

Calibrator of digital streams

MarsGen-61850

USER MANUAL

MC2.211.502 UM

Software “Synthesizer of Electrical Energy Signals for MarsGen-61850”

User Manual

2021

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A.1 System requirements

The Synthesizer of Electrical Energy Signals for MarsGen-61850 (Signal Editor or the Program below) works under operating MS Windows 7 or higher (32- or 64-bit architecture, the operating system must support the Cyrillic alphabet).

The system requirements are as follows:

Processor	Intel(R) Core(TM) i5-7500 CPU @ 3.40GHz
RAM	8,00 Gb
System type	64-bit operating system, x64-based processor
Hard disk	1Tb
Monitor	19" LED 1920x1080.

A.2 Installation

1. Insert the USB flash-drive with the Signal Editor installer on it into your PC.
2. Close all working Windows applications.
3. Launch the file **Install Signal Editor.exe**.
4. The Installation screen appears.
5. Click **Next**.
6. Check **I accept the License Agreement** and click **Next**.
7. Check **I accept the License Agreement** and click **Next**.
8. Uncheck "**Disable Windows fast startup...**" and click **Next**.
9. The list of the components being installed appears. Click **Next**.
10. Installation of the program starts.
11. Installation is complete. Click **Next**.
12. Click **Restart** in the next window. *Your computer will restart.*
13. The Signal Editor icon will appear on the desktop.



Fig. 2.1 Signal Editor icon

Once you have successfully performed all previous steps, the Program is ready to operate.

A.3 Removing Signal Editor

To remove the Program from your PC, open the Windows Control Panel, select “Add/Remove Programs”, and then select the “Signal Editor” item.

A.4 Operation

A.4.1 How to launch the Program

There are 3 ways to launch Signal Editor:

- Via any Windows file manager: open the file “Signal Editor.exe” in the folder where the Program was installed (C:\Program Files\Signal Editor is the default path)
- Click twice on the icon “Signal Editor” on the desktop
- Select “Signal Editor” in the Start menu.

The Program has a standard Windows-based user interface. Program settings are read from configuration files on each start-up. The configuration files contain information about the last-used settings:

- Interface settings
- Communications settings between the PC and calibrator MarsGen-61850: IP address, communications port, connection timeout, and serial number of the calibrator MarsGen-61850 (the Calibrator below)
- Stream generation data.

On starting the Program, it automatically scans communications ports and detects the connected Calibrator. The associated tab at the upper part of the window contains an indicator showing communications status: “Connected” (if the data exchange was correct and successful) and “Not connected” in case of no data exchange or an error. In this case, it is necessary to check the communications settings in the “Network settings” menu, and then click the “Reconnect” button.

A.4.2 Main window

The main window is conventionally divided into several areas: a menu bar, signal editor control tab consisting of the “Synthesizer” and “Synthesizer results” areas, and the “Calibrator” tab used to control the Calibrator.

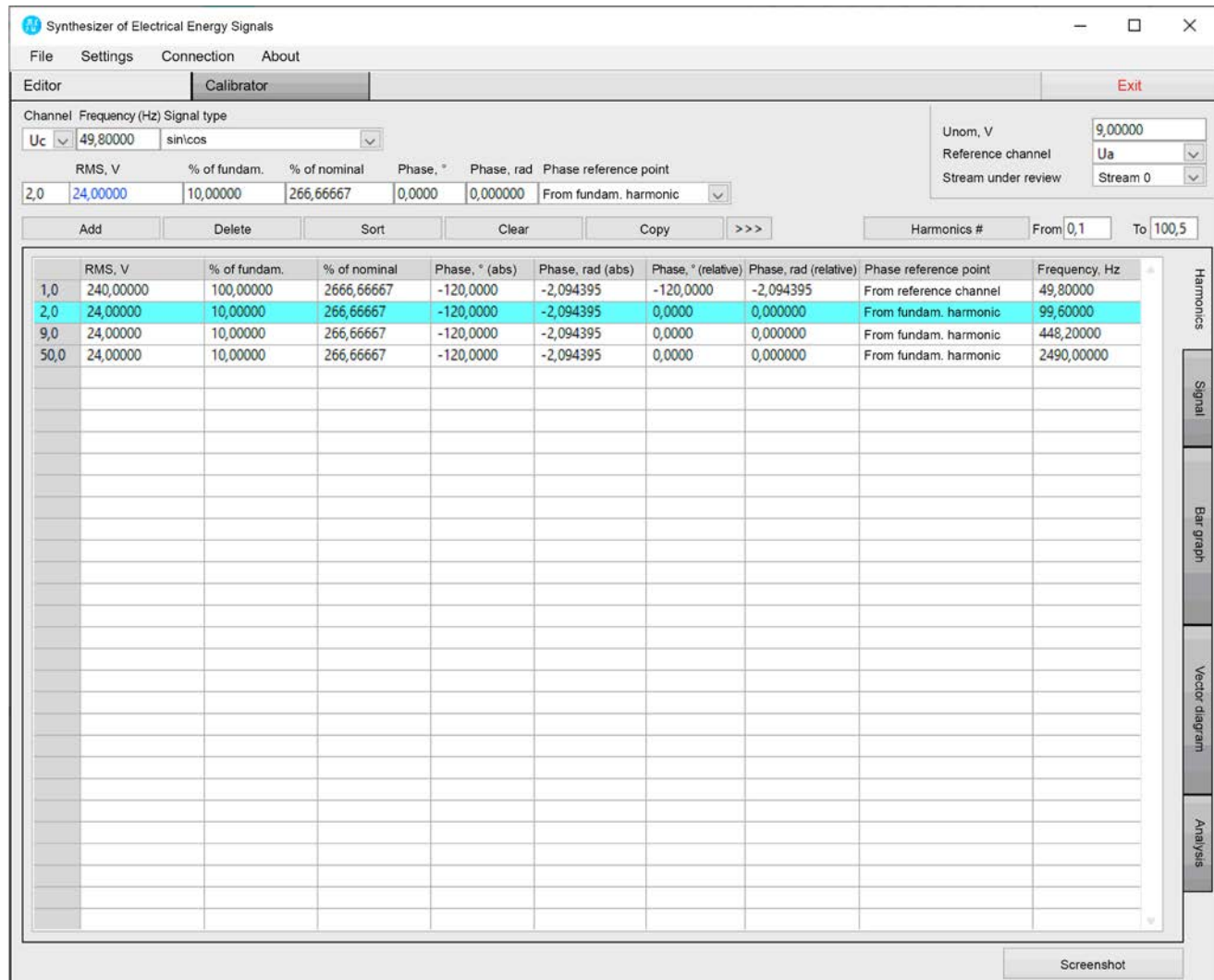


Fig. 4.2 Main window of the Program

A.4.3 Main menu

The menu bar located at the upper part of the Main window provides quick access to the basic functions of the Program.

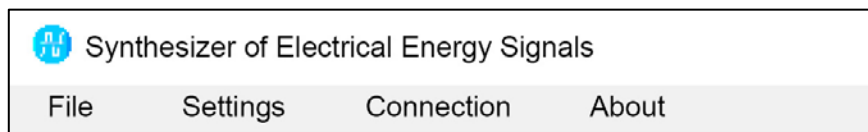


Fig. 4.3.1 Main menu of the Program

A.4.3.1 “File” menu

The menu contains file management commands: “Load”, “Save”, and “Export” used to call up the corresponding dialog boxes. If the data to be exported or saved are absent, the associated options are inactive.

- Load – loads a signal (synthesized in accordance with the pre-specified signal settings) from the selected *.sgn file to the currently active stream
- Save – saves the settings of a synthesized signal selected from the active stream to a *.sgn file
- Export – adjusts the settings of a synthesized signal selected from the active stream and exports it to a *.xlsx file or a *.txt file.

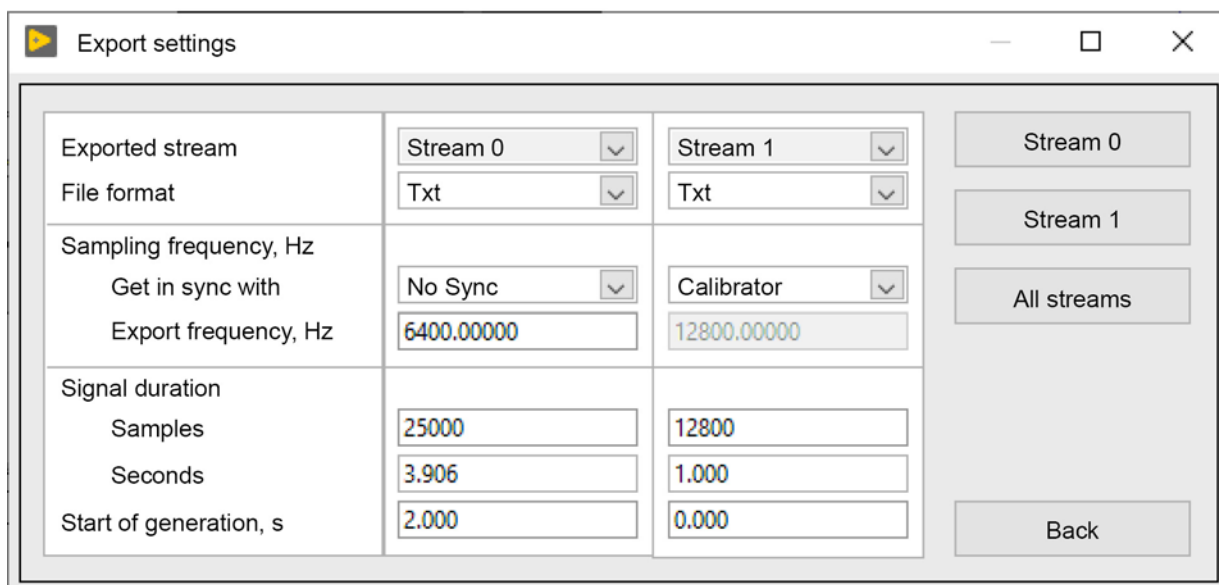


Fig. 4.3.2 “Export settings” dialog box

- o File format – used to select the format of the target file (*.xlsx or *.txt)

The “Sampling frequency” panel options:

- o Get in sync with – makes it possible to select the source for synchronizing the sampling frequency of the exported signal: with the frequency of the connected Calibrator or with the “Signal Editor” frequency. The “No sync” option allows you to specify the sampling frequency of the exported signal manually.
- o Export – the field is used to set and display the sampling frequency of the exported signal

The “Signal duration” panel options:

Samples – specifies the duration of the exported signal in the number of samples

Seconds – specifies signal duration in seconds (considering the predetermined value of sampling frequency)

- o Start of generation, s – specifies the time when generation of the exported signal starts.

A.4.3.2 “Program Settings” menu

The options make it possible to specify the settings for signal generation and to adjust editor interface.

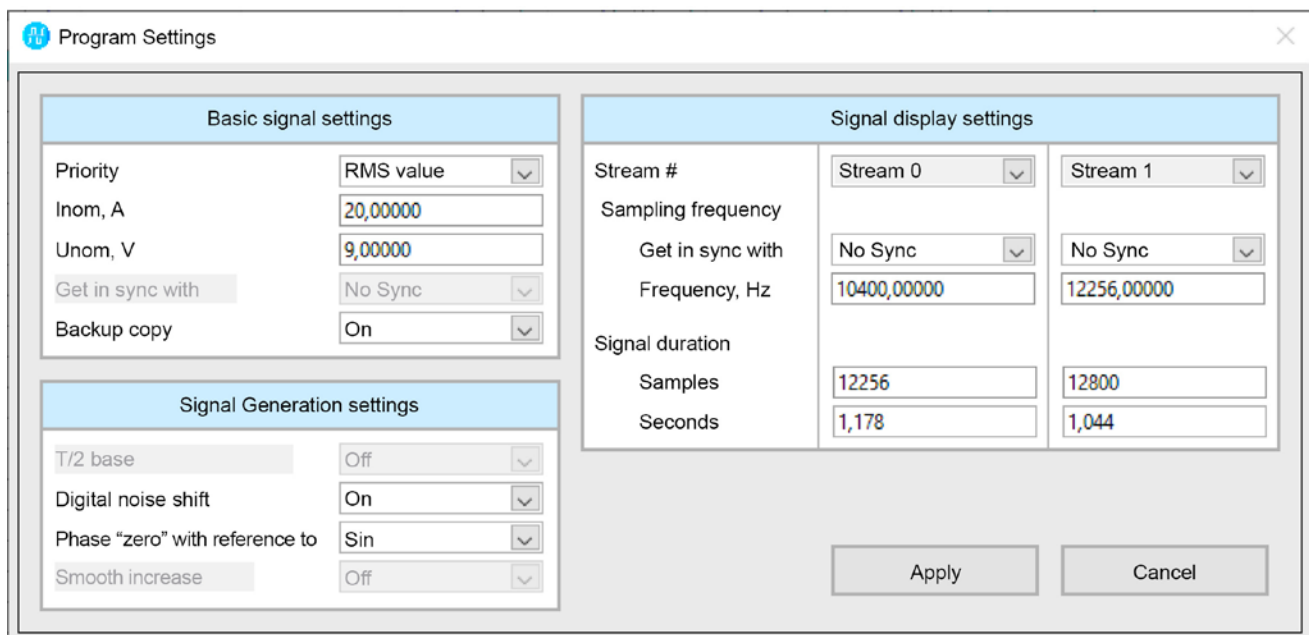


Fig.4.3.3 “Program settings” dialog box

Basic signal settings:

- Priority – sets the main parameter used to calculate/recalculate RMS values of signal components (harmonics)
- I_{NOM} , A – nominal value of current used to calculate the parameters of individual harmonics
- U_{NOM} , V – nominal value of voltage used to calculate the parameters of individual harmonics
- Backup copy – enables/disables the function of saving the last used signal generation settings.

Signal generation settings:

- Digital noise shift – when enabled, sigma-delta modulation is applied to the generated signal
- Phase “zero” with reference to – sets zero position for the phase angle of the generated signal with reference to sin or cos

Signal display settings:

- Get in sync with – when enabled, the sampling frequency is automatically set in accordance with the settings of the connected Calibrator

- Frequency, Hz – displays the sampling frequency of the signal selected in the active stream
- Signal duration – number of samples in the exported signal (may be specified in seconds considering the pre-specified value of sampling frequency).

A.4.3.3 “Connection” menu

The menu contains the list of available Calibrators. While in this menu, you can switch over the instruments, or use the Program in the “Editor” mode.

A.4.3.4 About

This option opens a pop-up window containing the information about the manufacturer and software version. Clicking on the manufacturer’s logo opens the manufacturer’s home page.

A.4.4 Signal synthesis

The “Synthesizer of Electrical Energy Signals” software provides the user with the tools for managing signals belonging to 2 independent streams. Each signal includes 8 waveforms (which are also called “phases” or “channels”): 4 current phases and 4 voltage phases. Each phase (channel) contains a waveform characterized by its fundamental frequency, by a number of additional settings (which determines signal type) and by harmonic components (harmonics) up to 1050 (including subharmonics and interharmonics).

Fig. 4.4.1 Area dealing with signal synthesis settings

Panel 1 – settings of a stream:

- I_{NOM} or U_{NOM} – nominal value of the active signal used to specify signal settings
- Reference channel – the option is used to select a signal (event) whose phase will be taken as a reference channel (phase)
- Active stream – used to select an active stream (0 or 1).

Panel 2 – settings of a channel (phase):

- Channel – active channel
- Frequency, Hz – fundamental frequency
- Signal type (sine wave, triangle wave, saw-tooth, ramp (which is the reverse of saw-tooth), rectangle (pulse), phase control, subharmonics, even harmonics, flicker, dips, swells, and noise)
- Additional settings depending on signal type.

Panel 3 – settings of harmonics:

– order of a harmonic (subharmonic or interharmonic)

RMS, A (RMS, V) – RMS value of the active harmonic

% of fundamental – RMS value of the active harmonic in % of fundamental (1st harmonic)

% of nominal – RMS value of the active harmonic in % of the nominal value

Phase, ° – Phase in degrees

Phase, rad – Phase in radians

Phase reference point – the option determines synchronization type for channels (with reference to: start of generation, or reference signal (for the 1st harmonic), or fundamental harmonic (for other harmonic components), or with reference to a voltage channel (for the channels of current).

All dependent parameters are recalculated automatically. For example, absolute values of amplitude are automatically recalculated to relative (% of fundamental, % of nominal and vice versa). The current list of active harmonics is represented in the corresponding table.

Toolbar 4 – contains buttons for managing harmonic components (harmonics, subharmonics and interharmonics):

- Add – a harmonic with the displayed settings is added to the active channel of the active stream
- Delete – a selected harmonic is deleted from the active channel of the active stream (if the harmonic of the given order (#) is absent in the selected channel, the Program will delete the last harmonic in the list
- Sort – the list of harmonics is arranged in order of increasing harmonic orders (#)
- Clear – all harmonics are deleted from the active channel of the active stream
- Copy – all harmonics in the active channel are copied to the selected phase (channel) or to all phases of this type
- > > > – all data from the active channel/selected stream are copied to the other stream
- Harmonics # – the active channel is filled with the harmonics and/or interharmonics with the displayed settings ranging within the harmonic orders specified in the adjacent fields.

A.4.5 Synthesized signal display area

The lower part of the Main Window contains the area with the results of synthesis. The corresponding tabs represent the table of harmonics, graphs of current and voltage waveforms, bar graph, and vector diagram along with the elements to control displayed results. The results can also be copied to the clipboard with the “Screenshot” button.

A.4.5.1 Harmonics

When creating a signal, you can add harmonics to a selected channel (phase) of an active stream. To do this, highlight a required harmonic from the list of harmonics, set the desired values in the fields and click the “Add” button. The harmonics with the frequency higher than 0.4 of the value set for the sampling frequency of this stream will not be used for signal generation (such harmonics are highlighted in red).

[illegible]

Fig. 4.5.1 Table of harmonics with specified parameters to be downloaded to the Calibrator

A.4.5.2 Signal

This tab is used to view the shape of the generated signal per phase and in total. The signal displayed for each phase is a combination of all waves in this phase. The current and voltage phases are located in separate graphs for clarity. You can view the signal in a selected phase (A, B, C, or N) or the total signal in all phases. Signal size on the graphs can be adjusted with the corresponding tools.

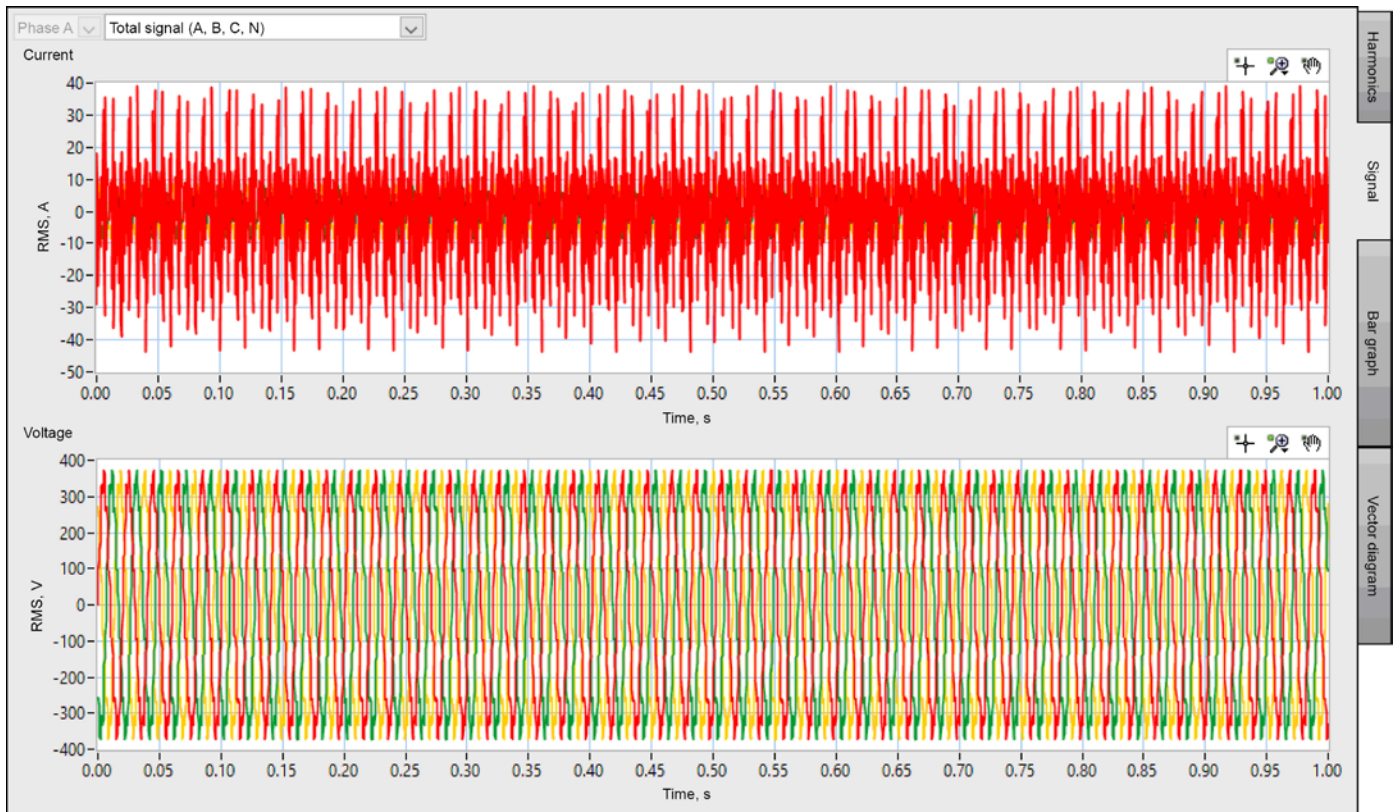


Fig. 4.5.2 View of synthesised signal

A.4.5.3 Bar Graph

Settings to display bar graphs:

- Object (RMS values of harmonics, RMS values of subharmonics/interharmonics, RMS value of all subharmonics/interharmonics)
- Measuring units (in absolute units, in % of fundamental, in % of nominal)
- Scale of the Y axis (linear, logarithmic, dB).

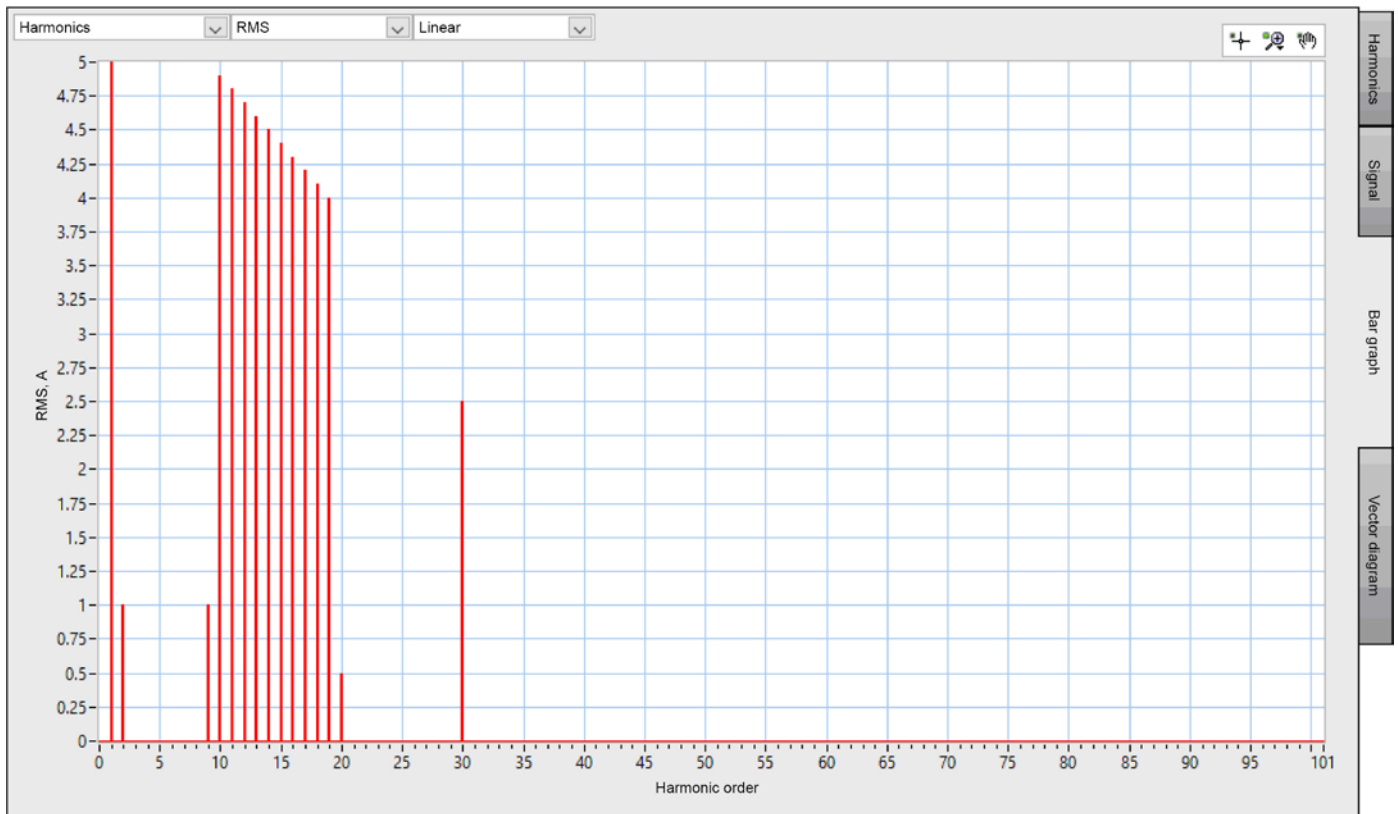


Fig. 4.5.3 Bar graph

A.4.5.4 Vector diagram

Settings to display vector diagrams:

Basic vector – the field is used to select a basic channel (a signal in this channel will be used to create a basic vector on the vector diagram: U_a or I_a)

Scale – scale of the vector diagram

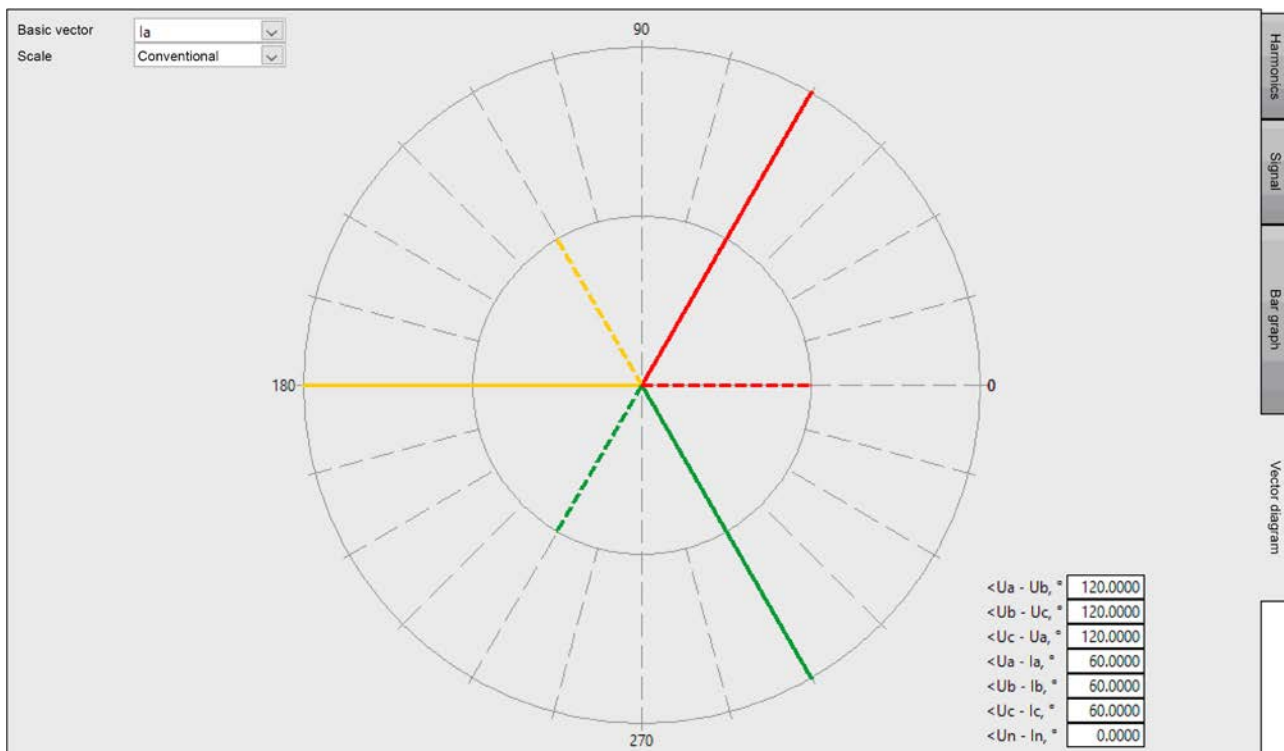


Fig. 4.5.4 Vector diagram

A.4.5.5 Analysis

The tab contains the table with all characteristics of the active signal.

	Phase A/AB	Phase B/BC	Phase C/CA	Phase N	Average/Sum	
I	5,2915	5,2915	5,2915	0	5,2915	A
U	243,5734	243,5734	243,5734	0	243,5734	V
IL	9,16515	9,16515	9,16515	0	9,16515	A
UL	421,88151	421,88151	421,88151	0	421,88151	V
P	636	636	636,00001	0	1908,00001	W
Q	1121,02097	1121,02097	1121,02097	0	3363,0629	var
S	1288,86928	1288,86927	1288,86928	0	3866,60783	VA
cosφ	0,49346	0,49346	0,49346	0	0,49346	
I1	5	5	5	0	5	A
U1	240	240	240	0	240	V
IL1	8,66025	8,66025	8,66025	0	8,66025	A
UL1	415,6922	415,6922	415,69219	0	415,69219	V
P1	600	600	600,00001	0	1800,00001	W
Q1	1039,23049	1039,23049	1039,23049	-0	3117,69147	var
S1	1200,00001	1200,00001	1200,00001	0	3600,00002	VA
cosφ1	0,5	0,5	0,5	0	0,5	
I0/1/2	4,53126E-15	5	7,81773E-9	0	0	A
KI0/2	9,06252E-14	1,56355E-7	0	0	0	
U0/1/2	3,30264E-13	415,69219	6,11814E-7	0	0	V
KU0/2	1,3761E-13	1,4718E-7	0	0	0	
THDFI	0,34641	0,34641	0,34641	0	0	
THDRI	0,32733	0,32733	0,32733	0	0	
THDFU	0,17321	0,17321	0,17321	0	0	
THDRU	0,17066	0,17066	0,17066	0	0	
φ(UU)	120	120	120	0	0	*
φ(UI)	60	60	60	NaN	0	*
F(I)	49,8	49,8	49,8	NaN	0	Hz
DC(I)	-7,21126E-8	1,91632E-9	7,01963E-8	0	0	A
F(U)	49,8	49,8	49,8	NaN	0	Hz
DC(U)	-8,68632E-8	-3,28694E-6	3,3738E-6	0	0	V

Fig. 4.5.5 Characteristics of generated signal

A.4.6 Calibrator control area

The area provides the tools to control the connected calibrator MarsGen-61850 and to display its status along with the status of each channel.

The Calibrator control area contains the following buttons:

1. Reconnect – the command enables reconnection to the Calibrator and requests its parameters (in case of successful connection).
2. Connection settings –used to specify the settings for connection with the Calibrator
3. Calibrator's settings – presents Calibrator's data and allows the user to change its operating parameters
4. Generation settings – configuring current and voltage scaling factors for each SV stream
5. Record signal to Calibrator – the command to record the synthesized signal to the internal memory of the Calibrator
6. Delete signal from Calibrator – the command to delete the synthesized signal from the internal memory of the Calibrator
7. Enable all channels/Disable all channels – the command to turn on/off signal generation in all channels of the stream. If signal generation is disabled in a certain channel, the sampled values in this stream are equal to zero, and the validity flag is set to "invalid".
8. Start/Stop – the command to start/stop signal generation
9. Active channels (Ia...In, Ua...Un) – you can enable/disable certain channels in the active stream, the colour indicates status of the channel:

- o Yellow – the channel is enabled, and the signal was not recorded
- o Green – the channel is enabled, and the signal was recorded without errors
- o Red – the channel is enabled, and the signal was recorded but the recorded signal is not in conformity with the one specified in Signal Editor, or the signal was recorded with errors
- o Grey – the channel is disabled.

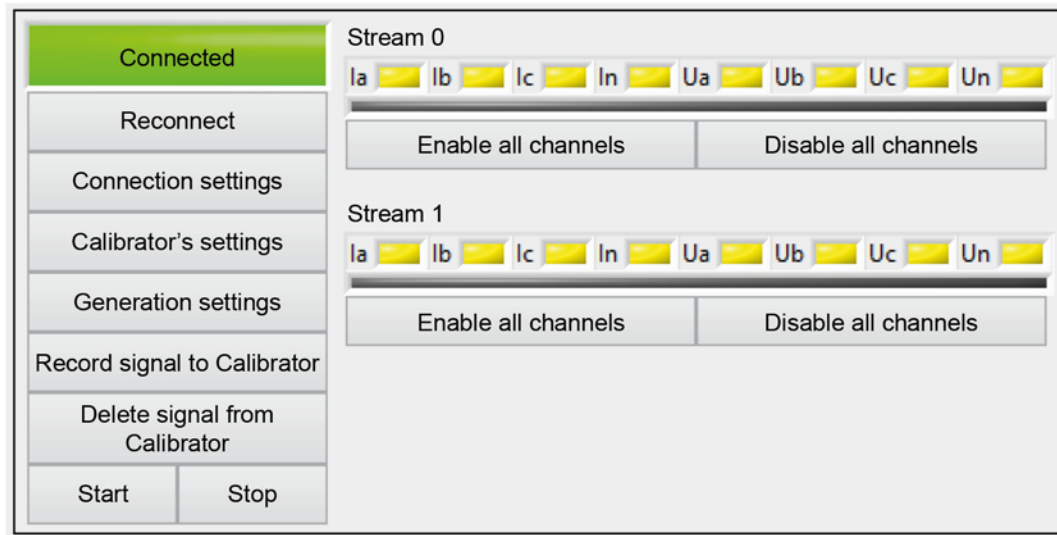


Fig.4.6.1 Calibrator control area

A.4.6.1 Connection settings

The “Connection settings” dialog has the following options:

- IP-address
- Port
- Calibrator’s serial number.

The above information is unique for each instrument (it is indicated on its front panel).

- Timeout (ms) – is the time when the Program waits for a response from the Calibrator to data request (300 ms by default)
- Communications protocol – selection of the transport layer protocol (TCP or UDP)
- Record delay (ms) – additional delay applied to recording current and voltage signals to the Calibrator (for UDP only)
- Each n-packets – period for applying the pre-specified value of “Record delay” (for UDP only).

It is recommended to increase the “Record delay” value in case of errors in the process of recording data to the Calibrator.

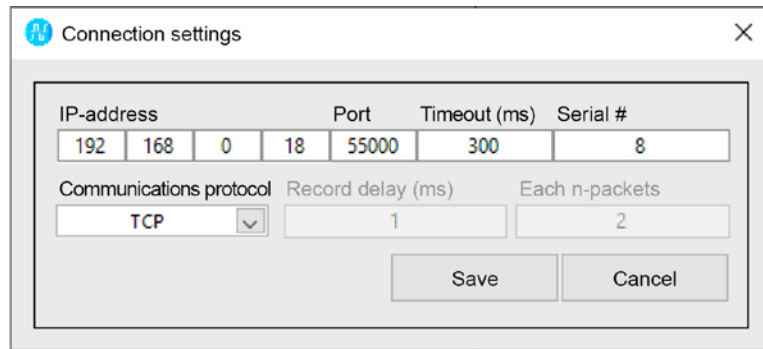


Fig. 4.6.2 “Connection settings” dialog box

A.4.6.2 Calibrator’s settings

The “Calibrator’s settings” dialog includes the following tabs:

- Stream 0
- Stream 1
- Calibrator’s data

The “Stream 0” and “Stream 1” tabs (which are identical with respect to their contents) are used to configure signal generation for corresponding streams. Each of the tabs includes 3 tabs: “Stream settings”, “Signal quality” and “Stream distortion”.

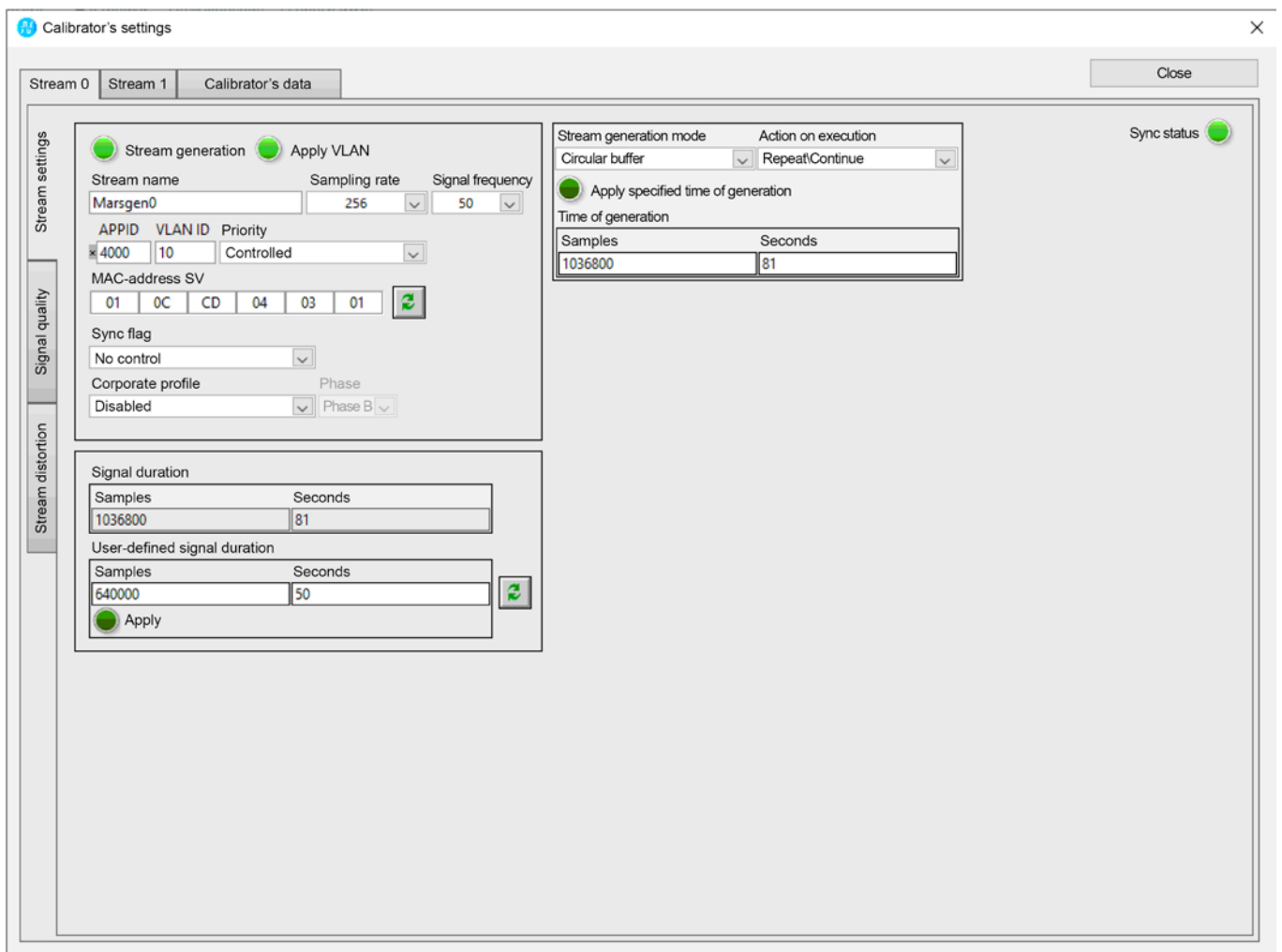


Fig. 4.6.3 “Calibrator’s settings” menu (“Stream settings” tab)

The options of the “Stream settings” tab:

- Stream generation mode:
 - Circular buffer – generation of the stream arranged in a loop
 - Continuous – stream signals are continuously recorded in the process of stream generation
- Action on execution – used to select what to do with stream generation after the specified time period or buffer length is over.
 - Repeat\continue
 - Set to zero
 - Stop generation
- Apply specified time of generation – when enabled, the stream is generated considering the pre-specified signal duration in samples or seconds. When the option is disabled, the time of generation is equal to the length of signal buffer.
- Time of generation – the time of stream generation specified in samples or seconds. When this time is over, the action selected in the corresponding field, will be executed. If the value in this field equals zero, the parameter is ignored, and the time of generation corresponds to the length of signal buffer.
- The “Stream generation” button – enables/disables generation of the stream
- The “Apply VLAN” button – enables/disables the use of VLAN ID when the stream is generated
- Stream name
- Sampling rate – used to select the sampling rate in samples per fundamental period (available values: 20, 24, 80, 96, 256, 288, 640)
- Signal frequency – used to select fundamental signal frequency (50 or 60 Hz)
- VLAN ID – used to specify VLAN identifier (802.1Q)
- APPID – used to specify application identifier. APPID is used to select and filter ISO/IEC 8802-3 frames containing Sampled Values (SV) messages and to distinguish between different SV streams (Application Association). The reserved range is from 0x4000 to 0x7FFF. If APPID is not specified, the default value is 0x4000.
- Priority – used to specify data priority according to 802.1P (applied when using VLAN only).
- MAC-address SV – used to specify destination MAC-address for SV messages in the generated stream. The MAC-address of the receiver (Destination address) is the address of the device to which the SV message is delivered (6 byte length). The messages may be unicast and multicast. According to IEC-61850, the MAC-addresses for multicast SV messages range from 01-0C-CD-04-00-00 to 01-0C-CD-04-01-FF.
- Sync flag – used to select the value for the field smpSynh in the given stream:

- o No control – the Calibrator is automatically set to the currently active synchronization mode
 - o No synch – synchronization is forced to the value 0 (none)
 - o Local sync – synchronization is forced to the value 1 (local)
 - o Global sync – synchronization is forced to the value 2 (global).
- Corporate profile – activates the IEC-61850 settings used by PAO “Rosseti”:
 - o Disabled – the profile is not available
 - o Single-phase current – the stream contains single-phase current signal
 - I_a
 - I_b
 - I_c
 - o Single-phase voltage – the stream contains single-phase voltage signal
 - U_a
 - U_b
 - U_c
 - o Three-phase current – the stream contains three-phase current signal (I_a , I_b , I_c).
 - o Three-phase voltage – the stream contains three-phase voltage signal (U_a , U_b , U_c).
- User-defined signal duration – used to specify customer’s signal duration in samples or seconds.
Please note that using a non-standard value of signal duration may lead to decreasing signal accuracy characteristics or deterioration of cyclic signal generation.

The “**Signal quality**” tab gives the possibility to specify power quality parameters of generated signals according to IEC 61850-9-2. The power quality settings can be applied to signals per each voltage and current phase of a stream.

- Clear all – used to clear all marked quality flags for all current and voltage phases.
- Ignore/Apply – used to disable/enable all previously activated quality flags.

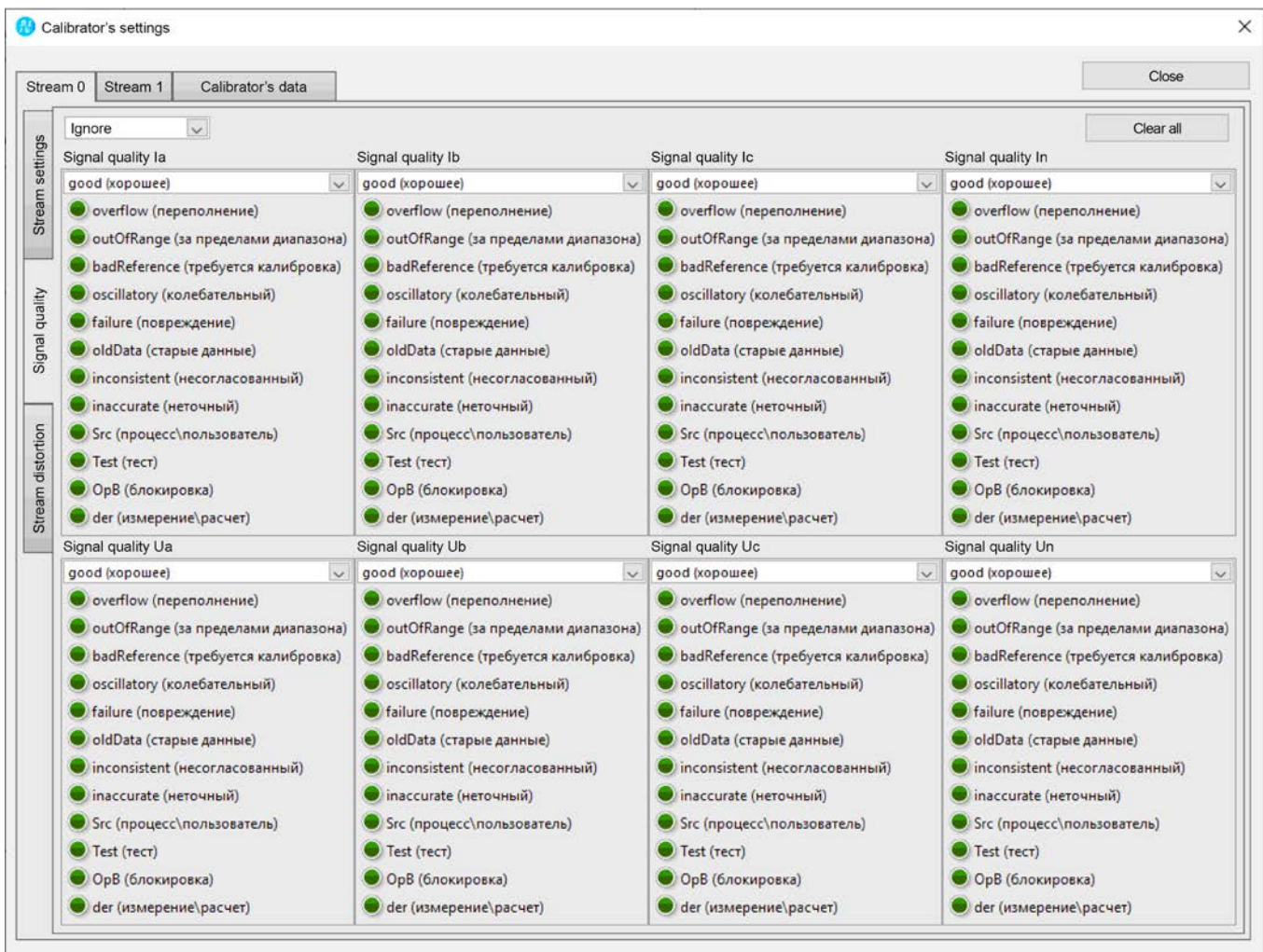


Fig.4.6.4 “Calibrator’s settings” menu (“Signal quality” tab)

The “**Stream distortion**” tab is used to specify the settings for simulation of disturbances/distortions of signals in the generated SV stream:

- Stream distortion – Apply/Ignore the distortion settings
- Packet loss:
 - Disabled
 - Successively at the beginning of a second
 - Successively at the end of a second
 - Accidentally – a packet loss map is generated once
 - Accidentally during each second – a packet loss map is newly generated during each second
- Number of packet losses – specifies the number of packets lost during each second
- Start index shift – the start index of transmitted data (smpCnt) is shifted (equals 0 by default)
- Packet duplication – the option is used to prohibit/allow a certain packet to be sent once again
- Duplicated packet – used to specify the number of the packet to be duplicated

Note! All options available on this tab should be used just for testing purposes. Otherwise the usage of these settings could result in deterioration of Calibrator's accuracy specifications, or generated streams could become inaccessible for external devices.

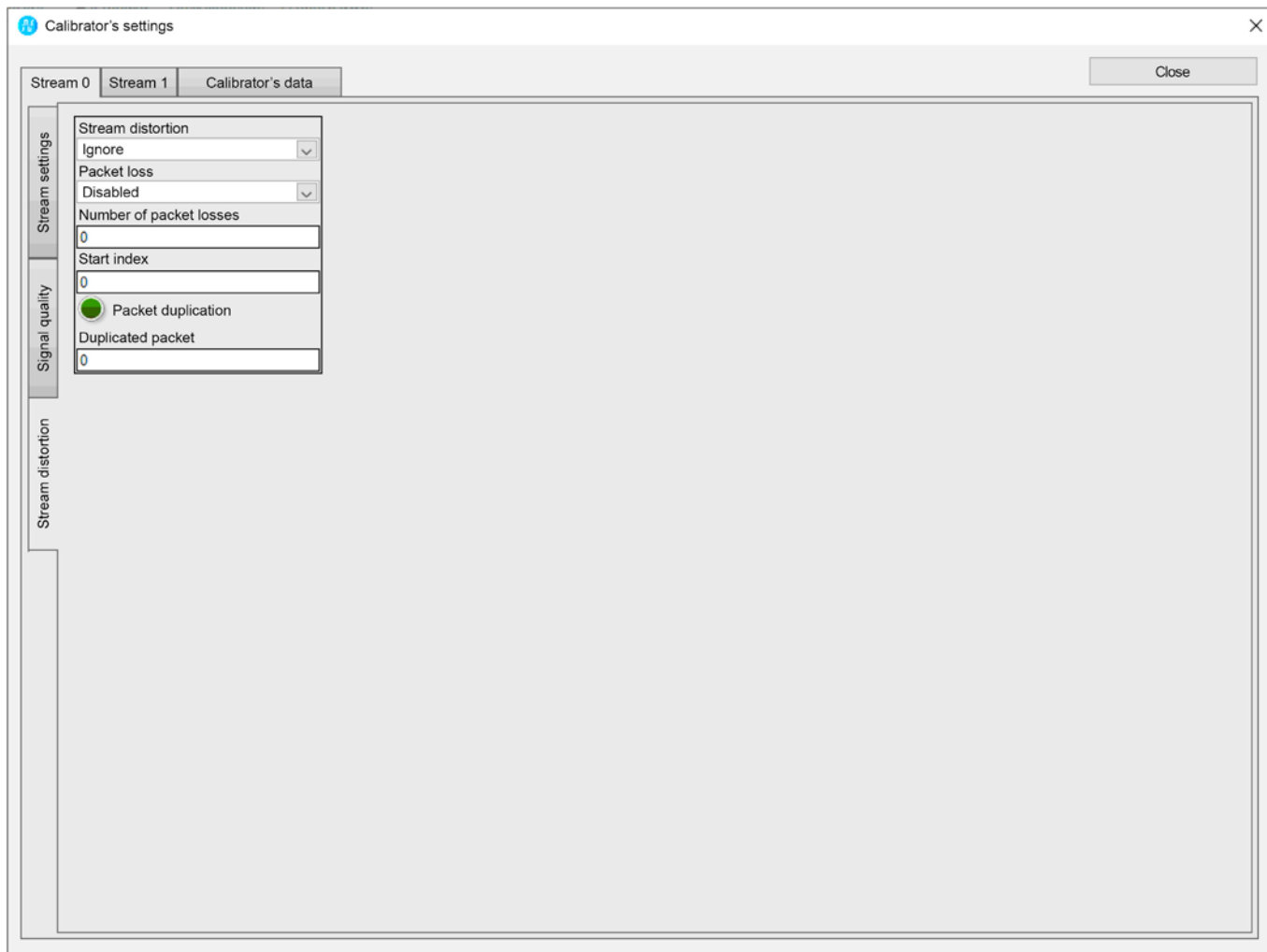


Fig.4.6.5 “Calibrator’s settings” menu (“Stream distortion” tab)

The tab “**Calibrator’s data**” contains:

- Firmware
 - Firmware version – current firmware version of MarsGen-61850
 - Protocol version – current version of the internal communications protocol (service information)
 - Date – date of release of the firmware version
- Software
 - Software version – current version of the high-level software “Signal Editor”
 - Protocol version – current version of the internal communications protocol (service information)
 - Date – date of release of the software version.
- Operating mode – used to select 1-stream or 2-stream operating mode

- Network parameters – used to view and modify the network configuration settings of the connected Calibrator.
- Synchronization settings – used to:
 - Select synchronization mode for the Calibrator
 - Select the operating mode for the Sync Output A and Sync Output B.

The Calibrator's synchronization modes are as follows:

- Internal – the internal clock of the Calibrator is synchronized with the internal quartz oscillator
- 1PPS positive – the internal clock of the Calibrator is synchronized with a positive-polarity 1PPS (1 pulse per second or 1 Hz frequency) timing signal applied to the “PPS in” input of the Calibrator.
- 1PPS negative – the internal clock of the Calibrator is synchronized with a negative-polarity 1PPS (1 pulse per second or 1 Hz frequency) timing signal applied to the “PPS in” input of the Calibrator.
- 10MHz positive – the internal clock of the Calibrator is synchronized with a positive-polarity 10MHz timing signal applied to the “PPS in” input of the Calibrator.
- 10MHz negative – the internal clock of the Calibrator is synchronized with a negative-polarity 10MHz timing signal applied to the “PPS in” input of the Calibrator.
- PTP client – the internal clock of the Calibrator is synchronized with an external source of PTP timing signals compliant with IEEE 1588v2 (available for Calibrators with model names ending with “-01”).
- GPS + PTP server – GPS synchronization + IEEE 1588v2 synchronization (available for Calibrators with model names ending with “-01”).

Operating modes for Synch Output 1 and Sync Output 2:

- Disabled – no synchronization
- Positive enabled – positive-polarity signal with specified frequency and pulse duration is applied to the corresponding output of the Calibrator.
- Negative enabled – negative-polarity signal with specified frequency and pulse duration is applied to the corresponding output of the Calibrator.

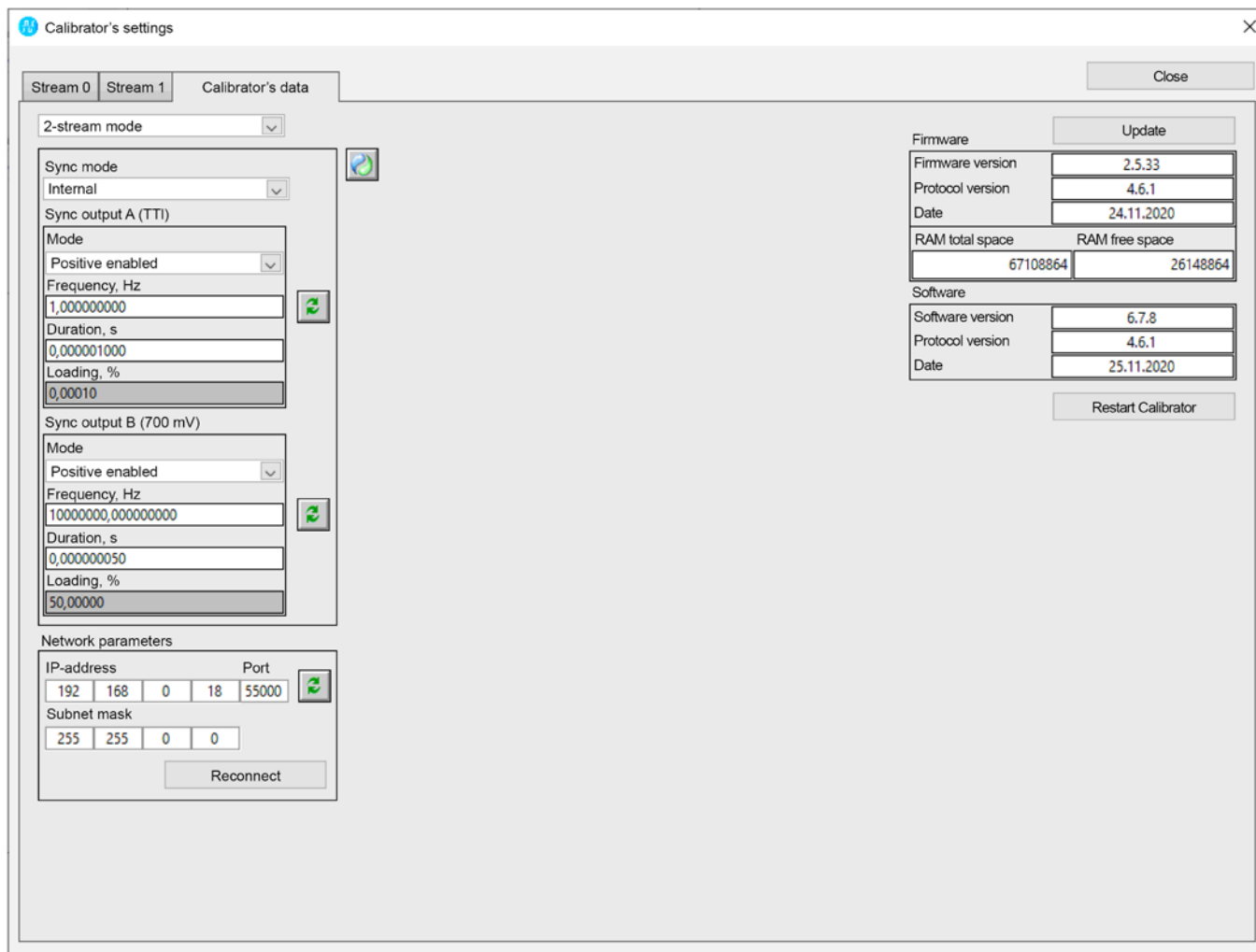


Fig. 4.6.6 “Calibrator’s settings” menu (“Calibrator’s data” tab)

A.4.6.3 Generation settings

The “Generation settings” dialog box makes it possible to specify voltage and current scaling factors for each SV stream.

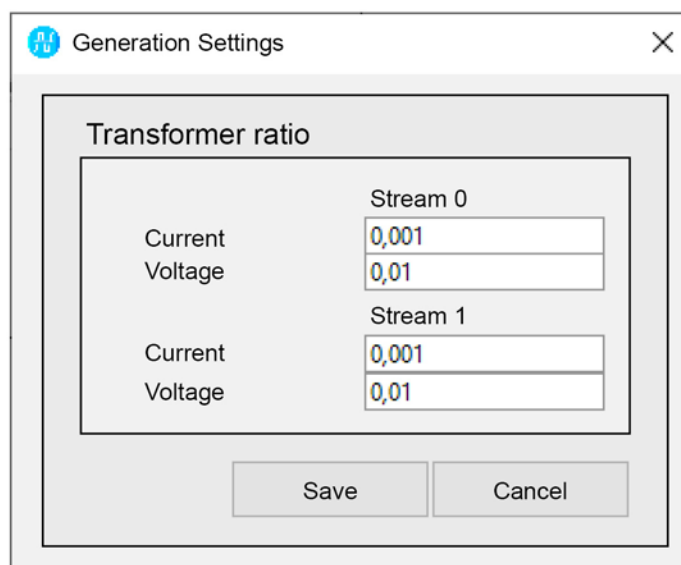


Fig. 4.6.6 “Generation settings” dialog box