samples.
- Ability to connect to a centre collecting data over an Ethernet LAN/WAN network of the substation.
- The recorder is secured against unauthorized access with several password levels and a PIN code for the front panel display.
- Ability to connect a printer to a local station and print specific records.
- Ability to assign weights to different triggers, which are added up during recording. This way records with the highest priority to be downloaded by the user can be identified.
- Ability to create advanced recording trigger criteria based on logical conjunctions and disjunctions (AND, OR).
- The following inputs can be connected to the logic gates:
  - Statuses of binary signals
  - Statuses of calculated signals (analogue signals):
    - Positive/zero/negative sequence current
    - Positive/zero/negative sequence voltage
    - Active power and its first derivative
    - Reactive power and its first derivative
    - Apparent power and its first derivative
    - Frequency and its first derivative
- In case of the aforementioned calculated signals it is possible to define threshold trigger values and their hysteresis. It is also possible to activate specific signals based on changes in their values over a defined period of time.
- In case of binary inputs the following types of triggers can be defined:
  - Falling edge
  - Rising edge
  - High level
  - Low level
- Statuses of triggers of calculated signals and trigger criteria can be attached to the recorded curves.

- Frequency criteria have resolution of 10 mHz.
- It is possible to activate recording manually from the front panel of the device.
- The records have defined recording pre-trigger and post-trigger times and continuation time.
- All information necessary for analysis is attached to the disturbance record file in the COMTRADE format.
- The recorder has an internal real-time clock, which can be synchronized to an external time source compliant with IRIG-B or NMEA standards with a 1 PPS signal.
- Time synchronization is subject to continuity and consistency conditions of the time signal, i.e. the internal clock of the recorder will not be adjusted if the read time signal does not differ from the previous reading, or it does not differ by a value either greater or lower than the time reading cycle. The continuity condition has to be met by at least two previous readings.
- A wide range of signals, which can be connected to contact outputs and LEDs to indicate alarms or operation of the device (see details below).
- The RZS-9 recorders are supplied with necessary software (ZPrAE-EDIT and iREC) and full documentation in Polish required to design, perform independent configuration and facilitate device operation.
- The manufacturer provides assistance during designing of external circuits, performs commissioning and periodical inspections of the supplied devices.

2. CONSTRUCTION.

The device was designed according to state of the art technology. The internal current and voltage elements, as well as the logic circuits are fully digital. The RZS-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. A multifunctional display and signal LEDs are located on the front panel. A 19”/3U/240 (483×133.5×245 mm) EURO housing is made of chromate plated aluminium, and provides higher resistance to EMC interference.

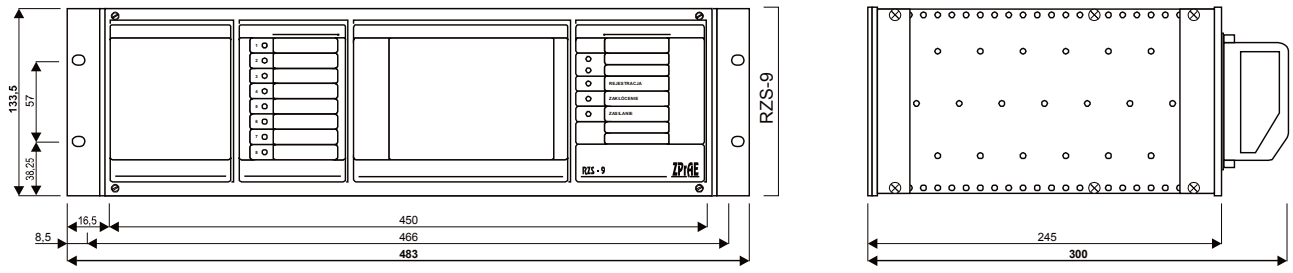


Fig. 2.1. External dimensions of the recorder.

2.1. Front panel.

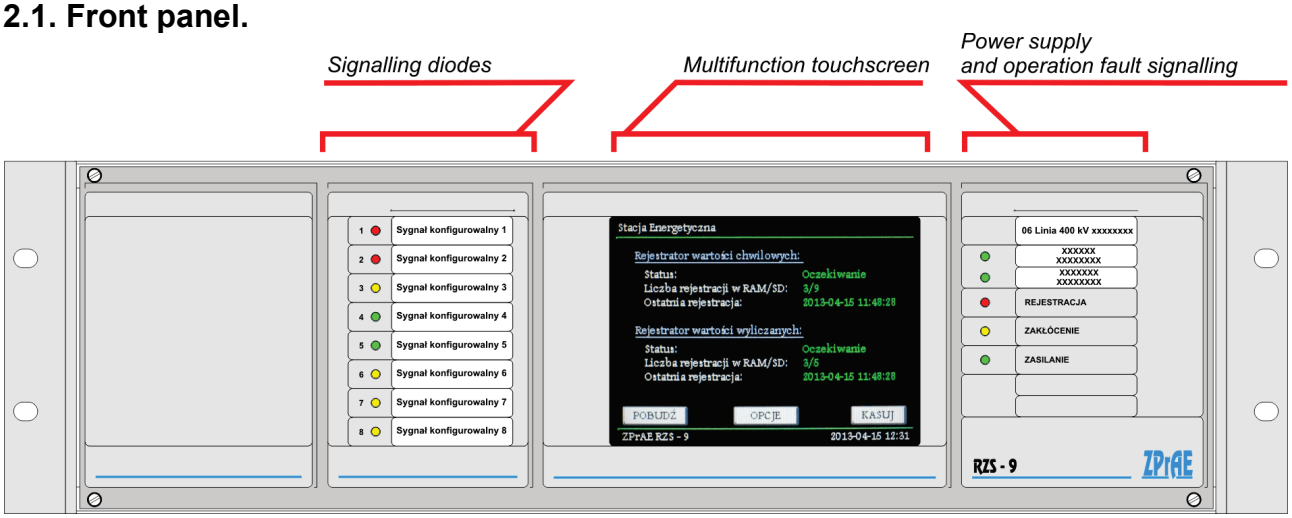


Fig. 2.2. Front panel.

2.2. LCD touchscreen.

The centre of the front panel has a colour touchscreen allowing checking recorder status, visualizing triggers, measurements and provides options to activate or lock the recorder. The default screen is the recorder memory preview. This mode displays current available memory and dates of last triggers of particular recorders.

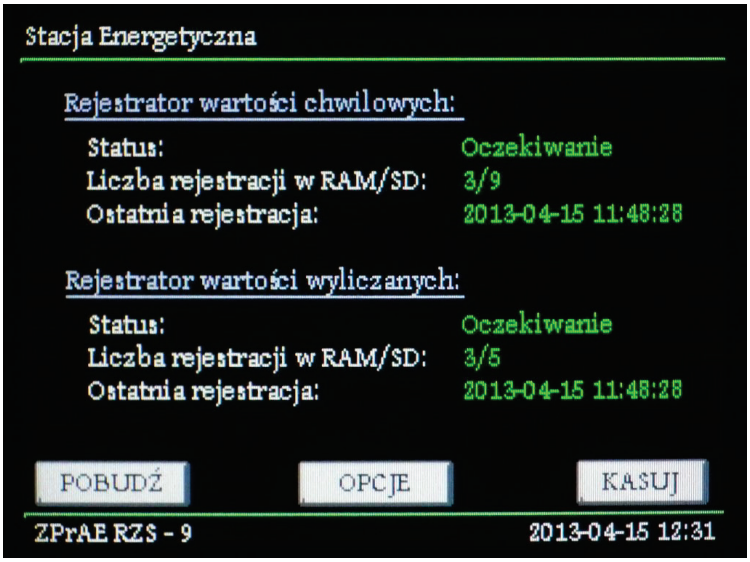


Fig. 2.3. Default screen.

Bottom of the screen displays the following virtual buttons:

- ***ACTIVATE*** – manual activation of digital fault and dynamic disturbance recorders
- ***OPTIONS*** – switch to the OPTIONS SCREEN (described later on).
- ***RESET* SIG.** – confirm saved logic signals of the recorder. It also switches off the „Record" LED activated after the last saved recording.

Fig. 2.4. OPTIONS screen

The OPTIONS screen can be used to lock or unlock the recorder unit. It is also possible to change the operating mode:

- **run-till-full** - the recorder saves the records in memory until it is full, then it locks and awaits for the user to authorize overwriting chosen records
- **circular** – the recorder saves data in the memory based on the circular buffer principle – if it runs out of space it starts overwriting the oldest records.

The following buttons are also available from options view:

- **CALCULATED VALUES** – press to access the preview screen with present values of configured calculated signals (fig. 2.5.).

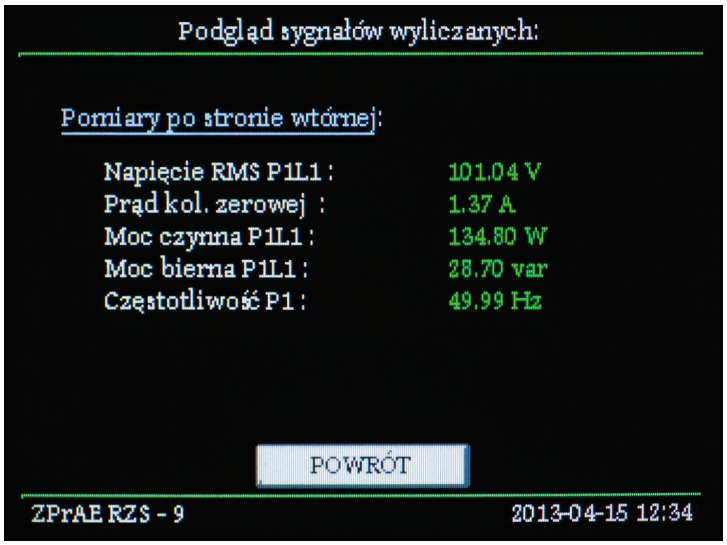


Fig. 2.5. Calculated signals preview screen.

- **TRIGGERS** – press to access the preview screen with currently activated criteria for triggering the recorder. There is also a light which is activated if a different recorder unit in a distributed system signals activation (fig. 2.6.).

Fig. 2.6. Active triggers preview screen.

- **BIN. INPUTS** – the button used to access a screen with visualization of logic states of binary inputs. A green light represents logic state „1”, while a grey one – „0” (fig. 2.7.)

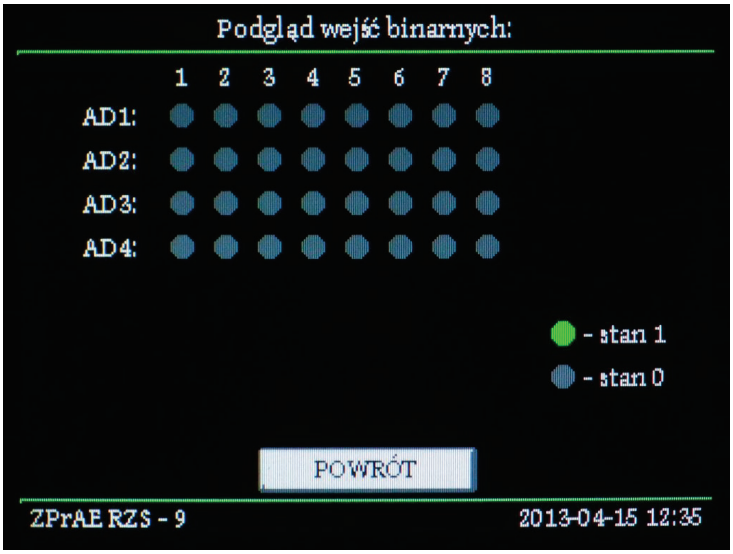


Fig. 2.7. Binary input preview screen.

- **AN. INPUTS** – press to see the analogue input screen. A list of all analogue modules in the device is displayed (fig. 2.8.). Press the „**...**” button assigned to a specific module to see results of measurements for specific phases (fig. 2.9.).

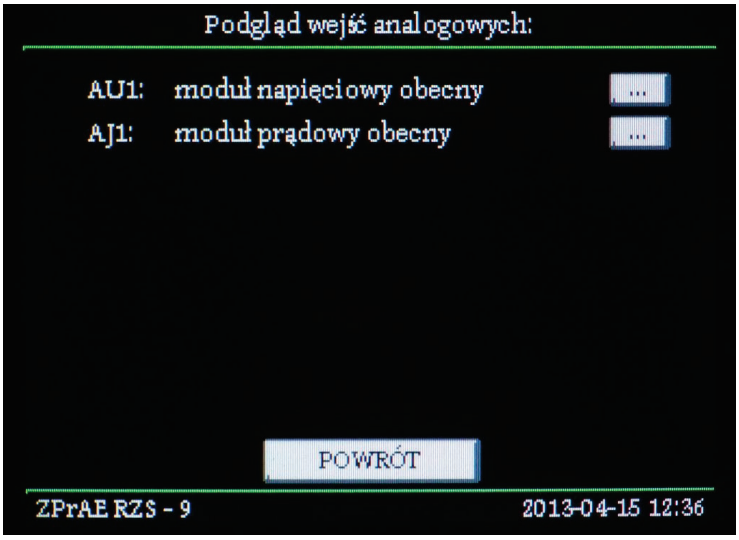


Fig. 2.8. Analogue input preview screen (available modules).

- **CONFIRM** – confirms chosen interlocks and the operating mode. A 4-digit PIN is required for verification (fig. 2.10.). The PIN code can be deactivated by setting it to "0000" in the ZPrAE-Edit software.

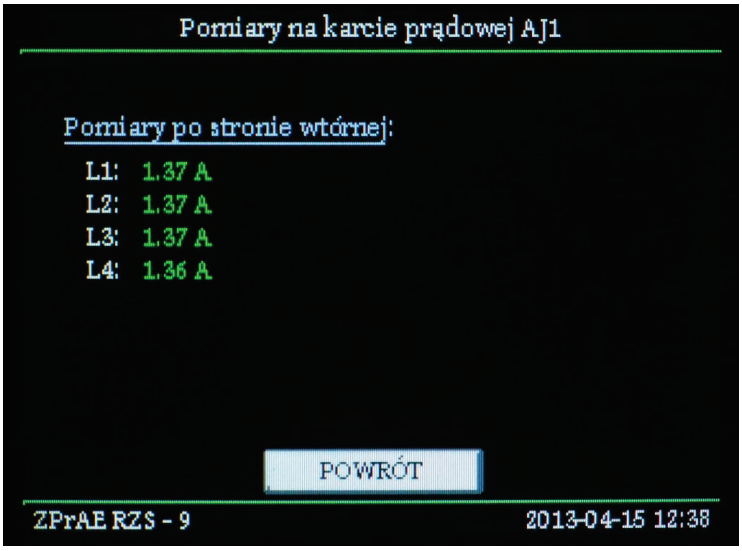


Fig. 2.9. Preview screen with current measurements from analogue inputs.

Fig. 2.10. Verification of the new settings with a PIN code.

- **RETURN** – return to the main screen and ignore potential changes to operating modes and interlocks.

2.3. LEDs signalling power, malfunction and operation.

The right side of the unit displays three LEDs indicating the operating mode:

- ***RECORD*** – red if a new recording was made, but it was not read by the user or accepted with a "RESET SIG" button.
- ***MALFUNCTION*** – yellow in case of an internal malfunction, i.e. if any problems with operation of the device are detected, i.e.: internal or external communication errors, configuration errors, non-volatile memory errors. The LED light up also during initialization of the device, for a few seconds after the power is turned on. If we are dealing with a distributed system of RZS-9 recorders, the main unit (with the MKI-4 module) also indicates a malfunction of any of the secondary recorders by lighting this LED and simultaneous signal of the "Malfunction" relay.
- ***POWER*** – green if there is a power supply to the device.

Additional two top LEDs indicate operation of a digital fault and dynamic disturbance recorder (below). If both of them work correctly the LEDs are green. If any of them was locked (manually or due to the activation conditions being met for an extended period of time), the colour will turn yellow.

The top description field is to be filled with the name of the bay/ facility monitored by the recorder.

2.4. Configurable signalling LEDs and signal description fields.

8 signalling LEDs and description fields for identification with a suitable name of the signal are located left from the LCD touchscreen. Multicolour super-bright RGB LEDs function as optical indicators. It is possible to use the software supplied with the recorder to select the preferred signals from a list available in the program. The LED colour can also be configured from the software level as well. 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.

2.5. Rear panel and modules of the RZS-9 recorder

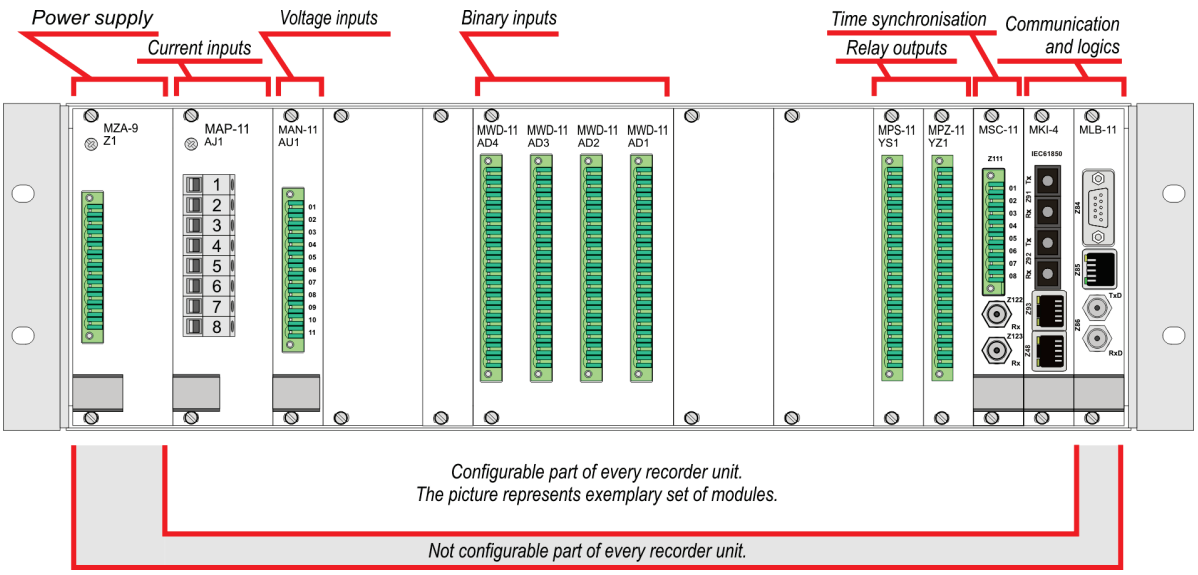


Fig. 2.11. Rear panel.

Card ports for external connections are located on the rear panel. LgY cables are recommended for external connections. The device has current, voltage, binary input and contact output, power and external communication connectors.

3. OPERATING PRINCIPLE.

RZS-9 is a fully configurable recording device with two correlated recorders of:

- *sampled values (DFR)* – recording configured binary and analogue signals in real time at frequency up to 10 kHz (user selected).

- *calculated values (DDR)* – recording signals calculated based on analogue measured values. They can be recoded at a frequency from 0.1 Hz (T=10 s) to 50 Hz (T=20 ms). The following calculated signals can be configured:
  - RMS voltage
  - RMS current
  - Voltage amplitude
  - Current amplitude
  - Zero sequence RMS voltage
  - Positive sequence RMS voltage
  - Negative sequence RMS voltage
  - Zero sequence RMS current
  - Positive sequence RMS current
  - Negative sequence RMS current
  - Frequency of voltage
  - Frequency of current
  - Apparent power
  - Active power
  - Reactive power
  - DC voltage
  - DC current

Both the digital fault and dynamic disturbance recorders can be triggered by advanced trigger conditions, configured based on AND and OR logic gates. Logic gates accept binary signals (or their edge) and configurable signals. It is also possible to define which of the recorders should be activated (sampled or calculated values, or both). In case of a distributed system of RZS-9 recorders, it is possible to define whether a specific trigger condition activates other recorders in the system or not. In case of calculated values it is also possible to configure activation thresholds and their hysteresis. A calculated signal can also be activated by change in an absolute value over a defined period of time (first derivative).

Apart from the ability to configure trigger conditions and sampling frequency, each recorder can have record times defined as per the chart below.

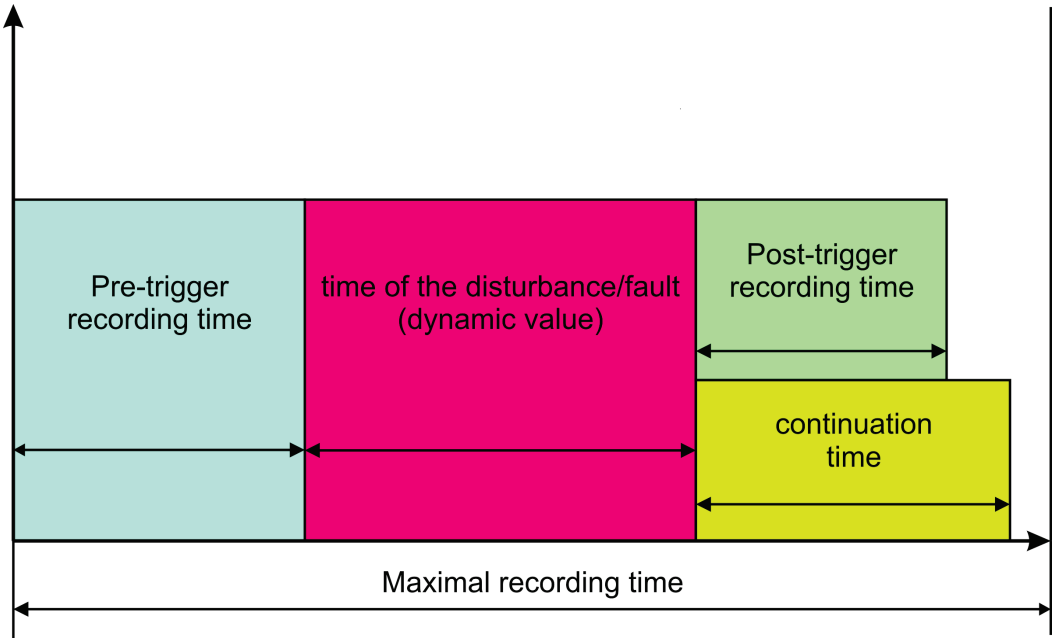


Fig. 3.1. Record time diagram

- *Pre-trigger time* - when a recorder is activated, the record is also going to contain curves over defined preceding *pre-trigger time.*
- *Time of disturbance* - is a dynamic time, depending on the type of the disturbance and lasts until trigger conditions disappear.
- *Post-trigger time* – after trigger conditions disappear, the recorder will attach to the record the curves over defined period of *post-trigger time.*
- *Continuation time* – is a specific time, which starts running after trigger conditions disappear. If during that time successive record trigger conditions occur, the recorder will be triggered again and the records will be merged into one. If no trigger occurs during the *Continuation time*, the record file will end after the P*ost-trigger time.*
- *Maximal record time* – is an overriding limit to the record file size. After the limit is reached recording will be stopped. In case of continued activation "interlock due to long-lasting activation" is applied and no more records are made until trigger conditions disappear.

The recording non-volatile memory can work in two modes (user selected):

- *Run-till-full* – recorder keeps saving records until the memory is full and locks until a user permits overwriting specific records. Active out-of-memory signals can be connected to LEDs or relay contacts.
- *Circular* - the recorder keeps saving records following the circular buffer principle – if it runs out of memory it starts overwriting the oldest records.

3.1. Time synchronization module (*MSC*)

The device's time synchronization is very accurate. Accuracy of the internal clock is greater than 20 PPM. Additionally it can be synchronized with a GPS receiver (NMEA signal + 1 PPS) or with a time source compliant with the IRIG-B standard. The aforementioned methods provide accuracy exceeding 5 µs. Thanks to this feature all RZS-9 recorders placed even in remote locations remain synchronized. The MSC-11 module accepts RS485 standard. It can also provide +24 V power supply for external GPS clock (for example SNC-11). In a distributed RZS-9 recorder system one MSC module in the main unit is sufficient. Accurate synchronization with the remaining units is performed over an optical link.

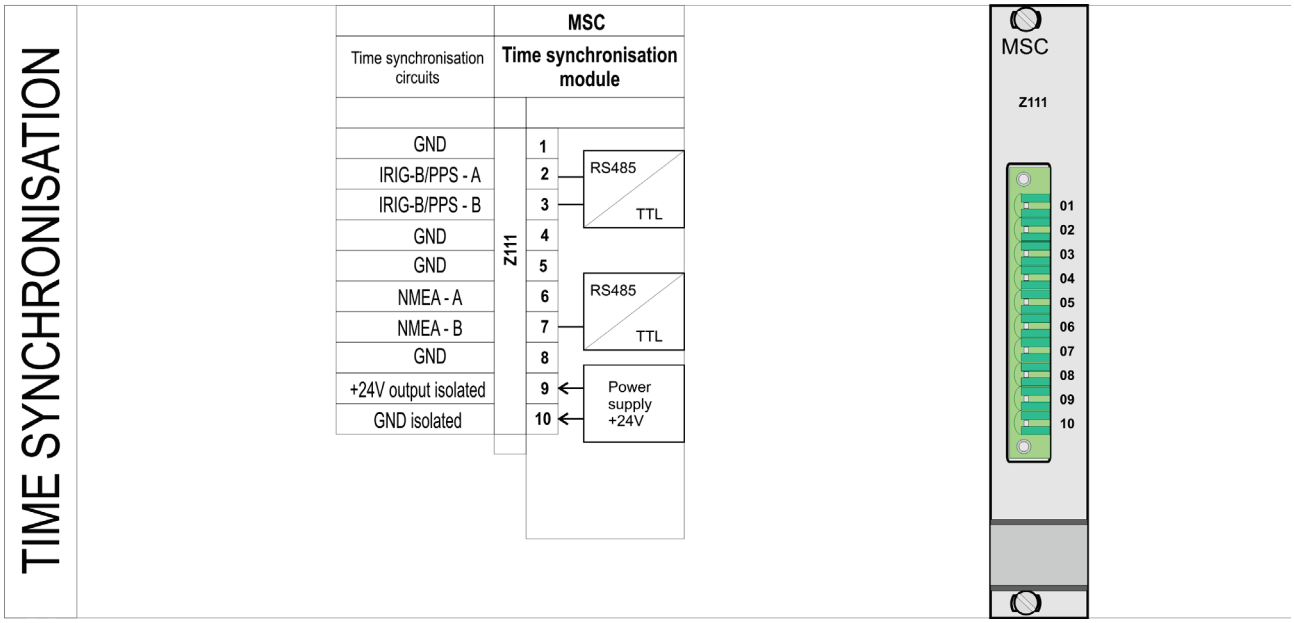


Fig. 3.2. MSC-11 time synchronization module.

3.2. Voltage inputs module (*MAN*)

The voltage input module contains precise, optically isolated measurement circuits based on state of the art sigma-delta (Σ-Δ) transducers. This enables 16-bit measurement results at 10 kHz frequency. Proper SINC 3 filtering provides anti-aliasing effect. High resolution and sampling rate enables precise curve recording and calculation of intermediate values. One voltage input module serves up to 4 voltages. The constant component can be filtered or not (software configuration).

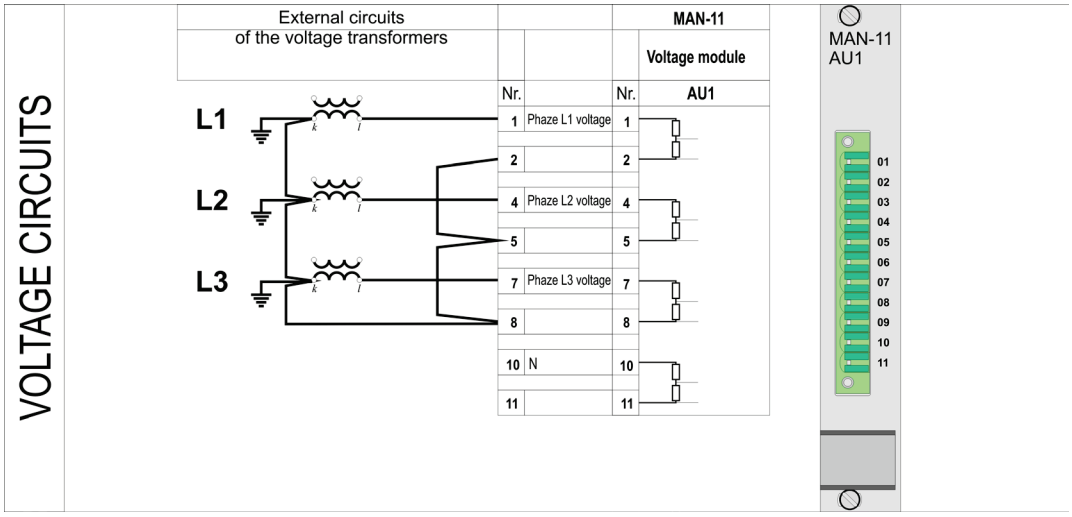


Fig. 3.3. Voltage circuits.

3.3. Current inputs module (*MAP*)

Construction of the current input module is similar to a voltage input module (*MAN*); however, a current shunt is used as the measuring element. This solution provides the ability to measure the constant component of current signals as well. The measuring transducer and the optical isolation path used are identical as those of voltage input module; therefore 16-bit measurement at 10 kHz is also used for calculations. One MAP module serves up to 4 currents.

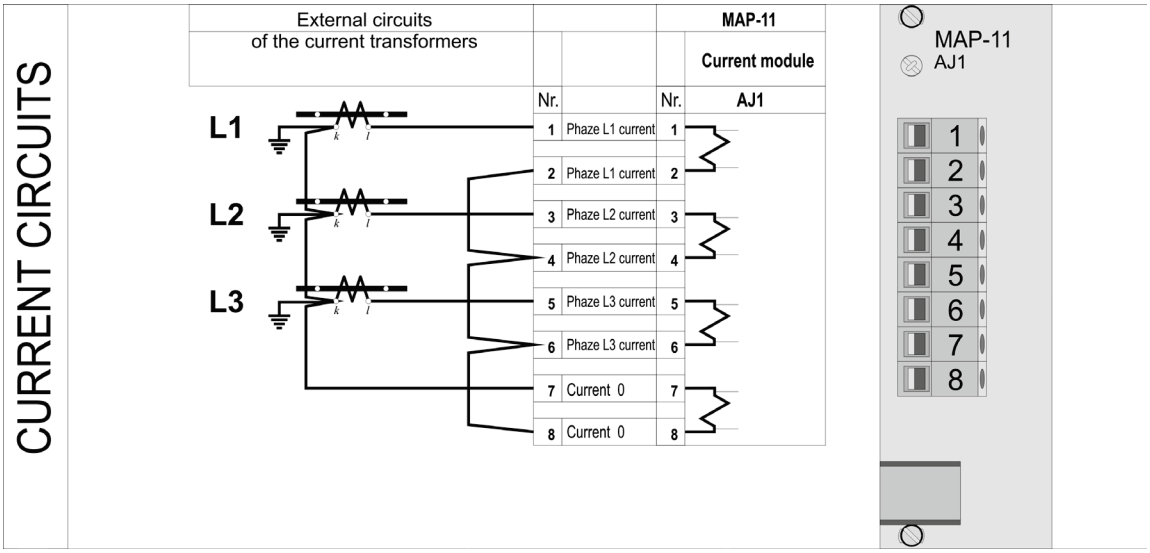


Fig. 3.4. Current circuits.

3.4. Binary inputs module (*MWD*)

Binary inputs are provided by MWD modules; each of the modules has eight independent optically isolated inputs. Input voltage is 220 V DC/AC (110 V DC/AC as an option).

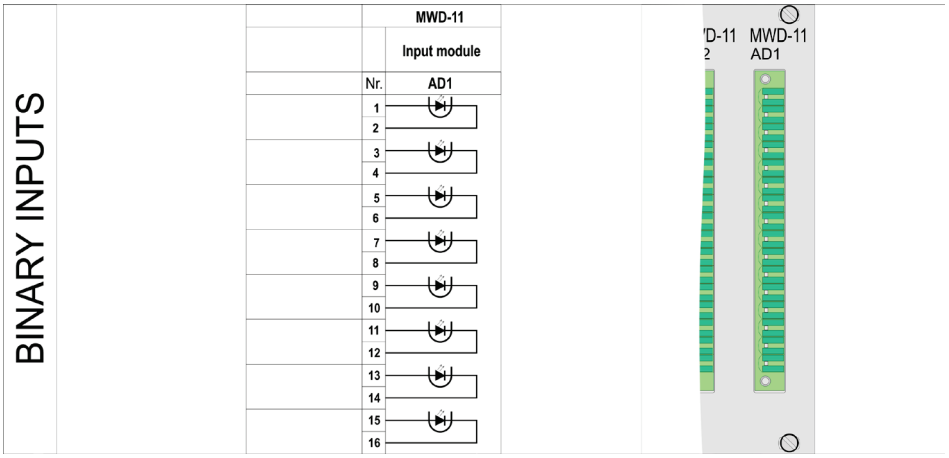
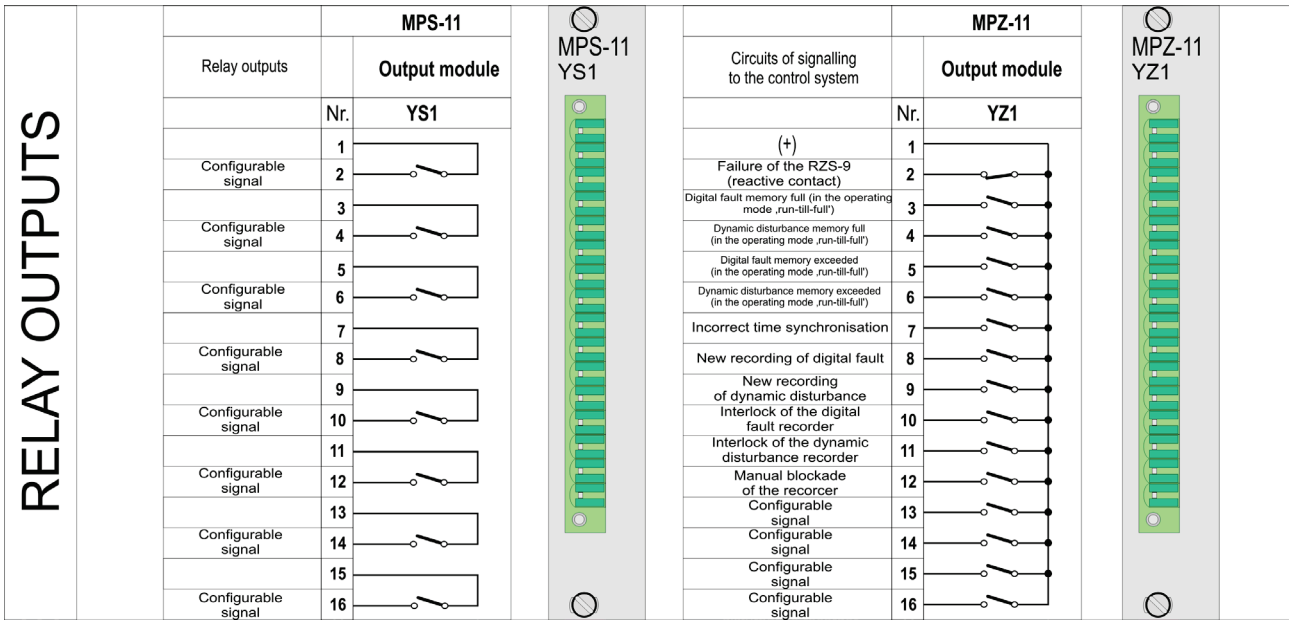


Fig. 3.5. Binary inputs.

3.5. Relay outputs module (*MPS* and *MPZ*)

Relay outputs of the MPZ module are designed to provide contact signals with the recorder's status. This module is equipped with fifteen contacts connected to operate with a common internal positive terminal (ref. to Fig 3.6). Other signal impulses may be sent by the MPS module equipped with eight independent contacts of output relays. The figure below shows factory configuration. In the software service mode the user can change the configuration or assign additional information to contacts unused by default. List of the available signals is provided later below in this paper.



Ref. 3.6. Contact outputs.

3.6. Recorder power supply module (MZA)

The MZA power supply module has two power supply connectors and two independent converters. Each of them can be supplied from an independent 220 V DC source or 230 V AC source (110 V as an option). Two independent power circuits provide full power supply redundancy. One active power source guarantees correct operation of the entire recorder.

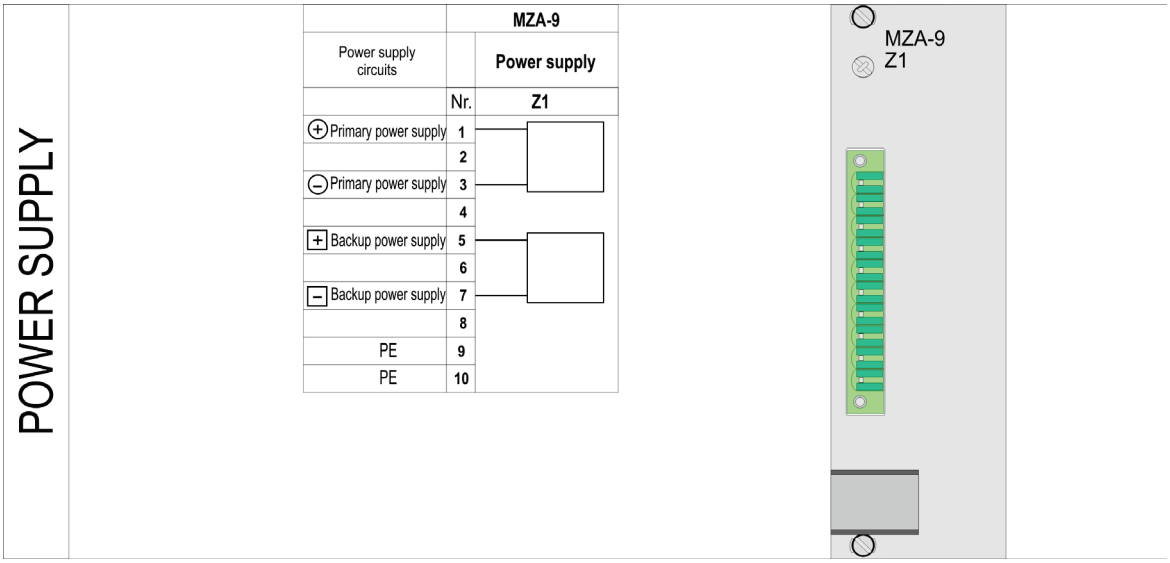


Fig. 3.7. Recorder power supply.

3.7. External communication.

External communication is handled by an MLB logic module and an MKI communications hub. The logic module collects and archives data. It is equipped with cache memory and non-volatile memory for storage of saved records. The module has an RS232 port, which can be used as a service communication port for ZPrAE-EDIT software. The Ethernet port of the MLB module is used for communication with the MKI hub module. The MKI hub module can be optionally equipped with an MOP expansion module, which provides additional RS232 and fibre-optic ports for engineering communication (ZP6 protocol) and for control system communication (IEC 60870-103 protocol).

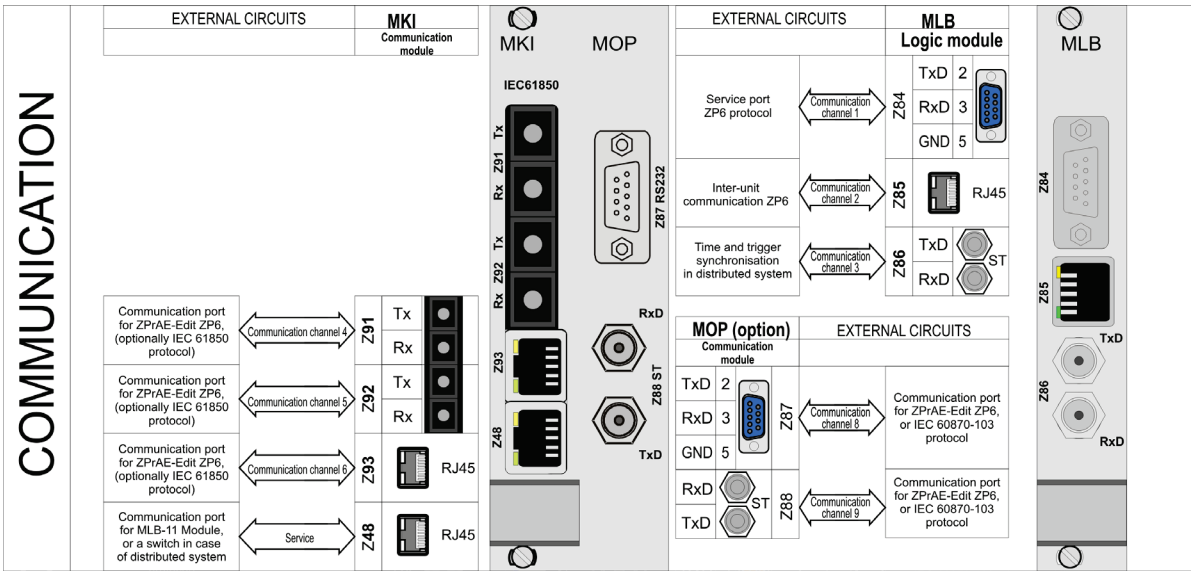


Fig. 3.8. RZS-9 communication.

3.8. Communication between recorders in a distributed system.

In case of a distributed system all MLB modules are connected to an external switch or an optional MLS module in one of the recorders over the Ethernet network. The whole system of RZS-9 recorders is equipped with one MKI communications hub. Communication with ZPrAE-EDIT software is initiated after the user connects to the MKI-4 module over the electrical Ethernet Z93 port, or optical Z91 or Z92 ports.

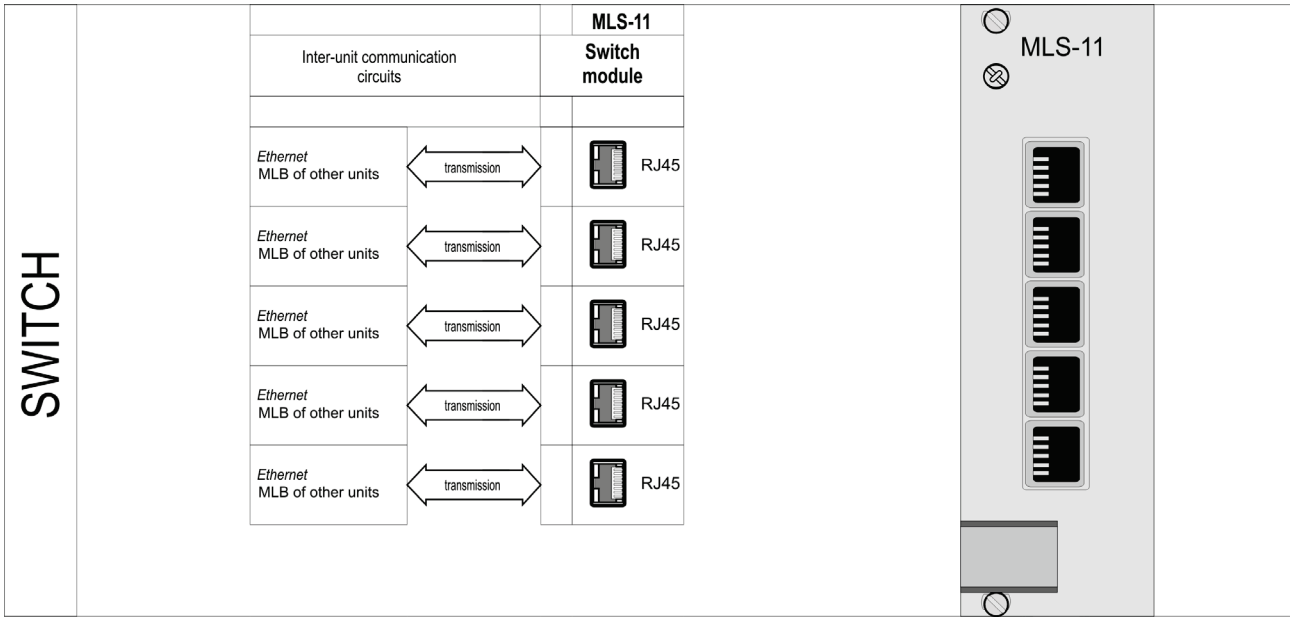


Fig. 3.9. Optional switch module after connection to a distributed RZS-9 system.

3.9. 4-20 mA converters inputs module.

Module of 4-20mA converter inputs (dedicated for measuring of voltage, current, temperature and resistance) is constructed similar to a current input module *MAP*, however the input elements are adapted to signal level of 4..20 mA of the measuring converters. The signal converters should have their own power supply. The Calculations are based on a 16-bit measurement at 10 kHz frequency. One module serves up to 4 4-20mA converters.

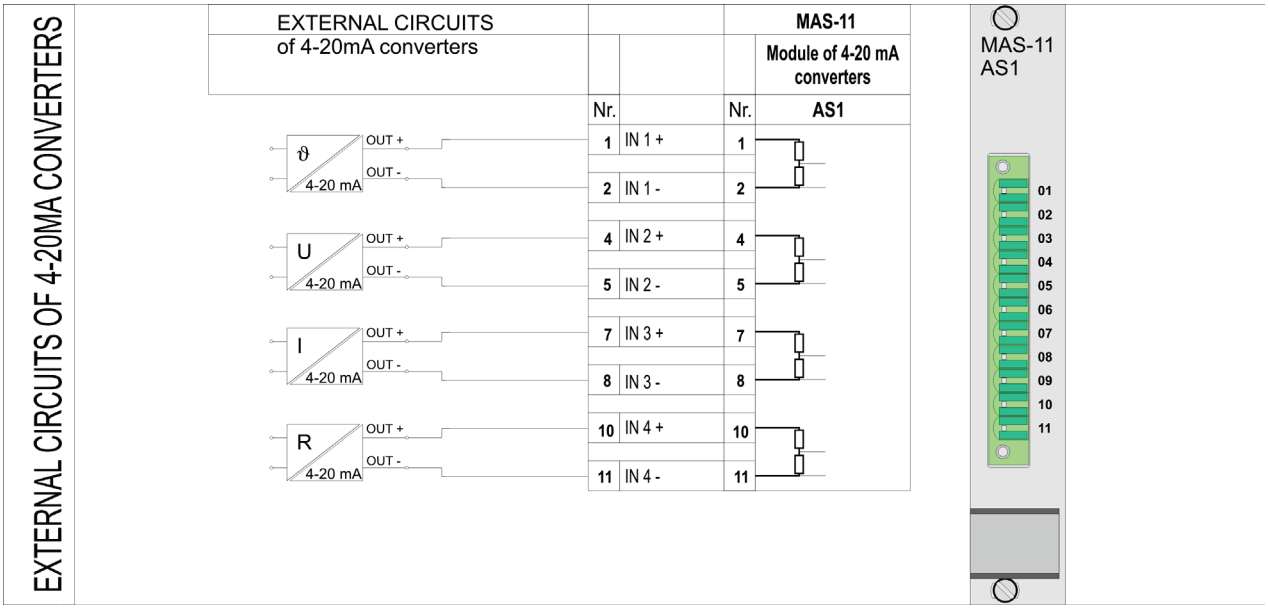


Fig. 3.4. Converters circuits 4-20mA.

3.10. Event recorder.

The main recorder memory is capable of storing up to 2 thousand events (triggers, diagnostic messages etc.), at 1 ms resolution. The events are stored the logic module MLB of every unit of the RZS-9. In case of too many recorded events the oldest data will be overwritten.

Data from the recorder can be optionally sent to a primary control and monitoring system via the IEC 61850 protocol. Event log can be also viewed in the proprietary ZPrAE-Edit software.

4. UTILITY SOFTWARE.

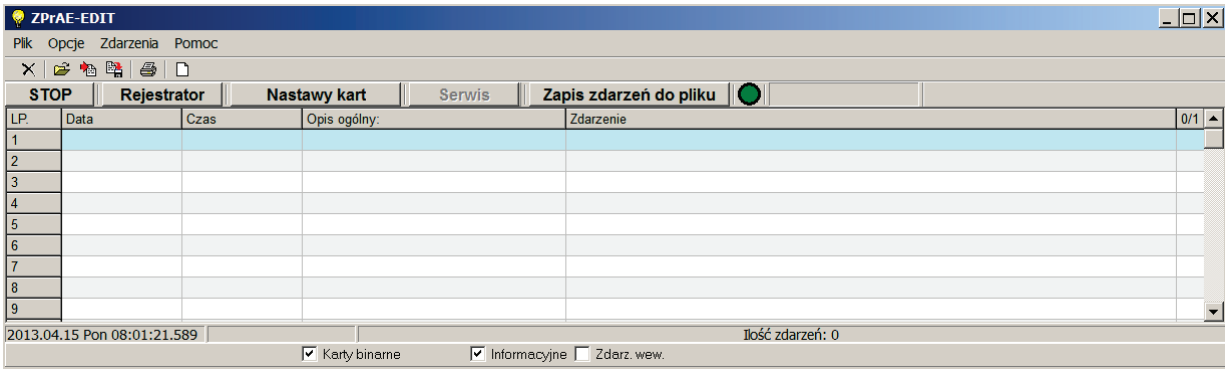
4.1. Installing and launching the software.

Along with an RZS-9 recorder the user receives software for its configuration and operation. Installation software is provided on CDs. In order to start installation launch the SETUP.EXE file from the CD provided and follow the instructions given by the installation program. Files necessary for the program to work will be copied to the computer and a base folder for the events in a given facility will be created (it can be selected during installation), where data files copied from device memory will be saved (with *.ZP6 extension). Depending of the Windows version the base folder will be located as follows:
- for Windows XP a folder under the following location:
C:\Documents and Settings\All Users\Dane aplikacji\ZPrAE\Dane
- for Windows Vista/7 a folder under the following location:
C:\ProgramData\ZPrAE\

After installation is complete a ZPrAE Sp. z o.o. folder will appear in the Windows start menu. The shortcut to ZPrAE EDIT software will be added in to that folder.

4.2. Start working with the ZPrAE - EDIT software.

After the software is launched the main window will be displayed; it can be used to view recorder contents or to access more windows to view operating status or to configure the device.



Ref. 4.1. 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.

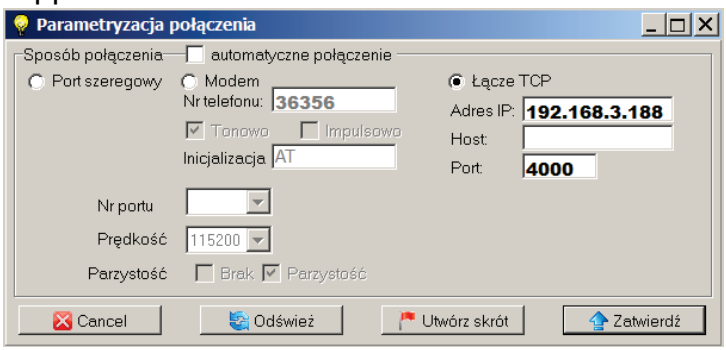


Fig. 4.2. Connection parameters window.

User can send data over various physical interfaces: RS232, RS485, and Ethernet. An RZS-9 recorder is equipped with RS232 and Ethernet ports as a standard. Due to amount of data exchanged between a computer and the recorder Ethernet connection is the recommended solution.

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

In case of an Ethernet connection is to be used, click “TPC Link” and provide an IP address of the device and a port number.

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 with the “Create a shortcut” button. This will create a link to the program with all current transmission parameters.

Many devices manufactured by our company can be connected to a LAN network. In order to find e.g. an IP address and a port of a device the following option can be selected from the menu: OPTIONS > FIND DEVICES IN THE NETWORK. A window (like the one shown below) with a list of devices will appear; searching takes up to 10 seconds.

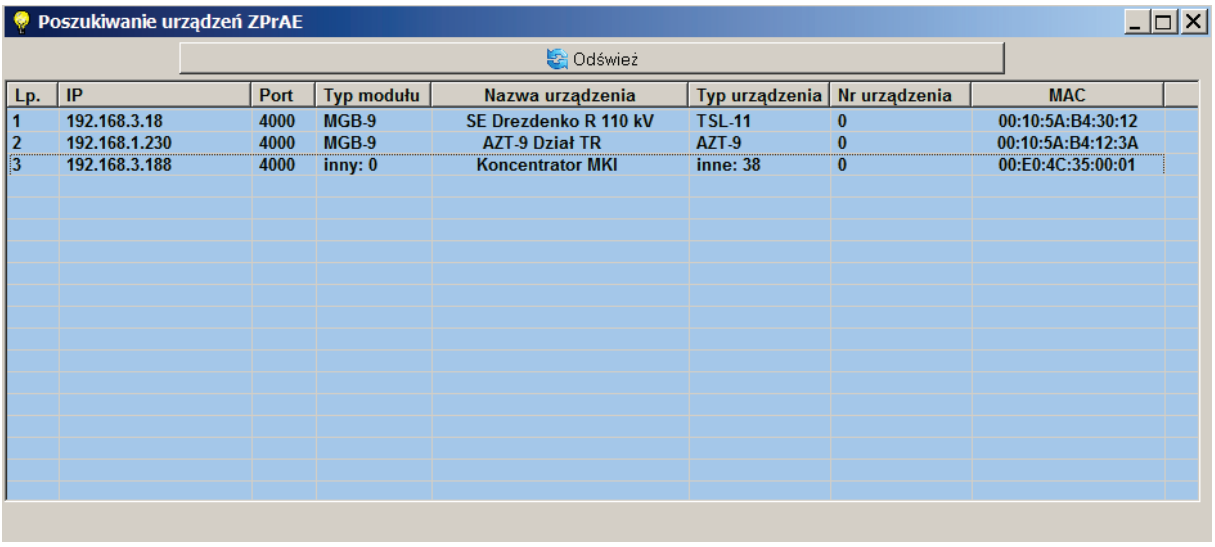


Fig. 4.3. Window for searching devices in a LAN network.

As clearly visible in the example above there are three devices in the LAN network. Double-clicking the selected device will configure the software to connect to that device.

The next step after selection of a device is to connect. In order to do so return to the main window of the programme and press the “START/STOP” button. The window with search for available devices on selected transmission channel will appear on the screen (refer to Fig. 4.4). Click INITIATE SCANNING to begin search for components of the recorder. Next, highlight the right device and press CONNECT TO THE SELECTED DEVICE. The program initiates communication with the selected device, closes the selection window and returns to main view.

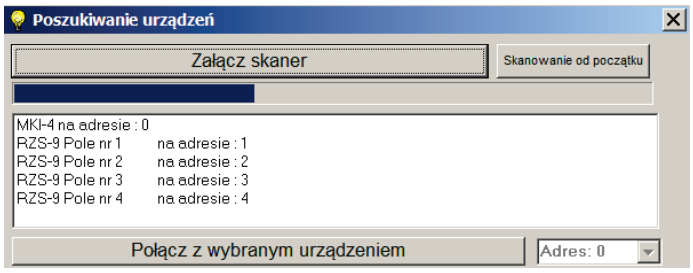


Fig. 4.4. Device scanner window

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,
- **Recorder** – access recorder setups and read saved records,
- **Module settings** – preview and change input modules' settings (binary and analogue)
- **Save events to a file** – save a file with current events to the base folder.

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

There are four levels of user right: 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, setups preview.
- Level 1 – default password: “haslo1” gives rights to reset signalling diodes.
- Level 2 – default password: “haslo2” gives right to set the device time synchronised with computer system time,
- Level 3 – default password: „haslo3” gives rights to send the setups 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 a 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.

4.4. PIN-code protection of the display.

User can enable additional protection of RZS-9 touchscreen by clicking OPTIONS-> Change the display PIN code. If the PIN value is other than „0000”, upon each confirmation of the changes in the device operating parameters from a touchscreen, a window asking the code will be displayed. Only after entering a correct code the changes will be accepted by RZS-9.

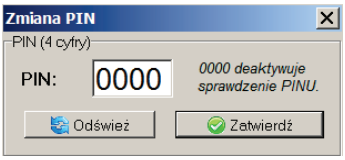


Fig. 4.5. Window for changing the display PIN code.

4.5. Read from the event recorder

A main program screen does not only contain the icons and buttons enabling the access to selected functions but it also includes a table of events 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 1 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. In the MAIN MENU click EVENTS, than DOWNLOAD EVENTS. After selecting this option, 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. In the events MENU select DOWNLOAD A SPECIFIED NUMBER OF EVENTS. A window as shown in the figure below will be displayed where it is necessary to enter a required number of events to be downloaded and press ENTER on a keyboard or OK in the software.

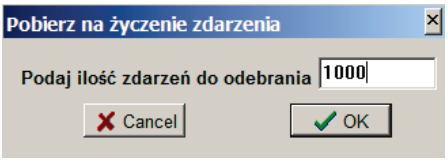


Fig. 4.6. Window for entering a number of events to be downloaded.

It is possible to activate an option of AUTO SAVE of events into the base folder in packages of 1000 events. In order to do so, click EVENTS in the MAIN MENU and mark option “AUTO SAVE AFTER 1000 EVENTS. If this option is enabled during. File name consists of the word EVENTS and date and time when the file was saved:

“Events 2008_03_26 13_03_42_749. ZP6”

The file will be saved in a base folder, in a subfolder of a given object (for example “Bay No. 1).

Button “Save events to file” on the toolbar in the main program window enables saving of last events received and shown in a table of events. Additionally the table of events in the main window will be cleared. When closing the program all unsaved events are saved to a file with a default name in a relevant folder.

4.6. Settings of current and voltage inputs modules.

Each of current and voltage input modules has 4 measuring lines. Detailed description of the modules is presented in chapter 3.2 and 3.3. In order to setup the analogue modules press MODUES SETUP in the MAIN WINDOW. A Window as described on fig. 4.7 will appear. It enables configuration of the inputs:

- description – a text that appears in a COMTRADE file as a full signal name,
- identifier – a text that appears in a COMTRADE file as a short signal name,
- ratio – actual setup of transformer primary and secondary side.

Status of the module is displayed with a LED situated next to arrows for choosing selected module. Green LED indicates that module is operational; red LED indicates it malfunction. Bay’s current transformation ratio is entered as a setup of a current card and bay’s voltage transformation ratio as voltage card setup.

There are special modules which support sensors with current output of 4..20mA. To configure such analogue card, it is necessary to specify the measuring unit and sensor minimal (for 4 mA) and maximal (for 20 mA) range.

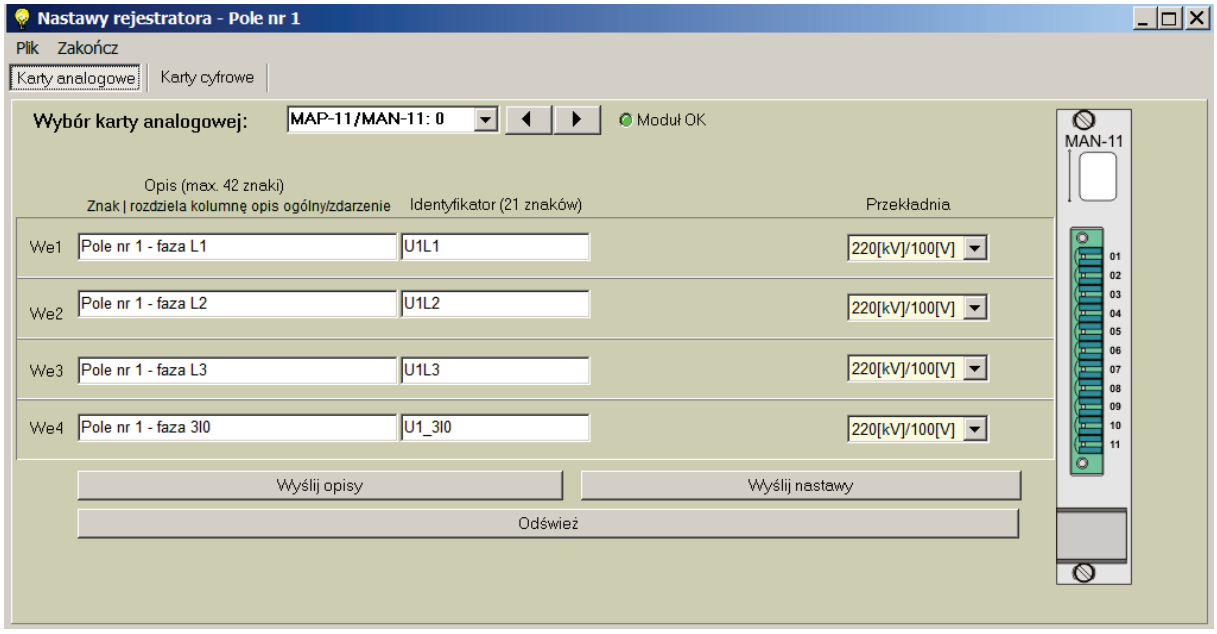


Fig. 4.7. Analogue card setup window.

After selecting BINARY INPYT MODULES option a window as shown in figure 4.8 below will be displayed. It enables module configuration:

- description – a text that appears in the table of events and in COMTRADE file as a full signal name,
- identifier – a text that appears in COMTRADE file as a short signal name.

As in case of analogue modules it is possible to check module status, presented with a LED. Green LED indicates that module is operational; red LED indicates malfunction.

Next to each input there is a status LED that informs whether power supply is applied to the input.

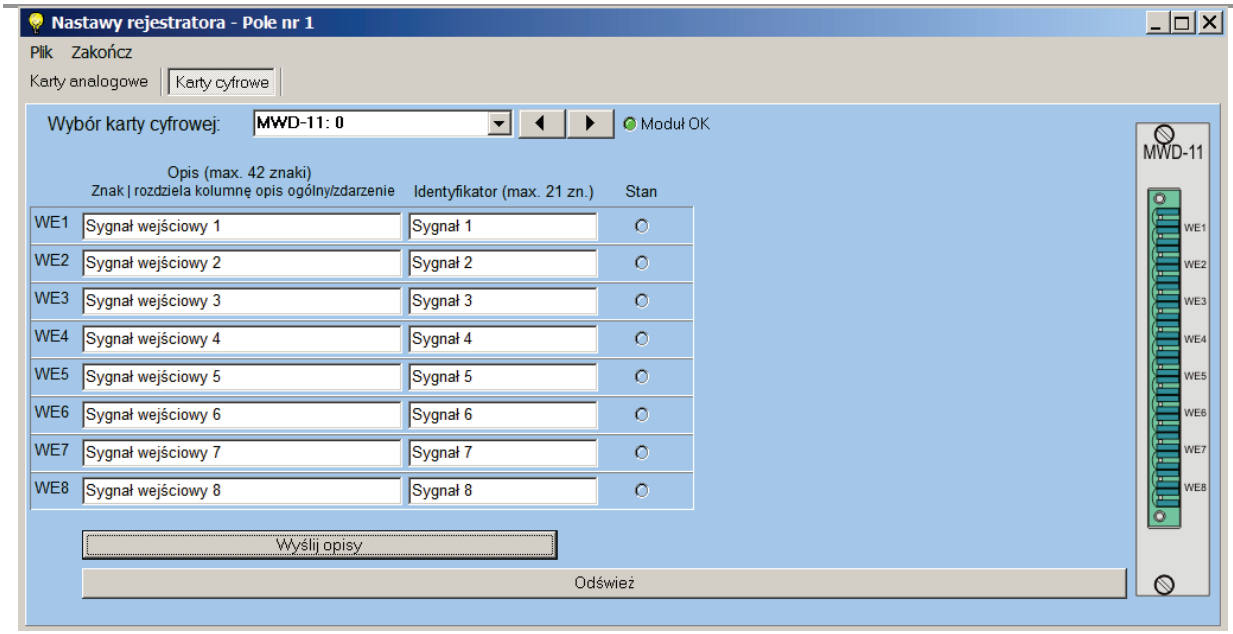


Fig. 4.8. Binary card setup window.

4.7. Readout from disturbance recorders.

RZS-9 device is equipped with two recorders:

- digital fault recorder (fast changing) – with sampling frequency from 1 kHz to 10 kHz
- dynamic disturbance recorder (slow changing) – with sampling frequency from 0.1 Hz to 50 Hz.

To check the list of recorded disturbances select RECORDER option in main program window. A window, that contains several tabs, as shown in figure below will be displayed:

- digital disturbance recorder tab,
- dynamic disturbance recorder tab,
- recorder setups tab,
- recorder triggers tab,
- calculated signals tab,
- configurable signalling tab.

First tab contains the list of sampled value record files that are saved on the device. Basic table includes:

- address – bank no. of device flash memory,
- strobe date and time – moment when the record was triggered,
- weight – it is an importance of the record depending on the trigger criterion,
- status – takes the values: “saved record” or “downloaded/confirmed” and other values in service mode.

By default the list is sorted chronologically but it can be sorted accordingly to values in other column by clicking a selected parameter.

When selecting a given record by highlighting the row and right clicking, the user may download the given record to a drive or allow it to be overwritten (only in case of selecting run-till-full mode). The recorder in run-till-full mode can overwrite only “empty” banks of records or records with status "downloaded/confirmed".

The user may trigger the sampled value recording (*DFR*) manually by selecting RECORDER TRIGGER button. The device will start recording the sampled values according to general recording time (pre-trigger recording time, post-trigger recording time). When data collection is completed a new entry highlighted in blue will appear.

To view the records on the computer, first it is necessary to save a given row as COMTRADE format by right clicking on the row and selecting download records option. When the record is downloaded to PC drive, program runs the viewer automatically and displays disturbance curves. Previously downloaded files can be viewed by selecting OPEN RECORD FOLDER in which the records archived on the computer are displayed.

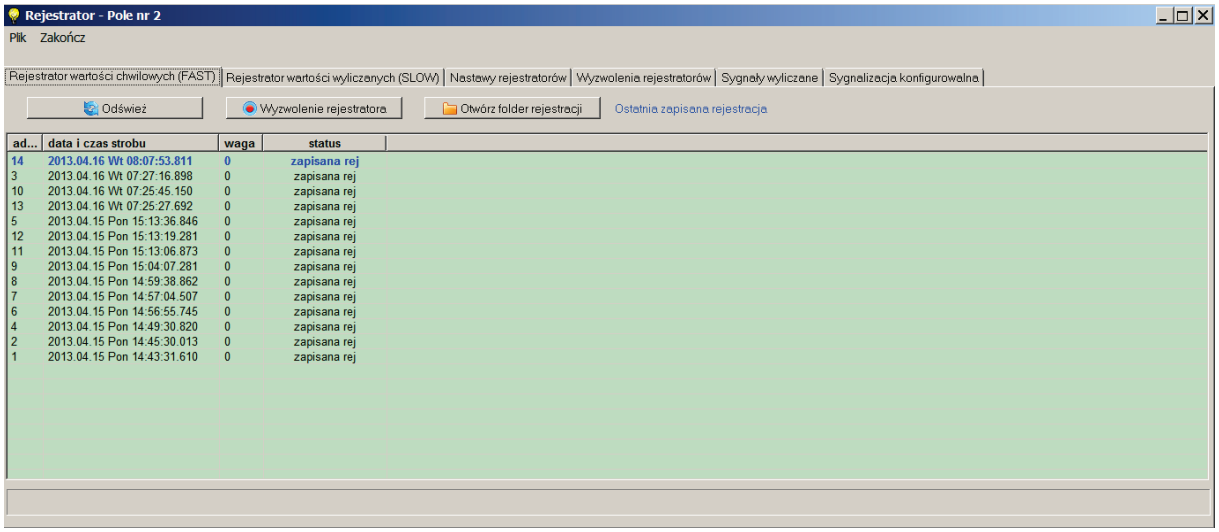


Fig. 4.9. Digital disturbance recorder window.

The procedure is similar in case of calculated value recording (*DDR*). All functions such as downloading, confirmation, sorting and viewing of the records are the same as in case of sampled value records. The figure below shows dynamic disturbance recorder tab.

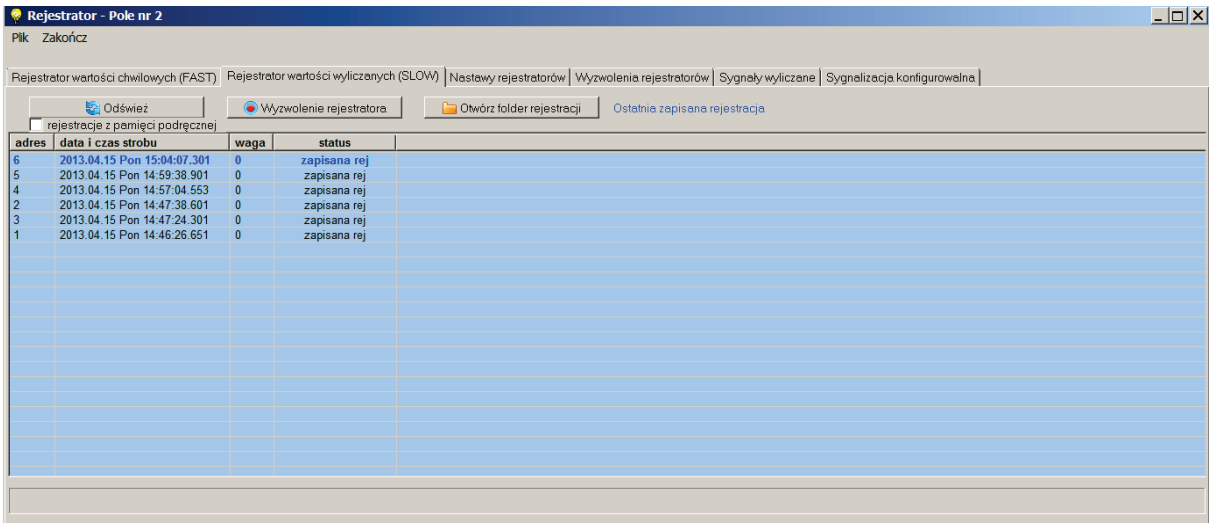


Fig. 4.10. Dynamic disturbance recorder window.

4.8. General setup of recorders.

This tab of the recorder window contains general recorder setups. Window layout is shown below.

In the upper part of the window there are various commands user can send, such as:

- SIGNALLING RESET – switches off the record light on the front panel of the device,
- LOCK THE RECORDER – results with locking the data collection function,
- UNLOCK THE RECORDER – results with unlocking the data collection function,
- ACTIVATE SLOW and FAST RECORDERS – activates digital disturbance and dynamic disturbance recorders at the same time.

Below the control buttons user can input the device name e.g. name of the bay linked with the recorder unit. In order to confirm the new name click SEND NAME of the DEVICE. Based on this name a subfolder for events and records is created.

The field below is used for selection of operating mode and memory limit of the recorder. The recorder can work in two modes of saving the new records i.e.: run-till-full mode or circular memory buffer mode. In case of run-till-full mode a new record can be saved only if there are empty banks or banks with “downloaded/confirmed” status available. To activate a signal before the recorder runs out of memory, the user can set a memory limit value in percentage. After clicking SEND SETUPS the aforementioned parameters are confirmed and saved by the recorder.

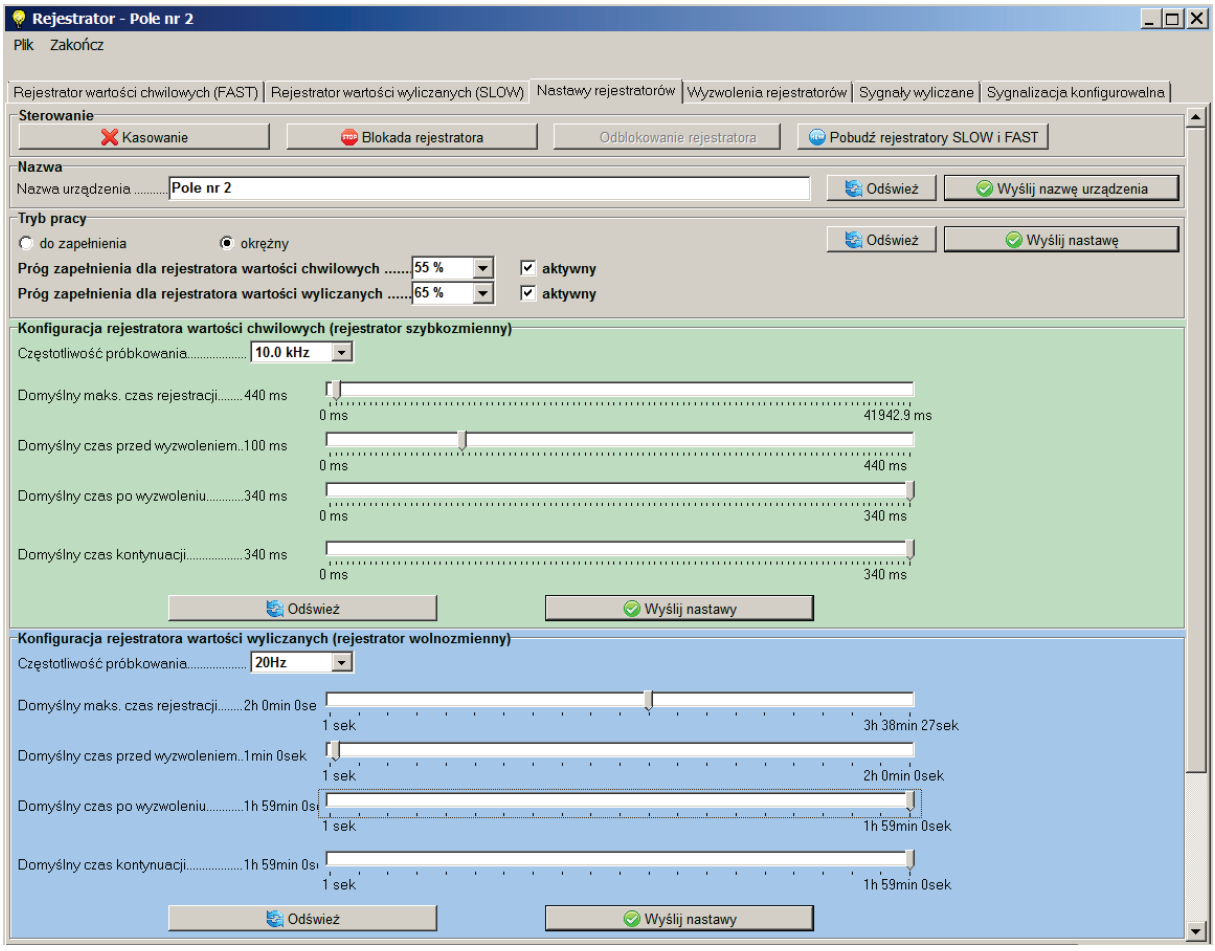


Fig. 4.11. Recorder setups window.

Configuration of digital fault recorder (fast changing disturbances) consists in determining:

- Sampling frequency: 1 kHz, 2 kHz, 5 kHz, 10 kHz to be selected,
- and default times:
- Maximal recording time,
- Pre-trigger time,
- Post-trigger time,
- Continuation time.

Maximal time of single digital fault record is defined based on the number of analogue and binary modules. Default times are used to define the recording times in case of activations with disabled dedicated trigger times and for activations from ZPrAE EDIT software. For digital disturbance recorder and maximal frequency of 10 kHz and standard bay input (4 currents, 4 voltages and 32 binary signals) maximal time of single digital fault record amounts to 23.3 seconds.

Configuration of dynamic disturbance recorder (slow changing disturbances recorder) is similar and consists in determining:

- Sampling frequency: 50 Hz, 20 Hz, 10 Hz, 5 Hz, 1 Hz, 0.5 Hz, 0.1 Hz to be selected,
- and default times:
- Maximal recording time,
- Pre-trigger time,
- Post-trigger time,
- Continuation time.

Maximal time of dynamic disturbance record is defined based on the number of calculated channels which are configured on the other tabs. Default times are used to define recording times in case of activations with disabled dedicated trigger times and for activations from ZPrAE EDIT software. For dynamic disturbance recorder and sampling frequency of 1 Hz and 16 calculated channels the maximal time of single dynamic disturbance record amounts to 9 hours.

4.9. Configuration of recorder triggers.

In a RZS-9 device it is possible to create trigger logic of digital disturbance and dynamic disturbance recorders. There are 16 advanced triggers available. Each trigger is created by a logic gate with 8 inputs. Each gate can be a disjunction or conjunction of input signals.

The following can be used as input signals:

- binary signals from input cards with trigger selected from low or high level, rising or falling edge, or a status change,
- statuses of calculated signals – after correct configuration of e.g. bay over-current function or under-frequency function.

Logic signal output from the gate may trigger the dynamic disturbance recorder or/and digital disturbance recorder as well as all recorders in the system (other RZS-9 units in a group of recorders).

For an advanced trigger, the user can define the weight of a record which will be shown in the record list. It may be helpful in selecting more important record.

For each advanced trigger, it is possible to define the alternative times of fast recording or calculated values recording. It makes it possible to reduce the time of recording triggered by busbar protection where the activation is very fast.

A window below shows two advanced triggers. First one is a simple trigger by binary input card (AD1.1) with input description „Switch P1" which is activated by high level. The other gate inputs are inactive. Advance trigger no. 1 activates the fast recorder with alternative times: pre-trigger recording time 25 ms, post-trigger recording time 250 ms and continuation time 250 ms.

In case of advanced trigger no. 2, the 3 conditions must be fulfilled (AND conjunction) i.e. activation of calculated signals: Voltage L1-P1; Current L1 – P1 and Frequency P1. When all the conditions are met, a slow recording (of calculated values), with alternative times: pre-trigger recording time 1 second, post-trigger recording time 4 seconds and continuation time 4 seconds, is triggered.

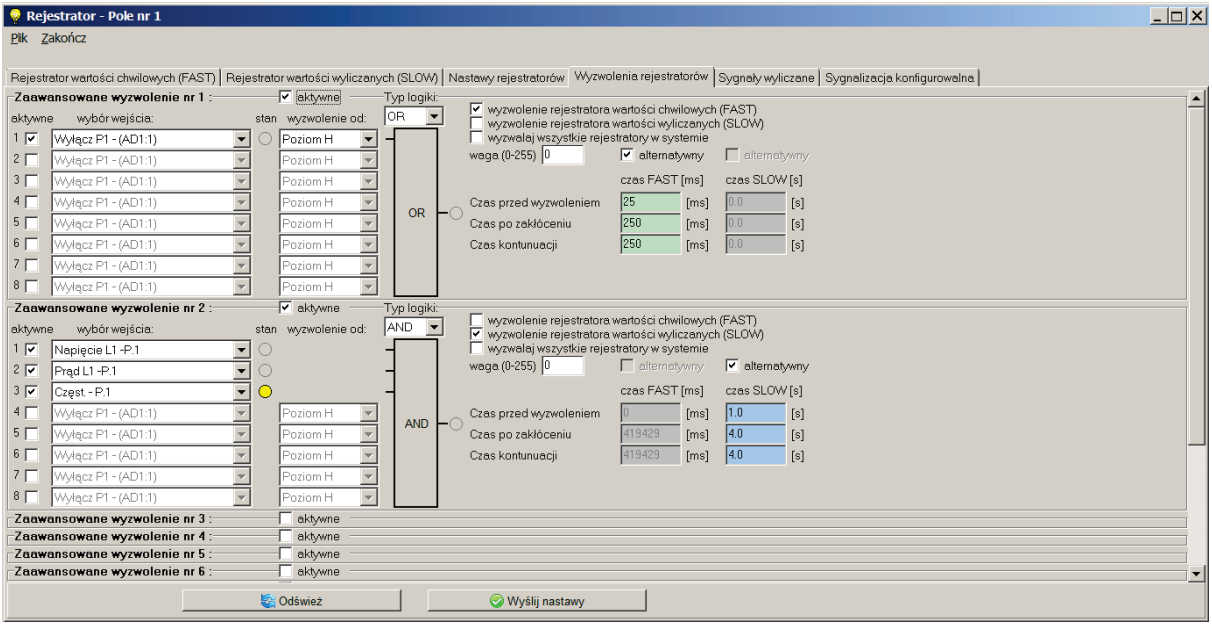


Fig. 4.12. Advanced trigger setup window.

4.10. Calculated signals setups

RZS-9 device can record selected signals, which are calculated based on basic signals of currents and voltages, such as:

- Positive/negative/zero sequence current and its first derivative,
- Positive/negative/zero sequence voltage and its first derivative,
- Active power and its first derivative,
- Reactive power and its first derivative,
- Apparent power and its first derivative,
- Frequency and its first derivative,

One of the tabs in the RECORDER window enables configuration of maximum 16 calculated signals. The user can choose the following functions:

- RMS Voltage and current,
- Current/voltage amplitude,
- Zero sequence RMS voltage/ current,
- Positive sequence RMS voltage/ current,
- Negative sequence RMS voltage/ current,
- Voltage/current frequency,
- Apparent, active, reactive power
- DC current/voltage

After a function for a given calculated signal is changed, it is necessary to select a signal source i.e. voltage or current input or in case of power measurement both sources.

Each calculated signal should be given a description (identifier) which is shown in COMTRADE files and other program options. Primary and secondary values of a measurement are displayed next to the description. For each calculated signal it is possible to set an individual activation limit based on value overrun (upper limit), decrease of the value below the limit (bottom limit) and increment of the value in set time (first derivative - dX/dt). The upper and bottom limits have separate activation and reset limit i.e. adjustable hysteresis. For activation from the first derivative, it is necessary to set an increment value and time range for which the increment is measured. Measuring windows for this parameters are: 10 ms, 20 ms, 30 ms, 40 ms, 50 ms, 60 ms, 80 ms, 100 ms, 120 ms, 150 ms, 200 ms, 250 ms, 300 ms, 400 ms, 500 ms, 600 ms, 750 ms, 800 ms, 1000 ms, 1200 ms, 1500 ms, 2000 ms.

Channel 16 may be used as an optional channel for recording the trigger criteria and activation of calculated signals. This applies to dynamic disturbance recorder.

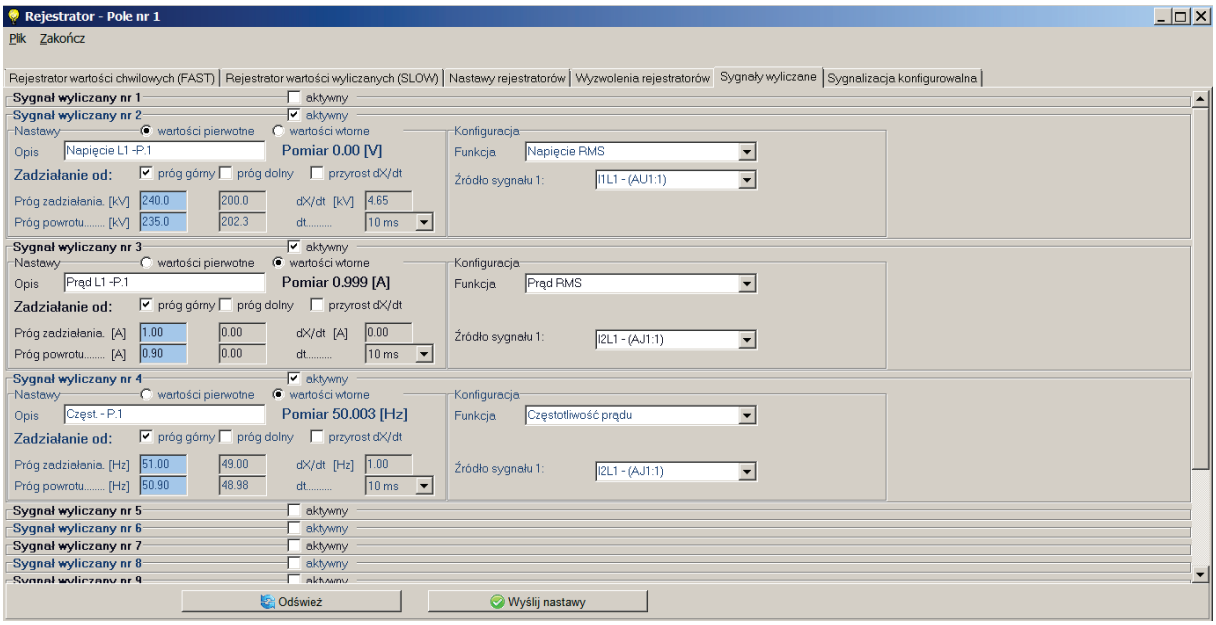


Fig. 4.13. Calculated signals window.

4.11. Configurable signalling.

On the front panel of RZS-9 recorder there are 8 programmable, multicolour LEDs with description slots. Moreover, the unit can be equipped with 15 relay contact signalling module MPZ and optionally with an MPS module consisting of 8 independent relays.

LED and relays configuration consists in assigning one signal from a list of available signals to a colour of a LED or a relay.

List of signals available to the user:

- Inactive signal
- Always active signal
- RZS-9 malfunction
- RZS-9 malfunction (normally closed contact)
- Run-till-full mode (inactive when in circular mode)
- New fast record in memory
- New slow record in memory
- Interlock of the dynamic disturbance recorder
- Interlock of the digital fault recorder
- RZS-9 manual interlock of the recorder
- Criterion interlock by long-lasting trigger – multiplex signal

- Interlock of activation by other units (long-lasting activation) – multiplex signal
- Digital disturbance recording in progress
- Dynamic disturbance recording in progress
- Manual control from software
- Activation of digital fault recording by other unit in the system
- Activation of dynamic disturbance recording by other unit in the system
- Memory limit set for digital fault recorder reached
- Memory limit set for dynamic disturbance recorder reached
- Full memory of digital fault recorder
- Full memory of dynamic disturbance recorder
- Activation of trigger condition no. 1..16
- Activation of calculated signal no. 1..16
- Display LED no. 1..8
- Correct signal of time synchronisation NMEA
- Correct signal of time synchronisation IRIG-B
- Communication error in optical connection ring
- Correct synchronisation signal 1 PPS
- No correct signal of time synchronisation (in general)
- Communication error with unit 1..32
- Internal error of unit 1..32
- Internal error of unit 32
- Unit malfunction 1..32
- New digital fault record in unit 1..32
- New dynamic disturbance record in unit 1..32
- Recorder interlock in unit 1..32

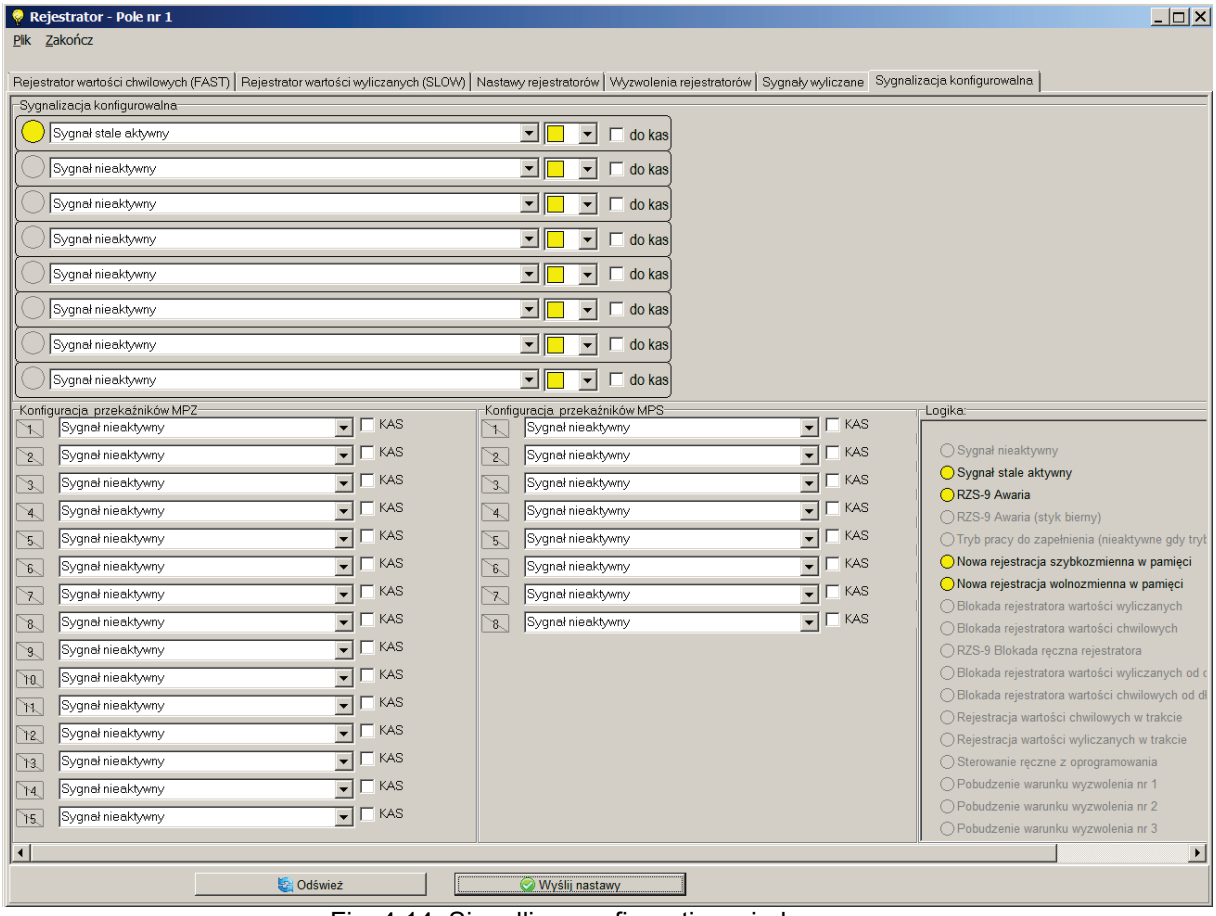


Fig. 4.14. Signalling configuration window.

5. 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 start menu by selecting 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. 5.1.

Main features of iREC software:

- Disturbance data analysis,
- Ability to display all or selected analogue or binary channels,
- Grouping i.e. combining the selected channels,
- Setting of channel amplification can be done separately for each curve,
- Any time scale,
- Ability to select any colour for each curve
- Ability to use up to two markers informing on curve values at a given moment , time difference, increment of value, median and mean value (between markers),
- Ability to display phasor diagrams, XY and harmonic graphs,
- Displaying the sequence of events,
- Attaching source files e.g. from other bays, recorders.
- Creating virtual channels: multi, sum, displacement angle, power, impedance, admittance, symmetrical components, frequency,
- Export of selected data to e.g. COMTRADE, TEXT or ZIP formats.

A detailed instruction in electronic format is supplied with iREC software. In this instruction few options of the program, which are helpful when analysing disturbances recorded by RZS-9 device, are presented.

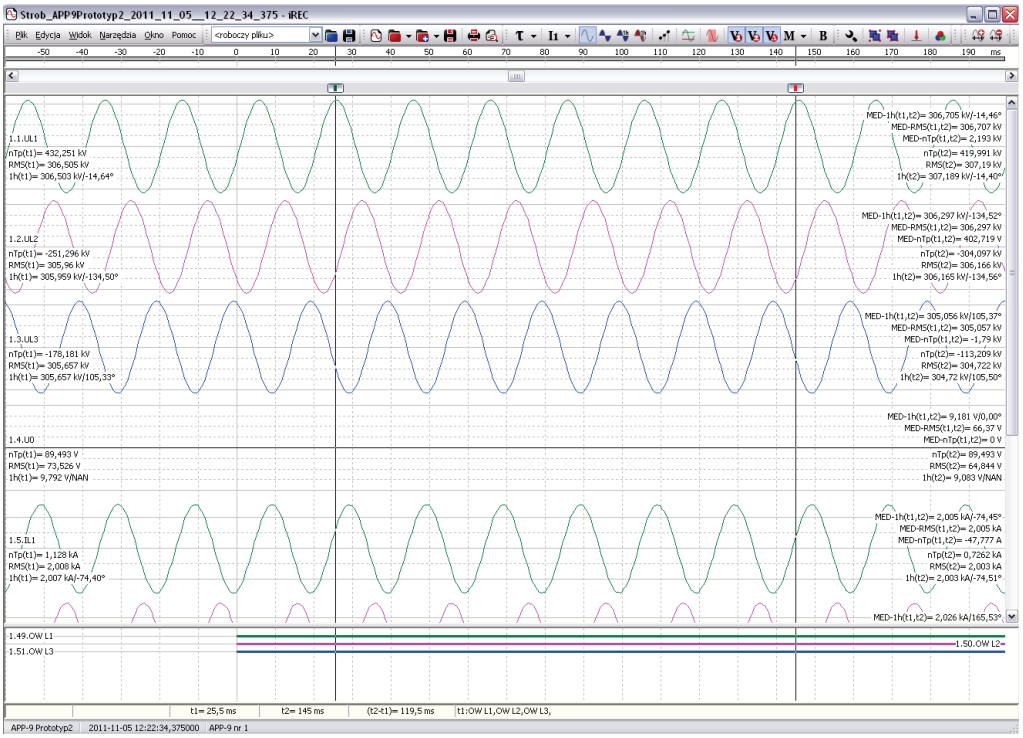


Fig. 5.1. iREC main window.

Figure 5.1. shows an example of a vector diagram of recorded currents and voltages of a fundamental component (diagram on the right) and harmonic component content at the marker location (bottom diagram).

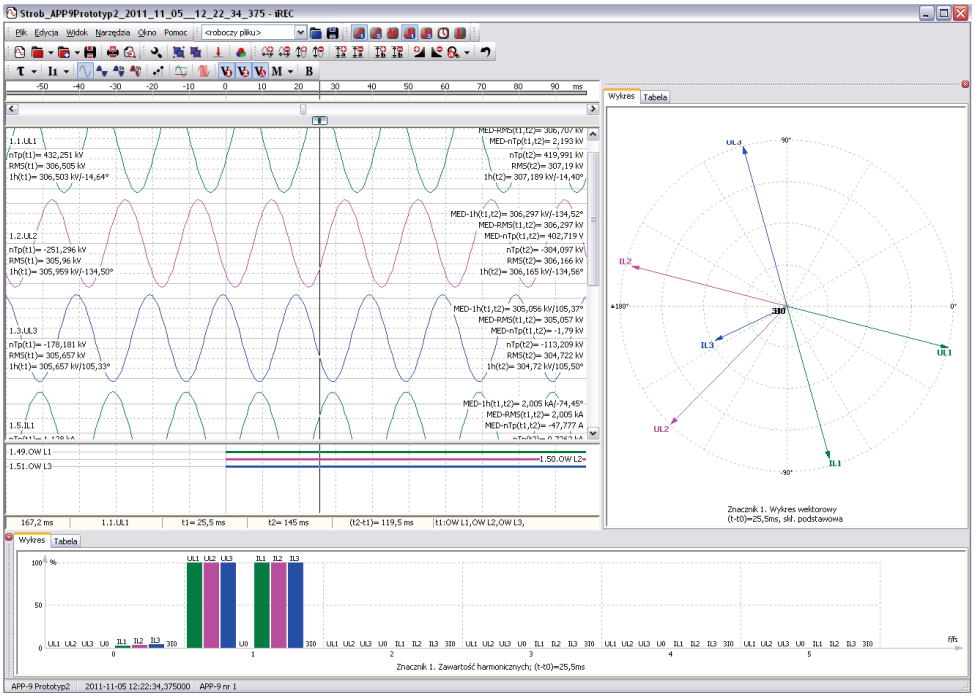


Fig. 5.2. iREC main window.

Voltages and currents can be displayed in values of primary as well as secondary side of instrument transformers. They can also be displayed in a standardised way, which is compared to nominal values. An option which is useful when analysing disturbances recorded by RZS-9 is a possibility to create virtual channels. After first readout of record

file from the device, the analogue and binary signals can be seen. With this software it is also possible to create one's own virtual channels e.g. creation of line-to-line voltages. In such case it is necessary to create a virtual channel to visualise voltage curve. An example of such configuration for U_{L1-L2} voltage is shown in fig. 5.3.

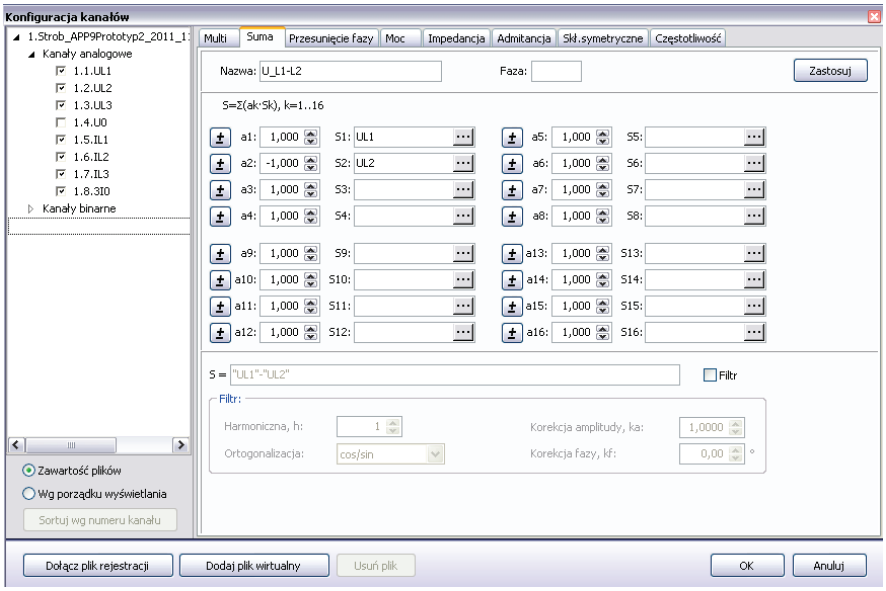


Fig. 5.3. U_{L1-L2} virtual channel configuration

To analyse the current direction criterion the user can use a curve of displacement angle between current and phase to neutral voltage. It can be obtained by creating virtual channel as in figure 5.4.

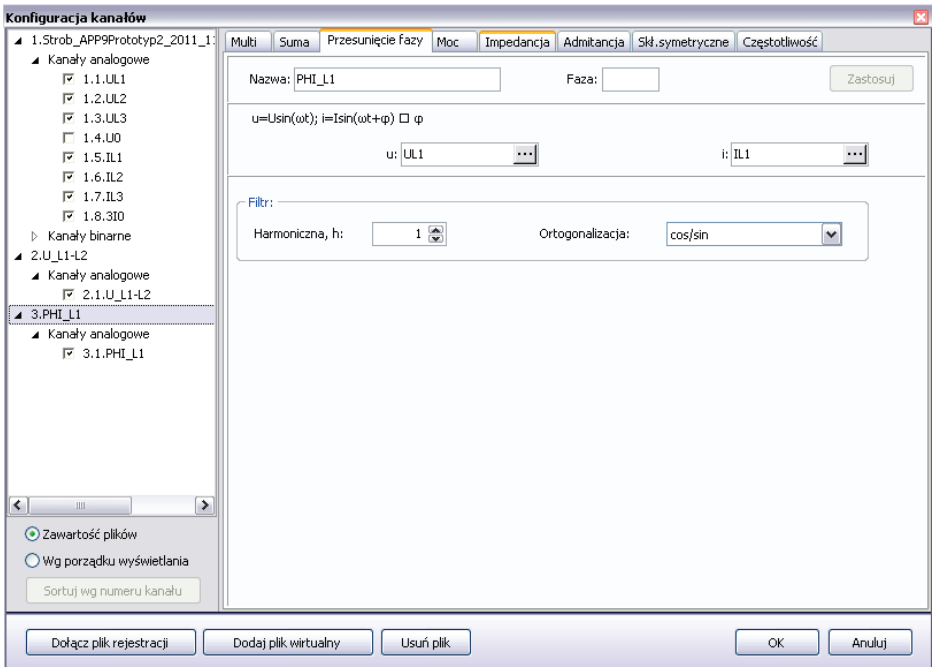


Fig. 5.4. PHI_{L1} virtual channel configuration

Figure 5.5. shows visualisation of created virtual channels U_{L1-L2} and PHI_{L1}.

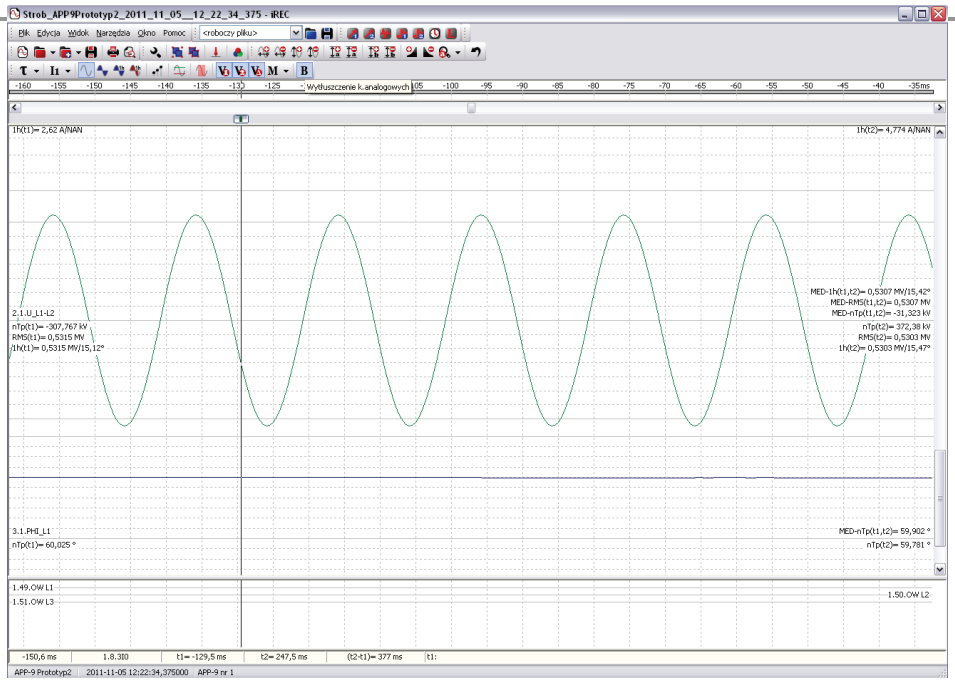


Fig. 5.5. Virtual channels visualisation.

By means of iREC software a given record can be analysed, printed out or exported as picture to PNG format.

iREC software enables attaching other source files of digital disturbance record to analysed curves. It may appear helpful in order to perform a combined or comparative analysis of curves of the same disturbances from various recorders e.g. various bays. Samples of attached channels are plotted on a common time axis based on the time markers that are defined in the source files with a resolution of 1 µs. Attaching operation is executed by selecting ATTACH FILE in the main menu by clicking ATTACH RECORDED FILE option in the CHANNEL CONFIGURATION window as in Fig. 5.3.

6. MKI-4 device hub module.

The device may be composed of many recorder units creating a set. In such situation one of the units (the primary unit) has an MKI module installed. The MKI module installed in the primary unit is meant for centralising information from secondary RZS-9 recorder units.

When connecting to the MKI module with the proprietary software, a function READING is available in the main menu. After clicking this function the list of recorder units is displayed, as in fig. 6.1. A description and transmission adres is displayed next to the symbolically presented recorder unit. Green colour of a description indicates an active data transmission with the recorder.

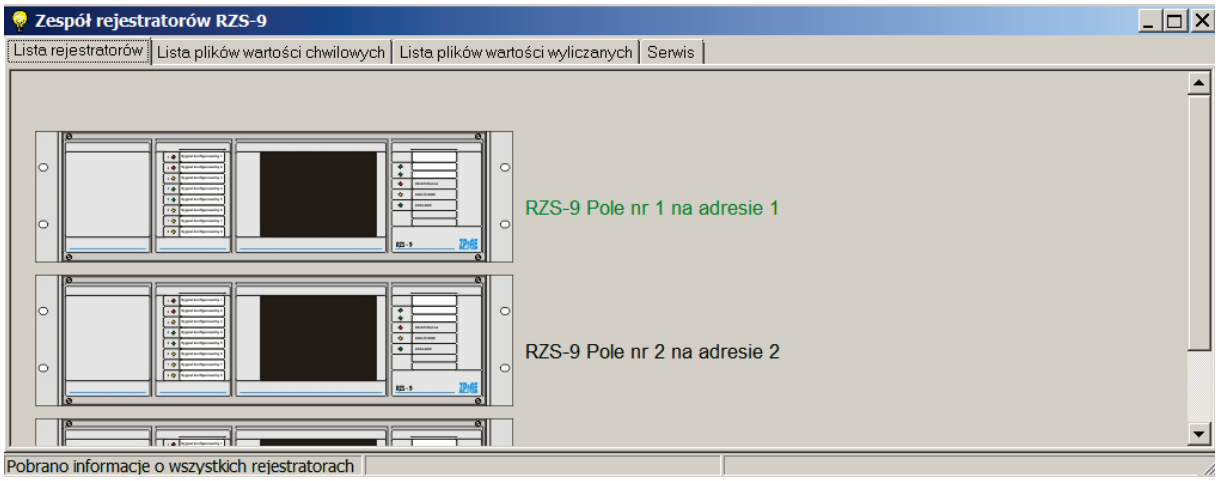


Fig. 6.1. Recorder visualisation window.

Next tab - LIST OF SAMPLED VALUES RECORD FILES, shows a list of records from each recorder unit. An example of a window is shown in fig. 6.2. DOWNLOAD SAMPLE VALUES RECORD FILES Option is available in the upper part of the window. If the option is checked the software will compare, the records on a hard drive of a local PC with records on the device. If the software finds a record that is not saved on the local drive, it will automatically download and save it to the PC's local drive.

List of sampled value record files is shown below and contains the following columns:

- No. – item number,
- File name – identifier of a disturbance file,
- Recorder – name of the device from which a file is downloaded,
- Weight – importance of a record as per trigger weight,
- Time – moment when the record was triggered.

User can select a record and open it in iREC viewer. They can also delete a file from the drive after entering a password for level three of user rights.

User can filter events from a selected period of time, as well as select files from a single recorder (recorder filter).

The tab for calculated value records is similar. The window is shown in fig. 6.3. To distinguish the files, the table containing sampled value records is pale green and table with calculated value records is pale blue.

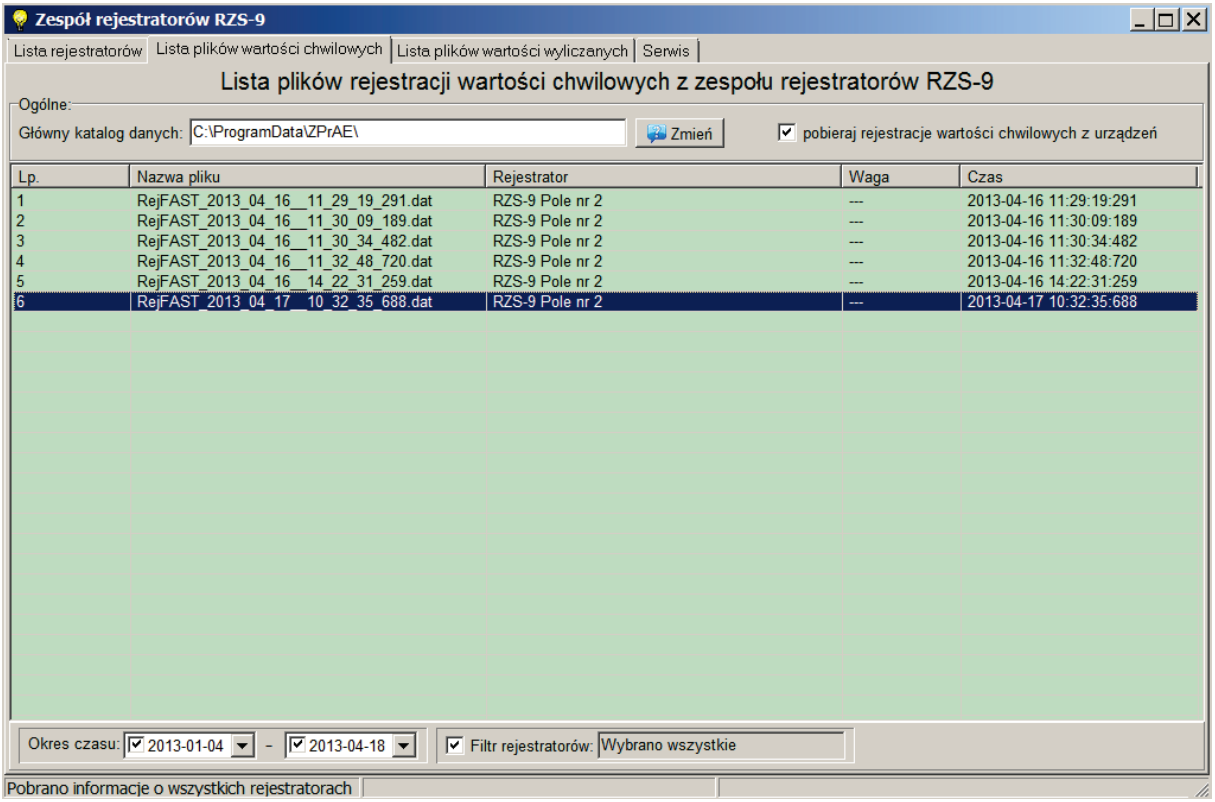


Fig. 6.2. List of sampled value record files.

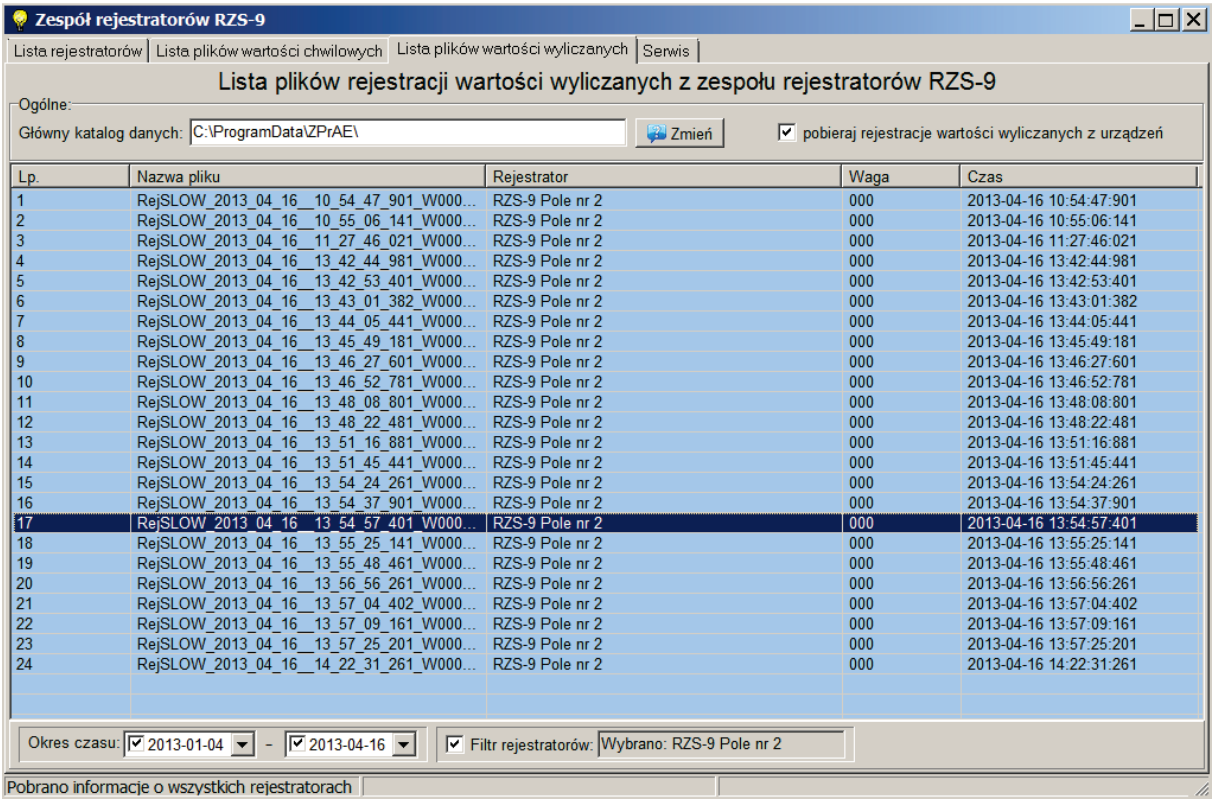


Fig. 6.3. List of calculated value record files.

7. SCOPE OF SERVICES PROVIDED BY THE MANUFACTURER.

The manufacturer provides support in designing of disturbance recording systems using the RZS-9. We have ready-to-use **project outlines.** The manufacturer supplies the RZS-9 recorder 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 (32) 22 00 120

8. TECHNICAL PARAMETERS OF THE RZS-9 RECORDER

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		< 30 W
Permissible time of auxiliary voltage decay		50 ms (for 0.8 U_{PN})
Permissible level of auxiliary voltage decay		30% U_P (for U_P = 0.8 U_{PN}, t = 1s)
Analog current inputs		
Rated current (optionally):		1 A AC / 1,41 A DC or 5 A AC / 7,07 A DC
Measuring ranges:	In = 1 A AC / 1.41 A DC (optionally)	40 I_n or 75 I_n
	In = 5 A AC / 7.07 A DC	40 I_n
Measuring Precision		± 0,5%
Acceptable permanent load:		2,5 I_n
Thermal strength 1 s		100 I_n
Power consumption		<0,2 VA/phase
Analog voltage inputs		
Rated voltage (U_n):		100 V AC / 141 V DC
Measuring ranges:		2 U_n lub 5 U_n
Measuring Precision:		± 0,5%
Power consumption:		<15 mVA/fazę
Analog inputs from converters		
Measuring ranges:		0..25 mA (for converters 4..20mA)
Measuring Precision		± 0,5%
Power consumption		<15 mVA/phase
Number of analog inputs *(current, voltage and from converters)*		max. 8 cards × 4 inputs = 32 inputs
Binary inputs		
Rated input voltage (Uw):		220 V DC / 230 V AC or other as agreed.
Power consumption:		< 0.5 W / input
Trigger:		Programmable: low and high state
Triggering levels:		0,7 U_{in} ± 5% (0,7 U_{in})
Number of signal inputs (maximally):		8 cards * 8 inputs = 64 inputs
Auxiliary relays		
Maximal continuous current		4 A
Maximal making capacity of the contacts		3 A / 250 V AC 0,15 A / 250 V DC; L/R=40 ms
Number of relay outputs (max.):	Card MPS	8 independent contacts (1 card)
	Card MPZ	15 contacts with common pole (1 card)
Recorder		
A/C conversion frequency:		16-bitów
Sampling frequency f_p:		1 kHz, 2 kHz, 5 kHz, 10 kHz
Max sampling jitter between A/D channels:		≤ 100 ns
Signal to Noise Ratio (SNR):		≥ 78 dB
Inter-channel crosstalk:		≤ -74 dB
RAM buffer capacity:		128 MB
Flash SD buffer capacity:		1 GB
Maximal time of single record (for parameters: f_p=10 kHz, 8 analog channels, 32 binary signals):		22 s
Pre-trigger recording time:		Regulated
Precision of the internal clock:		≤ 20 ppm
Precision of time synchronisation		≤ 5 µs

Communication	
Ethernet – RJ45 connection	Company protocol
Interface RS232	Company protocol
2 × Ethernet – RJ45 connection	Company protocol or IEC-61850 (optionally)
2 × Ethernet – fibre optic connection SC	Company protocol or IEC-61850 (optionally)
Insulation	
Overvoltage category	III
Rated voltage of insulation:	250 V
Proof voltage:	4 kV (1,2/50 □s)
Proof voltage of electrical strength of the insulation:	2,5 kV; 50 Hz; 1 min.
Enclosure protection degree	Front panel: IP50, remaining parts of the enclosure: IP20
General Data	
Acceptable range of storing temperature:	248 ÷ 343 K (from -25 to +70° C)
Acceptable range of working temperature:	263 ÷ 328 K (from -10 to +55° C)
Ambient humidity (with no water vapour condensation or ice)	95 %
Mechanical strength accordingly to PN-EN 60255-21-(1,2,3)	class 1
Electromagnetic compatibility accordingly to PN-EN 60255-26	class A
Ambient pressure:	70-110 kPa (0 – 3000 m npm)
Dimensions W×H×D [mm]:	19”/3U/240 (483×133,5×245)
Weight	13,2 kg

KK RZS-9 ENG; wyd.4; VIII 2015

RZS-9

OFFER

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

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

ZPrAE Sp.z o.o.

ZAKŁAD PRODUKCYJNY APARATURY ELEKTRYCZNEJ
Sp. z o.o. 41-100 Siemianowice Śląskie, ul. Marii Konopnickiej 13
tel: 32 22 00 120; fax: 32 22 00 125; e-mail: biuro@zprae.pl