# Energomonitor-61850EXT

Version 0.7.2

User Manual

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# Scope

The EnergoMonitor-61850EXT program (the Program below) is a software component designed to work with multifunctional reference meters named Energomonitor 61850 (the EM61850 below). The Program is used to configure the EM61850 and take control of measurement results.

The Program works under Windows 7, 8, 10, and 11.

# **1** Installation

- 1.1 Run the installer EM61850EXT\_Installer.exe
- 1.2 Click on Next.

🐙 EnergoMonitor61850EXT	—		$\times$
<b>Destination Directory</b> Select the installation directories.			
All software will be installed in the following locations. To install software into a different location, click the Browse button and select another directory.			
Directory for EnergoMonitor61850EXT C:\Program Files (x86)\MarsEnergo\	Bro	owse	
Directory for National Instruments products C:\Program Files (x86)\National Instruments\	Bro	owse	
<< Back Next >	>	Cano	el

1.3 Select I accept the License Agreement. Click on Next

🐙 EnergoMonitor61850EXT			_		$\times$
License Agreement You must accept the licenses displayed below to proceed.					
NATIONAL INSTRUMENTS SOFTWARE	LICI	ENSE AG	GRE	EMEN	r ^
CAREFULLY READ THIS SOFTWARE LICENSE AGI DOWNLOADING THE SOFTWARE AND/OR CLICKING COMPLETE THE INSTALLATION PROCESS, YOU AGREE TO THIS AGREEMENT. IF YOU DO NOT WISH TO BECOME A PAF BOUND BY ITS TERMS AND CONDITIONS, DO NOT INSTAL RETURN THE SOFTWARE (WITH ALL ACCOMPANYING V CONTAINERS) WITHIN THIRTY (30) DAYS OF RECEIPT. SUBJECT TO NI'S THEN-CURRENT RETURN POLICY. IF YOU ON BEHALF OF AN ENTITY, YOU AGREE THAT YOU HAVE AU THESE TERMS.	REEM THE D BE RTY TO L OR VRITT ALL J ARE THOP	ENT ("AG APPLICAB BOUND B" DTHIS AGF USE THE EN MATER RETURNS ACCEPTIN ATY TO BIN	REEM LE B Y THE REEME SOFT NALS J TO N NG THE	IENT"). UTTON TERMS ENT AND WARE, A AND THI NI WILL ESE TER E ENTITY	BY TO OF BE ND EIR BE MS TO
The software to which this National Instruments license applies is Energo	Monito	or61850E×T.			
() I acce	pt the l	_icense Agre	ement.		
○ I do no	)t acce	pt the Licens	e Agrei	ement.	
<< Bac	:k	Next >:	>	Can	cel

1.4 Click on Next.

🐙 EnergoMonitor61850EXT	—		$\times$
Disable Windows Fast Startup Disable Windows fast startup to prevent problems with installing or removing hardware.			
The fast startup capability introduced in Microsoft Windows 8 may cause problem or removing hardware. National Instruments recommends disabling Windows fast more information about fast startup, click the following link or visit ni.com/info and Code WinFastStartup.	s with inst startup. Fr enter the	alling or Info	
Windows Fast Startup Information			
Disable Windows fast startup to prevent problems with installing or removing h	ardware.		
<< Back Next >	>	Canc	el

1.5 Click on **Next.** Wait for the installation to complete.

🐙 EnergoMonitor61850EXT	-		×
Start Installation Review the following summary before continuing.			
Adding or Changing • EnergoMonitor61850EXT Files			
Click the Next button to begin installation. Click the Back button to change the installation s	settings.		
Save File << Back Next >	>	Cano	el

1.6 Click on Next.



1.7 Click on Restart. Your computer will be restarted.

EnergolV	1onitor61850EXT			$\times$	
U	You must restart yo If you need to insta choose to restart la software.	ur computer to complete this Il hardware now, shut down ter, restart your computer be	operation. the comput fore running	er. If you g any of this	8
	Restart	Shut Down	Re	start Later	

# 2 Connecting EM61850 and PC

2.1. Connect your PC to the WiFi point of the EM61850.

Network name: em61850-N (where N is a serial number of the EM61850).

Password: 12345678

Besides a WiFi connection, it is also possible to make a wired connection between the EM61850 and PC. The computer is connected to the Control port of the EM61850 via a patch cord.

2.2. Launch the program EM61850EXT. In case of successful connection the EM ONLINE indicator will be displayed. The connection can be configured in the menu Settings  $\rightarrow$  Connection (see section 3.1.5).



# 3 Operating the program

The buttons providing access to the main functions are located in the bottom line of the screen.



# 3.1. Settings

Register-61850

# 3.1.1 ADC

#### 3.1.1.1 Selecting measuring ranges

Select a required range for the analogue current or voltage input and click **Apply**. When a current range is being changed, the EM61850 emits 4 specific clicks. Voltage ranges are switched soundlessly.

ADC	Streams	Calcu	lation	Synchronizatio	on	Service
Voltage 800	ADC Range		00 02	Outgoing MAC source 9C 14 02 1E	stream Scale. x100 3 Off	00
Current 10	Z A Z B Z C Z N		em6185	Stream II	Apply	
			Rang	DUT Re	off Apply	
Verification Streams Mult	timeter Settings	Voltage range, V	A B C	N 800	source1 cos	

#### **3.1.1.2** Configuring the outgoing stream

The outgoing stream generated by the own (internal) ADC module of the EM61850 according to IEC 61850-9-2 consists of digital replicas of input analogue signals: 4 input currents and 4 input voltages. **ADC MAC** (the MAC address of the source of the stream) is displayed as reference information. Parameters are selected from the **Parameter** drop-down list.

**Stream ID** is the name of the stream, it may include characters from the Roman alphabet, digits and the underscore "\_" (other characters are not allowed according to the standard).

Dest MAC is the destination MAC address (MAC address of the data receiver)

**F** SV is the sampling rate, the admissible rates are: 24, 80, 96, 256, 288, 640 samples per a period of the rated network frequency.

VLAN ID is the subnetwork identifier of the stream.

**APPID** is the application identifier.

The Scale x1000 button enables a scaling factor that may be applied to the voltage ranges 1V, 2V and current ranges 0.1A, 0.25A. When active, the Scales x1000 indicator is

displayed at the bottom of the screen. The button is used to measure low currents and voltages. In this case RMS and RMS (1) readings are displayed in mV (voltage) and mA (current).

### **3.1.1.3 Configuring CTCS**



**Note!** This information relates to the versions operating with the instruments complete with a Current Transformer Calibration Switch (CTCS).

The **ON/OFF** button enables CTCS. Within an outgoing stream, the readings from the inputs of CTCS are assigned to the phases Ia and Ib. The button **Apply** makes it possible to select one among the 8 ranges available: 0.05, 0.1, 0.25, 0.5, 1, 2.5, 5, 10 A.

### 3.1.2 Streams

ADC	Streams	Streams Calculation Synchronization		Synchronization	Service			
OFF		OFF			Apply filter			
	Channel 1	Channel 2		SV Streams				
SV ID	em61850_37				Clear			
source MAC	00-02-9C-14-02-1B				filter			
destination MAC	01-0C-CD-04-00-00							
APPID (hex)	4000							
Sample per perion	256							
Packet loss	0 (0 %)							
Port	Вход1							
Stre	Stream lag (channel 1 - channel 2) microseconds							
Cor	porate profile							
SV Name SV Name SV Name SV Name	la lb lc ln U la lb lc ln U la lb lc ln U la lb lc ln U	a Ub Uc Un a Ub Uc Un a Ub Uc Un a Ub Uc Un	Apply					

When external streams are present at the EXT input of the EM61850, the names of the streams will be automatically displayed in the list **SV Streams.** 

The Energomonitor-61850 simultaneously processes streams in 2 channels. By default, one of these channels is its own channel (the Analogue input) which processes its own stream. The other one can accept an external stream. Besides, these 2 channels can both accept external streams. To select an active stream, open the left drop-down list. If you need 2 external streams to be processed, open 2 drop-down lists. Select the streams and click **Apply filter**.

#### Note!

If even one external stream is being processed at the moment, the Program will not be able to show an actual list of streams going through the EXT port because the filter of streams is ON. To view all streams at the EXT port, click on the button **Clear filter**.

If a stream has a corporate profile, enter its name in the "Corporate profile" table and mark its active phases accordingly.

## 3.1.3 Calculation settings



The calculation settings (which are set to default each time the EM61850 is turned ON/OFF) influence the readings of the instrument in all tabs. The left part of the panel contains the fields where the calculation settings for an analogue signal or for an external stream selected can be made. The right part contains the calculation settings to be applied to an external stream only. In addition, such options as the number of harmonics and interharmonics are backed up in the tab Multimeter >> Harmonics.

#### "F band"

The "F band" option sets a range across which the search for the fundamental frequency is performed.

#### "Reference signal"

Selection of the frequency in a polyphase system is based on the signal in a channel configured as the reference channel. The following options are available:

#### - Auto:

Initially channel Ua is taken as a reference channel. If an RMS value of signal in the reference channel appears to be less than 10% of the active measurement range, the first channel where an RMS value of signal exceeds the 10% threshold will be selected as the reference one automatically. The channels are scanned in the following order: Ua, Ub, Uc, Un, Ia, Ib, Ic, In. If a sufficient signal is detected in none of the channels, the search will be repeated once a second.

- **OFF** (by default):

The frequency of each channel is calculated independently of one another.

#### - Ua, Ub, Uc, Un, Ia, Ib, Ic, In:

The frequency of the selected channel is taken as the frequency of the system.

Correc	tion channel 1	Corre	ection channel 2
	Current Ki, Angle		Voltage Ku, Angle
la 1	0	Ua 1	0
lb 1	0	Ub 1	0
IC 1	0	Uc 1	0
In 1	0	Un 1	0

The "Correction" tabs are used to set correction factors ( $K_I$  and  $K_U$ ) for RMS and RMS (1) readings of the signal in the channel along with its angle correction value (if required).

## 3.1.4 Synchronization

ADC		Streams		Calculation	Synchronization	Service
	Sync	type				
Autonomous	PTP	PPS	CLK 10 MHz	Apply		
		Positive	Negative			
PPS Out				PPS		
	Off	On	Inversion			
	Frequency, Hz 1					
	Impulse duration, s 2E-6					
	Impulse delay, s 0					
CLK Out						
	Off On Inversion					
	Frequency, Hz 1				Terminators	
Impulse duration, s 0,2				PPS In CLK In	Apply	
		Impulse d	elay, s 0	СЦК		Арріу

Two types of synchronization are available: internal and external.

To enable an external source of PPS (pulse per second) signal, click on the button "PPS".

To turn on the internal source of PPS signal, select the button "Autonomous".

The buttons "PTP" and "CLK 10 MHz" are reserved for future applications.

If the EM61850 is configured to compare analogue input signals with an external stream, it is critically important to set the correct type of synchronization. If the EM61850 itself operates as a synchronization unit, select the internal synchronization ("Autonomous").

If you want to transmit PPS synch pulses to external devices, set the "**PPS out**" function to "**On**" or "**Inversion**".

To activate the settings in the instrument, click "Apply".

**CLK in (Clock Signal)** is an input on the panel of the EM61850 that can be used for connection of an external synchronization signal (will be active in further versions).

CLK out can be used in the same way as the PPS out.

The "**Terminators**" options are used to enable termination loads on the inputs "**PPS in**" or "**CLK in**", which makes it possible to eliminate beating of the PPS signal.

## 3.1.5 Service

ADC	Streams	Calculation	Synchronization	Service
IP 192 168	0 101 Connect		AD Synch bloc	Firmware ver Software ver C firmware ver Serial 37 Modification
		© Mars-Energ http://www.mars-energ	jo ergo.com	Firmware update

Click "Connect" to activate the program on the instrument with the specified IP address.

Click "Firmware update" to update the firmware of the instrument.

# 3.2. Comparator

Points to (moving	average 3	Digits after dec. point	3		Amp. Graph Error Graph	
	Ref	DUT			0,0100-	
	Analog Ua	Analog Ub			0.0050-	
	Scale factor	Scale factor	Error			
	001,00000	001,00000	Relative (%)		0,0000-	
RMS	000,003	000,005	033,241		-0.0050-	
RMS(1)	000,000	000,000	031,639			
DC	000,001	000,002			-0,0100-	
Phi	-98,303	005,622	103,925	Deg 🗢		
					0.0045-	
F	516,123	Hz 2436,602	Hz		0.00425-	
THD	211,016	% 080,319	%		0.004-	
					0.00375-	
					0,0035-	
					0,00325-	
					0 100	

#### 3.2.1 General information

The mode is used to compare the signals present on two phase inputs. The signals can relate to one stream or to different streams. Readings are taken once per second.

#### Fields:

**Scale Factor** – is used when the RMS and RMS (1) readings should be multiplied by a number, the number is specified in this field (equals 1 by default)

 $\mathbf{RMS}$  – shows actual RMS values of the voltage or current signal selected in the corresponding field

**RMS** (1) – shows actual RMS values of the  $1^{st}$  harmonic of the voltage or current signal selected in the corresponding field

Phi – shows phase shifts with reference to PPS (measurement units are selected from the adjacent dropdown list)

**Error** – displays calculated values of measurement error **Relative** (%) – is the relative error calculated according to the formula: Relative\_Error = (DUT – Ref) / Ref \* 100 **Absolute** – is the error calculated as: Absolute\_Error = DUT – Ref **F** – shows the frequency of the 1<sup>st</sup> harmonic of the selected signal **DC** – shows values of the DC component of the selected signal **THD** – shows total harmonic distortion of the selected signal **Note!** The errors of phase shift are always calculated according to the

**Note!** The errors of phase shift are always calculated according to the second formula (Absolute\_Error = DUT - Ref) regardless of the error type selected in the corresponding field.

**COS** and **SIN** – the buttons are used to select one of the methods (cosine based or sine based) for calculation of the phase offset of a signal curve with reference to a time stamp (PPS pulse).

source1	cos
source2	cos

The methods are referred to the extreme positions of a signal curve with respect to a PPS pulse:



**Cosine based:** the phase offset is assumed to be zero, if a time stamp (at the moment of going from one UTC second to the next) matches the curve of the fundamental signal harmonic at its maximum

**Sine based:** the phase offset is assumed to be zero, if a time stamp (at the moment of going from one UTC second to the next) matches the curve of the fundamental signal harmonic when it crosses the X axis from below.

#### 3.2.2 Amplitude graphs

A set of the amplitude curves of compared signals measured over 1 second is displayed on the upper graph panel. The horizontal axis contains fractions of a second adjustable with a logarithmic slider. By moving the slider to the rightmost position you can view the complete 1-second plot.

The lower graph represents the curves of the parameters selected from the dropdown list (RMS, RMS (1), Phi, F, DC, and THD).

The plots representing errors located in the next tab "**Error graph**" are managed in the same way.



# **3.3 Verification**

								-		×
✓ Choose verification device										
– Transformer										
Merging Unit										
Electricity meter										
		A	В	C	N					
Ph 🏨 🗛 💷 👧	Voltage range	, V 800	800	800	800		source1 cos		2	••
LA 🔄 🎑 🖌	Current range	, A 10	10	10	10	x 1000	source2 cos	E	NG	<b>~</b>

## 3.3.1 Verification of transformers

The procedure of accuracy testing (verification) of transformers is described in the user manual for the Energomonitor 61850.

## 3.3.1.1 Specifying nameplate data for tested transformers

The fields for specifying nameplate data become accessible only after selecting the transformer type.

Device under test Name	Current transformer Voltage transformer Current and voltage transformer test1	~
Analog / digital stream	Analog	•
One phase / Three phases	One phase	•
Visual inspection and verification of terminal markings	Pass	•
Software check	Pass	•
Insulation check	Pass	•
Serial		
Year	0	
Class		
Primary rated voltage, V	0	
Secondary rated voltage, V	0	
Rated frequency, Hz	0	
Rated load, VA	0	
Installation location		
Owner		1
Last verification date		

The user will be allowed to go to the next tab only after specifying the values of rated currents or voltages.

## 3.3.1.2 Specifying nameplate data for reference device

<<			>>		
Reference	Current and voltage transformer	-			
Name	test2	-		Save to my devices	Delete from my devices
Analog / digital stream	Analog	-		Reference devices	
Serial	1		>>	Analog / test2	A
Accuracy class	1				
Primary rated voltage, V	1		<<		v
Secondary rated voltage, V	1				
Primary rated current, A					
Secondary rated current, A					

When you select a device saved earlier, its nameplate information will appear in the fields automatically.

## 3.3.1.3 Performing verification

Loa	ad U/Un	om, %	8	Ratio error, %	Phase error, min	Permissible error,	% Permissib	ole phase error, mi ^
0.0	00 5.	63		-0.01	-0.13	0.02		0.01
0.0	00 5.	63		-0.02	-0.00	0.02		0.01 A
0.0	5.	63		-0.01	-0.03	0.02		0.01 B
								vC
	1	Voltag	le					
				DUT	Load power			Error standart
	Reference							
nalo	Reference		Ana	log	000.000		Correction	DUT - Ref
nalc	Reference og /		Ana	log 40 <sup>60</sup> 40	000.000		Correction of channels	$\frac{DUT - Ref}{Ref} * 10$
`20 -0	Reference		Ana -0	log <sup>1</sup> 40 <sup>60</sup> 80 <sup>°</sup> <sup>20</sup> 100 <sup>°</sup> 120- 120-	000.000		Correction of channels	$\frac{DUT - Ref}{Ref} * 10$ IEC 61869-6:2016
20 -0 5 of r	Reference bg /		Ana	log <sup>140</sup> <sup>60</sup> <sup>60</sup> <sup>80</sup> <sup>100</sup> <sup>120-</sup> f rated value 5.6	000.000		Correction of channels	DUT - Ref Ref IEC 61869-6:2016
<sup>220</sup> -0 5 of r	Reference bg /	ſ	Ana -0 % o Ch.	log 40 <sup>60</sup> 80 <sup>'</sup> 100 <sup>-</sup> 120- f rated value 5.6 RMS	000.000 Ratio error, %	Phase error, min	Correction of channels Add line	DUT - Ref Ref IEC 61869-6:2016
20 -0 5 of r	Reference bg /	ļ	Ana -0 % o Ch. B	og 40 <sup>60</sup> 80 <sup>′</sup> 100 <sup>′</sup> 120- f rated value 5.6 RMS ▼ 562.431	000.000 Ratio error, % -00.012	Phase error, min -00.329	Correction of channels Add line	<u>DUT - Ref</u> * 10 IEC 61869-6:2016
`20 -0 6 of r h.	Reference og /	ļ	Ana -0 % o Ch. B B	log <sup>1</sup> 40 <sup>60</sup> 80 <sup>°</sup> 100 <sup>°</sup> 120- f rated value 5.6 RMS ▼ 562.431 ▼ 000.000	000.000 Ratio error, % -00.012 000.000	Phase error, min -00.329 000.000	Correction of channels Add line Delete line	DUT - Ref Ref * 10
$^{20}$	Reference bg /		Ana -0 % o Ch. B B C	log <u>40</u> <sup>60</sup> 80 <sup>°</sup> <u>100<sup>°</sup></u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120 <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u> <u>120</u></u>	000.000 Ratio error, % -00.012 000.000	Phase error, min -00.329 000.000 000.000	Correction of channels Add line Delete line Save	DUT - Ref           Ref           IEC 61869-6:2016

The tab is used to record actual readings and results into the table in the process of verification. Test reports (rtf files) are created on this basis. Records (lines) are added to the table by clicking on the "Add line" button. To delete a line, highlight it with the mouse and press "Delete line". Test reports are saved on clicking the "Save report" button.



The correction of channels is only performed prior to testing of conventional current or voltage transformers. It should be performed in 30 min (or later) after applying power to the EM61850.

Note! Prior to starting correction of channels make sure that the measurement range set in the EM61850 is no less than the rated current/voltage value of the reference transformer. Correction should be repeated each time after changing a measurement range.

To start correction, connect the secondary of the reference transformer to the phase inputs A and B of the EM61850. Apply a voltage/current of value equal to its rated value to the reference transformer.

Click "**Start**". At this time, the EM-61850 will carry out correction, namely it will electronically compensate both amplitude and phase shift differences between signals in channels A and B.

To obtain the highest possible measurement accuracy, it is recommended to carry out the correction of channels after a considerable (greater than 5  $^{\circ}$ C) drop in ambient temperature and each time when a measurement range is changed.

# 3.3.2 Verification of Merging Units

Verification of merging units is performed for phase voltages, line voltages, and phase currents in each phase.

# 3.3.2.1 Verification tab

Merg	ging U	nit		$\nabla$							
Verification Specification	Proc	edure	Control								
Phase voltage Line voltage	Cha	annel AB	[		Add Line		Delete lin	e	Ор	en in othe	r window
Test #		U, V	U ref. V	U dut., V	ΔU, V	<mark>δ</mark> U, %	Error limit δU, %	αU ref., °	αU dut., °	ΔαU, °	Error limit ΔαU, °
		0	0,003348	0	-0,003348	-Inf	0	-48,33	0	48,33	0
	1	0	0	0	0	0	0	0	0	0	0
О, В О	2	0	0	0	0	0	0	0	0	0	0
Error limit δU, 0	3	0	0	0	0	0	0	0	0	0	0
Error limit ΔαU, 0	4	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0
Save	6	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0
Load	8	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0
Export report	10	0	0	0	0	0	0	0	0	0	0
									Signal	quality:	bad

Click "**Add** line" to add a line with actual readings to the table. Please note that just the readings for the channels indicated by a check mark will be added. The "Delete line" button will delete the latest record. The "**Open in other window**" button is used to open tables for all 4 phases.

Click "**Save**" to save current records to a file. Thus, a verification procedure can be interrupted, saved to a file and then resumed with the "**Load**" button.

Click "Export report" to generate a test report (pdf file).

# 3.3.2.2 Specification

Verification Specification Procedure C	Control
DUT name	Ref. name
Serial #	Serial #
Accuracy class 0	Accuracy class
Rated phase voltage 0	
Rated line voltage 0	Temperature, °C 0
Rated current 0	Humidity, % 0
Rated frequency, Hz 0	Pressure, kPa 0
Site	Network frequency, Hz 0
Owner	THD, % 0
Visual inspection and verification of	Software check  Network voltage, V

The "Specification" tab contains fields where the nameplate data for the tested device, reference device and test conditions are specified.

# 3.3.2.3 Procedure

Verification Specification	Procedure Control					bl			
Phase voltage Line voltage						U, V	Error limit δU, %	Error limit ΔαU, °	
Current		0,2	x	Urated	=	0	0,1	0,1	^
		0,5	x	Urated	=	0	0,1	0,1	
		1	x	Urated	=	0	0,1	0,1	
Delete line		1,2	x	Urated	=	0	0,1	0,1	1
		0	x		=	0	0	0	
Save		0	x		=	0	0	0	
		0	x		=	0	0	0	
Load		0	x		=	0	0	0	
Procedure		0	x		=	0	0	0	
MU_17.05.2023_		0	x		=	0	0	0	•

The tab is optional, and its fields can remain empty. However, with these fields the user can specify a verification procedure as a set of test points, save it to a file with the "**Save**" button and then activate it at any time with the "**Load**" button, if necessary. Then, if specified, these test points are displayed in the Verification tab as pop-up tips for signals to be applied to the tested device.



# 3.3.2.4 Control

Verification	Verification Specification Procedure Control								
	A	В	c O	N					
TUD	Ref 139,507	91,3699	62,3303	31,2633					
THD	DUT 0	0	0	0					
		_	_						
	Ref 1090,33	1760,16	2548,2	2461,08					
г	DUT 0	0	0	0					

The Control menu is used to keep watch on signal quality by monitoring such parameters as total harmonic distortion (THD) and the difference in frequencies of the tested and reference merging units (F). The parameters are highlighted, if their values fall outside the permissible range. Verification is useless and cannot be performed if THD is more than 5% and F is more than 0.001 Hz. Please note that the quality is checked just for the channels marked in the verification tab.

# 3.4 Streams

Voltage	Current	Points to (mooving	average 3 average)	✓ 3 Di d	gits after 3 ec. point	]		Freeze	Save
Scale factor					Scale factor				
001,00000	SV1 em61850_3	7			001,00000	SV2 No stream	1		
	А	В	С	Ν		А	В	С	N
RMS	000,004	000,004	000,006	000,005	RMS	000,000	000,000	000,000	000,000
RMS(1)	000,000	000,000	000,000	000,001	RMS(1)	000,000	000,000	000,000	000,000
F(1), Hz	1201,986	1806,961	2460,444	2460,530	F(1), Hz	000,000	000,000	000,000	000,000
THD, %	170,559	097,189	054,282	028,388	THD, %	000,000	000,000	000,000	000,000
Phi (abs), °	020,811	-03,309	-48,741	-67,567	Phi (abs), °	000,000	000,000	000,000	000,000
DC	002,581	001,121	-04,545	003,386	DC	000,000	000,000	000,000	000,000
						А	В	С	N
	Refe	rence chann	el	Error	RMS	-100,000	-100,000	-100,000	-100,000
	e	em61850 3	One-by-one	Relative %	RMS(1)	-100,000	-100,000	-100,000	-100,000
	, 	- ,	· · · · ·		F(1), Hz	-100,000	-100,000	-100,000	-100,000
					THD, %	-100,000	-100,000	-100,000	-100,000
			Phi di	mension min	Phi	-1248,632	198,564	2924,459	4054,000
					DC	-100,000	-100,000	-100,000	-100,000

This is a two-channel verification mode that makes it possible to compare 2 streams across all voltage or current phases. The streams to be compared are configured in the same way as described for the Comparator tab.

#### Fields:

**Scale factors** (these fields are adjacent to those with the names of streams) – set the multipliers to be applied to the RMS and RMS (1) readings of the corresponding streams.

**Reference channel** – this drop-down list is used to select one of the streams as a reference stream. The adjacent list is used to select one of the phases as a reference phase.

The **One-by-one** option means that each phase signal from one stream will be compared with the corresponding phase signal from another stream.

The **Error** field makes it possible to select the type of error: absolute or relative.

Note! Phase shifts of an external and internal stream	can
only be compared if the sources of these streams	are
synchronized. If 2 external streams are compared,	the
synchronization mode of the EM61850 is of	no
importance (see section 3.1.3).	

Reference chann	nel	Error
em61850_3	✓ One-by-one	Relative %
,	Ref. A	
	Ref. B	-
	Ref. C	insion min
	Ref. N	

# 3.5 Multimeter

### 3.5.1 U, I

em61850_37	Points to average 3 2 3 (moving average)								
U, I	P, Q, S Phasors Harmonics		Oscilloscope	Oscilloscope					
	Voltage				Current				
	А	В	С	N	А	В	С	N	Digits after
RMS, V, A	000,004	000,004	000,006	000,005	000,000	000,000	000,000	000,000	dec. point
RMS(1), V, A	000,000	000,000	000,000	000,001	000,000	000,000	000,000	000,000	
DC, V, A	002,677	001,248	-04,797	003,753	-00,130	-00,120	-00,158	-00,098	
Phi(abs), grad	-78,439	-13,270	022,204	008,142	-27,474	-71,603	-29,781	-04,383	
F, Hz	425,063	2203,664	2459,840	2459,887	1883,354	803,392	2450,245	2180,975	
THD, %	212,776	086,821	063,746	031,648	097,238	177,165	104,173	076,493	
Symmetry components									
		U1 000,12133			11	000,00085			
		U2 000,11433		12	000,00113				
		U0 000,02159			10	000,00093			
		K2 094,22622			К2	133,14624			
		ко 030,81455			ко	109,61524			

#### Fields:

RMS - RMS values of voltage/current

**RMS** (1) – RMS values of the  $1^{st}$  harmonic of voltage/current

DC – DC components of voltages and currents per each phase

**Phi** (abs) – absolute angles (between a voltage/current signal and PPS per each phase)  $\mathbf{F}$  – frequency

THD – Total harmonic distortion

Symmetrical components:

**U1(I1)** – positive sequence components

U2(I2) – negative sequence component

U0 (I0) – ze	ero sequence	component
--------------	--------------	-----------

**K2** – negative sequence ratio

K0 – zero sequence ratio

U, I	P, Q, S	Phasors	Harmonics	Oscilloscope	
	А	В	С	N	
U, V	56.9994	56.9996	56.9996	56.9994	
I, A	5.00004	4.99996	5.00004	5.00004	Sum
P, W	142.501	142.499	142.498		427.498
Q, Var	246.816	246.813	246.819		740.448
S, VA	284.999	284.996	285.001		854.996
PF	0.500004	0.500003	0.499993		0.5
P(1), W	142.501	142.499	142.498		427.498
Q(1), Var	246.816	246.813	246.819		740.448
S(1), VA	284.999	284.996	285.001		854.996
cos(phi)1	0.500004	0.500003	0.499993		
sin(phi)1	0.866023	0.866024	0.86603		
U^I, °	59.99972	59.99981	60.00047		
Bd type	0.5L	0.5L	0.5L	0.5L	

U2(I2)

**U1(11)** 

 $K0 = \frac{1}{U1(I1)}$ 

K2 =

Fields: U, V – RMS values of voltage I, A – RMS values of current **P**, **W** – active power **O**, Var – reactive power **S**, **VA** – apparent power **PF** – power factor P(1), W – active power of the 1<sup>st</sup> harmonic  $\mathbf{Q}$  (1),  $\mathbf{Var}$  – reactive power of the 1<sup>st</sup> harmonic **S** (1), **VA** – apparent power of the  $1^{st}$  harmonic Cos(phi)1 – cosine of the angle between the 1<sup>st</sup> harmonics of voltage and current Sin(phi)1 – sine of the angle between the 1<sup>st</sup> harmonics of voltage and current  $\mathbf{U}^{\mathbf{I}}$  – angle between the 1<sup>st</sup> harmonics of voltage and current per each phase **Bd type** – type of burden **Sum** – the fields relate to the corresponding parameters of a three-phase system (ABC)

## 3.5.3 Phasors



The tab "Phasors" displays numeric values of phase shifts among signals in the channels. The vector diagram shows phasors (angles with respect to PPS).

#### 3.5.4 Harmonics

	Analog							
	U, I	P, Q, S			Phasors	Harmo	onics Osci	illoscope
Vo	ltage (	Current	Ph	ase 🗛	ВС	N Digi	its after 3	
50	Harmonics			1	Interharm	onics	F, Hz	0009.71-
Ν	RMS	%	^	Ν	RMS	%	^ 24.0117	
1	9.707544	100.000		0.50	0.000138	100.000	1	4.99E-5- <mark>NININI.I.I.I.I.I.I.I.I.I.I.I.I.I.I.I.I.</mark>
2	0.001415	0.015					1	1 100
3	0.124181	1.279						0009.71
4	0.001016	0.010						
5	0.073639	0.759					25.3212	
6	0.000671	0.007						4.79E-5- <mark>-</mark> Ialdi-Ialahihi.I.Jalahih.I.Jalahi.I.Jalahih.I.J.Jat.Ialahihi.Ialaani
7	0.051807	0.534					1	1 100
8	0.000746	0.008					1	0009.71-
9	0.039844	0.410					1	
10	0.000827	0.009					25,2638	
11	0.031444	0.324	1					5.71E-5- <mark>41.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.</mark>
12	0.000822	0.008					1	1 100
13	0.026146	0.269	1				1	0000.01-
14	0.000879	0.009					1	
10	0.001720	0.224	~				29.7675	վ իլ էիսիսվել իլիս իեղեն ինվել հայ երելու է է հայ հայ հայ հայ
linclu	de Interharmonics							3.74E-5- <mark>11111111111111111111111111111111111</mark>

The buttons **Current/Voltage** allows you to select between current and voltage readings.

The Phase buttons are used to select a phase to be displayed.

The **Harmonics** field is used to specify a number of harmonics to be measured.

The Interharmonics field provides the same for interharmonics.

Four amplitude graphs related to phases A, B, C, and N are displayed on the right. Harmonic or interharmonic numbers are displayed along the horizontal axis. The vertical axis corresponds to magnitudes.



#### 3.5.5 Oscilloscope

In the **Oscilloscope** mode, the waveforms on the selected channels (based on the measurements over the latest second) are displayed. At the leftmost position of the logarithmic scaling slider the amplitudes within 0 to 0.001 s are plotted. By moving the slider to the rightmost position you can view the complete 1-second curves.

# **VERIFICATION REPORT**

Type: analogue voltage transformer Name: Accuracy class: <u>0.1</u> Serial No: <u>1</u> Rated primary voltage: <u>1000</u> V Rated secondary voltage: <u>5</u> V Rated frequency: <u>50</u> Hz Site: <u>Saint Petersburg</u> Owner: <u>Company</u> Last verification date, time: <u>01.01.2021</u>

Reference means of verification:

	Reference standard:	Comparator:
Name	Reference 1	Energomonitor-61850
Serial No	<u>1</u>	1
Accuracy class	0.01	0.02

Conditions during verification: Temperature <u>20</u> °C, Humidity <u>70</u> % Atmospheric pressure <u>100</u> kPa

Network frequency <u>50</u> Hz, network THD <u>0.1</u>, %, network voltage <u>220</u> V

1) Visual inspection and verification of terminal markings: pass

pass, fail

2) Software check: <u>pass</u>

pass, fail

3) Insulation check: <u>pass</u> pass, fail

4) Accuracy test results:

U/Un, %	S, VA	DUT	error
		δ <sub>f</sub> , %	$\Delta\delta$ , min
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

Summary result \_\_\_\_\_

pass, fail

Verification performed by

Signature

Name and surname

18.08.2022 Date

# **INSTALLING EM-61850EXT ON ANOTHER COMPUTER**

When installing the program on another PC, some aspects that need to be considered are as follows:

a) EM-61850 has no DHCP server, thus, to provide connection between the EM-61850 and a client computer, it is necessary to set up a static IP address of LAN or WLAN of the client.

For example:

	WLAN	LAN
IP address	192.168.0.11	192.168.0.10
Subnet mask	255.255.255.0	255.255.255.0

b) EM-61850 uses the following IP addresses:

WLAN	LAN
192.168.0.111 (for connection)	192.168.101 (for connection) 192.168.0.2 (in-service) 192.168.0.3 (in service)