



**Power Simulator / Calibrator**  
**CS 2890**  
**Instruction manual**  
*Version 1.1.1, Code No. 20 752 950*

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# 1 Introduction

The CS 2890 Power Simulator/Calibrator is handheld multifunction four-phase instrument intended for **simulation of typical voltages and current shapes and situations on electrical network** as well as for **calibrating and adjusting procedures** of Metrel Power Quality devices: MI 2883, MI 2885, MI 2892 and MI 2893.



Figure 1: CS 2890 Power Simulator/Calibrator instrument

## 1.1 Main Features

### 1.1.1 Power Simulator mode

- Simple and powerful waveform generator with various settings of PQ phenomena's;
- 4 voltage channels with wide simulation range: up to 300 Vrms in automatic mode, up to 350 Vrms in manual mode;
- 4 current channels with current clamps simulation ratio 1 V / 1000 A;

- Simultaneous voltage and current generation with eight 16-bit DA converters for accurate signal generation;
- Various event simulation: dip, swell, interrupt, inrush, transient and signalling;
- Voltage and current harmonics waveform simulation;
- Unbalanced voltage and current waveform simulation;
- Square flicker simulation;
- Various character load/type combination simulation;
- 4.3" (10.9 cm) TFT colour display.

### 1.1.2 Calibrator mode

- Stable voltage output (between phases L1 – L2) for predefined voltage calibration points for selected PQ Analyser: MI 2883/MI 2885/MI 2892/MI 2893:
  - 5-11-14-23-40-50-75-110-150-165-200-206-230-250-345-350-400-500V
- Stable current output for predefined current calibration points for selected PQ Analyser: MI 2883/MI 2885/MI 2892/MI 2893:
  - 0,050-0,100-0,200-1,000-2,000V ... (50A-100A-200A-1000A-2000A)

#### Note:

- calibration of Class S PQ Analysers: could be performed only with CS 2890 (uncertainty bellow 0.12%),
- calibration of Class A PQ Analysers: could be performed by use of substandard Volt-meter with the accuracy class at least 0.05%.

#### 1.1.2.1 Adjustment of CS 2890 output values

Voltage between L1 – L2 terminals and current outputs (on the L1, L2, L3, N current outputs) could be adjusted to exact value. To get the necessary correction, which should be entered in "Adjustment" mode, follow calibrated values from the CS 2890 calibration certificate or by using substandard Volt-meter (reading the exact value).

### 1.1.3 Adjustment of Metrel PQ instruments

In calibration mode the CS 2890 enables adjustment of Metrel PQ instruments (MI 2883, MI 2885, MI 2892 and MI 2893) in case of accuracy malfunction due to erased calibration constants or other influences affecting the measurement accuracy. Since the adjustment procedure is complex and requires additional sets of adapters, predefined adjustment process; please contact Metrel or authorized dealer for further instructions.

**Note: Adjustment could be done only by the qualified and trained persons.**








## 1.2 Safety considerations

To ensure operator safety while using the Power Simulator/Calibrator instruments and to minimize the risk of damage to the instrument, please note the following general warnings:



**The instrument has been designed to ensure maximum operator safety. Usage in a way other than specified in this manual may increase the risk of harm to the**

operator!

-  Do not use the instrument and/or accessories if any visible damage is noticed!
-  The instrument contains no user serviceable parts. Only an authorized dealer can carry out service or adjustment!
-  Only use approved accessories which are available from your distributor!
-  Instrument contains rechargeable NiMH batteries. The batteries should only be replaced with the same type as defined on the battery placement label or in this manual. Do not use standard batteries while power supply adapter/charger is connected, otherwise they may explode!
-  Hazardous voltages exist inside the instrument. Disconnect all test leads, remove the power supply cable and switch off the instrument before removing battery compartment cover.
-  Maximum voltage between any phase and neutral output is 350 V<sub>RMS</sub>. Maximum nominal voltage between phases is 700 V<sub>RMS</sub>.
-  Check Power Simulator/Calibrator wiring before turning on, in order to prevent misuse and electrical shock.

### 1.3 Applicable standards

The SC 2890 Power Simulator/Calibrator is designed and tested in accordance with the following standards:

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#### *Electromagnetic compatibility (EMC)*

EN 61326-2-2: 2013

Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-2: Particular requirements - Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems

- Emission: Class A equipment (for industrial purposes)
- Immunity for equipment intended for use in industrial locations

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#### *Safety (LVD)*

EN 61010-1: 2010

Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements

EN 61010-2-030: 2010

Safety requirements for electrical equipment for measurement, control and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits

EN 61010-031: 2015

Safety requirements for electrical equipment for measurement, control and laboratory use –

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	Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test
EN 61010-2-032: 2012	Safety requirements for electrical equipment for measurement, control and laboratory use Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test

**Note about EN and IEC standards:**

Text of this manual contains references to European standards. All standards of EN 6XXXX (e.g. EN 61010) series are equivalent to IEC standards with the same number (e.g. IEC 61010) and differ only in amended parts required by European harmonization procedure.

## 1.4 Abbreviations

In this document following symbols and abbreviations are used:

$U_{Nom}$	Nominal voltage
$I_x$	Current output
N, GND, $L_x$	Voltage output
$U_{fund}$	Fundamental voltage
$I_{fund}$	Fundamental current
$U_{h_n}$	n-th harmonic voltage
$I_{h_n}$	n-th harmonic current
$V_{RMS}$	RMS voltage
$A_{RMS}$	RMS current
$THD_U$	Voltage THD
$THD_I$	Current THD

## 2 Description

### 2.1 Front panel



Figure 2: Front panel

Front panel layout:

- |                            |   |
|----------------------------|---|
| 1. LCD                     | Colour TFT display, 4.3 inch (10.9 cm), 480 x 272 pixels.   |
| 2. F1 – F4                 | Function keys.  |
| 3. ARROW keys              | Moves cursor and selects parameters.  |
| 4. ENTER key               | Step into submenu.  |
| 5. ESC key                 | Exits any procedure, confirms new settings.   |
| 6. SHORTCUT keys           | Quick access to main instrument functions.  |
| 7. LIGHT key<br>(BEEP OFF) | Adjust LCD backlight intensity: high/low/off<br>If the <i>LIGHT</i> key is pressed for more than 1.5 seconds, beeper will be disabled. Press & hold again to enable it. |
| 8. ON-OFF key              | Turns on/off the instrument.  |

## 2.2 Connector panel



### ⚠ Warnings!

- ⚠ Use safety test leads only!
- ⚠ Max. short-term voltage of external power supply adapter is 14 V!
- ⚠ Always turn off Power Simulator/Calibrator before plugging in or plugging out test leads.

Figure 3: Front connector panel

#### Front connector panel layout:

- 1 Clamp-on current transformers ( $I_1$ ,  $I_2$ ,  $I_3$ ,  $I_N$ ) output terminals.
- 2 Voltage ( $L_1$ ,  $L_2$ ,  $L_3$ , GND, N) output terminals.
- 3 12 V external power socket.

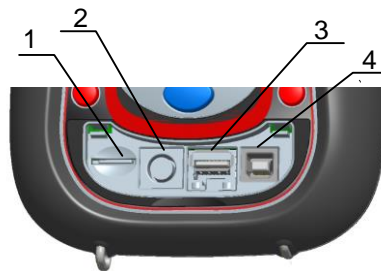


Figure 4: Upper connector panel

#### Upper connector panel layout:

- 1 Not applicable.
- 2 Not applicable.
- 3 Ethernet connector (*Not applicable*).
- 4 USB connector (*used for FW upgrading*).

## 2.3 Bottom view

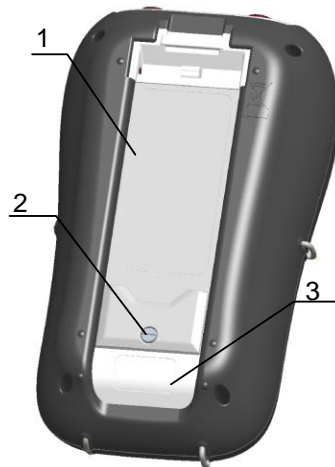


Figure 5: Bottom view

Bottom view layout:

1. Battery compartment cover.
2. Battery compartment screw (unscrew to replace the batteries).
3. Serial number label.

## 2.4 Accessories

### 2.4.1 Standard accessories

Table 1: Power Calibrator/Simulator standard accessories

Description	Pieces
Flexible shielded current leads A 1504	4
Colour coded voltage measurement leads A 1594	5
USB cable	1
Measurement DC lead A 1555	1
Adapter for current measurement leads A 1669	1
12 V / 3A Power supply adapter	1
NiMH rechargeable battery, type HR 6 (AA)	6
Soft carrying bag	1
Compact disc (CD) with manual	1
Calibration certificate	1

### 3 General Setup


General setup menu can be accessed by using SETTINGS key  from Main menu (Power Simulation mode). From the “GENERAL SETUP” menu, colour model for displaying phase measurements can be reviewed, configured and saved. It is also possible to view instrument information.






Figure 6: General setup menu

Table 2: Description of General setup options

<b>Colour Model</b>	Select colours for displaying phase measurements.
<b>Calibration</b>	Select calibration mode
<b>Instrument info</b>	Information about the instrument.

Table 3: Keys in General setup menu

	Select submenu.
	Enters submenu.
	Returns to the Main menu (Power Simulation mode)

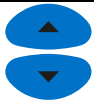
#### 3.1 Colour model

In COLOUR MODEL menu, user can change colour representation of phase voltages and currents, according to his needs. There are some predefined colour schemes (EU, USA, etc.) and a custom mode where user can set up its own colour model.



Figure 7: Colour representation of phase voltages





Selects Colour scheme.



Returns to the General setup menu.

### 3.2 Calibrator

Calibration function is used for **calibrating and adjusting** of Metrel Power Quality Analysers, like: MI 2883, MI 2885, MI 2892 and MI 2893. Calibrator assures stable voltage reference for periodic control of the instruments.



Figure 8: Calibrator screen

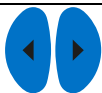
Table 4: Description of Calibrator options

<b>Instrument name</b>	: MI 2883, MI 2885, MI 2892 and MI 2893
<b>Fundamental voltage</b>	Select calibration test point for voltage output (5 ÷ 500 V) Note: In the calibration mode, voltage is generated via terminals L1 – L2
<b>Fundamental current</b>	Select voltage calibration point for current output terminals (0,050 ÷ 2.000 V)
<b>Frequency</b>	Calibration frequency 50.00/60.00 Hz

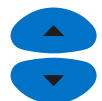
Table 5: Keys in Calibration menu



Activates adjustment and fine output voltages tuning. See next [section](#) for details.



Select parameter value



Scrolls cursor between options



Returns to the GENERAL SETUP (one press); MAIN menu (second press)

**Note:** After leaving CALIBRATION menu (test terminals L1 – L2) bi-phase voltage automatically appears on DUT.

### 3.2.1 Adjustment

The main purpose of Adjustment menu is to generate exact voltage, which is used during the calibration process of the Power Quality devices.

To enter into ADJUSTMENT menu, press F1 (ADJUST) button from the Calibration screen:

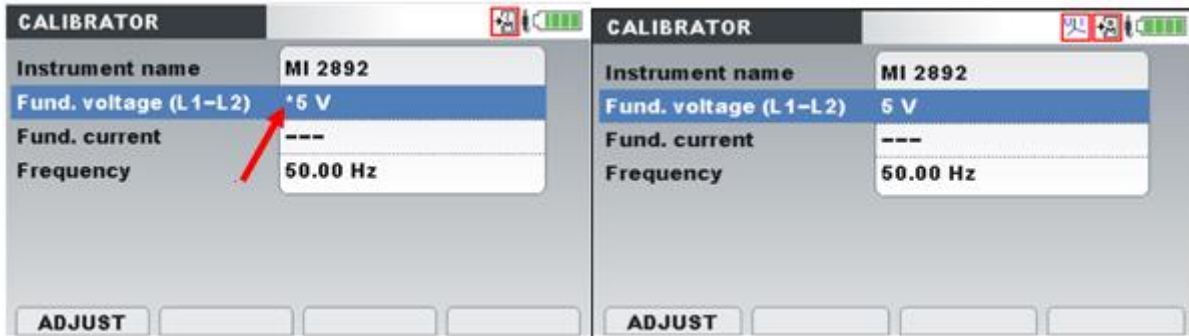



Figure 9: Calibrator screen - "Default" and "Adjusted" CS 2890 voltage output

**Note:** Default CS 2890 voltage output is note **with sign** "\*" on the screen, Adjusted value **without sign** "\*" .

Table 6: Keys in Calibration menu

	Activates adjustment (ADJUST) and fine tuning of output voltages. See next section for details.
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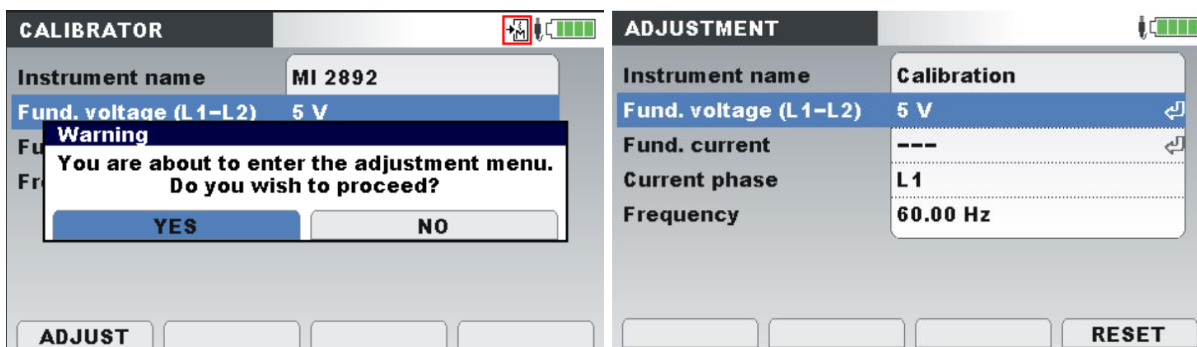





Table 7: Keys for entering into Adjustment menu

	Select parameter value: YES/NO
	Confirmation/Reject entering into Adjustment menu
	Returns to Calibrator menu



Returns to General Setup menu

Each calibration test point can be fine adjusted (fine-tuned), in order to provide stable and absolute reference for the instrument. Exact values can be obtained from the Calibration certificate or parallel connected substandard Volt-meter.

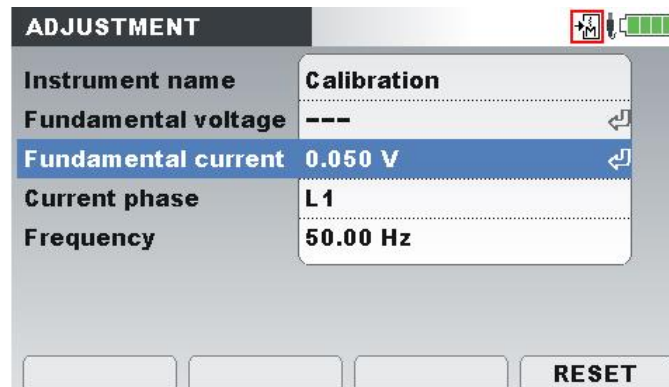


Figure 10: Adjustment screen

Table 8: Description of Calibrator options

<b>Fundamental voltage</b>	Select voltage calibration test point for adjustment
<b>Fundamental current</b>	Select current (voltage) calibration test point for adjustment
<b>Current phase</b>	Select current phase (for current generation only)
<b>Frequency</b>	Select frequency

Table 9: Keys in General setup menu

	Select calibration point
	Scrolls cursor between options
	Enters submenu for entering value measured by reference voltmeter or getting it from the CS 2890 calibration certificate
	Returns to the Main menu.



To ensure correct measurement, it is essential that the CS 2890 instrument is regularly calibrated. If used continuously on a daily basis, a **three-month calibration period** is recommended, otherwise **annual calibration** is sufficient.

### 3.2.2 Adjustment of voltage output

1. Adjustment of CS 2890 voltage (between terminals L1 – L2) by using Calibration certificate:

Voltage output (L1-N)				
JUC	Reference	Uncertainty	Error	Limit
V	V	V	V	V
5	5,00450	0,00088	-0,00450	± 0,05000 ✓
50	50,0033	0,0071	-0,0033	± 0,0500 ✓
75	74,9870	0,0096	0,0130	± 0,0500 ✓
11	11,0106	0,0013	-0,0106	± 0,1100 ✓
110	109,967	0,013	0,033	± 0,110 ✓
165	164,945	0,019	0,055	± 0,110 ✓
23	23,0146	0,0043	-0,0146	± 0,2300 ✓
230	229,943	0,051	0,057	± 0,230 ✓
345	345,035	0,072 *	-0,035	± 0,230 ✓
40	40,0059	0,0059	-0,0059	± 0,4000 ✓
400	400,041	0,086 *	-0,041	± 0,400 ✓
500	499,99	0,10 *	0,01	± 0,40 ✓

\* Voltage output L1-L2

Figure 11: CS 2890 Calibration certificate – voltage output

Selection of 5V on the CS 2890 generates 5,00450V on the CS 2890 output (value from the calibration certificate), so it is necessary to adjust the voltage correction of 5,0045V.

Press ADJUST (1.) → Press **YES** to Enter the Adjustment menu → Press Enter and enter the corrected value of 5,0045V and confirm the value by pressing Enter key

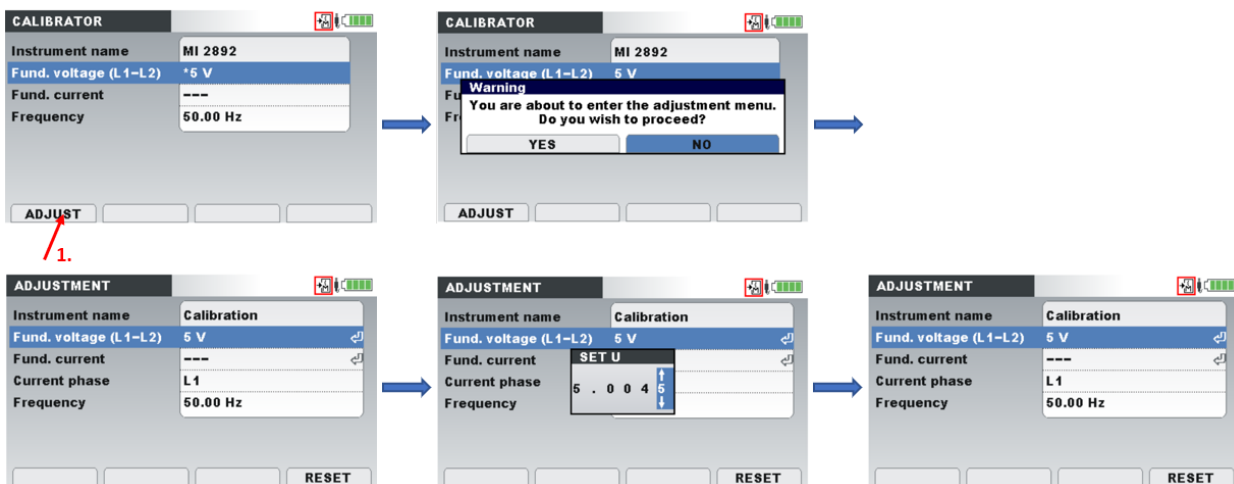


Figure 12: Adjustment procedure using values from the calibration certificate

**Note:** Adjust all calibration points from the calibration certificate, which are needed for the calibration.

2. Adjustment of CS 2890 voltage by using **Substandard Volt-meter**:

Connect substandard Volt-meter to CS 2890:



Figure 13: Connection for the voltage adjustment procedure using substandard Volt-meter

Connect L1 and L2 outputs from the CS 2890 to substandard volt-meter inputs.

Press ADJUST (1.) → Press **YES** to Enter the Adjustment menu → Press Enter and enter the corrected value of 5,0045V (value from the substandard volt-meter) and confirm the value by pressing Enter key

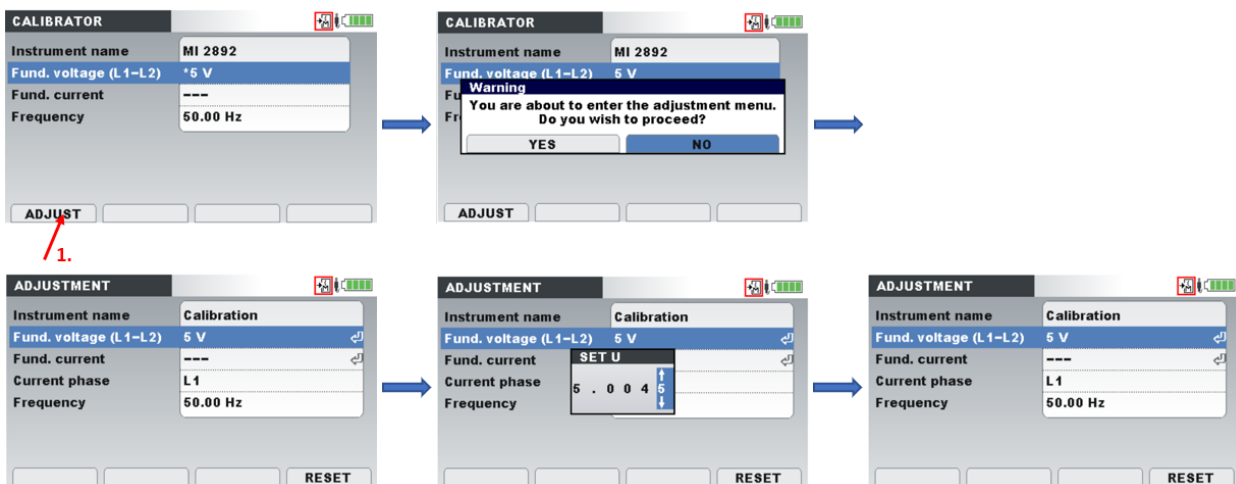


Figure 14: Voltage adjustment procedure using values from the substandard Volt-meter

### 3.2.3 Adjustment of current output

1. Adjustment of CS 2890 current outputs - **using Calibration certificate**. Please note, that all outputs (L1, L2, L3, N) at all calibration points should be adjusted.

Output mV	UUC mV	Reference mV	Uncertainty mV	Error mV	Limit mV
I1	50	50,019	0,017	-0,019	± 0,125 √
I2	50	50,106	0,018	-0,106	± 0,125 √
I3	50	50,029	0,017	-0,029	± 0,125 √
In	50	50,021	0,017	-0,021	± 0,125 √
I1	100	99,964	0,028	0,036	± 0,250 √
I2	100	100,004	0,028	-0,004	± 0,250 √
I3	100	99,995	0,028	0,005	± 0,250 √
In	100	99,987	0,028	0,013	± 0,250 √
I1	200	199,975	0,052	0,025	± 0,500 √
I2	200	199,928	0,052	0,072	± 0,500 √
I3	200	199,984	0,052	0,016	± 0,500 √
In	200	200,072	0,052	-0,072	± 0,500 √
I1	1000	1000,17	0,12	-0,17	± 2,50 √
I2	1000	999,89	0,12	0,11	± 2,50 √
I3	1000	999,88	0,12	0,12	± 2,50 √
In	1000	1000,48	0,12	-0,48	± 2,50 √
I1	2000	2000,83	0,22	-0,83	± 5,00 √
I2	2000	1999,98	0,22	0,02	± 5,00 √
I3	2000	2000,21	0,22	-0,21	± 5,00 √
In	2000	2000,90	0,22	-0,90	± 5,00 √

Figure 15: CS 2890 Calibration certificate – current output

Selection of 50mV on the CS 2890 generates 50.019mV on the CS 2890 output (value from the calibration certificate), so it is necessary to adjust the current correction to 50,019mV (phase L1).

Select 0,050V under Calibration mode (1.) → Press ADJUST (2.) → Press **YES** to Enter the Adjustment menu → Press Enter and Enter the corrected value of 0,05002V and press Enter

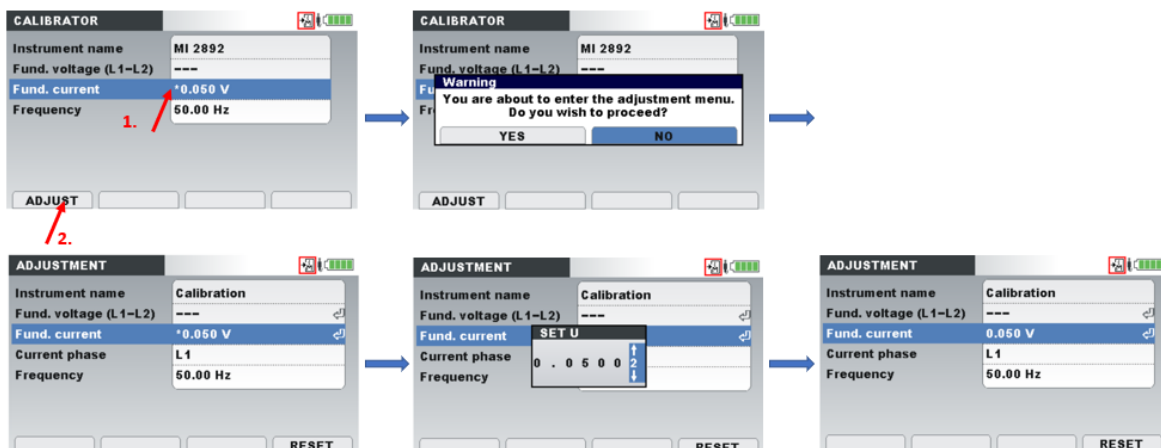


Figure 16: Current adjustment procedure using values from the calibration certificate

2. Adjustment of CS 2890 current output by using **substandard Volt-meter**:

Connect substandard Volt-meter to CS 2890 using special adapter A 1669. Current output should be burned with 110 kΩ (or parallel connected PQ Analyser).



Figure 17: Connection diagram for current adjustment procedure using substandard Volt-meter

Press ADJUST (1.) → Press **YES** to Enter the Adjustment menu → Select calibration current (2.) (0.050V) and appropriate phase (L1) (3.) → Press Enter and Enter the corrected value of 0.05029 V (value from the substandard Volt-meter) and press Enter

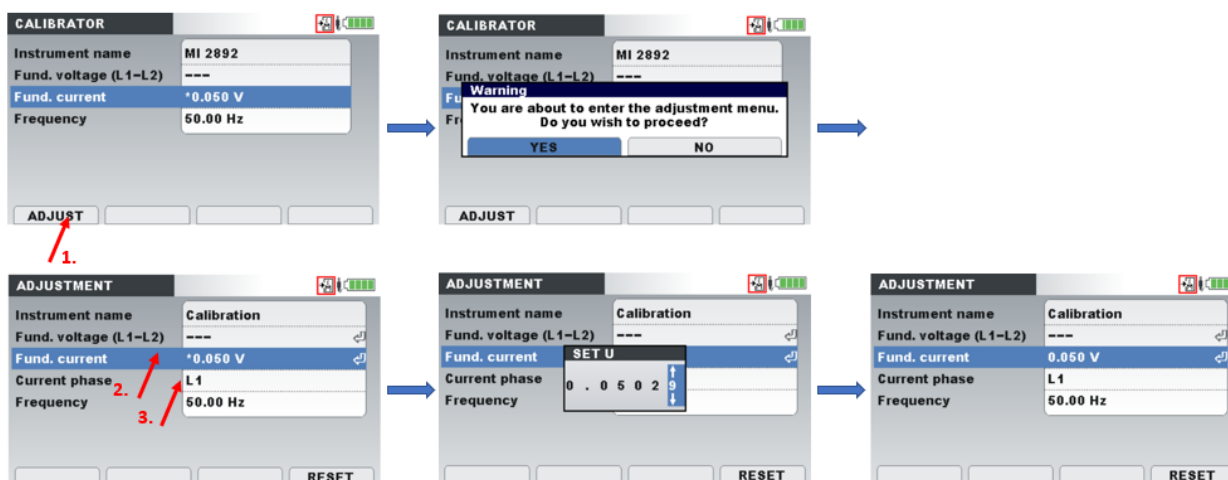


Figure 18: Adjustment procedure using values from the substandard Volt-meter

**Important notes:**

- Adjust all calibration points (all phases and neutral for the current)
- Adjusted values are valid till:
  - o Manual Reset – by pressing RESET button under Adjustment menu

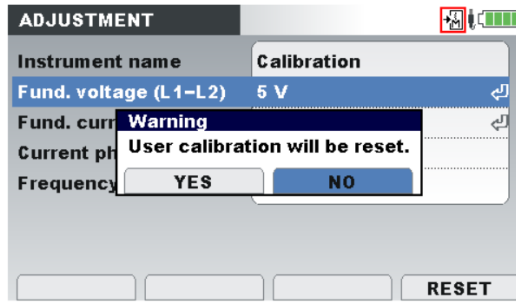


Figure 19: Reset of Adjusted values to default one

- Leaving Calibration menu, Power On/Off **does not perform** reset of Adjustment values
- For the selection of appropriate Volt-meter, please contact your distributor for detail instructions
- Adjustment values are marked on the LCD without sign “\*”

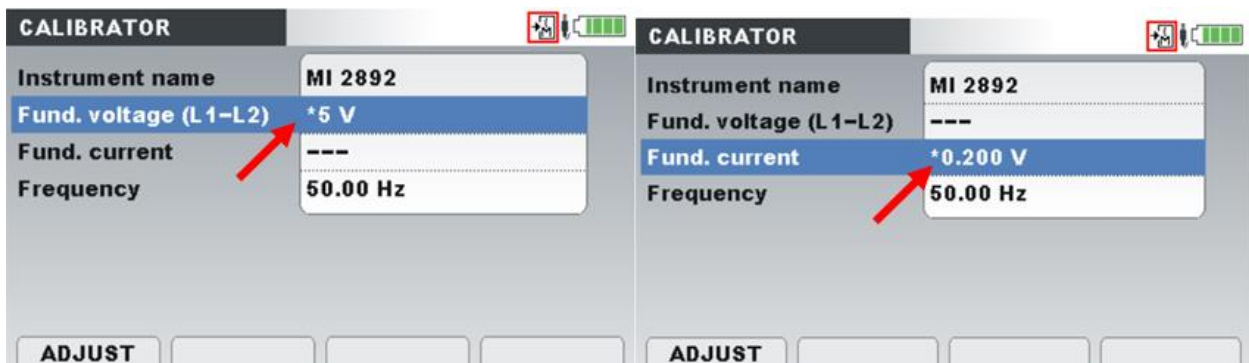


Figure 20: Voltage, Current value is NOT Adjusted (marked with sign “\*”)

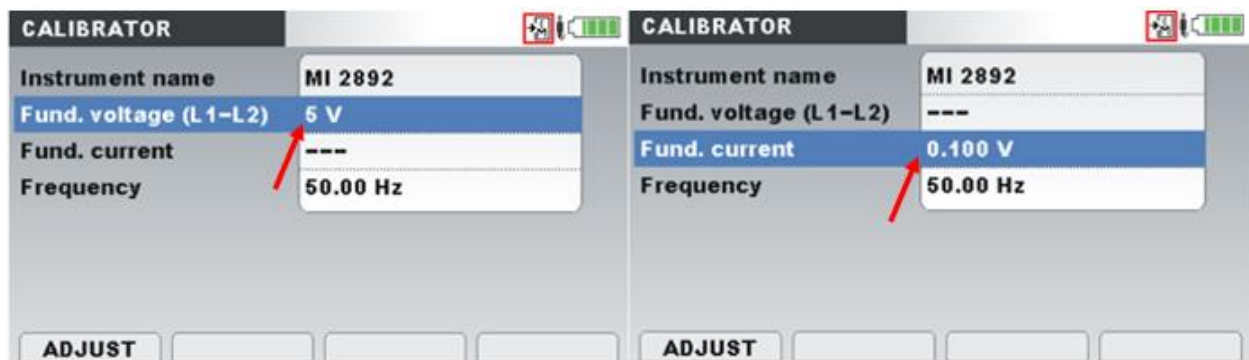


Figure 21: Voltage, Current value IS Adjusted (without sign “\*”)



### 3.3 Instrument info

Basic information concerning the instrument (company, serial number, firmware and hardware version) can be viewed in this menu.

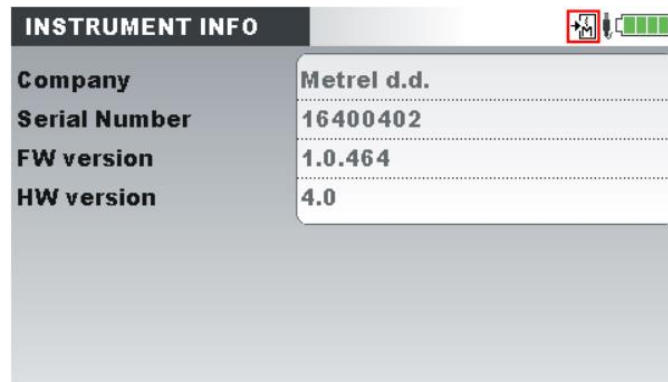


Figure 22: Instrument info screen

Table 10: Keys in Instrument info screen

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<b>ESC</b>	Returns to the General setup menu.
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## 4 Operating the instrument – Power Simulator

After powering ON, the CS 2890 works in Power Simulator mode - default instrument functionality.

The instrument front panel consists of a colour LCD display and keypad. Generated waveforms and instrument status are shown on the display. Basic display symbols and keys description are shown on figures below.



Figure 23: Power Simulator Display symbols and keys description

During simulation campaign, SCOPE screen can be observed as shown on figure below.



Figure 24: Common display symbols and labels on SCOPE screen

## 4.1 Instrument status bar

Instruments status bar is placed on the top of the screen. It indicates different instrument states. Icon descriptions are shown in table below.

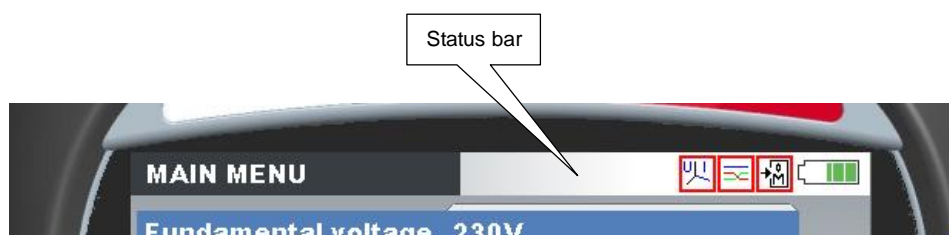



















Figure 25: Instrument status bar

Table 11: Instrument status bar description





	Indicates battery charge level.
	Indicates that charger is connected to the instrument. Batteries will be charged automatically when charger is present.
	Indicates that instrument is overheated and does not provide requested output signals.
	Instrument simulates pure resistive generator network.
	Instrument simulates inductive generator network.
	Instrument simulates capacitive generator network.
	Instrument simulates pure resistive load network.
	Instrument simulates capacitive load network.

	Instrument simulates inductive load network.
	Harmonics on current outputs are generated.
	Harmonics on voltage outputs are generated.
	Harmonics on both current and voltage outputs are generated.
	Unbalance is presented on current outputs ( $I_1 \neq I_2 \neq I_3$ ).
	Unbalance is presented on voltage outputs ( $U_1 \neq U_2 \neq U_3$ ).
	Unbalance is presented on both current and voltage outputs.
	Instrument simulates wrong connection.
	Flicker simulation with squared distribution.

## 4.2 Instrument keys





Instrument keyboard is divided into four subgroups:

- Function keys
- Shortcut keys
- Menu/zoom manipulation keys: Cursors, Enter, Escape
- Other keys: Light and Power on/off keys

Function keys     are multifunctional. Their current function is shown at the bottom of the screen and depends on selected instrument function.






Quick setup and function shortcut keys are shown in tables below. They provide quick access to the most common instrument functions.

Table 12: Shortcut keys

	Generate single and poly-phase dip event.
	Generate swell and transient events.
	Set voltage and current harmonics.
	Set load type and load character.

For more details, read section 4.4 Keyboard shortcuts keys.

Table 13: Function keys

	Shows General Setup screen from Main menu.
	Set backlight intensity (high/low/off).
	Hold  key for 1.5 second to disable/enable beeper sound signal.
	Switch On/off the instrument. Note: Hold key for 5 seconds in order to reset instrument, in case of failure.

Cursor, Enter and Escape keys are used for moving through instrument menu structure, entering various parameters. Additionally, cursor keys are used for zooming graphs and moving graph cursors.

## 4.3 Instrument Main Menu

### 4.3.1 Power Simulator Menu

After powering on the instrument, the “MAIN MENU” screen (Power Simulator function) is displayed. From this menu all instrument options are manipulated. The CS 2890 default menu screen is always “Simulator” screen.

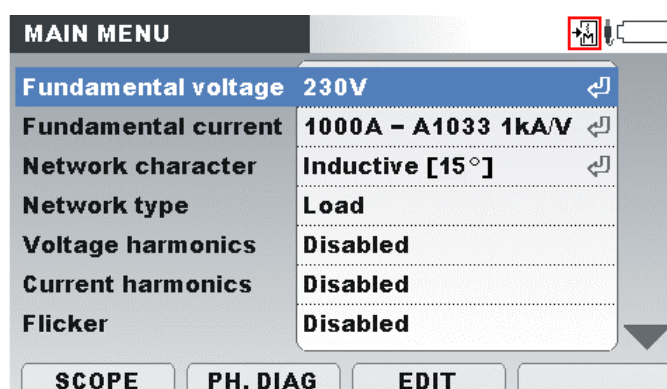





Figure 26: Main menu – Simulator window

Table 14: Instrument Main menu options

Fundamental voltage	Selection of system fundamental nominal voltage.
Fundamental current	Selection of system fundamental nominal current.
Network character	Selection of between resistive, inductive and capacitive load type and determine the angle.
Network type	Selection of between load (export) and generated (import) system.
Voltage harmonics	Selection of between disabled, predefined low, high and manually adjusted harmonics on voltage.
Current harmonics	Selection of between disabled, predefined low, high and manually adjusted harmonics on current.
Flicker	Disable or enable flicker and adjust its parameters.
Voltage unbalance	Select between disabled, predefined low, high and manually adjusted unbalance on voltage.
Current unbalance	Selection between disabled, predefined low, high and manually adjusted unbalance on current.
Frequency	Selection between predefined system frequencies.
Event type	Select various network events: dip, swell, interrupt, inrush, signalling, transient and adjust its parameters.
Event occurrence	Selection of event trigger (keys, time delay between selected events): Keys only, 10 s, random, manual.
Sequence	Redefine output voltage and current sequence.
Factory reset	Resets system settings to factory defaults.




By using function keys, user can access scope and phase diagram screens or edit menu, that allows modifying detailed parameters for each generated signal.

### 4.3.2 Fundamental voltage



By using left  and  right cursor keys user can select system fundamental (nominal) voltage in 10 V steps within 50 V to 300 V range. Enter key  allows user to enter desired nominal voltage directly. Selected voltage is immediately applied on all phases. If it's necessary different voltage can be applied on different voltage outputs. See section 4.9 *Edit menu* for details. If all other voltage options (harmonics, flicker, events) are disabled then output voltage will be equal to fundamental voltage.

### 4.3.3 Fundamental current

Power Simulator current clamp output simulate A 1033 current clamps with voltage output (ratio: 1 V = 1000 A). In order to get valuable results on the measurement instrument, it is necessary to select A 1033 (1000 A/V) current clamps in configuration menu. Please check measuring instrument Instruction manual for details.

By using left  and  right cursor user can select system fundamental (nominal) current in 100 A steps within 100 A to 1000 A range. Enter key  allows user to enter desired nominal current directly. Selected current is immediately applied on all phases. If it's necessary different current can be applied on different current outputs. See section 4.9 *Edit menu* for details. If all other current options (harmonics, inrush, unbalance) are disabled them current output will be equal to fundamental current.

### 4.3.4 Network character

By using left  and  right cursor, user can switch between and set three network characters:

- Resistive network character– where voltage and current are in phase
- Inductive network character – where current is lagging behind voltage


Phase shift can be adjusted, by entering the submenu  and setting the phase angle, by which the current lags the voltage. Current lag can be set in 1° resolution within 0° to 180° range. These settings will affect phases L1, L2 and L3.



Figure 27: Current lags voltage by 25° angle

- Capacitive network character – where current is leading in front voltage.




Phase shift can be adjusted, by entering the submenu  and setting the phase angle, by which the current lead the voltage. Current lead can be set in 1° resolution within 0° to 180° range. These settings will affect phases L1, L2 and L3.





Figure 28: Current leads voltage by 5° angle

#### 4.3.5 Network type

By using left  and  right cursor, user can switch between Generator and Load network type:



- Generator network type – Power Simulator simulate generator, where voltage and current have opposite direction. Phase shift between voltage and current (defined by Network character phase shift) is additionally shifted for 180°. These settings will affect phases L1, L2 and L3.
- Load network type – Power Simulator simulate load, where voltage and current are in phase. Phase shift between voltage and current (defined by Network character phase shift) is not additionally shifted. These settings will affect phases L1, L2 and L3.

#### 4.3.6 Voltage harmonics

By using left  and  right cursor, user can switch between different voltage harmonic set options:

- Disabled – no voltage harmonics are present.
- Low – 5 % of Fundamental voltage is present on 3<sup>rd</sup>, 5<sup>th</sup> and 7<sup>th</sup> harmonic simultaneously. These settings will affect all phases.
- High – 15 % of Fundamental voltage is present on 3<sup>rd</sup>, 5<sup>th</sup> and 7<sup>th</sup> harmonic simultaneously. These settings will affect all phases.
- Manual – user defined harmonic set is generated on voltage output. See section 4.7 *Harmonics* for details how to define harmonic set.




#### 4.3.7 Current harmonics

By using left  and  right cursor, user can switch between different current harmonic set options:



- Disabled – no current harmonics are present.
- Low – 5 % of Fundamental current is present on 3<sup>rd</sup>, 5<sup>th</sup> and 7<sup>th</sup> harmonic simultaneously. These settings will affect all phases.
- High – 15 % of Fundamental current is present on 3<sup>rd</sup>, 5<sup>th</sup> and 7<sup>th</sup> harmonic simultaneously. These settings will affect all phases.

- Manual – user defined harmonic set is generated on current output. See section 4.7 *Harmonics* for details how to define harmonic set.

### 4.3.8 Flicker



By using left  and  right cursor, user can enable or disable flicker generator. If enabled, Flicker generator can be adjusted, by entering the submenu with  key and setting the flicker parameters. See section 4.8 *Flickers* for details how to adjust parameters.

### 4.3.9 Voltage unbalance

By using left  and  right cursor, user can switch between unbalance options:



- Disabled – no unbalance is present in the system.
- Low – 1 % of negative (u-) and zero (u0) unbalance is added to the system.
- High – 5 % of negative (u-) and zero (u0) unbalance is added to the system.
- Manual – user can adjust custom unbalance, by adjusting voltage amplitude and phase angle of each phase in EDIT MENU. See section 4.6.2 *Unbalance diagram* for details.

### 4.3.10 Current unbalance

By using left  and  right cursor, user can switch between unbalance options:

- Disabled – no unbalance is present in the system.
- Low – 5 % of negative (i-) and zero (i0) unbalance is added to the system.
- High – 30 % of negative (i-) and zero (i0) unbalance is added to the system.
- Manual – user can adjust custom unbalance, by adjusting current amplitude and phase angle of each phase in EDIT MENU. See section 4.6.2 *Unbalance diagram* for details.



### 4.3.11 Frequency

By using left  and  right cursor, user can switch between predefined system frequencies:

- 50 Hz
- 60 Hz

System frequency may be manipulated more accurate by using Edit menu. See section 4.9 *Edit menu* for more detailed description.

### 4.3.12 Event type

By using left  and  right cursor, user can switch between predefined system events. List of available events:



- Dip – voltage dip



- Swell – voltage swell
- Interrupt – voltage interrupt
- Inrush – inrush current
- Signalling – signalling voltage event for remote control of network equipment
- Transient – voltage transient

See section 4.10 *Events* for event setup and configuration.

### 4.3.13 Event occurrence



By using left  and  right cursor, user can change time interval of event occurrence. Following options are available.

- Keys only – single events will occur manually, by pressing shortcut keys.
- 10 s – selected event will occur once each 10 seconds.
- Random – selected event will occur randomly in between 1 second and 20 second interval.
- Manual – user selectable event occurrence interval. By pressing ENTER key, additional dialog will be open, where user can set event occurrence interval within 1 s ... 60 s.



Figure 29: Manual set time delay dialog

### 4.3.14 Swap channels

By using left  and  right cursor, user can select following options to swap channels:

- Voltage [1 2 3 N] – status of voltage channel mapping. Press ENTER to change it.
- Current [1 2 3 N] – status of current channel mapping. Press ENTER to change it.

For example, voltage U1 can be sent to output terminal L3, instead of terminal L1 (normally used), and vice versa. In this way, simulator is used do simulates wrongly connected Power Quality analyser. See next Figure 30: Swapping instrument channels and section 4.11 *Swap connection terminals* for details.

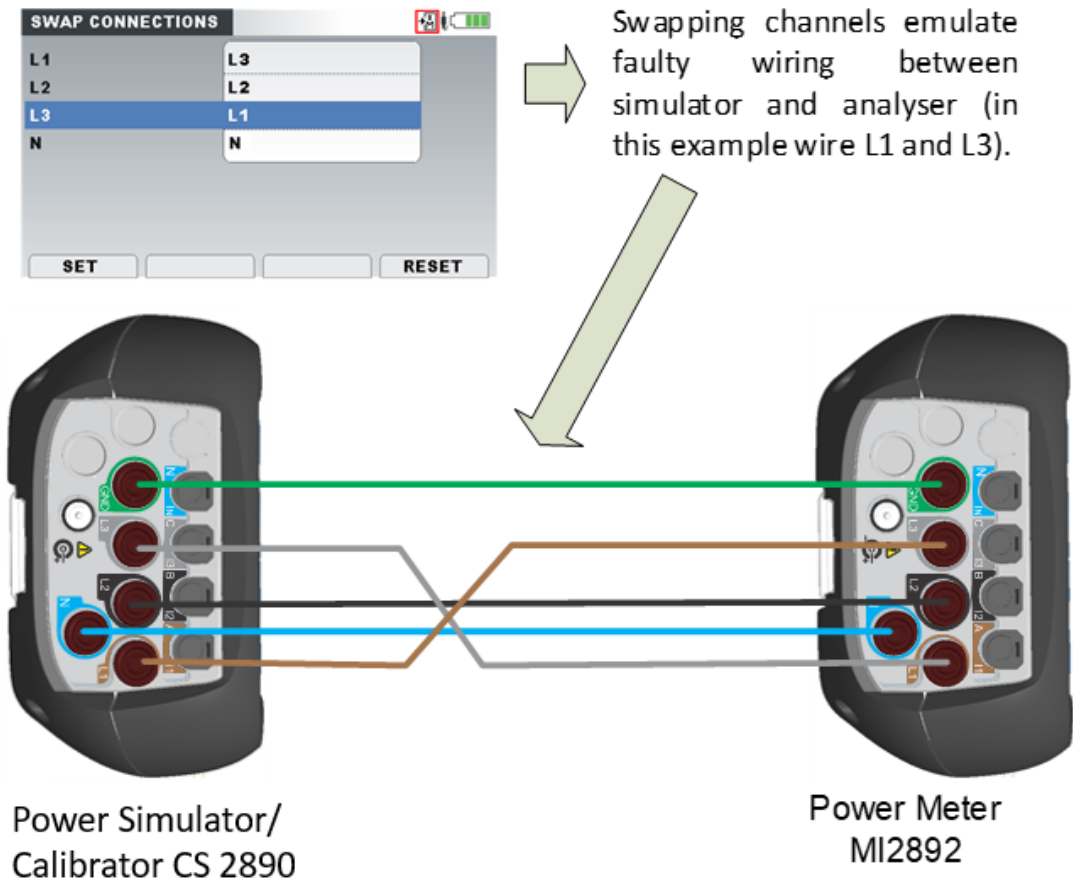


Figure 30: Swapping instrument channels

### 4.3.15 Factory reset


Factory reset set instrument settings to factory default settings. Note, that this will reset all user defined parameters. After ENTER key is pressed, a confirmation is required in order to perform the reset.

## 4.4 Keyboard shortcuts

Power Simulator has few keyboard shortcuts in order access common functions quickly. Each shortcut key has two working regimes: short or two seconds long key press. See table below for detailed description.

Table 15: Shortcut keys

<b>DIP</b>	Short press	Enable single phase dip event.
	Long press (2 s)	Enable single phase interrupt event.
<b>Swell</b>	Short press	Enable single phase swell event.
	Long press (2 s)	Enable single phase inrush event.
<b>Harmonics</b>	Short press	Generates harmonics on voltage.
	Long press (2 s)	Generates harmonics on current.

	Short press	Changes between inductive/capacitive network character
	Long press (2 s)	Changes between load/generator network type.

### 4.5 Scope screen

Voltage and current parameters can be observed in the scope screen. Currently generating waveform can be viewed in graphical form (SCOPE). User can enter the screens by pressing **F1** key from Main menu. Various combinations of voltage and current waveforms can be displayed on the instrument, as shown below.

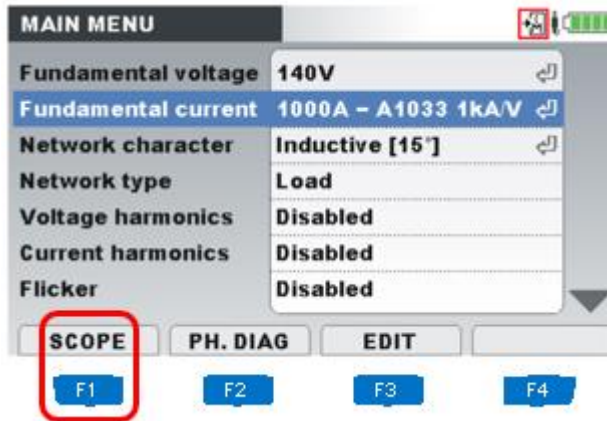


Figure 31: Entering into Scope screen presentation

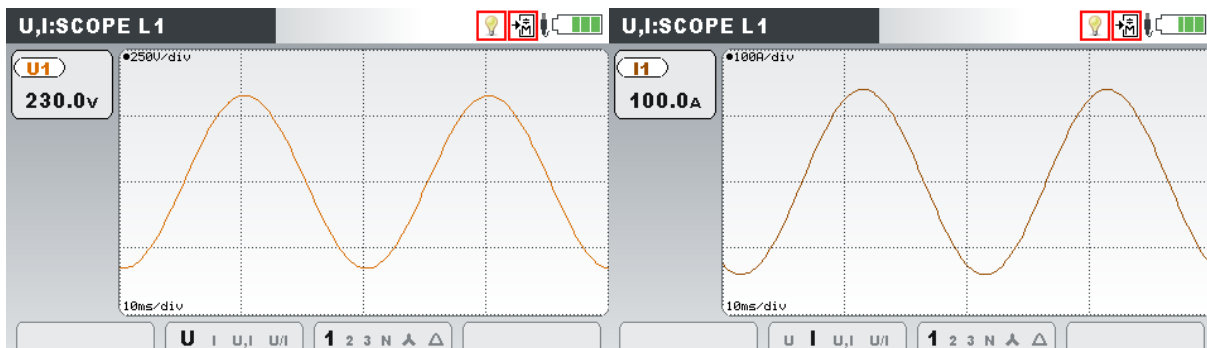


Figure 32: Voltage and current waveform mode

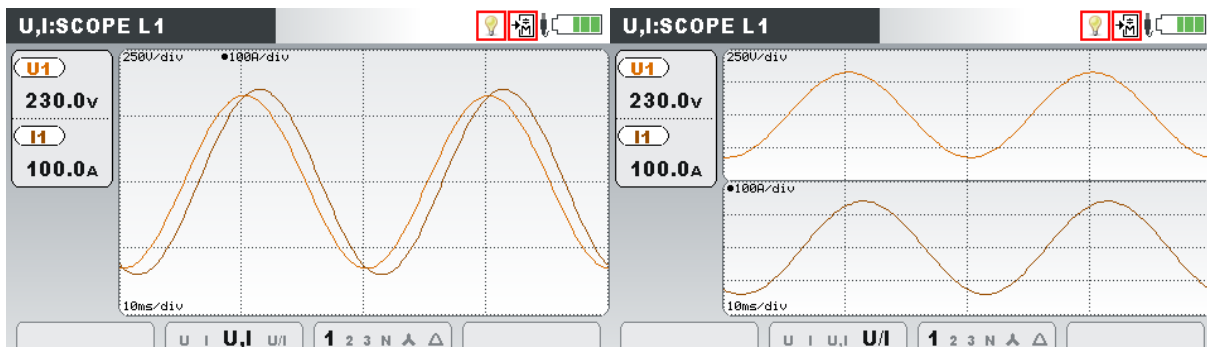


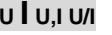

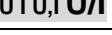













Figure 33: Voltage and current waveform mode - single mode and dual mode

Table 16: Instrument screen symbols and abbreviations

U1, U2, U3, Un	True effective value of phase voltage: $U_1, U_2, U_3, U_N$
U12, U23, U31	True effective value of phase to phase voltage: $U_{12}, U_{23}, U_{31}$
I1, I2, I3, In	True effective value of current: $I_1, I_2, I_3, I_N$

Table 17: Keys in Scope screen

		Selects which waveforms to show:
		Shows voltage waveform.
		Shows current waveform.
		Shows voltage and current waveform (single graph).
		Shows voltage and current waveform (dual graph).
		Selects between phase, neutral, all-phases and line view:
		Shows waveforms for phase L1.
		Shows waveforms for phase L2.
		Shows waveforms for phase L3.
		Shows waveforms for neutral channel.
		Shows all phase waveforms.
		Shows all phase-to-phase waveforms.
		Selects which waveform to zoom (only in U/I or U+I).
		Sets vertical zoom.
		Sets horizontal zoom.
		Returns to the Main menu.

## 4.6 Phase Diagram

Phase diagram graphically represents system frequency, fundamental voltages, currents and phase angles of the simulated waveforms. This view is strongly recommended for checking instrument settings before and during simulation, as most issues arise from wrongly connected instrument. Phase diagram screens display:

- Graphical presentation of voltage and current phase vectors of the simulated system,
- Symmetrical components and unbalance of the simulated system.

### 4.6.1 Phase diagram

By entering PHASE DIAGRAM option,  key, from MAIN MENU, the following screen is shown (see figure below).

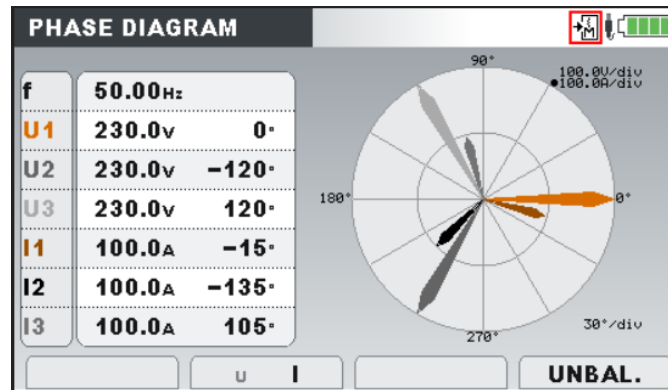


Figure 34: Phase diagram screen

Table 18: Instrument screen symbols and abbreviations

f	Frequency.
U1, U2, U3	Fundamental voltages $U_{fund1}$ , $U_{fund2}$ , $U_{fund3}$ with relative phase angle to $U_{fund1}$ .
I1, I2, I3	Fundamental currents $I_{fund1}$ , $I_{fund2}$ , $I_{fund3}$ with relative phase angle to $U_{fund1}$ .

Table 19: Keys in Phase diagram screen

<b>F2</b>	<b>U I</b> <b>I U</b>	Selects voltage for scaling (with cursors). Selects current for scaling (with cursors).
<b>F4</b>	<b>UNBAL.</b>	Switches to UNBALANCE DIAGRAM view.
		Scales voltage or current phasors.
<b>ESC</b>		Returns to the Main menu.

### 4.6.2 Unbalance diagram

Unbalance diagram represents current and voltage unbalance of the generating system. Unbalance arises when RMS values or phase angles between consecutive phases are not equal. Diagram is shown in figure below.

Both voltage and current unbalances can be set from Main menu by selecting either of predefined “low” or “high” unbalance. It is also possible to use manual settings menu, to set each phase separately through EDIT MENU, accessible through EDIT button -

**F1** key from Phase diagram / Unbalance diagram screens, or **F3** key from Main menu.

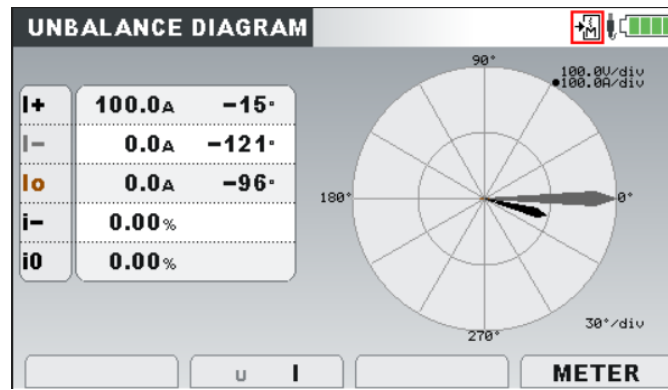




Figure 35: Unbalance diagram screen

Table 20: Instrument screen symbols and abbreviations

U0	Zero sequence voltage component $U^0$
I0	Zero sequence current component $I^0$
U+	Positive sequence voltage component $U^+$
I+	Positive sequence current component $I^+$
U-	Negative sequence voltage component $U^-$
I-	Negative sequence current component $I^-$
u-	Negative sequence voltage ratio $u^-$
i-	Negative sequence current ratio $i^-$
u0	Zero sequence voltage ratio $u^0$
i0	Zero sequence current ratio $i^0$

Table 21: Keys in Unbalance diagram screen

F2	U I	Shows voltage unbalance measurement and selects voltage for scaling (with cursors).
	I U	Shows current unbalance measurement and selects current for scaling (with cursors).
F4	METER	Switches to PHASE DIAGRAM view.
		Scales voltage or current phasors.
		Returns to the Main menu.

## 4.7 Harmonics

Harmonics represent voltage and current signals as a sum of sinusoids of power frequency and its integer multiples. Sinusoidal wave with frequency k-times higher than fundamental (k is an integer) is called harmonic wave and is denoted with amplitude and a phase shift (phase angle) to a fundamental frequency signal. Example of a signal with added harmonics is shown on figure below.

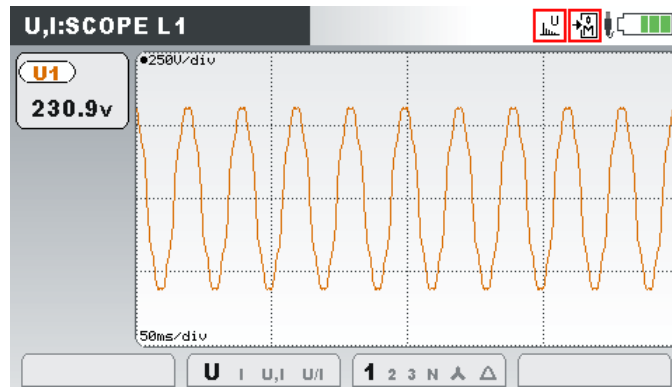


Figure 36: 230V fundamental voltage signal with added 5% of 3<sup>rd</sup>, 5<sup>th</sup> and 7<sup>th</sup> harmonic

### 4.7.1 Harmonics settings screen

By entering either Voltage or Current harmonics option from MAIN MENU, harmonics screen is shown (see figures below). In these screens, voltage or current harmonics are shown. All values presented are in % of phase fundamental voltage / current).

VOLTAGE HARMONICS				
%	U1	U2	U3	Un
THD	0.00	0.00	0.00	0.00
h 2	0.00	0.00	0.00	0.00
h 3	4.00	0.00	0.00	0.00
h 4	0.00	0.00	0.00	0.00
h 5	0.00	0.00	0.00	0.00
h 6	0.00	0.00	0.00	0.00

RESET    SET    VIEW    BAR


Figure 37: Voltage harmonics settings screen

CURRENT HARMONICS				
%	I1	I2	I3	In
THD	2.00	0.00	0.00	0.00
h 2	0.00	0.00	0.00	0.00
h 3	11.0	0.00	0.00	0.00
h 4	0.00	0.00	0.00	0.00
h 5	0.00	0.00	0.00	0.00
h 6	0.00	0.00	0.00	0.00

RESET    SET    VIEW    BAR

Figure 38: Current harmonics settings screen

If Manual option is selected at Voltage or Current harmonics setup, user can modify settings for each of the specified, all up to 50<sup>th</sup>, voltage and/or current harmonics. Currently selected parameter is coloured blue. A selection window, referred to figure below, is opened after pressing ENTER key. Setting is made by using cursor keys,

confirmed as the window is closed (ENTER or ESC key) and enabled, when SET  key is pressed.

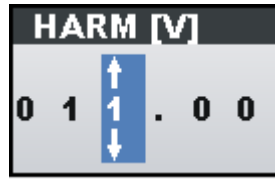







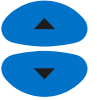



Figure 39: Set harmonic selection window

Description of symbols and abbreviations used in METER screens are shown in table below.

Table 22: Instrument screen symbols and abbreviations

THD	Total voltage / current harmonic distortion THD <sub>U</sub> and THD <sub>I</sub> in absolute values (V or A) or in % of fundamental voltage / current harmonic.
h1 ... h50	n-th harmonic voltage U <sub>h<sub>n</sub></sub> or current I <sub>h<sub>n</sub></sub> component in absolute values (V or A) or in % of fundamental voltage / current harmonic.

Table 23: Keys in Harmonics (METER) screens

	<b>RESET</b>	Reset all harmonics to zero.
	<b>SET</b>	Refresh (activate) currently set manual harmonics.
	<b>VIEW</b>	Enters window to switch between absolute (V, A) and relative (% of nominal) harmonics values. 
	<b>BAR</b>	Switches to BAR view.
		Shifts through harmonic components.
		Shifts through channels, increase/decrease harmonic level. Switches between absolute and relative harmonics values.
		Enters harmonic selection window.
		Returns to the Main menu.
		Closes harmonic selection window. Closes window to switch between absolute and relative harmonics values.

### 4.7.2 Histogram (Bar)

Bar screen displays dual bar graphs. The upper bar graph shows voltage harmonics and the lower bar graph shows current harmonics.



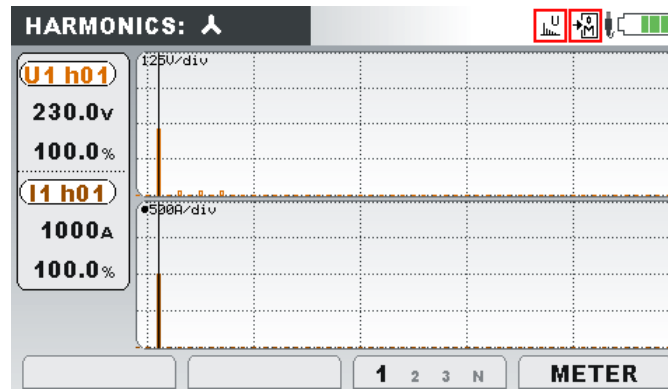


Figure 40: Harmonics histogram screen

Description of symbols and abbreviations used in BAR screens are shown in table below.

Table 24: Instrument screen symbols and abbreviations

Ux h01 ... h50	Voltage harmonic component in $V_{RMS}$ and in % of fundamental voltage; [x: 1, 2, 3, n].
Ix h01 ... h50	Current harmonic component in $A_{RMS}$ and in % of fundamental current; [x: 1, 2, 3, n].
Ux THD	Total voltage harmonic distortion $THD_U$ in V and in % of fundamental voltage; [x: 1, 2, 3, n].
Ix THD	Total current harmonic distortion $THD_I$ in $A_{RMS}$ and in % of fundamental current; [x: 1, 2, 3, n].

Table 25: Keys in Harmonics (BAR) screen

	<b>1 2 3 N</b>	Selects between single phases and neutral channel harmonics bars.
<b>F3</b>	<b>1 2 3 N</b>	Shows harmonics components for phase L1.
	<b>1 2 3 N</b>	Shows harmonics components for phase L2.
	<b>1 2 3 N</b>	Shows harmonics components for phase L3.
	<b>1 2 3 N</b>	Shows harmonics components for neutral channel.
<b>F4</b>	<b>METER</b>	Switches to METER view.
		Scales displayed histogram by amplitude.
		Scrolls cursor to select single harmonic bar.
<b>ENTER</b>		Toggles cursor between voltage and current histogram.
<b>ESC</b>		Returns to the Main menu.

## 4.8 Flickers

Flicker is impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time. Power Simulator/Calibrator use amplitude modulation according to the IEC 61000-4-15 standard, to provide flicker on voltage outputs.

By enabling Flickers option from the MAIN MENU, flicker is added to the voltage outputs. Flicker parameters depend on fundamental voltage of the system and selected system frequency. Pst value may be set as desired in ranges 0.50 to 5.00 in 0.10 steps, whereas CPM and  $\Delta U/U$  values are defined according to IEC61000-4-15 standard.



	L1	L2	L3
Pst	1.00	1.00	1.00
CPM	2	1620	4800
$\Delta U/U$	0.02191	0.00407	0.00000







Figure 41: Flicker settings menu

Description of symbols and abbreviations used in FLICKERS screen is shown in table below.

Table 26: Instrument screen symbols and abbreviations

Pst	Short term flicker perceptibility.
CPM	Voltage changes per minute.
$\Delta U/U$	Voltage fluctuation in %.

Table 27: Keys in Flickers screen

	<b>RESET</b>	Reset flickers to default.
	<b>SET</b>	Refresh (activate) currently set flickers.
		Scrolls between Pst and CPM parameters.
		Scrolls cursor to select single phase.
		Enters parameter settings submenu.
		Returns to the Main menu. Closes parameter settings submenu.

### 4.9 Edit menu

The menu is accessed by pressing **F3** key from Main menu. Main feature of this menu is displaying and ability to modify settings for each phase and system frequency. Currently selected parameter is coloured blue (see figure below). Note, that certain system parameters (e.g. Flicker generator) depend on fundamental voltage setting, rather than voltage parameters provided through edit menu.

	L1	L2	L3	N
Urms	230.0	230.0	230.0	10.00
Uphase	0.0	220.0	240.0	240.0
Irms	1000	1000	1000	0.0
Iphase	120.0	0.0	240.0	240.0
Freq.	50.00 Hz			
DPF	1.00	1.00	1.00	

Figure 42: U,I: Parameters screen

User can move between parameters using cursor keys. By pressing ENTER key, parameter value selection window is displayed. By pressing cursor keys, parameter value is changed. Selection window can be closed by using either ESC or ENTER key. At same time, set parameters are enabled. Separate voltage, current, phase angle can be manipulated separately.

Voltage can be set in 0.01 V resolution within voltage range 0.00 V to 350.00 V by using arrow keys.

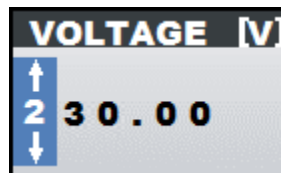


Figure 43: Set voltage selection window

Current can be set in 0.1 A resolution within current range 100.0 A to 2000.0 A by using arrow keys.



Figure 44: Set current selection window

Angle offset for both current and voltage phases can be set in 1° step.

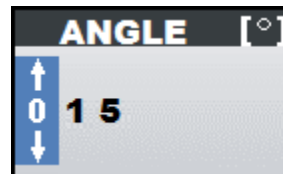


Figure 45: Set phase selection window

System frequency can be set:

- when chosen, user can set frequency in 1 Hz step by using left/right arrow keys,
- when chosen, user can enter selection menu by pressing ENTER key, then set desired frequency in 0.01 Hz step within frequency range 45.00 Hz to 70.00 Hz by using arrow keys.









Figure 46: Set frequency selection window

Settings can be reset to default values by using RESET option. This will discard all but frequency changes made.

Table 28: Instrument screen symbols and abbreviations

L1, L2, L3, N	Phases.
Urms	Phase voltage.
Uphase	Voltage phase angle.
Irms	Phase current.
Iphase	Current phase angle.
Freq.	System frequency.
DPF	U-I Displacement power factor ( $\cos \phi$ )

Table 29: Keys in Edit menu screen

	<b>SET</b>	Refresh (activate) currently set values.
	<b>RESET</b>	Resets all but frequency parameters to default settings.
		Scrolls cursor between options.
		Scrolls cursor to select single phase.
		Enters parameter value selection window.
		Returns to the Main menu. Exits from parameter value selection window.

## 4.10 Events

This section describes event generator functionality, their corresponding screens and manipulation. Six types of events can be generated: voltage dip, swell, interrupt, current inrush, signalling and transient. For each of them user can set various parameters. Additionally, some of them can occur on single or multiple phases.

### 4.10.1 Dip

Voltage Dip is sudden voltage reduction, followed by voltage recovery after a short time interval, from a few periods of the sinusoidal wave of the voltage to a few seconds.

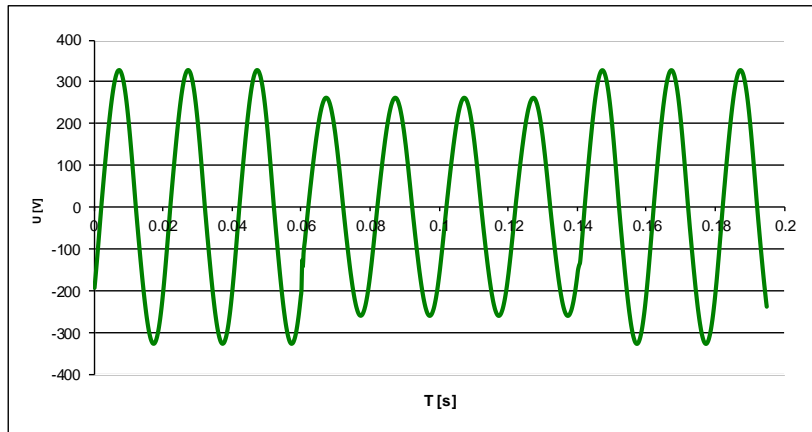


Figure 47: Dip event, 80 %  $U_{Nom}$ , 4 periods long

Dip can be manually triggered with **Dip** shortcut key or can be periodically repeated, according to EVENT OCCURRENCE setting in MAIN MENU. By entering the Dip submenu, following options are available:

- Level – using left and right cursor key, user can set dip level in range 10 % to 99 % of  $U_{nom}$ .
- Duration – using left and right cursor key, user can set dip duration in periods from 1 period to 100 periods.
- Phase type – user can switch between Single (L1) and Poly-phase event type.

New settings will apply when SET is pressed or when dip settings submenu is closed.

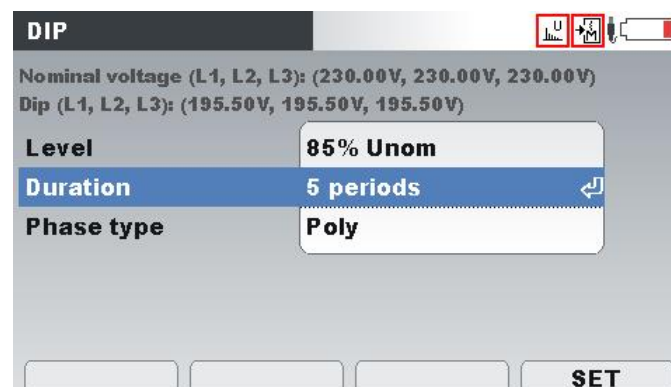






Figure 48: Dip settings submenu

Table 30: Keys in dip settings submenu

<b>F4</b>	<b>SET</b>	Refresh (activate) currently set dip.
		Scrolls cursor between options.
		Modifies parameter.
		Enters parameter value selection window.
		Returns to the Main menu. Exits from parameter value selection window.

### 4.10.2 Swell

Swell is sudden voltage increase, followed by voltage recovery after a short time interval, from a few periods to a few seconds.

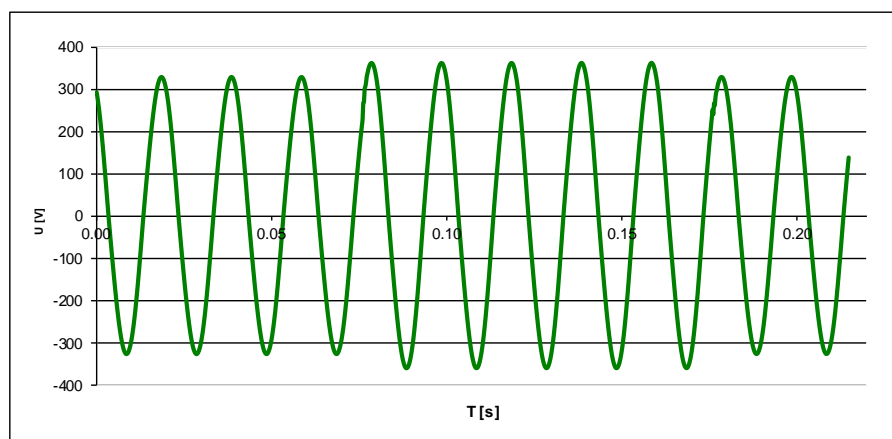


Figure 49: 5 periods long swell, 110 %  $U_{Nom}$

Swell can be manually triggered with **Swell** shortcut key or can be periodically repeated, according to EVENT OCCURRENCE setting in MAIN MENU. By entering the Swell submenu, following options are available:

- Level – using left and right cursor key, user can set swell level in range 101 % to 150 % of  $U_{nom}$ .
- Duration – using left and right cursor key, user can set swell duration in periods from 1 period to 100 periods.
- Phase type – user can switch between Single (L1) and Poly-phase event type.

New settings will apply when SET is pressed or when swell settings submenu is closed.

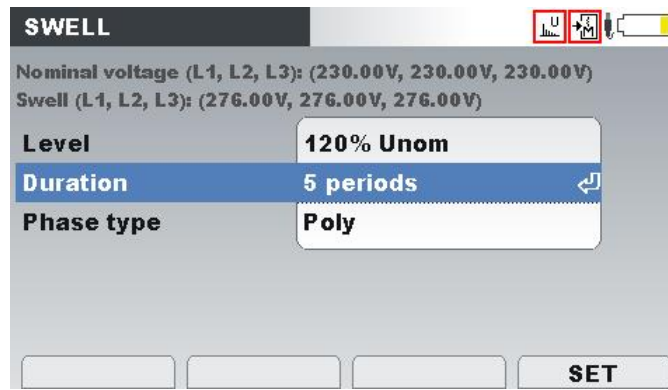


Figure 50: Swell settings menu

Table 31: Keys in swell settings submenu

	<b>SET</b>	Refresh (activate) currently set swell.
		Scrolls cursor between options.
		Modifies parameter.
		Enters parameter value selection window.
		Returns to the Main menu. Exits from parameter value selection window.

### 4.10.3 Interrupt

Interrupt is condition where output voltage at the output terminals drops to selected interrupt level, usually too few percent of nominal voltage.

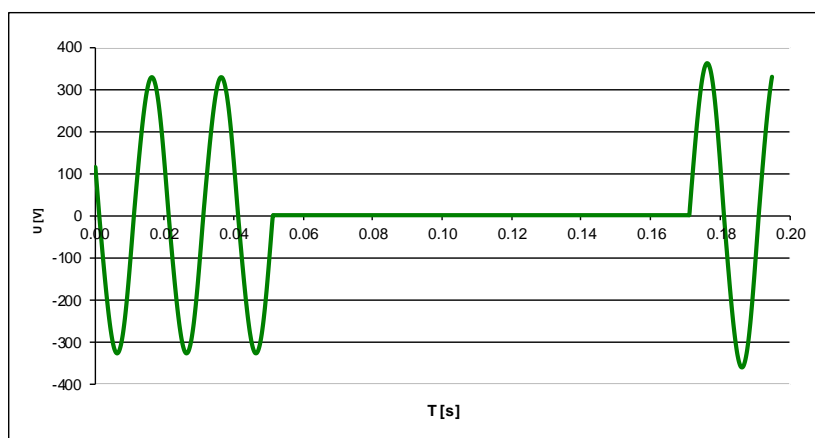


Figure 51: Interrupt 0 %  $U_{Nom}$ , 5 periods long

Interrupt can be manually triggered with shortcut key (long press – 2 s) or can be periodically repeated, according to EVENT OCCURRANCE setting. By entering the Interrupt submenu, following options are available:

- Level – using left and right cursor key, user can set interrupt level in range 0 % to 10 % of Unom.
- Duration – using left and right cursor key, user can set interrupt duration in periods from 1 period to 100 periods.
- Phase type – user can switch between Single(L1) and Poly-phase event type.

New settings will apply when SET is pressed or when Interrupt settings submenu is closed.

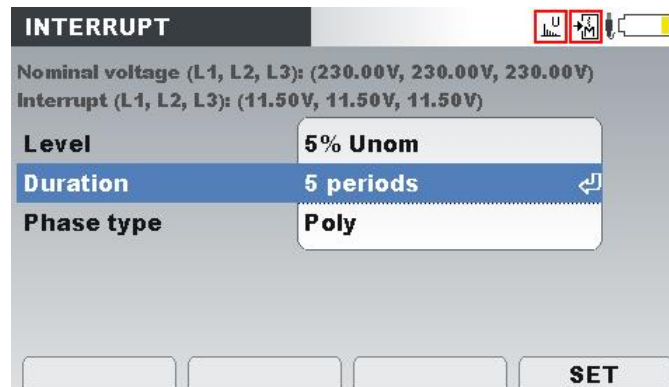







Figure 52: Interrupt settings submenu

Table 32: Keys in interrupt settings submenu

	<b>SET</b>	Refresh (activate) currently set interrupt.
		Scrolls cursor between options
		Modifies parameter.
		Enters parameter value selection window.
		Returns to the Main menu. Exits from parameter value selection window.

#### 4.10.4 Inrush

Inrush current is transient current associated with energizing of transformers, cables, reactors, etc. Usually high current is drawn, which produce voltage dip consequently. Inrush current waveshape is generated by applying logarithmic formula:

$$I_{inrush} = \frac{1}{2} + \frac{(1 - \log(k))}{\frac{1}{2}}$$

to particular part of the current waveform,



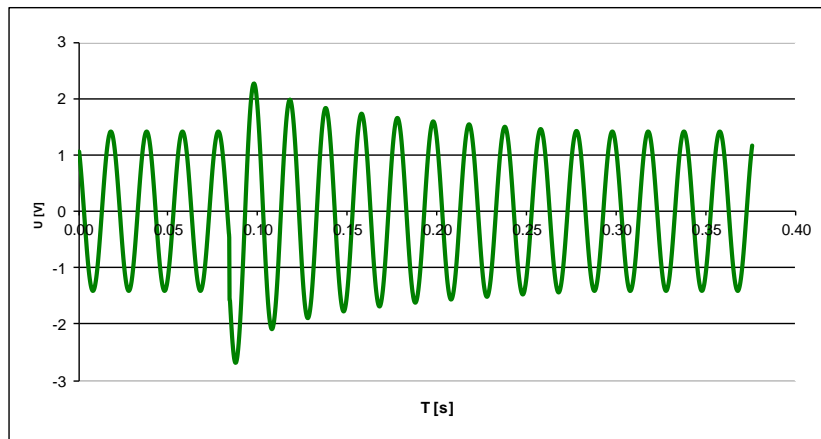


Figure 53: Inrush on voltage

- $U_{inrush} = U \cdot \log(1 + k)$  to particular part of the voltage waveform,

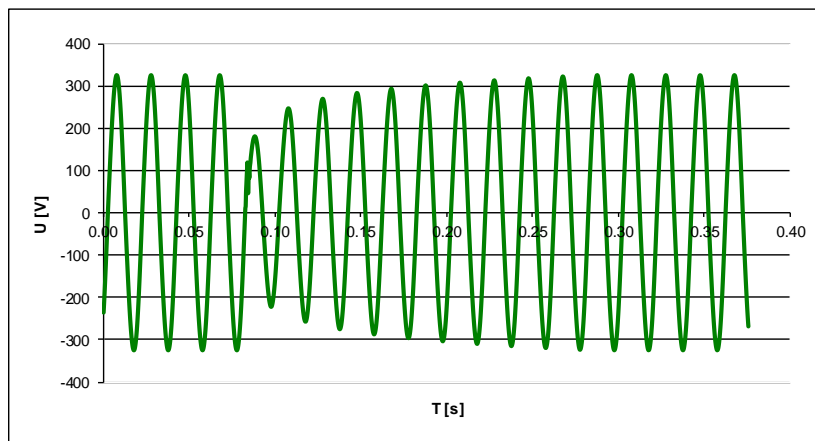


Figure 54: Inrush on current

In practice, inrush current event will generate approximately 50% overshoot of Fundamental current and it will last about 10 seconds. Inrush event can be manually triggered with **Swell** shortcut key (long press – 2 s) or can be periodically repeated, according to EVENT OCCURRENCE setting in MAIN MENU. By entering the submenu, next options are available:




- Phase type – user can switch between Single(L1) and Poly-phase event type.

New settings will apply when SET is pressed or when Inrush settings submenu is closed.



Figure 55: Inrush settings submenu

Table 33: Keys in inrush settings submenu

	<b>SET</b>	Refresh (activate) currently set inrush.
		Modifies parameter.
		Returns to the Main menu.

### 4.10.5 Signalling

Signalling voltage is voltage superimposed to the output voltage for the purpose of transmission of information in the public supply network and to network users' premises. Power Simulator/Calibrator provides “ripple control signal”: superimposed sinusoidal voltage signals in the frequency range 70 Hz to 3 000 Hz.

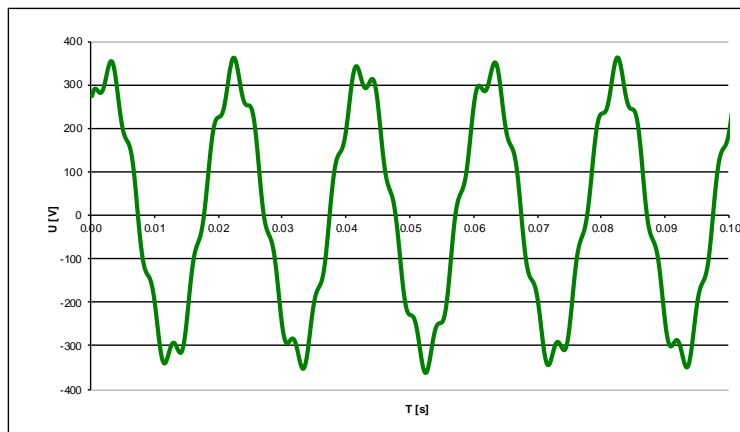


Figure 56: Generated signalling, 10 %  $U_{Nom}$ , signalling frequency 316.0 Hz

Signalling event is periodically repeated, according to EVENT OCCURRENCE setting in MAIN MENU. By entering the submenu, next options are available:

- Level – using left and right cursor key, user is given the option to set amplitude, based on % of currently generating signal. Level may be set in range 0 % to 10 % of  $U_{nom}$ .
- Duration – using left and right cursor key, user can set signalling duration in seconds, from 1 s to 100 s.

- Phase type – using left and right cursor key, user can switch between Single(L1) and Poly-phase event type.
- Frequency – using left and right cursor key, user can set signalling frequency in 0.1 Hz increments in range from 50.0 Hz to 3000.0 Hz.

New settings will apply when SET is pressed or when Signalling settings submenu is closed.

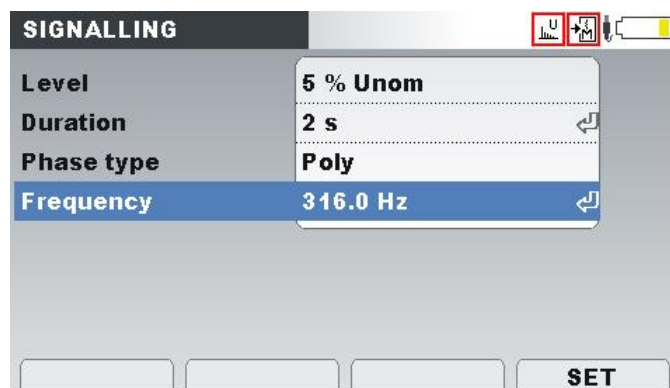







Figure 57: Signalling settings submenu

Table 34: Keys in signalling settings submenu

	<b>SET</b>	Refresh (activate) currently set signalling.
		Scrolls cursor between options
		Modifies parameter.
		Enters parameter value selection window.
		Returns to the Main menu. Exits from parameter value selection window.

#### 4.10.6 Transient

Transient is overvoltage with a duration of a few milliseconds. Power Simulator generates oscillatory damped transient on U1 channel, as shown on figure below. Transient event has overshoot approximately 70% of nominal voltage high and last about 8% of period duration (period is defined with Frequency parameter), as shown on figure below.

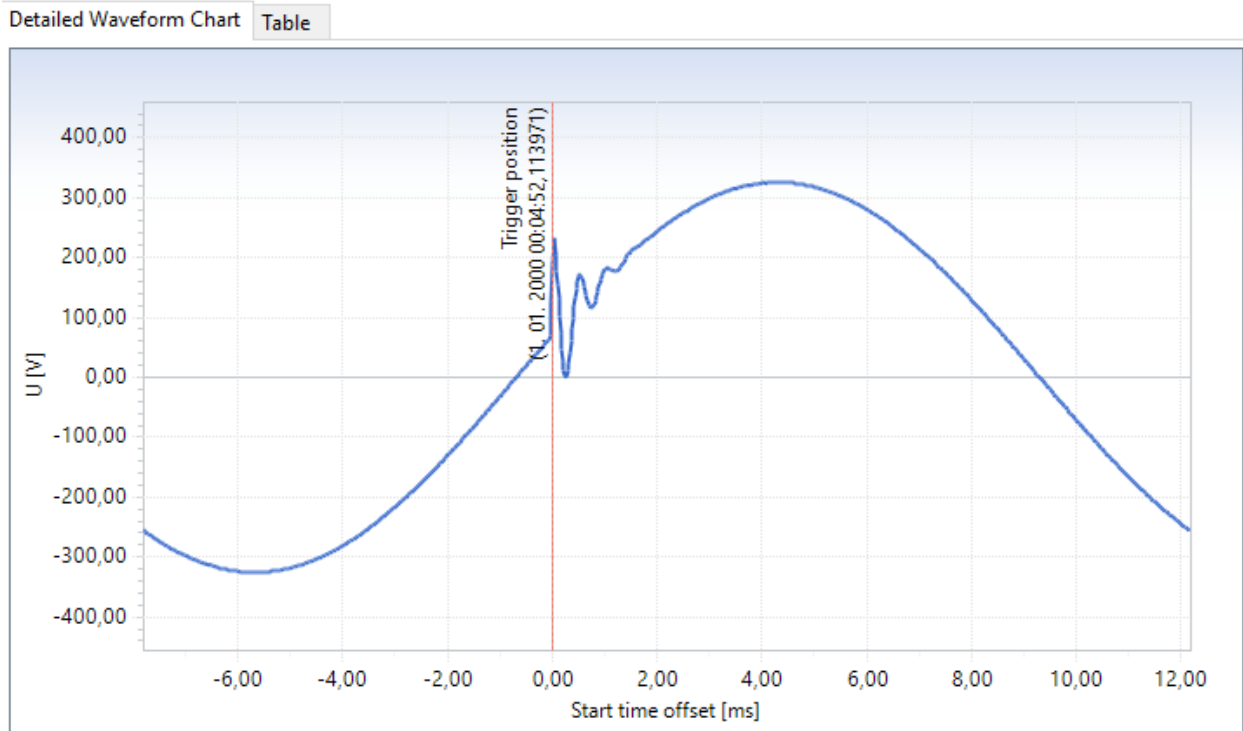


Figure 58: Generated transient sample, captured by MI 2892 Power Master

Transient event is periodically repeated, according to EVENT OCCURRENCE setting in MAIN MENU. By entering the submenu, next options are available:

- Phase type – user can switch between Single(L1) and Poly-phase event type.

New settings will apply when SET is pressed or when Transient settings submenu is closed.



Figure 59: Transient settings submenu

Table 35: Keys in transient settings submenu

	<b>SET</b>	Refresh (activate) currently set transient.
		Modifies parameter.
		Returns to the Main menu.

## 4.11 Swap connection terminals

In order to represent problems with wrongly connected instrument, and to see how difficult is to spot such problem, Power Simulator has additional functionality for swapping voltage or current channels. Both voltage and current channels can be swapped. By entering a submenu through “Voltage” or “Current” option user can manually swap two output channels (voltage or current). This simulates wrong clamps/voltage lead connection, without physically swapping cables. New settings will apply when SET is pressed or when Swap connections submenu is closed.

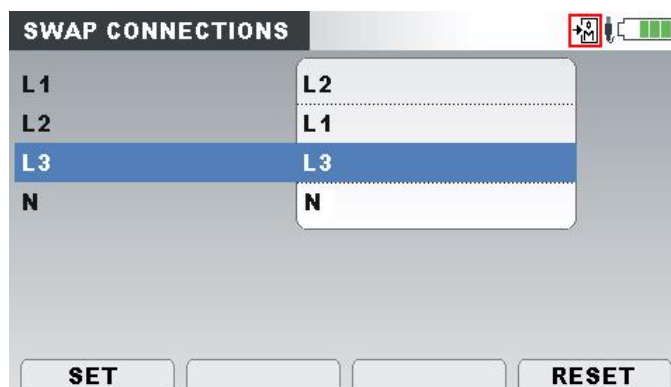







Figure 60: Change sequence submenu screen

Table 36: Keys in Swap connections screen

	<b>SET</b>	Activates swap of Voltage / Current channels.
	<b>RESET</b>	Set Voltage / Current channels to normal connection.
		Enters parameter value selection window.
		Modifies parameter (in selection window).
		Returns to the Main menu. Exits from parameter value selection window.

## 5 Instrument Usage – Power Simulator

### 5.1 Wiring of CS 2890 to Metrel's PQ Analyser

This section describes how to connect Power Simulator CS 2890 to Metrel's Power Quality Analyzer's (MI 2883/MI 2885/MI 2892/MI 2893) using enclosed test leads.

**Note: This connection is valid only for the Power Simulator functionality!**

All outputs from Power Simulator CS 2890 should be connected to adequate inputs of Metrel's PQA.

Current leads should be connected as shown in Figure 61: CS 2890 and MI 2892 connection – Power Simulator mode. I1 current output from Power Simulator should be connected to I1 input of PQA, I2 current output from Power Simulator to I2 input of PQA and similar for inputs I3 and In.

Voltage leads should be connected as shown in Figure 61: CS 2890 and MI 2892 connection – Power Simulator mode. L1 voltage output from Power Simulator should be connected to L1 input of PQA, L2 output to L2 input and similar inputs L3, N and GND.

Note: Since the MI 2883 PQA does not have GND input, GND output on the CS 2890 should remain unconnected.

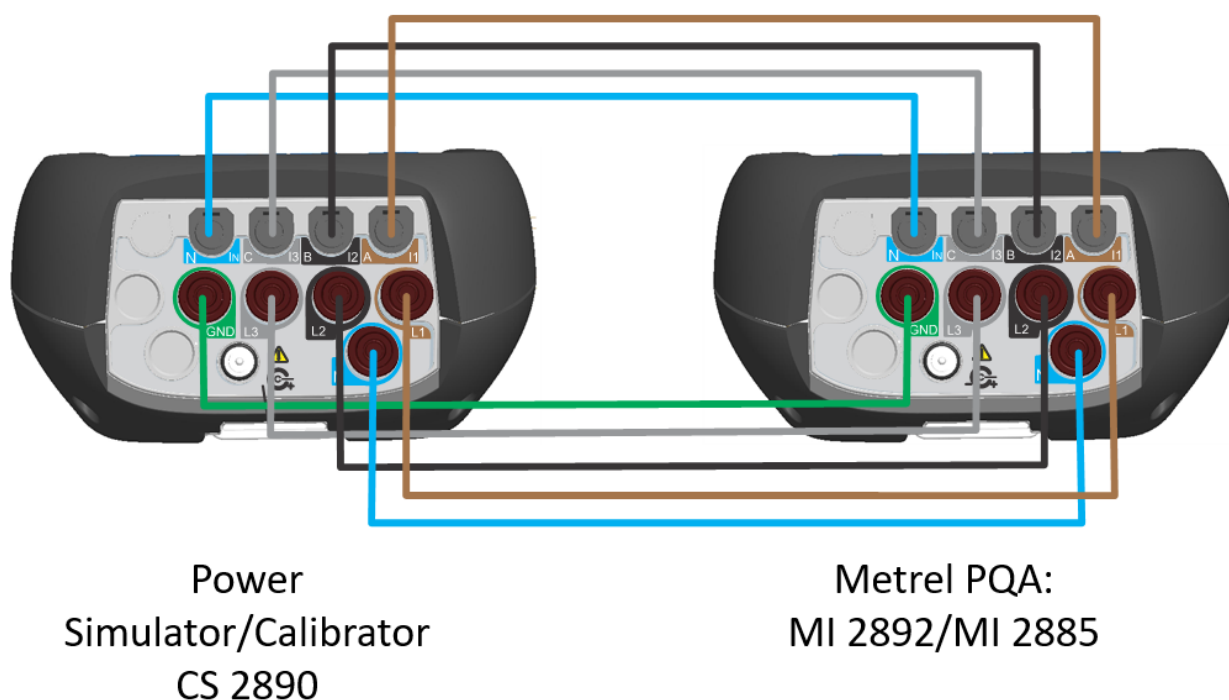


Figure 61: CS 2890 and MI 2892 connection – Power Simulator mode

After connecting all input/output ports, Power Simulator CS 2890 and PQA (MI2892/MI2885) may be turned on and are ready for use.

## 5.2 Simulation campaign

In following section recommended signal simulation is described. Metrel PQA MI 2892 is used as tested instrument. Refer to Power Master MI 2892 Instruction manual for handling measuring site. We recommend to strictly follow the guidelines in order to avoid common problems, measurement and simulation mistakes. Figure below shortly summarizes recommended simulation practice. Each step is then shortly described in details.

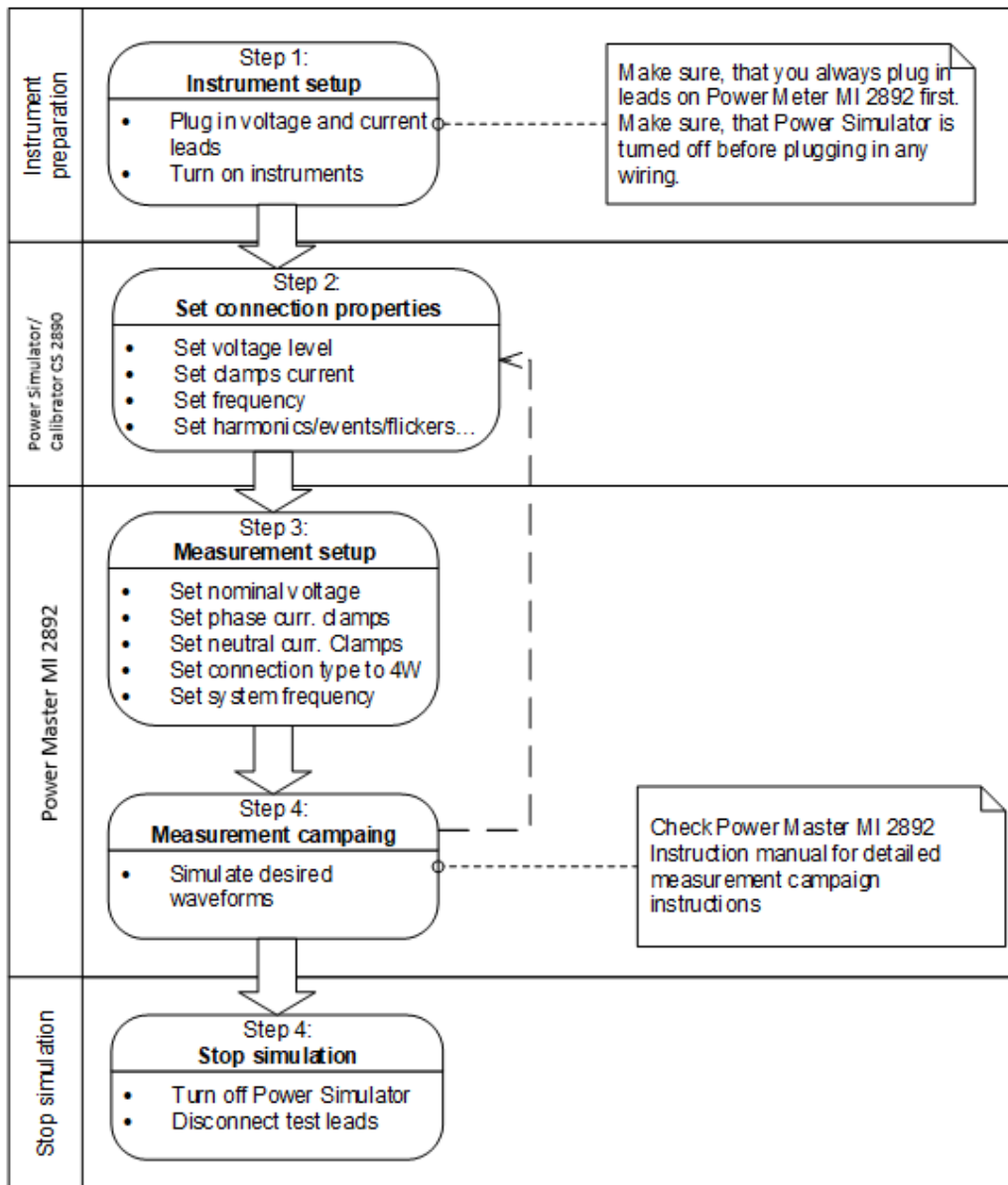


Figure 62: Recommended simulation practice

### 5.2.1 Step 1: Connection setup

Preparation of Power Simulator/Calibrator CS 2890 and Power Master MI 2892 includes the following steps:

- Visually check both instruments and accessories.
- Make sure, that Power Simulator/Calibrator CS 2890 is turned off.

- Connect test leads as described in [section 5.1](#). Always plug in leads on the PQA first and after that to Power Simulator/Calibrator.

### Warnings!

- **Don't use visually damaged equipment!**
- **Always use batteries that are in good condition and fully charged.**

## 5.2.2 Step 2: Power Simulator setup

Power Simulator setup adjustment is performed after we find out details regarding wanted simulated waveform:

- set desired fundamental voltage level,
- set clamps current,
- set system frequency,
- set harmonics/events/flickers/unbalances... as desired.

## 5.2.3 Step 3: PQA setup

On the PQA, for example MI 2892, enter Connection setup submenu. Following parameters have to be set in order to provide trustworthy measurements:

- Nominal voltage L-N: nominal voltage represents goal voltage of our simulated environment. Generally, this means setting it to same value, as fundamental voltage on simulator site.
- Phase current clamps: in order to provide correct current measurements, A 1033 clamps with proper A/V ratio should be chosen, as seen in simulator's main screen.
- Neutral current clamps: in order to provide correct current measurements, A 1033 clamps with proper A/V ratio should be chosen, as seen in simulator's main screen.
- Connection type: 4W
- System frequency:
  - 50Hz if <55Hz setting on Power Simulator
  - 60Hz otherwise
- Connection check will show, if everything was set correctly. In case of wrong connection, repeat step 3. If that didn't help eliminating the problem, re-check wiring between Power Simulator and MI 2892.
- Set up alarms/events to fit your needs.
- Set up recorder.

## 5.2.4 Step 4: Measurement campaign

Perform simulation and measurement scenarios. For detailed instructions regarding measurements, check Power Master MI 2892 Instruction manual.

## 5.2.5 Step 5: Stop simulation

Turn off Power Simulator. Safe removal of test leads is important for user's maximum safety.

### Warning!

- **Always turn off Power Simulator/Calibrator first, and only then disconnect test leads.**



## 6 Instrument usage – Power Calibrator

In order to maintain high accuracy of your PQ Analyser, instrument should be periodically checked. Each Metrel PQ instrument come with Calibration certificate (see [Annex I](#)).

CS 2890 Power Calibrator has stable and precise voltage output, which can be used for periodic calibration and adjustment of Metrel Power Quality Analysers.

CS 2890 is intended for calibrate Class A (MI 2892/MI 2893) as well as Class S (MI 2885/MI 2883) power quality analysers.

**Calibration Power Quality Analysers**, Metrel recommends to use:

- **Using reference value from the CS 2890 calibration certificate. In this case, adjustment to the refence from the calibration certificate is needed. Example of CS 2890 calibration certificate is under [Annex II](#) – CS 2890 Calibration Certificate**This procedure is valid for **Class S PQ Analysers**.
- **Using substandard Volt-meter (proposed accuracy at least  $\pm 0.05\%$ ). In this case, the CS 2890 voltage is adjusted referred to the reading from the Volt-meter. This procedure is valid for Class A PQ Analysers (also for Class S).**

Calibration procedure is described under [Item 6.2](#).

### Notes:

It is **important** that PQ Analyser under calibration is powered with batteries (not connected to external power supply) and all other cables (USB, GPS, etc) are **disconnected** from the instrument (to exclude the influence of power network).

Assure that PQ instrument has fully charged batteries before starting the calibration procedure.

Power Calibrator **must be** attached to the +12V power supply to generate accurate and stable output.

Turn on the PQ Analyser and Power Calibrator and leave them working for at least 30 minutes, in order to assure stabile temperature environment.

## 6.1 Calibration of PQ instruments

Calibration voltage output is present on the CS 2890 terminals L1 – L2 as it is shown on Figure 63: Calibrator output terminals below. Selected Fundamental current is present on all four outputs simultaneously.

All current clamps and transducers used for current measurement with PQ instruments have voltage outputs, and therefore PQ instrument measure voltage and translate it into current according to their Current-to-Voltage ratio. Calibrator is referenced as A 1033 current clamps with 1000 A / 1 V ratio.

As a reference value can be used (for voltage and current calibration):

- Reference value from the CS 2890 Calibration certificate
- Reference value measured with substandard Volt-meter

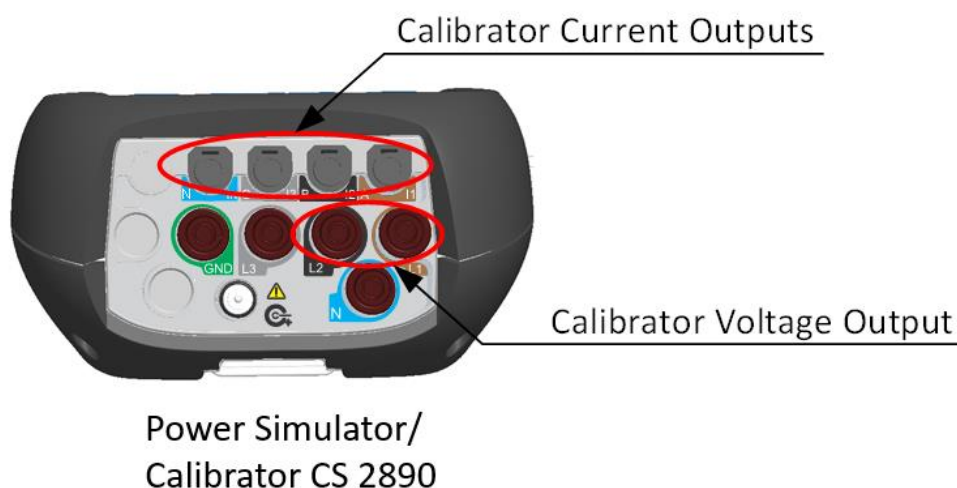


Figure 63: Calibrator output terminals

Calibration of PQA voltage and current channels should be calibrated separately; channel per channel, according the PQA producer specification.

**Note:** Before starting calibration procedure, adjustment procedure needs to be done, referring to the section [Adjustment](#).

### 6.1.1 Calibration of PQ Analyser voltage inputs – MI 2893/MI 2892/MI 2885/MI 2883

Before starting the calibration procedure, adjust voltage output (L1-L2) with the reference values from the CS 2890 calibration certificate (valid for Class S) or by using substandard volt-meter (valid for Class A).



PQA – MI 2893/MI 2892/MI  
2885/MI 2883

Power Calibrator CS 2890

Battery operated during  
calibration process!

Attach +12V Supply to the  
Power Calibrator during  
calibration process!

**Do not use external power  
supply during calibration!**

Figure 64: Connection for calibration voltage input L1 on MI 2893/MI 2892/MI 2885/MI 2883

Calibration voltage test points for PQ Analysers:

Nominal voltage range: 50 V  
Calibrated voltages: 5V - 50V - 75V

Nominal voltage range: 110V  
Calibrated voltages: 11V - 110V - 165V

Nominal voltage range: 230V  
Calibrated voltages: 23V - 230V - 345V

Nominal voltage range: 400V  
Calibrated voltages: 40V - 400V - 500V

### 6.1.2 Calibration of voltage input for Class S PQA (MI 2883 example)

As reference value, for adjusting the calibration voltage on the CS 2890, values from the CS calibration certificate are used (example – Annex I)

Reference → value from the CS 2890

UUC → indicated value on the calibration item (MI 2883)

Uncertainty – expanded measurement uncertainty (k=2)

Error → UUC – Reference

Limit → limit of error ( $\pm$ ), for MI 2883  $\pm 0.5\%$

UUC set-up: Voltage ratio 1:1, Connection: 4W, Synchronisation: U1, System frequency: 50 Hz

In this case, the output of the CS 2890 is Adjusted with the reference value taken from the CS 2890 calibration certificate. Perform Adjustment procedure for all voltage calibration points before starting calibration procedure (check section [3.2.2 Adjustment of voltage output](#))

	Reference	Frequency	UUC	Uncertainty	Error	Limit	
Unom=50V							
Input	V	Hz	V	V	V	V	
L1-N	5	50	5.05	0.01	-0.05	0.25	✓
L1-N	50	50	50.04	0.04	-0.04	0.25	✓
L1-N	75	50	75.03	0.05	-0.03	0.25	✓
Unom=110V							
L1-N	11	50	11.04	0.01	-0.04	0.55	✓
L1-N	110	50	110.04	0.08	-0.04	0.55	✓
L1-N	165	50	164.96	0.12	0.04	0.55	✓
Unom=230V							
L1-N	23	50	23.03	0.02	-0.03	1.15	✓
L1-N	230	50	230.1	0.17	-0.1	1.15	✓
L1-N	345	50	345.1	0.25	-0.1	1.15	✓
Unom=400V							
L1-N	40	50	40.01	0.03	-0.01	2.00	✓
L1-N	400	50	399.9	0.29	0.1	2.00	✓
L1-N	500	50	499.9	0.36	0.1	2.00	✓

Table 37: MI 2883 voltage calibration performed with CS 2890 (Uncertainty based on CS 2890 Calibration certificate)

After performing measurements on channel L1, it is necessary to proceed also to other channels (L2, L3, GND).

### 6.1.3 Calibration of voltage input for Class A PQA (MI 2892 example)

In this case, Adjustment of the CS 2890 calibration voltage is done with the substandard Volt-meter. Adjust all voltage calibration points before starting calibration procedure. As reference Volt-meter, Keysight 34461 were used.

Reference → value from the CS 2890

UUC → indicated value on the calibration item (MI 2892)

Uncertainty → expanded measurement uncertainty (k=2)

Error → UUC – Reference

Limit → limit of error ( $\pm$ ), for MI 2892  $\pm 0.1\%$

UUC set-up: Voltage ratio 1:1, Connection: 4W, Synchronisation: U1, System frequency: 50 Hz

	Reference	Frequency	UUC	Uncertainty	Error	Limit	
Unom=50V							
Input	V	Hz	V	V	V	V	
L1-N	5	50	5.01	0.01	-0.01	0.05	✓
L1-N	50	50	50.02	0.01	-0.02	0.05	✓
L1-N	75	50	75.02	0.01	-0.02	0.05	✓
Unom=110V							
L1-N	11	50	11.02	0.01	-0.02	0.1	✓
L1-N	110	50	110.03	0.02	-0.03	0.1	✓
L1-N	165	50	164.98	0.02	0.02	0.1	✓
Unom=230V							
L1-N	23	50	23.02	0.01	-0.02	0.23	✓
L1-N	230	50	230.0	0.06	0	0.23	✓
L1-N	345	50	345.0	0.08	0	0.23	✓
Unom=400V							
L1-N	40	50	40.01	0.01	-0.01	0.40	✓
L1-N	400	50	400.0	0.10	0	0.40	✓
L1-N	500	50	500.0	0.12	0	0.40	✓

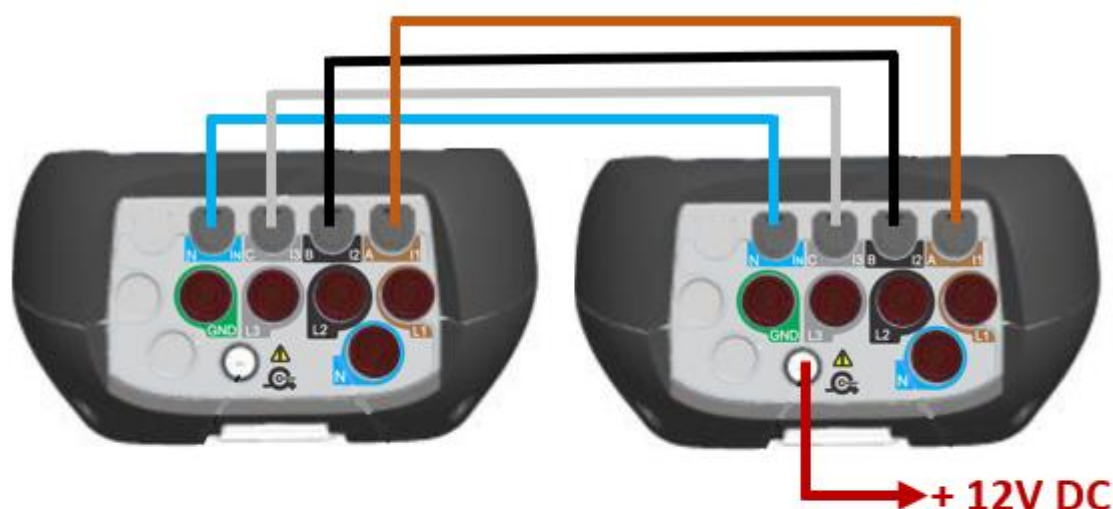
*Table 38: MI 2892 voltage calibration performed with CS 2890 (Uncertainty based on substandard Volt-meter Keysight 34461)*

After performing measurements on channel L1, it is necessary to calibrate other channels (L2, L3 and GND).

### 6.1.4 Calibration of PQ Analyser current inputs – MI 2893/MI 2892/MI 2885/MI 2883

Before starting the calibration procedure, adjust all current outputs per all phases and neutral terminal with the reference values from the CS 2890 calibration certificate (valid for Class S) or by using substandard volt-meter (valid for Class A).

Connect output I1 from CS 2890 to input I1 on the unit under test (MI 2885); output I2 to input I2 and similar for other inputs/outputs according the figure below:



PQA – MI 2892/MI  
2892/MI 2885/MI 2883

Power Calibrator CS 2890

Battery operated during  
calibration process

**Do not use external  
power supply during  
calibration!**

Attach +12V Supply to the  
Power Calibrator

Figure 65: Connection for calibration of current input on MI 2893/MI 2892/MI 2885/MI 2883

Calibration current (presented as voltage) test points for PQ Analysers:

Nominal current range: 100 A  
Calibrated currents: 0.050V – 0.100V – 0.200V

Nominal voltage range: 1000 A  
Calibrated currents: 0.050V – 1.000V – 2.000V

### 6.1.5 Calibration of current inputs for Class S PQA (MI 2883 example)

Reference → value from the CS 2890

UUC → indicated value on the calibration item (MI 2883)

Uncertainty → expanded measurement uncertainty (k=2)

Error → UUC – Reference

Limit → limit of error ( $\pm$ ), for MI 2883  $\pm 0.5\%$

UUC set-up: Voltage ratio 1:1, Connection: 4W, Synchronisation: I1, System frequency: 50 Hz, Primary current: 5A, Secondary current: 5A

	Reference	Frequency	UUC	Uncertainty	Error	Limit	
Range=100A							
Input	mV	Hz	A	A	A	A	
I1	50	50	49.96	0.04	0.04	0.25	✓
I2	50	50	50.02	0.04	-0.02	0.25	✓
I3	50	50	50.04	0.04	-0.04	0.25	✓
N	50	50	50.12	0.04	-0.12	0.25	✓
I1	100	50	99.94	0.07	0.06	0.50	✓
I2	100	50	99.93	0.07	0.07	0.50	✓
I3	100	50	100.0	0.07	0	0.50	✓
N	100	50	100.1	0.07	-0.1	0.50	✓
I1	200	50	199.9	0.15	0.1	1.0	✓
I2	200	50	199.8	0.15	0.2	1.0	✓
I3	200	50	200.0	0.15	0	1.0	✓
N	200	50	200.1	0.15	-0.1	1.0	✓
Range=1000A							
I1	50	50	49.97	0.04	0.03	0.25	✓
I2	50	50	50.01	0.04	-0.01	0.25	✓
I3	50	50	50.03	0.04	-0.03	0.25	✓
N	50	50	50.13	0.04	-0.13	0.25	✓
I1	1000	50	1000.0	0.7	0	5.0	✓
I2	1000	50	999.9	0.7	0.1	5.0	✓
I3	1000	50	1000.0	0.7	0	5.0	✓
N	1000	50	1001.0	0.7	-1	5.0	✓
I1	2000	50	2001	1.40	-1	10	✓
I2	2000	50	2000	1.40	0	10	✓
I3	2000	50	2000	1.40	0	10	✓
N	2000	50	2001	1.40	-1	10	✓

Table 39: MI 2883 current calibration performed with CS 2890 (Uncertainty based on Calibration certificate)

### 6.1.6 Calibration of current inputs for Class A PQA (MI 2892 example)

Reference → value from the CS 2890

UUC → indicated value on the calibration item (MI 2892)

Uncertainty → expanded measurement uncertainty (k=2)

Error → UUC – Reference

Limit → limit of error ( $\pm$ ), for MI 2892  $\pm 0.25\%$

UUC set-up: Voltage ratio 1:1, Connection: 4W, Synchronisation: I1, System frequency: 50 Hz, Primary current: 5A, Secondary current: 5A

	Reference	Frequency	UUC	Uncertainty	Error	Limit	
Range=100A							
Input	mV	Hz	A	A	A	A	
I1	50	50	49.98	0.02	0.02	0.13	✓
I2	50	50	50.01	0.02	-0.01	0.13	✓
I3	50	50	50.02	0.02	-0.02	0.13	✓
N	50	50	50.07	0.02	-0.07	0.13	✓
I1	100	50	99.96	0.03	0.04	0.25	✓
I2	100	50	99.95	0.03	0.05	0.25	✓
I3	100	50	100.0	0.03	0	0.25	✓
N	100	50	100.1	0.03	-0.1	0.25	✓
I1	200	50	199.9	0.06	0.1	0.5	✓
I2	200	50	199.9	0.06	0.1	0.5	✓
I3	200	50	200.0	0.06	0	0.5	✓
N	200	50	200.1	0.06	-0.1	0.5	✓
Range=1000A							
I1	50	50	49.99	0.03	0.01	0.13	✓
I2	50	50	50.01	0.03	-0.01	0.13	✓
I3	50	50	50.02	0.03	-0.02	0.13	✓
N	50	50	50.06	0.03	-0.06	0.13	✓
I1	1000	50	1000.0	0.14	0	2.5	✓
I2	1000	50	999.9	0.14	0.1	2.5	✓
I3	1000	50	1000.0	0.14	0	2.5	✓
N	1000	50	1001.0	0.14	-1	2.5	✓
I1	2000	50	2001	1	-1	5	✓
I2	2000	50	2000	1	0	5	✓
I3	2000	50	2000	1	0	5	✓
N	2000	50	2001	1	-1	5	✓

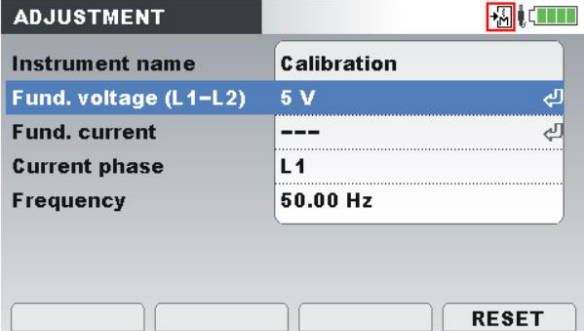


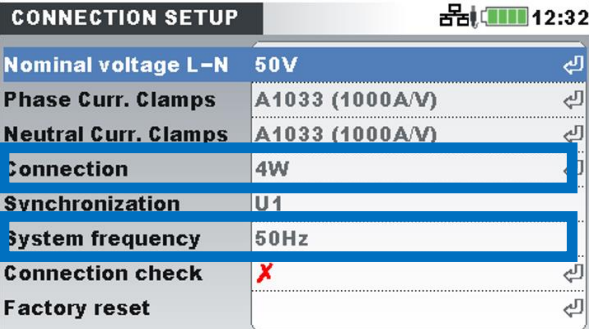


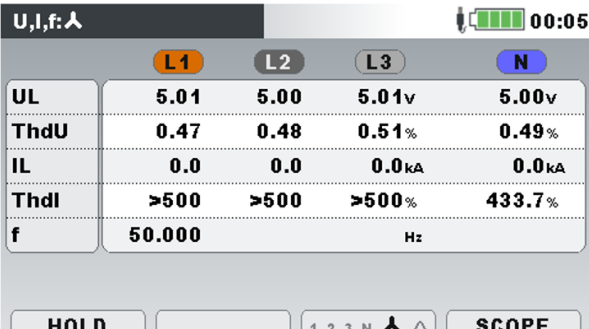
Table 40: MI 2892 current calibration performed with CS 2890 (Uncertainty based on substandard Volt-meter Keysight 34461)



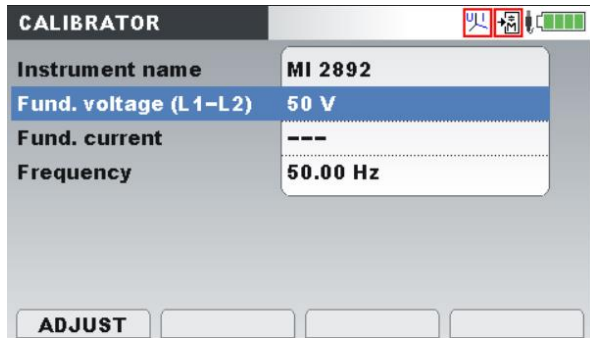
## 6.2 Calibration procedure

### 6.2.1 Voltage

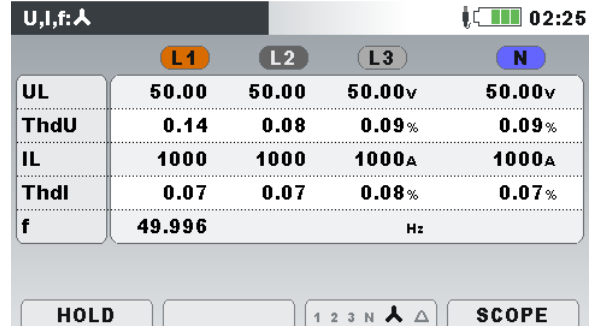
Short overview of necessary performed steps for voltage calibration (test sample MI 2892). Please check the connection instructions under item 6.1.1.

Power Calibrator - CS 2890	Power Master – MI 2892																														
<p>In ADJUSTMENT Menu:</p>  <p>Perform Adjustment for all calibration points → Item 3.2.2</p>																															
<p>In CALIBRATOR Menu set: <b>Instrument name:</b> 2892 (for Power master)</p> 	<p>Press  shortcut key and set:</p> <ul style="list-style-type: none"> <li>Nominal voltage: 50V</li> <li>Connection: 4W</li> <li>System frequency: 50 Hz</li> </ul> <p>Return to MAIN MENU</p> 																														
<p>In CALIBRATOR Menu set: <b>Fundamental voltage:</b> 5 V</p> 	<p>Press  shortcut key and read voltage values for L1, L2, L3, GND ÷ N (read value for the first phase and then reconnect to the next one). Compare them with values from the MI 2892 Certificate report.</p>  <table border="1" data-bbox="837 1751 1428 2078"> <thead> <tr> <th></th> <th>L1</th> <th>L2</th> <th>L3</th> <th>N</th> </tr> </thead> <tbody> <tr> <td>UL</td> <td>5.01</td> <td>5.00</td> <td>5.01v</td> <td>5.00v</td> </tr> <tr> <td>ThdU</td> <td>0.47</td> <td>0.48</td> <td>0.51%</td> <td>0.49%</td> </tr> <tr> <td>IL</td> <td>0.0</td> <td>0.0</td> <td>0.0kA</td> <td>0.0kA</td> </tr> <tr> <td>Thdl</td> <td>&gt;500</td> <td>&gt;500</td> <td>&gt;500%</td> <td>433.7%</td> </tr> <tr> <td>f</td> <td colspan="4">50.000 Hz</td> </tr> </tbody> </table>		L1	L2	L3	N	UL	5.01	5.00	5.01v	5.00v	ThdU	0.47	0.48	0.51%	0.49%	IL	0.0	0.0	0.0kA	0.0kA	Thdl	>500	>500	>500%	433.7%	f	50.000 Hz			
	L1	L2	L3	N																											
UL	5.01	5.00	5.01v	5.00v																											
ThdU	0.47	0.48	0.51%	0.49%																											
IL	0.0	0.0	0.0kA	0.0kA																											
Thdl	>500	>500	>500%	433.7%																											
f	50.000 Hz																														

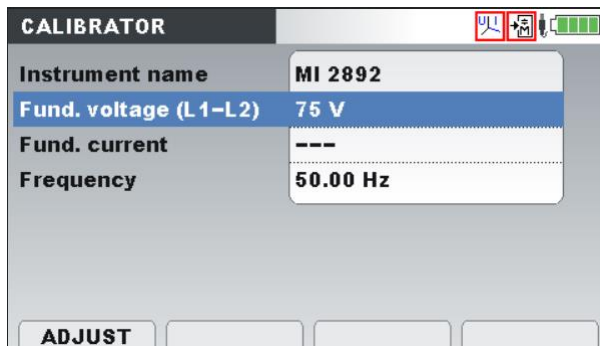
In CALIBRATOR Menu set:  
**Fundamental voltage: 50 V**



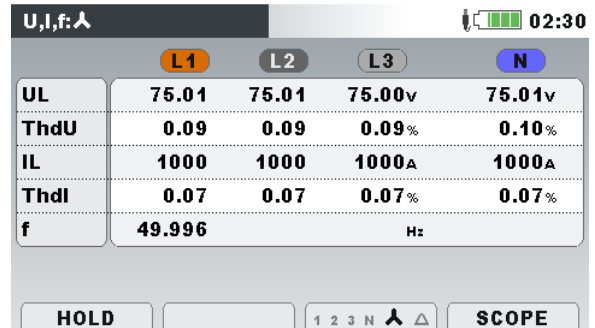
Read voltage values for L1, L2, L3, GND ÷ N and compare them with Certificate report values



In CALIBRATOR Menu set:  
**Fundamental voltage: 75 V**

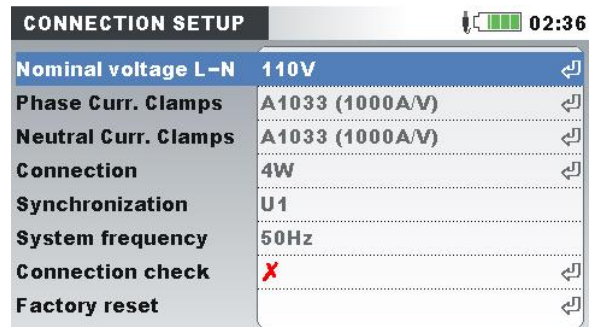


Read voltage values for L1, L2, L3, GND ÷ N and compare them with Certificate report values



Press shortcut key and set:  
• Nominal voltage: 110V

Return to Main Menu



In CALIBRATOR Menu set:  
**Fundamental voltage: 11 V**



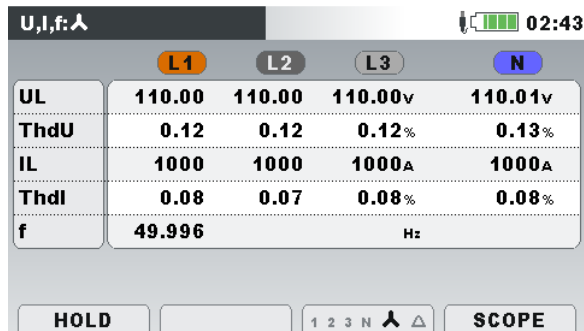
Press shortcut key and read voltage values for L1, L2, L3, GND ÷ N. Compare them with values from the Certificate report.



In CALIBRATOR Menu set:  
**Fundamental voltage: 110 V**



Read voltage values for L1, L2, L3, GND ÷ N and compare them with Certificate report values



In CALIBRATOR Menu set:  
**Fundamental voltage: 165 V**



Read voltage values for L1, L2, L3, GND ÷ N and compare them with Certificate report values



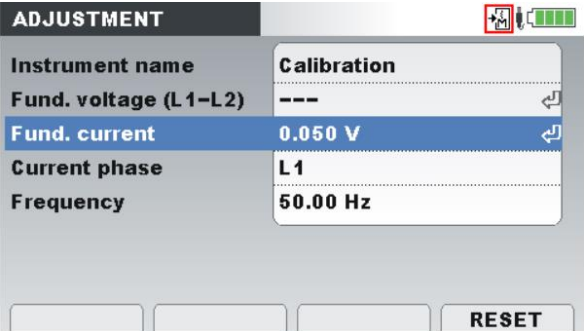
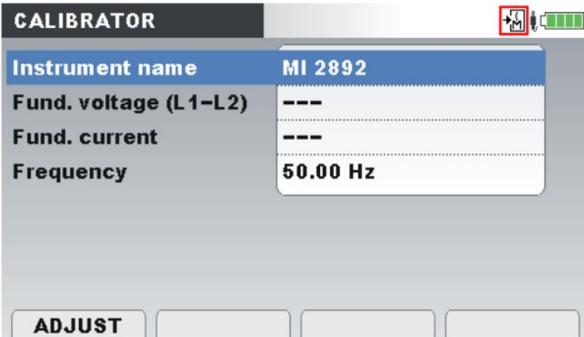

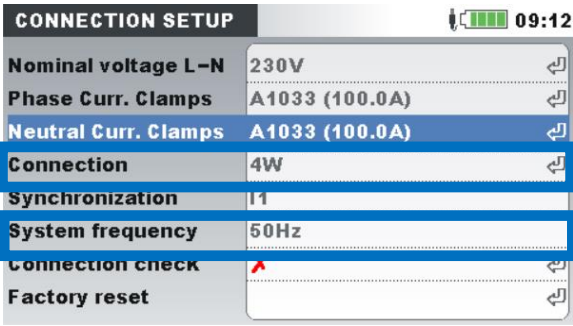
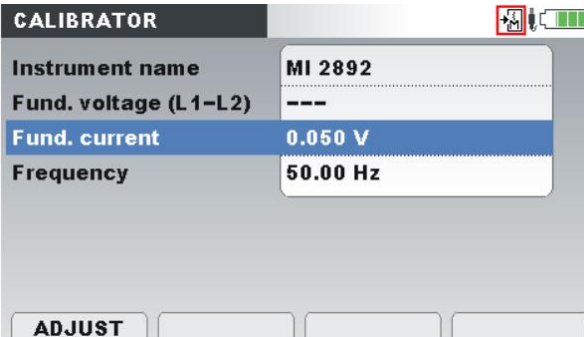

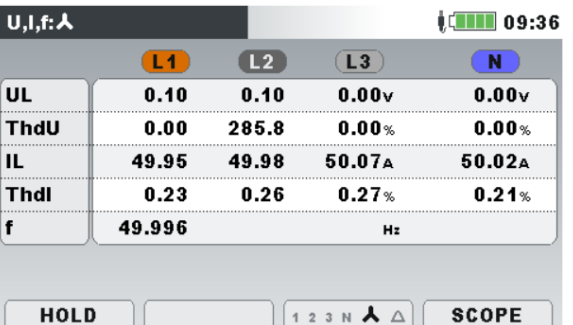
Note 1:

Continue with above described procedure (Unom=230V & Unom=400V), until all points from Calibration certificate are not checked.

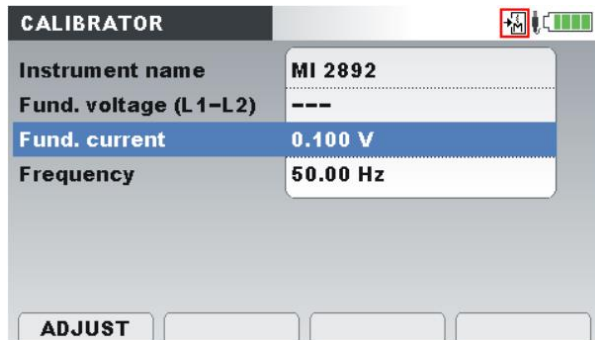
Table 41: Calibration procedure - voltage

### 6.2.2 Current

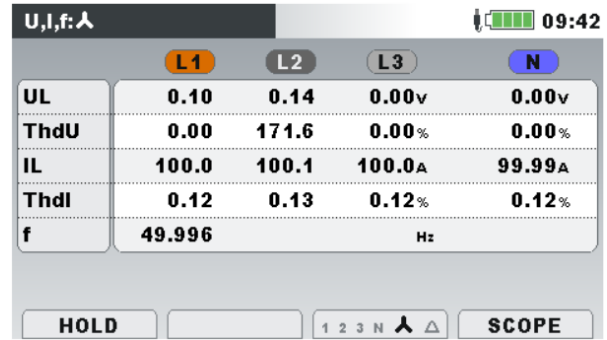
Short overview of necessary performed steps for current calibration (test sample MI 2892). Please check the connection instructions under item 6.1.2.

<p><b>Power Calibrator – CS 2890</b></p> <p>In ADJUSTMENT Menu:</p>  <p>Perform Adjustment for all calibration points (all phase and neutral currents) → Item 3.2.3</p>	<p><b>Power Master</b></p>																														
<p>In CALIBRATOR Menu set: <b>Instrument name:</b> 2892 (for Power master)</p> 	<p>Press  shortcut key and set:</p> <ul style="list-style-type: none"> <li>• Current clamp range: 100A</li> <li>• Connection: 4W</li> <li>• System frequency: 50 Hz</li> </ul> <p>Return to MAIN MENU</p> 																														
<p>In CALIBRATOR Menu set: <b>Fundamental current: 0.050 V</b></p>  <p>Note: calibration current is generated on all three phases and neutral line simultaneously.</p>	<p>Press  shortcut key and read current values for L1, L2, L3, N. Compare them with values from the MI 2892 Certificate report.</p>  <table border="1" data-bbox="842 1742 1417 2067"> <thead> <tr> <th></th> <th>L1</th> <th>L2</th> <th>L3</th> <th>N</th> </tr> </thead> <tbody> <tr> <td>UL</td> <td>0.10</td> <td>0.10</td> <td>0.00v</td> <td>0.00v</td> </tr> <tr> <td>ThdU</td> <td>0.00</td> <td>285.8</td> <td>0.00%</td> <td>0.00%</td> </tr> <tr> <td>IL</td> <td>49.95</td> <td>49.98</td> <td>50.07A</td> <td>50.02A</td> </tr> <tr> <td>ThdI</td> <td>0.23</td> <td>0.26</td> <td>0.27%</td> <td>0.21%</td> </tr> <tr> <td>f</td> <td colspan="4">49.996 Hz</td> </tr> </tbody> </table>		L1	L2	L3	N	UL	0.10	0.10	0.00v	0.00v	ThdU	0.00	285.8	0.00%	0.00%	IL	49.95	49.98	50.07A	50.02A	ThdI	0.23	0.26	0.27%	0.21%	f	49.996 Hz			
	L1	L2	L3	N																											
UL	0.10	0.10	0.00v	0.00v																											
ThdU	0.00	285.8	0.00%	0.00%																											
IL	49.95	49.98	50.07A	50.02A																											
ThdI	0.23	0.26	0.27%	0.21%																											
f	49.996 Hz																														

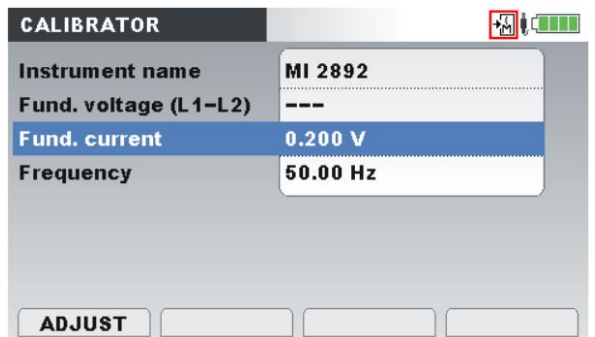
In CALIBRATOR Menu set:  
**Fundamental current: 0.100 V**



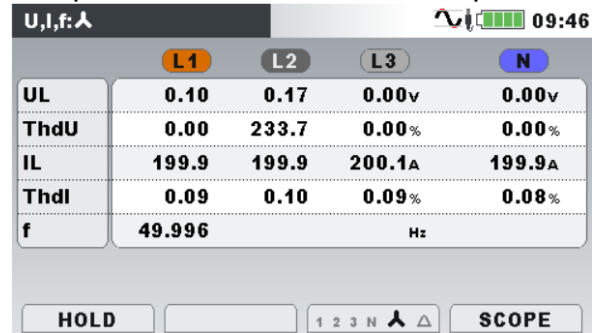
Read current values for L1, L2, L3, N and compare them with Certificate report values



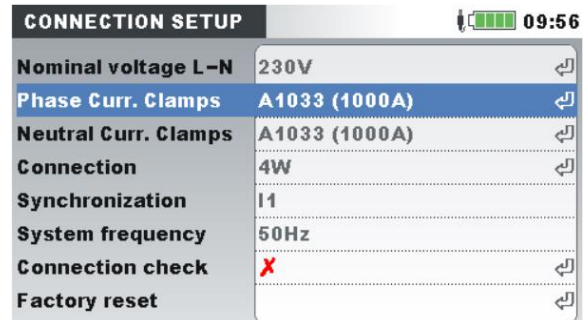
In CALIBRATOR Menu set:  
**Fundamental current: 0.200 V**



Read current values for L1, L2, L3, N and compare them with Certificate report values



Press shortcut key and set:  
 • Nominal clamp range: **1000A**  
 Return to Main Menu



In CALIBRATOR Menu set:  
**Fundamental current: 0.050 V**



Press shortcut key and read current values for L1, L2, L3, N. Compare them with values from the Certificate report.





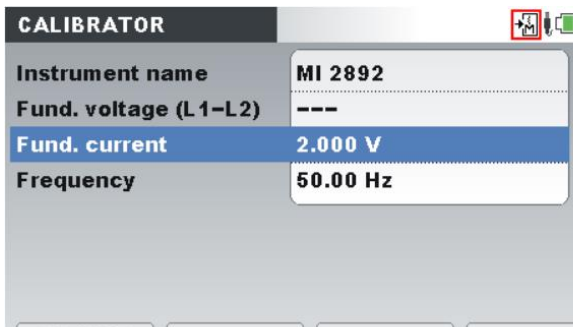
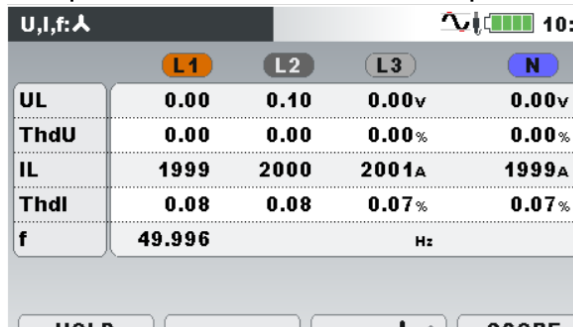
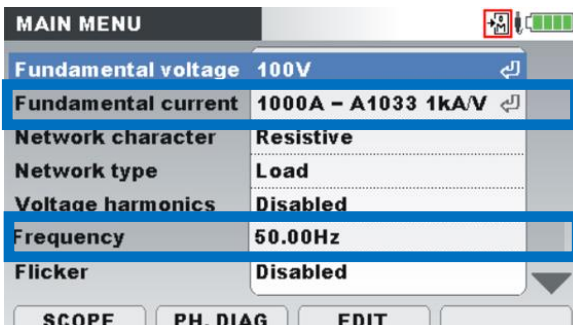

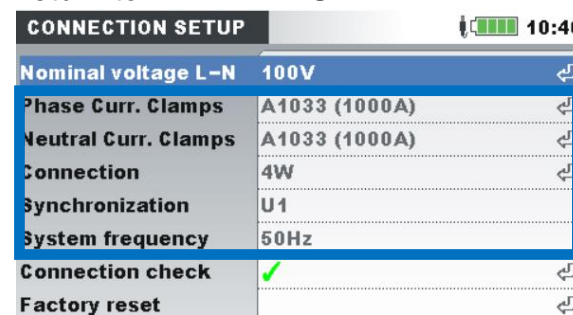
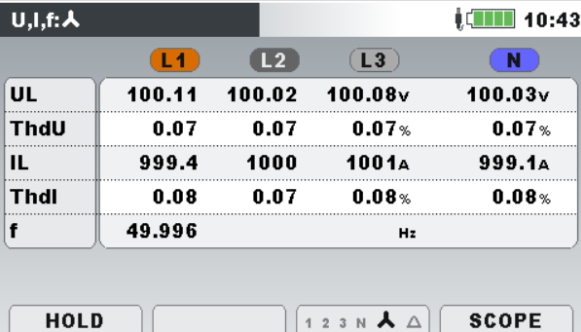
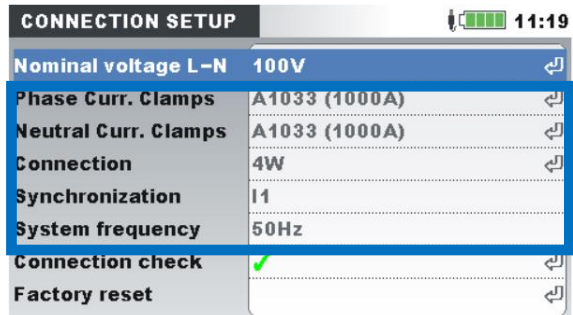
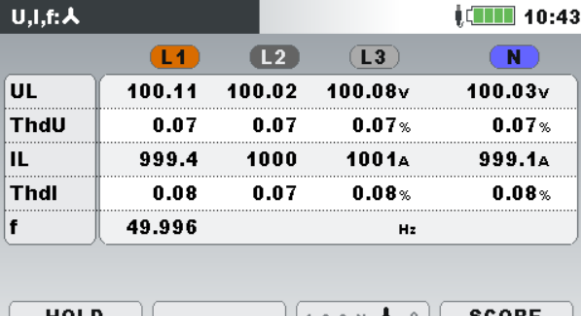
<p>In CALIBRATOR Menu set: <b>Fundamental current: 1.000 V</b></p> 	<p>Read current values for L1, L2, L3, N and compare them with Certificate report values</p> 
<p>In CALIBRATOR Menu set: <b>Fundamental current: 2.000 V</b></p> 	<p>Read current values for L1, L2, L3, N and compare them with Certificate report values</p> 

Table 42: Calibration procedure - current

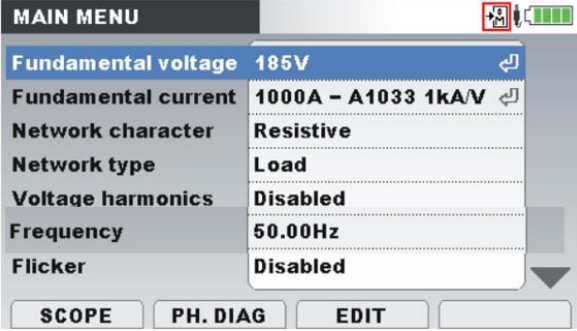
### 6.2.3 Frequency


Short overview of necessary performed steps for frequency calibration (test sample MI 2892). Please check the connection instructions under item 5.1.

<p><b>Power Simulator</b></p> <p>In MAIN MENU set:</p> 	<p><b>Power Master</b></p> <p>Press  shortcut key and set:</p> <ul style="list-style-type: none"> <li>• Current clamp range: 1000A</li> <li>• Connection: 4W</li> <li>• Synchronization: U1</li> <li>• System frequency: 50 Hz (or 60 Hz)</li> </ul> <p>Return to MAIN MENU</p> 
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	<p>Press <b>Ulf</b> shortcut key and read frequency value. Compare it with value from the MI 2892 Certificate report.</p>  <table border="1" data-bbox="837 324 1420 654"> <thead> <tr> <th></th> <th>L1</th> <th>L2</th> <th>L3</th> <th>N</th> </tr> </thead> <tbody> <tr> <td>UL</td> <td>100.11</td> <td>100.02</td> <td>100.08<sub>v</sub></td> <td>100.03<sub>v</sub></td> </tr> <tr> <td>ThdU</td> <td>0.07</td> <td>0.07</td> <td>0.07%</td> <td>0.07%</td> </tr> <tr> <td>IL</td> <td>999.4</td> <td>1000</td> <td>1001<sub>A</sub></td> <td>999.1<sub>A</sub></td> </tr> <tr> <td>ThdI</td> <td>0.08</td> <td>0.07</td> <td>0.08%</td> <td>0.08%</td> </tr> <tr> <td>f</td> <td colspan="4">49.996 Hz</td> </tr> </tbody> </table>		L1	L2	L3	N	UL	100.11	100.02	100.08 <sub>v</sub>	100.03 <sub>v</sub>	ThdU	0.07	0.07	0.07%	0.07%	IL	999.4	1000	1001 <sub>A</sub>	999.1 <sub>A</sub>	ThdI	0.08	0.07	0.08%	0.08%	f	49.996 Hz			
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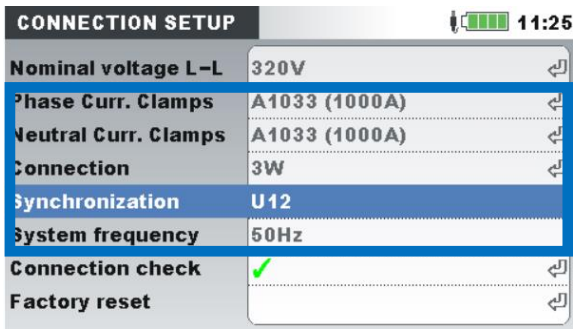
In MAIN MENU set:





Press  shortcut key and set:

- Current clamp range: 1000A
- Connection: 3W
- Synchronization: U12
- System frequency: 50 Hz (or 60 Hz)

Return to MAIN MENU



Press  shortcut key and read frequency value. Compare it with value from the MI 2892 Certificate report.



	L12	L23	L31
UL	320.6	320.4	320.6v
ThdU	0.11	0.12	0.13%
IL	999.4	1000	1001A
ThdI	0.07	0.08	0.08%
f	49.996		Hz

Table 43: Calibration procedure - frequency

### 6.3 Power Quality Analyser adjustment procedure

In case, that calibration results are not under specified limits, the UUC should be adjusted first and after that calibration should be repeated again. In such case we recommend to:

- Set measuring constants to default value,
- Adjust the UUC according the Metrel procedure.

**Note:** Since the adjustment procedure is very sensitive process, please contact your distributor for detail instructions.



## 7 Technical specifications

### 7.1 General specifications

Working temperature range (Power Simulator):	0 °C ... 40 °C
Storage temperature range:	-40 °C ... 70 °C
Max. humidity:	95 % RH (0 °C ... 40 °C), non-condensing
Pollution degree:	2
Protection classification:	Reinforced insulation
Measuring category:	CAT I / 300 V
Protection degree:	IP 30
Dimensions:	23 cm x 14cm x 8 cm
Weight (with batteries):	1.36 kg
Display:	Colour 4.3" (10.9 cm) TFT liquid crystal display (LCD) with backlight, 480 x 272 dots.
Batteries:	6 x 1.2 V NiMH rechargeable batteries type HR 6 (AA) Battery operation up to 30 mins* <b>Given accuracy is guaranteed only when battery charger is present.</b>
External DC supply - charger:	100-240 V~, 50-60 Hz, 1.5 A~, CAT II / 300 V 12 V DC, min 3 A
Maximum supply consumption:	12 V / 3 A (while charging batteries)
Battery charging time:	3.5 hours*

\* The charging time and the operating hours are given for batteries with a nominal capacity of 2500 mAh.

### 7.2 Signal generator

#### 7.2.1 General description

Max. output voltage (Phase – Neutral):	370 V <sub>RMS</sub>
Max. output voltage (Phase – Phase):	740 V <sub>RMS</sub>
Minimal voltage output load impedance:	200 kΩ
Minimal current output load resistance	10 kΩ
D/A converter	16 bits 8 channels, simultaneous sampling
Sampling frequency:	720 x System Frequency (36 kHz@50 Hz)
Reference temperature	23 °C ± 2 °C

#### 7.2.2 Voltages

**Fundamental RMS voltage output:  $U_{1Rms}$ ,  $U_{2Rms}$ ,  $U_{3Rms}$ ,  $U_{NRms}$ , AC+DC**

Output voltage	Resolution	Accuracy
50 ... 300 V	10 V	± 0.1 %

**Event RMS voltage output:  $U_{1Rms}$ ,  $U_{2Rms}$ ,  $U_{3Rms}$ ,  $U_{NRms}$ , AC+DC**

Event voltage	Resolution	Accuracy
0 ... 350 V	1 % of fundamental output voltage	$\pm 2 \%$

**7.2.3 Current****Fundamental RMS current  $I_{1Rms}$ ,  $I_{2Rms}$ ,  $I_{3Rms}$ ,  $I_{NRms}$ , AC+DC.**

Range	Output voltage	Overall current accuracy
A 1033 (100 A ... 1000 A)	100 mV ... 1 V	$\pm 0.1 \%$

**7.2.4 Frequency**

Frequency range	Resolution	Accuracy
45 Hz ... 70 Hz	1 Hz	$\pm 10$ mHz

**7.2.5 Flickers**

Flicker type	Flicker range	Resolution	Accuracy
$P_{st}$	0.5 ... 5.0	0.1	$\pm 1 \%$

**7.2.6 Voltage harmonics**

Harmonics range	Resolution	Accuracy
$U_{hN}$ 1 % ... 100 % of fundamental output voltage	1 %	$\pm 5 \%$ of $U_{hN}$

$U_{hN}$ : generated harmonic voltage

N: harmonic component 2<sup>nd</sup> ... 50<sup>th</sup>

**7.2.7 Current harmonics and THD**

Harmonics range	Resolution	Accuracy
$I_{hN}$ 1 % ... 100 % of fundamental current	1 %	$\pm 5 \%$ of $I_{hN}$

$I_{hN}$ : measured harmonic current

N: harmonic component 2<sup>th</sup> ... 50<sup>th</sup>

**7.2.8 Unbalance**

	Unbalance range	Resolution	Accuracy
$u^-$	0.5 % ... 5.0 %	0.1 %	$\pm 0.15 \%$
$u^0$			$\pm 0.15 \%$
$i^-$	0.0 % ... 20 %	0.1 %	$\pm 1 \%$
$i^0$			$\pm 1 \%$

**7.2.9 Time and duration uncertainty****Real time clock (RTC) temperature uncertainty**

Operating range	Accuracy	
0 °C ... 70 °C	$\pm 3.5$ ppm	0.3 s/day
0 °C ... 40 °C	$\pm 2.0$ ppm	0.17 s/day

**Event duration uncertainty**

	Measuring Range	Resolution	Error
Event Duration	1 s ... 60 s	1 s	$\pm 1$ cycle

**7.2.10 Calibrator/Adjustment**

Warmup time	Minimum 30 minutes, connection to external power supply <b>is obligatory</b>
Settling time	Less than 10 seconds
Reference temperature	23 °C $\pm$ 2 °C
Voltage/current stability	$\pm$ 0.06% (90 days)
Adjustment value resolution (under Adjustment menu)	0,0001 V
Voltage selection	5 V - 11 V - 14 V - 23 V - 40 V - 50 V - 75 V - 110 V - 150 V - 165 V - 200 V - 206 V - 230 V - 250 V - 345 V - 400 V - 500 V

Measuring uncertainty at the Metrel PQA calibration should be calculated from uncertainty of correction that is derived from calibration of the CS 2890 or from substandard V-meter and other contributions of the measuring uncertainty budget like stability, resolution, and influence quantities. It is recommended that for measuring uncertainty calculation user follow the guidelines from EA 4/02 document - Expression of the Uncertainty of Measurement in Calibration.

## 8 Maintenance

### 8.1 Inserting batteries into the instrument

1. Make sure that the power supply adapter/charger and measurement leads are disconnected and the instrument is switched off before opening battery compartment cover.
2. Insert batteries as shown in figure below (insert batteries correctly, otherwise the instrument will not operate and the batteries could be discharged or damaged).



Figure 66: Battery compartment

1	Battery cells
2	Serial number label

3. Turn the instrument upside down (see figure below) and put the cover over the batteries.



Figure 67: Closing the battery compartment cover

4. Screw the cover on the instrument.

### Warnings!

- **Hazardous voltages exist inside the instrument. Disconnect all test leads, remove the power supply cable and turn off the instrument before removing battery compartment cover.**
- **Use only power supply adapter/charger delivered from manufacturer or distributor of the equipment to avoid possible fire or electric shock.**
- **Do not use standard batteries while power supply adapter/charger is connected, otherwise they may explode!**
- **Do not mix batteries of different types, brands, ages, or charge levels.**
- **When charging batteries for the first time, make sure to charge batteries for at least 24 hours before switching on the instrument.**

### Notes:

- Rechargeable NiMH batteries, type HR 6 (size AA), are recommended. The charging time and the operating hours are given for batteries with a nominal capacity of 2500 mAh.
- If the instrument is not going to be used for a long period of time remove all batteries from the battery compartment. The enclosed batteries can supply the instrument for approx. 30 minutes.

## 8.2 Batteries

Instrument contains rechargeable NiMH batteries. These batteries should only be replaced with the same type as defined on the battery placement label or in this manual. If it is necessary to replace batteries, all six have to be replaced. Ensure that the batteries are inserted with the correct polarity; incorrect polarity can damage the batteries and/or the instrument.

## 8.3 Precautions on charging new batteries or batteries unused for a longer period

Unpredictable chemical processes can occur during charging new batteries or batteries that were unused for a longer period of time (more than 3 months). NiMH and NiCd batteries are affected to a various degree (sometimes called as memory effect). As a result, the instrument operation time can be significantly reduced at the initial charging/discharging cycles.

Therefore, it is recommended:

- To completely charge the batteries.
- To completely discharge the batteries (can be performed with normal working with the instrument).
- Repeating the charge/discharge cycle for at least two times (four cycles are recommended).

When using external intelligent battery chargers one complete discharging /charging cycle is performed automatically.

After performing this procedure, a normal battery capacity is restored. The operation time of the instrument now meets the data in the technical specifications.

## 8.4 Notes

The charger in the instrument is a pack cell charger. This means that the batteries are connected in series during the charging so all batteries have to be in similar state (similarly charged, same type and age).

Even one deteriorated battery (or just of another type) can cause an improper charging of the entire battery pack (heating of the battery pack, significantly decreased operation time).

If no improvement is achieved after performing several charging/discharging cycles the state of individual batteries should be determined (by comparing battery voltages, checking them in a cell charger etc). It is very likely that only some of the batteries are deteriorated.

The effects described above should not be mixed with normal battery capacity decrease over time. All charging batteries lose some of their capacity when repeatedly charged/discharged. The actual decrease of capacity versus number of charging cycles depends on battery type and is provided in the technical specification of batteries provided by battery manufacturer.

# 9 Firmware upgrade

Metrel as manufacturer is constantly adding new features and enhance existing. In order to get most of your instrument, we recommend periodic check for software and firmware updates. In this section firmware upgrade process is described.

## 9.1.1 Requirements

Firmware upgrade process has following requirements:

- **PC computer** with installed latest version of PowerView software. If your PowerView is out of date, please update it, by clicking on “Check for PowerView updates” in Help menu, and follow the instructions.
- **USB cable**

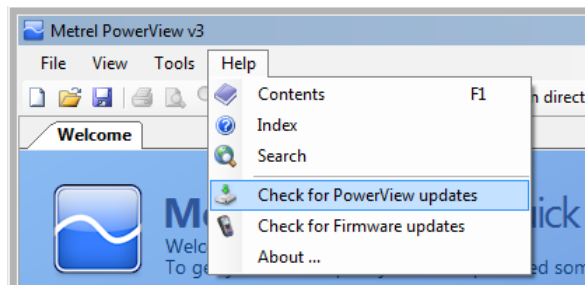


Figure 68: PowerView update function

### 9.1.2 Upgrade procedure

1. Connect PC and instrument with USB cable
2. Establish USB communication between them. In PowerView, go to Tools→Options menu and set USB connection as shown on figure below.

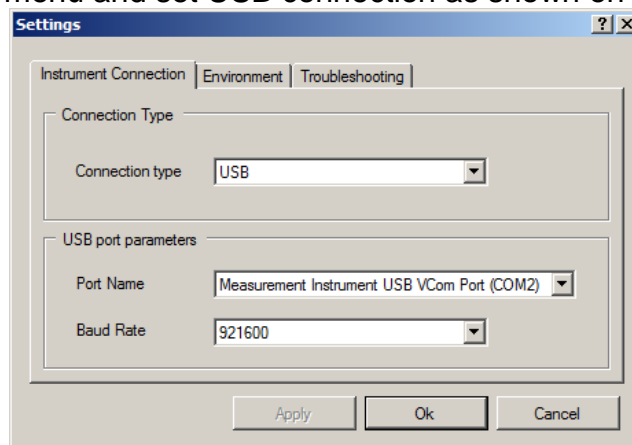


Figure 69: Selecting USB communication

3. Click on Help → Check for Firmware updates.

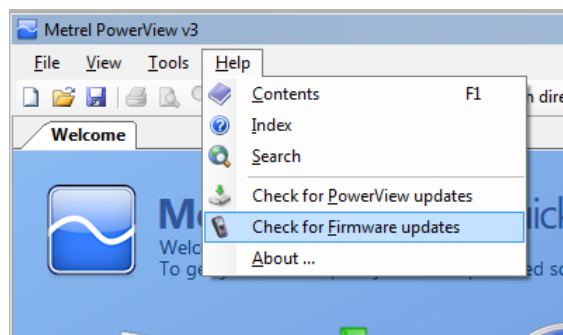


Figure 70: Check for Firmware menu

4. Version checker window will appear on the screen. Click on Start button.

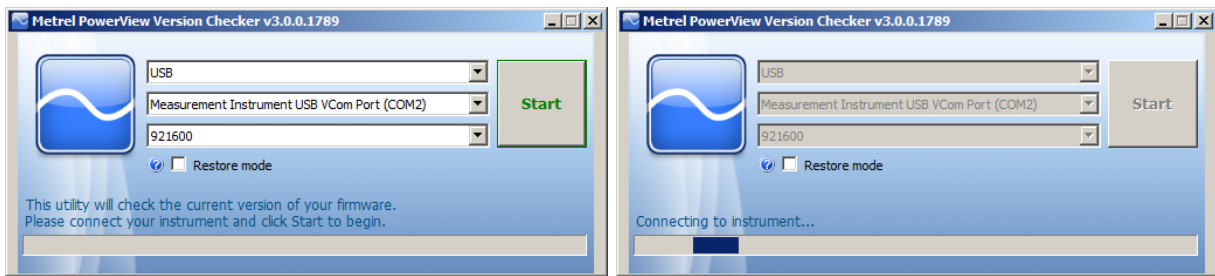


Figure 71: Version checker window

5. If your instrument has older FW, PowerView will notify you that new version of FW is available. Click on Yes to proceed.

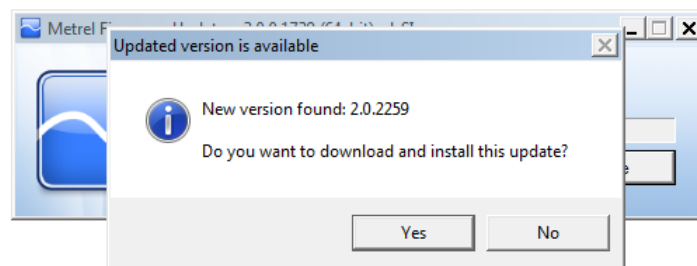


Figure 72: New firmware is available for download

6. After update is downloaded, FlashMe application will be launched. This application will actually upgrade instrument FW. Click on RUN to proceed.

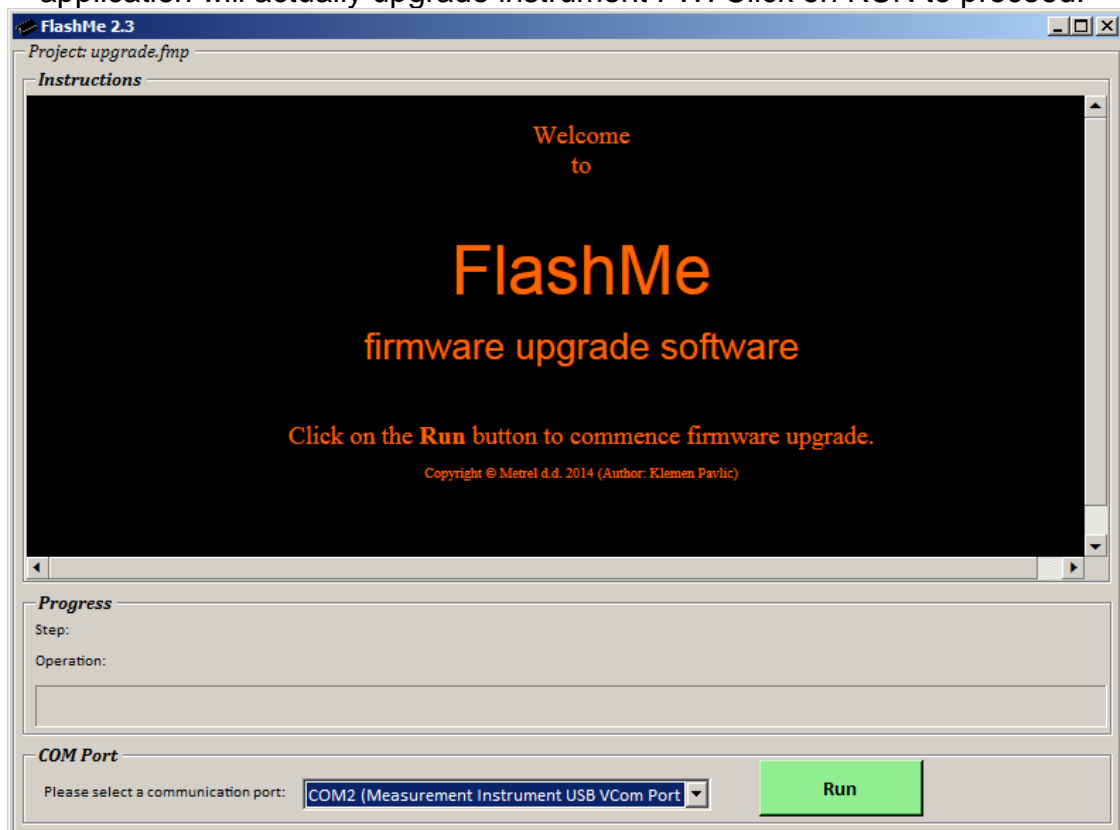


Figure 73: FlashMe firmware upgrade software starting screen



- FlashMe will automatically detect Power Master instrument, which can be seen in COM port selection menu. In some rare cases user should point FlashMe manually to COM port where instrument is connected. Click then on Continue to proceed.



Figure 74: FlashMe configuration screen

- Instrument upgrade process should begin. Please wait until all steps are finished. Note that this step should not be interrupted; as instrument will not work properly. If upgrade process goes wrong, please contact your distributor or Metrel directly. We will help you to resolve issue and recover instrument.



Figure 75: FlashMe programming screen

## 10 Power supply considerations

When using the original power supply adapter/charger the instrument is fully operational immediately after switching it on. The batteries are charged at the same time, nominal charging time is 3.5 hours.

The batteries are charged whenever the power supply adapter/charger is connected to the instrument. Inbuilt protection circuit controls the charging procedure and assure maximal battery lifetime. Batteries will be charged only if their temperature is less than 40 °C.

If the instrument is left without batteries and charger for more than 2 minutes, time and date settings are reset.

### Warnings!

- Use only charger supplied by manufacturer.
- Disconnect power supply adapter if you use standard (non-rechargeable) batteries.

## 11 Cleaning

To clean the surface of the instrument, use a soft cloth slightly moistened with soapy water or alcohol. Then leave the instrument to dry totally before use.

** Warnings!**

- Do not use liquids based on petrol or hydrocarbons!
- Do not spill cleaning liquid over the instrument!

**11.1 Periodic calibration**

To ensure correct measurement, it is essential that the instrument is regularly calibrated. **If used continuously on a daily basis, a three-month calibration period is recommended, otherwise annual calibration is sufficient.**

**11.2 Service**

For repairs under or out of warranty please contact your distributor for further information.

**Manufacturer address:**

METREL d.d.  
Ljubljanska 77,  
SI-1354 Horjul,  
Slovenia

Tel: +(386) 1 75 58 200  
Fax: +(386) 1 75 49 095  
Email: metrel@metrel.si  
<http://www.metrel.si>

## 12 Annex I – MI 2892 Calibration Certificate

Example of Calibration certificate for MI 2892, from which you can get:

- List of calibration test points
- Reference value for the tested UUC



### CALIBRATION CERTIFICATE

number: **Specimen**

Page 1 of 6

Customer

Instrument **Power Master**Manufacturer **Metrel**Type **MI 2892**Serial No. **123456789**

Calibration procedure Calibration was carried out by comparison of values indicated, or set, on the object calibrated, with values of measurands, realized with measurement standards. Detailed descriptions, where necessary, are given along with measurement results.

Environmental conditions Temperature: 24.4 °C ± 1 °C Relative humidity: 22 % ± 10 %

Date of calibration **2019-01-01**

Calibration results are given on the following pages

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The SA is one of the signatories of multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates. The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02.

Performed by: Approved by:  
Head of Calibration Laboratory

Date of issue:

**Jure Božnar****Janko Mole****2019-01-01**

Reproduction of the complete certificate is allowed. Parts of the certificate may only be reproduced with written approval of the calibration laboratory. This certificate is issued provided that the Slovenian Accreditation do not assume any liability.

METREL d.d., Ljubljanska cesta 77, SI-1354 Horjul, SLOVENIA, Phone: +386 1 7558 200,  
Fax: + 386 1 7549 095, ID VAT No: SI 56 387 512, <http://www.metrel.si>, e-mail: [metrel@metrel.si](mailto:metrel@metrel.si)



## CALIBRATION CERTIFICATE

number: Specimen

Page 2 of 6

### Object calibrated (UUC):

Power Master

Calibrated parameters:

- AC voltage
- AC current
- Frequency

### Calibration procedure:

- L-KP-ACV (ver. 5.0)
- L-KP-ACI (ver. 5.0)
- L-KP-FTI (ver. 4.0)

Metrel template: Power Metrel MI 2892\_b4

The calibration was carried out with reference multimeter. Multifunction calibrator was as source.

### Measurement conditions:

For the purpose of temperature stabilization, the UUC was stored in the measurement room prior to calibration for at least four hours.

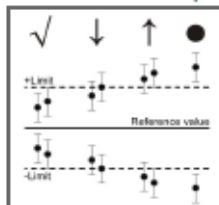
### The tables includes following data:

Reference	set or indicated value on the standard
UUC	set or indicated value on the calibration item
Uncertainty	expanded measurement uncertainty ( $k = 2$ )
Error	UUC - Reference
Limit	limit of error ( $\pm$ ), specifications

Limits of error for individual measured parameters are stated along with the measurement results and are calculated from manufacturer's specification given in:

Metrel, Power Master, MI 2892, Instruction manual, version 1.1, Code No. 20 752 217

The statment of compliance is based on a 95% coverage probability for the expanded uncertainty.



√ - Compliance with the specification limit.

● - Non-compliance with the specification limit.

↓ - It is not possible to state compliance although the error is within the limit.

↑ - It is not possible to state non-compliance although the error is outside the limit.

The uncertainty of measurement stated is composed of the uncertainties of the calibration procedure and those of the object calibrated during calibration. An uncertainty component for the long-term instability of the object calibrated has not been included.



# CALIBRATION CERTIFICATE

number: Specimen

Page 3 of 6

## MEASUREMENT RESULTS

### 1. AC VOLTAGE

UUC set-up: Voltage ratio: 1:1, Connection: 4W, Synchronization: U1, System frequency 50 Hz.

#### U nominal = 50 V

Input	Reference V	Frequency Hz	UUC V	Uncertainty V	Error V	Limit V
L1-N	5,00	50	5,00	0,01	0,00	0,05 ✓
L2-N	5,00	50	5,00	0,01	0,00	0,05 ✓
L3-N	5,00	50	5,00	0,01	0,00	0,05 ✓
Earth-N	5,00	50	5,00	0,01	0,00	0,05 ✓
L1-N	50,00	50	50,00	0,01	0,00	0,05 ✓
L2-N	50,00	50	50,00	0,01	0,00	0,05 ✓
L3-N	50,00	50	50,00	0,01	0,00	0,05 ✓
Earth-N	50,00	50	50,00	0,01	0,00	0,05 ✓
L1-N	75,00	50	75,00	0,01	0,00	0,05 ✓
L2-N	75,00	50	75,00	0,01	0,00	0,05 ✓
L3-N	75,00	50	75,00	0,01	0,00	0,05 ✓
Earth-N	75,00	50	75,00	0,01	0,00	0,05 ✓

#### U nominal = 100 V

Input	Reference V	Frequency Hz	UUC V	Uncertainty V	Error V	Limit V
L1-N	11,00	50	11,00	0,01	0,00	0,10 ✓
L2-N	11,00	50	11,00	0,01	0,00	0,10 ✓
L3-N	11,00	50	11,00	0,01	0,00	0,10 ✓
Earth-N	11,00	50	11,00	0,01	0,00	0,10 ✓
L1-N	110,00	50	110,00	0,02	0,00	0,10 ✓
L2-N	110,00	50	110,00	0,02	0,00	0,10 ✓
L3-N	110,00	50	110,00	0,02	0,00	0,10 ✓
Earth-N	110,00	50	110,00	0,02	0,00	0,10 ✓
L1-N	165,00	50	165,01	0,02	0,01	0,10 ✓
L2-N	165,00	50	165,01	0,02	0,01	0,10 ✓
L3-N	165,00	50	165,01	0,02	0,01	0,10 ✓
Earth-N	165,00	50	165,01	0,02	0,01	0,10 ✓



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LN-011

## CALIBRATION CERTIFICATE

number: Specimen

Page 4 of 6

### U nominal = 230 V

Input	Reference V	Frequency Hz	UUC V	Uncertainty V	Error V	Limit V
L1-N	23,00	50	23,00	0,01	0,00	0,23 ✓
L2-N	23,00	50	23,00	0,01	0,00	0,23 ✓
L3-N	23,00	50	23,00	0,01	0,00	0,23 ✓
Earth-N	23,00	50	23,00	0,01	0,00	0,23 ✓
L1-N	230,00	50	230,00	0,05	0,00	0,23 ✓
L2-N	230,00	50	230,00	0,05	0,00	0,23 ✓
L3-N	230,00	50	229,99	0,05	-0,01	0,23 ✓
Earth-N	230,00	50	229,99	0,05	-0,01	0,23 ✓
L1-N	340,00	50	340,02	0,06	0,02	0,23 ✓
L2-N	340,00	50	340,01	0,06	0,01	0,23 ✓
L3-N	340,00	50	340,01	0,06	0,01	0,23 ✓
Earth-N	340,00	50	340,00	0,06	0,00	0,23 ✓

### U nominal = 400 V

Input	Reference V	Frequency Hz	UUC V	Uncertainty V	Error V	Limit V
L1-N	40,00	50	40,00	0,01	0,00	0,40 ✓
L2-N	40,00	50	40,00	0,01	0,00	0,40 ✓
L3-N	40,00	50	40,00	0,01	0,00	0,40 ✓
Earth-N	40,00	50	39,99	0,01	-0,01	0,40 ✓
L1-N	400,00	50	400,02	0,07	0,02	0,40 ✓
L2-N	400,00	50	400,01	0,07	0,01	0,40 ✓
L3-N	400,00	50	400,01	0,07	0,01	0,40 ✓
Earth-N	400,00	50	400,01	0,07	0,01	0,40 ✓
L1-N	999,7	50	999,8	0,2	0,1	0,40 ✓
L2-N	999,7	50	999,7	0,2	0,0	0,40 ✓
L3-N	999,7	50	999,7	0,2	0,0	0,40 ✓
Earth-N	999,7	50	999,7	0,2	0,0	0,40 ✓



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LJ-011

## CALIBRATION CERTIFICATE

number: Specimen

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### 2. AC CURRENT

UUC set-up: Voltage ratio: 1:1, Connection: 4W, Synchronization: I1, System frequency 50 Hz,  
Primary current: 5A, Secondary current: 5A.

Selected clamp A 1033

Range = 100 A (indication 100 A at input 100 mV)

Input	Reference mV	Frequency Hz	UUC A	Uncertainty A	Error A	Limit A
I1	50,00	50	49,99	0,01	-0,01	0,13 ✓
I2	50,00	50	49,99	0,01	-0,01	0,13 ✓
I3	50,00	50	49,99	0,01	-0,01	0,13 ✓
IN	50,00	50	49,99	0,01	-0,01	0,13 ✓
I1	100,00	50	99,99	0,02	-0,01	0,25 ✓
I2	100,00	50	99,99	0,02	-0,01	0,25 ✓
I3	100,00	50	99,99	0,02	-0,01	0,25 ✓
IN	100,00	50	99,99	0,02	-0,01	0,25 ✓
I1	199,92	50	199,92	0,04	0,00	0,5 ✓
I2	199,92	50	199,92	0,04	0,00	0,5 ✓
I3	199,92	50	199,91	0,04	-0,01	0,5 ✓
IN	199,92	50	199,91	0,04	-0,01	0,5 ✓

Range = 1000 A (indication 1000 A at input 1000 mV)

Input	Reference mV	Frequency Hz	UUC A	Uncertainty A	Error A	Limit A
I1	50,00	50	50,00	0,01	0,00	0,13 ✓
I2	50,00	50	50,00	0,01	0,00	0,13 ✓
I3	50,00	50	50,00	0,01	0,00	0,13 ✓
IN	50,00	50	50,00	0,01	0,00	0,13 ✓
I1	1000,0	50	1000,0	0,1	0,0	2,5 ✓
I2	1000,0	50	1000,0	0,1	0,0	2,5 ✓
I3	1000,0	50	1000,0	0,1	0,0	2,5 ✓
IN	1000,0	50	1000,0	0,1	0,0	2,5 ✓
I1	2000	50	2000	1	0	5 ✓
I2	2000	50	2000	1	0	5 ✓
I3	2000	50	2000	1	0	5 ✓
IN	2000	50	2000	1	0	5 ✓





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## CALIBRATION CERTIFICATE

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### 3. FREQUENCY

U1 = 100 V, I1 = 1000 A, U12 = 320 V

Settings	Reference Hz	UUC Hz	Uncertainty Hz	Error Hz	Limit Hz	
Sinhronization: U1, 4W	50,000	49,999	0,003	-0,001	0,010	√
Sinhronization: I1, 4W	50,000	49,999	0,003	-0,001	0,010	√
Sinhronization: U12, 3W	50,000	49,999	0,003	-0,001	0,010	√

## 13 Annex II – CS 2890 Calibration Certificate

Example of Calibration certificate for CS 2890, from which you can get:

- Exact Reference value for the specific measurement test point



### CALIBRATION CERTIFICATE

number: E-vzorec

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Customer	<b>Metrel d.d.</b> Ljubljanska cesta 77 1354 Horjul
Instrument	<b>Power Simulator / Calibrator</b>
Manufacturer	<b>Metrel</b>
Type	<b>CS 2890</b>
Serial No.	<b>16400402</b>
Calibration procedure	Calibration was carried out by comparison of values indicated, or set, on the object calibrated, with values of measurands, realized with measurement standards. Detailed descriptions, where necessary, are given along with measurement results.
Environmental conditions	Temperature: 22 °C ± 1 °C    Relative humidity: 29 % ± 10 %
Date of calibration	<b>2019-01-17</b>
Calibration results	are given on the following pages

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The SA is one of the signatories of multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates. The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA Publication EA-4/02.

Performed by:	Approved by:	Date of issue:
	Head of Calibration Laboratory	
<b>Jure Božnar</b>	<b>Janko Mole</b>	<b>2019-01-17</b>



Reproduction of the complete certificate is allowed. Parts of the certificate may only be reproduced with written approval of the calibration laboratory. This certificate is issued provided that the Slovenian Accreditation do not assume any liability.

METREL d.d., Ljubljanska cesta 77, SI-1354 Horjul, SLOVENIA, Phone: +386 1 7558 200,  
Fax: + 386 1 7549 095, ID VAT No: SI 56 387 512, <http://www.metrel.si>, e-mail: [metrel@metrel.si](mailto:metrel@metrel.si)



## CALIBRATION CERTIFICATE

number: E-vzorec

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### Object calibrated (UUC):

Power Simulator / Calibrator

Calibrated parameters:

- AC voltage
- Frequency

### Calibration procedure:

- L-KP-ACV (ver. 7)
- L-KP-FTI (ver. 5)

Metrel template: Power Simulator Calibrator Metrel CS 2890\_a2

The calibration was carried out with reference multimeter.

### Measurement conditions:

For the purpose of temperature stabilization, the UUC was stored in the measurement room prior to calibration for at least four hours.

UUC power supply: adapter + insulation transformer

Calibration was performed using test leads/accessories owned by calibration laboratory.

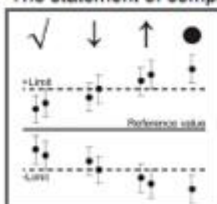
### The tables includes following data:

Reference	set or indicated value on the standard
UUC	set or indicated value on the calibration item
Uncertainty	expanded measurement uncertainty ( $k = 2$ )
Error	UUC - Reference
Limit	limit of error, specifications

Limits of error for individual measured parameters are stated along with the measurement results and are calculated from manufacturer's specification given in:

METREL Power Simulator / Calibrator CS 2890, Instruction manual, Version 1.0,

The statement of compliance is based on a 95% coverage probability for the expanded uncertainty.



✓ - Compliance with the specification limit.

● - Non-compliance with the specification limit.

↓ - It is not possible to state compliance although the error is within the limit.

↑ - It is not possible to state non-compliance although the error is outside the limit.

The uncertainty of measurement stated is composed of the uncertainties of the calibration procedure and those of the object calibrated during calibration.

An uncertainty component for the long-term instability of the object calibrated has not been included.



## CALIBRATION CERTIFICATE

number: E-vzorec

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### MEASUREMENT RESULTS

Power supply over insulation transformer.

#### 1. AC VOLTAGE (f = 60 Hz)

##### Voltage output (L1-N)

UUC V	Reference V	Uncertainty V	Error V	Limit V	
5	5,00450	0,00088	-0,00450	± 0,05000	√
50	50,0033	0,0071	-0,0033	± 0,0500	√
75	74,9870	0,0096	0,0130	± 0,0500	√
11	11,0106	0,0013	-0,0106	± 0,1100	√
110	109,967	0,013	0,033	± 0,110	√
165	164,945	0,019	0,055	± 0,110	√
23	23,0146	0,0043	-0,0146	± 0,2300	√
230	229,943	0,051	0,057	± 0,230	√
345	345,035	0,072 *	-0,035	± 0,230	√
40	40,0059	0,0059	-0,0059	± 0,4000	√
400	400,041	0,086 *	-0,041	± 0,400	√
500	499,99	0,10 *	0,01	± 0,40	√

\* Voltage output L1-L2



## CALIBRATION CERTIFICATE

number: E-vzorec

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### Current output - voltage

On output was load 110 k $\Omega$ .

Output mV	UUC mV	Reference mV	Uncertainty mV	Error mV	Limit mV	
I1	50	50,019	0,017	-0,019	$\pm 0,125$	√
I2	50	50,106	0,018	-0,106	$\pm 0,125$	√
I3	50	50,029	0,017	-0,029	$\pm 0,125$	√
In	50	50,021	0,017	-0,021	$\pm 0,125$	√
I1	100	99,964	0,028	0,036	$\pm 0,250$	√
I2	100	100,004	0,028	-0,004	$\pm 0,250$	√
I3	100	99,995	0,028	0,005	$\pm 0,250$	√
In	100	99,987	0,028	0,013	$\pm 0,250$	√
I1	200	199,975	0,052	0,025	$\pm 0,500$	√
I2	200	199,928	0,052	0,072	$\pm 0,500$	√
I3	200	199,984	0,052	0,016	$\pm 0,500$	√
In	200	200,072	0,052	-0,072	$\pm 0,500$	√
I1	1000	1000,17	0,12	-0,17	$\pm 2,50$	√
I2	1000	999,89	0,12	0,11	$\pm 2,50$	√
I3	1000	999,88	0,12	0,12	$\pm 2,50$	√
In	1000	1000,48	0,12	-0,48	$\pm 2,50$	√
I1	2000	2000,83	0,22	-0,83	$\pm 5,00$	√
I2	2000	1999,98	0,22	0,02	$\pm 5,00$	√
I3	2000	2000,21	0,22	-0,21	$\pm 5,00$	√
In	2000	2000,90	0,22	-0,90	$\pm 5,00$	√

### 2. FREQUENCY (Voltage = 50 V)

UUC Hz	Reference Hz	Uncertainty Hz	Error Hz	Limit Hz	
50	49,997	0,001	0,003	$\pm 0,010$	√
60	59,996	0,001	0,004	$\pm 0,010$	√