MIC Complex Managment Software

Recorder

User Manual

Version 3.3

Contents

This manual is intended for Recorder software users, operators of automated measurement systems and other specialists, using MIC complexes manufactured by RPE MERA.

The manual contains following sections:

- Terms and definitions with detailed descriptions of terms;
- Basic information about the MIC Complex management software Recorder, including the description of purpose, functions and structure. Illustrative material about on-screen forms, with which user works;
- Description of measuring system organization, including measuring channels configuration creation, user page creation with information display forms, modules and channels settings;
- Description of channels measuring and calibration procedure;
- Description of plugins, which expands functionality of the software;
- Attached methodological and reference materials.

The manual serves as an initial introduction to the Recorder software, also as step by step operations description, execution of which is necessary for the user during measurement system operation. Therefore, first sections of this manual have introductory meaning, where you can find links to following sections with more detailed description of the previously mentioned operations.

Manual contains a large number of illustrative materials – on-screen forms provided to a user during a work. Thereby, to facilitate the perception of the material, drawings are not numbered, and the whole text, relevant to each drawing, located directly next to it and designed as a numbered section item.

Terms and Definitions

Balancing	Alignment of the Channel Input Signals
SC - Scaling characteristic	The characteristic of the logical channel responsible for the conversion of electrical values into physical
Scaling	Forming a scale, table, graph, or formula that determines the correspondence between the values of values at the output and input of the measuring channel
Sample	1. Obtaining a single measurement the values of the physical process parameters 2. Recording the measured values of the parameters of the physical process using Recorder in the MERA or USML format
Measuring board	Measurement module embedded on PSI board, connected as a peripheral device to the motherboard bus of the computer, on which Recorder software installed
Measuring channel	The set devices for signal transmission and signal transformation necessary for obtaining measurement information
Measuring complex	A measuring means containing a number of synchronized measuring channels, including various applications running on a shared computer. The measuring complex has several measuring modules and a controller for communication with a computer with proper control software installed, for example Recorder.
Measuring module	Unit that forms the measuring channels and installed in the crate of the MIC measuring complex. Type, scheme of switching and settings of units are determined by measurement tasks. Primary converters (sensors) of measured parameters or matching devices of signals from sensors connected to the input of the measuring modules, and the output is connected to the communication controller with the control computer.
Frame	Folder with recorded signal in the USML directory
Calibration	An operation during which metrological characteristics of the measuring channels are established under specified conditions by determining the relationship between the value of a quantity obtained using a calibrated channel and the corresponding value of a quantity reproduced by a standard unit of quantity

Measurement System Configuration	The composition and structure of the measuring channels of the system with a description of their switching schemes, operating ranges, calibration characteristics and functions of signal processing and registration
Legend	List of data item names displayed on the chart and their corresponding colors or other symbols
Metrological characteristics	Characteristics of the measuring channel that affect the measurement result and its error
PEAK – Peak value	The maximum absolute value (from 0 to max.) of the measured scalar value for a given time interval
PEAK - PEAK	The maximum absolute value (from min. to max.) of the measured scalar value for a given time interval
Plug-in	Additional program module that extends the functionality of the Recorder software
Verification	The operation of metrological control, during which the metrological characteristics of the measuring channel are confirmed, and the compliance of the channel as a means of measurement with the legal requirements on ensuring the uniformity of measurements is determined
Software package	Installation distribution kit, containing several software modules. In this manual, unless otherwise specified, the terms package and software package mean Recorder distribution kit
Working directory	A directory with files in the MERA or USML format containing records of the measured signals, and service files with data of recording time and other parameters
UTS – Universal Time System	A set of tools that provide a temporary reference of measuring channels between individual devices. Consists from a UTS signal source, digital communication lines and input channels of special UTS devices
RMS – Root mean square	Square root of the mean square (the arithmetic mean of the squares of a set of numbers) of multiple measurement values a1, a2, …, an
Trend	The tendency of a parameter or function to change over time
Trigger	A set of signal parameters that allows you to distinguish the moment of change of the logical state of the signal
TTL	Signals with discrete values “0” and “1”

Level	Named trigger, triggered, as a rule, by the value of the signal, time or trend of any assessment. When it is triggered, a command is formed to perform any action, for example, to issued warning message
Display Form	Window displaying signals or parameters in graphical or digital form
MIC	Multichannel measuring and measuring-computing complexes MIC, designed and manufactured by RPE «MERA»
WinPOS	Package of post-experimental processing of measurement information, designed by RPE «MERA»

1 General information about the MIC complex management software Recorder

1.1 Objective

The MIC complex management software Recorder is designed to control MIC multichannel measuring and measuring-computing complexes, used as part of automated information-measuring systems and automated control systems for various technological processes.

Management functions include: setting up measuring channels; collecting, processing, storing and visualizing measuring information; generating commands upon reaching preset values of the measured parameters.

Recorder software comes with MIC systems and should be installed on your computer, connected to the MIC systems controller via Ethernet. Recorder software requires a computer running under OS Windows10 or later Windows versions.

Computer for operating Recorder software with required parameters can be included in the MIC package with the pre-installed and configured Recorder software by user's request, or purchased and configured by user independently.

Recommended control computer configuration - CPU Core i5/4Gb/2Tb/DVDRW/LAN 1Gbit - can be specified to meet the requirements for a system that uses MIC complexes.

Several MIC systems can work under the control of a single computer with Recorder software, and received data can be transmitted for processing to several workstations and controllers, and also displayed on the screens of several automated workplaces.

Recorder is a software part of the measurement system, the hardware part of which consists of multi-channel measurement complexes MIC and also determined by the metrological characteristics of the measurement system.

1.2 MIC complexes operated by Recorder

Recorder can be configured to operate with complexes and modules:

- complexes MIC-026, MIC-036 with MS bus, LC and MC type measuring modules;
- complexes MIC-017, MIC-224, MIC-236, MIC-251M/252M/254M with RXI bus and MR type measuring modules, ME amplifier modules, MT test modules;
- specialized complexes MIC-140, MIC-170, MIC-185, MIC-700, MIC-800, MIC-1100, MIC-1150, MIC-1200, MIC-1500 and others;
- complexes MIC-355, 355-M, MIC-551/552/553 with PXI bus and MX type measuring modules.

The Recorder software settings in the system using certain devices have features that are described in the User Manuals for these devices.

1.3 Functions performed

The Recorder software with MIC measuring complexes has the following functionality:

Configuration functions:

- automatic detection of the system hardware composition;
- setup of the measurement modules;
- forming a set of configurations of the measurement system with the possibility of selecting the desired configuration for operation in the future.

Signal recording\registering functions corresponding to pace of measurement:

- continuous signals reception and recording to the built-in hard disk of the control computer (data collection stations);
- show input signals of selected channels in display forms as waveforms or digital values on automated workplace screens; configure display forms;
- automatic start and stop of recording: by TTL, by the signal level of the selected channel, by the preset time;
- switch between image pages containing different sets of display forms;
- providing service interaction of the control computer with MIC complexes for synchronization of measurement's start/stop and synchronous control of several

complexes.

Levels control function corresponding to pace of measurement:

- control of measured values and converted parameters, comparison with warning/alarm set values for selected channels;
- notification by color indication on the digital form when the set point is triggered.

Additional functions implemented when special software plug-ins activated:

- spectral processing of the recorded/played signal with display in the form of spectrograms (up to 8192 spectral lines, various weight functions, averaging);
- express processing – calculation of RMS, PEAK, PEAK-PEAK, the average value of the recorded/played signal on all channels, displayed as numeric values in the table and as an arbitrary number of graphs depending on time (trends);
- cold junction temperature compensation for temperature measurements using thermocouples.

Metrological support at the stage of preparation for measurement:

- automated calibration of analog channels;
- automated balancing of analog channel.

Additional functions during the measurement preparation stage:

- self-diagnostics of measuring modules and units, with detection of signal line breakage for certain types of modules.

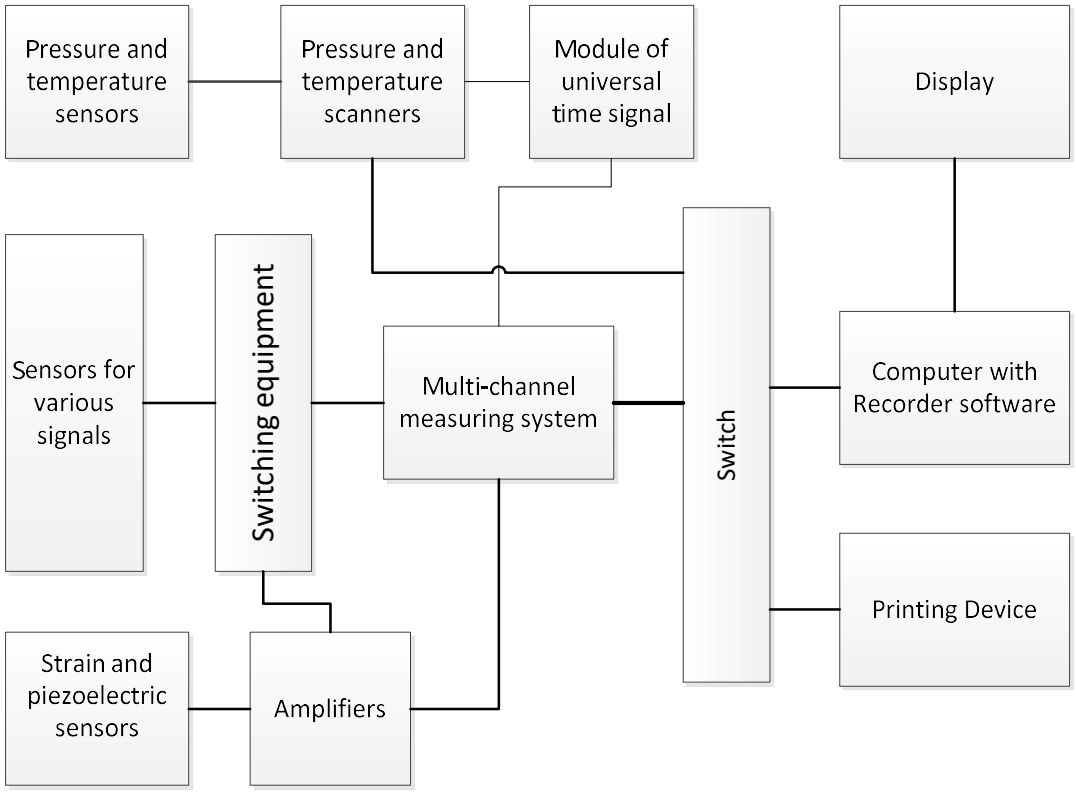
Recorder functions can be extended with additional plug-ins provided.

2 Organization of the measurement system under control of Recorder Software

2.1 Measurement system structure with Recorder

1. Following equipment can be part of a measurement system controlled by Recorder software. The number and switching schemes are determined by the measurement and control tasks:
   - Computer with installed Recorder software and display,
   - Network equipment - Ethernet switch,
   - One or more measuring systems with communication controllers and measuring or functional modules,
   - Primary converters, sensors, switching equipment, normalizing modules,
   - Servers and modules of the unified time system,
   - Digital signal reception and transmission equipment.

2. The example of measurement system structure is shown in the following figure::



2.2 Installing the Recorder software on a computer

RPE MERA supplies control computers with pre-installed and configured software while ordering measurement systems.

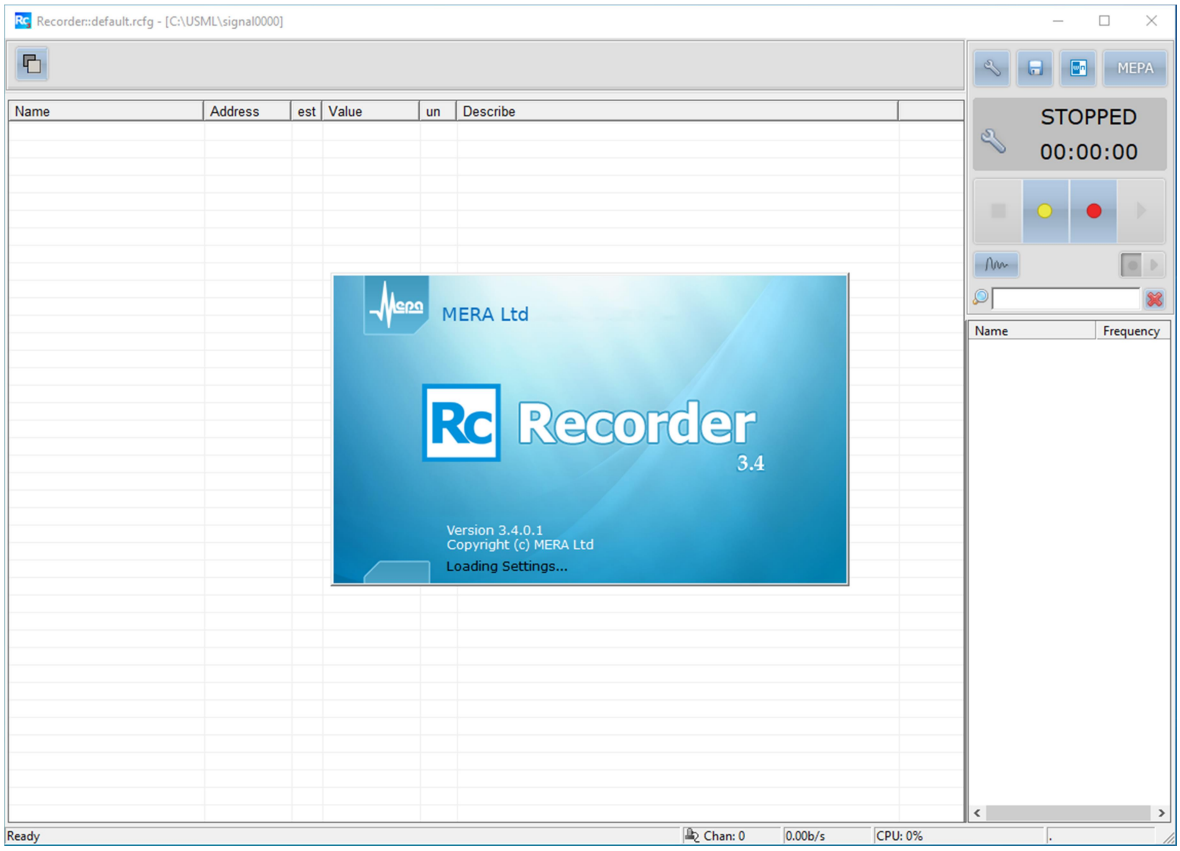
For self-installation of software, user is provided with an installation kit, which includes: the Recorder software, a set of standard plug-ins and drivers for measuring modules. Updated versions of Recorder software are available on the website ***www.nppmera.ru.***

To install the Recorder software on your computer, open the distribution kit folder and run the installation program ***recorder-x.x.x.x-installer.exe***.

Installation of ***recorder-3.4*** or later versions of Recorder software is recommended.

It is possible to use the installation program from a computer disk, over the network or from a CD.

The icon  will appear in the "Start" menu after installation and rebooting the controlling computer. This icon can also be copied to the taskbar. Recorder starts with opening the program main window.



The following information is briefly displayed in the center of the screen while preparing the program for launch:

- The logo and name of the software developer,
- Logo and name of the Recorder software,
- Software version.

As a rule, the MIC measuring system is delivered to the user with already installed plug-ins and all necessary drivers. Device drivers do not need to be reinstalled when the program is updated.

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2.3 Recorder configuration procedure

Purpose of configuring Recorder software is to organize the operation of the measurement system with a sufficient set of hardware to perform a certain amount of measurements with the required accuracy and the required representation of measurement information.

The result of the configuration is the creation of a system **configuration file**, which should allow you to reproduce the obtained measurement results under unchanged conditions.

Creating a measurement system **configuration file** requires the following steps, described in the sections mentioned in parentheses:

- Perform the necessary hardware switching of the measurement system equipment (section 2.2);
- In accordance with the measurement tasks, select the modules and measurement channels to use. Specify in the program settings which of the available channels will be used for measurements and which signal sources they will be connected to, i.e. describe and name the channels (section 4);
- Configure the modules and channels in use: set the sample rate, select input ranges, and so on(sections 7 and 8);
- Determine the composition of measurement visualization tools. Configure forms for embedded and user pages and link them to measurement channels (sections 5 and 6);
- Make general settings for Recorder software: set the time for updating information on the display screen and the scan speed, select the recording/saving mode type of start (section 3.5);
- Create path templates for recording received measurement data (section 3.5.2);
- Check the readiness of the measurement system (section 9.1);
- Make measurements (section 9.2) and results processing (section 9.4).

We recommend that you configure Recorder in the way so that the CPU usage during signal registration does not exceed 70%. The program settings are saved in the configuration file. The current configuration can be saved to a file with any name in the configuration folder created by the user on the computer's hard disk. Lately you can always download the saved configuration (for more information, see section 4.7).

3 User interface

Operation with the software is going in the dialog mode. The software manages via a graphical interface. Control elements have an inscription or an icon that allows intuitive understanding of their purpose. Most control elements have pop-up suggestions.

The user of the Recorder software must have the working experience with Windows operating system.

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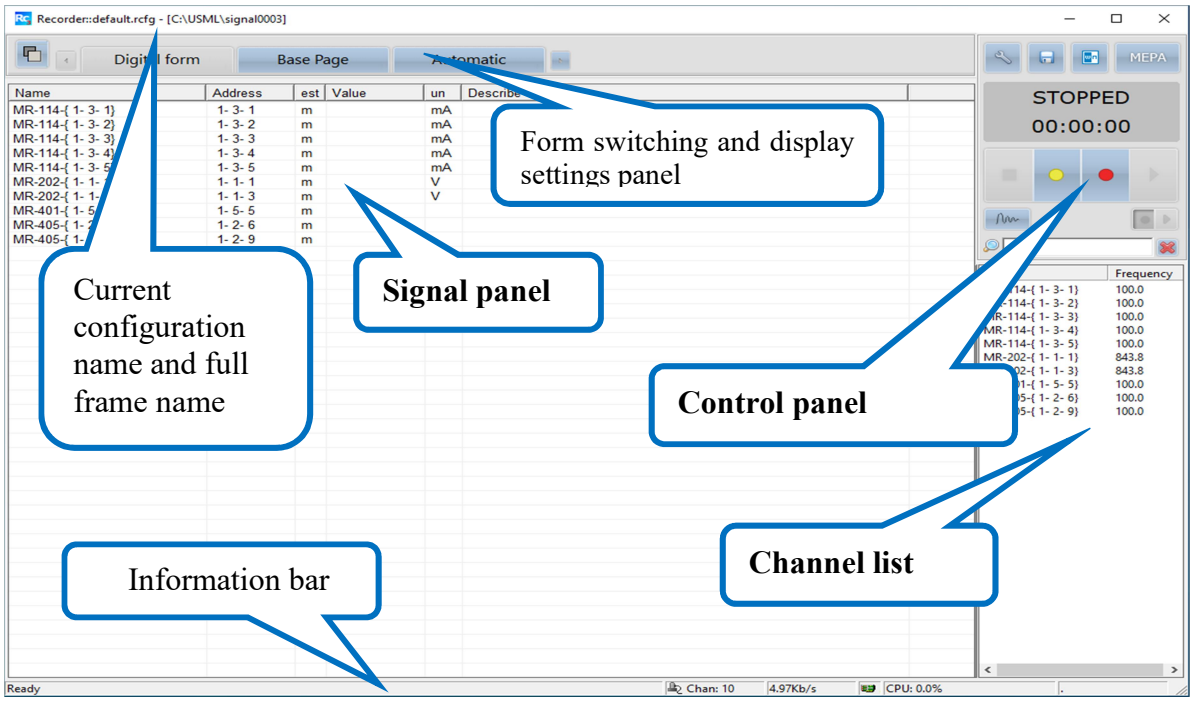
3.1 Software main working window

1. The main working window of Recorder includes the following panels:
    - A **Signal panel** that can display one of the three built-in pages or pages created by the user (section 3.3),
    - **Control panel** (section 3.2),
    - **Channel list panel** (section 3.4),
    - Panel for displaying the current configuration and signal name (window header),
    - The system readiness panel or error message (bottom line of the working window).



3.2 Control panel

1. The Recorder controls are located at **Control panel** and **Form switching and display settings panel.**

   When the mouse cursor is over control elements, pop-up suggestions are displayed on the screen indicating the purpose of this element and the hot-key combination on the computer keyboard.

2. **Control panel** contains **Status Display Panel** and control buttons.

   Status Display Panel can take one of the values: Stopped, View, Record and displays the time of viewing or recording signals from the start.

3. Control buttons:

 - complex configuration **Setup** mode for the current session (F12)

 - save the current configuration by default, without requesting the name of the saved configuration (Alt - F2)

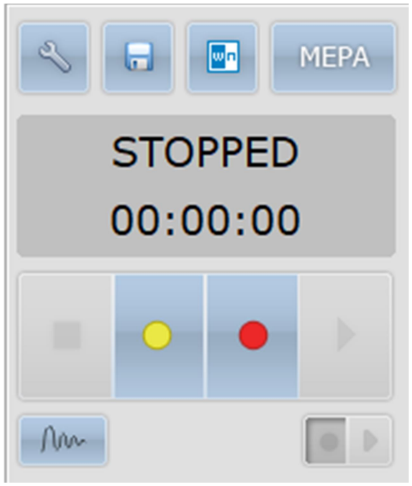
 - open the last recorded measurement for analysis in WinPOS package of the signal processing

 - allows to set the name of the measurement for registering the measurement information

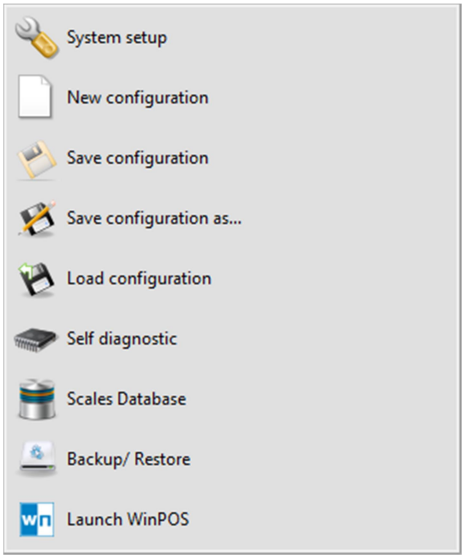
 - preview (F3)

 - stop viewing/recording (Esc)

 - record mode (F2)



4. **Selecting additional control and configuration**



functions menu is activated by the button 

and contains the following functions:

- **Self-diagnostic** - performs an automatic self-diagnosis procedure. Protocol file is created based on self-diagnosis results. This file can be saved;
- **Save configuration as...** - save the current configuration under a unique name, the standard dialog box for saving the file is displayed (Shift-F2);
- **Load configuration** - load a previously saved configuration, and displays the standard dialog box for selecting the file to be loaded (Alt-F3);
- **Scales Database** – opens the window for managing the calibration\scaling characteristics database.

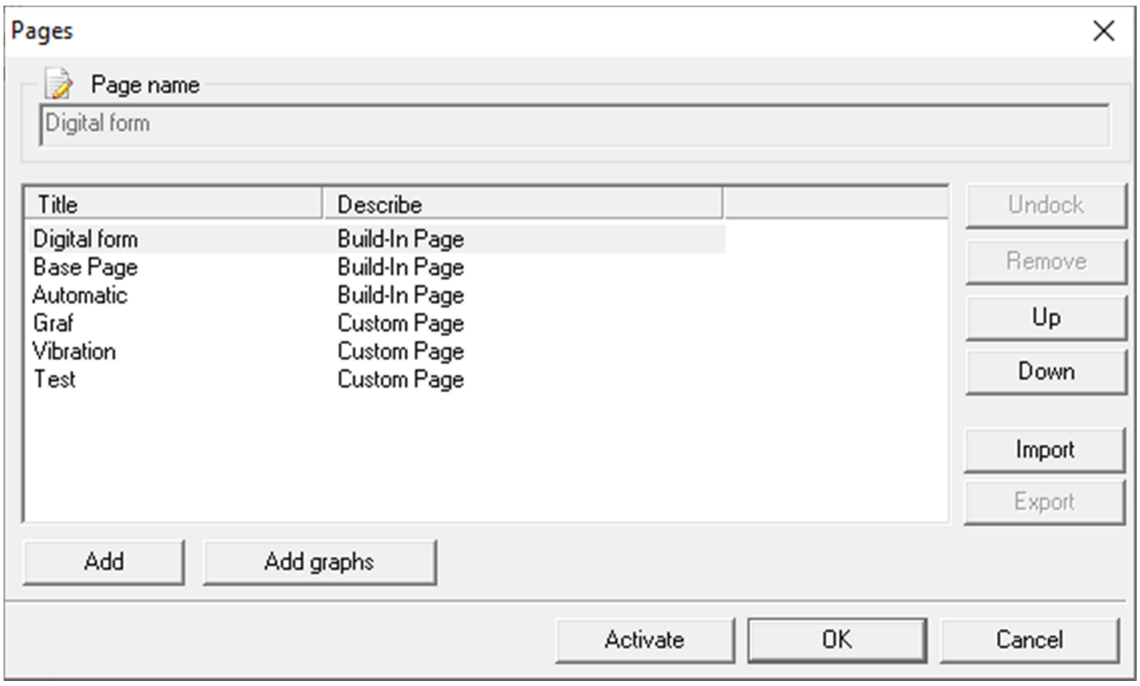
3.3 Signal panel

1. **Signal panel** is designed for visualization of measurement and reference information required by the user during operation. For clarity of information presentation, Recorder provides functions for sequential display of three built-in pages and any number of user pages on which the user can place and configure forms from the list of custom page forms. The list of user forms on the screen can be edited using the buttons located on the right side.

   For more information about selecting and describing the signal panel pages see section 5.

   Forms configation is described in section 6.

2. **Signal panel settings** window opens after clicking the button  on the **Form Switching** panel. The user can add new pages, activate one of the existing pages, delete unnecessary ones, or detach the page from the Recorder window.



3. After activating **Graph** page using button **Add graphs**, the list of forms can be accessed by clicking the button  in the top line of the page, the button  allows to delete an unnecessary form, and button  automatically arrange forms on the page.

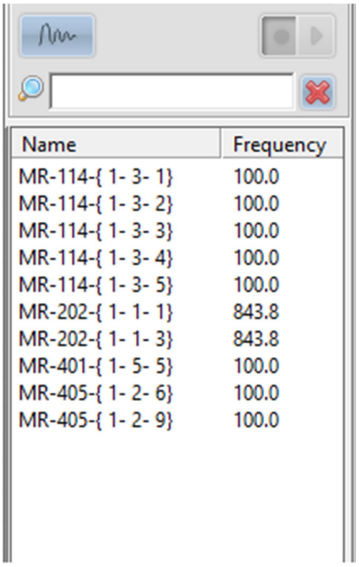
4. After activating **Mimic diagram** page using button **Add**, the list and configuration functions for forms become available in the top line of the page. In addition to the graphic designation the buttons purpose is highlighted when the cursor placed over the button:

3.4 Channel list panel

1. **Channel list panel** it intended for displaying the list of active channels and opening the settings window for these channels.

   By default, the channel name in the list formed from the name of the module with the address of the channel of this device specified in curly brackets. See section 7.2. When configuring the system, it is advisable to give the channel the name of the measured signal.

2. The name of the channel and the sample rate (sampling frequency) are indicated for each channel. You can also use this panel for:



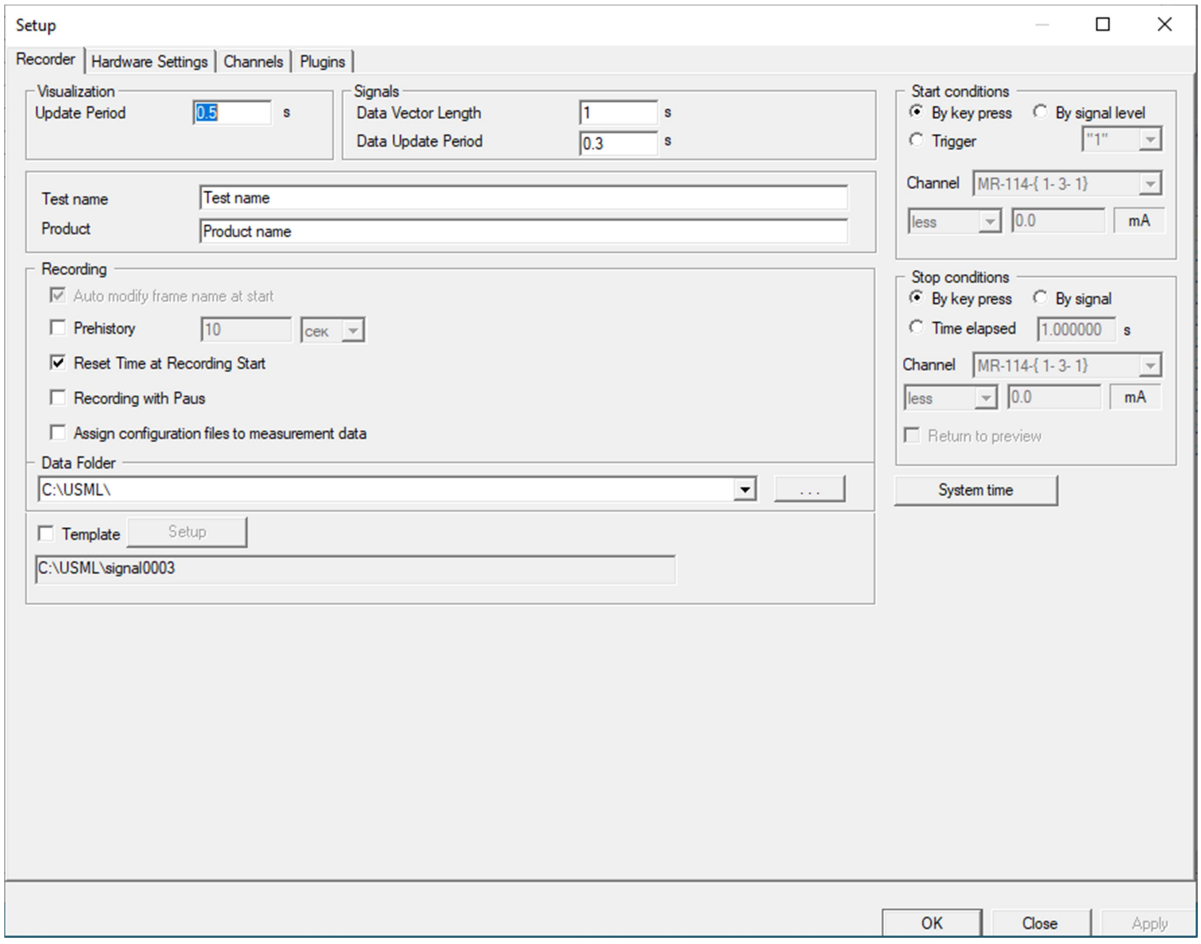
   - select the current channel for more information about it,
   - configure the channel settings,
   - change the order of output signals displayed in the forms on the signal panel.

   The current channel can be selected by:

   - "up" and "down" cursor buttons on the keyboard,
   - mouse cursor,
   - using the name filter located above the channel list.

3.5 General configuration of Recorder software

1. General configuration window of Recorder software (**Setup**) can be opened from **Control panel** by clicking the button  , or by **F12** keybord button:



3.5.1 Signal display parameters

1. **Visualization** field of **Recorder** tab**:**

   Update period - specifies the data update period on the working window screen. The period value is directly entered in the input field using keyboard.

2. **Signals** field of **Recorder** tab:

   - **Data Vector Length** - specifies the input signal time interval which displayed on the screen and in the PC memory (this data is available to plug-ins and third-party programs via special software interfaces. For more information, refer to the "Recorder programmer's Guide");
   - **Data update period** - specifies the data update period in the program's internal buffers. Data updated by portions using time interval specified in this field. The buffer contents are used for calculating measurements estimations by channels.

3. Fields **Test Name** and **Product Name** of **Recorder** tab contain specific test and product names. This data will be saved in the output file along with the measured signal values, which will be very useful when processing a large amount of information collected during testing of various devices;

3.5.2 Data recording

Section **Recording** of **Recorder** tab sets:

1. **Auto modify frame name at start –** when this option enabled the file name that stores the recorded information will be automatically modified each time recording mode starts. If the specified file name contains at least one digit, it will increase by 1. If the file name does not contain digits, an index of four digits will be added to the end of the name, starting from 0000. Note: In recent versions of the software this field is marked by default and cannot be changed;

2. **Prehistory** - enabling this feature allows you to save signal of a predetermined length before recording. When you set a ten-second backstory, a ten-second interval of signal data before the moment operator starts the record mode will be added to the recorded data.

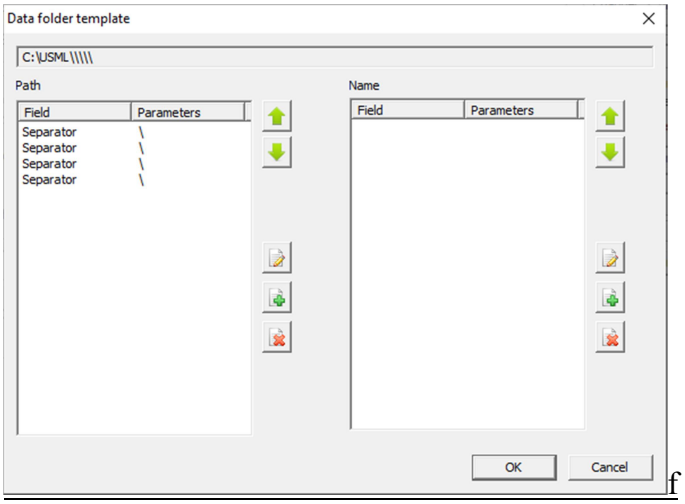
3. **Reset Time at Recording Start** - when this option is enabled, each new data recording will start from a zero second.

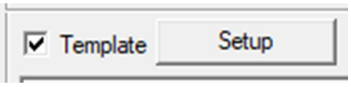
4. **Recording with Pauses** allows making a series of recordings in a single frame.

5. **Assign configuration files to measurements data** - this option automatically place the current configuration file in the directory with the recorded data. Lately this will help to determine which parameters were used for recording.

6. **Data Folder** – specify the folder on the computer's hard disk where the registered data will be stored. To specify or create a working folder for writing data, click the button to the right of the field and then follow the suggested dialog.

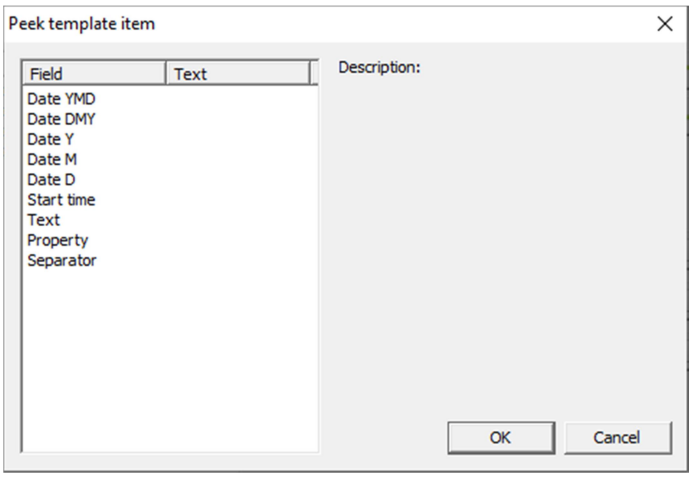
7. **Template** – template for creating the working folder structure and the recording frame name



8. This mode is enabled by the setting checkbox and then using **Setup** button 

Opened **Data folder Template** window allows to configure the **Path** and the **Name** of the file with saved data.

9. The ***Path*** and ***Name*** are formed from the same set of parameters from the **Peek template item** window, which opens by clicking  .



The path contains an additional "\" ***Separator*** parameter that defines the folder attachment.

Parameters are entered sequentially in the Description of the Path and Name with confirmation by entering **OK.**

If necessary, parameters can be removed from the Description by clicking  , or rearranged by buttons  and  .

After clicking **OK** in the **Data folder Template** window, the template will be saved and shown in the lower row of the **Setup** window.

When the flag in the **Template** section is set up data will be recorded according to the settings you made.

3.5.3 Recording Start and Stop conditions

1. Activation mode for viewing or recording the signal is set in **Start conditions** section of **Recorder** tab enabling one of the switches:

- **By hotkey** - by default, the view/record mode is started by pressing the keys  **(F3**– view) and  **(F2** – recording) respectively.
- **By level** - switching from view mode to recording mode when signal level exceeds specified value. In this case, the lower three fields become available, where should be specified required channel (by selecting from the suggested list) and the level that should be analyzed. The trigger level is set by a threshold value, and recording is enabled if the signal passes through the specified threshold in the specified direction. Signal front direction, increasing or decreasing, is set by selecting the desired direction in the corresponding field.
- **Trigger start** - the mode for starting viewing or recording when an external control signal arrives at the digital input of the device. In this case, when you press the keys  **(F3**–

view) and  **(F2** – recording) the program switches to the corresponding mode, but data registration begins only when the control signal arrives.

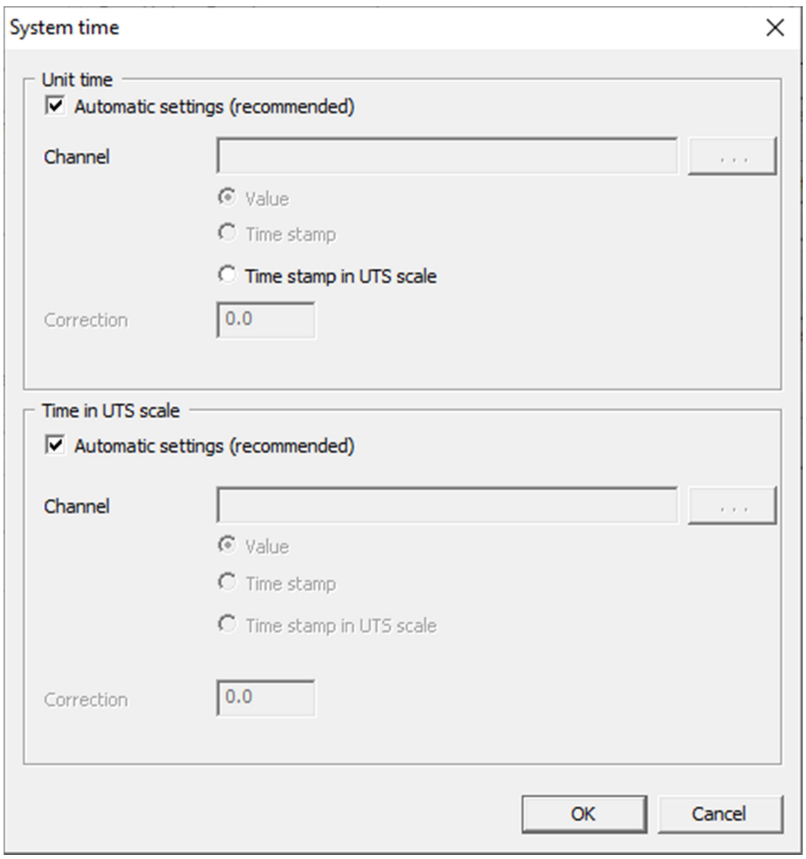
2. **Stop conditions** section of **Recorder** tab:

By key pressed, By signal, Time elapsed – selecting one of these switches sets the condition for disabling recording mode – or manually by pressing the button  (**ESC**), either by level, or after a specified time, respectively. In the second and third cases, the corresponding fields become available. The settings are made in the same way as for **Start conditions**.

3.5.4 System time in Recorder

System time button on the **Recorder** tab opens a window of the same name, in which:

1. When **Automatic settings** flag is set on, the instrument time and the time in the UTS scale will be counted from the moment the Recorder switches to **View** or **Record** mode (displayed on the control panel).
2. To start time counting from an external source whose signals are received via the channel of the measuring system, switch to manual mode (remove the flag).



3. The channel carrying the time information can be selected from the list after clicking the button . . . .
4. Selectors **Value/Time Stamp/Time Stamp in UTS scale** used for desired time representation.
5. If necessary, in the lower field of the window may be set up the time correction relative to switching time of VIEW mode or RECORDING mode.

4 System configuration creation

4.1 Composition of the measurement system

1. The Recorder software can have any number of program configurations. Configuration files are stored in the Recorder program folder by default, but you can specify any folder on disk to save settings. When you start the Recorder, the last working configuration will be load.

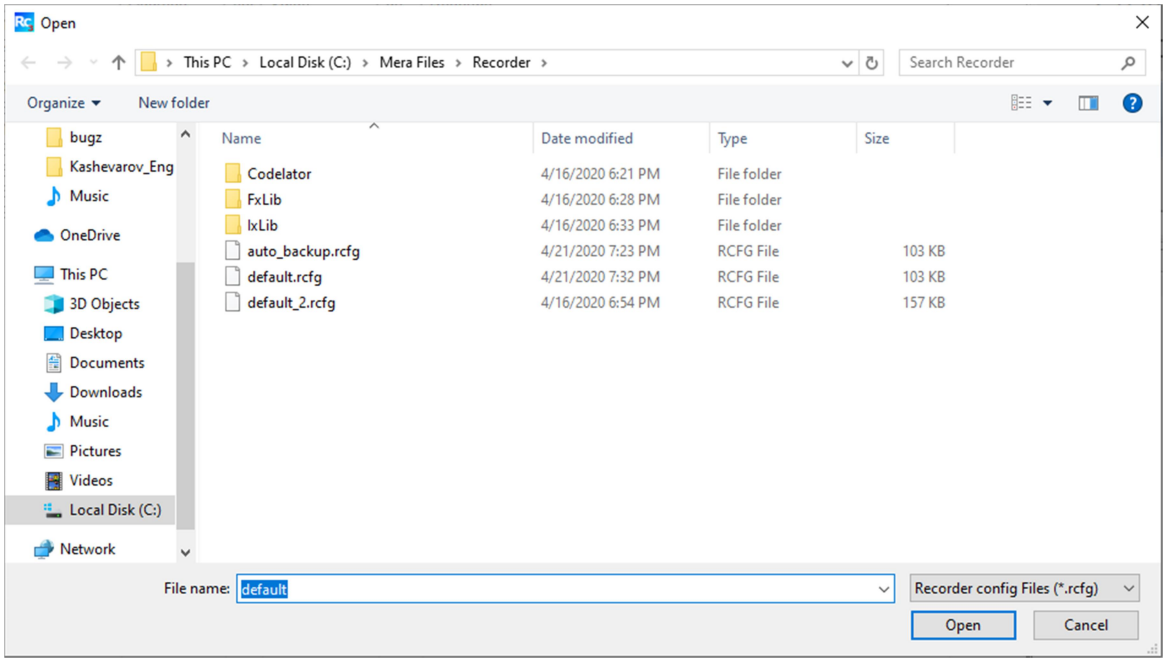
   A configuration is defined as:
   - number and parameters of MIC complexes connected to a PC;
   - the location of the modules, their type and configuration;
   - list of channels, their names and the binding to the hardware;
   - calibration characteristics connected to channels;
   - downloaded plugins list and their specific settings (for example, setting up cold junction temperature compensation).

4.2 Configuration Loading

1. Configuration loading and editing must be performed in **Stop** mode.

2. To download the configuration you should press the button 

on Recorder **Control Panel**. In the menu that appears, select Upload configuration, and then a folder containing configuration files *.rcfg will automatically open in the Explorer window:

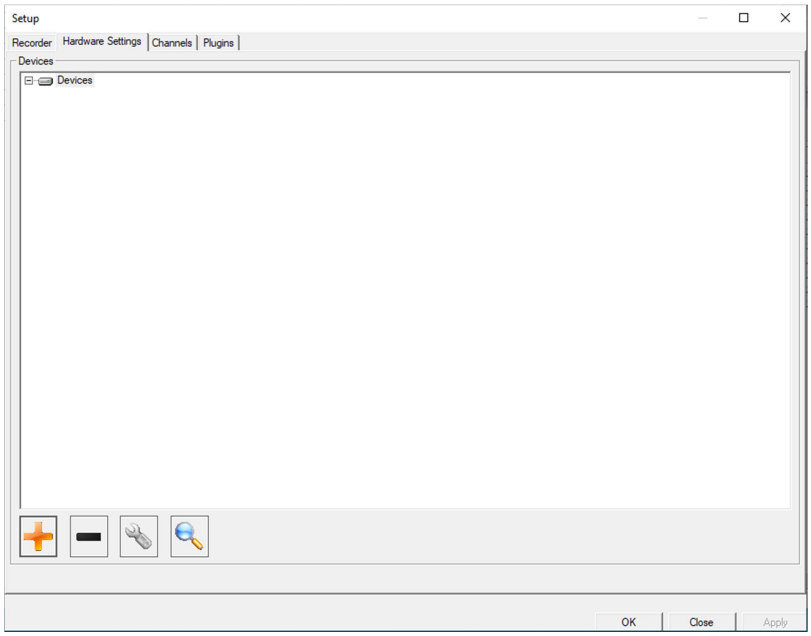


3. After selecting the file with the required configuration, click Open.
4. Recorder will load selected configuration.

4.3 Connection of complexes and crate controllers

To create a new system configuration, one of the existing configurations can be edited and saved with a new name, or sequence of following steps should be done.

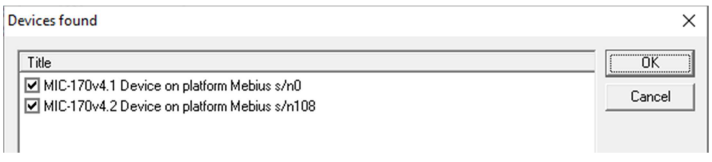
1. After starting Recorder click the button  - **Recoder SETTINGS** on the **Control Panel** or press **F12** and in opened **Setup** window select **Hardware Settings** tab

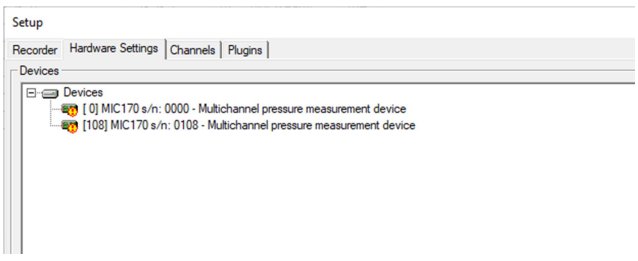


2. Right-click on the **Devices** and select **Device auto search**, or click the button 

3. After the short message **Device Search**, a window opens with a list of **Devices Found**

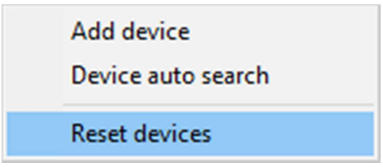
4. After confirming the selection of devices by clicking OK, these devices will appear in the **Hardware Settings** tab of **Setup** window.



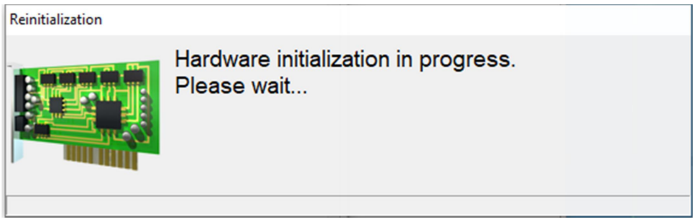


Serial numbers in the lines indicate that the devices are recognized correctly, but the sign  warns that they should be initialized.

5. Again, as in step 1, open the menu and select **Reset devices**.



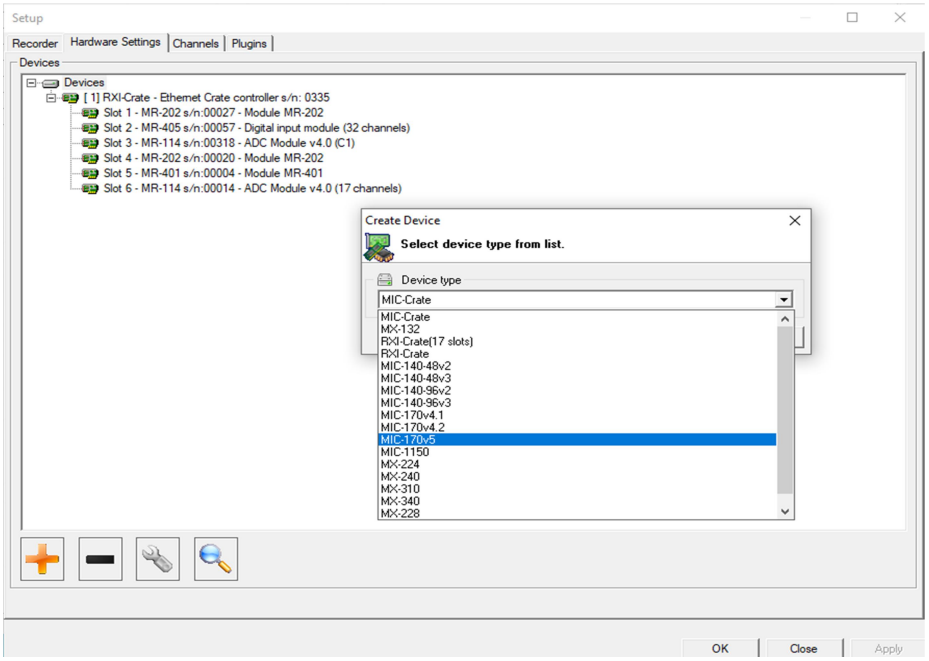
6. Initialization of detected devices will start.



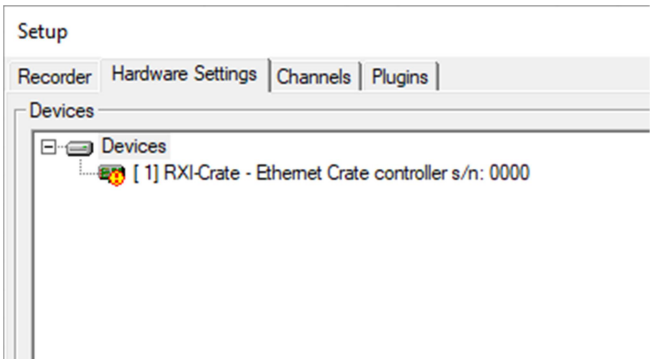
7. As a confirmation of successful initialization, the warning sign (step 4) will disappear.

8. If for some reason devices located in the local network of the measurement system are enabled, but are not detected by auto-search, follow the steps described in paragraphs 9 - 17.

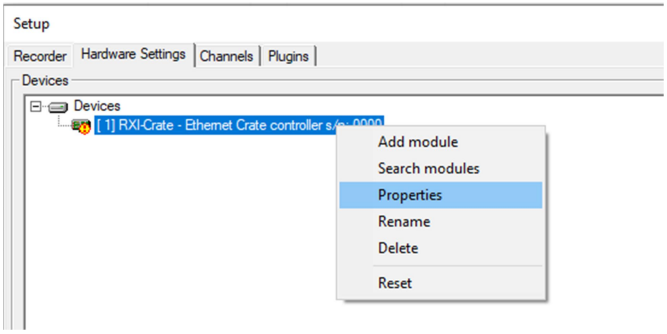
9. Click the **Add Device** or use button  . After that, the **Create Device** window opens, where a drop-down list shows the list of devices that can be included in the system configuration. For a complex with the RXI bus (MIC-236), select the RXI-Crate and click **Create**.



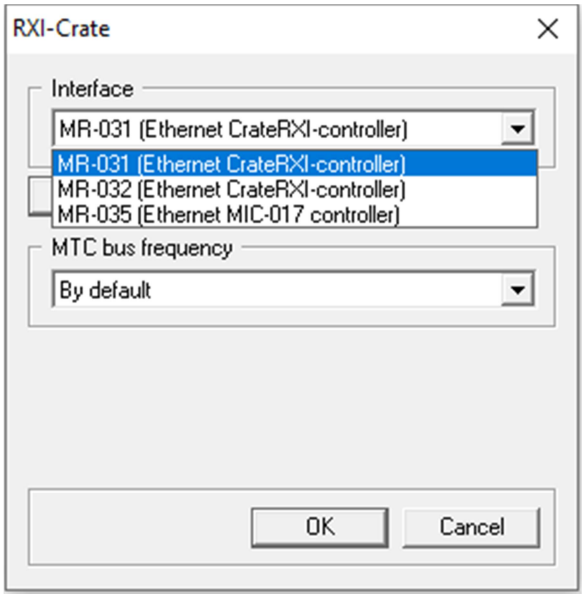
10. Name of the crate will appear in the list of devices at line [1].
11. At the beginning of the line, there will be a yellow icon that tells you to initialize the crate controller.



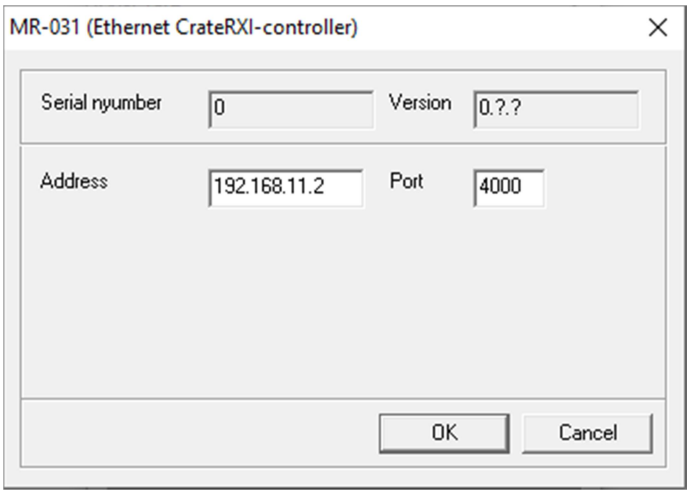
12. Right-click the line [1] and select **Properties**.



13. In the RXI-Crate window that opens, from the drop-down list select the type of controller that installed in the crate (see the MIX complex passport) of the customizing MIC complex. Do not close the **RXI-Crate** window.



14. Click the **Properties** in **RXI-Crate** window. In opened window enter controller IP **Address**, which is shown in the controller passport or in MIC complex passport. Close the current window by clicking **OK** and **RXI-Crate** window also by clicking **OK**.



15. Controller IP address can also be defined as follows:

    192.168.<type>.<s/n>,

    where <s/n> - 2 less significant digits of controller serial number.

    Controller type defined according to the table:

Controller type	MC-031	MR-031	MC-032	MR-032	MIC-140
< type > digits in IP-address	10	11	12	13	14

For example, for MC-032 controller with the factory serial number 03200025, the IP address will be 192.168.12.**25**.

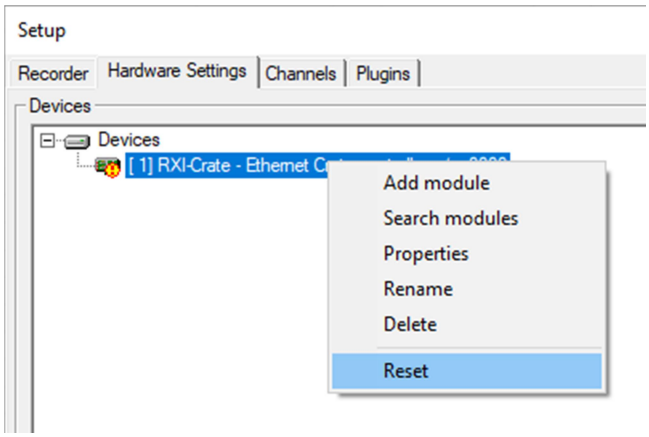
16. PC connection requires a correct setting of the network card.

    Set the IP address in the format 192.168. XXX.YYY, where XXX is from 000 to 015, and YYY is from 001 to 255. It must be different from address of the controller.

    Subnet mask fixed 255.255.240.0.

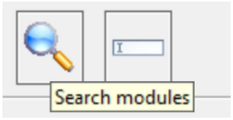
    For more information about setting up a network connection, see the MS Windows User Guide. It may differ depending on the operating system version.

17. Right-click the root menu **Device** and select **Reset Devices** or select **Reset** from line[1] menu. Crate controller will be initialized.

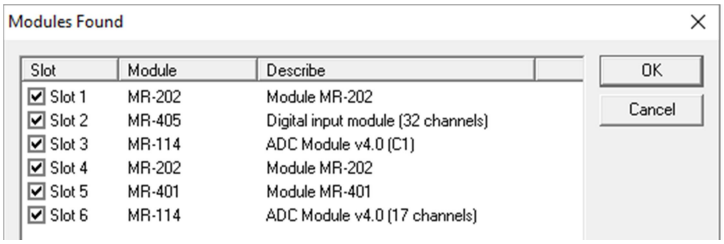


4.4 Connection of modules

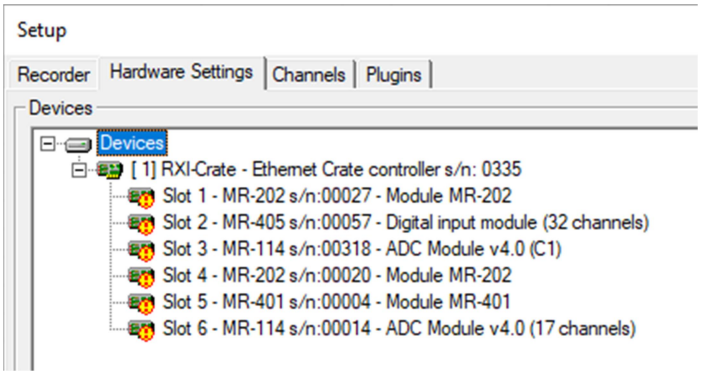
1. Select the [1] MIC-Crate line again and click **Search Modules** button.



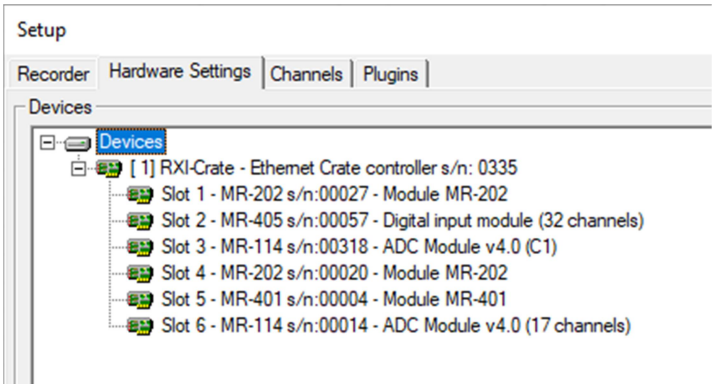
2. In opened **Modules Found** window select modules that will be used in the work in ***Slot*** column and confirm selection by pressing **OK**.



3. The list of all selected modules will be displayed in the general list of the Device.

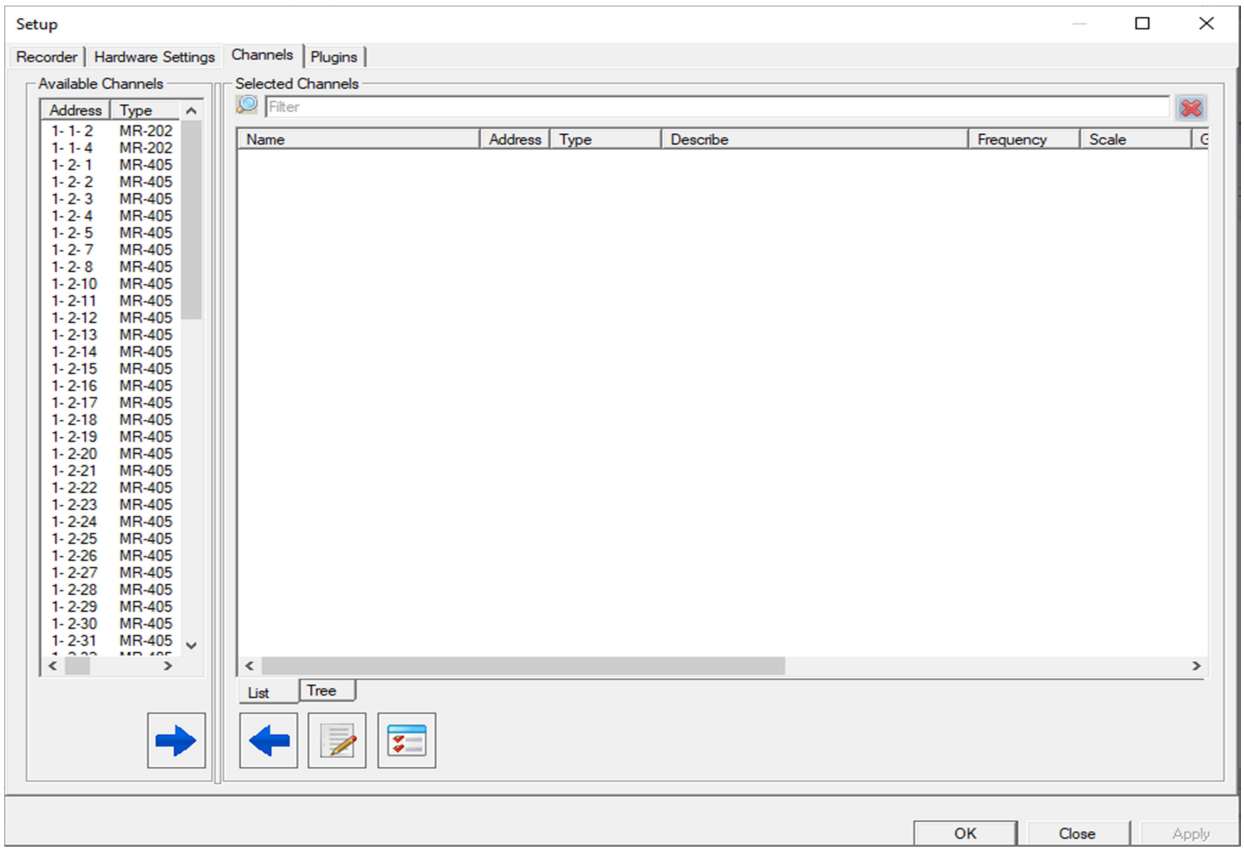


4. Right-click **Device**, select **Reset Devices**, then initialization of all selected modules will start.

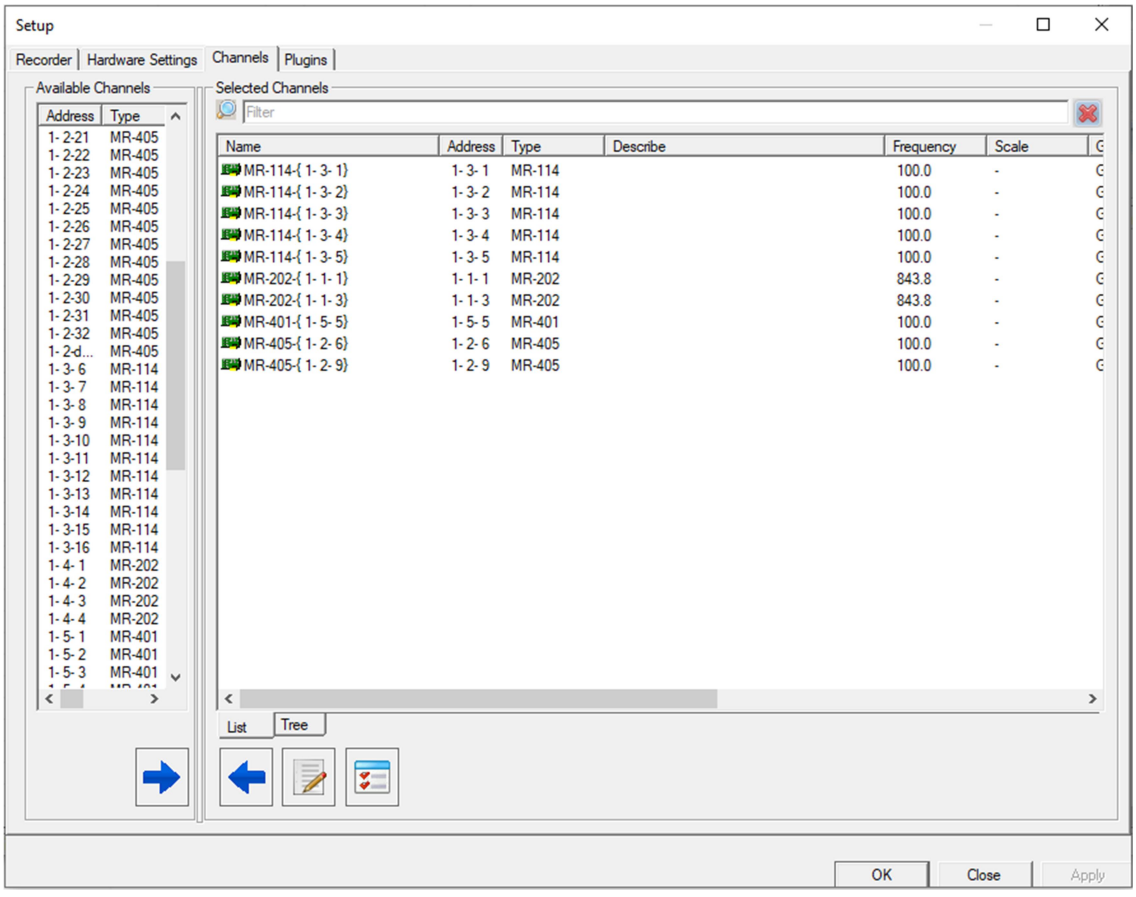


4.5 Channel Selection

1. Click the **Channels** tab in the **Setup** window.

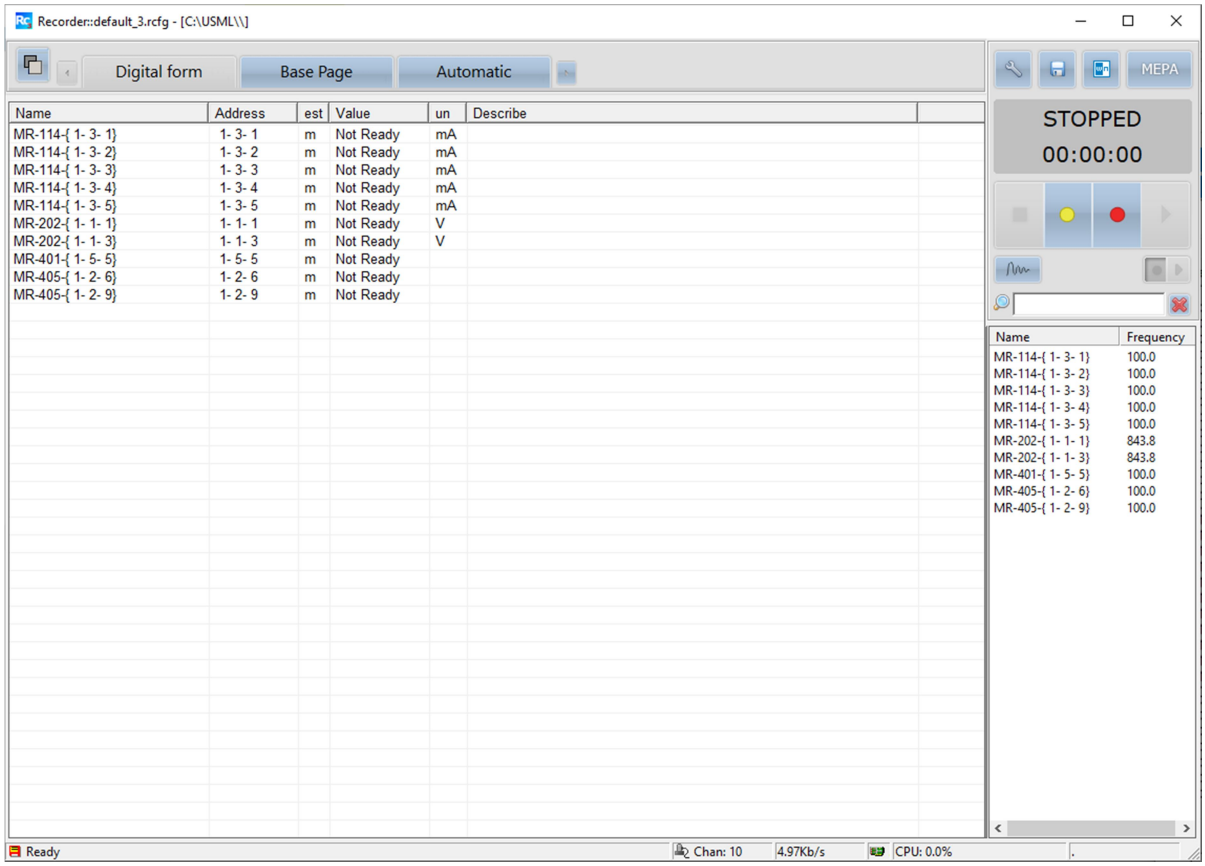


2. In **Available Channels** window use **Ctrl** and **Shift** buttons to select the channels need to be included in the system configuration, and click the right arrow at the bottom of the window:

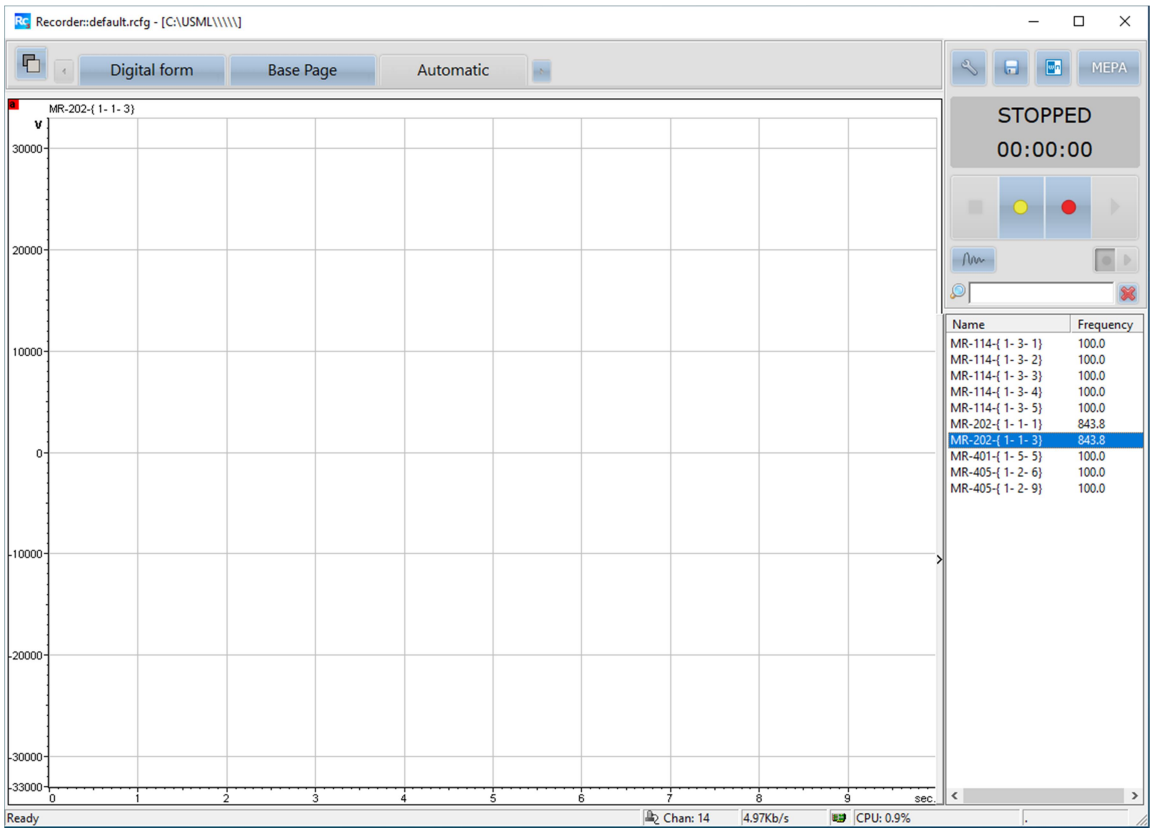


3. Selected channels are displayed in the **Selected Channels** field of the **Channel**s tab. List of **Selected Channels** can be edited using arrows buttons on the bottom line.

4. After clicking **OK** in **Setup** window, the channel list will be fully displayed in the **Channel List** field on the right side of the main Recorder window. Channels selected for signal visualization will be displayed in **Digital Form** and on **Base Page** of Recorder main window.



5. The **Automatic** page displays only the signal of the selected channel. The page can be used for sequential or selective signals view in measuring channels. Selection of a channel performed by selecting it in the **Channel List** field.



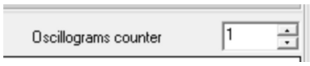
6. When creating a list of ***Selected channels***, each channel is automatically assigned a name of the type **MA-AAA {X-Y-Z}**, where:

   - **MN-AAA**-module name,
   - **{X-Y-Z}** - channel address: sequence numbers of the complex in the measurement system, slot numbers, and channel numbers,
   - Non-modular devices (for example: MIC-140, MIC-170, MIC-184) receive channel addresses consisting of two groups of digits **{X-Z}**: the device number in the measurement system and the channel sequence number.

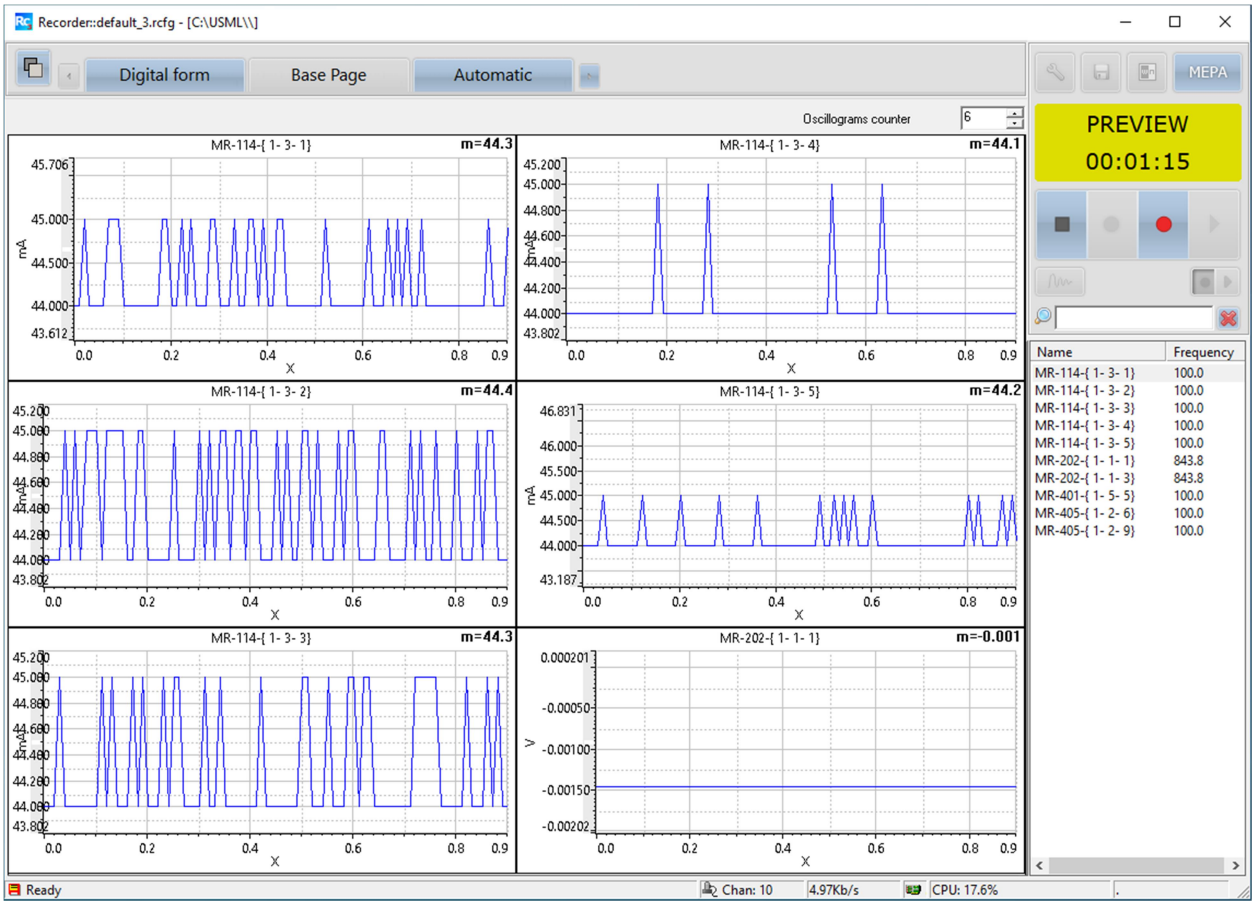
7. Automatically assigned names are used in all channel lists, settings windows, and forms until they are renamed, which can be done in the **Channel settings** window (section 8.1). The address of the channel, thus, remains unchanged.

4.6 Checking configuration settings

1. To visualize the signals of the selected channels, waveforms can be outputted on the **Base page** and the **Automatic** page to display the signals.

2. The **Automatic** page displays one signal selected in the **Channel List**.
3. The number of waveforms placed on the **Base page** can be set using the counter 

in the top line of the page. The waveforms are placed in the order specified in the **Channel List.**



4. End-to-end channel health check can be performed when a signal corresponding to its operating ranges is connected to the channel input, then click the **VIEW** (yellow) or **RECORD** (red) button on the control panel of the main window. When work finished, press **STOP** or Esc button.

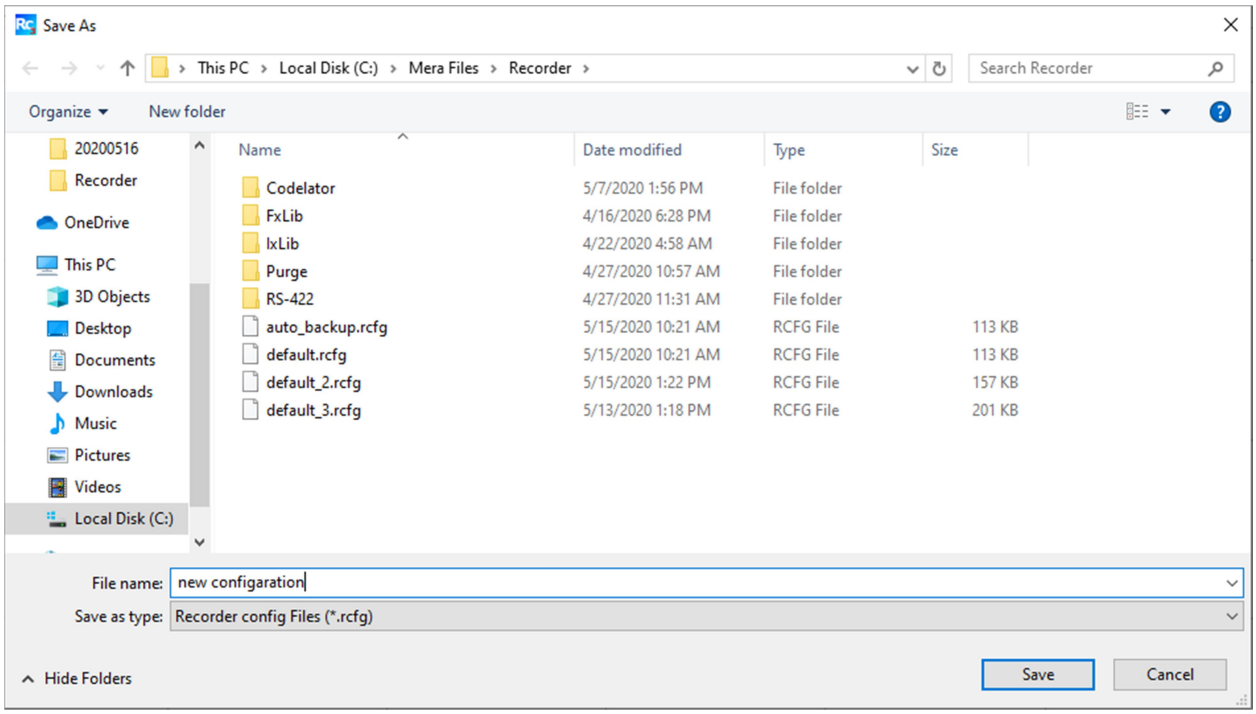
5. In the process of forming the configuration of the measurement system, it is advisable to check the settings that are being performed. Not only when selecting complexes, modules and channels, but also for other operations described in this Manual:
    - Modules and channels settings,
    - Channel calibration,
    - User pages and forms creation,
    - Level settings,
    - Creating data entry templates,
    - Settings of the universal time system and others.

4.7 Configuration Saving

1. To save the current configuration under the current name, press the button on the control panel  - **Save configuration (Alt-F2)** or by exiting Recorder with confirmation of saving the configuration.

2. To save the configuration in a new file with a unique name click the menu button 

, choose **Save configuration as...** and in opened window change file name to name under which new configuration will be saved and press **Save** button:

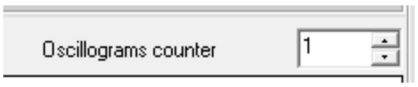


3. Saving the system configuration after each setting saves time when creating new system settings.

5 User Page Creation

5.1 User Pages

1. The following pages are embedded and cannot be deleted:

- **Base page** - a form for displaying an arbitrary number of waveforms (up to 16 waveforms can be selected using counter 

on the **Form switching** panel, as shown in paragraph 20 of section 5);
- **Automatic form -** this form displays waveforms for channels selected in the **Channel List**;
- **Digital form** - displays a list of channels, current estimations, and additional information.

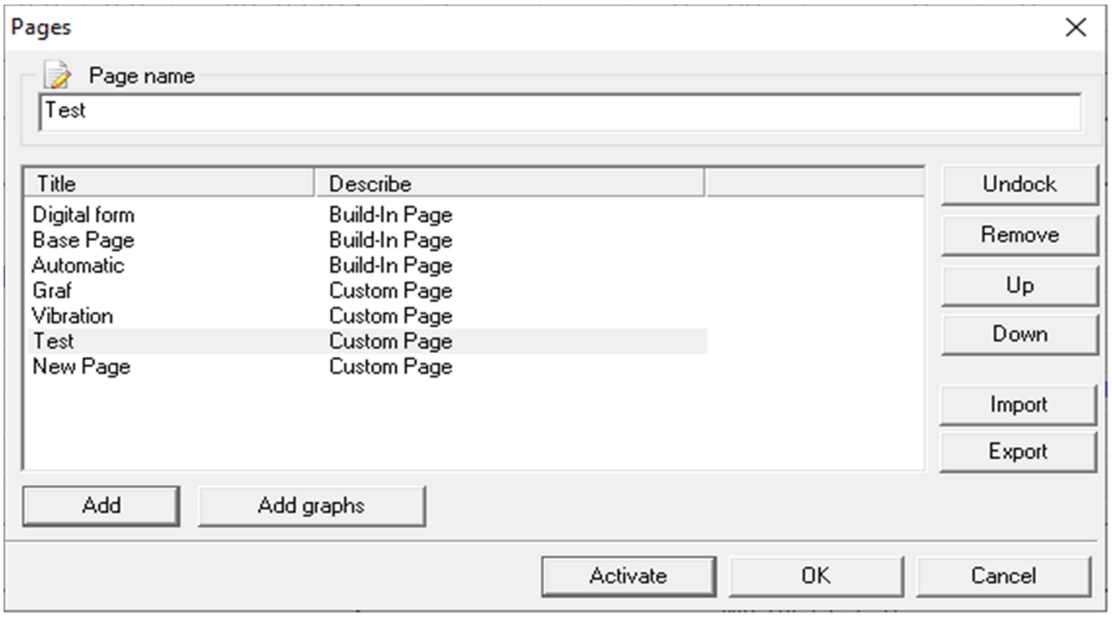
2. In addition to built-in pages, it is possible to create two types of user pages by clicking the corresponding buttons: **Add graphs** and **Add** (for mimic diagram).

The **mimic diagram** page can display all the signal and reference information in the most convenient way for the user. The **graph** page is less functional, but easier to set up and can be used for simple measurement systems.

A **mimic diagram** is a graphical information model that conditionally displays the functional and technical diagram of an object and information about its state to the extent necessary for the operator to perform functions assigned to him.

In both cases, **New Pages** will be generated, which should be named if there are more than one user pages.

A common window is used for naming, placing in the list, and activating **graph** and **mimic diagram** pages.

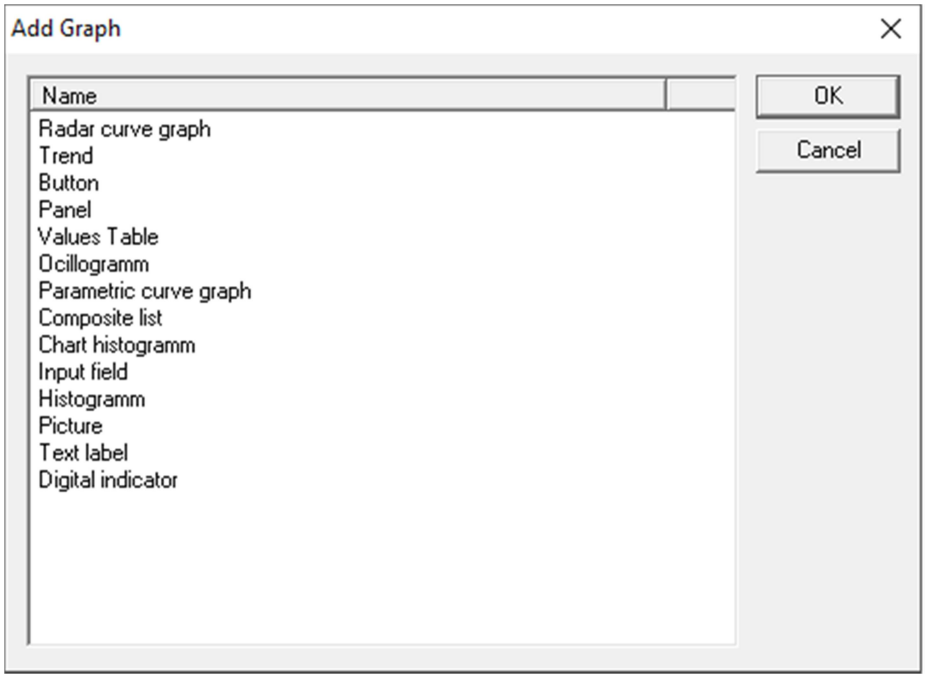


3. If the **graph** page is selected (**Add graphs** button), then clicking **Activate** opens the page for creating a graphic form. To create and edit forms use buttons in the upper right part of the screen:

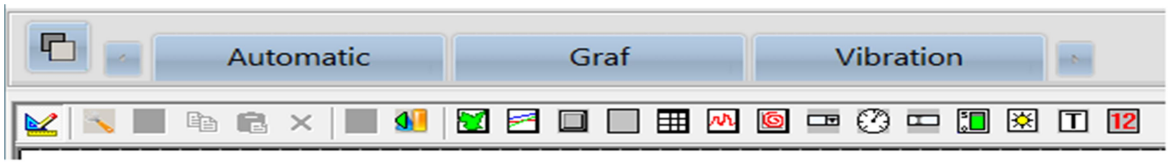
Add Graph - to open the menu for selecting form elements,

Remove Graph - to delete element ,

Auto Arrange Graphs - to rearrange elements positions of on the page automatically.



4. If a **mimic diagram** page is selected (**Add** button), clicking **Activate** opens a page where you can create a form that includes graph and mimic diagram elements. Select items from the list at the top of the screen:



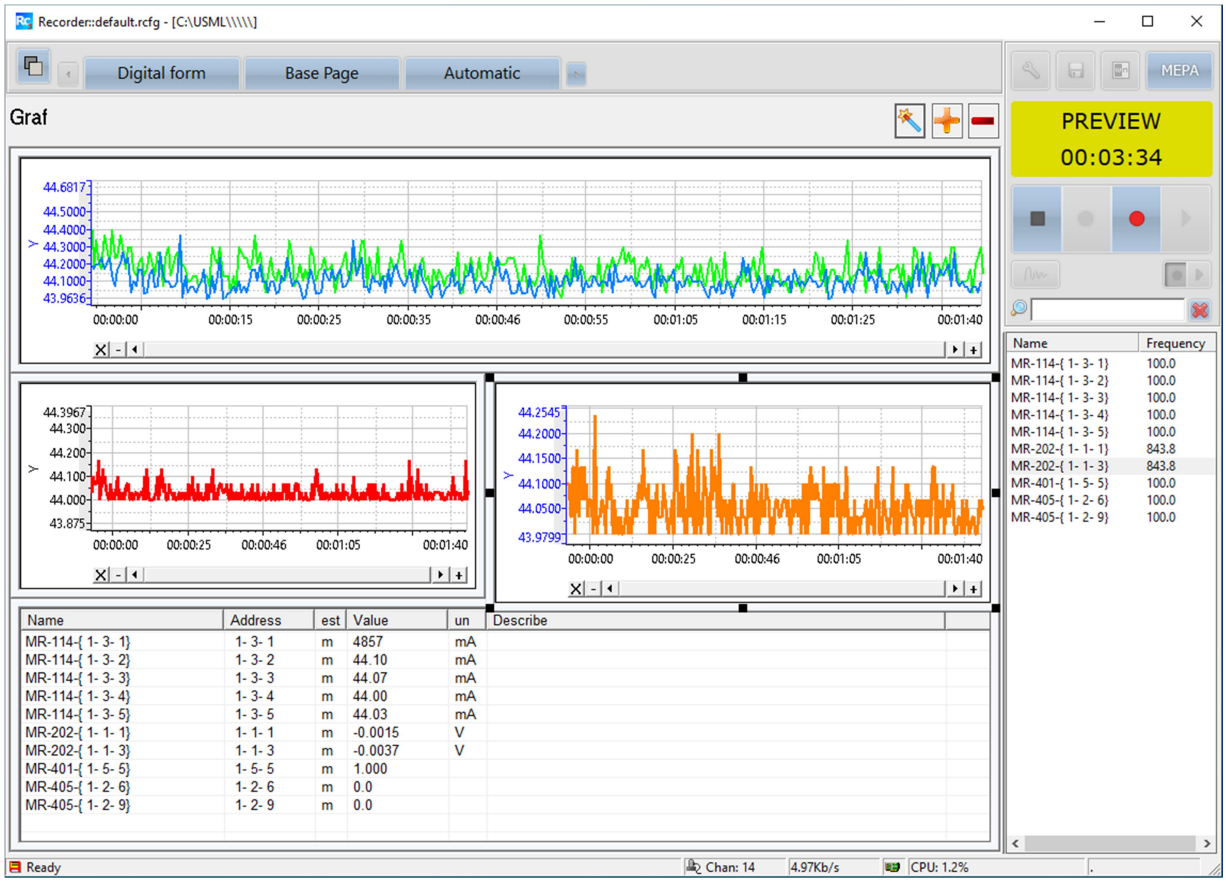
5. Items displayed on the page can be moved on the screen by cursor and resized after selecting them with the left mouse button.

6. Form elements can be further customized to meet the requirements for displaying measurement, reference information and the user's wishes.

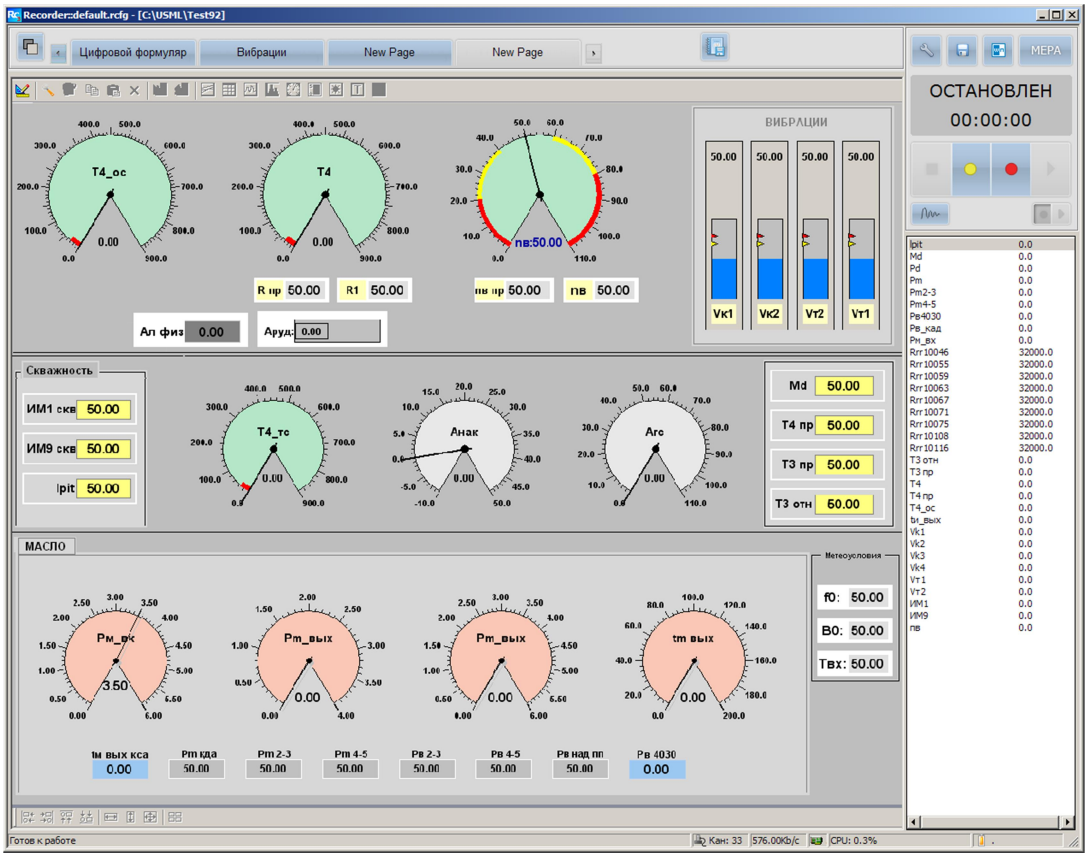
You can switch to the configuration mode for any form element by right clicking on the form image and selecting **Properties** from the menu that appears. Then **Setup** window for corresponding element opens. Various form elements configuration described in section 5.2.

5.2 Examples of forms configuration

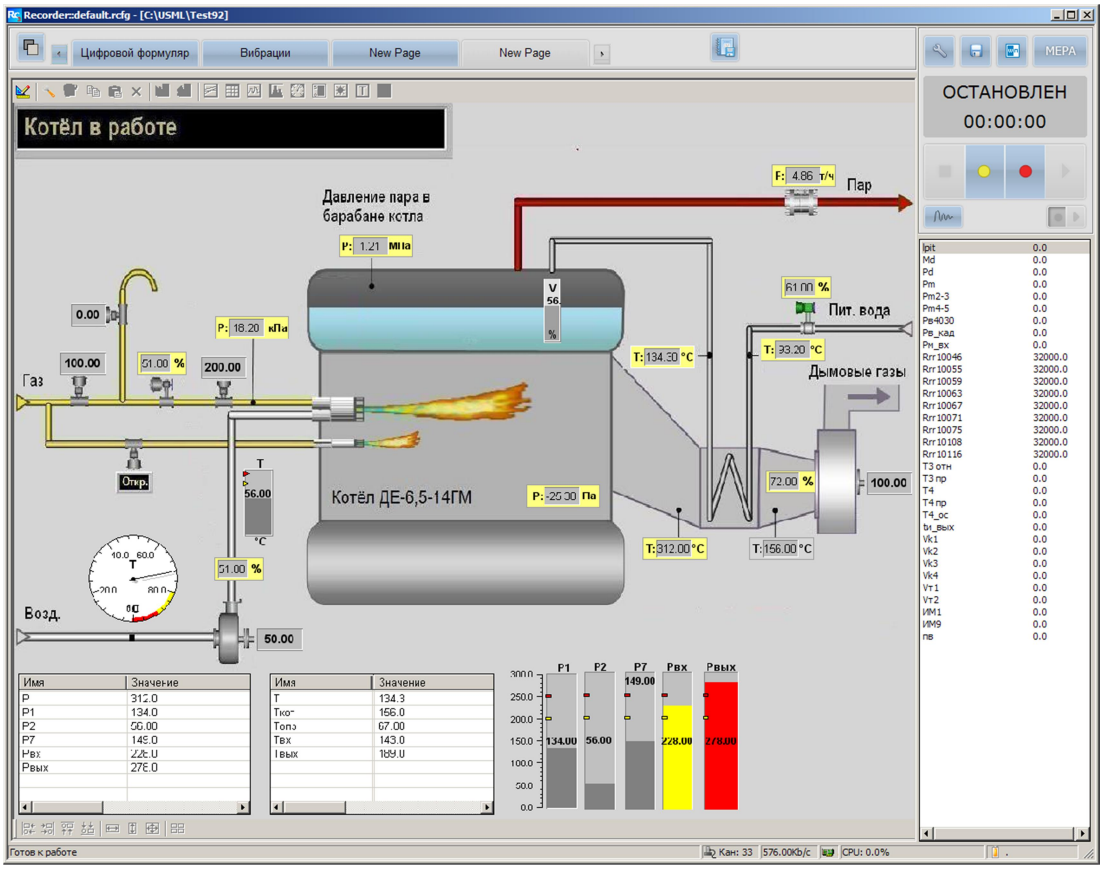
1. Example of configuring a user graph page



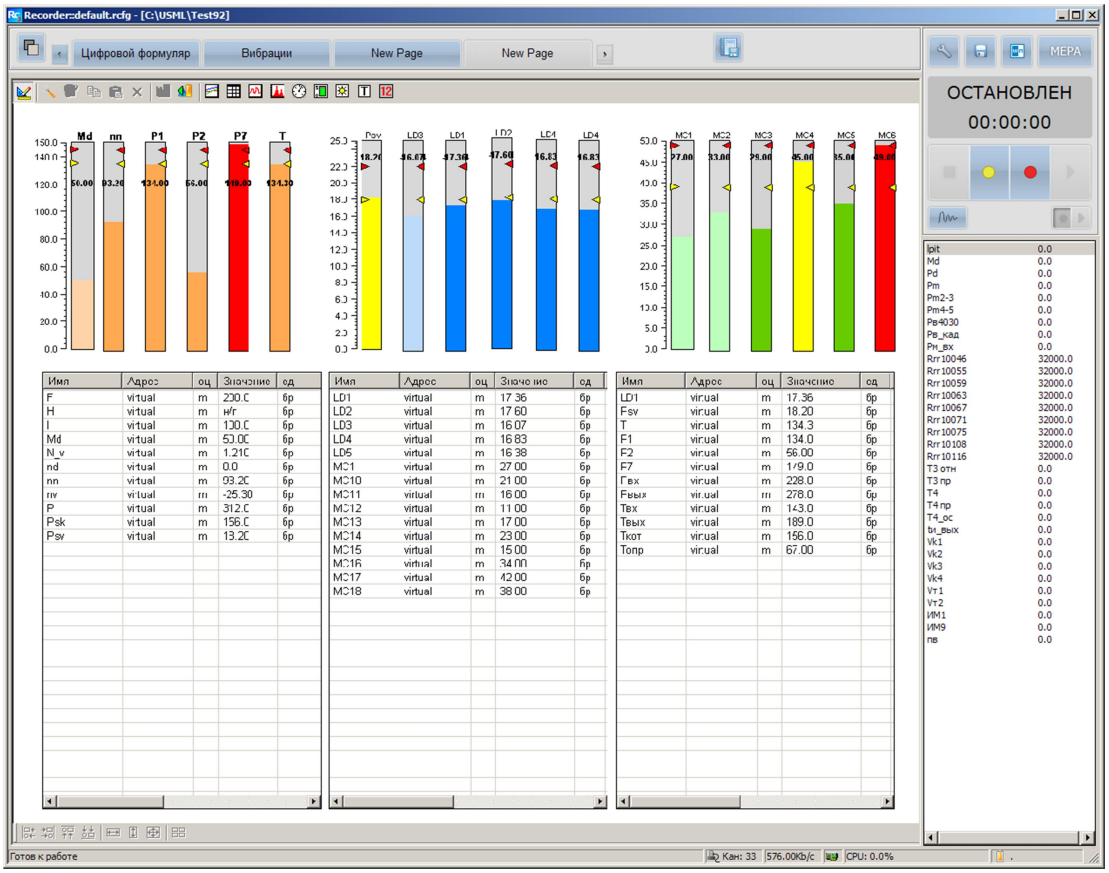
2. Example of configuring a user mimic diagram page



3. Example of configuring a user mimic diagram page



4. Example of configuring a user mimic diagram page

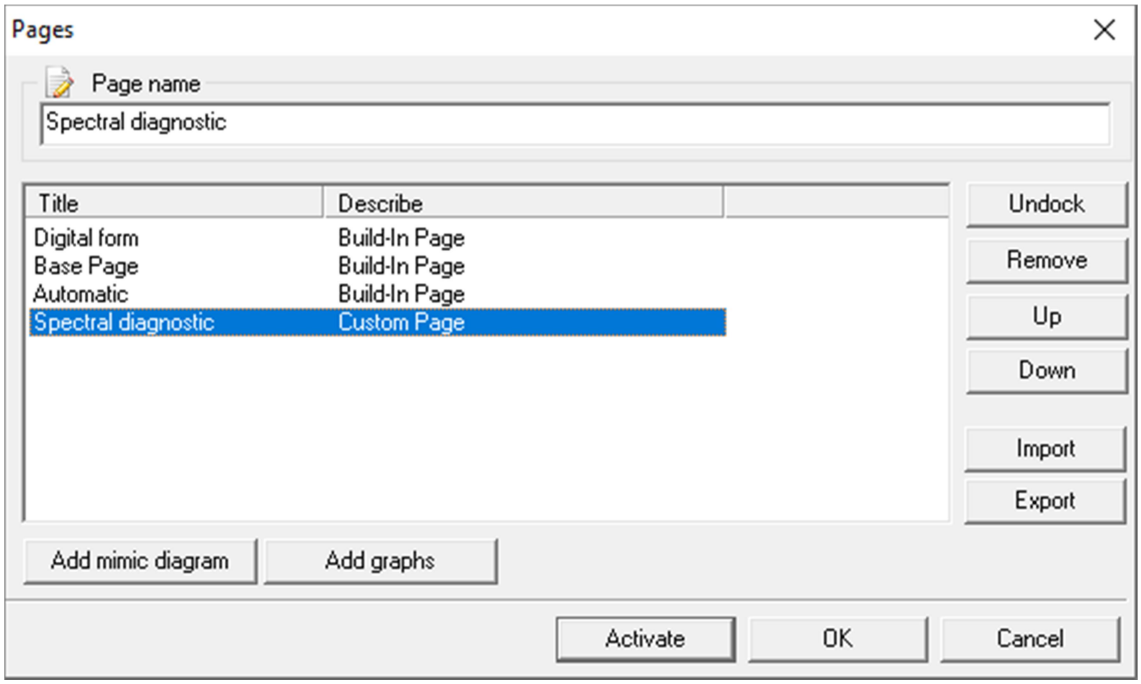


5.3 Operation with mimic diagrams

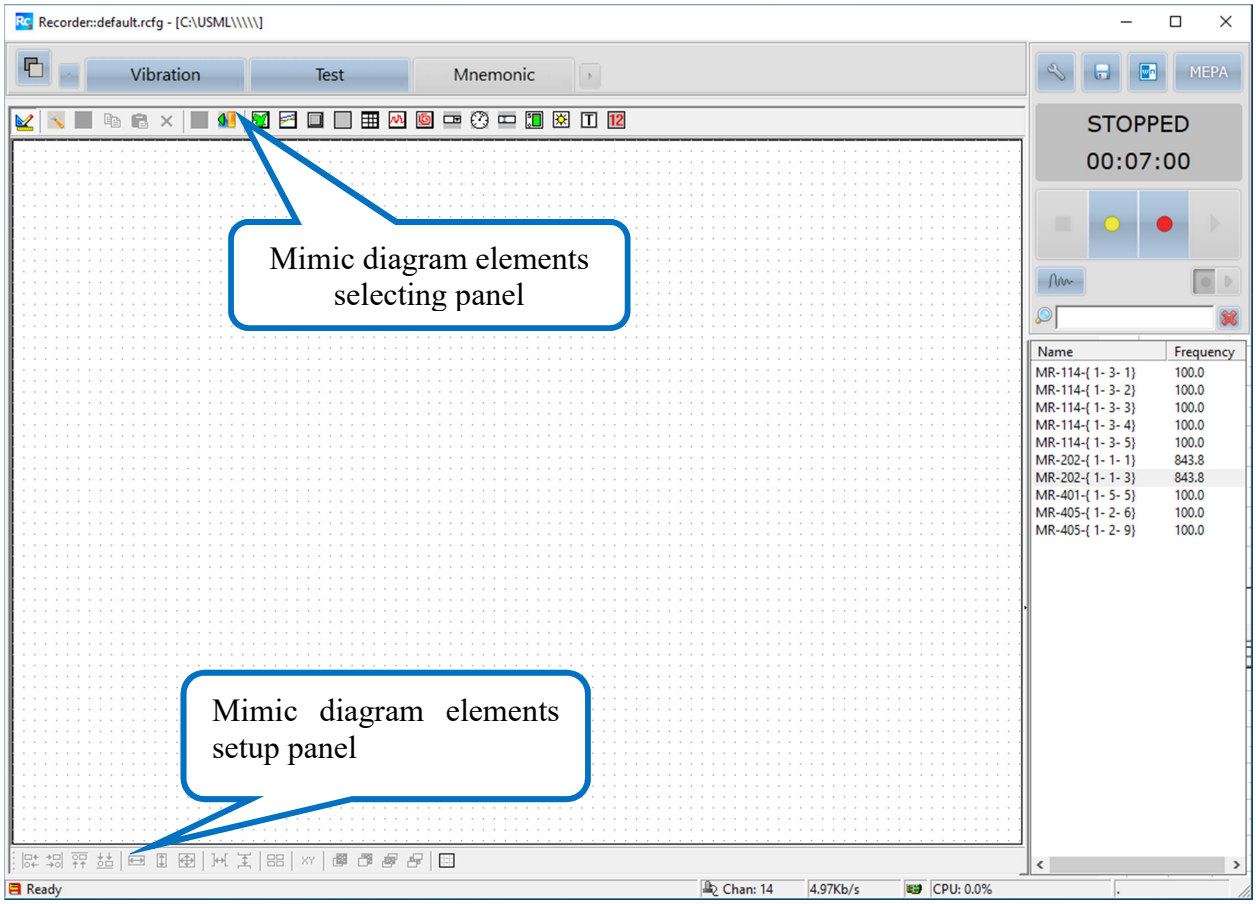
5.3.1 Creation of mimic diagram page

1. To create a form using the mimic diagram (graph) page, following steps should be done:

- Open the window **Pages** using the button  on **Control Panel**.
- In **Pages** window, click **Add** (for mimic diagram) or **Add graphics** button. A new entry New Page will appear in the list of pages.



- In the field **Page Name** enter the name of the created mimic diagram page.
- After clicking **Activate**, the window will close and a new page will appear on the screen. The opening of the mimic diagram page is shown below.



2. **Control Panel** used to display and configure form elements:

 Enable and disable editing mode

 Opens the **Tool settings** window.

 Opens the properties window for selected objects

 Copy selected object

 Paste copied object

 Delete selected object

 Add an object to the library

 Select an object from the library

 Add element “Radar curve graph”

 Add element “Trend” (section 6.4),

 Add element "Values table"

 Add element “Oscillogram” (section 6.3),

 Add element "Histogram" (section 6.5),

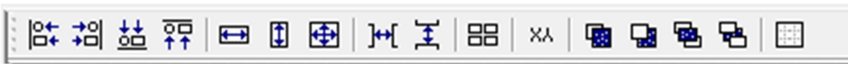
 Add element **“**Dial gauge chart**”** (section 6.6),

 Add element "Picture"

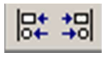
 Add element "Text label"

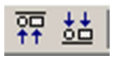
 Add element "Digital indicator"

3. The **Control Panel** can be hidden or displayed using a special combination: press the CTRL button and left click on the free area of the mimic diagram. The edit mode must be disabled by clicking  button.
4. To add an element on a page:
   - enable editing mode with the button  ;
   - click the appropriate element button on the **Control Panel**;
   - click the left button of the mouse on the page where you want to place the element. The element will be displayed at the cursor position.
5. To delete an element, select it and use the button  **.**
6. The location of elements on the page is set using buttons that are activated when you select the elements that you want to configure:



Use the offset buttons on the alignment panel to group all elements on the page. Select two or more items and click the appropriate button.

 - Align selected elements to the left or right edge of the last selected element.

 - Align selected elements to the upper or lower edge of the last selected element.

 - Make the selected elements of the same width, height, and size, respectively, for the last selected element.

7. To place form elements on the page and align horizontally and vertically, select the elements to align using Shift and click  - **Form as a table**. Following window will open:

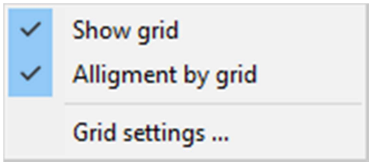
In the window, set the number of rows and columns of the form page where displayed elements will be allocated automatically.

- The elements will be arranged in the reverse order of the selection.
- Elements are aligned to the left edge of the leftmost element and to the top edge of the topmost element.
- The size of all elements will be equal to the size of the last selected element.

8. Another way to align elements is to use a grid on the screen:

click the last button on the **Mimic diagram elements setup panel**

In the menu that opens, you can:



- after opening the **Grid Setting…**, set the grid pitch vertically and horizontally,
- set the **Align by grid** mode flag and perform alignment,
- after you align the elements, unset the flag **Show grid** to hide the grid.

9. The order of applying image layers on the page is set by buttons  .

5.3.2 Mimic diagram page configuration

1. The page background gives visibility to each mimic diagram. If there are many mimic diagrams in the measuring system configuration, their different backgrounds allows the user to quickly identify opened page.

   Use the button  to add a background, this action will open **Tool settings** window**:**

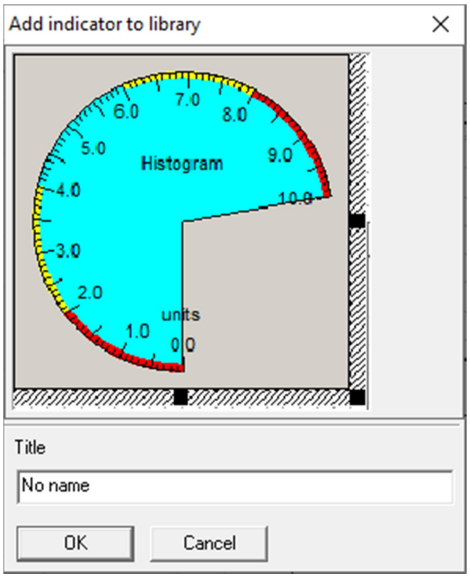
   Use this window to delete or replace the Background image for an opened page, or set the background for a new page.

2. The **File** field displays a link to the background image for the current page:
   - To remove the background of the page, click on the **Remove** button and then **OK**.
   - To set the page background, click the button  and in the opened window select the desired image. After clicking the **OK** button, the **Tool settings** window will close and the selected image will become the background of the page.
3. In the **Diagram size** field you can select the zoom type for the image and screen of the mimic diagram.
   - **By window size –** the image will be scaled according to the current window size, without keeping the proportions.
   - **By picture size –** the working area of the mimic diagram will be created according to the size of the image, and scroll bars will automatically appear if necessary.
   - **Set size** – the user can independently set the desired size according to resolution of the user's display.

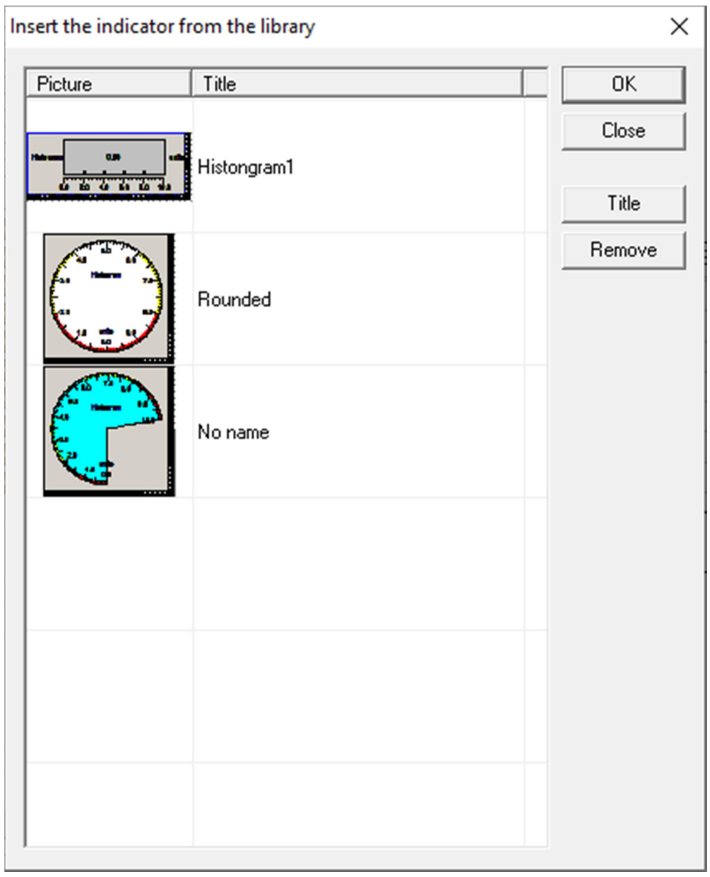
5.3.3 Predefined components library

1. The user can configure any of the components in the desired way, and then save it to the library for further use. This avoids the need to re-configure the same type of elements.

2. To save the configured element to the library, select it in the page field and click  - **Add object to the library**. In the window that opens, enter the **Name** and click **OK**.



3. To insert an element from the library, click  - **Select object from the library**, select an element, and click OK. After closing the window, click the mouse in the position where you want to place an element.
4. In the same window you can rename or delete the required elements using the **Title** and **Remove** buttons.



5. The library is stored in the MERA Files directory in the IxLib subdirectory. During installation the default folder is "C:\Mera Files\Recorder\IxLib\". You can transfer the library to another computer by simply copying library file.

6 Description and settings of elements of forms

6.1 Setup features

1. On user graph and mimic diagram pages, forms can be created using elements that use common configuration tools for setup.

2. The element settings tools are available in the **Setup** windows, which open by clicking the **Properties** button after selecting an element on the screen and then right-clicking on the selected item.

3. The **Setup** windows for many elements have similar and identically located settings tools that provide:

    - tools for selecting a channel or a list of channels whose measurement information should be displayed by the element;
    - setting the **Move parameters from channel** flag when you first enable it, which allows you to synchronize the settings of the measuring module, the channel and the form element that the selected channel is connected to. In the future, the settings are automatically duplicated;
    - settings for ranges of displayed signal values;
    - setting the dimensions and parameters of the chart axes and display scales;
    - renaming form elements, axes, scales, and dials;
    - legend design;
    - selecting and configuring fonts for all labels on the form page;
    - graphic and color design of elements;
    - level settings.

4. Some of the tools in the **Setup** windows are not described in this Recorder user manual because they are intended for factory settings and system diagnostics.

5. The following sections 6.X.X describe the settings for various elements.

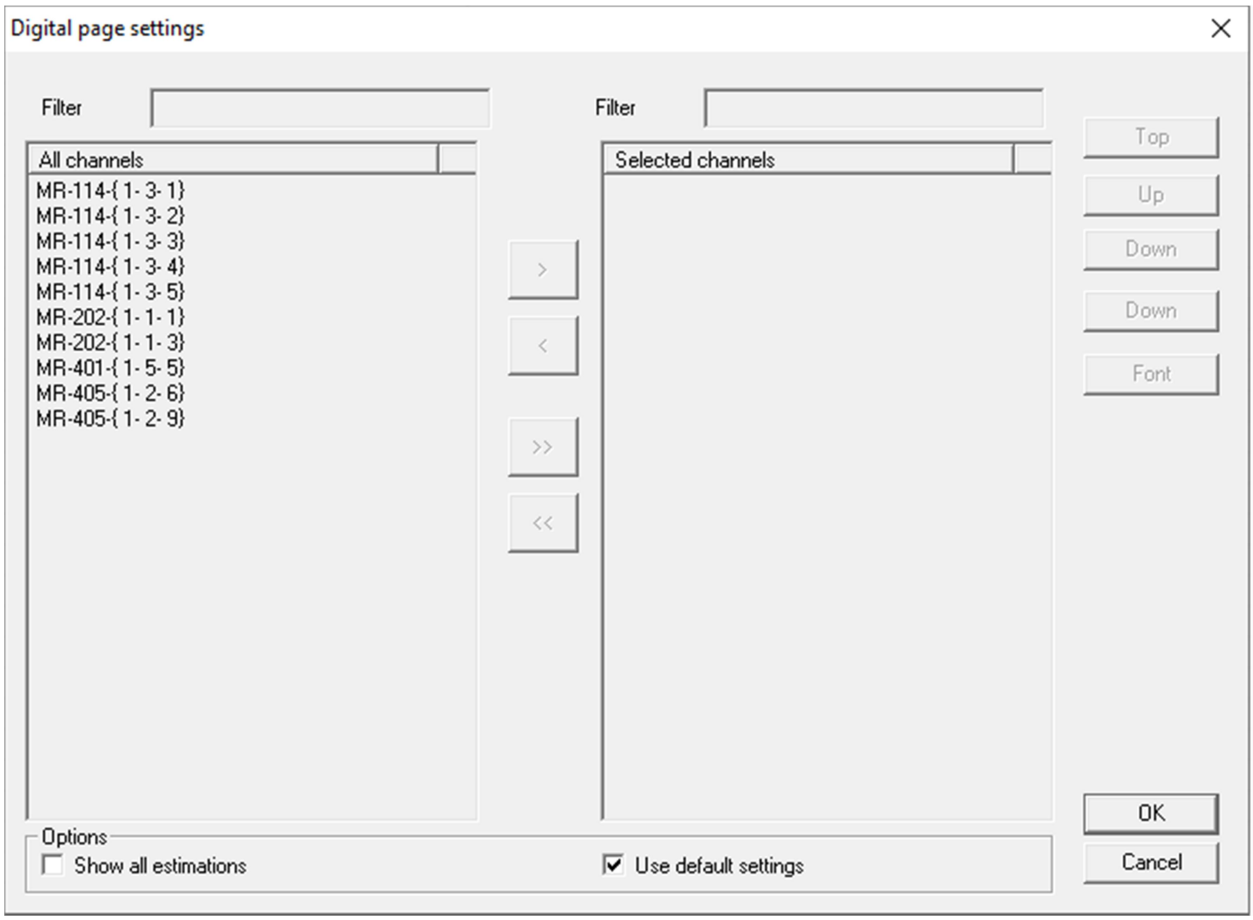
6.2 Values Table

1. A **Values table** is a representation of channel values in a table

2. To add table of values to the page element, press  .

Name	Address	est	Value	un	Describe
MR-114-{ 1- 3- 1}	1- 3- 1	m		mA	
MR-114-{ 1- 3- 2}	1- 3- 2	m		mA	
MR-114-{ 1- 3- 3}	1- 3- 3	m		mA	
MR-114-{ 1- 3- 4}	1- 3- 4	m		mA	
MR-114-{ 1- 3- 5}	1- 3- 5	m		mA	
MR-202-{ 1- 1- 1}	1- 1- 1	m		V	
MR-202-{ 1- 1- 3}	1- 1- 3	m		V	
MR-401-{ 1- 5- 5}	1- 5- 5	m			
MR-405-{ 1- 2- 6}	1- 2- 6	m			
MR-405-{ 1- 2- 9}	1- 2- 9	m			

3. The **Values table** is configured in the **Digital page settings** window

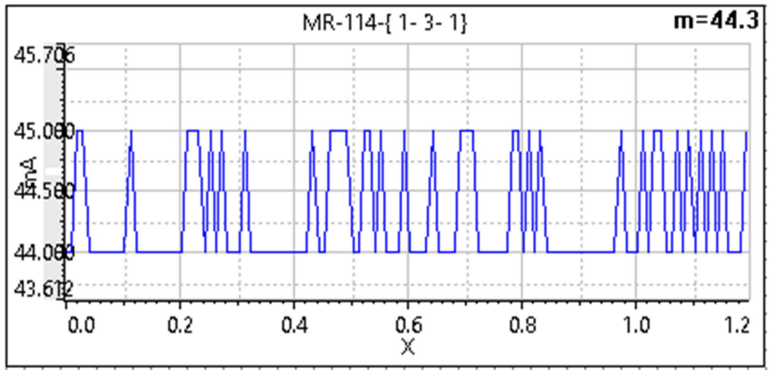


4. Left field displays active channels list of the Recorder. In the form, channels are displayed in the order that was set in the settings window. To change the position of a channel in the list, first select it and then click the appropriate arrow button.
5. If you select the **Use default settings** option, all buttons will become unavailable, all signals will be selected, and the program settings will be applied to the signals: the order of display and font.
6. While using the button **Font**, settings changes apply to the entire table.

6.3 Waveform window

6.3.1 Adding the Waveform window

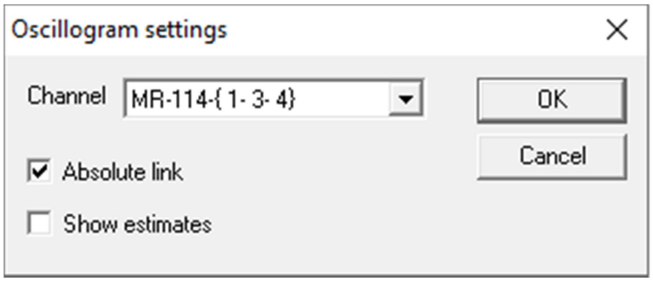
1. The waveform used to display changes of signal of the selected channel over time at the **Base** page and **User** pages.
2. To add the waveform window, click the button 
3. To change the scale of the chart axes, place the cursor on the custom axis and rotate the mouse wheel in the desired direction.



4. In the **Oscillogram settings** window, you can choose the type of link to the channel – **Absolute** or **Relative.**

   - If absolute binding selected, select from the drop-down list the channel that will be displayed on this waveform, regardless of the current channel selected in the Recorder.

   - In relative binding mode, you must set the offset in the channel list relative to the selected channel. Therefore, when you change the current channel of the Recorder, the channel displayed on the waveform will change.



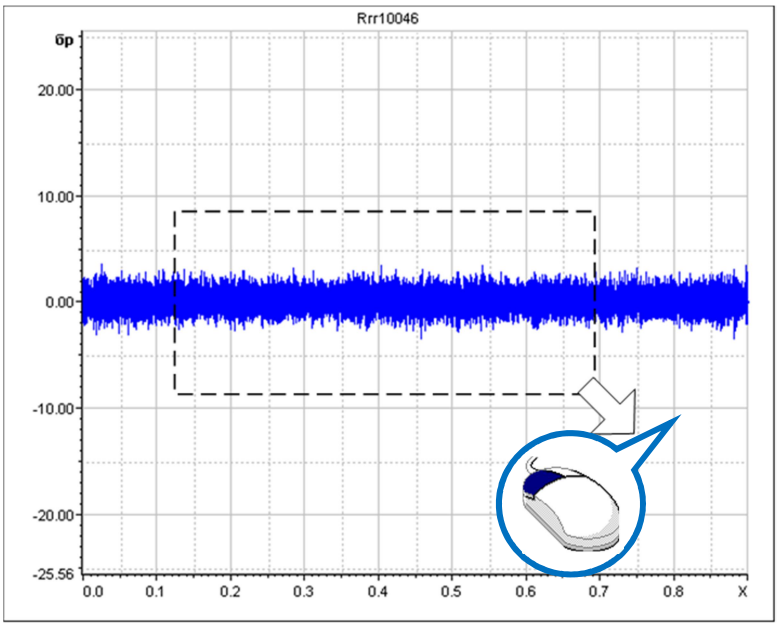
5. When you select the **Show estimations** flag, all estimations enabled for the channel are displayed along with the waveform.
   In the figure of paragraph 3, m=44.3 is the average value for the last calculated interval.

6.3.2 The Chart Scaling

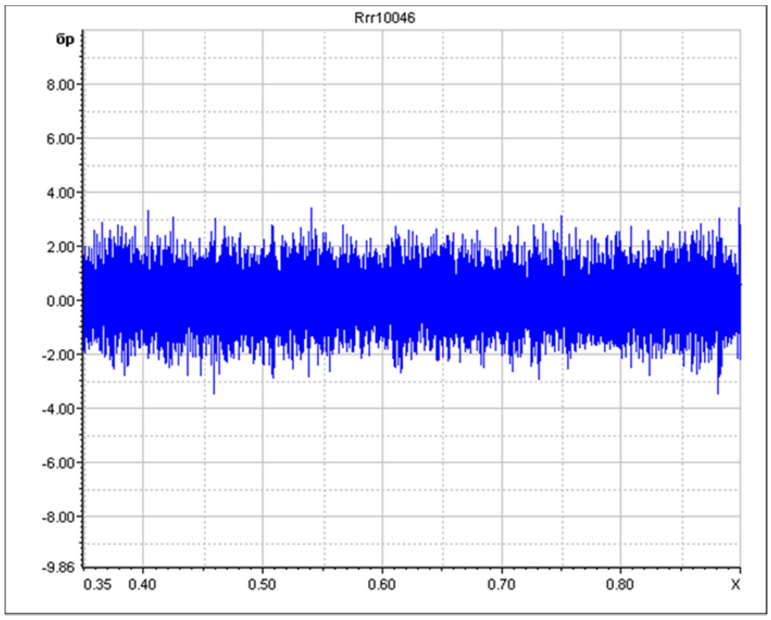
1. The chart scaling method described in this section applies to waveforms and trends on the User and Base pages.

2. To select the desired area on the chart, select it with the mouse while holding down the Ctrl key, moving the mouse pointer from top to bottom and from left to right.

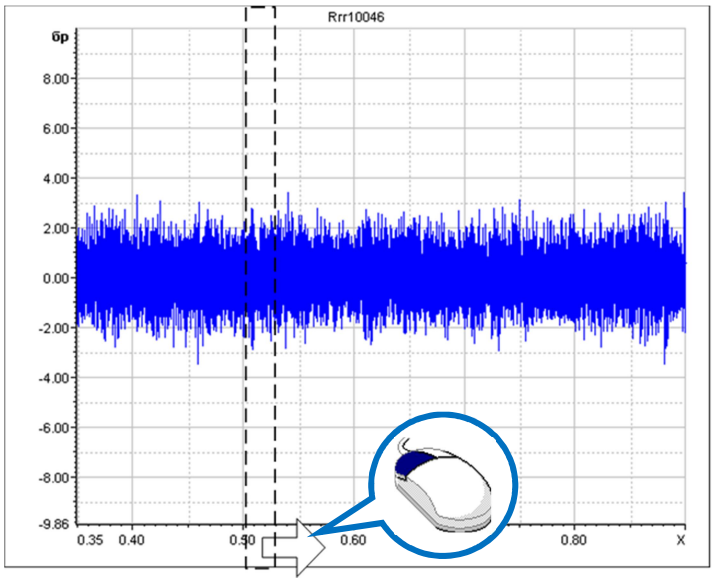
Scaling Process:



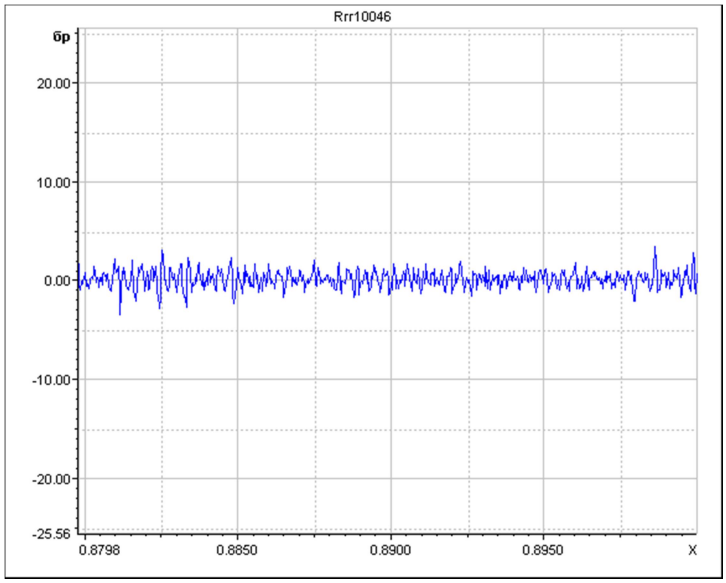
The result of the scaling:



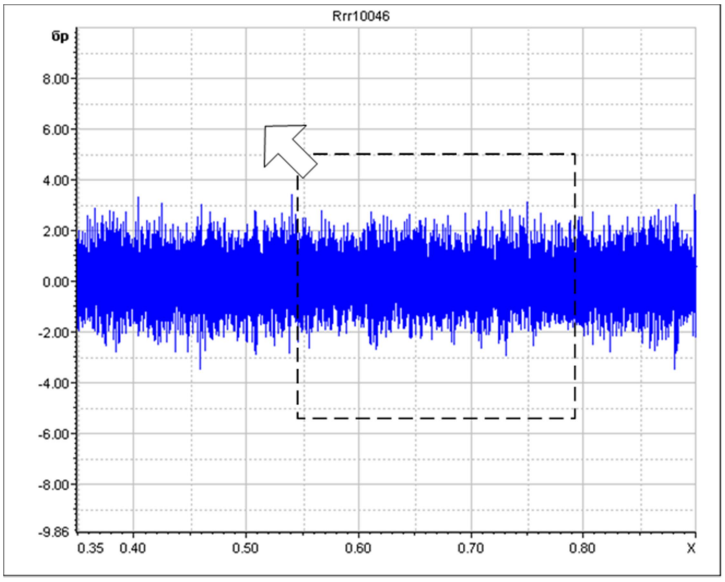
1. To scale the signal only on one of the axes, hold down the Ctrl key and select the desired area on the axis, moving the mouse cursor from left to right for the X axis and from top to bottom for the Y axis:



The result of the scaling:

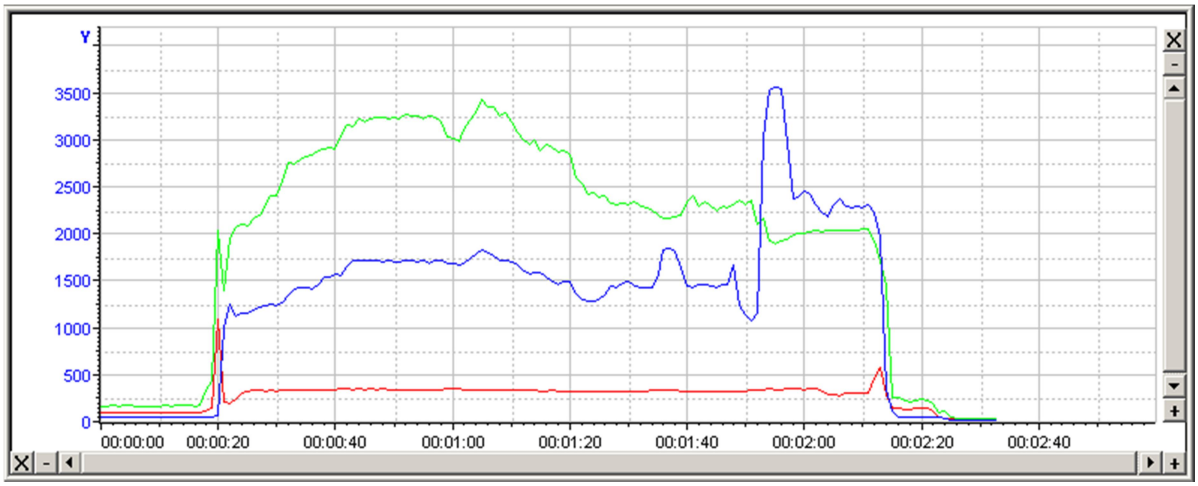


2. To return the scale to its original state, make a selection with the mouse while holding down the **Ctrl** key, moving the mouse from right to left and from bottom to top:

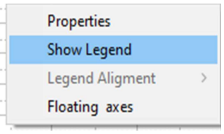


6.4 Trend window

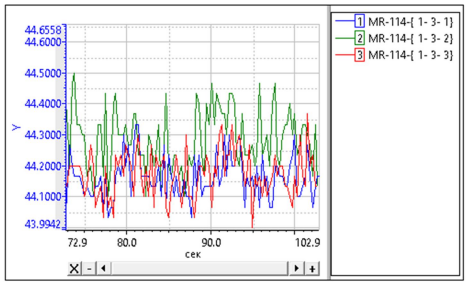
1. A trend is a change in a parameter over time.
2. To add a trend window, click  .

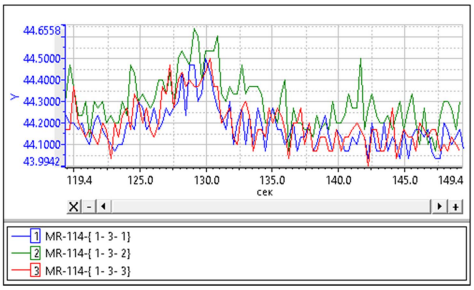


3. To display the legend in the trend window click the right mouse button and chose **Show Legend** from menu.



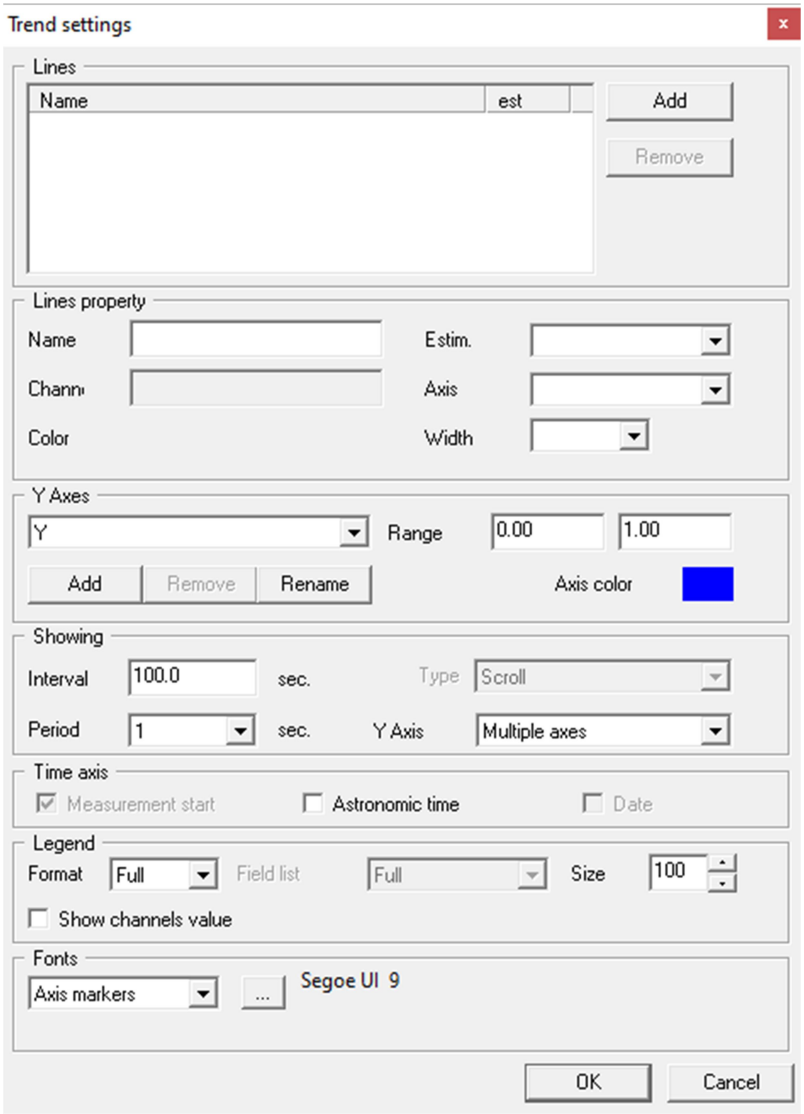
4. By clicking again the right mouse button the **Legend Aligment** menu line will be activated. The legend can be placed either on the right side of the trend or at the bottom:





5. To configure the **Trend settings**, you need:
   - Add a line. On the **Lines** field, use the **Add** button to open the **Select channel** window and select the channel or channels whose signals should be represented in the trend window;
   - In the **Lines Property** field**,** sequentially select desired channel, determine the color and thickness of the line and select the type of signal trend estimation from the **Estimation** drop-down list: ***Mean, RMV, RMS, Amplitude, P2P***.
   - The **Y Axis** field adjusts the **Axis color** and **Range** of the axis, also adds additional axes and sets their names;
   - The **Representation** field specifies the signal storage **Interval** and the **Period** – the time after which a new estimation adds to the trend;
   - In the **Time axis** field, the measurement is linked to time. If you want the date to be displayed, select the **Astronomic time** option and then the **Date** option. If you select the option **Measurement start**, the current time of the experiment will be displayed.

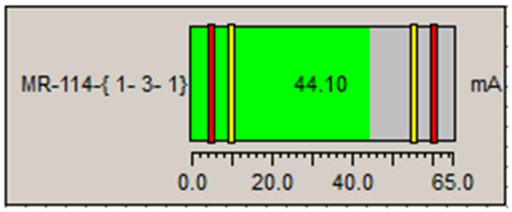
If you select only one option **Astronomic time** the current time is displayed on the X axis.



6.5 Rectangular histogram

1. Histogram – graphical representation of the scalar value of the signal.

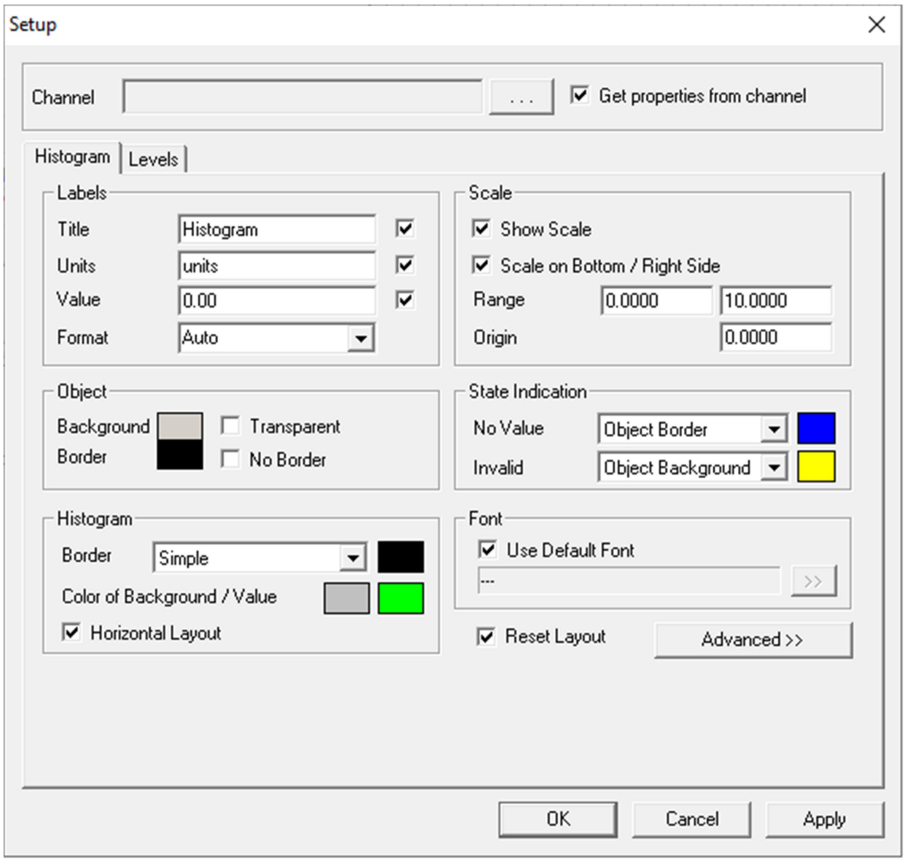
   Rectangular histogram can be added to the form page by button  .



2. The histogram field displays the current graphical representation of the signal, its digital value, warning and emergency levels.
3. The rectangular histogram settings are carried out in the tabs of **Setup** window: **Histogram** (section 6.5.1) and **Levels** (section 6.5.2) tabs, as well as in the **Properties** window that opens with the **Advanced** button (section 6.5.3).

6.5.1 Basic settings for a rectangular histogram

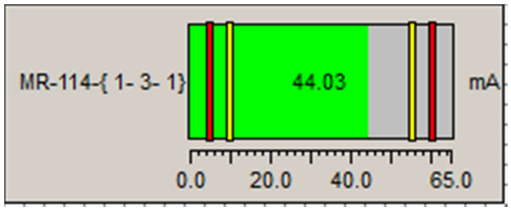
1. The main settings are made in the **Histogram** tab**.**
2. The button  opens the **Select Channel** window, where you need to select a channel. Its name will be displayed in the **Channel** field of the **Setup** window**.**
3. All text fields in the **Labels** section are editable. To display these fields on the histogram, you should mark flags in appropriate fields. Selected channel name displayed in the **Title** field. The **Value** field contains the number that the indicator displays. You can select the **Format** of the record value for this number.
4. The **Histogram** field sets the background color of the histogram and the color of the values. Select the type of histogram frame and set its color from the drop down list.
5. **Object** field **–** define how the histogram element is displayed. This field sets the background of the component. If you select the **Transparent** option, the component background will merge with the page background. To display a frame around a histogram component select the **Frame** option and set its color.
6. In the **State Indication** field there are two options: **No value** and **Invalid**. The settings are available by selecting a color in the drop-down menus if there is no value on the indicator, and if the Recorder registers an invalid value.
7. The default **Font** is Arial 8. To change the font, deselect this option and select a new font that will apply to all text fields in the histogram.
8. The **Reset Layout** flag enables automatic recalculation of the position of indicator elements. When the flag is set, all manual settings for the position and size of the indicator elements will be reset.
9. Additional options for changing the text font, for example, for the name, are available on the **Label** tab of the **Setup** window, which opens by the **Advanced >>** button**.**



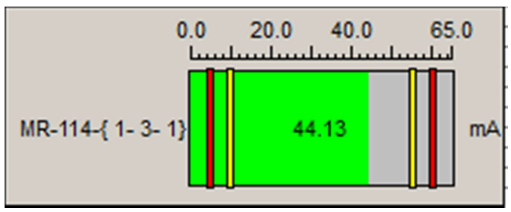
10. To display the scale on a histogram set the **Show scale** flag on the **Scale** section and set the display **Range**.
11. Two options are used to display the scale in the desired position:

    Horizontal Layout in the **Histogram** field and the *Bottom/right* option in the **Scale** field.

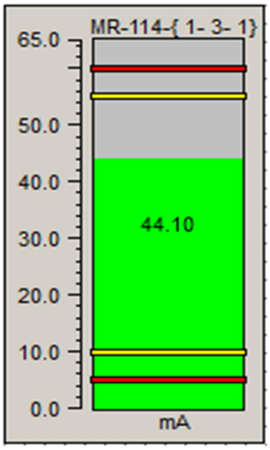
The figures below show the options for placing the scale with different combinations of these options:



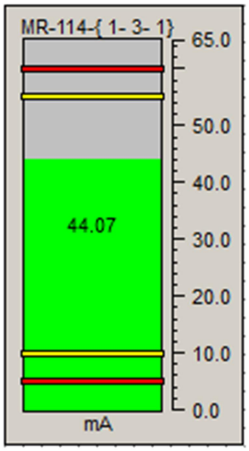
- The following options are marked:
  Horizontal position
  Bottom/right



- *Horizontal arrangement* option marked and the option *Bottom/right* removed



- Options *Horizontal arrangement* and *Bottom/right* removed

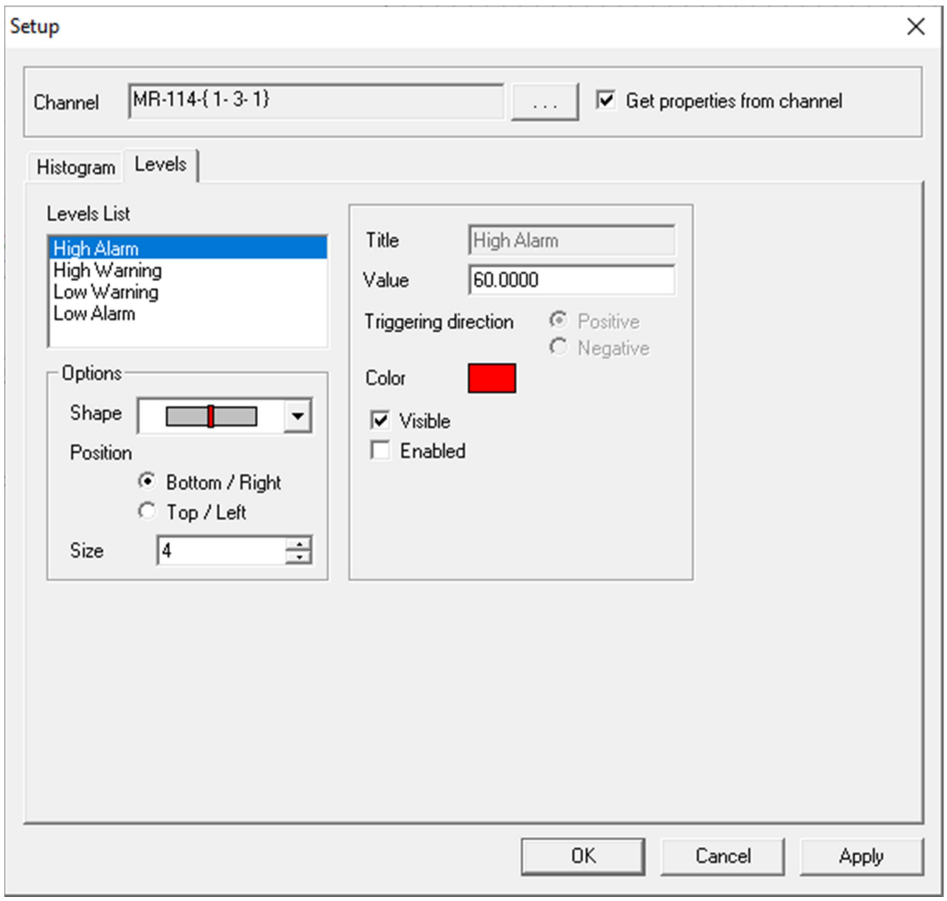


- The option *Bottom/right* is marked and *Horizontal position* option removed

6.5.2 Setting up rectangular histogram levels

1. Levels are signal values that you want to track during the measurement process.

   Settings of levels performs on the **Levels** tab of the rectangular histogram **Setup** window:



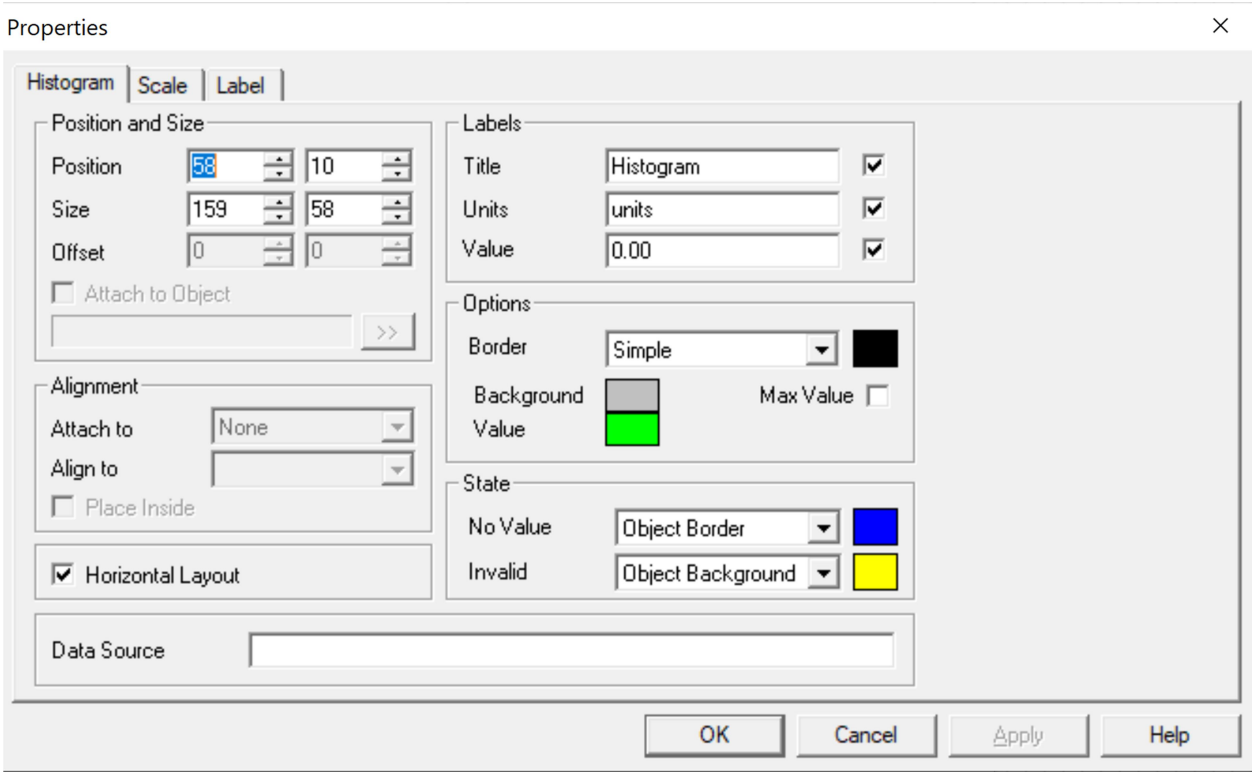
- On the left field, you can select the desired level, then select the shape, the position and the size in the **Options** field.
- The right field allows editing the level name.
- A level **Value** is set for each level and the response direction is selected:
  - **Positive** - the measured signal value becomes greater than the level value;
  - **Negative** - the measured signal value becomes less than the level value.
- Selects the display **Color** that the display bar will accept when the level is triggered;
- **Size** counter allows you to select the size of the level label;
- In order for the level not to be displayed on the histogram, it is enough to uncheck the **Visible** flag.

6.5.3 Additional settings for the rectangular scale

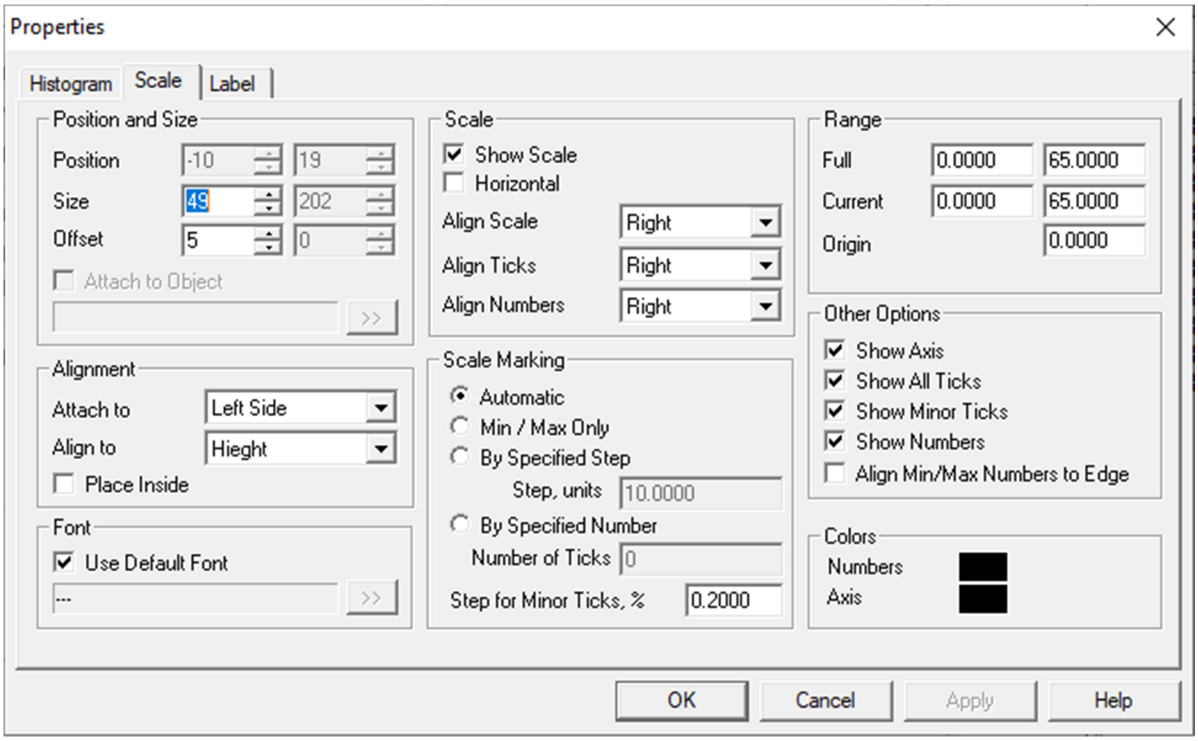
1. Additional settings for a rectangular histogram can be made in one of three tabs: **Histogram, Scale,** and **Label** of the **Properties** window, which opened by pressing **Advanced>>** button.
2. Each tab contains elements that define the parameters and design of the form. The selection

of settings in each tab linked to the settings in the other tabs. Thus, additional form settings require repeated access to each tab.

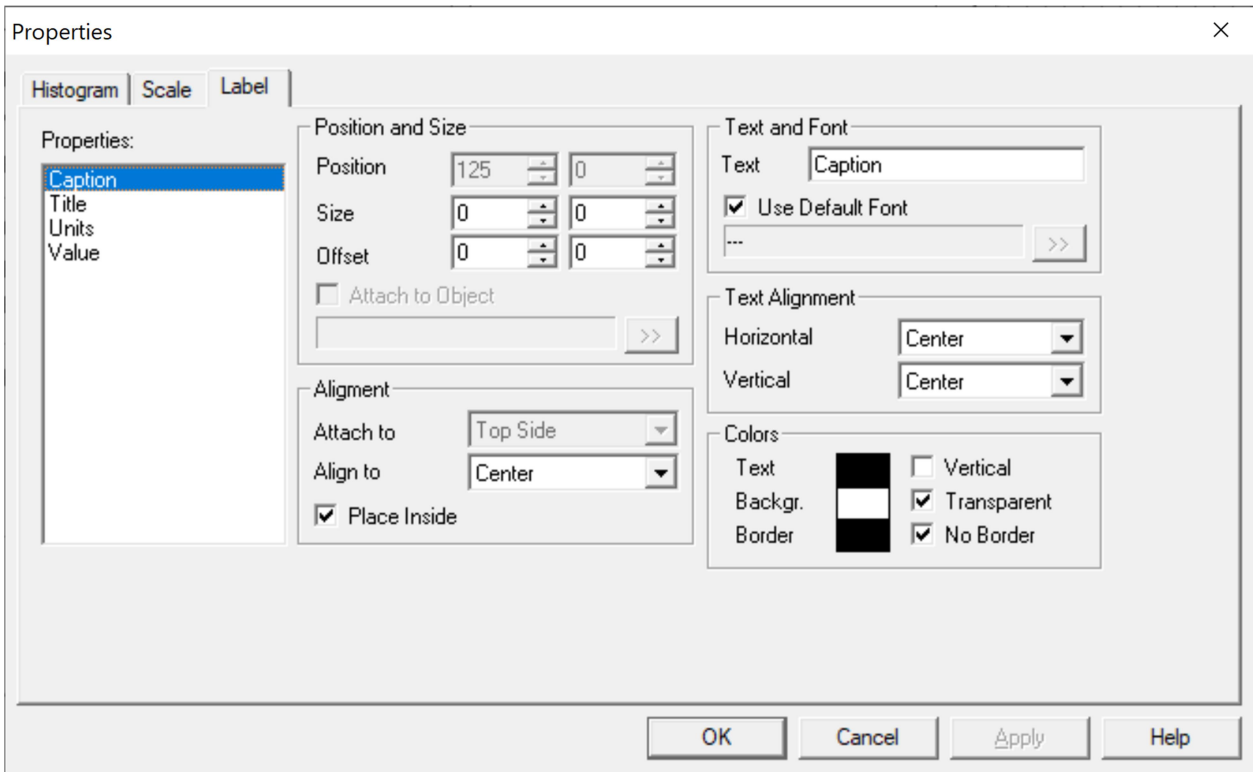
3. When making changes to the settings of each tab, it activates the **Apply** button, which allows you to view the results of settings and continue settings without closing the window.
4. After all settings, click **OK** to save them.
5. On the **Histogram** tab, you can set the size, position, and color options for the histogram field.



6. On the **Scale** tab**:**
   - The **Position and Size** field sets the size and position of the scale in the frame,
   - In **Alignment** section you can make settings for placing text inside a rectangle,
   - In the **Scale** section, you can disable the display of the scale, determine the horizontal or vertical position, and determine the direction of alignment of the scale parameters,
   - In the **Scale Markings** section you can define the layout options,
   - In the **Range** section, set the boundaries of the full and current ranges and the origin of the scale coordinates.



7. On the **Label** tab you can set font parameters and position of the required labels on the histogram fields.



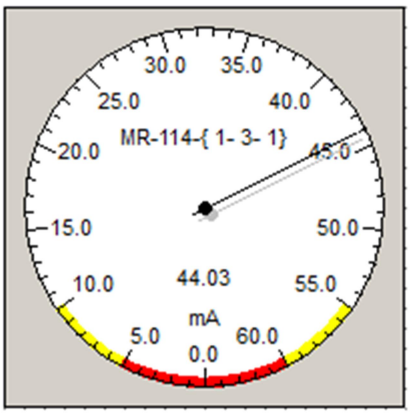
6.6 *Dial gauge chart*

1. The **Dial gauge chart** has the form of an dial indicator and serves to provide information in the form of traditional analog arrow devices, such as pressure gauges, tachometers, etc.

2. You can add a dial indicator to the page using the button  .

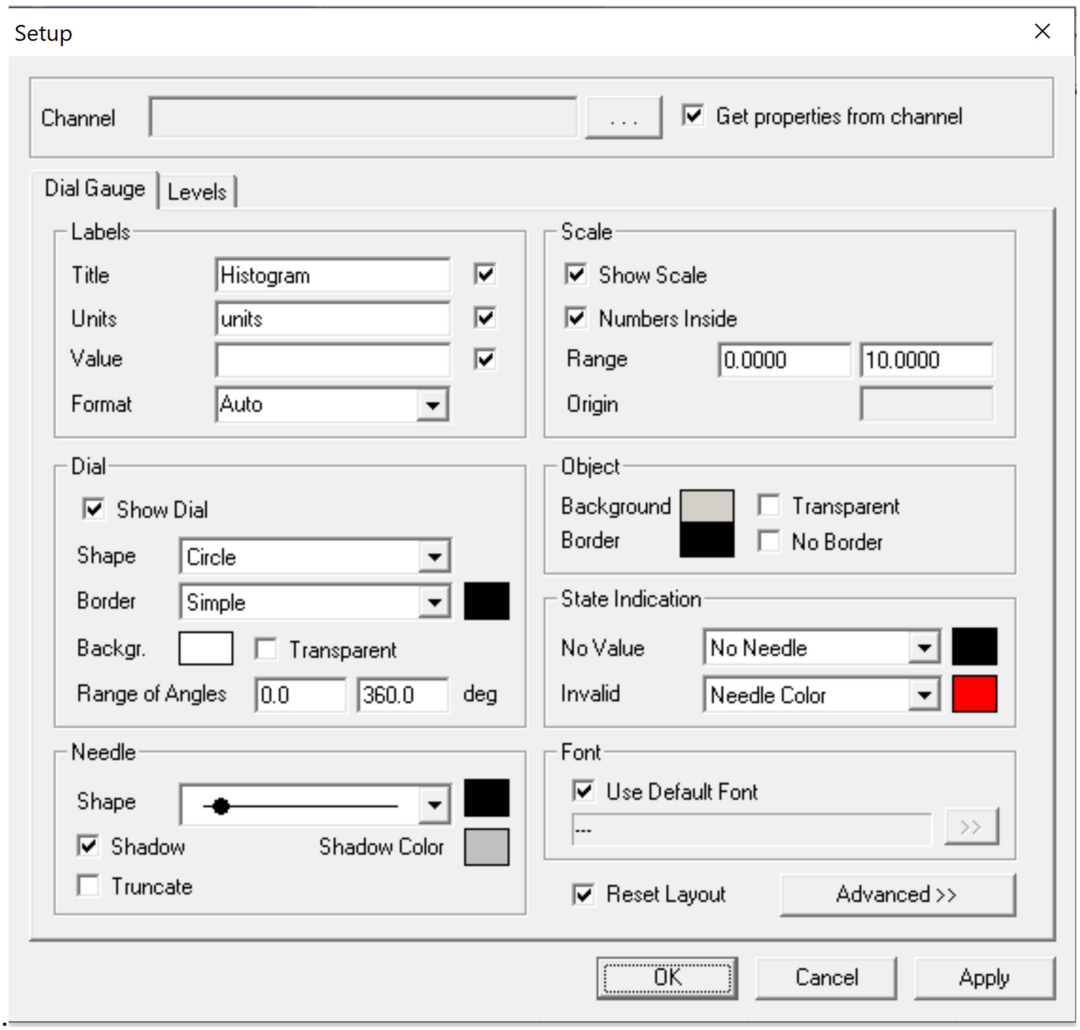
3. Chart Dial gauge chart settings are made in the following windows:

- Tab **Dial Gauge** of **Setup** window (section 6.6.1),
- **Levels** tab of **Setup** window (section 6.6.2),
- **Properties** window by clicking the **Advanced>>** button in the **Setup** window (section 6.6.3)**.**



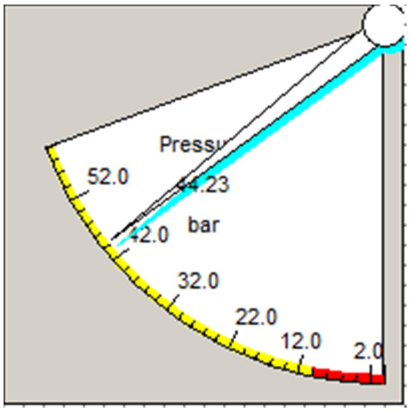
6.6.1 Basic settings of Dial gauge chart

1. On the **Dial Gauge** tab click on the button  , then **Select Channel** window will open and the channel selection can be made. The name of the selected channel will be displayed in the **Channel** field.
2. Fields in **Label** section are editable. To display these fields on the Dial gauge chart, you must set appropriate flags in this field. The **Value** field contains the number that the indicator displays. To record this number, you can select a format from the list.

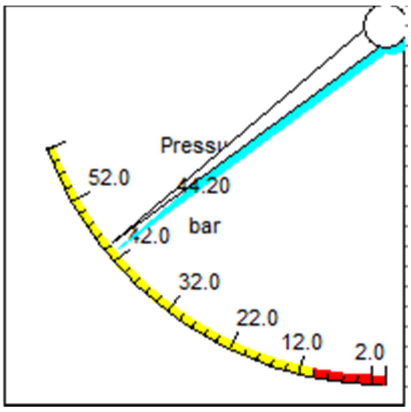


3. In the **Dial** section select one of the options for displaying the dial: *Circle* or *Rectangular*, set the color of the dial, and set the range of angles.

- When you select a round view and set the angle, part of the dial and scale is displayed



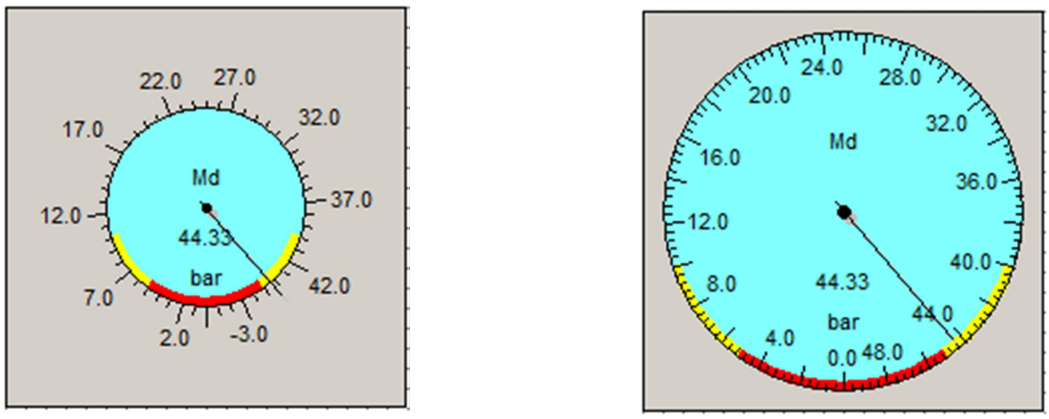
- When you set the angle a rectangular dial shows part of the scale, and the size of the dial does not change.



4. If you want to set the representation of part of dial or scale, this setting should be made on the **Dial** or **Scale** tabs, respectively, in the circular Dial gauge chart **Setup** window (section 6.6.3).
5. The **Range of Angles** field on the **Dial gauge** tab displays only the new data that was entered on the **Scale** tab in the circular Dial gauge chart **Properties** window. The entered range on the **Dial** tab in **Properties** window will not be reflected on this tab.
6. **Object** options section – define how the dial indicator element is displayed. If the rectangular type is selected, the component dimensions match the size of the dial. There are two options – background and frame. You can set the background to transparent, and then the dial will have a mimic background. If you select the no border option, the border will not be drawn, otherwise you must set the border color to display it.
7. The **State Indication** field has two options: **No value** and **Invalid**. Here you can configure the status indication for the case when there is no value on the indicator, and if the Recorder registers an invalid value. To do this, select the appropriate item in the drop-down menu and assign a color.
8. **Needle.** There are several ways to display the Needle. Select the pointer **Shape** from the drop-down list and set its color. If you need to display a shadow, just select this option and set the shadow color. Additional needle settings can be made in the Dial gauge chart **Properties** window on the **Needle** tab.

   Font. By default, the Arial 8 font is used. To change the font, deselect this option and select a new font and size.

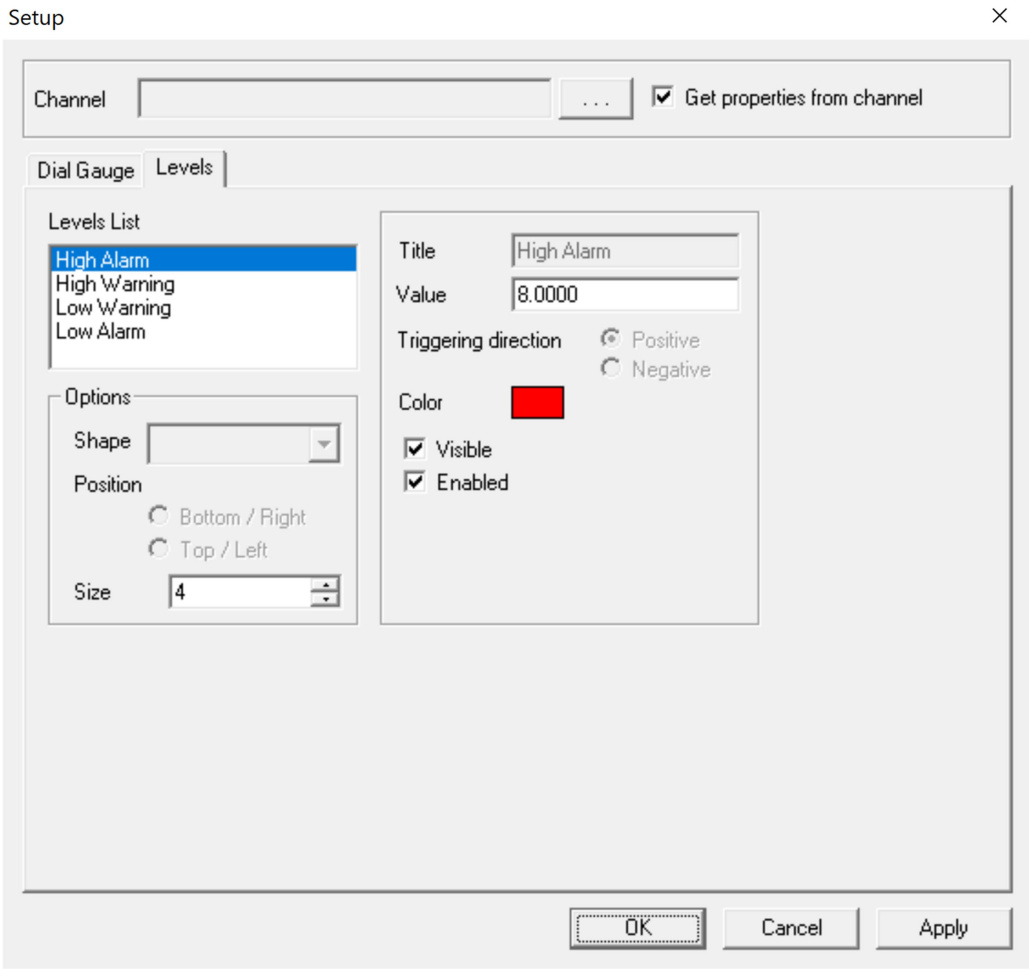
   The font assigned here applies to all text fields in the Dial gauge chart. However, if you need to change the font in a specific text field, such as the name, you can do this on the **Label** tab of the chart Dial gauge chart **Properties** window
9. The **Scale** section. To display the scale, select the *Show scale* option and set the range for displaying the Dial gauge chart. The scale can be displayed both inside and outside the circle, as shown in the pictures below:



6.6.2 Setting Dial gauge chart levels

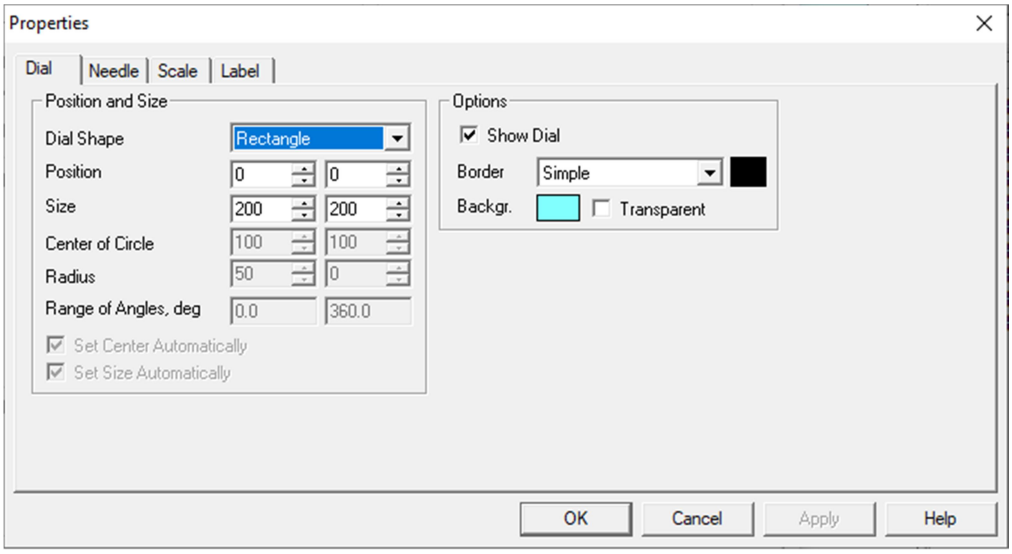
1. Levels for a Dial gauge chart are set in the same way as for a rectangular one (section 6.5.2). Dial gauge chart levels are displayed as segments on a circular scale.

2. The level **Size** determines the thickness of the segment selected for level.

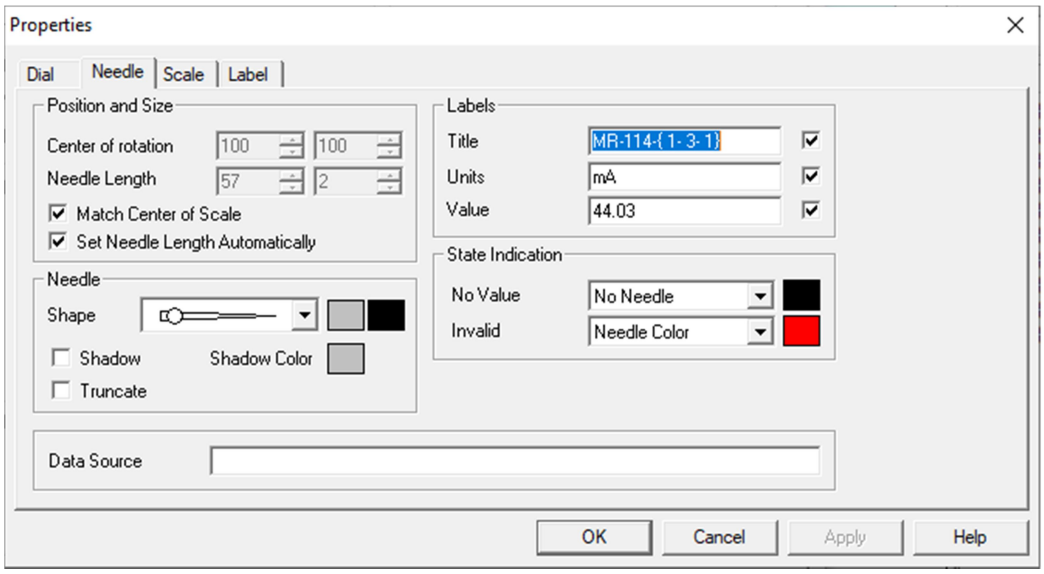


6.6.3 Additional settings for the Dial gauge chart

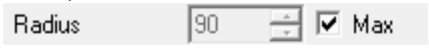
1. Additional settings for the Dial gauge chart can be made in the **Properties** window on four tabs: **Dial, Needle, Scale,** and **Label**.
2. The **Dial** tab defines the shape of a dial: circular or rectangular:
   - For the circular shape, if the flag *Set Center Automatically* is not selected, you must set the center position. You can also set the dial Radius, if the *Set Size Automatically* flag is not selected.
   - For a rectangular dial type, you can also set the position and size.

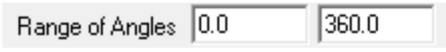


3. Additional pointer settings are made on the **Needle** tab. The options in the **Needle**, **Labels**, and **State Indication** sections are configured the same way as on the **Dial Gauge** tab (section 6.6.1).

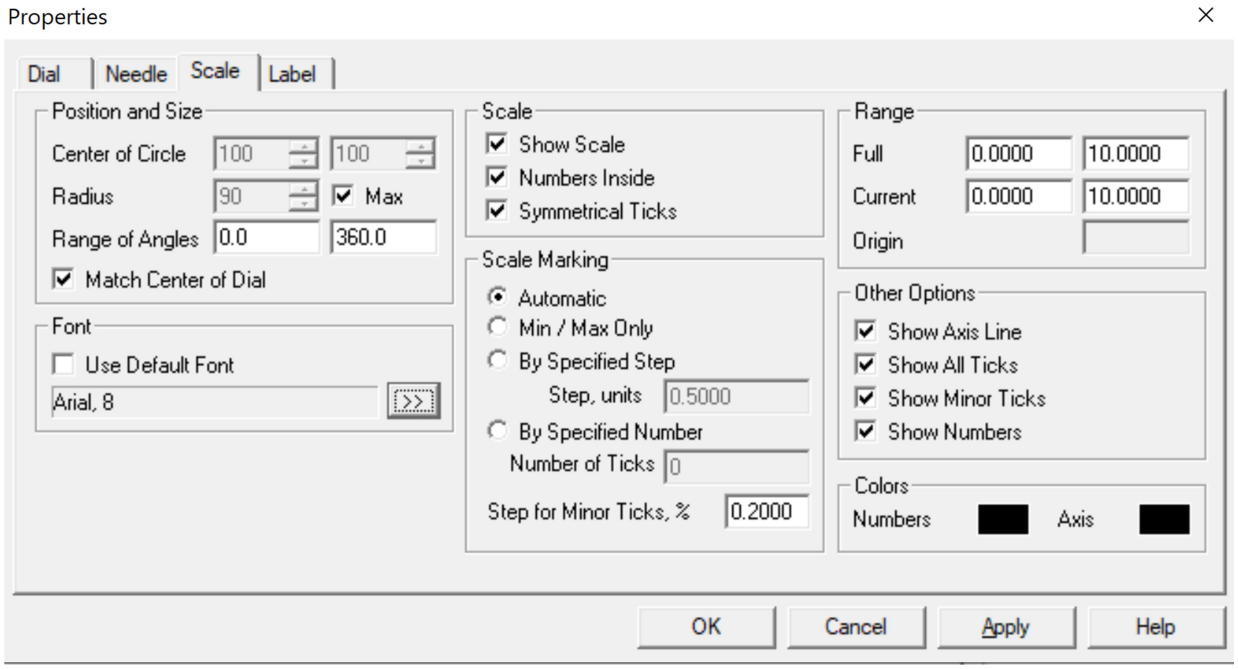


   - On this tab, you can also set the position of the center of rotation of the needle and its length. To make the center of rotation of the needle coincide with the center of the scale, just select the appropriate option.

4. On the **Scale** tab, the center coordinates are set automatically in the **Position and Size** field if there is a corresponding binding on the **Scale** tab, but by disabling automatic detection, the center can be defined in the **Center of Circle** fields
   - In the **Position and Size** field, the scale radius is set as the maximum within the scale size, or set in the window 

;
   - Sets the angular size and position of the scale 

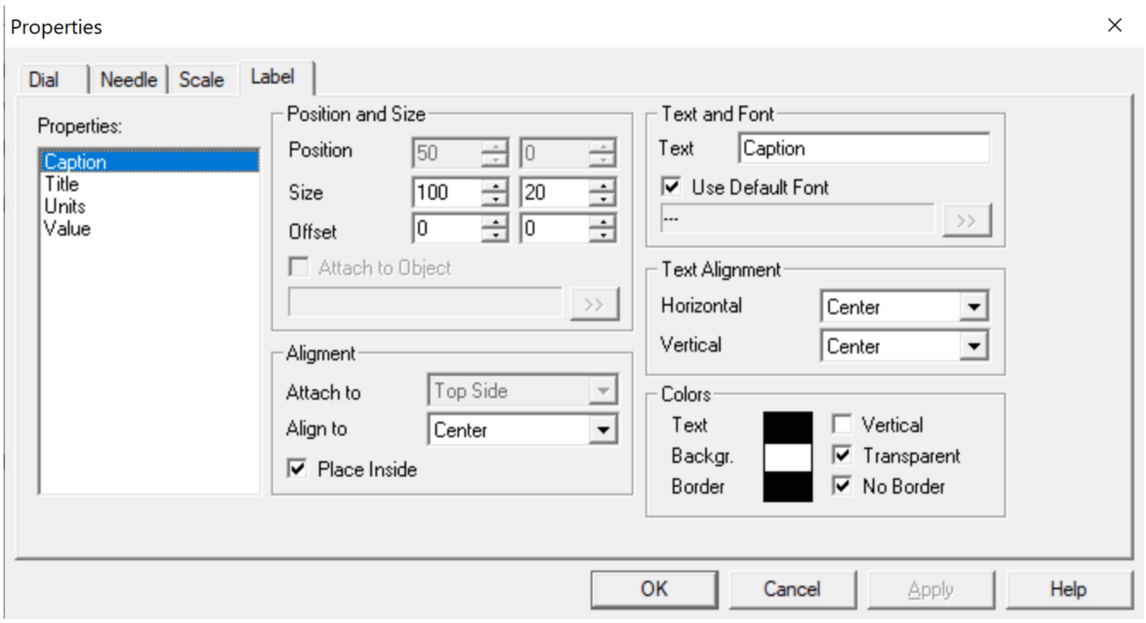
;
   - The font is selected "by default", or selected from the list of available fonts and configured in the Word window that opens with a button  ;



   - In the **Scale** and **Other options** fields, you can select the representation and digitization modes of the scale by setting corresponding flags;
   - In the **Scale Marking** field, you can set the number and parameters of the main and additional scale divisions; only the extreme values that are set in the scale Range field can be set automatically.

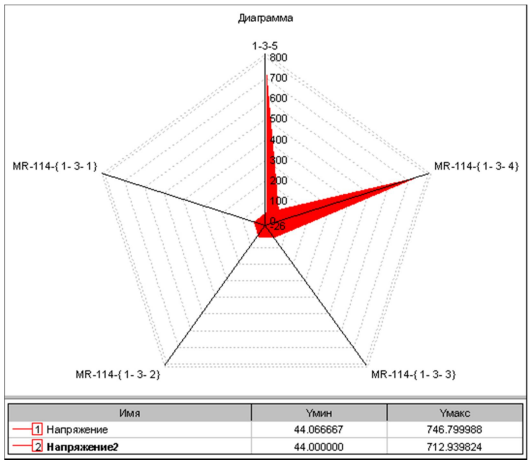
5. On the **Labels** tab, you can edit the display of the value, measurement units, and Dial gauge chart header. To edit a parameter, you should:
   - Select it in the list on the left panel;
   - In the **Text and Font** field, edit the parameter name and select the font for displaying the parameter on the Dial gauge chart. The default font is Arial 8;
   - If you uncheck the **Transparent** option in the **Colors** field, you can see that the text is inside a rectangle for which you can set a background. If the **No border** option is not selected, the rectangle will have a border for which you also need to select a color;
   - In the **Text Alignment** field, settings are made for the location of text inside the rectangl.;
   - The size of the rectangle is set in the **Position and Size** field;

- You can adjust the position of the label relative to the Dial gauge chart in the Text Alignment field: User can independently adjust the position and size of most of the indicator elements. Dimensions are set in screen pixels.

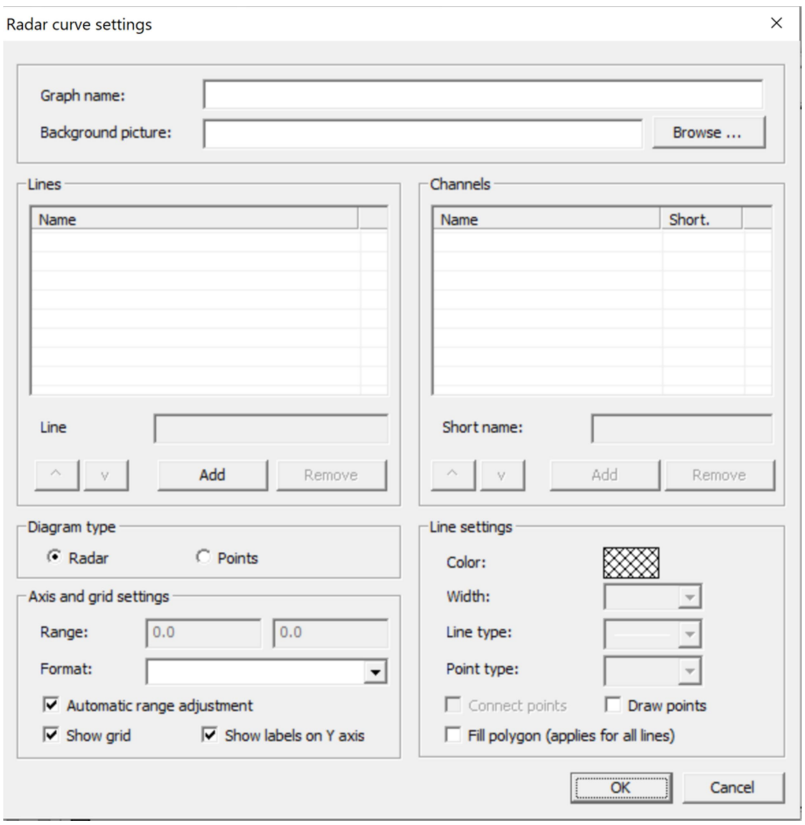


6.7 Radar chart

1. **Radar chart** – a type of circular histogram for representing data grouped by a single feature.
2. **Radar chart** are useful for comparative analysis of two or more objects by a group of common features, or for visualization of several parameters of slow processes simultaneously.
3. You can add a radar chart to the page using the button  .



4. The number of chart lobes automatically determined by the number of connected channels.
5. **Radar curve settings** window can be opened by the **Properties** button, after clicking the right mouse button in the field of element:



6. The settings window contains the following fields:
   - **Graph Name** entry field;
   - **Background picture** selection field, where file with the prepared drawing should be chosen. You can access Explorer on your PC's disk by clicking the **Browse…** button;
   - The **Lines** definition of the chart;

     Line - a logical group of channels for displaying on the diagram as a continuous line of a single color.
   - **Diagram type** selection: radar or dot;
   - Defining ranges and data presentation format, or automatically ranges definition;
   - Determination of the parameters of the line of the chart;
   - Flag for setting the inner area of the chart to be shaded.
7. The **Legend** inclusion and its location can be selected in the menu that opens after clicking the right mouse button in the field of element.

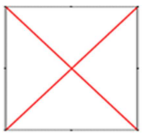
6.8 Different elements of mimic diagrams

6.8.1 Picture and animated image

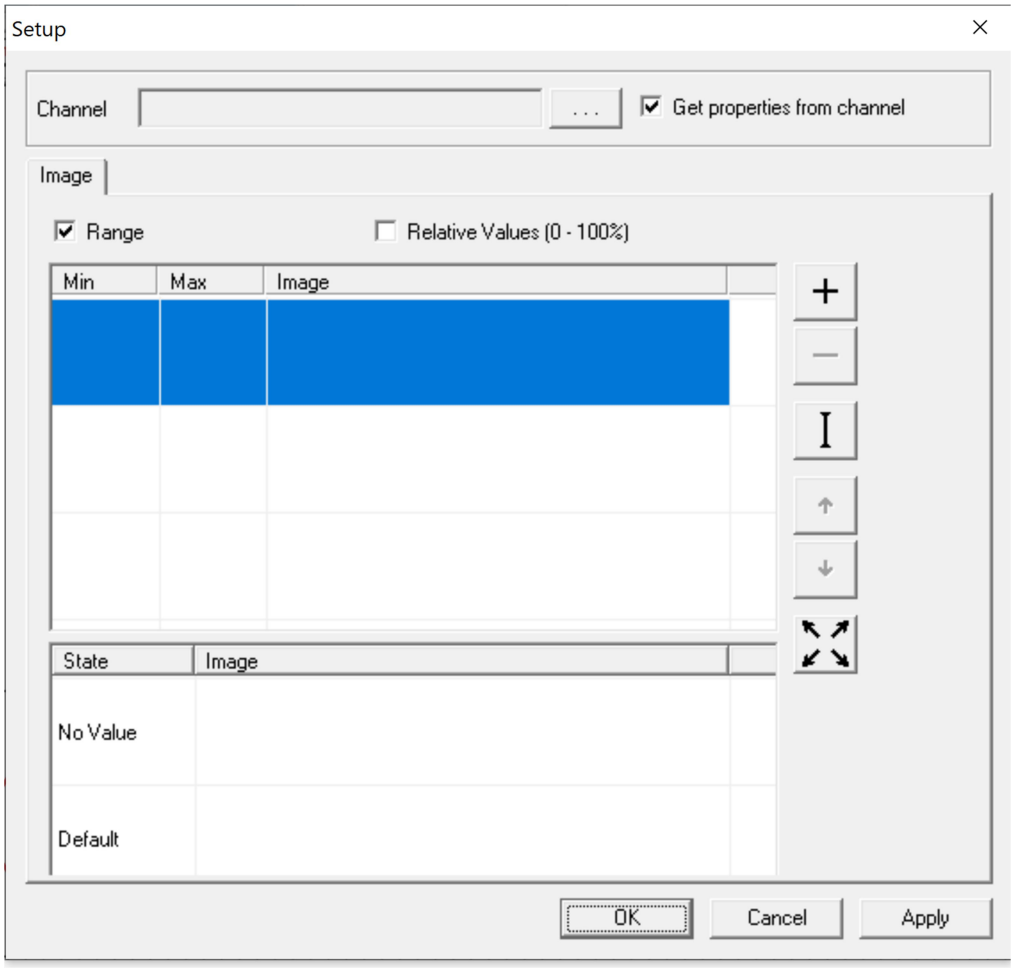
1. Picture and animated image used to indicate processes that depend on the measured parameters. You can configure images or animations for ranges of values of the current scalar estimation of channel.

2. To insert an animation object, click  .

   A rectangle marks the place where a new animation element will be added:



3. Right-click on the rectangle and the **Properties** button to open the **Setup** window, where you can perform the following operations:

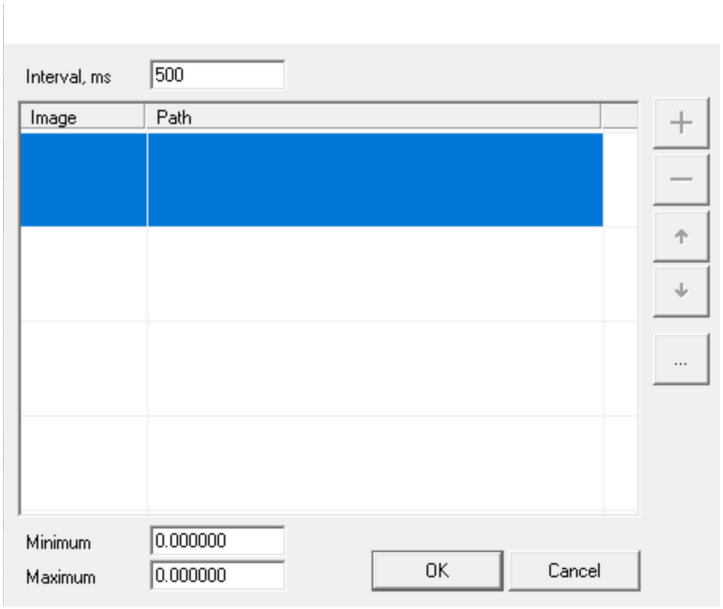


- Selection and synchronization with the settings of the **Channel** linked to the element; in this case, the images of the animation element will be changed in accordance with the settings (levels) of the connected measuring channel;
- If you want to display a static picture or animation that does not require dynamic changes when changing the values of the system parameters, binding to the channel is not

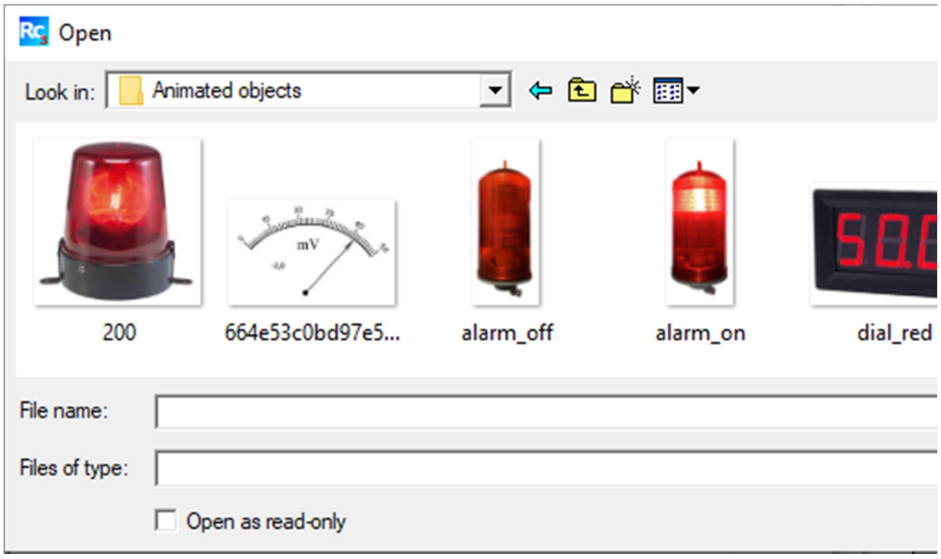
necessary, for this you should follow the instructions in paragraph 7;

- Use the buttons  and  to add or remove the range of signal values in the channel that the animation element should reflect;
- Use the buttons  and  to change the order of linking images to signal ranges.

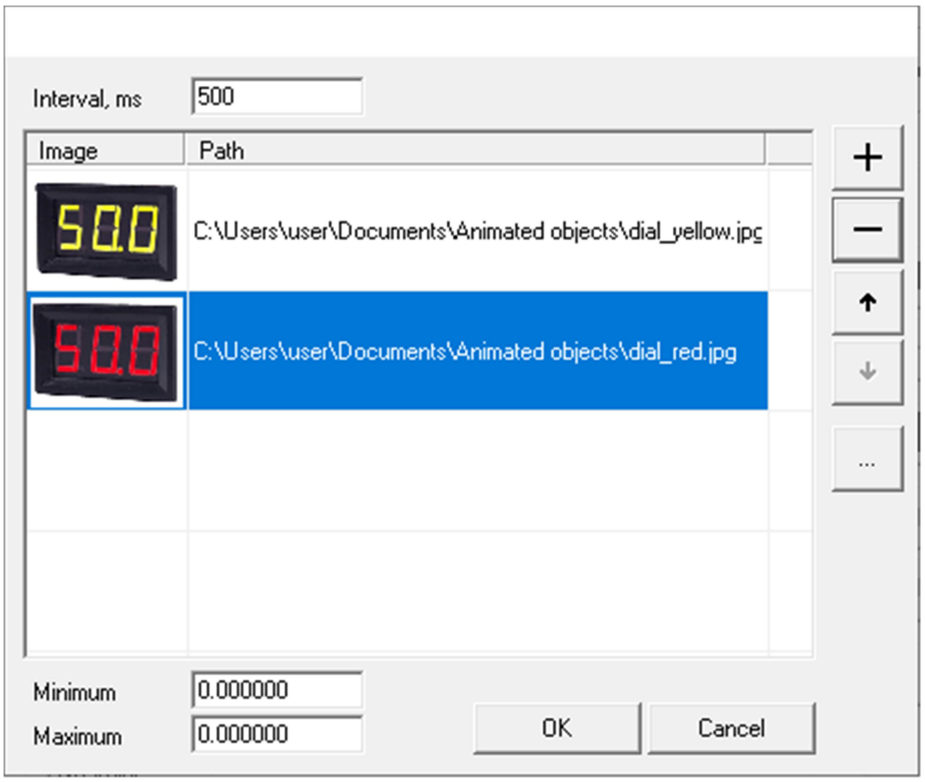
4. To select a picture corresponding to the selected range, double-click on the line in the image field with the left mouse button, as a result a window will open in which, by pressing the lower button on the right  the Explorer opens, through which you can access pre-prepared images.



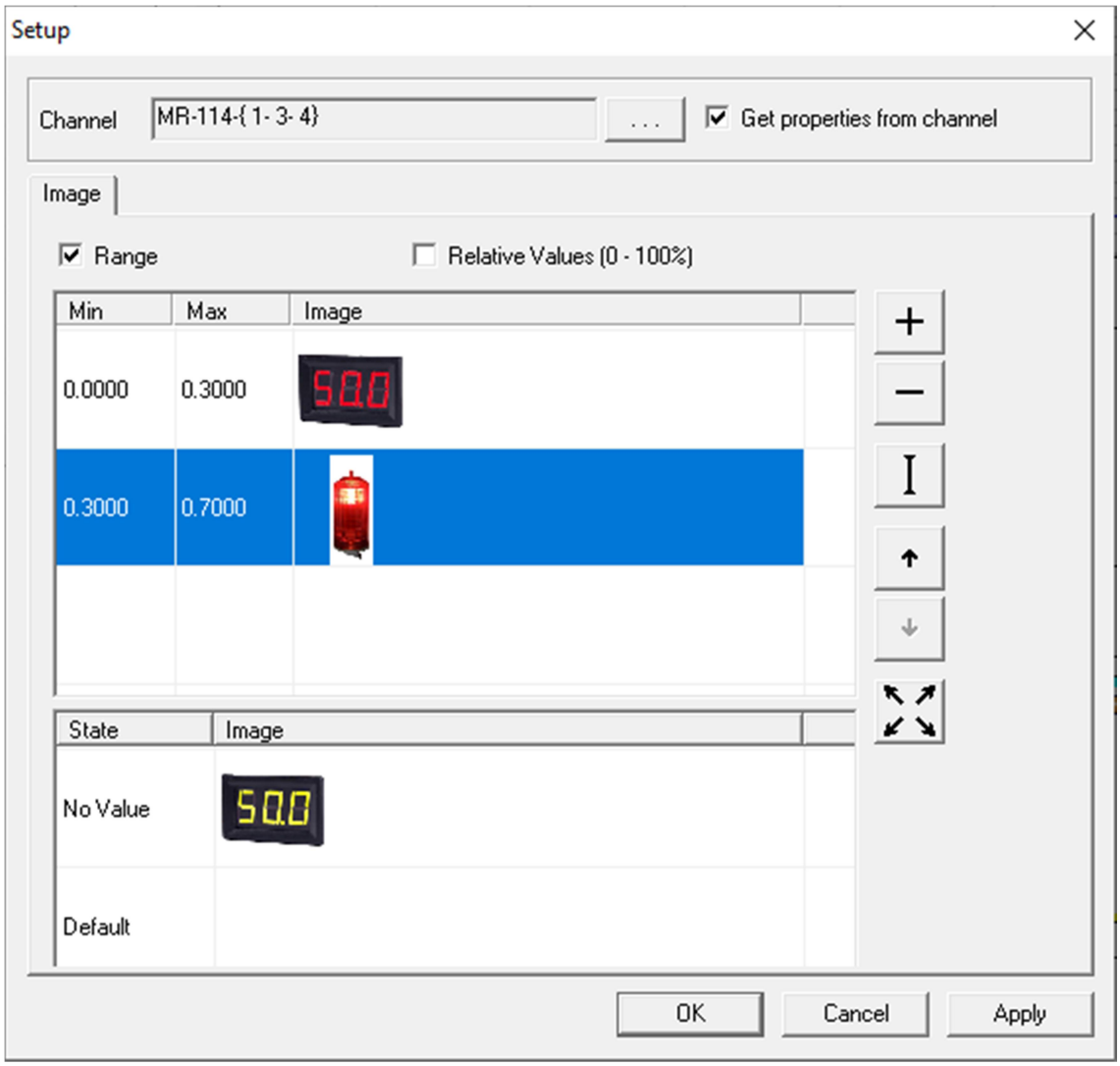
Explorer with a folder of Animated object files:



5. After selecting images in the Explorer, you should set the Minimum and Maximum value of the signal ranges in which the specified image will be displayed on the mimic diagram page.
6. Setting a time interval between two images ensures that they are switched periodically.



7. Images can be displayed on a page without being linked to a channel, or if there is no signal in the channel. To do this, repeat the steps described in paragraph 2, 3, 4, and 5 by selecting the corresponding **Default** or **No value** line at the bottom of the window in paragraph 3.
8. The setup window for channel MR-114-(1-3-4) has views for signals:
    - No value (Yellow dial),
    - From 0.0000 to 0.3000 (Red dial),
    - From 0.3000 to 0.7000 (Red light).



9. The described channel animation setting assumes:

   - Yellow dial output when there is no signal,
   - Red dila indication of the signal value up to 0.3000,
   - Periodic output of the emergency red light when the signal level is higher than 0.3000.

6.8.2 Digital indicator

1. The digital indicator is a simplified version of the **Rectangular histogram** element. It is configured identically to the description in the **Rectangular histogram** section. The differences are in pre-configured and hard-defined parameters, such as the absence of a scale and a rectangle indicating the value.

2. The **Digital indicator** is added to the form page using the button  .

3. The use of a **Digital indicator** simplifies the creation of mimic diagrams consisting mainly of a large number of simple indicators.

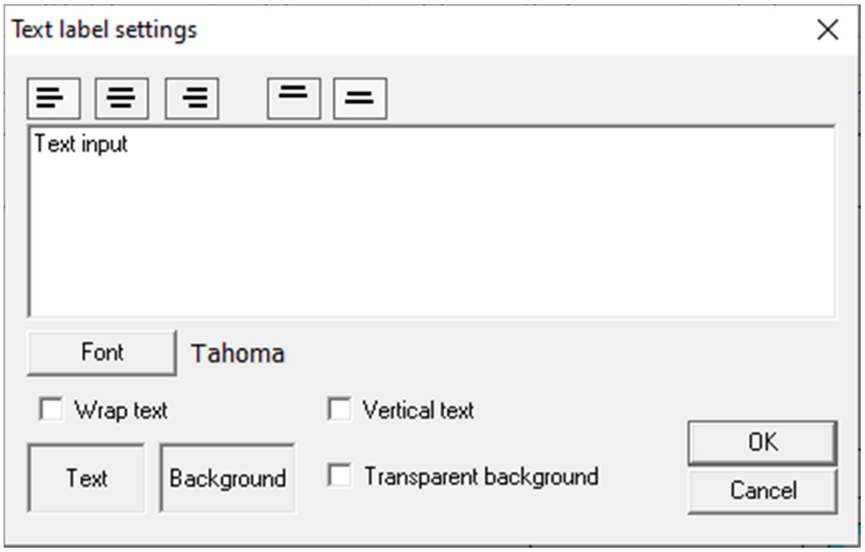
6.8.3 Text label

A **text label** is a label that you can use to add captions, titles, descriptions, and other text information to the mimic diagram.

To add a text label to the mimic diagram, use the button  .

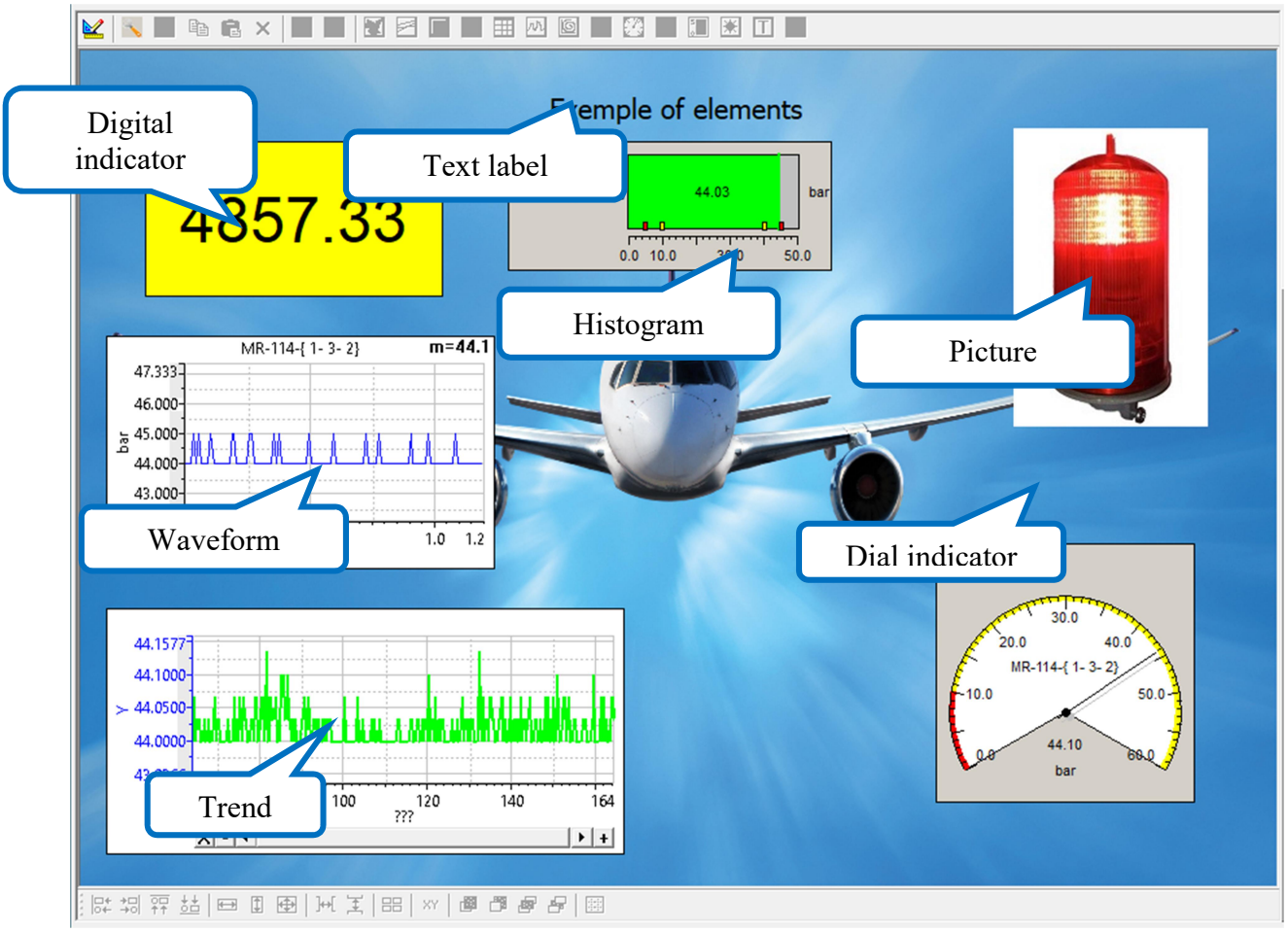
In the **Text label settings** window, you can set:

- **Text** – font, font style, size, color,
- Alphabet (Latin, Cyrillic, etc),
- Alignment direction,
- Text direction,
- Background - color and transparency



6.8.4 Illustration

Example of using mimic diagram elements



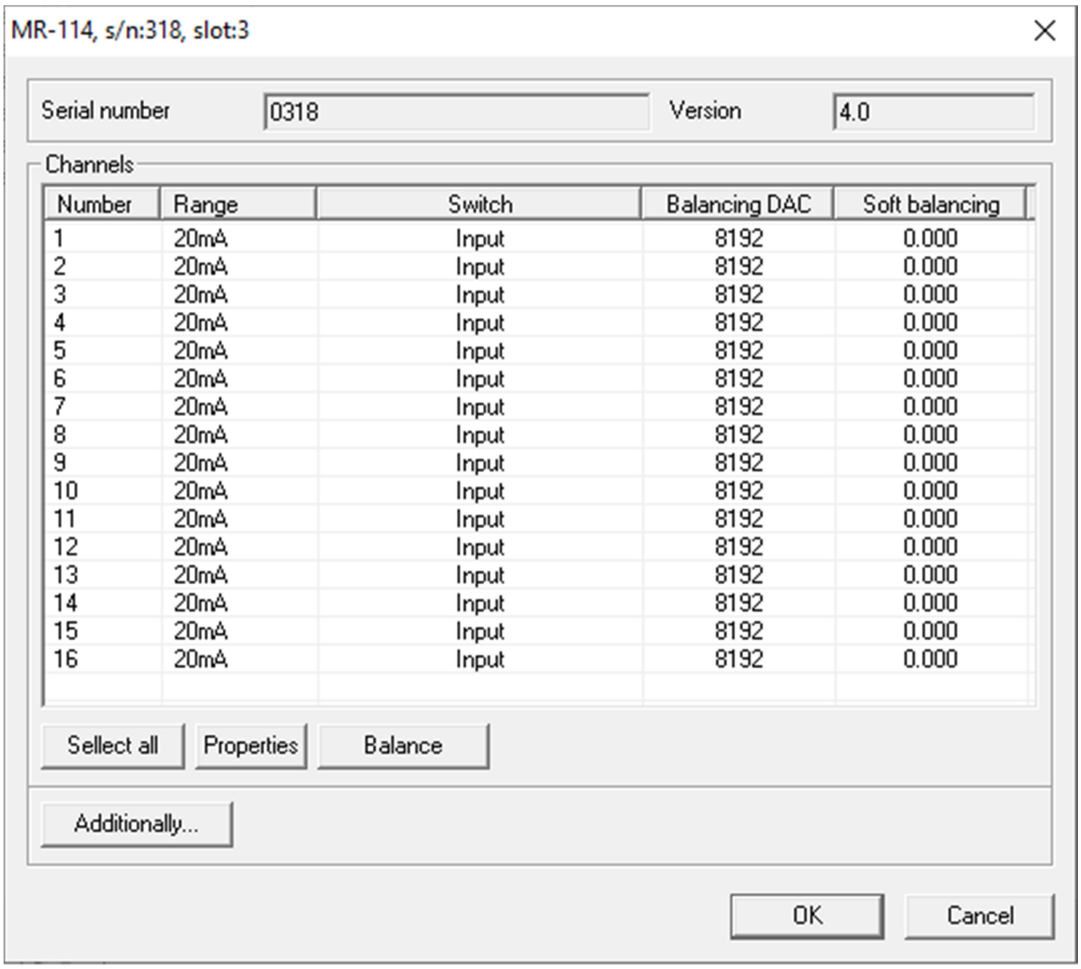
7 Modules Configuration

7.1 Module basic setup information

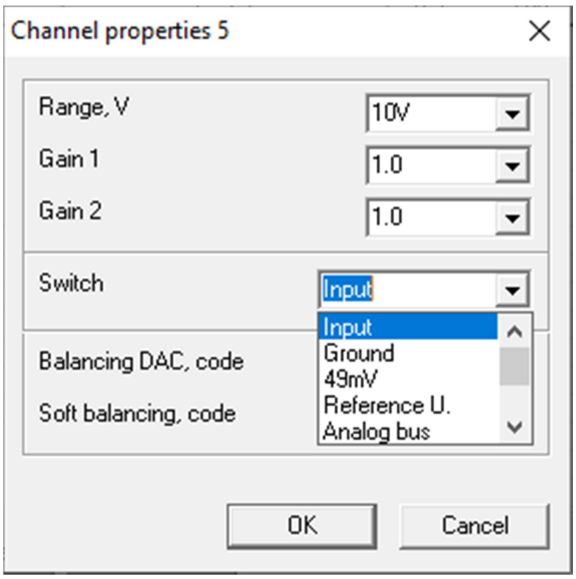
1. Modules in the MIC complexes form hardware channels and their configuration is an integral part of the operation of configuring measuring channels.
2. Depending on the type of module and the connection scheme of primary converters modules can have a different number of measuring channels and their characteristics.
3. When configuring modules, you should take into account the allowed CPU load of the computer on which the measurement information should be collected and processed. CPU load should not exceed 70%, which can be monitored in the viewing mode when all channels of the measurement system are running, as well as in the test recording mode. If the data stream entering the computer exceeds the allowed values, the mode control field of the main Recorder window will be highlighted with a red border. In this case, some of the measurement information may be lost.
4. The amount of data flow is affected by: the number of modules and channels involved in them, the sampling rate, and the frequency of the ADC.
5. Module functions: reception, switching, amplification, filtering and analog-to-digital conversion of primary converters signals. Digital signals from the ADC output of the module via the common crate bus are sent to the crate controller and then to the computer with the Recorder control software.
6. MIC measurement complexes controlled by Recorder can work with many different types of measurement modules. The procedure for configuring modules and hardware channels formed by them is illustrated by examples of some common modules MR-114, MR-202, MR-451, MC-212.
7. The procedure for configuring most modules is usually given in the operating manuals of these modules or in the operating manuals of the MIC complexes that these modules are part of.
8. Module settings are performed in the hardware properties settings dialog boxes, which become available after selecting their name in the **Hardware properties** tab of the settings window and clicking the **Module Properties** button  in the lower line of the tab.

7.2 MR-114 module configuration

1. The MR-114 module is designed for digitizing input voltages over 16 switched channels. The module properties window looks like:



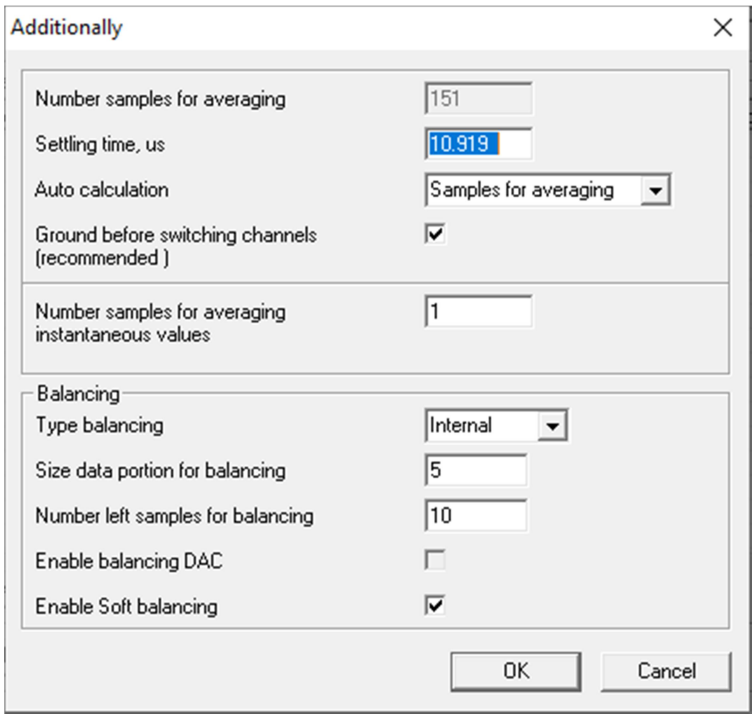
2. By default, all channels of the module have a maximum measurement **Range** of 10 V. To change the range of one or more channels, select these channels and click the **Properties** button, which opens the **Channel properties** window:



3. In the **Range** field, you can select one of the following signal ranges from the drop-down list: 10 V, 5 V, 2.5 V, 625 mV, 100 mV, 50 mV, 25 mV, 20 mV; The **Gain** fields reflect the gain values of amplifiers 1 and 2, which are set automatically when the measurement range is selected. In this case, the total coefficient is equal to their product.
4. The **Switch** mode settings is common to all channels:
   - In the **Input** position - inputs are polled and input signals are measured across all channels;
   - In the **Ground** position - input of the switch, the DAC is grounded and balanced, the results of which are reflected in the fields below the **properties** window;
   - Position **49 mV**-used for checking the module's operability, evaluating the correctness of calibration and other technological operations;
   - When selecting **Reference U.** or an **Analog bus** diagnostics of the module operation and other technological operations are performed.

5. Click the **Additionally…** button (paragraph 1) to open a window with the same name in which the following options are available:

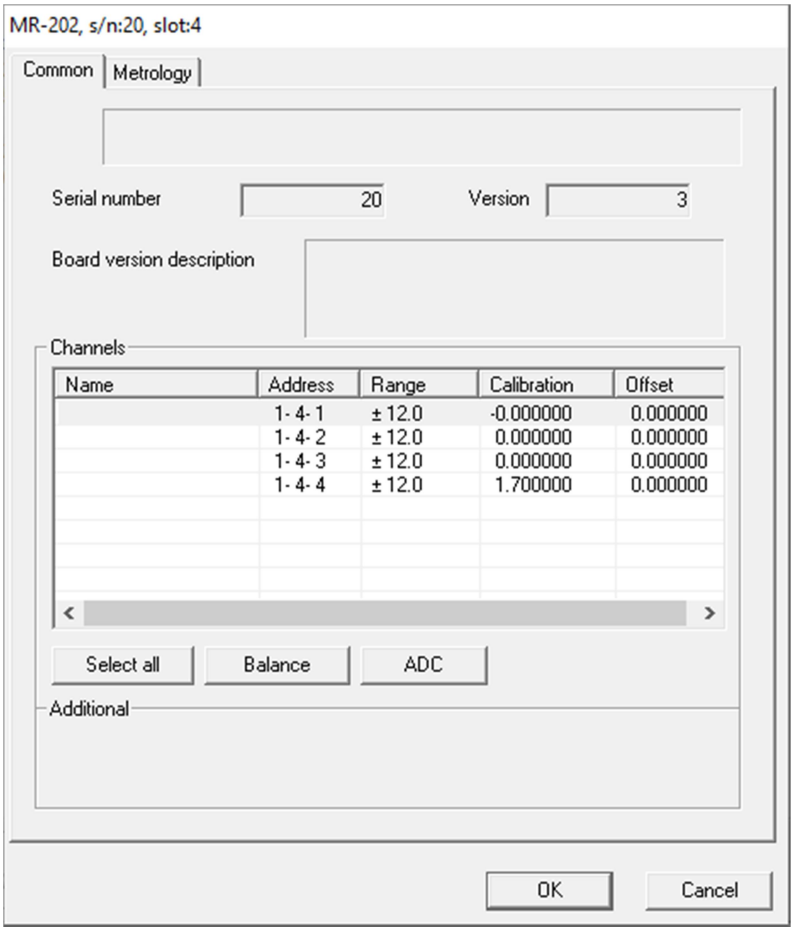
   - Setting, auto-calculation and parameter control for **averaging** measurements;
   - Setting the flag **Ground before switching channels** in the measurement mode;
   - Setting the mode and parameters for balancing.



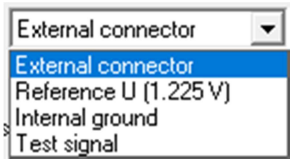
Click **OK** to confirm settings, and **Cancel** to cancel them.

7.3 MR-202 module configuration

1. The MR-202 module designed for measuring signals from dynamic process sensors.
2. The module properties window has two tabs **Common** and **Metrology**.



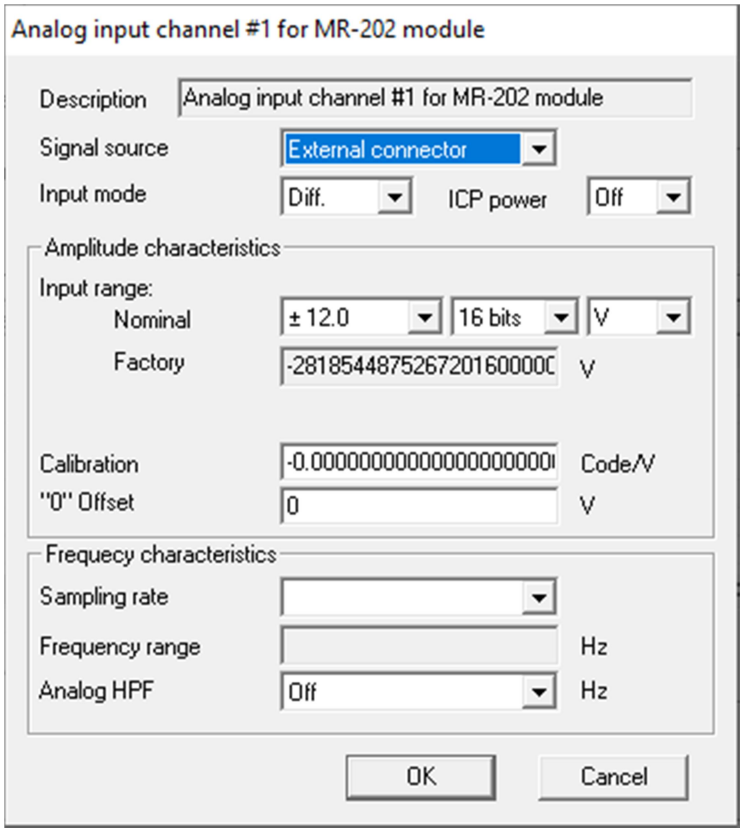
3. The **Common** tab displays a list of module channels, input ranges set by default ±12 V, and calibration parameters.
    - Each channel of the module has its own ADC and independent parameter settings, which become available after selecting the configurable channel(s) and pressing the **ADC** button, after which the **Analog input channel # of the module MR-202** window opens;
    - Use the **Balance** button to start automatic channel balancing.
4. The **Analog input channel # of the module**, opened by the **ADC** button allows you to:



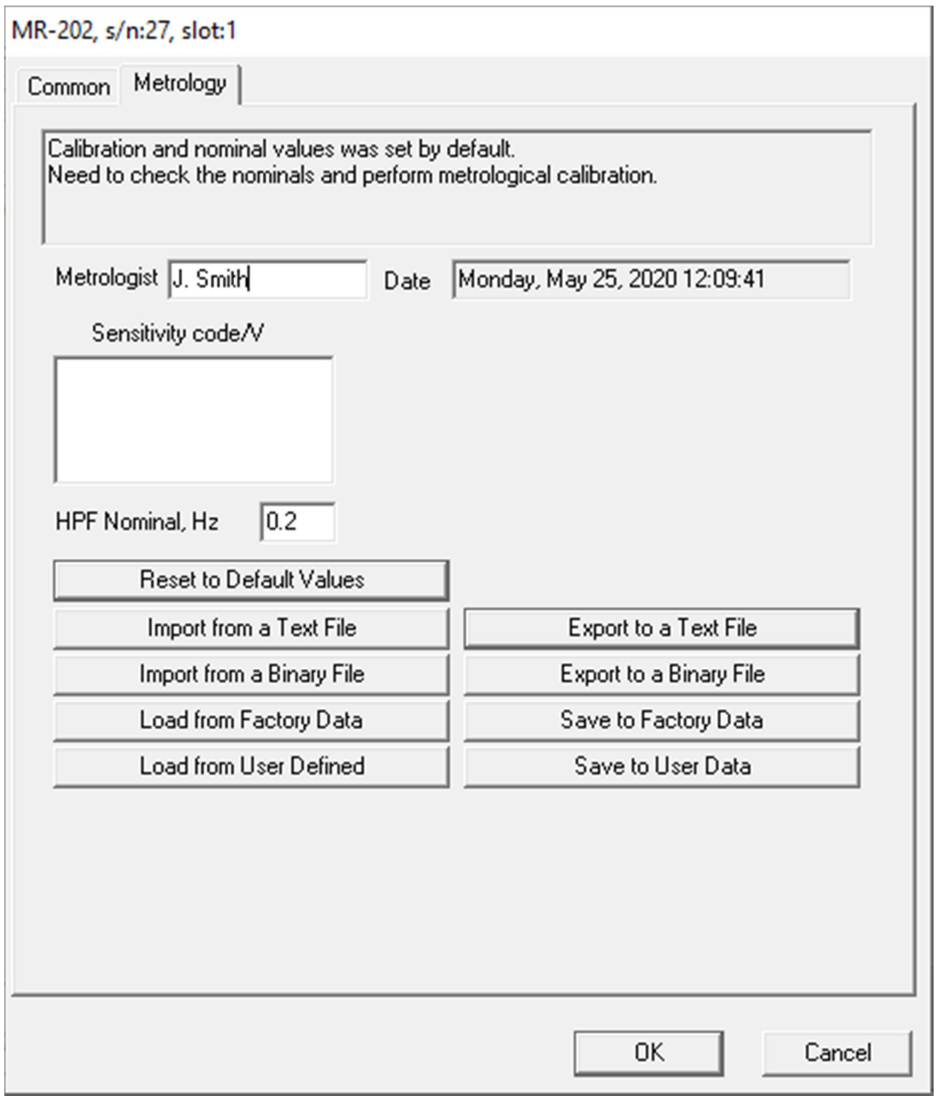
- select the signal source at the ADC input:

- define the Input mode: Diff. / Nondiff.,
- connect power to ICP sensors: 4/10mA,
- select the input dynamic range from the list,

- set the ADC bit depth to 16 bit or 24 bit,
- Set the frequency range and sampling frequency,
- Connect the HPF at the ADC input

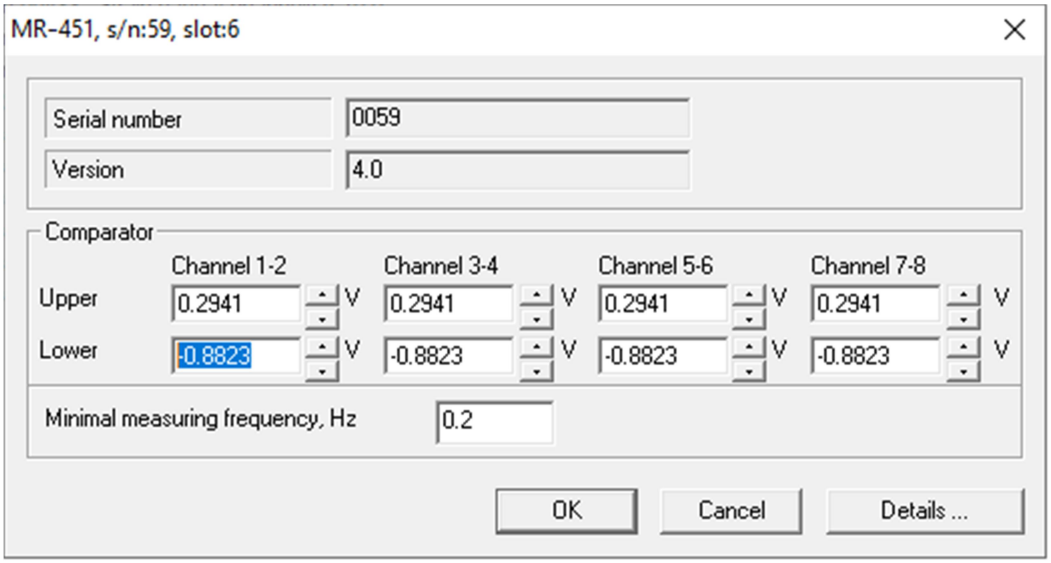


5. The **Metrology** tab contains information about the terms and scaling results of the module channels.


MR-202, s/n:27, slot:1
Common
Metrology
Calibration and nominal values was set by default.
Need to check the nominals and perform metrological calibration.
Metrologist
J. Smith
Date
Monday, May 25, 2020 12:09:41
Sensitivity code/V
HPF Nominal, Hz
0.2
Reset to Default Values
Import from a Text File
Export to a Text File
Import from a Binary File
Export to a Binary File
Load from Factory Data
Save to Factory Data
Load from User Defined
Save to User Data
OK
Cancel

7.4 MR-451 module configuration

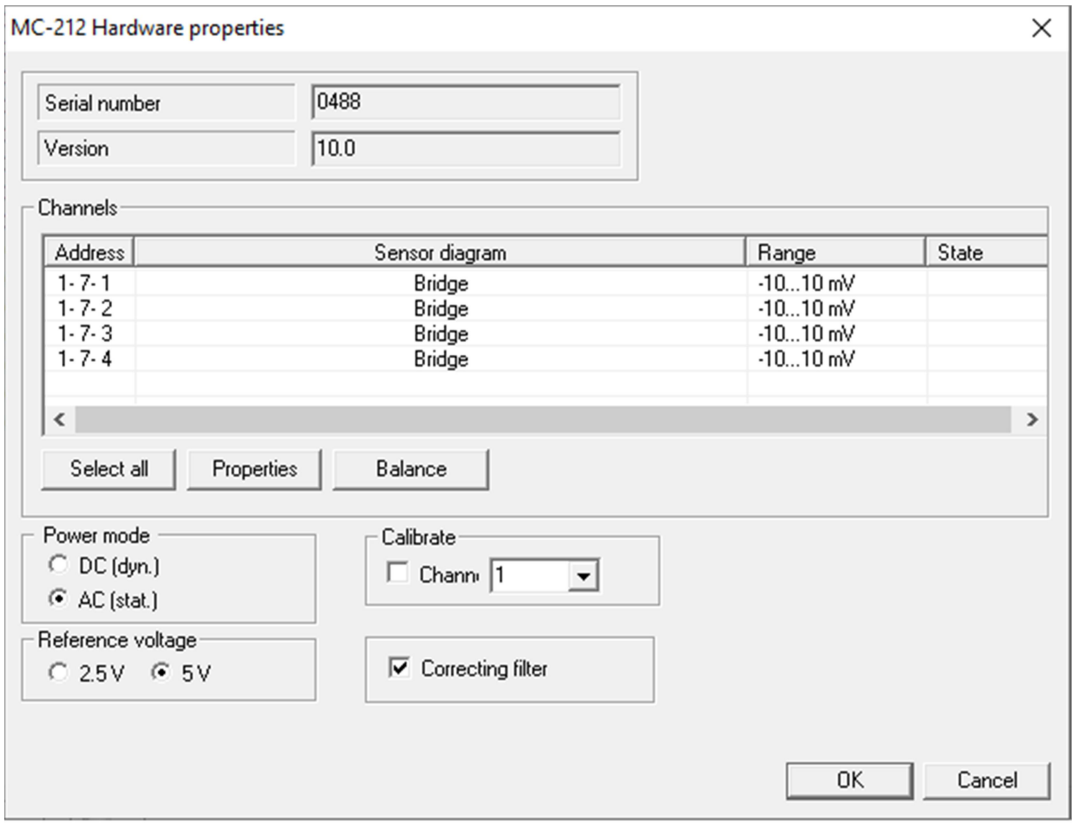
1. The MR-451 module designed to measure the frequency of periodic signals.
2. The properties window for a module of the MR-451 type looks like:



3. To configure the Mr-451 measuring module, the response thresholds and the minimum measured frequency should be set (the method for selecting threshold levels and measuring time is described in the user operating guide for the MR-451 module).
4. To set the comparator trigger threshold the upper and lower values of the measured signal are set in the **Comparator** fields. Out of the module's 8 channels, every two consecutive channels get the same settings. A properly selected hysteresis (the difference between the threshold levels) significantly increases the noise immunity of the measuring channels.
5. The minimum frequency measured by the module is set in the **Minimal-measured frequency, Hz field** and entered using the keyboard. Click **Yes** to confirm installations, and **No** to cancel them

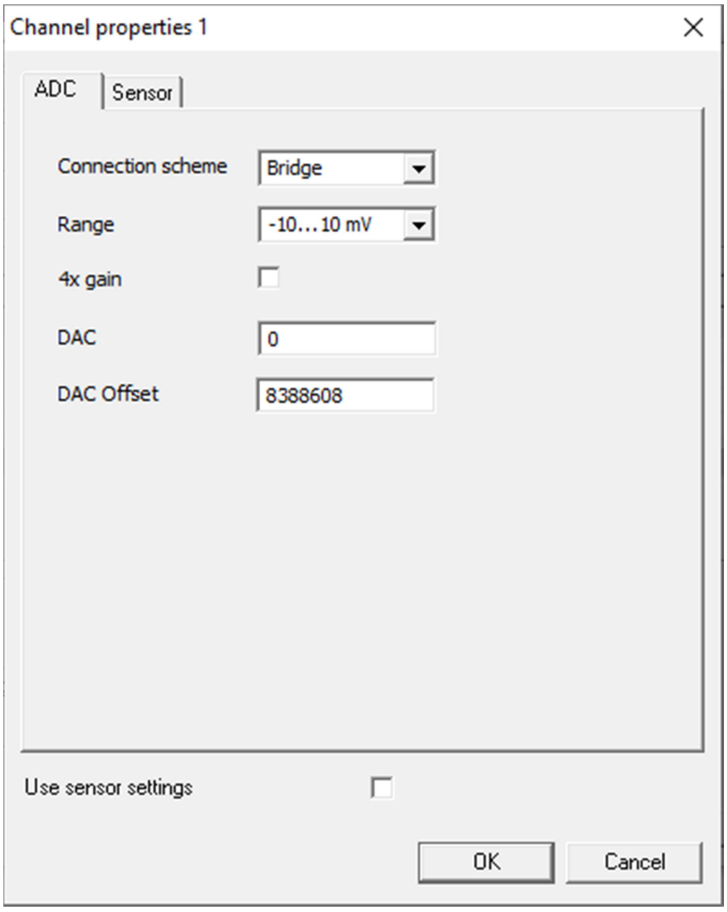
7.5 MS-212 module configuration

1. The MS-212 module is designed for strain-gauge measurements in the MIC-026 and MIC-036 complexes.
2. The module **MS-212 Hardware properties** window looks like this

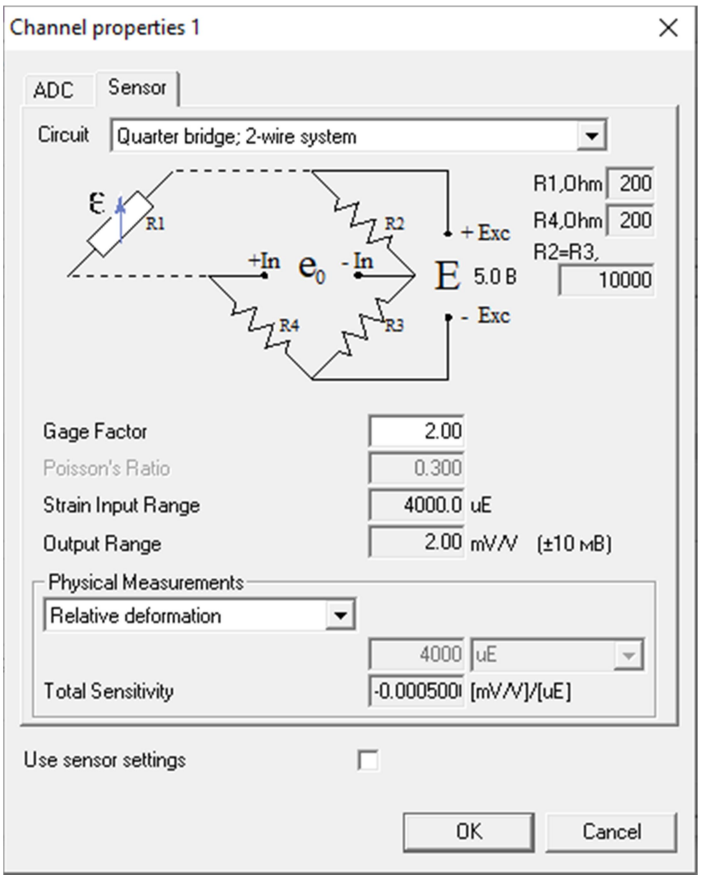


3. By default, all 4 channels of the module have sensors connected according to the Wheatstone bridge circuit scheme and are configured for the range -10...+10 mV.
4. A reference voltage of 2.5 V or 5 V can be set simultaneously for all channels of the module and the **Power mode** can be selected:
    - **DC(Direct current)** - for measuring signals of dynamic (fast) processes or
    - **AC(Alternating current)** - for measuring slow (static) signals;
5. Setting the **Correcting filter** flag, turn on IIR and FIR filters. The declared metrological parameters of the module are relevant when the filter is enabled. When these filters are turned off, the measuring channel bandwidth expands, but the noise level increases. Setting applied for all channels of the module at the same time.
6. The MS-212 module provides for some types of sensors (for example, the pressure sensor) the ability to perform automatic calibration of the measuring channel, independently for each channel of the module used. To perform internal calibration select the **Calibrate** flag and select the measuring channel from the suggested list. Then click **Yes**. After calibration of one specified channel complete, repeat the operation for the remaining channels. After all channels have been calibrated, the field flag must be unchecked.

7. Subsequent settings can be made after selecting the channel(s) and clicking the **Properties** button.



8. **Channel № Properties** window that opens on the ADC tab you should:
    - determine the connection Scheme to the sensor (Bridge/Half-Bridge/Quarter-Bridge),
    - select the measurement **Range** in mV from the eight options in the drop down list,
    - set the option to enable the built-in **amplifier**, if necessary;
    - In the DAC and DAC Offset fields, the balancing registers are manually set or corrected for fine tuning;
    - Set the **Use sensor settings** flag, after which the settings made on the **Sensor** tab in the channel **Properties** window are accepted.
9. On the **Sensor** tab following actions are available:
    - selection of strain gauge **Circuit**: according to the selected short description of the sensor, its electrical circuit and resistance values are given; **Range of relative strain measurements** is also automatically determined;
    - selection of the performed **Physical Measurements** typ: **Relative deformation, Elastic Modulus and Arbitrary sensitivity**; automatic conversion of measurement units is performed.



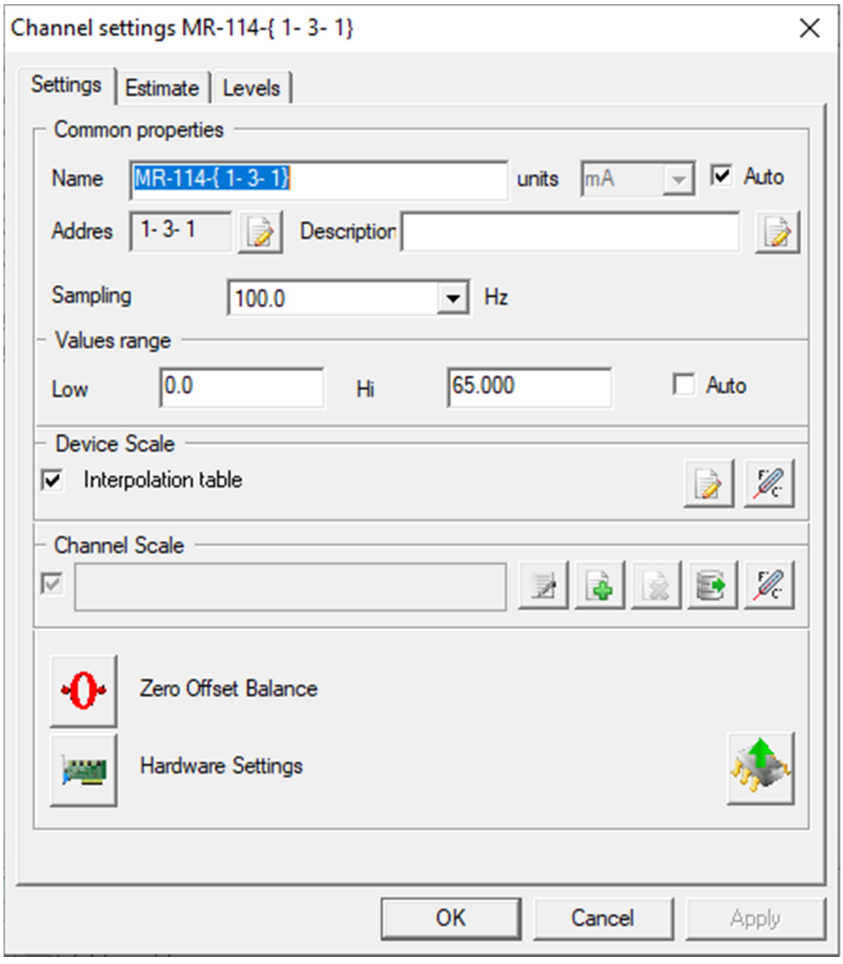
10. Detailed configuration and work with MS-212 module described in its operating manual.

8 The configuration of the measurement channels

8.1 Channel Settings

1. Addition to configuring modules, to further configure the measurement channels of the measurement system, you can:
   - bind the channel to the measurement object,
   - define and configure the scaling characteristics of the channel,
   - define algorithms for computing estimations of the signals,
   - set channel levels.

2. To configure a channel or group of channels, open the channel **Channel settings** window by double-clicking on the selected channel(s) in the **Channel List** panel of the main Recorder window. The window opens on the **Settings** tab:

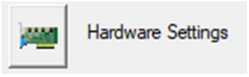


3. It is advisable to change the channel names by linking them to the measurement object and the measured parameter. You can do this in the **Name** field. the channel **Address** {X-Y-Z} specified in the field below will be saved. The channel name can be arbitrary and follow the rules for creating a Windows file name. Channels data saved as separate files. It is important

that Windows does not distinguish between names that differ only in case characters.

4. In the channel **Description** field you can provide an informal description of the logical channel and provide the necessary reference information.
5. In the **Units** field, enter the unit of measurement corresponding to the parameter being measured. The name of units of measurement can be set by the user at any time by entering directly in the **Units** field, or selected from the drop-down list displayed when clicking the arrow button to the right of this field. To do this, unset the **Auto**. When you add a new unit of measurement it will be added to the list. When the **Auto** flag is set, the **Units** field records the designation of the electrical signals measured by the channel (for example: **V, mA**, or **Ohms**) or is taken from the connected CC(SC).
6. In the **Sampling** field, you can select the frequency of polling of the module's channels. The selected channel polling frequency is applied to all channels in the module.
7. The **Address** field contains the hardware address of the channel defined when configuring devices and modules.

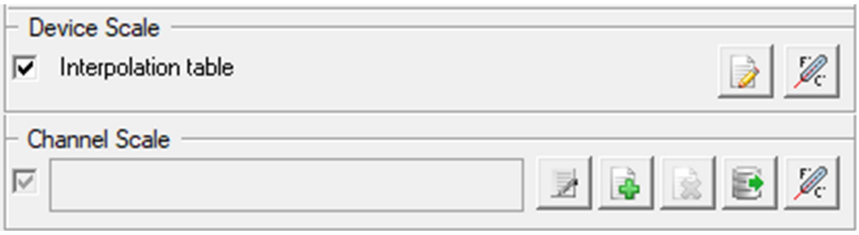
   Changing the hardware address of the channel allows you to change the binding of the logical channel to the hardware one and can be done by clicking the button  next to it and selecting a different hardware channel from the list that opens.
8. Setting the **Values range** can be performed after removing the Auto flag.

   The new range value can be directly entered in the **High** and **Lower** fields. The ordinate scale will change accordingly on the channel waveform on the **Base** and **Automatic** pages, as well as in the forms. 

button opens the configuration window for the module, which includes customizable channels. Hardware settings are described in section 7.
9. On the **Settings** tab of the **Channel Settings** window, you can start the scaling characteristics settings described in section 8.2.

8.2 Setting up scaling characteristics

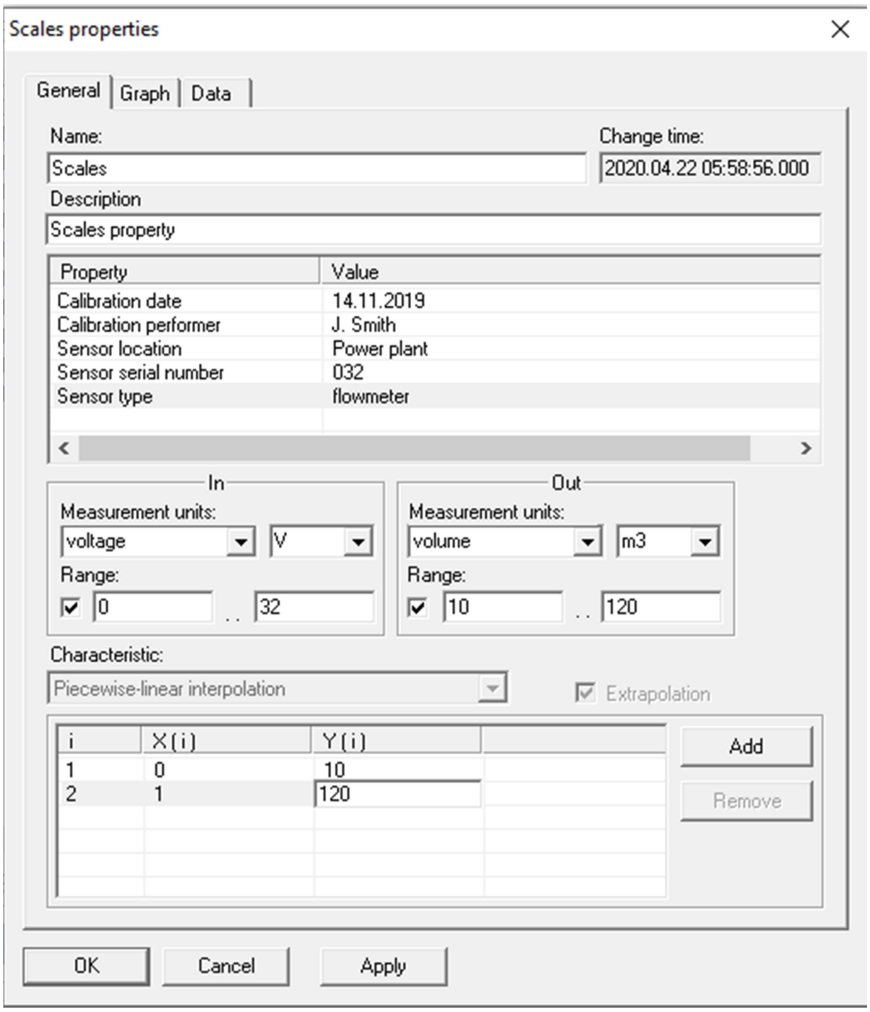
1. On the Settings tab, the Device Scale and Channel Scale fields display the names of calibration/scaling characteristics of the configurable channel:



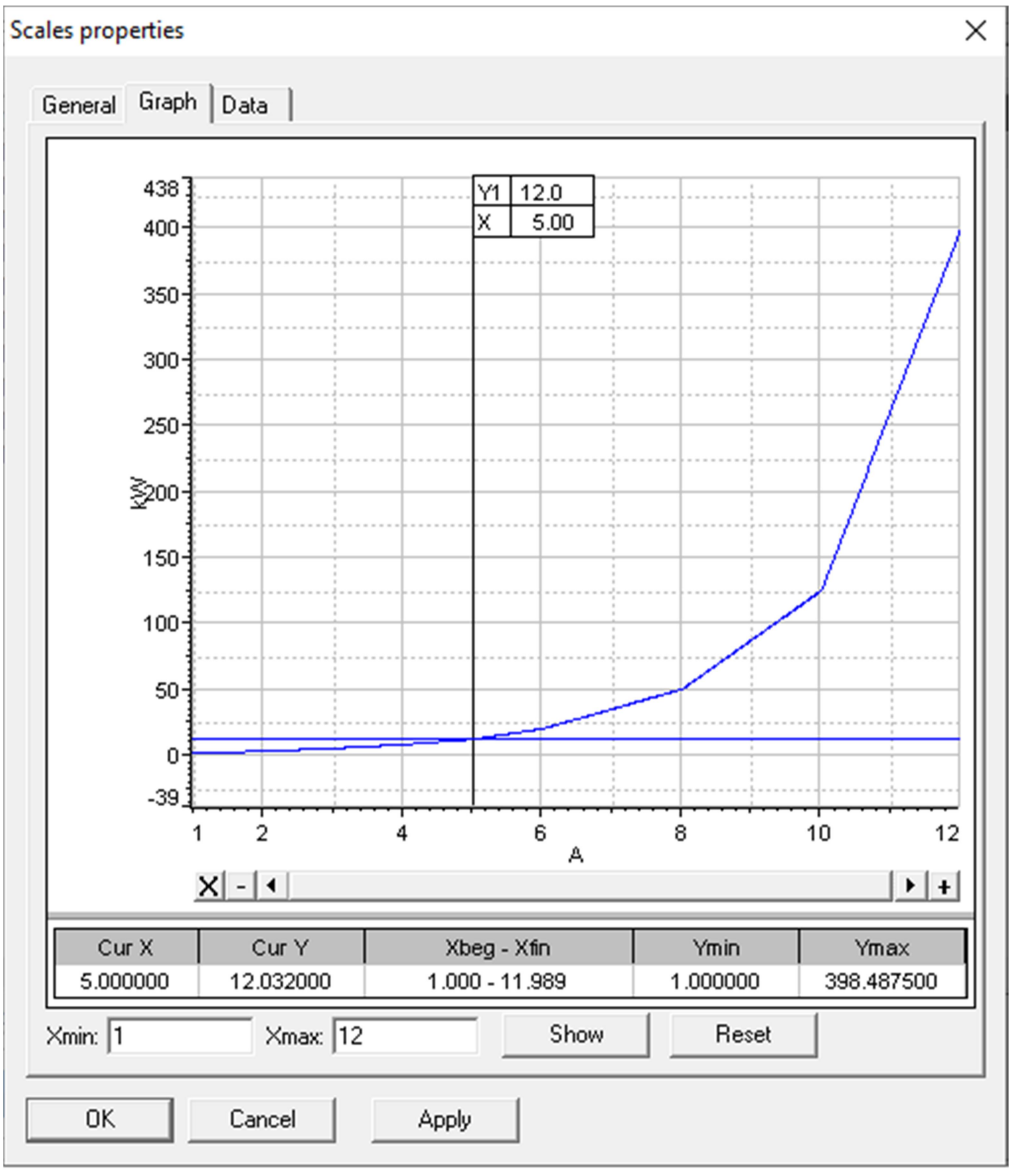
2. If necessary, the SC can be replaced with scaling characteristics from the SC Database, from State Standards (for example, GOST in Russia), or edited existing SC and CC, or disabled.
3. If all channel characteristics are disabled, the measured values are outputed for recording or

visualization in the values of ADC output codes.

4. To edit the current hardware SC, click the button  in the **Device Scale** field. As a result, the **Scales properties** dialog box will be displayed.



5. An example of SC piecewise linear interpolation is shown in tabular form on the General tab, and in graphical form on the Graph tab:

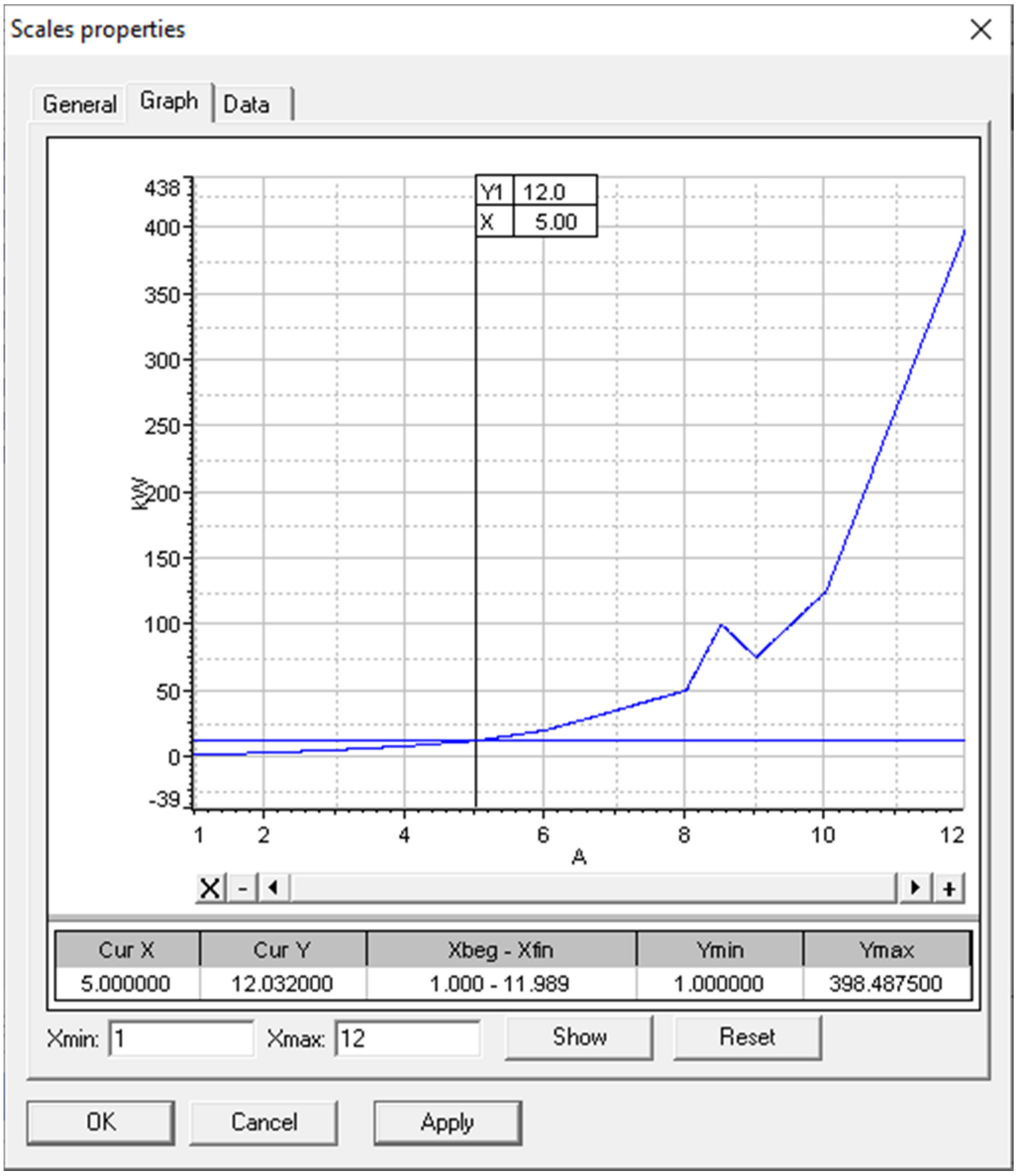


6. To edit any point of the scaling characteristic in the table, select it from the available ones or enter it, and then click on the value to edit it.
7. Following buttons are used during editing:
   - the **Add** button allows you to enter additional calibration/scaling points. After clicking on it an additional row with a new node is added to the table;
   - the **Delete** button allows you to delete the selected point from the calibration/scaling characteristic;
   - when you click **Cancel** the changes are ignored;
   - to confirm the changes and close the edit mode, click the **Apply** and **OK** buttons;
   - if you want to continue the calibration characteristic beyond the range in which the calibration was performed, select the " check box" in the **Extrapolation** field**.**
8. Entering a new point X-8.5 bY=100 in the table, we get the changed **SC** shown on the **Graph** tab:

i	X(i)	Y(i)
1	8.5	100
2	1	1
3	2	3
4	3	5
5	4	8
6	5	12

Add

Remove



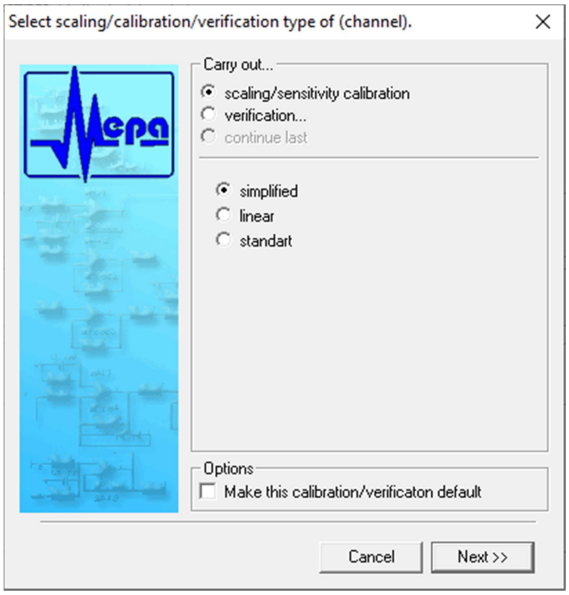
9. To connect a new scaling characteristic, click the button  in the **Channel Scale** field, and the dialog for selecting the characteristic type will be displayed:

In this window, you can select a new characteristic of the specified type, or import an existing characteristic from a file by selecting **Import from File** or database, by selecting **Load from ScaleDB**.

10. To delete a characteristic just click the  button in the **Channel Settings** window and after receiving confirmation the characteristic will be deleted.

11. This button  allows you to load the factory CC from the module's ROM.

12. The buttons  in the **Device Scale** and **Channel Scale** fields allow you to launch the software module for automated calibration/scaling/verification of hardware and channel, respectively. When you click this button, a dialog box for selecting the type of operation is displayed on the screen, as shown in the figure:



13. A description of the calibration/scaling/verification procedure is given in the "Method of verification of MIC complexes".

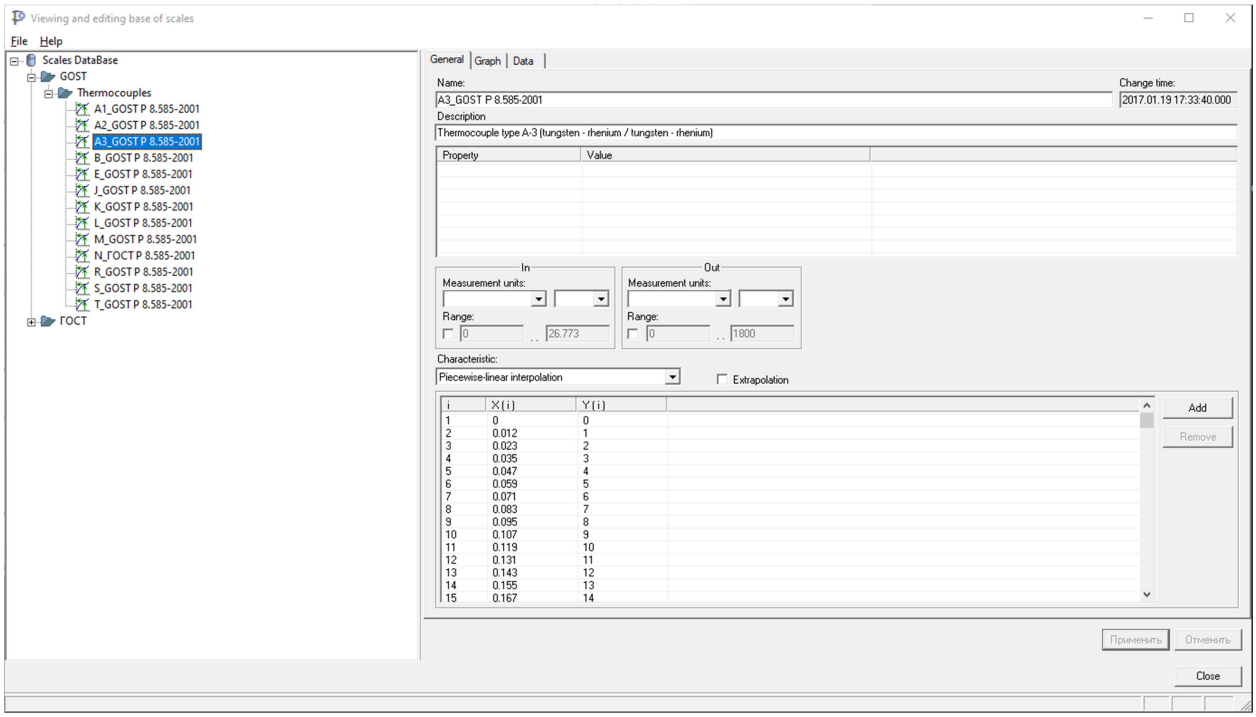
8.3 Scaling characteristics database

8.3.1 SC import

1. A specialized **scaling characteristics database** (SCDB) allows you to work centrally with SC, view them in a graphical representation, copy, and store additional information, such as the description and serial number of the sensor corresponding to this characteristic. All characteristics are stored in a catalog structure, which makes it easier to work with a large number of objects. The user interface provided by the database allows you to access the SC from all the software products of RPE "MERA".

2. To import SC from the database, click the button in the **Channel Settings** window.

3. After you select the **Load from ScaleDB** line and click **Create**, the **Viewing and editing base of scales** window opens on the **General** tab:

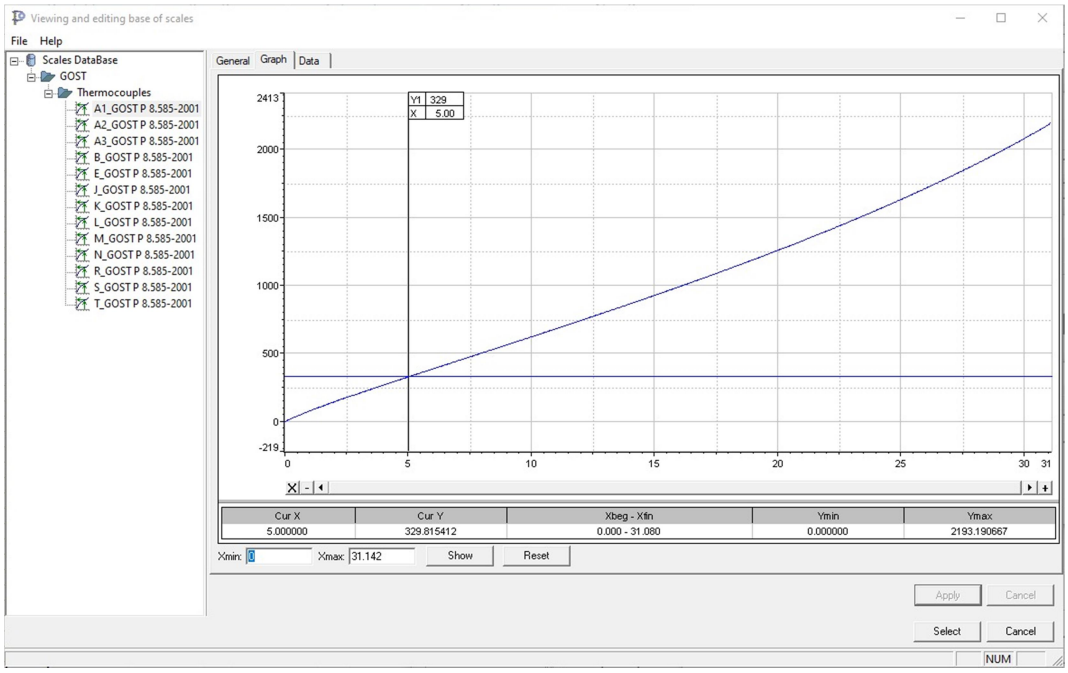


4. You can manage SCDB folders, search, and import SC using the Explorer in the left field of

the window. The SC in the file representation can also be imported from other sources. To do this, click **File**, then **Import** and find the file in the computer Explorer that opens.

- Information in the **Name** and **Description** fields appears after selecting the line with the name of the SC in the left field. You can configure the input and output signal units and ranges in the **Input** and **Output** fields.

5. A graphical representation of the selected SC is available on the **Graph** tab.



6. If during the selection and configuration of the channel SC you need to replace it, delete the SC by clicking the button  in the **Channel Settings** window

8.3.2 SC creation

1. User can build one of the four calibration characteristics specified in the **Create new scale** window (subsection 2 above) using the **Scales Properties** windows, which open after selecting the characteristic type and clicking **Create**. To do this, enter the SC values in the lower field of the window (paragraph 4) in section 8.2, enter a **Name** and **Description**, and click **Add**.

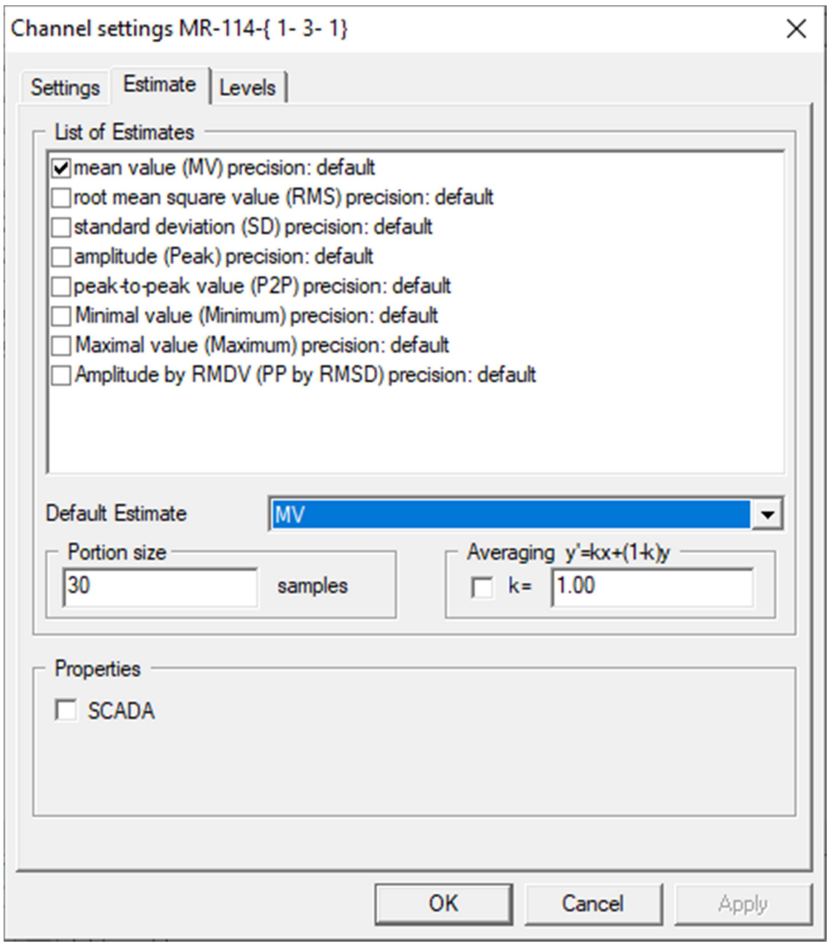
8.3.3 SC export

1. To export the SC available in the measuring channel to the SCDB, click the button  in the **Channel Settings** window (paragraph 2 of section 8.1). In the window that opens, select the folder to save the SC and click the **Select** button. The SC will be placed in the SCDB.
2. You can export the characteristics that are available in the GHDB to text files and import them from text files. This ensures compatibility with previous versions of Recorder, which did not support SCDB.
3. You can also access the GHDB window by clicking the button 

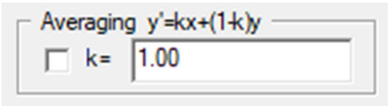
in the main Recorder window and selecting the Scale Database menu item.

8.4 Setting up measurement channel estimations

1. The **Estimations** tab of the **Channel Settings** window is used to configure additional channel properties and configure parameters for various estimations for the measurement channel.



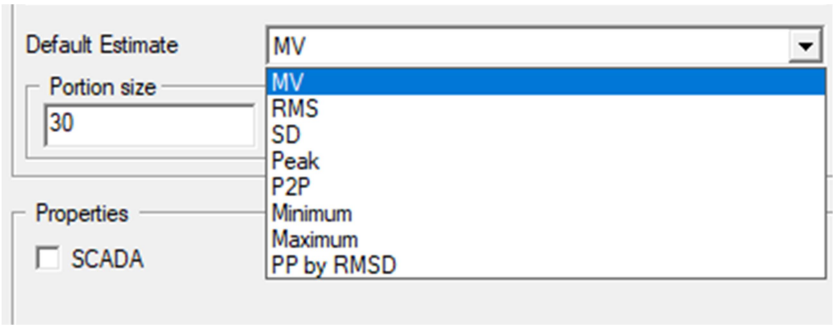
2. If necessary you can enable the averaging mode for estimations to do this you need to check the box in the **Averaging** field and set the coefficient ***k***.



3. Setting the SCADA flag allows you to set a special channel operation mode, which is necessary when building SCADA systems.

4. The length of the portions for the evaluation is specified in the field **Portion Size** by which estimations will be calculated. Increasing the portion size leads to greater smoothing and averaging of estimations. By default, the portion size is set as the number of counts during the data update period and is automatically recalculated when the channel and Recorder parameters are changed. If you set it manually, the portion length will not change automatically when the channel frequency or data update period changes. You can restore the automatic setting by setting the portion size -1.

5. By setting the appropriate switches, you can enable the calculation of necessary estimations. On the screen in a digital form, you can display several of the specified estimations. In this case, the ***Default Estimation*** will be displayed as the main one on the **Digital** form, and all calculated estimations will be displayed on the **Graph** forms.



6. The default for each channel is enabled and displays the calculation of the mathematical expectation.

   Averaging is performed using the formula:

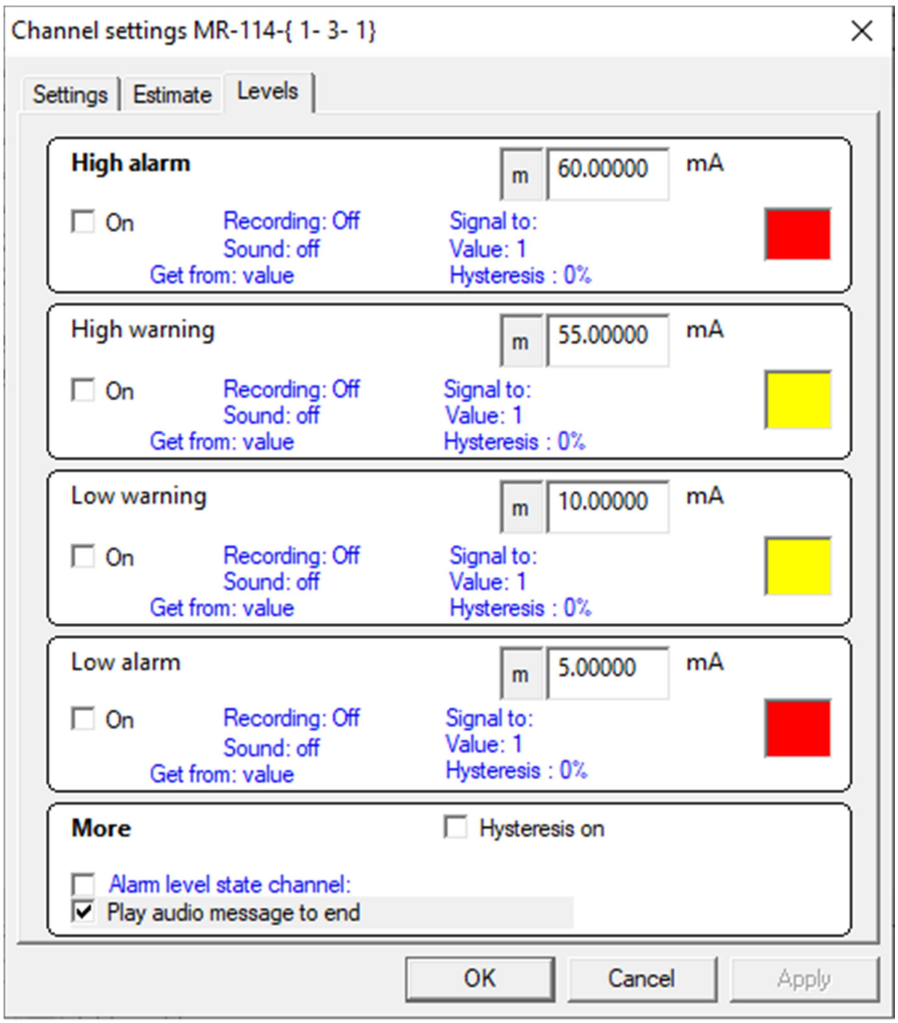
$$y' = k \cdot x + (1 - k) \cdot y$$, where:

y’ — the new estimation value
x — estimation received by the last portion
k — the averaging factor
y — previous estimation value

8.5 Levels settings

1. Levels can be set when setting up form elements or when setting up channels. In the latter case the element’s settings will be taken from the channel.
2. The **Levels** tab of the **Channel Settings** window allows you to configure up to four levels for each channel. For each level, you can configure:

   - Trigger level,
   - Indication color when triggered (displayed in the table and mimic diagram),
   - Automatically enabling data logging when the level is triggered, the **Recording** field,
   - Playing an audio signal when the level is triggered the **Sound** field,
   - Output of the set value to the channel when the level is triggered **Signal to** and the **Value**.

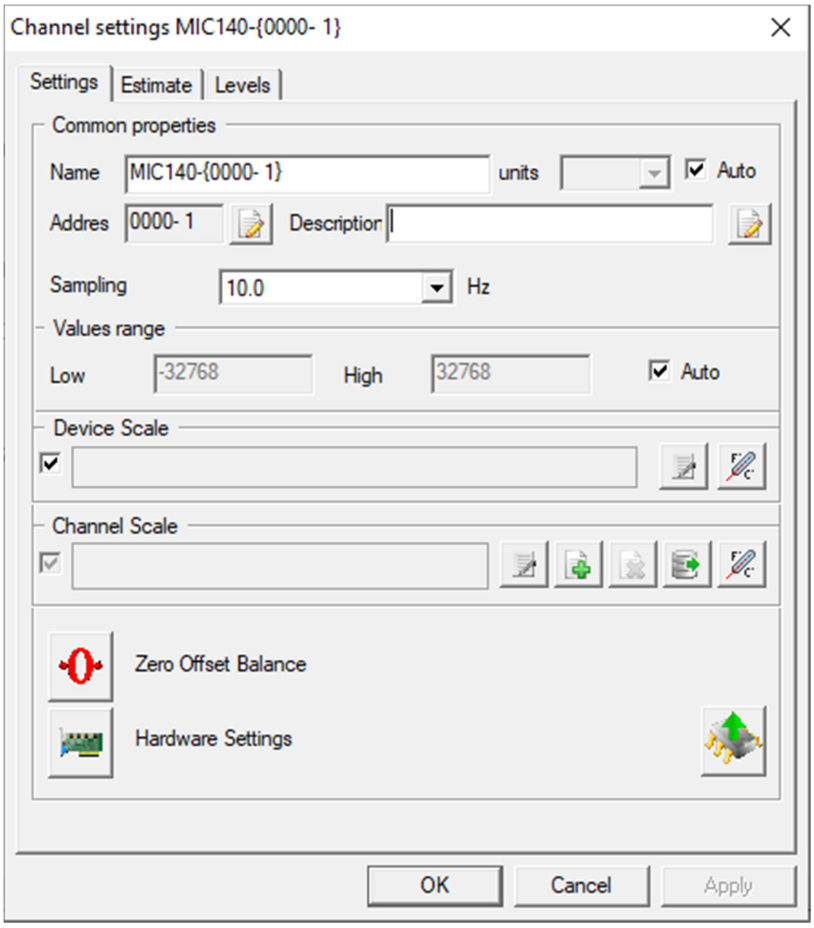


3. Additionally can be set up:

- The **Alarm level state Channel** flag allows you to control the state of the level from outside, for example, the control script. Used in SCADA systems.
- The **Play audio message to end** flag sets the audio notification playback mode. If the flag is unchecked, the sound will only be played when the level is triggered, if this time is less than the duration of the message. When this flag is set, the voice message is not interrupted, regardless of the channel state in which the level was triggered.
- The **Hysteresis on** flag allows you to take into account the hysteresis when the level is triggered. In order to avoid chattering state of the level, the hysteresis is adjusted by clicking the right mouse button on the level value.

8.6 Configuration of the channels of the complex MIC-140

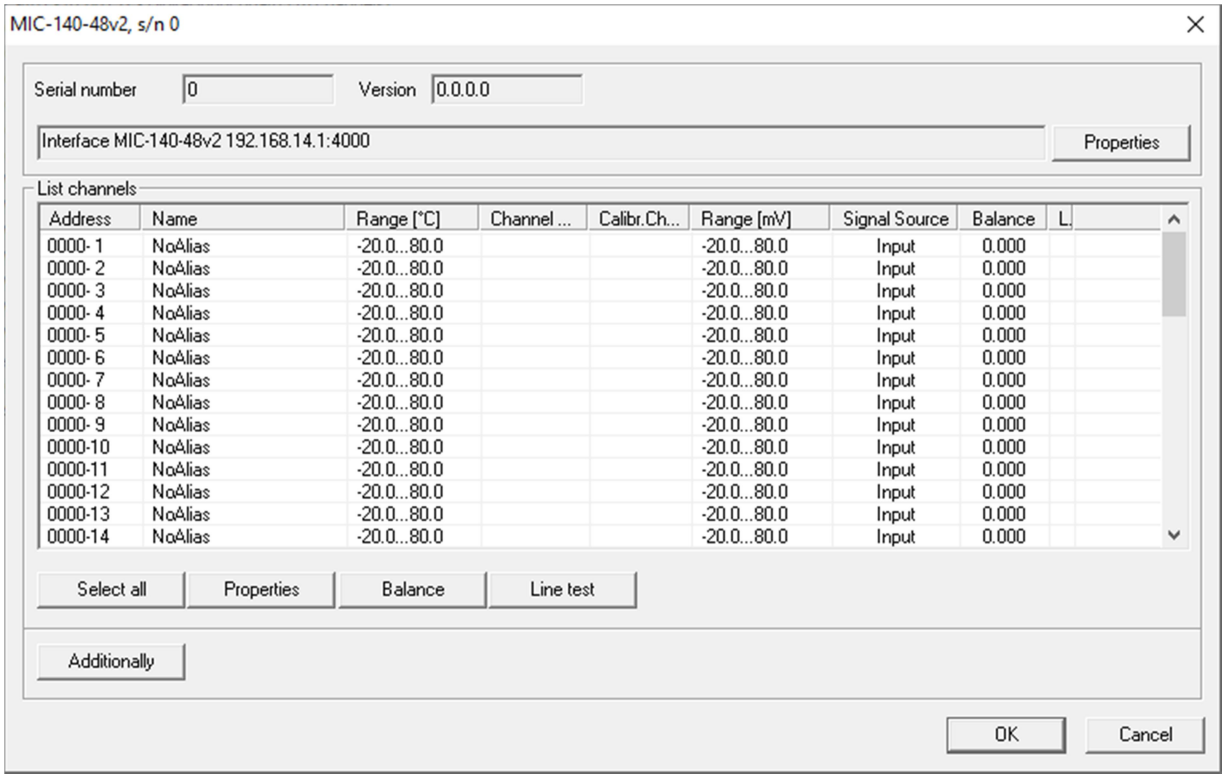
1. This section shows, as an example, the configuration of channels of the MIC-140 complex.
2. The MIC-140 complex designed for temperature measurement using thermocouples with automatic cold junction temperature compensation.
3. The complex has several versions that differ in protection from the external environment and the number of measuring channels, which can be 48 or 96. The complex has several built-in sensors for measuring the temperature of the cold junction. The channel setup order is the same for all versions.
4. The **Channel Settings** window becomes available after selecting a **Properties** in the menu that opens with the right mouse button in the **Channel List** field:



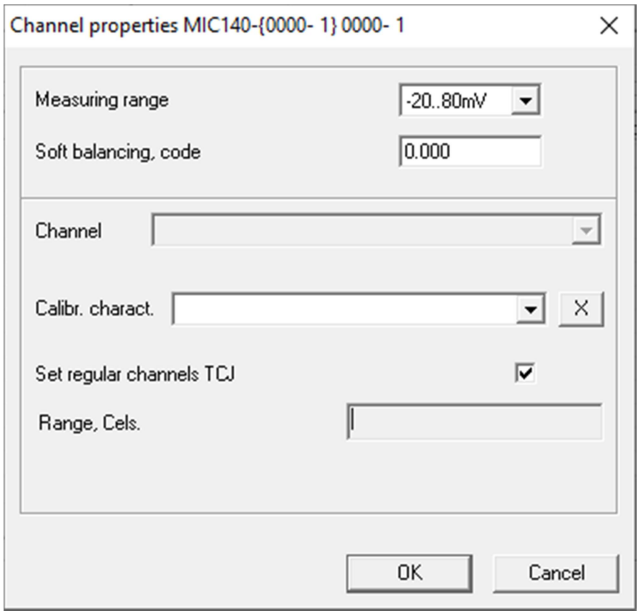
5. The channel **Name** is set so that it is convenient to associate the channel with a point on the measuring circuit.
6. The **Description** field contains a comment on the measurement point.
7. After removing the flag **Auto,** if necessary, the **units** field is set by default or the temperature measurement unit in °C can be selected. When using a non standard SC thermocouple other units of measurement can be selected.

8. In the **Values range** fields, the limits of temperature measurements are set automatically by their loaded **SC**, but after removing the flag in the **Auto** field, they can be adjusted.

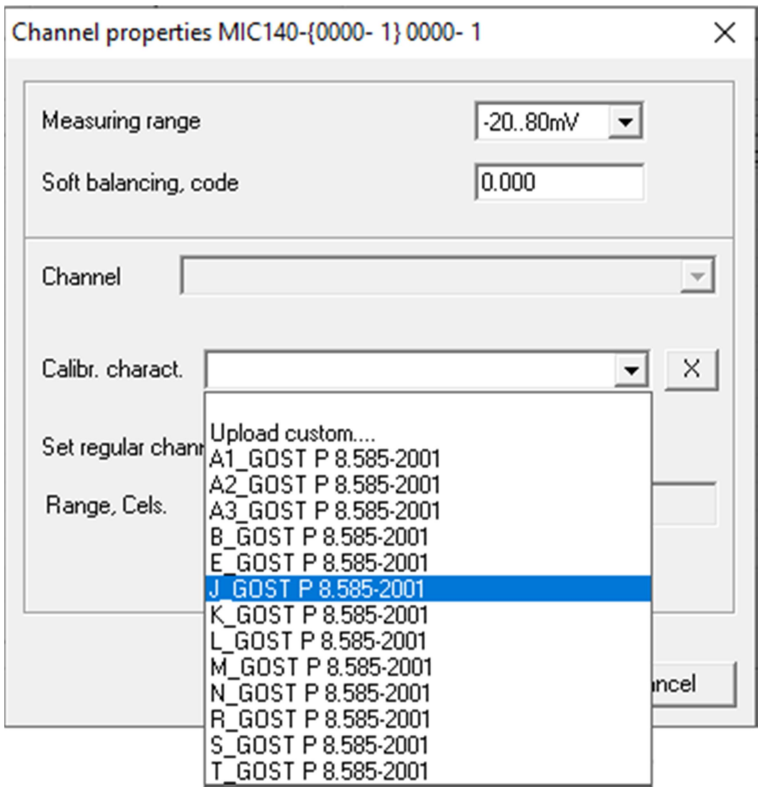
9. Clicking the hardware configuration button  opens a window with a list and characteristics of all channels of the MIC-140 complex. Using the cursor and **Ctrl** or **Shift** keys to select the custom channel (channels), click the **Properties** and **Additionally** buttons one after the other.



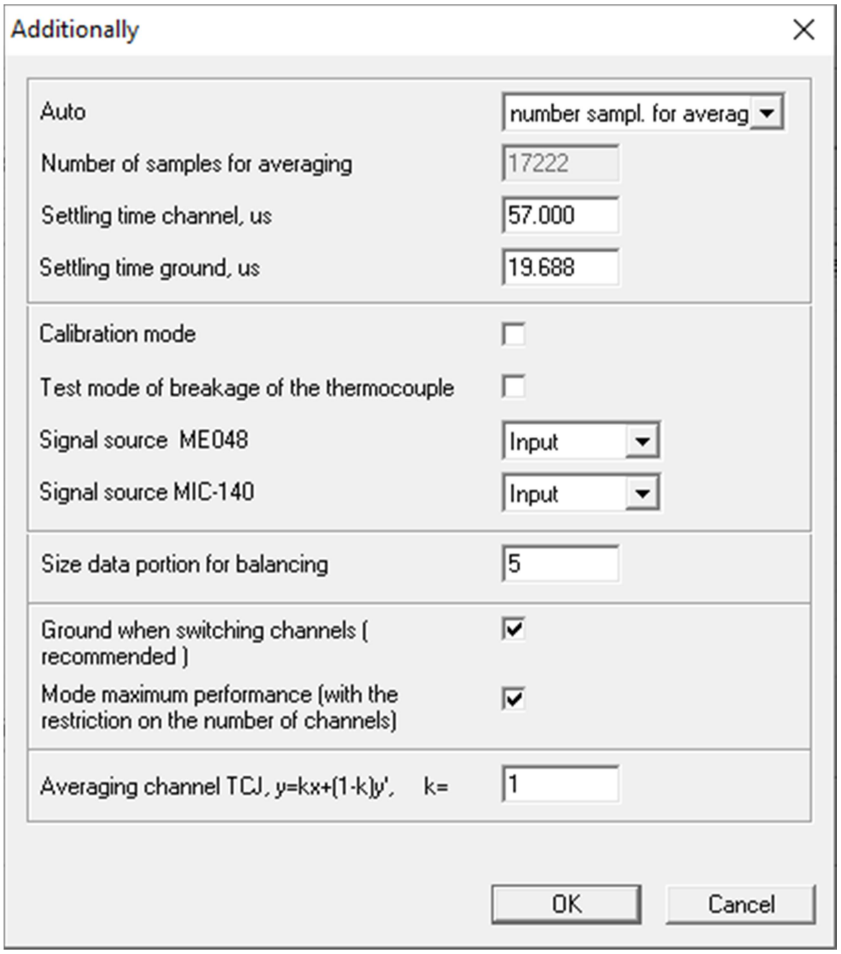
10. In the **Channel Properties** window, following parameters are set:



- Output voltage range of the connected thermocouple from the drop-down list;
- Flag **Set regular channels TCJ** provides default use of the signals of the regular TCJ sensors installed in the MIC-140. Removing the flag allows you to select a different TCJ sensor, for example, in the event of a fault
- Scaling characteristic from the SCDB for the type of thermocouple that is connected to the configurable channel\channels:



11. In the **Additionally** window following parameters are set:



- Averaged values of measurements calculation parameters (pre-installed);
- Operating mode (calibration / test lines/ switching input for calibration balancing and measurements). When the calibration mode is enabled, the cold junction temperature is not compensated. Is used for calibration of the channels in the mV;
- Selection of maximum performance mode;
- Averaging the TCJ channel;

12. The settings made should be represented in the hardware configuration window in the **list of MIC-140 complex channels** field.

    In this window, you can also:

    - Check the **thermocouple lines**.
    - Perform Balancing.

9 Performing measurements

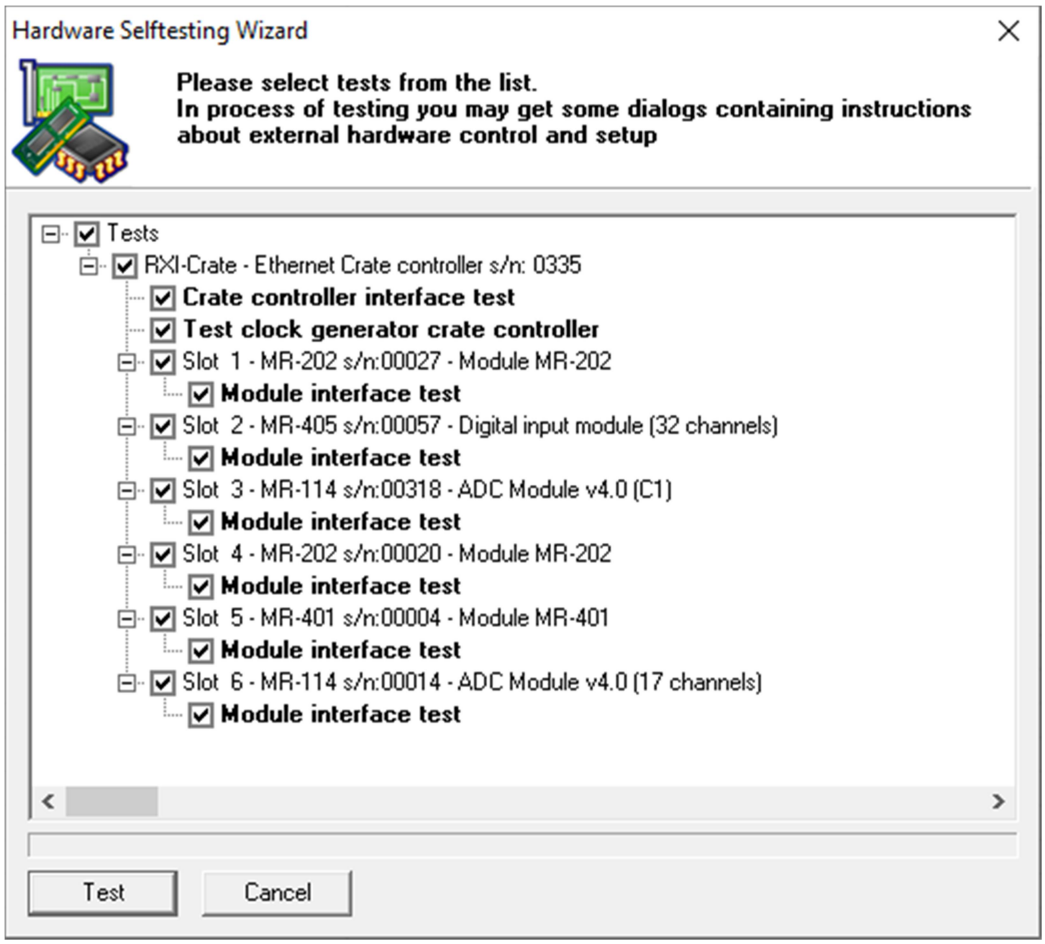
1. Measurements can be made after complete configuration of the hardware and software parts of the measuring system.
2. Configuration of the hardware part of the system is described in the manuals for the operation of the measurement system and the equipment included in the system: measuring complexes, computers, switching equipment, unified time system equipment, etc.
3. The basic settings of the Recorder software are described in the previous sections of this guide. Additional settings described in the operating manuals for measurement systems that use Recorder and other interoperable software.

9.1 Readiness check

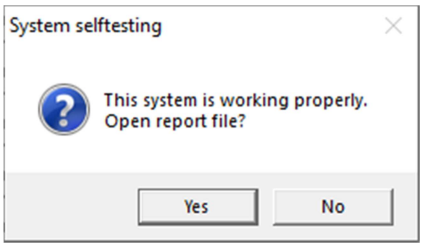
9.1.1 Self-testing

1. Automatic testing mode is enabled by pressing the button 

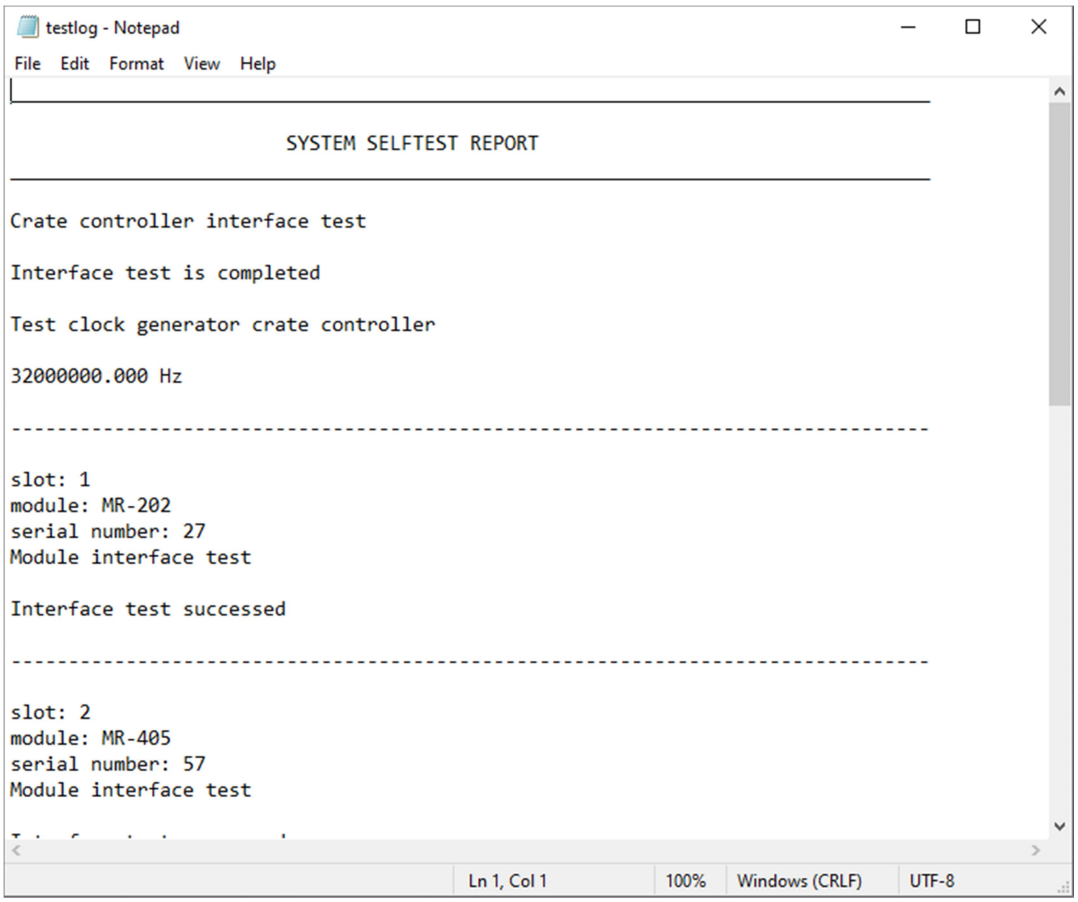
and selecting the **Self diagnostic** item  on the control panel of the main Recorder window, after which the hardware **Hardware Selftesting Wizard** configuration window :



2. In the **Hardware Selftesting Wizard** window, a list of equipment included in the measurement system configuration will be offered for testing. The user must mark the necessary test items. Tests available for different types of devices may differ: for example, some modules have a function for checking the integrity of the signal line to the sensor.
3. The results of automatic testing are displayed on the screen as a message in a window:



4. The test report is formed as a text file and looks like**:**

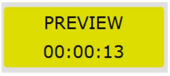


5. The test report can be edited, the user can add their own notes during the tests, and it can be used as a test log. After testing, the report can be saved as a plain text file. NotePad editor is a simple standard text editor, usually included as an application for Windows. The rules for working with the editor are described in the Windows operating system manuals.
6. If hardware problems occur when using MIC systems, it is recommended to send the resulting self-testing report of the system to the specialists of RPE “MERA” along with the error description.

9.1.2 Viewing waveforms

1. Checking the readiness of the measurement system for recording can be performed, in particular, by viewing waveforms of signals in the measurement channels on the **Base** or user pages.
2. To view slowly changing signals it is advisable to use the **Digital** form page or **Digital** forms and **Values tables** on user pages
3. When connecting sensors or other signal sources to channel inputs, the forms must display the expected signal shapes and values.
4. The signal viewing mode on the base page is started by pressing the button  **(F3)**. В этом режиме в окна просмотра в реальном времени выводятся осциллограммы входных сигналов, начиная с активного канала и далее по порядку в соответствии с количеством окон просмотра на странице. Активным можно сделать любой канал в любой момент времени, в том числе и во время просмотра. In this mode, waveforms of

input signals are displayed in real-time in viewing windows, starting from the active channel and then in order according to the number of viewing windows on the page. You can make any channel active at any time, even during viewing process.

5. If necessary, the observed signals can be scaled for better display, as described in section 6.3.2.
6. If there are more channels used in the measurement system than can be displayed on the Base waveform page, the channels can be viewed and evaluated sequentially. To do this, a new active channel is selected by clicking the mouse, starting from which the signals of the measuring channels are displayed on the screen.
7. After launch, the information field 

indicates that the complex is in preview mode, and displays the viewing time, i.e. the time elapsed since the viewing mode was enabled.
8. The preview mode is intended for checking the performance of the measurement system and the correct configuration of its channels before turning on the recording mode, as well as for analyzing parameters at the *pace of the experiment* without registering data to the hard disk.
9. Viewing mode is stopped by pressing the  (**ESC**) button.

9.2 Signal recording

1. Before you start recording signals, specify the frame in which the information will be saved. The directory where the results files will be saved must be specified on the system configuration settings wimdow - **Recorder** tab of **Setup** window (Section 3.5).

2. To select a file for saving measurement results, click the button  (F4) on the toolbar of the Main window and select either an existing empty frame or enter the name of a new frame in the standard folder selection dialog

3. For multiple consecutive runs of the registration mode, it is recommended to enable the Auto modify frame name at start option on the Recorder tab. This saves the operator from entering a new name each time he starts Recorder software.

4. If the Auto modify frame name at start is disabled for each test, by default, the results will be written to the same file every time the recording starts, erasing the previous information.

5. If you set the Auto modify… flag, the numeric indexes at the end of the file name will increase by one each time you run it. Alphabetic characters are not modified. If there are no numeric indexes in the name, they will be added automatically. Recording starts by pressing the button  (F2).

6. After launch, the information field 

indicates that the complex is in recording mode. This field displays the time that has elapsed since recording mode was enabled.

7. When automatic start is set, recording will start after the conditions entered on the **Recorder** tab (section 3.5) are met.

8. When recording signals, the user's monitor can be displayed by choice (section 5): waveforms of signals, a table of current values of signals, forms created by the user (section 6) or generated by plug-ins (section 11).

9. If waveforms are displayed on the monitor, then the same operations are applied to them as in view mode – zoom, shift, and change the active channel.

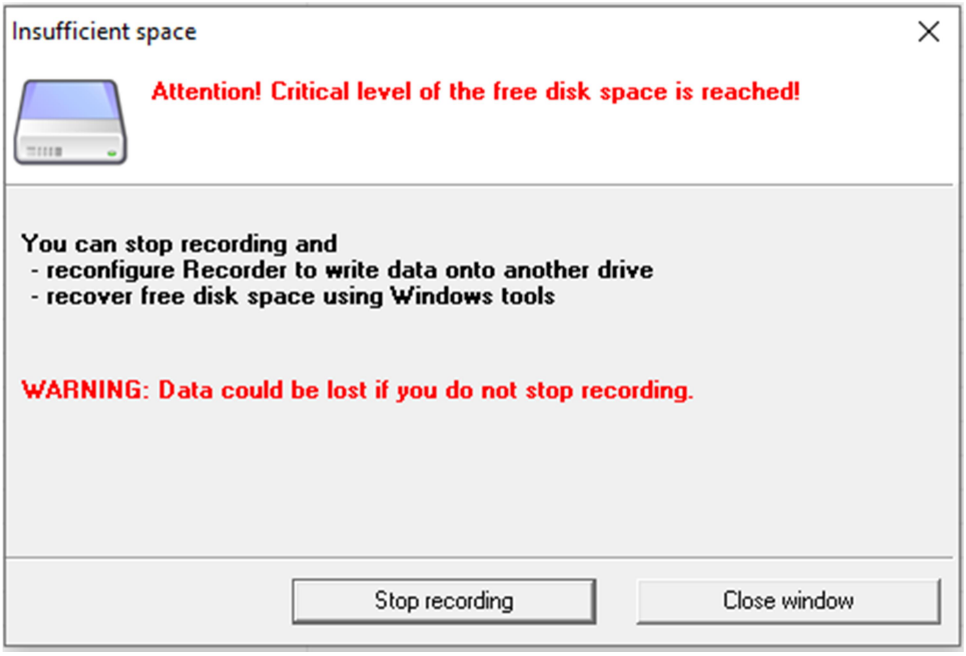
10. The recording mode ends by pressing the button  (ESC).

11. You can switch from recording mode to viewing mode by pressing  (F3). In this case, at the next start of recording, depending on the recorder settings, a new frame may be started, or recording will continue to the current frame

9.3 Control of free disk space

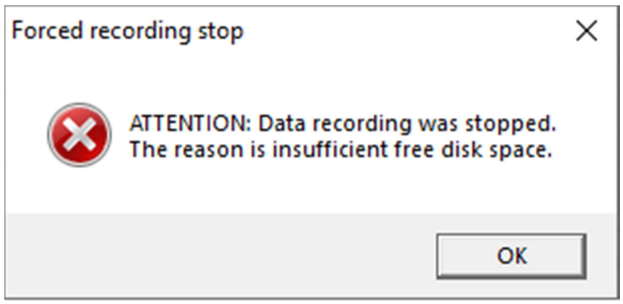
1. Recorder controls the amount of free disk space for recording data.

2. If the current data flow leaves free disk space for recording signals that last no more than 10 minutes, a warning window will be displayed on the monitor:



3. If the recording mode will not be changed, then when the critical amount of free space on the hard disk for recording the signal became less than 1 minute, the recording will stop

automatically and a message will be displayed on the monitor:



9.4 Recommendations for data processing

1. To process the recorded information, we recommend using the **WinPOS signal processing Package** developed by RPE " MERA».

2. To transmit the recorded signal for processing to **WinPOS** just click the button  on the toolbar of the **Main** window

3. The processing program will start if it has been pre-installed and configured according to the processing tasks, and a file with test results will be opened in it.
4. ***WinPOS*** is designed for digital signal processing with graphical representation of results and print output results.
5. Functionality of the **WinPOS** package*:*
    - working with data in binary and text formats, USML files, and files in MERA format;
    - signal processing using more than 50 algorithms, including:
        - autospectrum, mutual and complex spectrum, spectrum transformations;
        - coherence and incoherency function;
        - transfer function;
        - recursive and non-recursive filtering (filter constructor);
        - logarithm;
        - integration and differentiation;
        - envelope;
        - rationing and centering;
        - arithmetic operations;
        - autocorrelation and cross correlation;
        - probability characteristics;
        - probability distribution density;
        - oversampling;
        - three-dimensional spectrum;
    - processing dynamic processes using specialized algorithms for:
        - building trends;
        - Nyquist Plot ;
        - Building a Campbell diagram;
        - perform ordinal 3D analysis;
    - script support(VBScript). Based on VBS the user can:

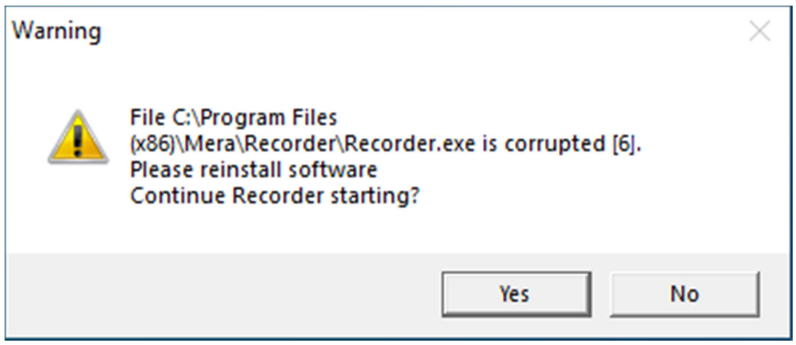
    - create your own signal processing algorithms;
    - automate the input signal processing process (from selecting the input file / signal to documenting the processing results);
    - use a powerful script-based command mode;
- interface support with drag&drop technology and keyboard controls;
- providing the user with a detailed help system with the availability of:
    - detailed description of the interface;
    - explanation of algorithms and their settings;
    - a complete guide to using WinPOS objects in Visual Basic Script scripts;
    - indexing and searching for help articles;
- availability of tools for creating schedules and preparing reports (comments, callouts, line numbers, etc.)
- free configuration of charts on the page;
- making charts with comments, callouts, and signatures;
- print results;
- saving the result in a file;
- insert into an MS Word document;
    - batch data processing;
    - editing USML files;
    - processing large files (more than 2000 MB).

6. We recommend processing files in the MERA format, which significantly saves disk space compared to the USML format.

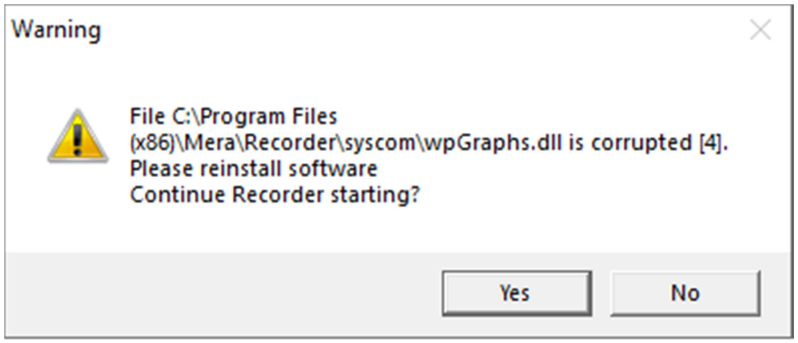
7. When using other programs, such as Exel, MathCad, etc., to process measurement results obtained in Recorder, you must convert the recorded information to the form available for the processing program you are using.

9.5 Software integrity control

1. Recorder SOFTWARE has a built-in mechanism for monitoring the integrity of binary software components that make up the software. At each launch, the size, date, version, checksum, and other parameters of the protected components are checked. Made in the form of dll files, and ActiveX (COM) components. If a discrepancy is detected, warnings are issued:



Or:

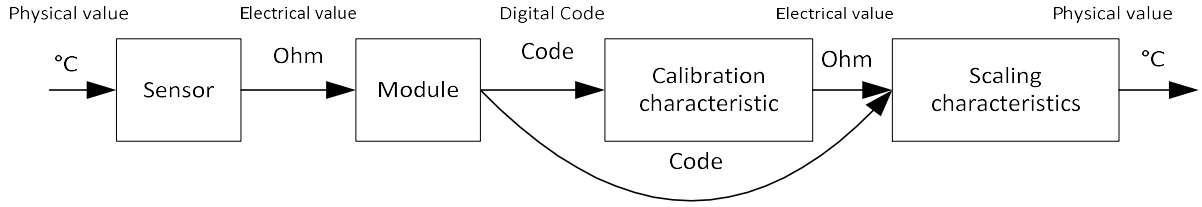


2. The user can choose whether to continue running the SOFTWARE or refuse to do so and fix the problem, with subsequent launch.

10 Calibration and scaling of measuring channels

10.1 Calibration/scaling/verification tasks

1. The process of measuring a certain physical quantity by a measurement system controlled by the Recorder software can be represented (see the figure) as:



- converting a measured physical quantity into an analog electrical signal,
- conversion of analog electrical signal in channel circuits and equipment,
- analog-to-digital conversion of the signal in the ADC module to binary code and transfer it to a computer with the Recorder software,
- measurement information containing the value of the measured physical quantity recieving from the binary code by the Recorder software.

In this case, the Recorder takes into account the signal transformations made by the sensor, channel equipment, and ADC and reproduces the physical value with an error not exceeding the permissible measurement error defined for this channel.

2. The functional relationship between codes and values of measured physical quantities is called **end-to-end *scaling characteristics* of the channel (SC of the channel)** and is defined:

    - **Scaling characteristic (SC) of the sensor**, which is a function of converting the measured physical quantity into an electrical signal at the sensor output. SC is obtained by measuring the electrical signals at the sensor output, when the sensor is exposed to the reference values of the measured physical quantity at the control points of the measurement range. SC can be given: in the sensor passport, in databases of standardized SC (for thermocouples), obtained experimentally and represented by some approximating function;
    - **The calibration characteristic of the channel (CC**), which determines the correspondence between signal digital representation at the output of the ADC module and the values of electrical values at the input of the channel. Depending on the type of module, the input electrical values can be: current, voltage, resistance, charge. CC is formed in the factory by determining output number of codes when applying reference values of electrical signals in the nominal range of the module operation to the channel input. The process of obtaining CC is called **channel sensitivity calibration**, or in short, **channel calibration.**

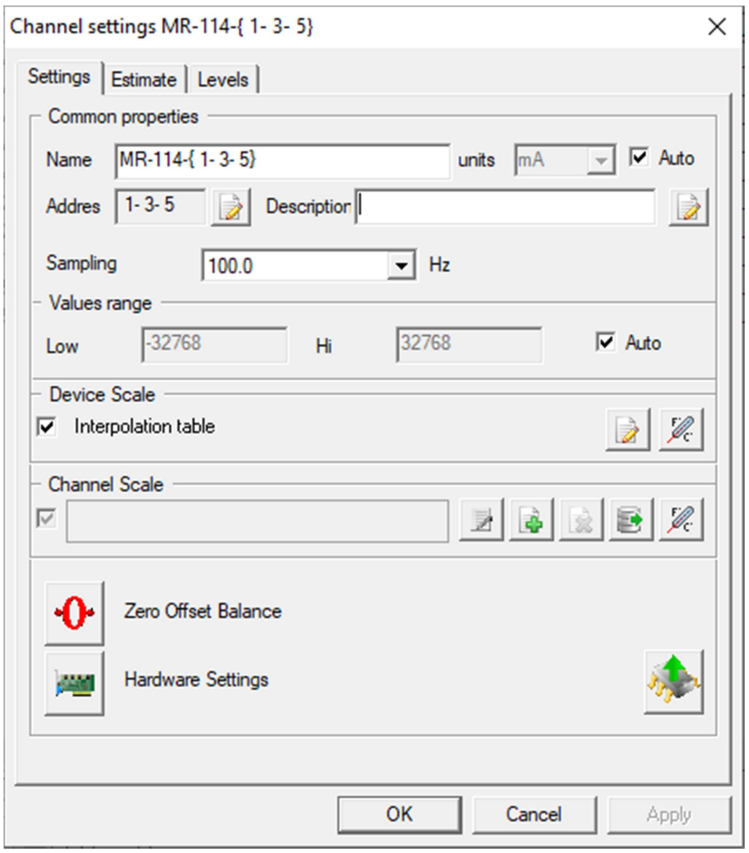
CC can be written to the module's ROM, or on a disk that is passed to the user with delivered

measuring equipment.

3. From the output of the MIC module, the signal is digitally transmitted to the computer, where digital representation are converted by the Recorder software into a numerical representation in units of measured physical quantities.
4. To obtain the values of the measured physical quantity, Recorder converts the digital codes from the measuring module to a physical quantity, taking into account all the signal transformations in the sensor and channel before obtaining a code representation, i.e. using the SC sensor and the CC channel.
5. To obtain the values of the measured physical quantity, in some cases, a **pass-through *calibration characteristic of the channel*** can be used, obtained by determining the number of codes at the output of the ADC module when the reference influence of the physical quantity on sensor at the control points of the channel measurement range.
6. Channel **verification** involves the process of monitoring the metrological characteristics of the channel in order to determine its operability before making measurements. The verification of measuring channel is similar to obtaining a pass-through SC of the channel by sending arbitrary signals to the sensor in the operating range of the measurement channel or when a sensor simulator is connected to the channel.
7. The Recorder settings in the channel verification mode can also be used for the next (secondary) **verification of the measurement system**, when all the requirements of the "MIC complex verification Methodology" are met.
8. To obtain the described calibration, scaling characteristics and channel verification, Recorder uses a common software module that is used both for factory settings of the equipment and for preparing the measurement system for operation.
9. Usually a standard calibration of sensitivity with use of the reference instrument is performed by the specialists of the manufacturer.

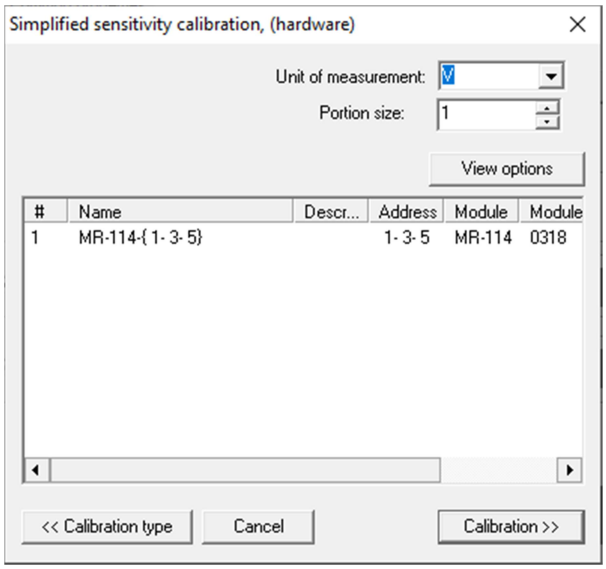
10.2 Switching to channel calibration/scaling mode

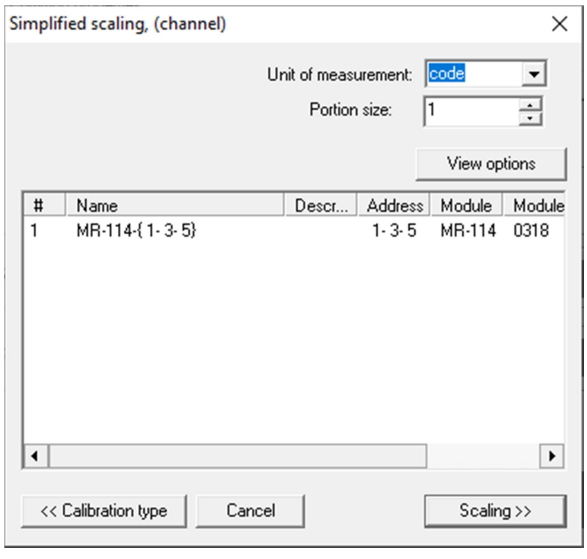
1. The Recorder dialog windows for setting up and performing various operations related to calibration/scaling of channels are similar and have the same purpose for the fields of the same name, taking into account the type of operation being performed.
2. **Module calibration** is usually performs under factory conditions. The user, if necessary, can perform this operation if he has the means to set the reference electrical values, guided by the document « MIC complexes method of verification»;
3. **Channel calibration** allows you to calibrate the channel sensors and is described in section 10.2 . The calibration characteristic setting operation is described in section 8.2;
4. You can switch to the scaling/calibration mode from the **Channel Settings** window using the buttons -  **Calibrate module** or **Edit module channel scale**.



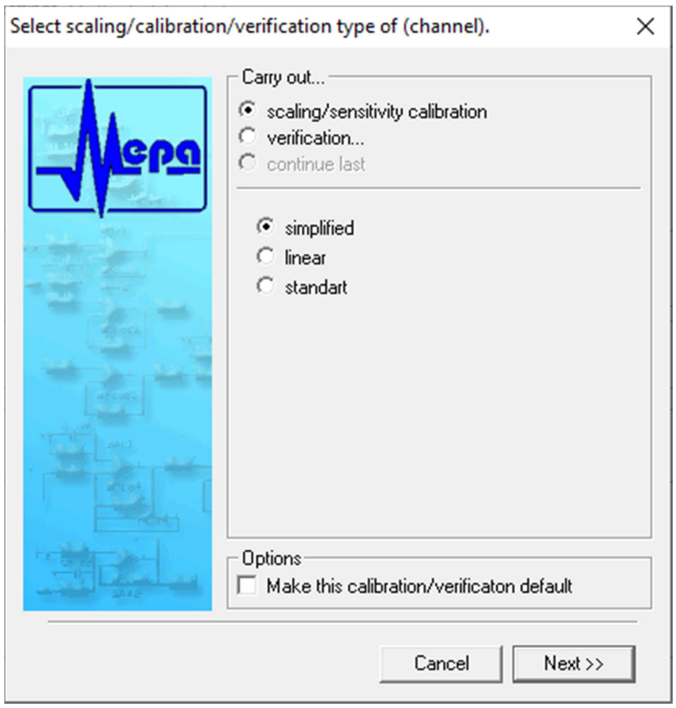
5. To perform simultaneous calibration of several channels of the same type, select them on the **Channels** tab of the settings window or in the main Recorder window in the list of channels, open the channel settings window, and click the button  to switch to calibration mode.

6. Pressing the buttons  opens the windows of the **Simplified sensitivity calibration, (hardware)** or **Simplified scaling, (channel)**, respectively:





7. To select a different type of operation (linear or standard), click the **<<Calibration Type** button to go to **Select scaling/calibration/verification type of (channel)**.



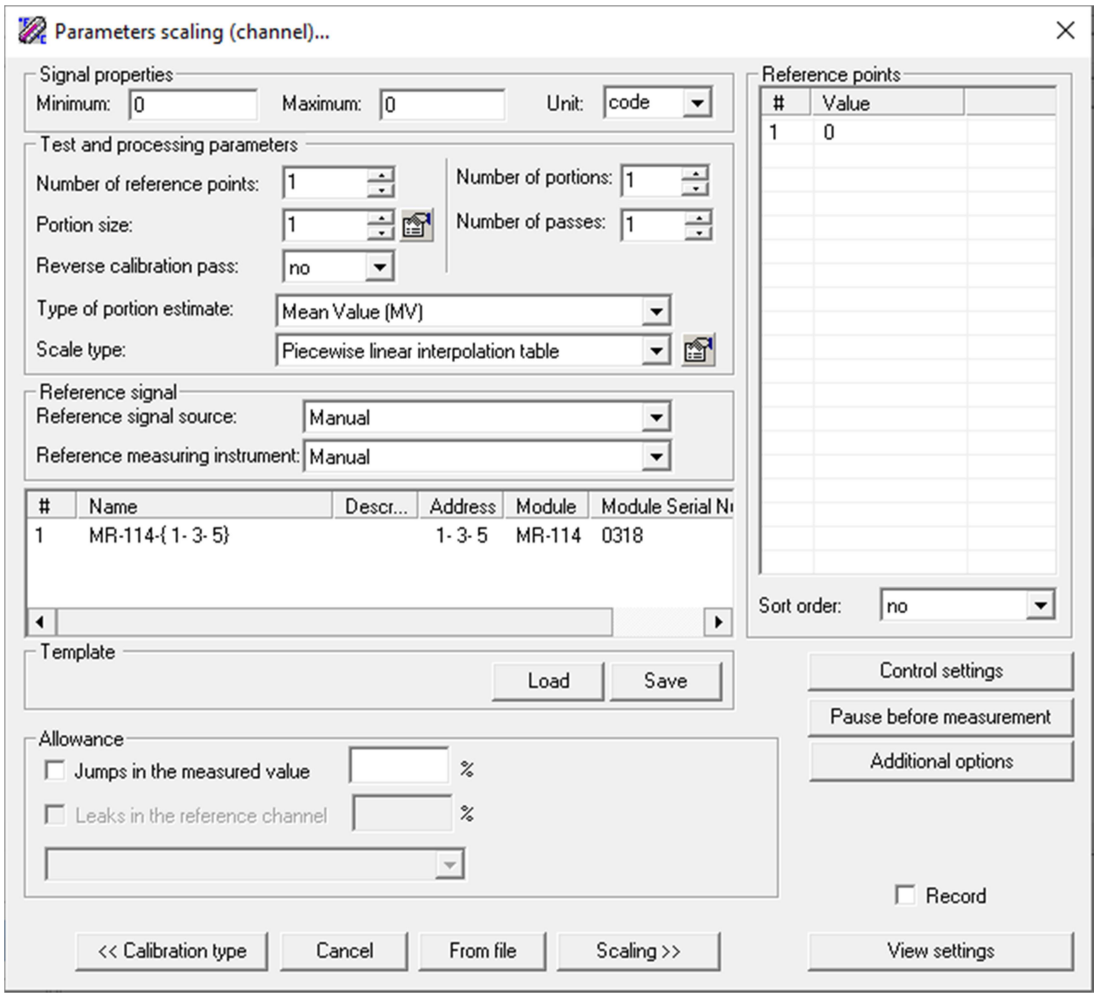
8. The choice of calibration/scaling type depends on the operation being performed and determines the number of settings for channel calibration parameters.
9. When choosing the type of *calibration/scaling*, keep in mind that:
    - **simplified** calibration/scaling has minimal initial settings and allows to use an arbitrary number of control points during the calibration/scaling process.
    - **linear** calibration/scaling of the measuring channel is made at the value of one reference point (reference input value) and can be produced only under conditions of linearity of the characteristic in the calibrated measuring range and if the allowed value of the initial offset is not exceeded when the input signal is set to zero;
    - **standard** (described below) calibration/scaling has a wide range of initial settings, assumes calibration/scaling by a pre-determined number of control points, allows to configure the parameters of selection of measurements at control points, which allows you to choose the type of representation of the resulting calibration/scaling characteristic (coefficient, polynomial, etc.).
10. It is possible to save the settings as a template for reuse. Examples of configuring calibration parameters for different types of modules are given in Appendix D (section 12.4).
11. Setting the flag in the **Options** field – **Make this calibration/verification default** configures the program so that the next time you click the calibration button in the **Channel settings** window, the corresponding calibration type window opens.
12. After selecting the type of calibration/scaling, press the button 

.

10.3 Standard calibration

1. When you select the Standard calibration type, the window for configuring parameters of the

standard sensitivity calibration opens, **Parameters scaling (channel)…** window below:



2. ***Standard calibration*** of a channel can be performed using a previously generated **Template**, for that you should use:

   - The button Load used to enter previously set calibration parameters. When you click this button, you will see a file selection dialog box where the required calibration parameters (mode) are saved;
   - The button Save used to save the set calibration parameters (mode). Saving the set calibration mode will further reduce the time required to set up / calibrate the measuring channels;

3. The button << Calibration type returns to the **Select scaling/calibration/verification type of (channel)** window.
4. In the Signal properties fields set:

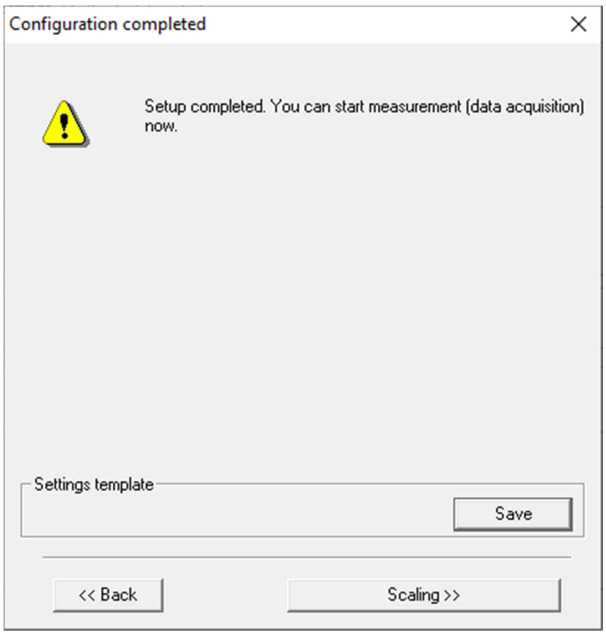
   Minimum\Maximum limits of measurement and **Units** of measured physical quantity.

5. In the fields with the name **Test and processing parameters** set:

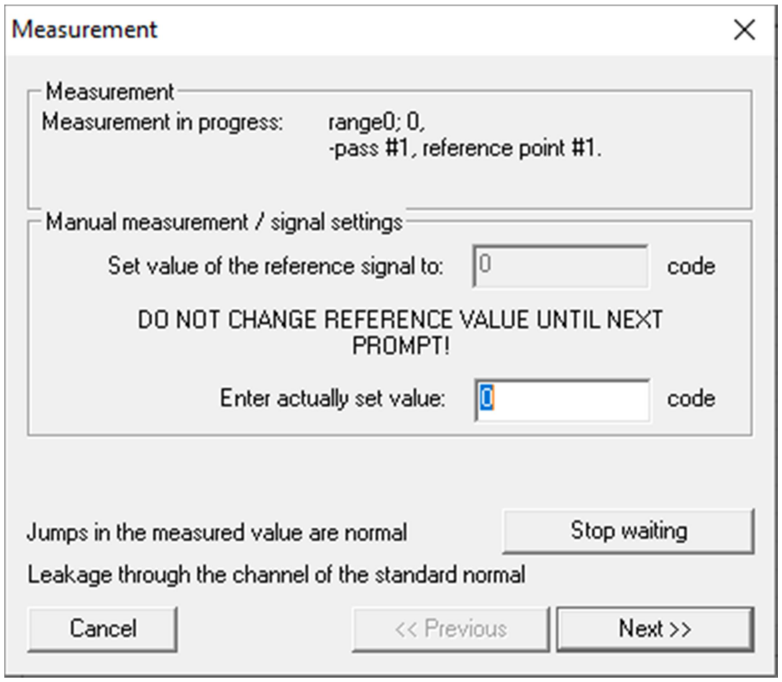
   - **Number of reference points** — the number of control points that are automatically evenly distributed over the selected range of input signal changes.The results of the measurement range and number of control points settings are automatically displayed in the **Reference points** section;

- **Portion size** - specifies the number of single samples of the measured signal values. These samples are used for averaging the measured value. Averaging the values allows you to reduce the random error when calculating SC. As the sample length increases, the random error decreases;
- **Reverse calibration pass** - enables a mechanism that in calibration/scaling mode, in addition to a direct pass through the control points, the reverse calibration pass is performed. This function is necessary if you need to take into account the sensor's hysteresis;
- **Number of portions** — the number of samples of the mentioned above portion size measured for a single control point Number of portions - the number of samples of the above length, measured for one control point;
- **Number of passes -** the number of measurement cycles of the values of the reference signal from the minimum to the maximum value and vice versa;
- **Type of portion estimate (estimation)** - determines which type of signal estimation the SC is based on. The parameter is selected from the suggested list: Mean Value, standard deviation(SD), amplitude, P2P, etc. The first is used for constant level calibration, and the others are used for variable (harmonic) reference signal calibration. The specific type of parameter to be evaluated is determined by the user depending on the physical parameters to be measured;

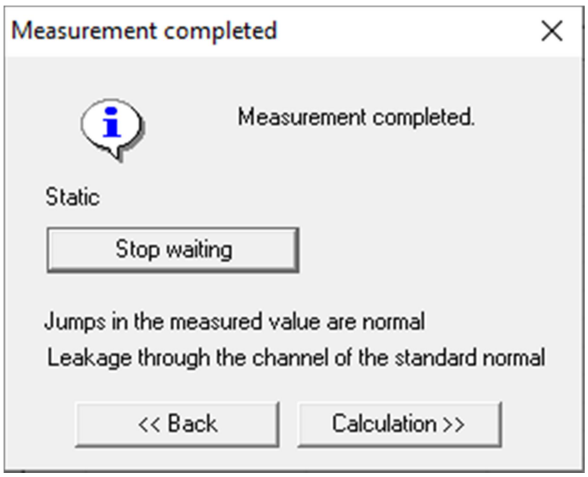
6. Recommendations for setting the portion size and number of portions:
   - When performing calibration/scaling, the portion size should be set in proportion to the sample rate of the module being checked:
   - 10 Hz-10 points, 100 Hz-100 points, etc.
7. In the given example, the settings are selected: the portion size is equal to 10 counts, i.e. at a sampling rate of 100 Hz (a period of 0.1 s), one measurement will take place once per second).
8. In the **Scale type** field, select the type of calibration/scaling characteristic that will be generated as a result of calibration of the measuring channel from the list:
   - Scale factor – the calibration result is a scale factor (SC type y = ax);
   - N-order polynomial - the calibration result is the coefficients of the linear dependence described by an N-order polynomial (SC type y = K0 + K1x +...+ Knx);;
   - Linear interpolation table – the calibration result is presented as a table representing a piecewise linear relationship with nodes at the control points that were used for calibration.
9. In section **Reference signal** is set:
   - **Reference signal source** field select from the list how to set the reference value at control points;
   - **Reference signal instrument** field select from the list the method for registering the specified reference value of control points.
10. The calibration process is started by clicking the **Scaling>>** button. As a result, a dialog box will be displayed with a notification that the settings have been completed.



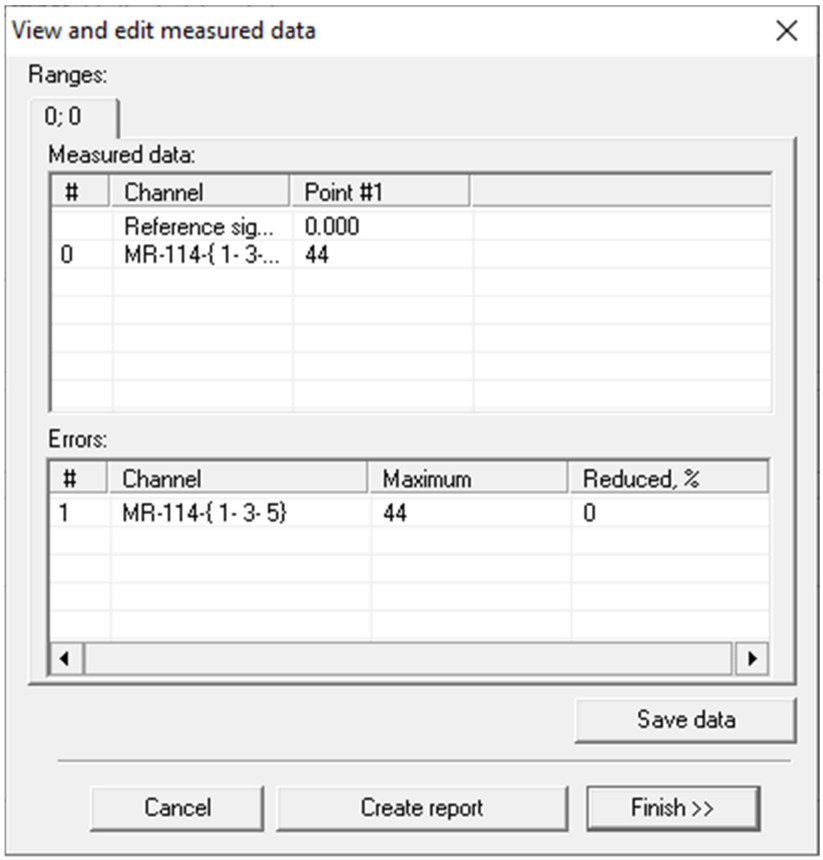
11. When you click the ***Scaling>>*** button in the **Configuration completed** window, the calibration process begins. The **Measurement** window displays a dialog box with a suggestion to send the next reference signal value to the channel input, corresponding to the value specified in the **Enter actually set value** field:



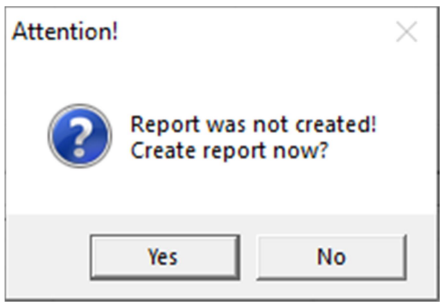
12. After connecting the reference value signals to the calibrated channel(s) input, click the **Next>>** button. After passing all the control points, the **Measurement completed** window is displayed on the screen:



13. Clicking the **Calculation>>** button completes the calibration procedure and displays the results in the data **View and edit measured data** window.



When you click **Finish>>**, you are prompted to create a calibration Protocol, which may be required, for example, when performing verification. Otherwise click **Cancel**.

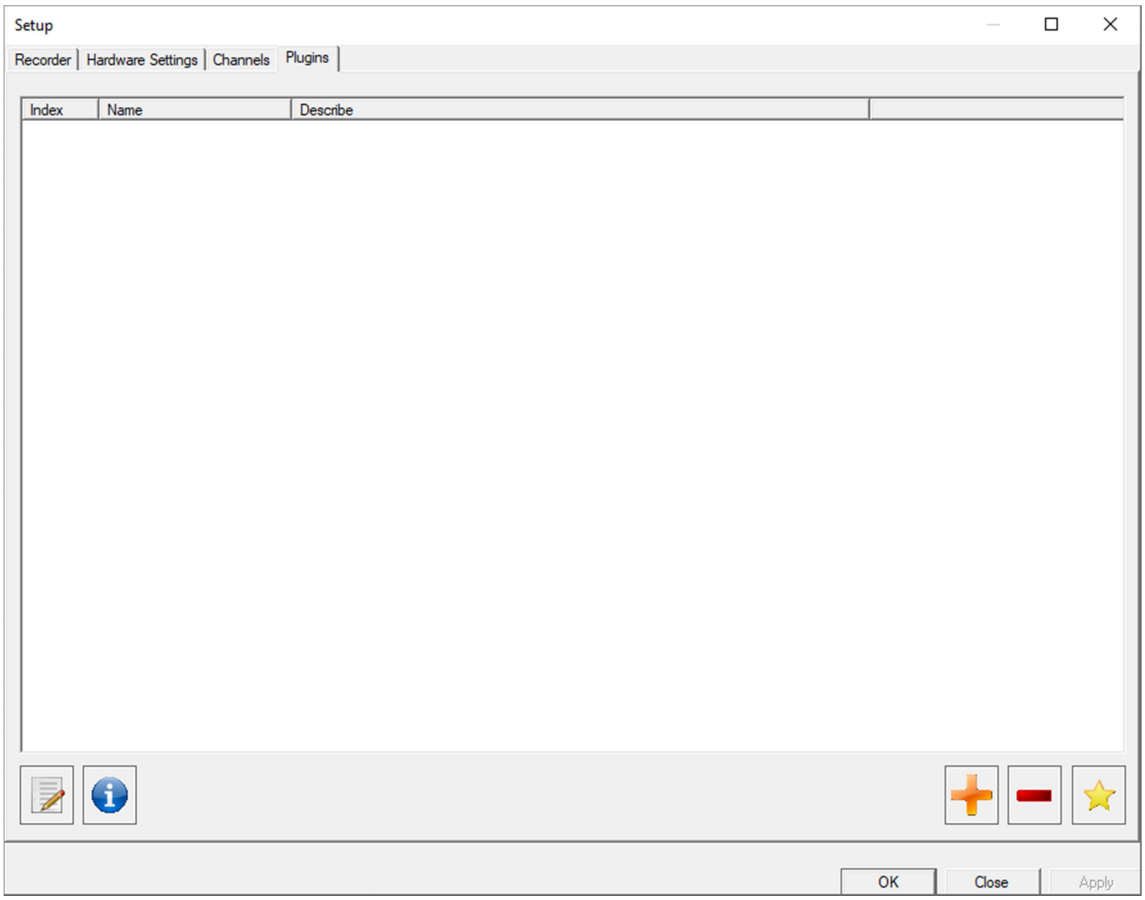


11 Plugins

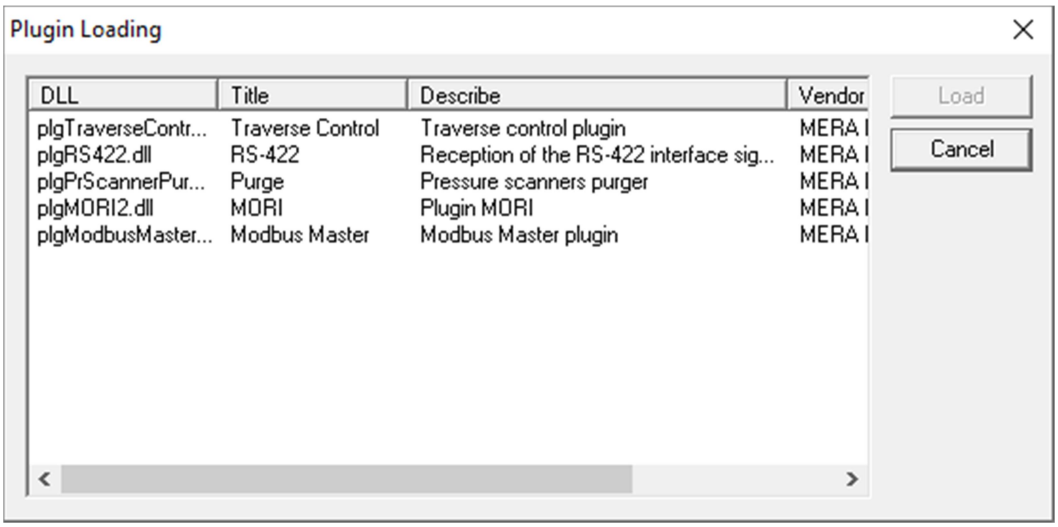
11.1 Connecting plugins

1. The user can extend the functionality of Recorder by developing plug-ins that allow performing measurement tasks. If necessary, you can change the software interface, add new function buttons, indicators, and so on. Thus, the user is given the opportunity to adapt the Recorder program to specific task.
2. For information on plug-in development, see the "Programmer's Guide for developing Recorder plug-ins".
3. For independent development of plugins, a special set of files is required – PluginSDK, which is available on the website of the RPE "MERA".

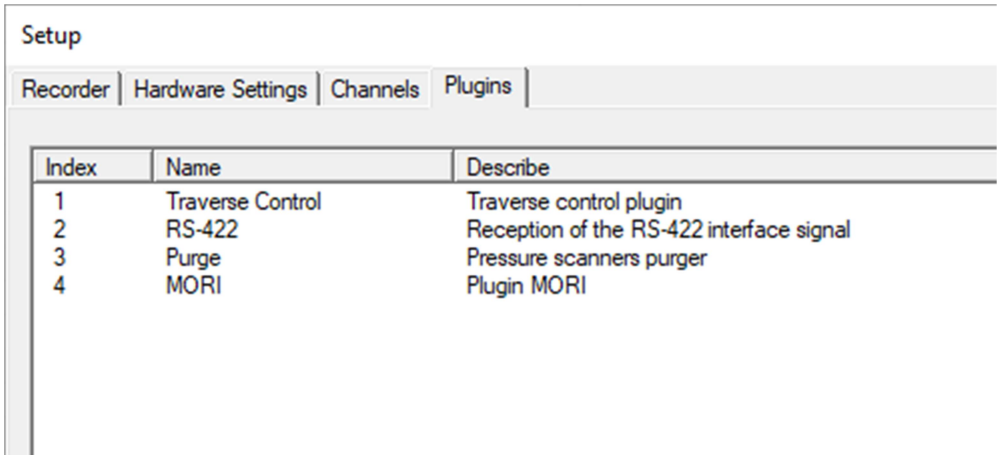
4. The Recorder program allows you to connect additional subroutines-plug-ins which are independent software modules. You can do this on the **Plugins** tab of the **Setup** window:



5. You can access the list of plug-ins and subprograms that extend the functionality of Recorder by clicking the button  , and then **Plugin Loading** window opens:

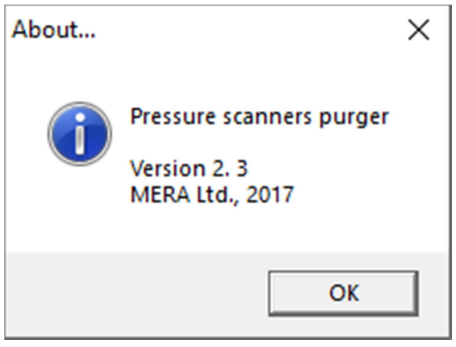


6. This window contains: the plugin file name (*. dll), the plugin name, a brief description of the functions performed, and the developer.
7. To download the plugin, select it from the list and click the **Load** button. To cancel the download of the plugins, press the **Cancel** button and close the window**.**
8. As a result of downloading, the plugin will be connected to the main program, its name and brief description will be displayed on the **Plugins** tab of the **Setup** window:

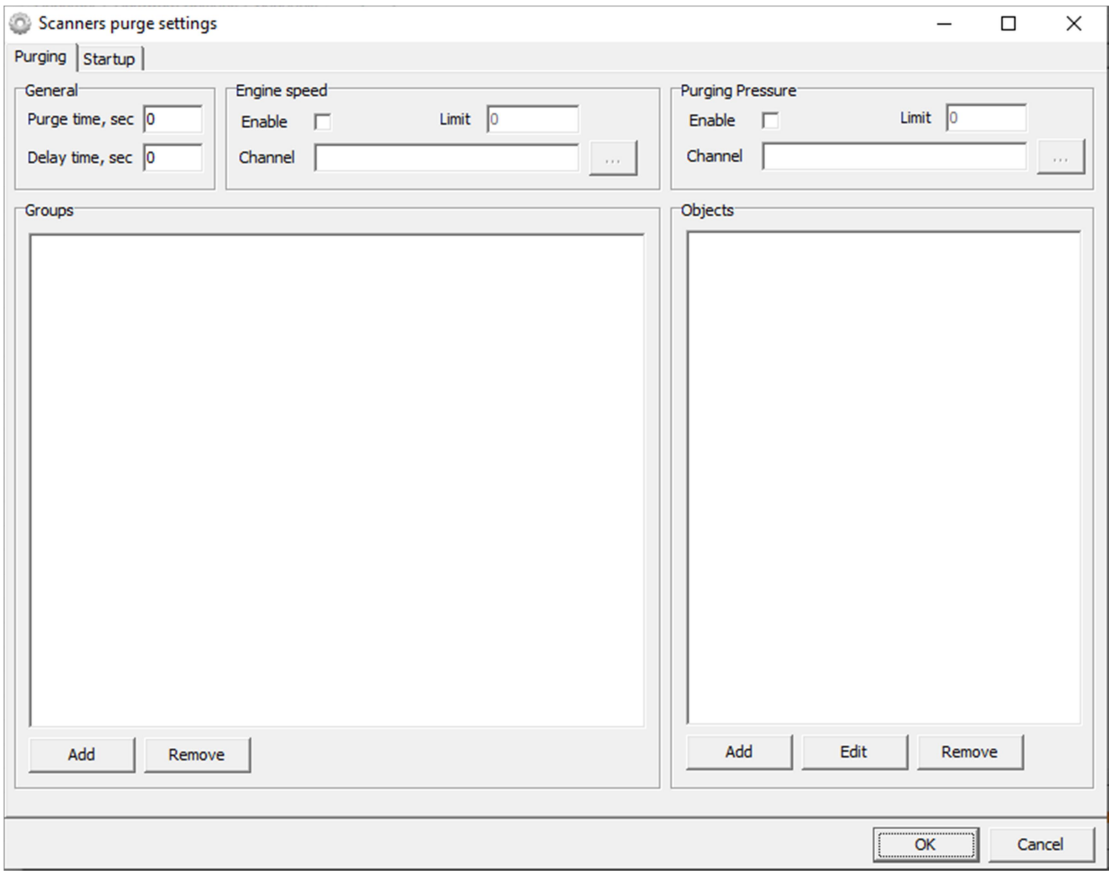


9. To view information about the plugin, select the line with the plugin name and click the button  .

Example of a window with information about the plugin:



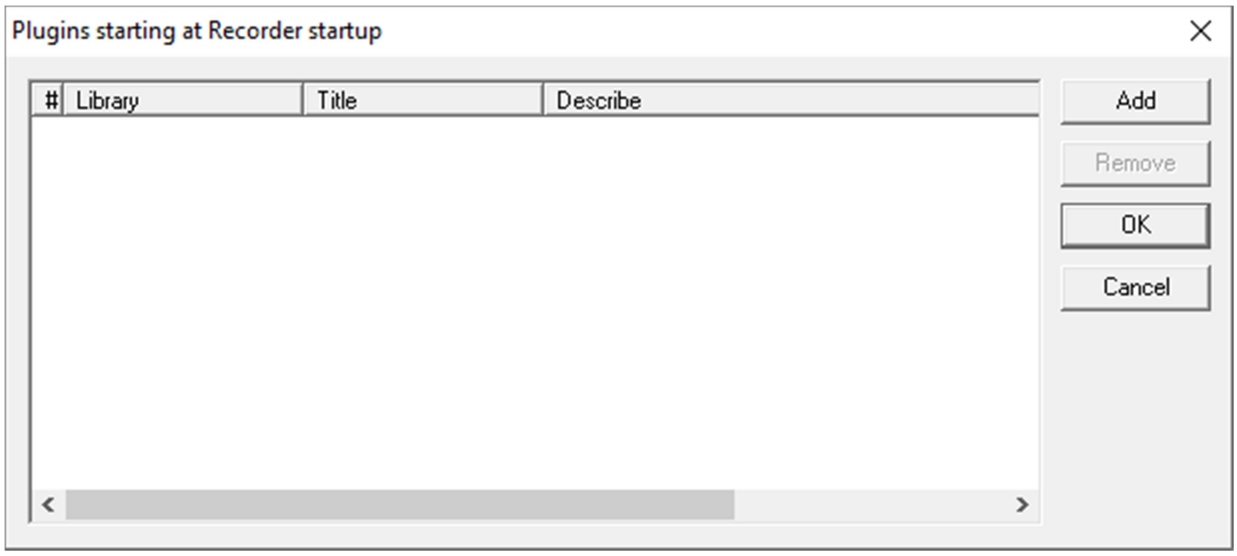
10. For those plugins that require configuration, when you select the line with the plugin name and click the button  , the **{Plugin name} settings** window opens, for example:



11. Each of the plugins has its own settings window. Configuring the most used plugins is described in section 11.2.

12. To stop working and download the plugin from Recorder, click  .

13. In order for the selected plugin to be loaded automatically when you start the Recorder program, click the button  , and then the **Plugins starting at Recorder startup** window opens with information about plugins:



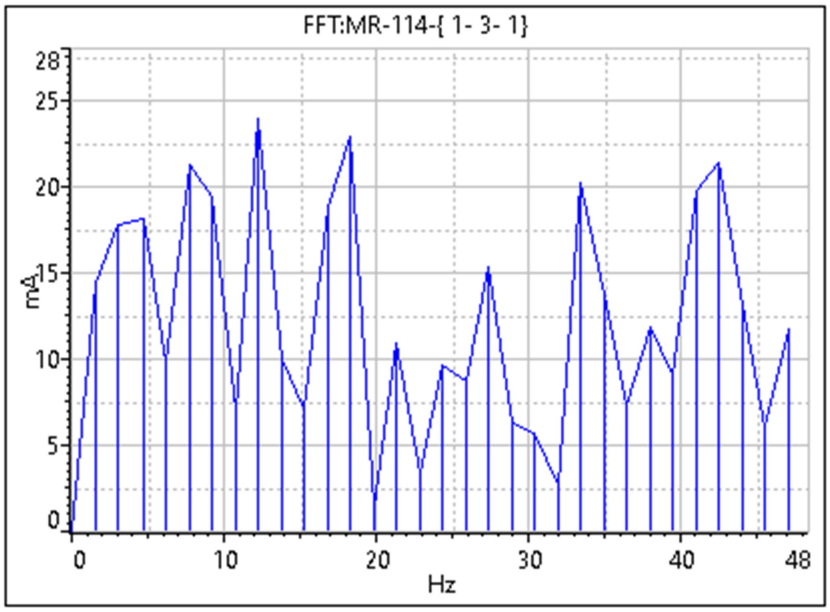
14. To add a plugin to the list of automatically loaded ones, click **Add** button. As a result, a window with a list of ready-made subprograms will be displayed on the screen. To remove a subprogram from the list of automatically loaded you need to press the **Delete**.

11.2 Standard plug-ins

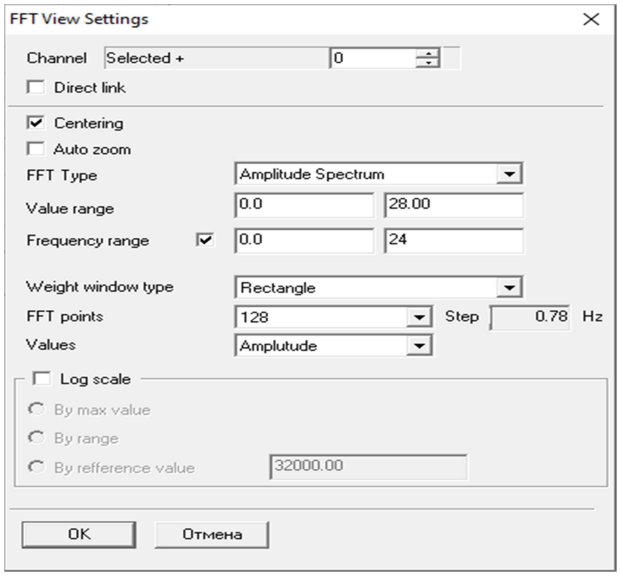
Standard plug-ins are included in the Recorder software package.

11.2.1 FFT form

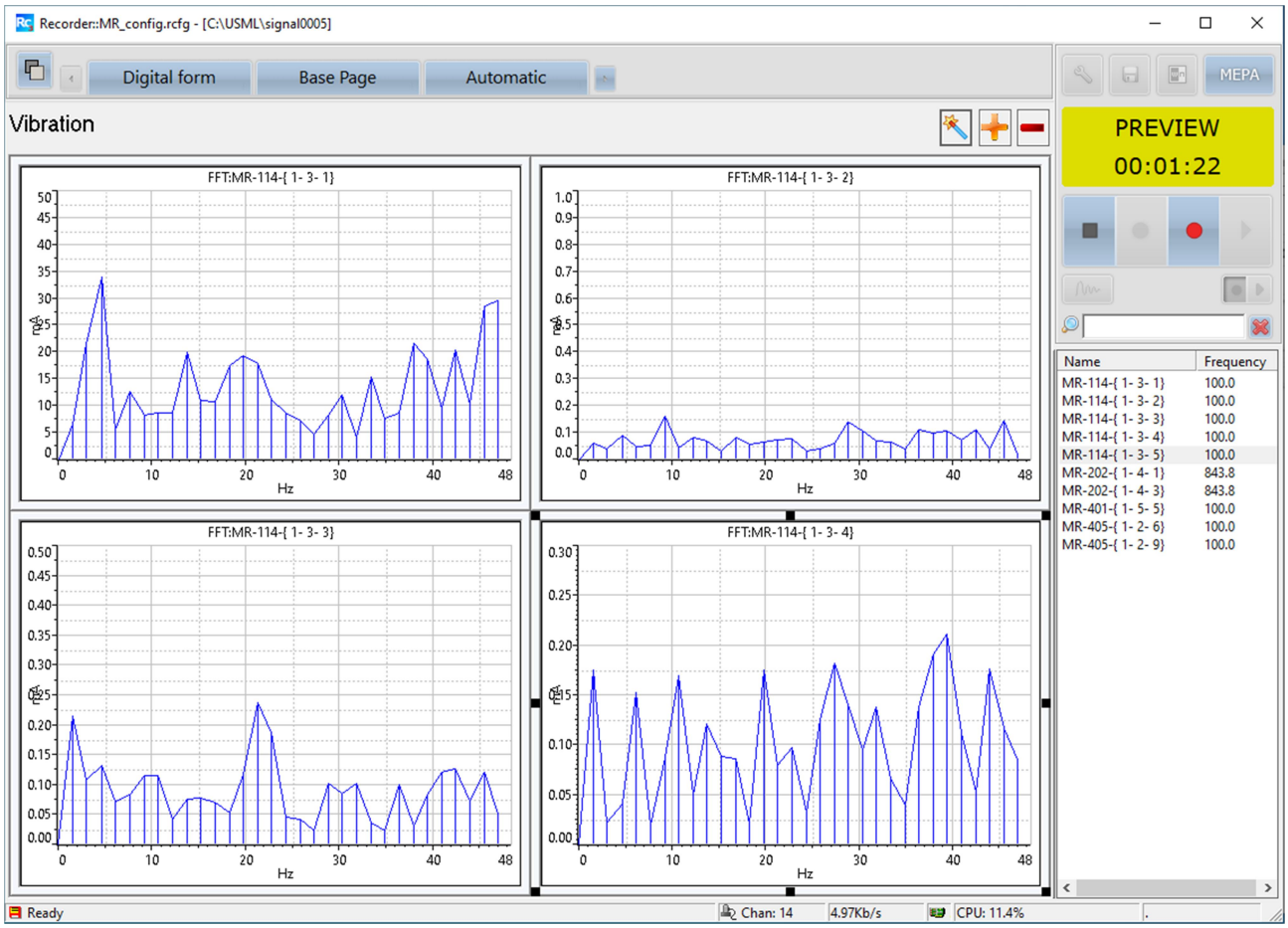
1. The **FFT form** plugin allows you to decompose the signal at the rate of the experiment into the frequency spectrum using the FFT algorithm:



2. FFT View Settings window:

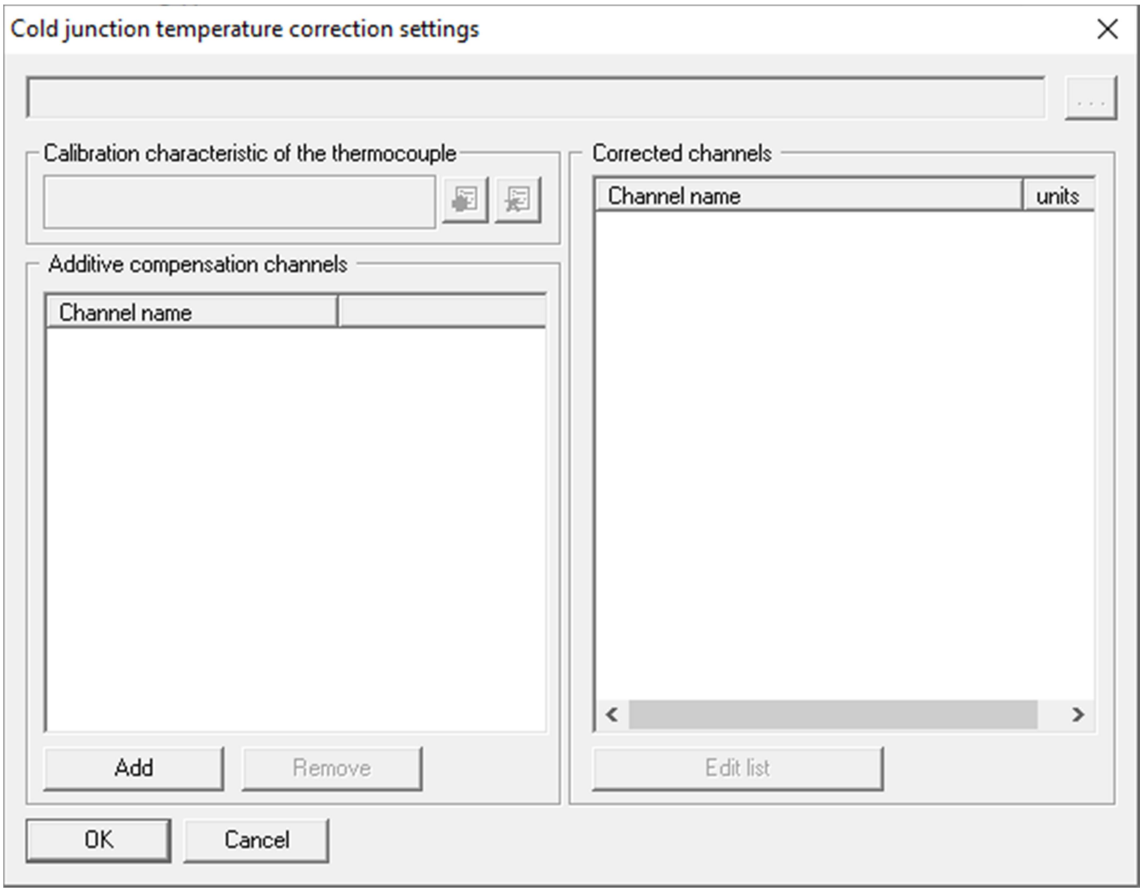


3. The plugin allows you to add spectral decomposition display graphs to custom pages. Example of a custom page with four FFT windows:

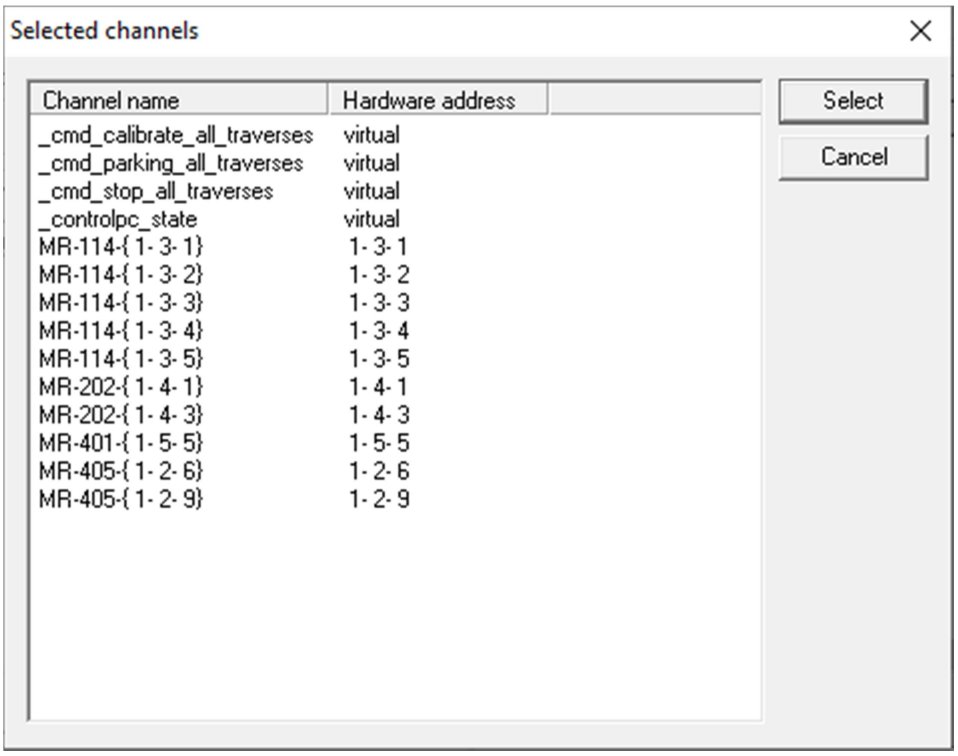


11.2.2 Cold junction temperature compensation

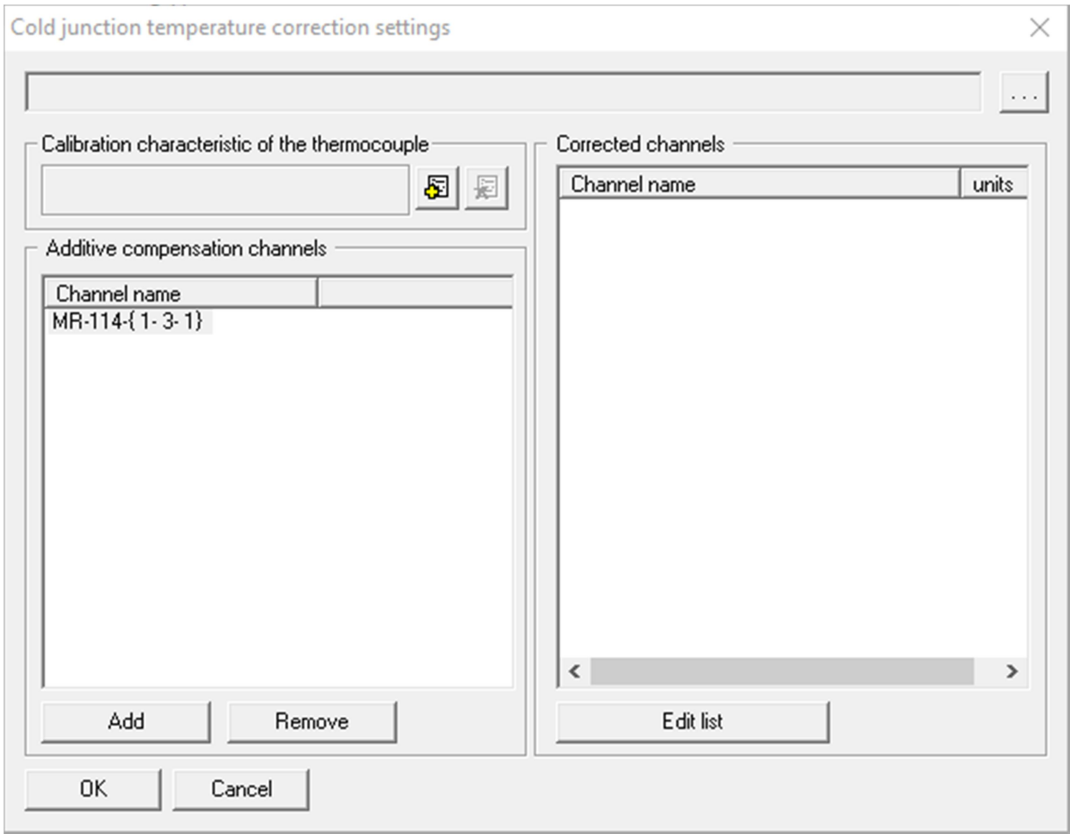
1. The plug-in allows you to perform at the pace of experiment compensation of the cold junction temperature when conducting temperature measurements using thermocouples. The settings window looks like this:



2. To configure the **Additive compensation channels** list, specify the channel to which connected the absolute temperature sensor installed at the junction point (in our case, the channel is called “At”). To select a channel, click the **Add** button and in the window that opens with the list of channels, select the channel of the module to which the temperature sensor is connected (in this case, " At”):

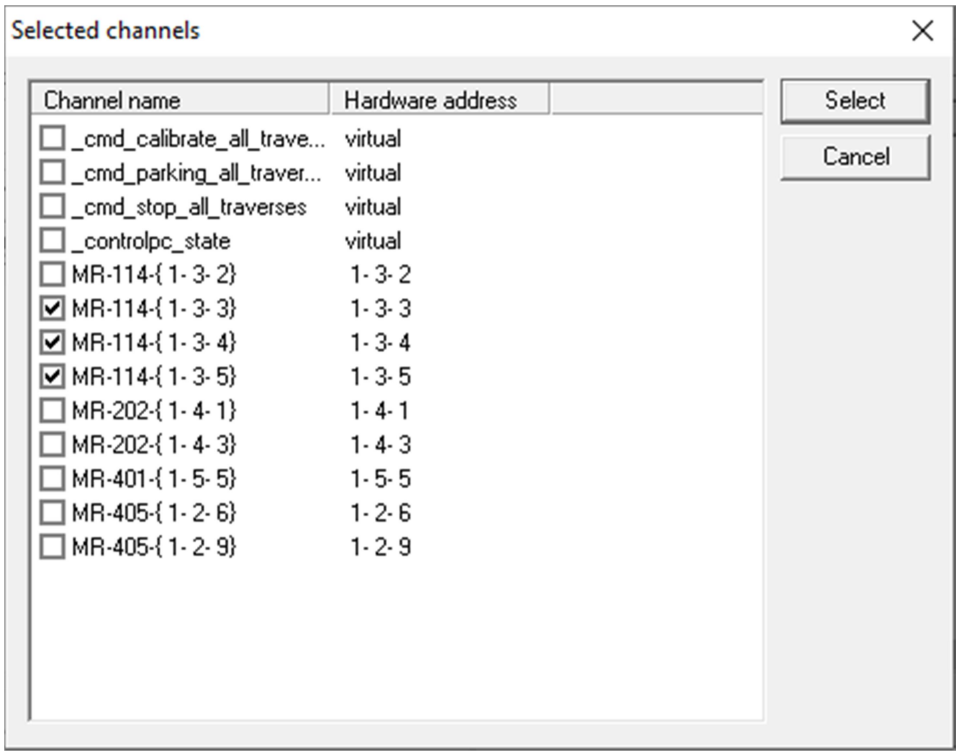


3. Then click the **Select** button, after which the window closes and the selected channel appears in the list of **Additive compensation channels:**

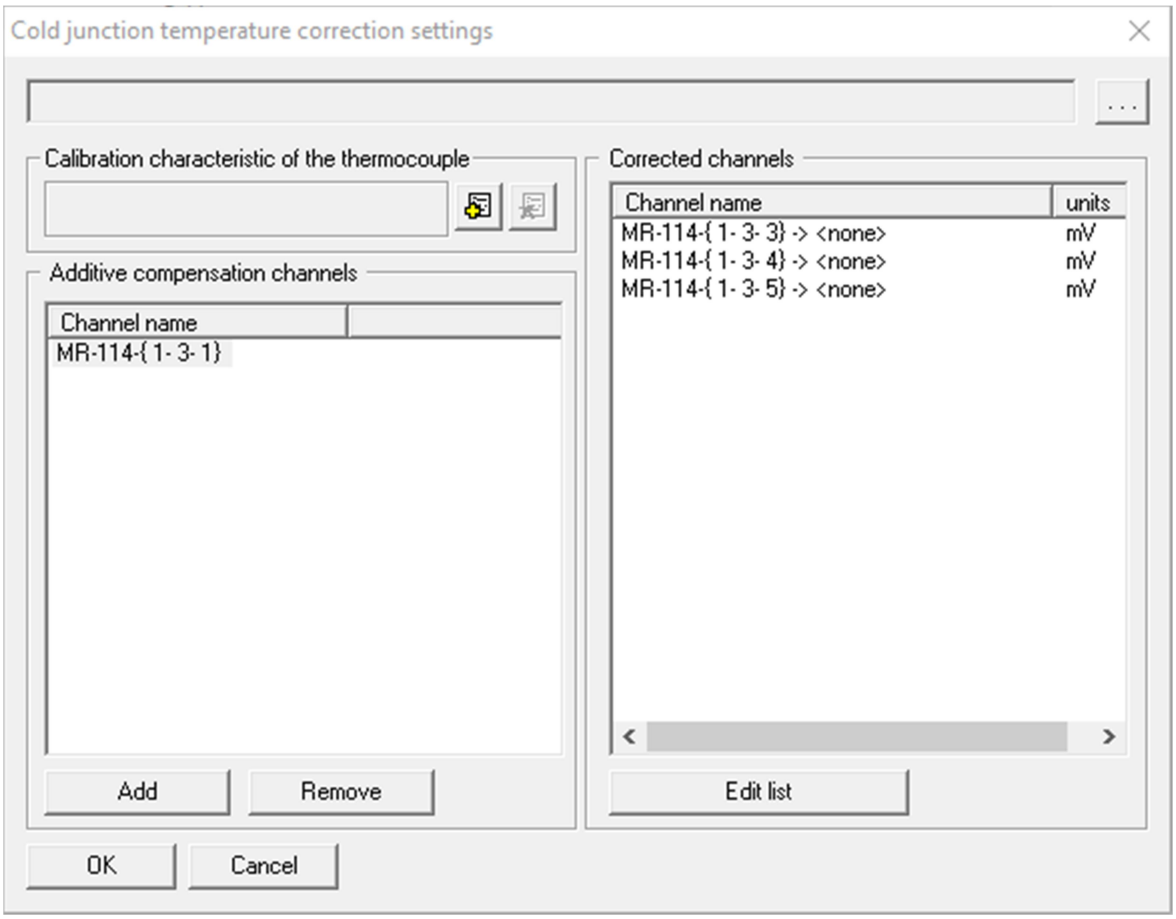


4. In the **Corrected channels** list of the plug-in configuration window, specify channels with connected thermocouples (in our case, channels of the MS-114 module) for which cold junction compensation must be performed. To do this, click the **Edit list** button. In the

window with the list that appears, mark setting flags the MS-114 module channels for which cold junction compensation will be performed.



5. Then click the **Select** button, after which the window closes, and the selected channels will appear in the list of **Corrected channels.**
6. If you need to compensate different types of thermocouples using a single channel, you should create several groups.



7. After selecting the channels, the button  in the section “calibration characteristic of the thermocouple " becomes available, which should be clicked to select the SC thermocouples connected to the compensated channels. In the window that opens for selecting the SC type, select " *Linear interpolation table*” and click Add.

8. After closing all opened windows, including the Recorder **Setup** window, channels containing the corrected data will be created automatically. These channels will have a name like: ***“<original channel name>_cor”***

9. For correct operation of the plug-in, the compensation channel must be scaled and stores data in °C units, and compensated channels with thermocouples must store data in mV (hardware CC should be connected on and channel SC disconnected).

11.3 Project File

Some of the Recorder parameters can only be configured by editing the *project file*. This file usually has the .cfg extension. When you first install Recorder SOFTWARE, a project file is automatically created with the default settings and the name recorder.cfg. During subsequent installations of the Recorder SOFTWARE, the existing file is not replaced or modified. The project file has text format, so you can edit it in any text editor, such as Notepad.

Structurally, the file consists of sections, each section begins with a name in square brackets. For example, the main section is called "[recorder]". Parameters are set by expressions like: <parameter name>=<value>. Parameter names are case-sensitive. The values of constants that enable or disable any settings are written as ***enabled*** for enabling and ***disabled*** for disabling. For example, the command that enables clearing service logs when running Recorder *ClearLogAtStartUp=enabled*. To improve the readability of the file, you can add comments to it. a comment is a string that begins with a semicolon.

Most of the parameters set in the project file do not require user intervention. However, some of them may be useful for advanced users for specialized software configuration.

The main parameters are listed below.

Section [hostdevice] **Special configuration of hardware**	
backplane_freq	MTC crate bus frequency value The default setting is 14745600
CrateClkSync	Enabling/disabling synchronization of the clock frequency for MC modules with the frequency of the crate controller. Disabled by default Enabling this option causes the digitization frequency to be recalculated for modules and may cause minor delays when starting Recorder.
Section [recorder] **Basic settings for Recorder**	
DefaultConfig	Name of the loaded configuration when starting Recorder. This field is automatically modified when loading or saving the configuration performed in Recorder. Manual modification of this field may be required in exceptional cases when starting Recorder with the existing configuration causes the

	program to crash or the system to freeze.
ReserveDiskSpace	Enabling the pre-reservation mode for data logging on the hard disk. This option allows you to save data on disk even if the system freezes. Enabling this option will significantly increase the starting time for Recorder software. For correct operation, you need to set an additional *ReserveTime* parameter.
ReserveTime	The duration of the expected registration for the function of pre-reserving hard disk space for data registration.
AutoPreviewOnStartUp	Automatically enabling *View* mode when starting Recorder
GraphForms	Permission/prohibition of the use of graphical forms. By default, it is allowed. You may need to prohibit the use of graphic forms to run Recorder on a PC with incorrectly working video subsystem drivers.
ClearLogAtStartUp	Clearing the debugging log when starting the software
UTS	Enabling Universal Time System support (UTS)
DigInCCChan	Enabling support for digital channels on the crate control modules.
Section [digital form] **Configuring digital form parameters**	
digits	Number of displayed significant digits
font_size	Font size
font_name	Font name
Section [plugins] **List of running plugins**	
plgcounter	The number of plugins that are loaded together with Recorder
plugindll[i]	Path to the library with the plugin. Where ***i*** is the plugin number starting from 0. The path can be specified either absolute or relative to the plugins Recorder directory. These fields are automatically modified when you configure the list of loaded plugins in the Recorder settings window. You may need to manually edit this section to disable plug-ins that cause the system to crash at startup.

To start Recorder with the desired project file, set the following parameters in the start command line /cfg:<project file name>. To run Recorder with different project files, you can

create shortcuts with different /cfg parameters.

12 Appendix

12.1 Appendix A. Method of measuring channels calibration

12.1.1 Requirements of the metrological evaluation program for measuring channels

1. To obtain a sufficiently accurate calibration characteristic of the channel and an adequate assessment of its error, it is necessary to conduct at least 10-20 measurements at each control point. In this case, measurements are made, starting from the minimum value of the measurement range to the maximum and back.
2. For measuring channels with non-linear characteristics, the minimum allowable number of control points is assumed to be 11, evenly distributed from the minimum to the maximum of the effective measurement range.

12.1.2 Calculation of errors

1. The estimation $\widetilde{\Delta}_{sH}$ of the systematic component Δ_s of the error of the measuring channel with variation at point *x* of the measurement range is calculated using the formula:

$$\widetilde{\Delta}_{sH} = \frac{\overline{\Delta'} + \overline{\Delta''}}{2},$$

where $\overline{\Delta'}$ and $\overline{\Delta''}$ are the average values of the error at point *x* of the measurement range obtained during the measurement process with slow, continuous changes of the informative parameter of the input signal from the smaller (for $\overline{\Delta'}$) and larger (for $\overline{\Delta''}$) values to the value *x*:

$$\overline{\Delta'} = \frac{1}{n}\sum_{i=1}^{n}\Delta'_i,$$

$$\overline{\Delta''} = \frac{1}{n}\sum_{i=1}^{n}\Delta''_i,$$

where n - is the number of implementations of the error while determining $\overline{\Delta'}$ and $\overline{\Delta''}$,

Δ'_i and Δ''_i implementations (counts) of errors obtained on *i* experimental step when changing the informative parameter, the input signal from the side of smaller and larger values to the value *x*.

2. If there is no variation, the estimation $\widetilde{\Delta}_s$ of systematic error is determined by the formula:

$$\widetilde{\Delta}_s = \frac{1}{n}\sum_{i=1}^{n}\Delta_i,$$

where n is the number of experiments while determining $\widetilde{\Delta}_s$, Δ_i - the *i*-th implementation (counting) of the error.

3. The estimation $\widetilde{\sigma}[\overset{\circ}{\Delta}_H]$ of the average square deviation of the random component of the error at point *x* of the measurement range of the channel with variation is determined by the formula:

$$\widetilde{\sigma}[\overset{\circ}{\Delta}_H] = \sqrt{\frac{\sum_{i=1}^{n}(\Delta_i' - \overline{\Delta'})^2 + \sum_{i=1}^{n}(\Delta_i'' - \overline{\Delta''})^2}{2n-1}},$$

or

$$\widetilde{\sigma}[\overset{\circ}{\Delta}] = \sqrt{\frac{\sum_{i=1}^{n}(\Delta_i - \widetilde{\Delta}_s)^2}{n-1}}, \text{ if there is no variation.}$$

4. The estimation of variation at point *x* of the measurement range is defined as the absolute value of the difference between $\overline{\Delta'}$ and $\overline{\Delta''}$:

$$\widetilde{H} = \left|\overline{\Delta'} - \overline{\Delta''}\right|.$$

5. The estimation $\widetilde{\Delta}$ of an error Δ of a particular channel at point *x* of the measurement range is defined as the highest absolute value of the measured values Δ_i' and Δ_i'', or, if there is no variation, as the highest absolute value of the Δ_i.

6. The estimation $\widetilde{\Delta}$ (also known as absolute error over the entire range) of the error of a particular channel over the entire measurement range is defined as the highest value of the error estimations at the control points.

7. The estimation of the error over the entire measurement range is calculated as:

$$\gamma = \frac{\widetilde{\Delta}}{|x_{max} - x_{min}|}100\%,$$

Where x_{max}, x_{min}- the maximum and minimum values of the range of the measured parameter, respectively.

12.2 Appendix B. USML Format (. usm)*

1. An information file of the USML type has the following structure:

Header of the information file	Table of parameter passports	Data/Information
32 bytes	58 • < number of parameters>	The size is not limited

2. The file header structure is as follows:

USML	Product Name	Test name	Test date YY.MM.DD	Number of parameters (characteristics)	Reserve field
4 bytes	8 bytes	8 bytes	8 bytes	2 bytes	2 bytes

3. Passport structure of the parameter contained in the passport table:

Parameter Name	Characteristic Name or DR	Size	Discreteness	K0	K1	The length of the array	Format	Tb	Te	Reserve
12bytes	12bytes	8bytes	4bytes	4	4	4	1	4	4	1

4. The information structure is as follows:

Array of values of the first parameter	A sign of the end of the array (FFFF)	Array of values of the second parameter	A sign of the end of the array (FFFF)	. . . . .	Array of values for the last paramet	A sign of the end of the array (FFFF)

5. General remarks

5.1. Each individual file can contain either a direct record (DR) of parameter information or parameter characteristics. Storage of DR and characteristics in one file is not allowed.

5.2. The same file can store characteristics of different parameters.

5.3. The maximum number of parameters (characteristics) in a single file is 65536.

6. The header of USML file.

6.1. The first four-byte field must contain the letters "USML".

6.2. The ***product name, test name***, and ***test date*** fields contain 8-byte character strings.

7. Table of parameter passports

7.1. The ***characteristic name*** field contains the symbolic name of the characteristic or the string "DR" if the file contains a direct record of parameter information.

7.2. The sampling step, scale coefficients K0 and K1, and the start and end times of information in the array are set in floating-point format.

7.3. Scale factors are taken into account in the following way:

$y = K1 \bullet (x – K0)$, where

x - value of a parameter or characteristic in the array;

y - converted value of x.

If K 1=0.0, scaling is not used.

7.4. The ***length of the array*** is an unsigned integer.

7.5. The **format of the value** field is 1 byte and may contain the following values:

The Format Field	Length	Format	Analog in C	Analog in Pascal
1	1 byte	integer	unsigned char	byte
2	2 bytes	integer	short	integer
3	4 bytes	integer	int	longint
4	4 bytes	floating-point	float	single
8	8 bytes	floating-point	double	double

8. Arrays of parameter values (characteristics) follow the order of their passports in the passport table. The number of bytes occupied by each value is determined by *the* ***format of the value*** field in the passport.

*12.3 Appendix C. MERA format (USMLext *.mera)*

1. The MERA data recording format is an extension of the USML format. However, it lacks some of the limitations of the specified format and provides more convenient access to both parameters and the descriptor. The MERA format is characterized by a different representation of data on physical storage medium: instead of a single file in the USML format (with the *.usm extension), data in the MERA format is distributed across several files (with extensions that define the data type). It is desirable to allocate different directories on the disk for different records of the MERA format, since parameters with the same names cannot be stored in the same folder, but this is not a requirement if there are no parameters with the same name.
2. List of files by data type :

The name of the test.mera	- test information and list of parameters
Parameter name1.dat	- the actual binary data of the parameter
Parameter name1.x	- binary data for the X axis (only if there is an uneven step)
Name of sc.tx	- file(s) of scaling characteristics, connected using links

3. The ***.mera** file has the syntax of a standard *ini*-file: [section], field=field value, ";" – comment. Any field can be skipped, then its default value is taken.

Fields in the **[MERA]** section - file header (example with a list of fields):

[MERA]	- file signature
Test=TestName	- test name
Prod=ProductName	- product name
Date=03.02.01	- test date
Time=12:34:45.789	- test time
;LinkAll=TRUE	- flag that allows all *.dat files in this directory to be considered as parameters (if LinkAll=TRUE). However, all fields for these parameters are filled in with default values. If this flag is missed, commented out, or LinkAll=FALSE, only the parameters whose names are in the *.mera file are enabled

4. For each parameter in the ****.mera*** file, there is a **[parameter Name]** section (example with a list of fields):

[{16-1}-M2408]	- parameter name
Char=N/V	- characteristics name ("NV", "FRF", "spectrum»,…)
Comment=Test: Test1	- signal comment
StartTime=01:02:03.045	- time to start recording the parameter, by default: Time(from header) + Start(sec.)

XUnits=sec.	- dimension on the X-axis, by default: "sec.“
YUnits=mV	- dimension on the Y-axis
ZUnits=mA	- dimension on the Z-axis (for 3D parameters)
ZStep=1	- Z-axis step (for 3D parameters)
Start=0	- the start time (the initial value of X) , by default: 0
Step=3.125e-005	- discreteness, by default: 1
Freq=32000	- frequency, by default: 1
k0=0	- the coefficients of the linear transformation, if not specified: k0=0, k1=1
k1=0.038	
XFormat=int	- the format of the data on the X-axis, by default: int
YFormat=double	- the format of the data on the Y-axis, by default: int
maxY=11172	- maximum value of Y
minY=-14358	- minimum value of Y
TX0=calibration.tx	TX files (must be located in the same folder). If k1 and k0 are specified, the linear transformation is performed first. If TX1=,TX2=,...,TXN= are specified, scaling(s) will be applied sequentially.

5. **IMPORTANT!** It is not necessary to specify all the fields of the .mera file, however, it is desirable to specify the **XFormat** and **YFormat** fields, because they determine how the data file will be interpreted. The values of these fields:

`byte`	- signed 8-bit integer
`int`	- signed 16-bit integer
`int32`	- signed 32-bit integer
`single`	- Single-Precision Floating Point
`double`	- Double-Precision Floating Point

6. The file *.**tx** contains the coefficients of the polynomial, or nodes of interpolation. It can be one of two types:

x0 y0 x1 y1 x2 y2 ….	- piecewise linear transformation.
k0 k1 k2 …	- polynomial. The number of coefficients corresponds to the degree of the polynomial, i.e. k0, k1-linear transformation, k0,...k7-polynomial of the 7th degree, etc.

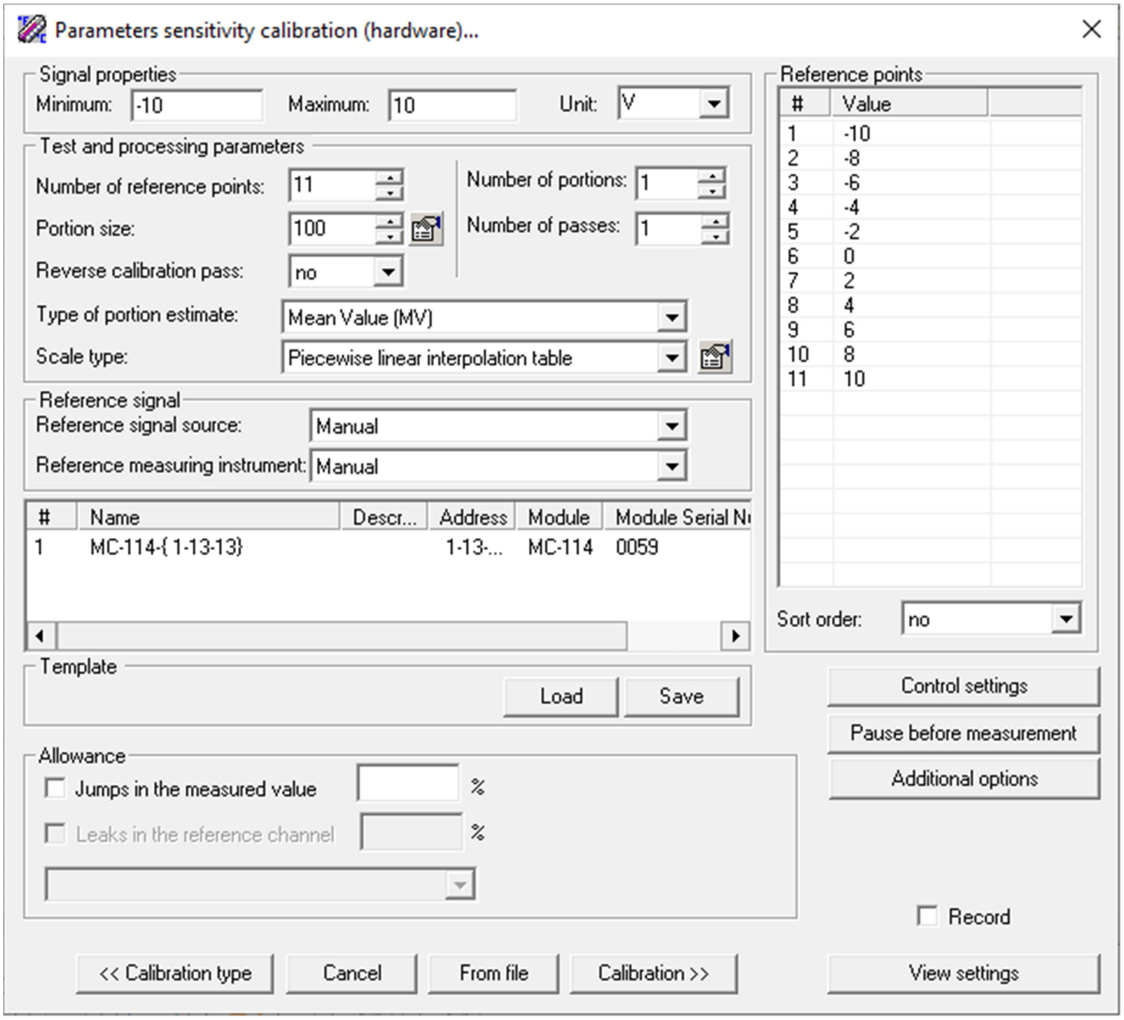
7. Recommendations for programmer’s usage

It is convenient to use the functions **`GetPrivateProfileString()`** and **`WritePrivateProfileString()`** to access header information and parameter information. See the corresponding MSDN articles.

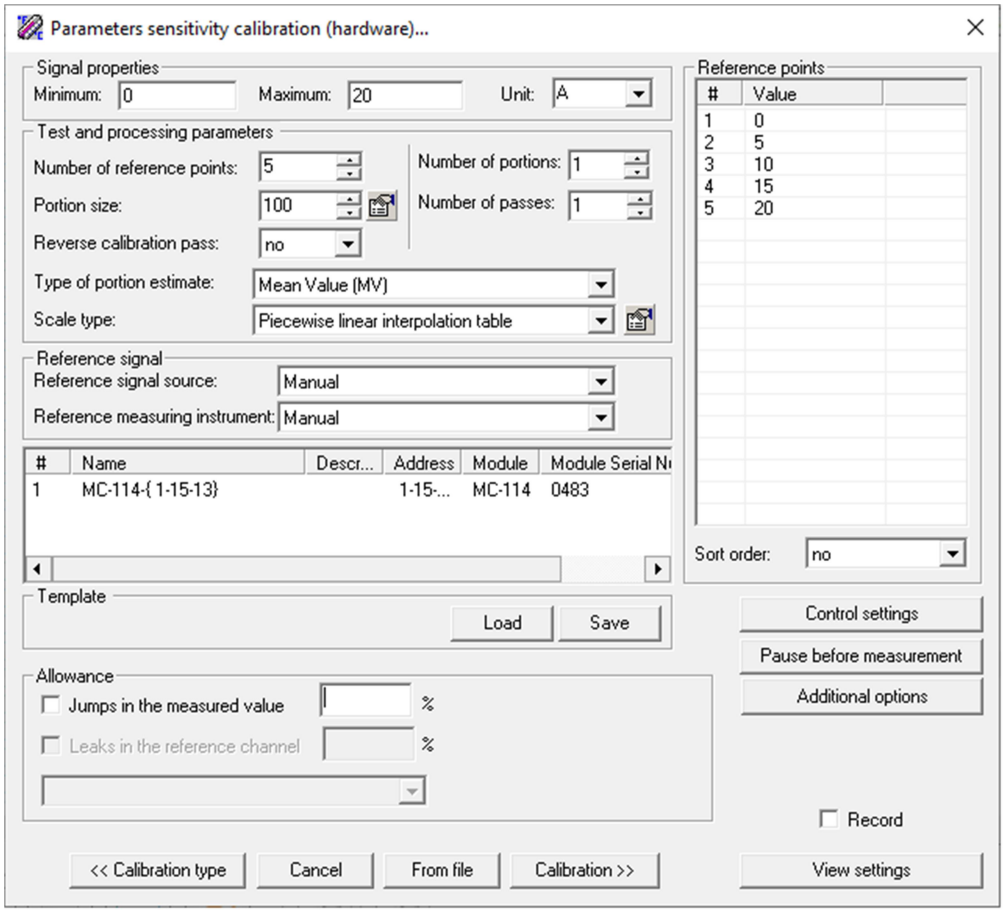
12.4 Appendix D. Examples of configuring calibration parameters

(for some types of measuring modules)

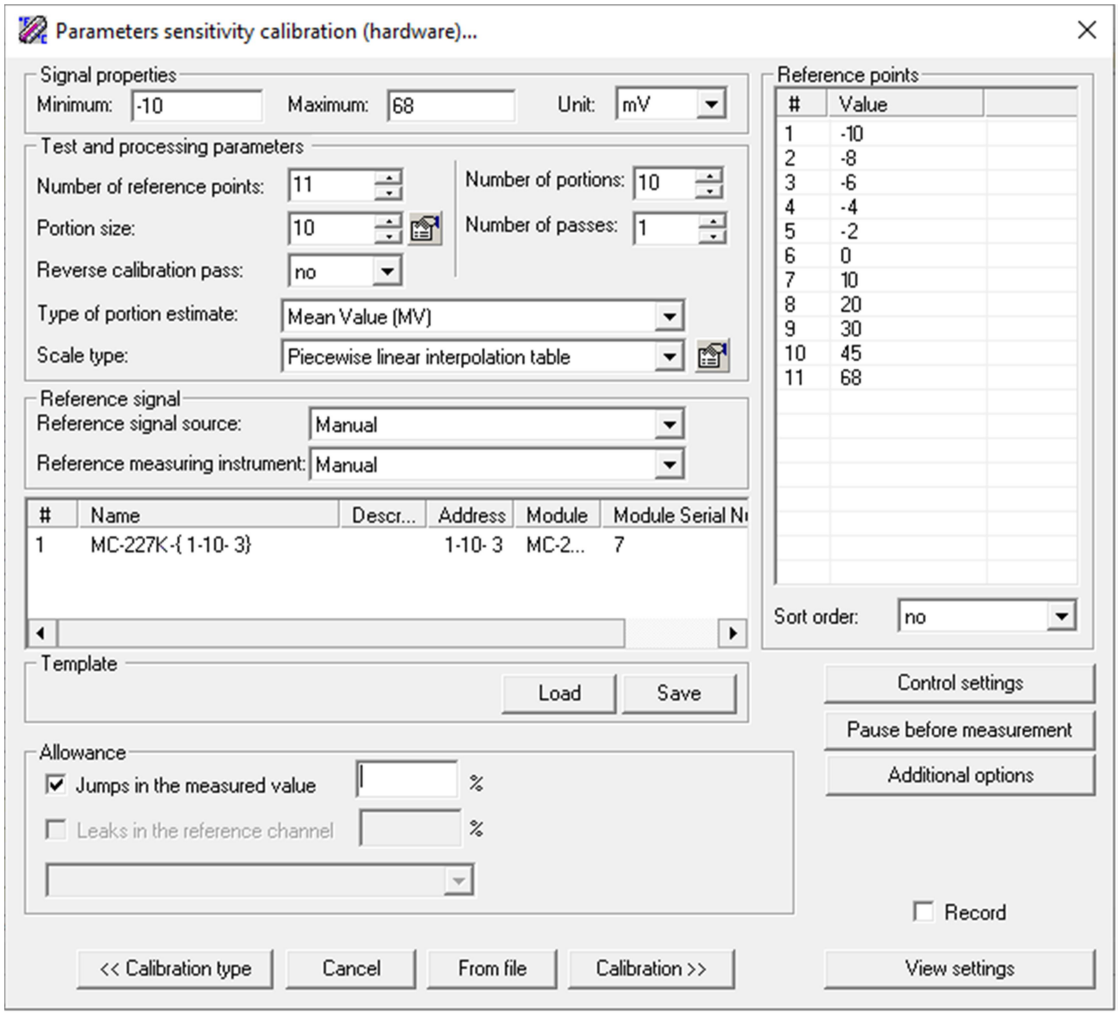
MC-114 module (calibration range -10...+10 V):



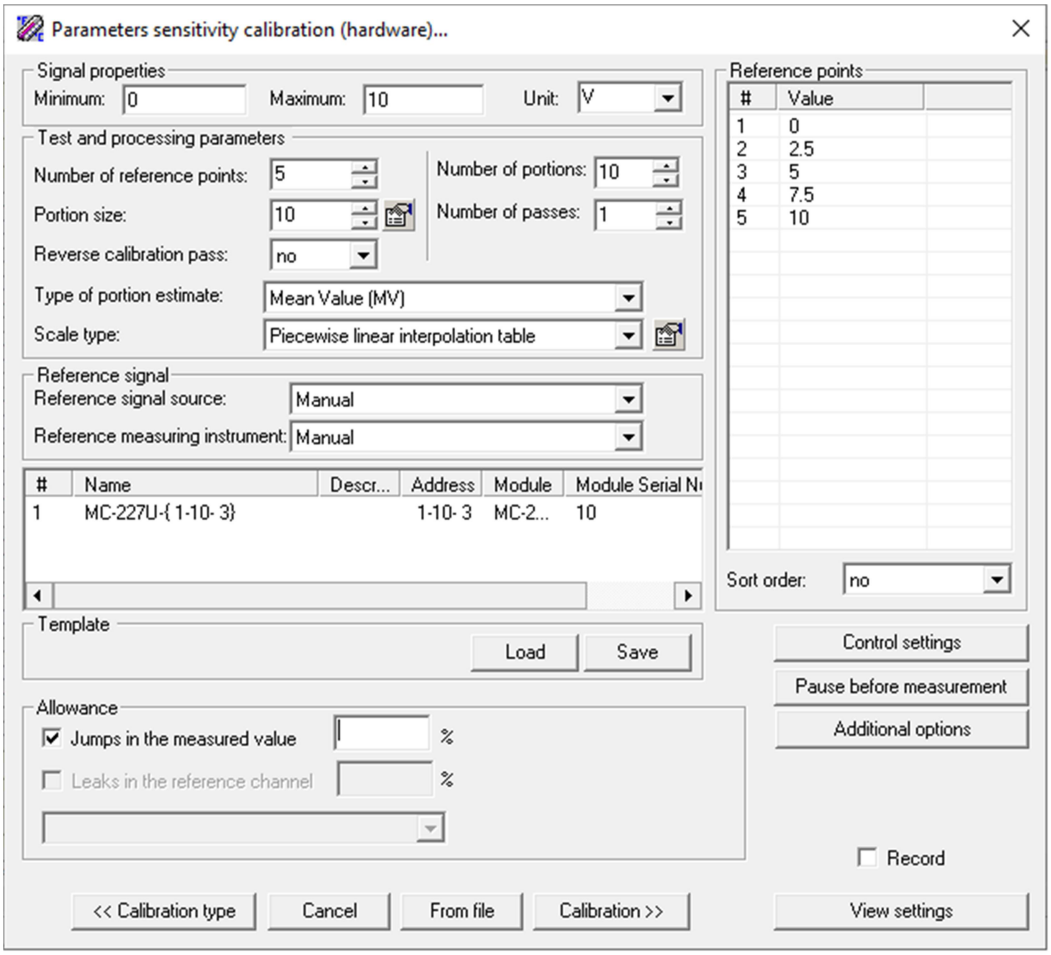
MC-114 s module (0.20 mA range calibration):



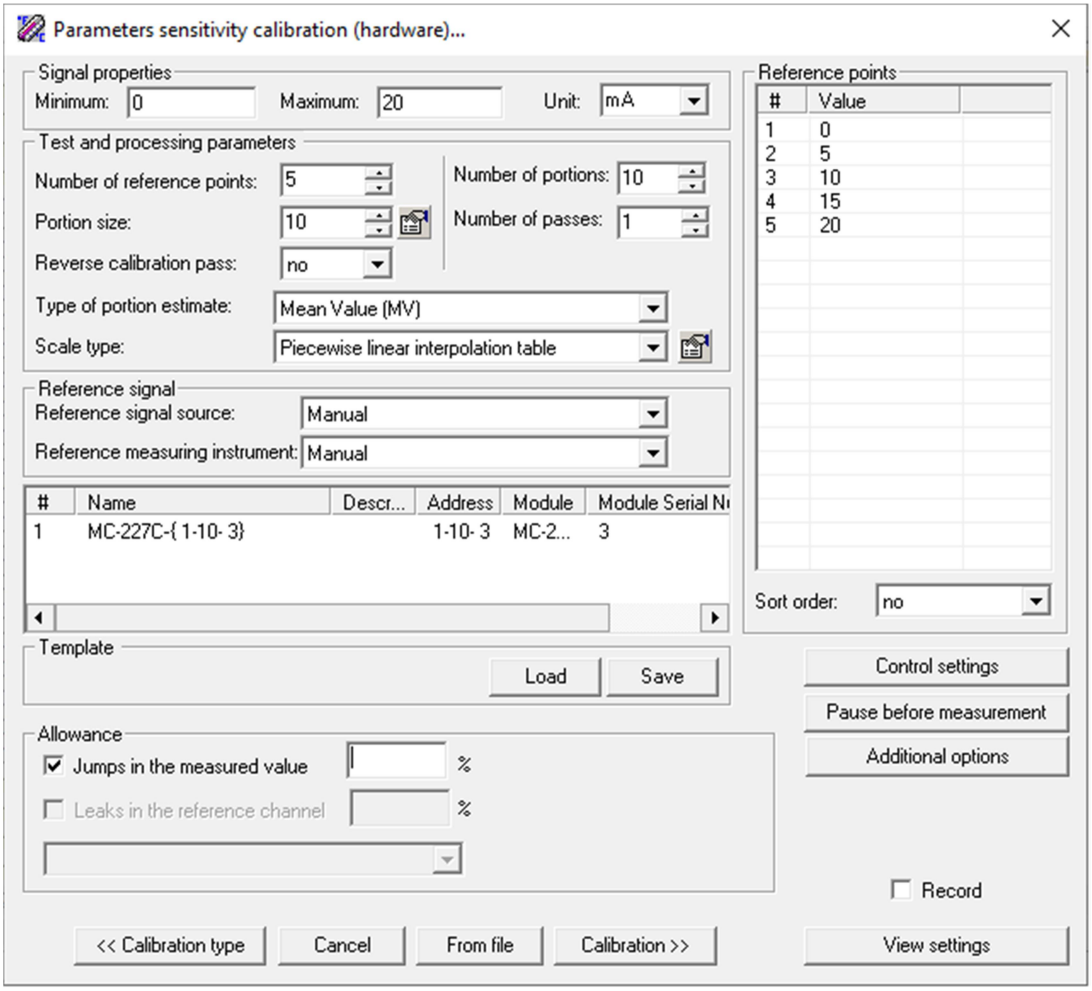
MC-227K module (calibration range -10...+68 mV):



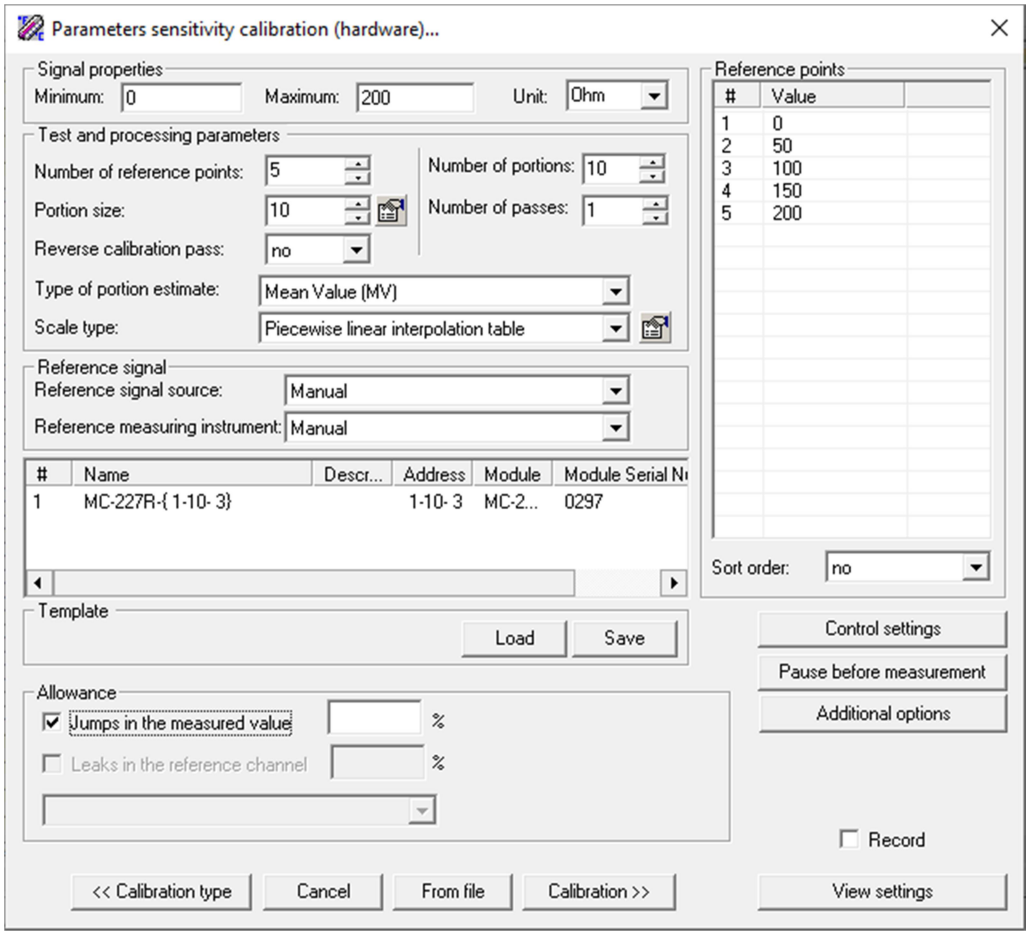
MC-227U module (calibration range 0...10 V):



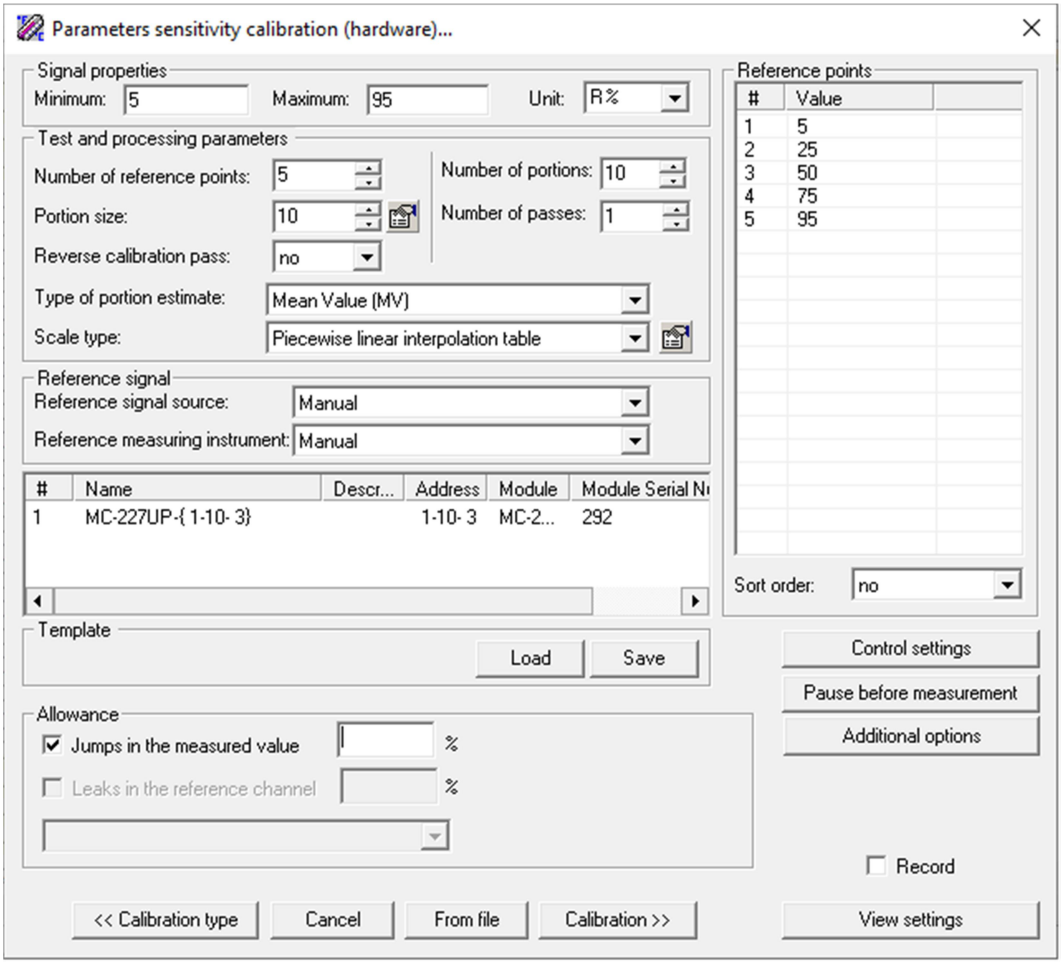
MC-227 C module (0.20 mA range calibration):



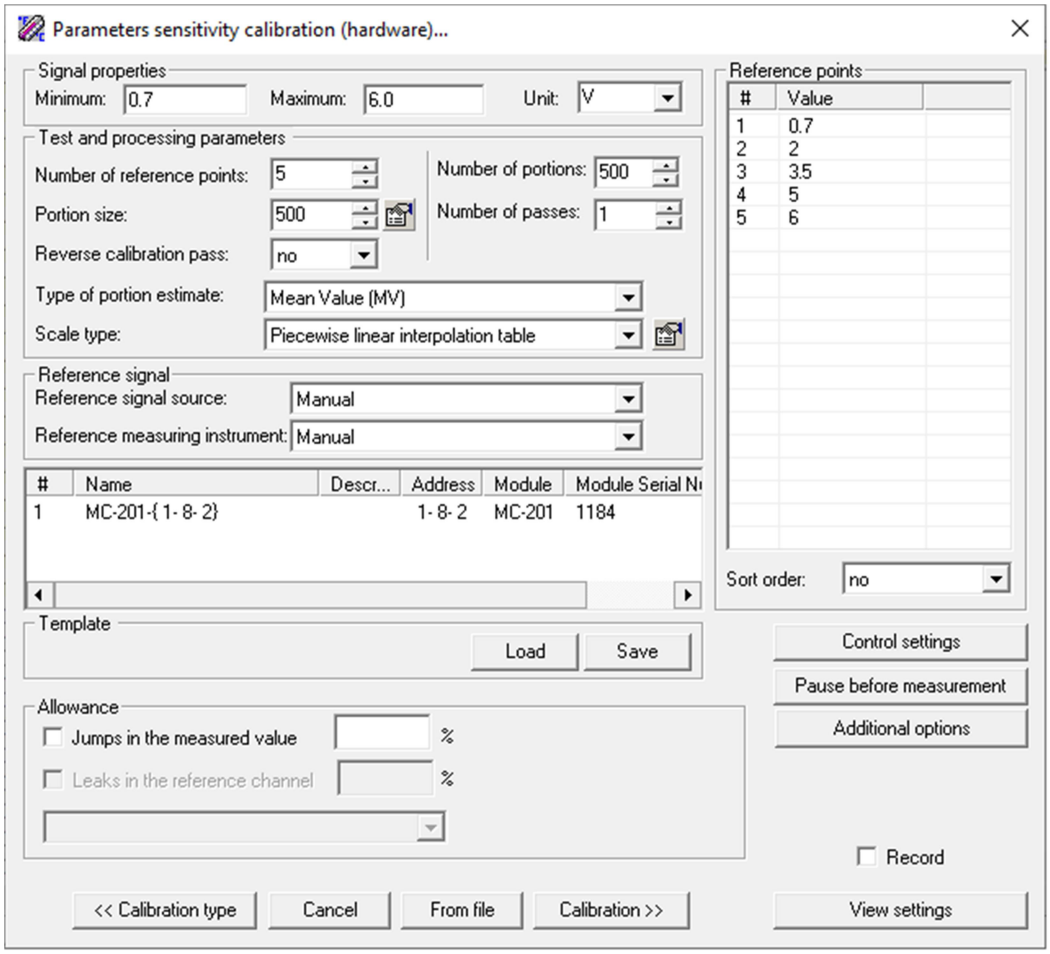
MC-227R module (calibration range 0 ... 200 Ohms):



MC-227UP module (relative resistance):



MC-201 module (dynamic calibration with variable signal):



12.6 Appendix E. Possible malfunctions and methods of their elimination

The Recorder program freezes when trying to access an external device.	Check the communication lines with the external device (for example, MIC-036). Check the power connection on the device. Turn the device off and on.
On the Recorder status display panel the symbol  is lit	Check the correct paths for registering data. Reset the device Restart the computer.
The Recorder cannot connect to an external device	If the device was turned off while Recorder was running and turned on again, restart the Recorder. Check the communication lines with the external device (for example, MIC-036). Check the power connection on the device. Turn the device off and on.
Time discrepancy of synchronous data recorded by several devices under the Recorder control (when using UTS)	Make sure that the option to sync the tactile generator modules with the crate controller is enabled. This option is enabled by adding a line: `CrateClkSync=enabled` in section `[system]` of recorder.cfg file