Power Simulator

MI 2891

Instruction manual

Version 1.2.3, Code No. 20 752 463

METREL®

Distributor:

Manufacturer:

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CE Mark on your equipment certifies that it meets European Union requirements for EMC, LVD, ROHS regulations.

1 Introduction

Power Simulator is handheld multifunction four-phase instrument for simulation of typical voltages and current shapes and situations on electrical network.

Figure 1.1: Power Simulator instrument

1.1 Main Features

- Simple and powerful waveform generator with various settings.
- 4 voltage channels with wide simulation range: up to 350 Vrms.
- 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/character type combination simulation.
- Saving predefined signal setup into SD memory card
- 4.3'' (10.9 cm) TFT colour display.

1.2 Safety considerations

To ensure operator safety while using the Power Simulator 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 370 V_{RMS}. Maximum nominal voltage between phases is 740 V_{RMS}. Do not connect output terminals to external voltage source (see Figure 2.2).**

⚠ **Check Power Simulator wiring before turning on, in order to prevent misuse and electrical shock.**

⚠ **During instrument operation ventilation holes on casing should always stay open to ensure sufficient air-flow for cooling (see Figure 2.1).**

1.3 Applicable standards

The Power Master are designed and tested in accordance with the following standards:

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
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 – 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
$Ufund_n$	Fundamental voltage
$Ifund_n$	Fundamental current
Uh_n	N-th harmonic voltage
Ih_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 2.1: 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 (BEEP OFF)**	Adjust LCD backlight intensity: high/low//off If the *LIGHT* 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.
9.	**Ventilation holes**	Ventilation holes on casing should always stay open

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 before plugging in or plugging out test leads.
- Always connect leads on Power Simulator first to avoid electric shock hazard.

Figure 2.2: 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, N, GND) output terminals.
3 12 V external power socket.

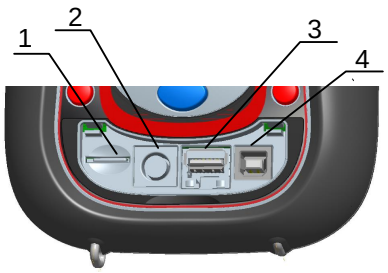


Figure 2.3: Upper connector panel

Upper connector panel layout:

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

2.3 Bottom view

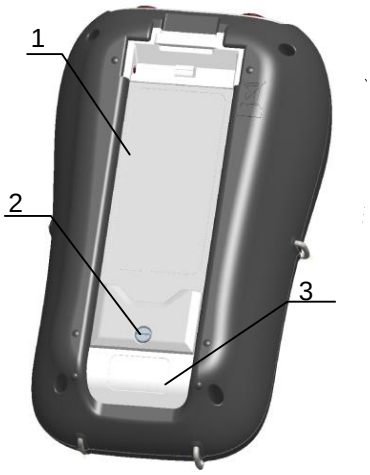


Figure 2.4: Bottom view

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 2.1: Power Master standard accessories

Description	Pieces
Flexible shielded current leads	4
Colour coded voltage measurement leads	5
USB cable	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

2.4.2 Optional accessories

See the attached sheet for a list of optional accessories that are available on request from your distributor.

3 Operating the instrument

This section describes how to operate the instrument. 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 figure below.

Figure 3.1: Display symbols and keys description

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

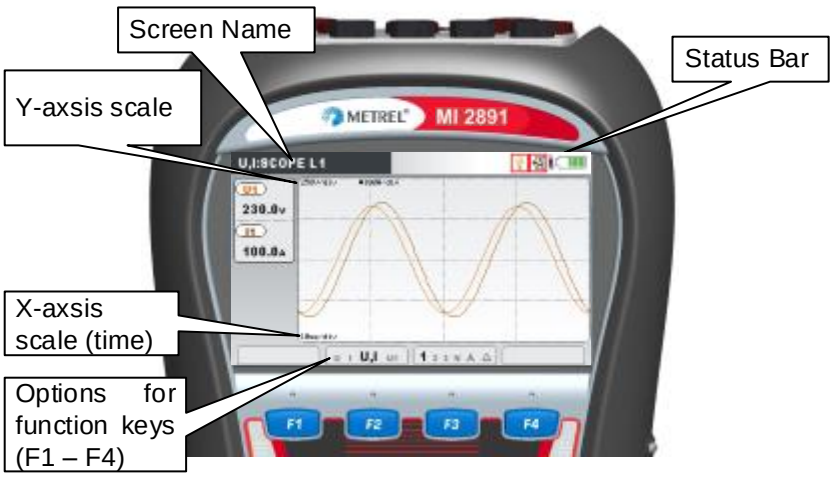


Figure 3.2: Common display symbols and labels on SCOPE screen

3.1 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.

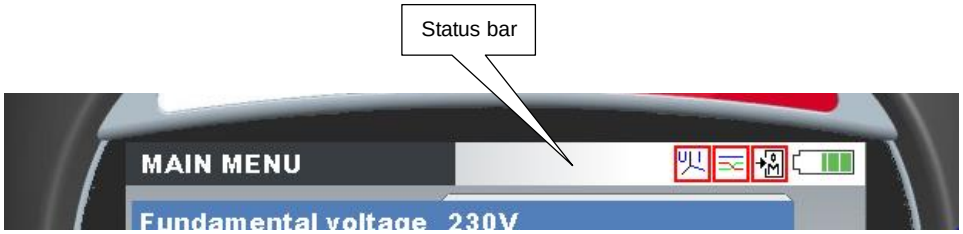


Figure 3.3: Instrument status bar

Table 3.1: 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.
°C	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.

3.2 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 3.2: 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.
	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.

For more details, read section *3.4 Keyboard shortcuts*.

Table 3.3: Function keys

F1	**SCOPE**	For monitoring the voltage and current scope on the screen.
F2	**PH. DIAG**	Phase diagram presentation on the screen.
F3	**EDIT**	Enters signal parameters submenu screen.
F4	**RECALL**	Saving and Recall the signal parameters into the SD card.

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.

3.3 Instrument Main Menu

After powering on the instrument, the “MAIN MENU” screen is displayed. From this menu all instrument options are manipulated.

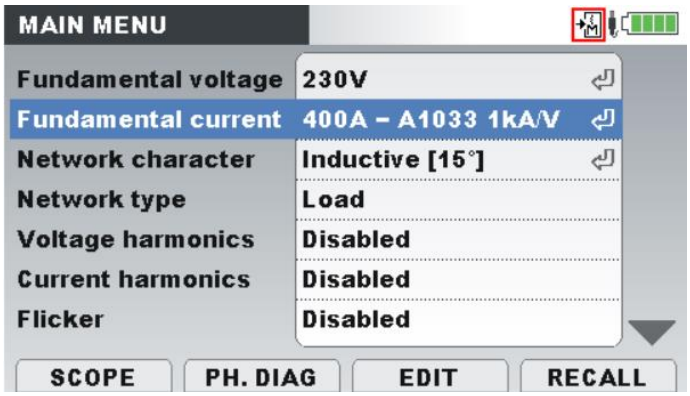


Figure 3.4: Main menu

Table 3.4: Instrument Main menu options

Fundamental voltage	Select system fundamental nominal voltage.
Fundamental current	Select system fundamental nominal current.
Network character	Select between resistive, inductive and capacitive load type and determine the angle.
Network type	Select between load (export) and generated (import) system.
Voltage harmonics	Select between disabled, predefined low, high and manually adjusted harmonics on voltage.
Current harmonics	Select 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	Select between disabled, predefined low, high and manually adjusted unbalance on current.

Frequency	Select between predefined system frequencies.
Event type	Select various network events: dip, swell, interrupt, inrush, signalling, transient and adjust its parameters.
Event occurrence	Select 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 to factory defaults.

General setup menu can be accessed by using SETTINGS key. By using function keys, user can access scope and phase diagram screens or edit menu, that allows modifying detailed parameters for each generated signal.

3.3.1 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 ENTER 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 *3.9 Edit menu* for details. If all other voltage options (harmonics, flicker, events) are disabled then output voltage will be equal to fundamental voltage.

3.3.2 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 ENTER 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 *3.9 Edit menu* for details. If all other current options (harmonics, inrush, unbalance) are disabled them current output will be equal to fundamental current.

3.3.3 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 ENTER 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 3.5: 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 ENTER 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 3.6: Current leads voltage by 5° angle.

3.3.4 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 has opposite direction. Phase shift between voltage and current (defined by Network character phase shift) is additionally shifted for 180^0. 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.

3.3.5 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^{rd}, 5^{th} and 7^{th} harmonic simultaneously. These settings will affect all phases.
- High – 15 % of Fundamental voltage is present on 3^{rd}, 5^{th} and 7^{th} harmonic simultaneously. These settings will affect all phases.
- Manual – user defined harmonic set is generated on voltage output. See section *3.7 Harmonics* for details how to define harmonic set.

3.3.6 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^{rd}, 5^{th} and 7^{th} harmonic simultaneously. These settings will affect all phases.
- High – 15 % of Fundamental current is present on 3^{rd}, 5^{th} and 7^{th} harmonic simultaneously. These settings will affect all phases.
- Manual – user defined harmonic set is generated on current output. See section *3.7 Harmonics* for details how to define harmonic set.

3.3.7 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 *3.8 Flickers* for details how to adjust parameters.

3.3.8 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 *3.6.2 Unbalance diagram* for details.

3.3.9 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 *3.6.2 Unbalance diagram* for details.

3.3.10 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 *3.9 Edit menu* for more detailed description.

3.3.11 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 *3.10 Events* for event setup and configuration.

3.3.12 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 3.7: Manual set time delay dialog

3.3.13 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 and section *3.11 Swap connection terminals* for details.

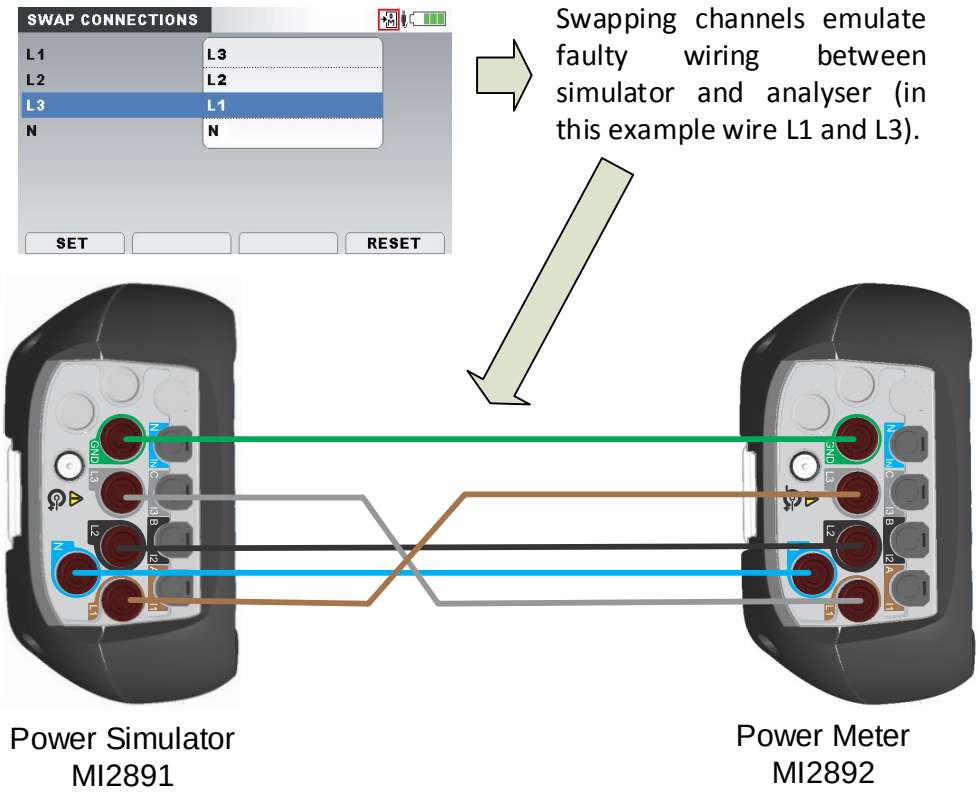


Figure 3.8: Swapping instrument channels

3.3.14 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.

3.4 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 3.5: Shortcut keys

DIP	Short press	Enable single phase dip event.
	Long press (2 s)	Enable single phase interrupt event.
Swell	Short press	Enable single phase swell event.
	Long press (2 s)	Enable single phase inrush event.
	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.

3.5 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.

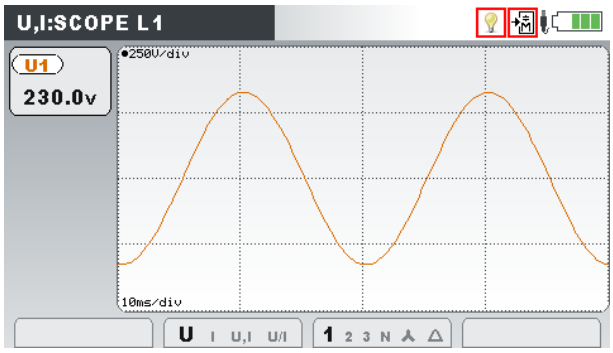


Figure 3.9: Voltage only waveform

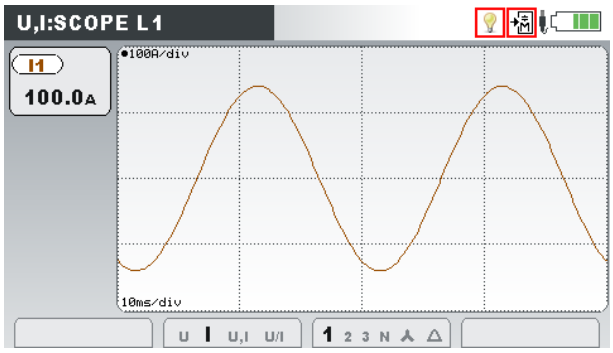


Figure 3.10: Current only waveform

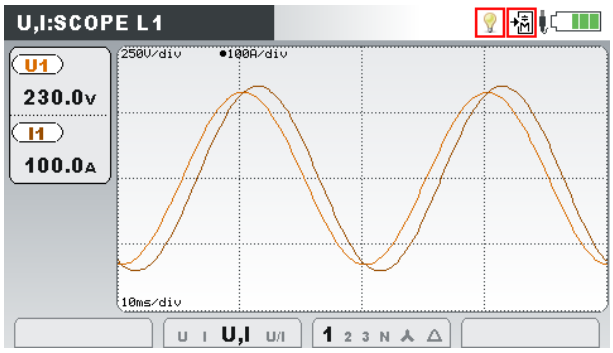


Figure 3.11: Voltage and current waveform (single mode)

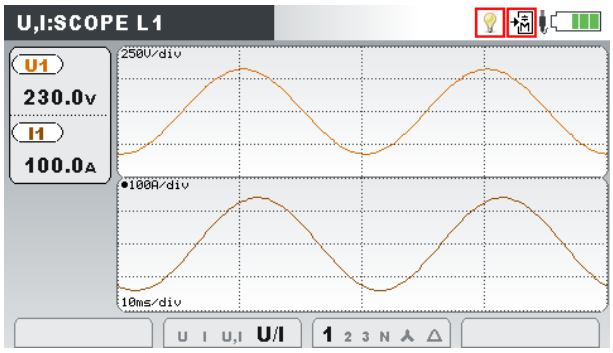


Figure 3.12: Voltage and current waveform (dual mode)

Table 3.6: 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 3.7: Keys in Scope screen

		Selects which waveforms to show:
F2	**U** I U,I U/I	Shows voltage waveform.
	U **I** U,I U/I	Shows current waveform.

	U I **U,I** U/I	Shows voltage and current waveform (single graph).
	U I U,I **U/I**	Shows voltage and current waveform (dual graph).
F3		Selects between phase, neutral, all-phases and line view:
	1 2 3 N Δ	Shows waveforms for phase L1.
	1 **2** 3 N Δ	Shows waveforms for phase L2.
	1 2 **3** N Δ	Shows waveforms for phase L3.
	1 2 3 **N** Δ	Shows waveforms for neutral channel.
	1 2 3 N Δ	Shows all phase waveforms.
	1 2 3 N **Δ**	Shows all phase-to-phase waveforms.
ENTER	Selects which waveform to zoom (only in U/I or U+I).	
	Sets vertical zoom.	
	Sets horizontal zoom.	
ESC	Returns to the Main menu.	

3.6 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 (see *Figure 5.1* for connecting Power Simulator with Power Quality Analyser). Phase diagram screens display:

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

3.6.1 Phase diagram

By entering PHASE DIAGRAM option, F2 key, from MAIN MENU, the following screen is shown *(see figure below)*.

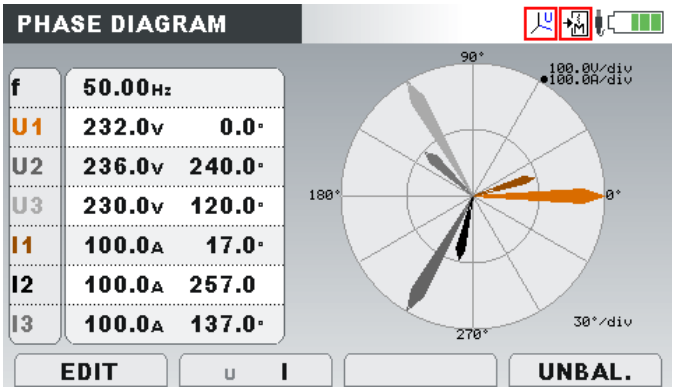


Figure 3.13: Phase diagram screen

Table 3.8: Instrument screen symbols and abbreviations

f	Frequency.
U1, U2, U3	Fundamental voltages $Ufund_1$, $Ufund_2$, $Ufund_3$ with relative phase angle to $Ufund_1$.
I1, I2, I3	Fundamental currents $Ifund_1$, $Ifund_2$, $Ifund_3$ with relative phase angle to $Ufund_1$.

Table 3.9: Keys in Phase diagram screen

F1	**EDIT**	Enters signal parameters submenu screen. This option is available only if Voltage or Current unbalance in Main menu is set to Manual. See section *3.9 Edit menu* for details.
F2	**U** I **I** U	Selects voltage for scaling (with cursors). Selects current for scaling (with cursors).
F4	**UNBAL.**	Switches to UNBALANCE DIAGRAM view.
▲ ▼		Scales voltage or current phasors.
ESC		Returns to the Main menu.

3.6.2 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.

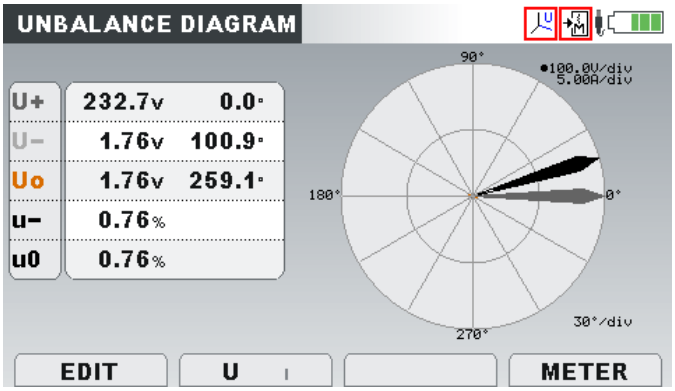


Figure 3.14: Unbalance diagram screen

Table 3.10: Instrument screen symbols and abbreviations

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

Table 3.11: Keys in Unbalance diagram screen

F1	**EDIT**	Enters signal parameters submenu screen. This option is available only if Voltage or Current unbalance in Main menu is set to Manual. See section *3.9 Edit menu* for details..
F2	**U** I **I** U	Shows voltage unbalance measurement and selects voltage for scaling (with cursors). Shows current unbalance measurement and selects current for scaling (with cursors).
F4	**METER**	Switches to PHASE DIAGRAM view.
▲ ▼		Scales voltage or current phasors.
ESC		Returns to the Main menu.

3.7 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.

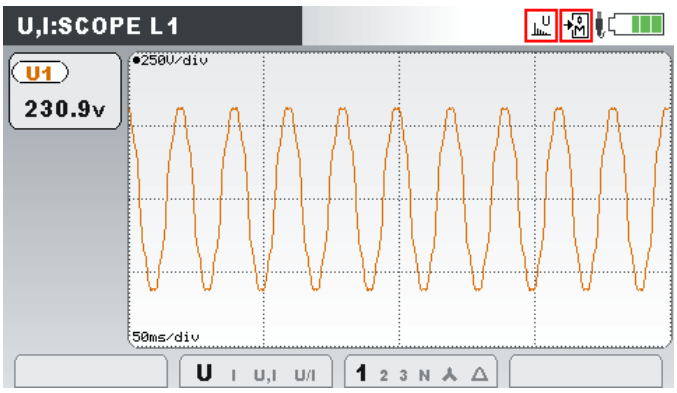


Figure 3.15: 230V fundamental voltage signal with added 5% of 3rd, 5th and 7th harmonic

3.7.1 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).

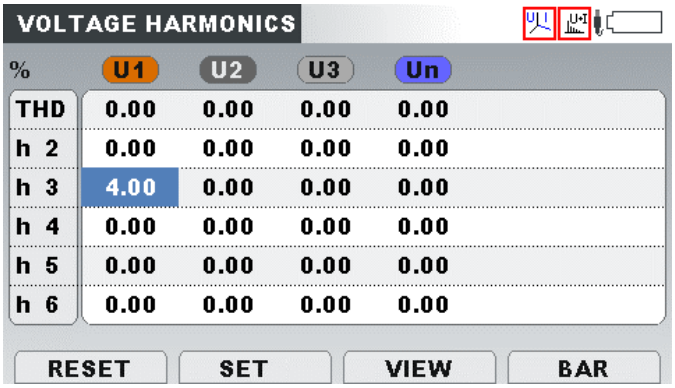


Figure 3.16: Voltage harmonics settings screen

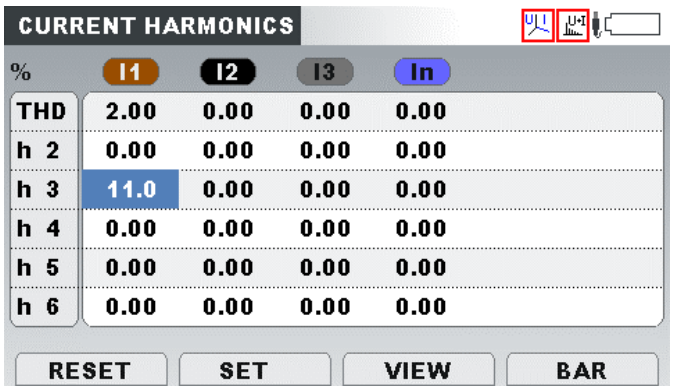


Figure 3.17: Current harmonics settings screen

If Manual option is selected at Voltage or Current harmonics setup, user can modify settings for each of the specified, all up to 50th, voltage and/or current harmonics. Currently selected parameter is coloured blue. A selection window, example in *Figure 3.18*, 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 F2 key is pressed.

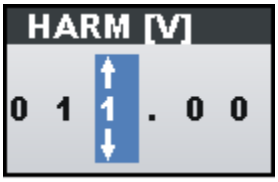


Figure 3.18: Set harmonic selection window

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

Table 3.12: Instrument screen symbols and abbreviations

THD	Total voltage / current harmonic distortion THD_U and THD_I in absolute values (V or A) or in % of fundamental voltage / current harmonic.
h1 … h50	n-th harmonic voltage Uh_n or current Ih_n component in absolute values (V or A) or in % of fundamental voltage / current harmonic.

Table 3.13: Keys in Harmonics (METER) screens

F1	**RESET**	Reset all harmonics to zero.
F2	**SET**	Refresh (activate) currently set manual harmonics.
F3	**VIEW**	Enters window to switch between absolute (V, A) and relative (% of nominal) harmonics values. VIEW %
F4	**BAR**	Switches to BAR view.
▲ ▼		Shifts through harmonic components.
◀ ▶		Shifts through channels, increase/decrease harmonic level. Switches between absolute and relative harmonics values.
ENTER		Enters harmonic selection window.
ESC		Returns to the Main menu. Closes harmonic selection window. Closes window to switch between absolute and relative harmonics values.

3.7.2 Histogram (Bar)

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

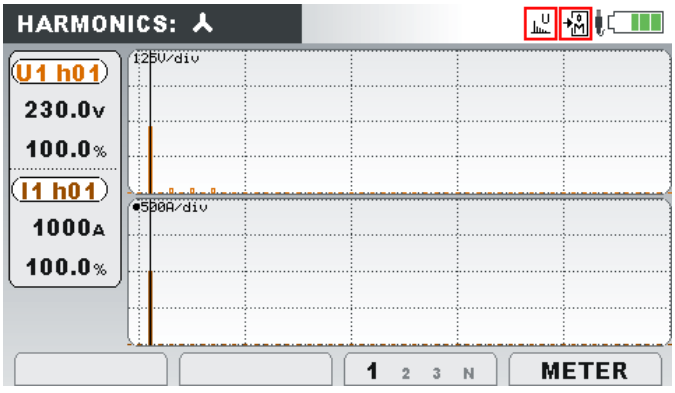


Figure 3.19: Harmonics histogram screen

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

Table 3.14: 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 3.15: Keys in Harmonics (BAR) screen

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

3.8 Flickers

Flicker is impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time. Power simulator 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 ΔU/U values are defined according to IEC61000-4-15 standard, table 5.

Figure 3.20: Flicker settings menu

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

Table 3.16: Instrument screen symbols and abbreviations

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

Table 3.17: Keys in Flickers screen

F1	**RESET**	Reset flickers to default.
F2	**SET**	Refresh (activate) currently set flickers.
▲ ▼		Scrolls between Pst and CPM parameters.
◀ ▶		Scrolls cursor to select single phase.
ENTER		Enters parameter settings submenu.
ESC		Returns to the Main menu. Closes parameter settings submenu.

3.9 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.

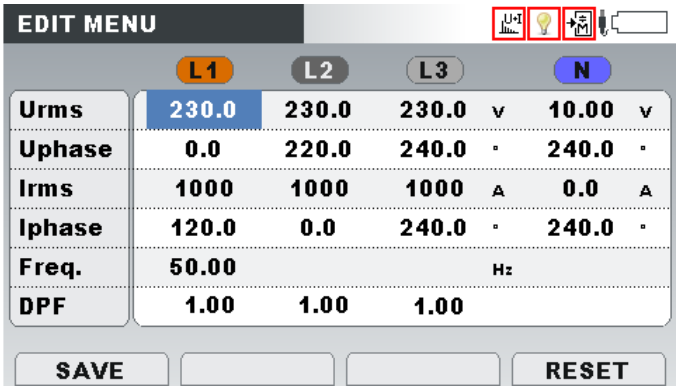


Figure 3.21: U,I: Parameters screen

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.

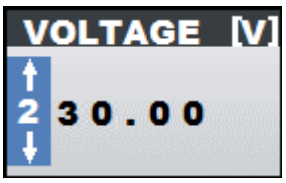


Figure 3.22: Set voltage selection window

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

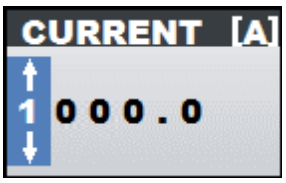


Figure 3.23: Set current selection window

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

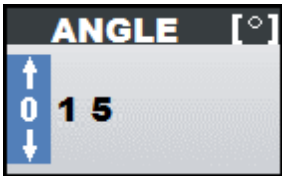


Figure 3.24: Set phase selection window

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 3.25: Set frequency selection window

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

Table 3.18: 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 φ)

Table 3.19: Keys in Edit menu screen

F1	**SET**	Refresh (activate) currently set values.
F4	**RESET**	Resets all but frequency parameters to default settings.
▲ ▼		Scrolls cursor between options.
◀ ▶		Scrolls cursor to select single phase.
ENTER		Enters parameter value selection window.
ESC		Returns to the Main menu. Exits from parameter value selection window.

3.10 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.

3.10.1 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.

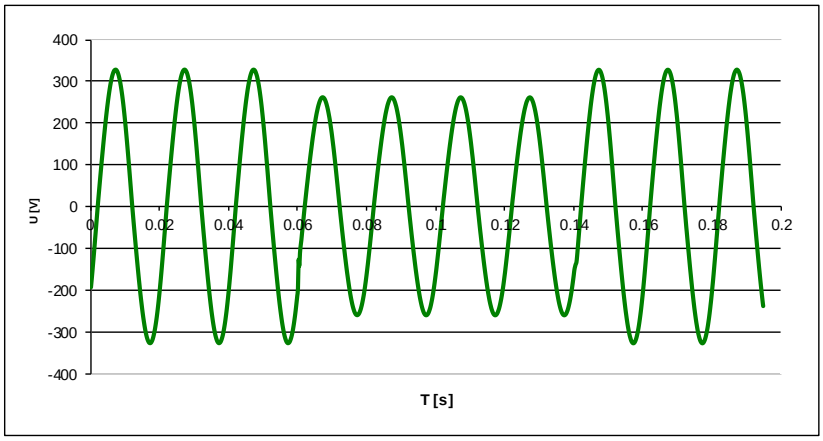


Figure 3.26: Dip event, 80 % U_{Nom}, 4 periods long

Dip can be manually triggered with **Dip** shortcut key or can be periodically repeated, according to EVENT OCCURRANCE 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 Unom.
- 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.

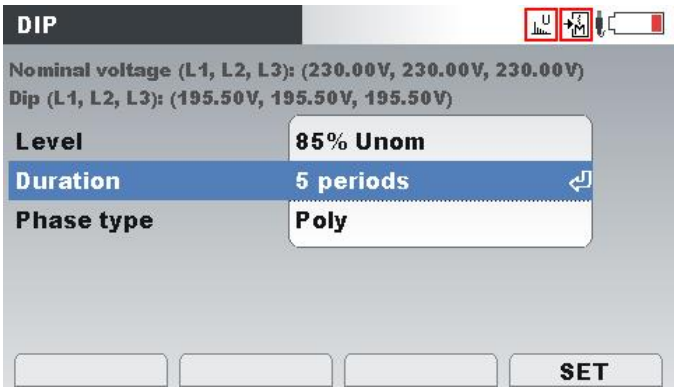
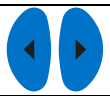


Figure 3.27: Dip settings submenu

Table 3.20: Keys in dip settings submenu

F4	**SET**	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.

3.10.2 Swell

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

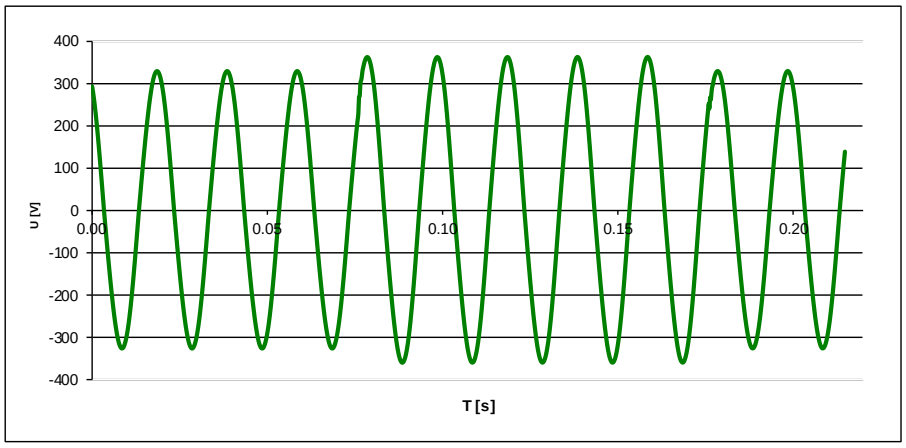


Figure 3.28: 5 periods long swell, 110 % U_{Nom}

Swell can be manually triggered with **Swell** shortcut key or can be periodically repeated, according to EVENT OCCURRANCE 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 Unom.
- 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.

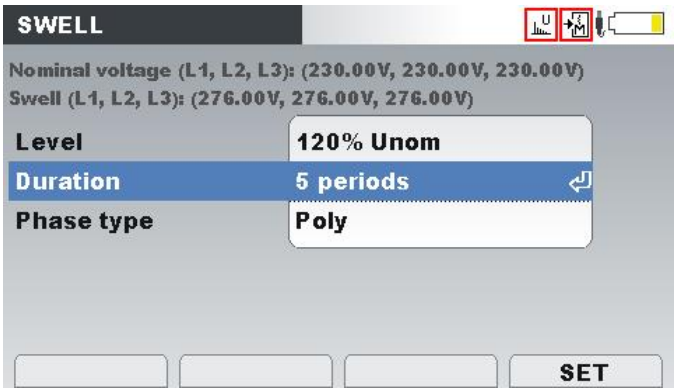


Figure 3.29: Swell settings menu

Table 3.21: Keys in swell settings submenu

F4	**SET**	Refresh (activate) currently set swell.
		Scrolls cursor between options.
		Modifies parameter.
ENTER		Enters parameter value selection window.
ESC		Returns to the Main menu. Exits from parameter value selection window.

3.10.3 Interrupt

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

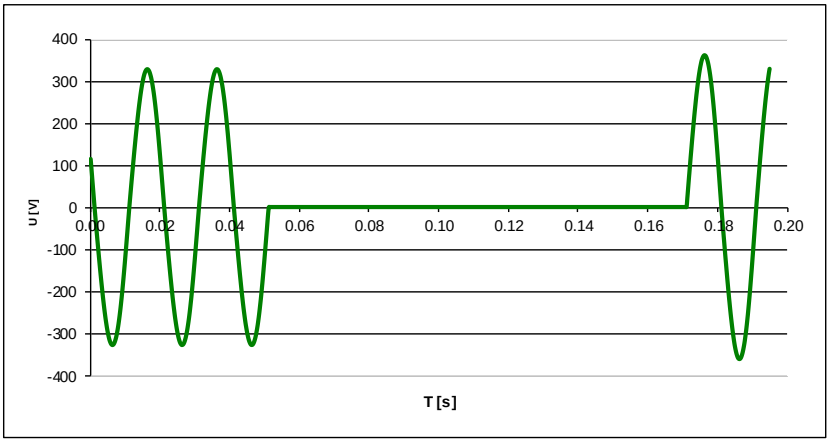


Figure 3.30: Interrupt 0 % U_{Nom}, 5 periods long

Interrupt can be manually triggered with Dip 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.

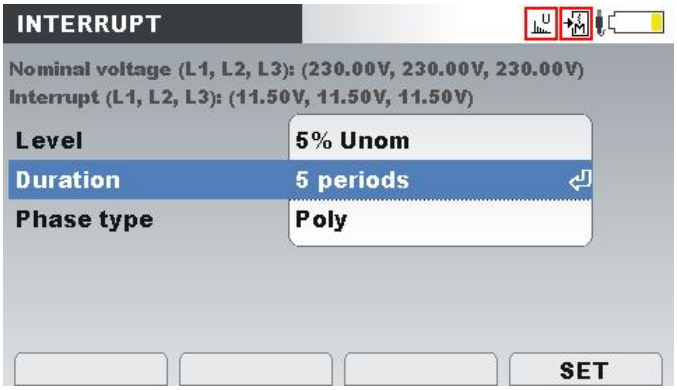


Figure 3.31: Interrupt settings submenu

Table 3.22: Keys in interrupt settings submenu

F4	**SET**	Refresh (activate) currently set interrupt.
		Scrolls cursor between options
		Modifies parameter.
ENTER		Enters parameter value selection window.
ESC		Returns to the Main menu. Exits from parameter value selection window.

3.10.4 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:

- $I_{inrush} = \frac{\frac{1}{2} + (1 - \log(k))}{\frac{1}{2}}$ to particular part of the current waveform,

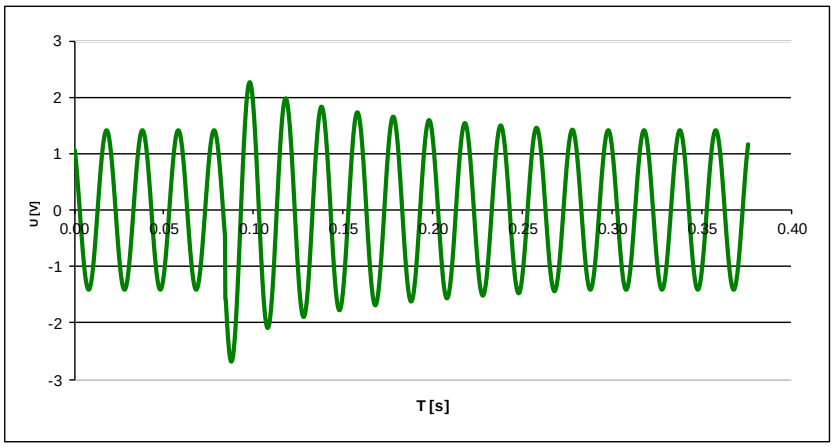


Figure 3.32: Inrush on voltage

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

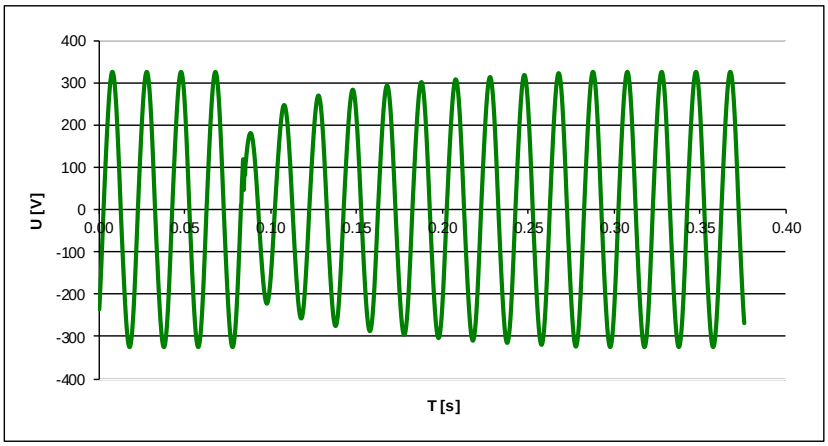


Figure 3.33: Inrush on current

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 OCCURRANCE 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 3.34: Inrush settings submenu

Table 3.23: Keys in inrush settings submenu

F4	**SET**	Refresh (activate) currently set inrush.
◄ ►		Modifies parameter.
ESC		Returns to the Main menu.

3.10.5 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 provides “ripple control signal”: superimposed sinusoidal voltage signals in the frequency range 70 Hz to 3 000 Hz.

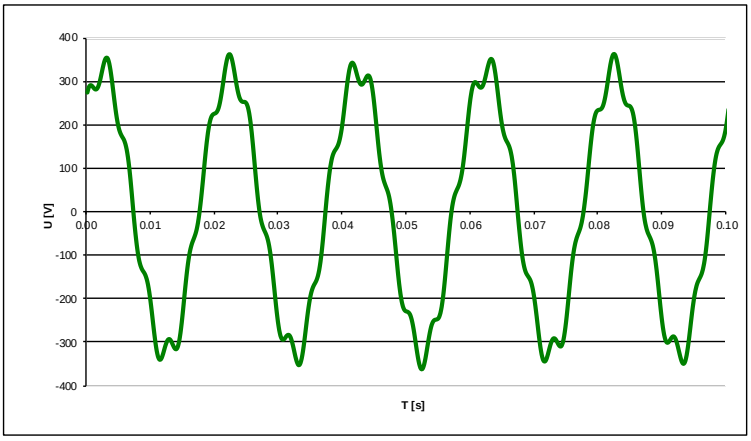


Figure 3.35: Generated signalling, 10 % U_{Nom}, signalling frequency 316.0 Hz

Signalling event is periodically repeated, according to EVENT OCCURRANCE 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 Unom.
- 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.

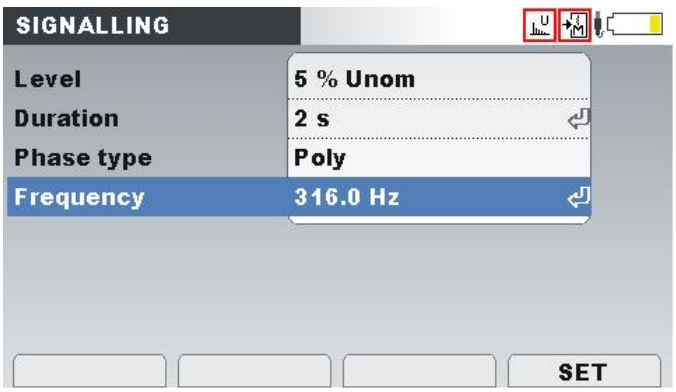


Figure 3.36: Signalling settings submenu

Table 3.24: Keys in signalling settings submenu

F4	**SET**	Refresh (activate) currently set signalling.
		Scrolls cursor between options
		Modifies parameter.
ENTER		Enters parameter value selection window.
ESC		Returns to the Main menu. Exits from parameter value selection window.

3.10.6 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 have 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.

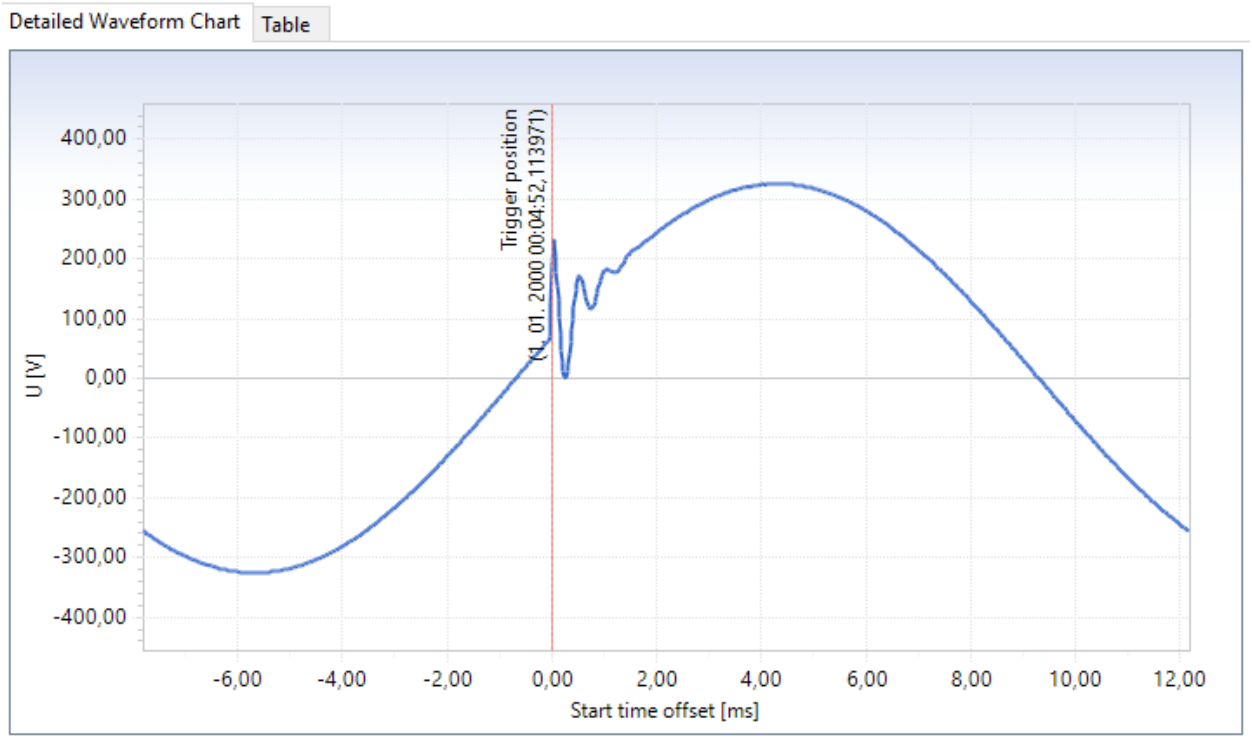


Figure 3.37: Generated transient sample, captured by MI 2892 Power Master

Transient event is periodically repeated, according to EVENT OCCURRANCE 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 3.38: Transient settings submenu

Table 3.25: Keys in transient settings submenu

F4	**SET**	Refresh (activate) currently set transient.
		Modifies parameter.
ESC		Returns to the Main menu.

3.11 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.

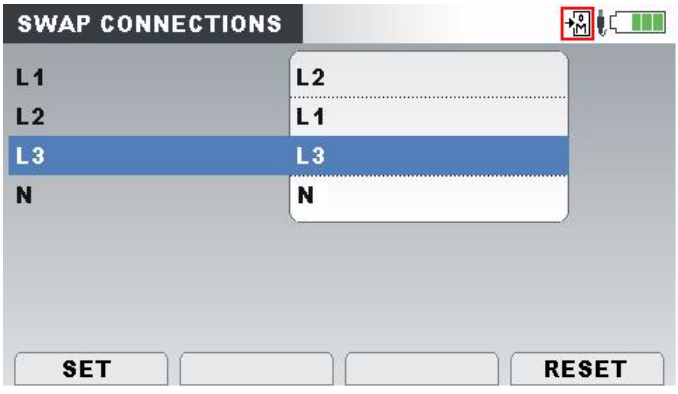


Figure 3.39: Change sequence submenu screen

Table 3.26: Keys in Swap connections screen

F1	**SET**	Activates swap of Voltage / Current channels.
F4	**RESET**	Set Voltage / Current channels to normal connection.
ENTER		Enters parameter value selection window.
◄ ►		Modifies parameter (in selection window).
ESC		Returns to the Main menu. Exits from parameter value selection window.

3.12 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.

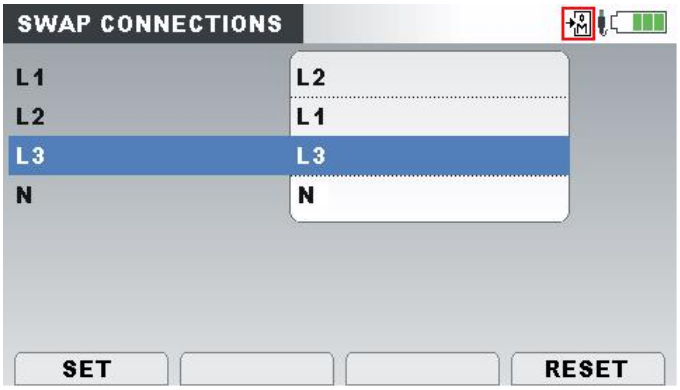


Figure 40: Change sequence submenu screen

Table 27: Keys in Swap connections screen

F1	**SET**	Activates swap of Voltage / Current channels.
F4	**RESET**	Set Voltage / Current channels to normal connection.
ENTER		Enters parameter value selection window.
◄ ►		Modifies parameter (in selection window).
ESC		Returns to the Main menu. Exits from parameter value selection window.

3.13 Instrument memory (microSD card)

Power Simulator/Calibrator use microSD card for storing the signal setup. Prior instrument use, microSD card should be formatted to a single partition FAT32 file system and inserted into the instrument, as shown on figure below.

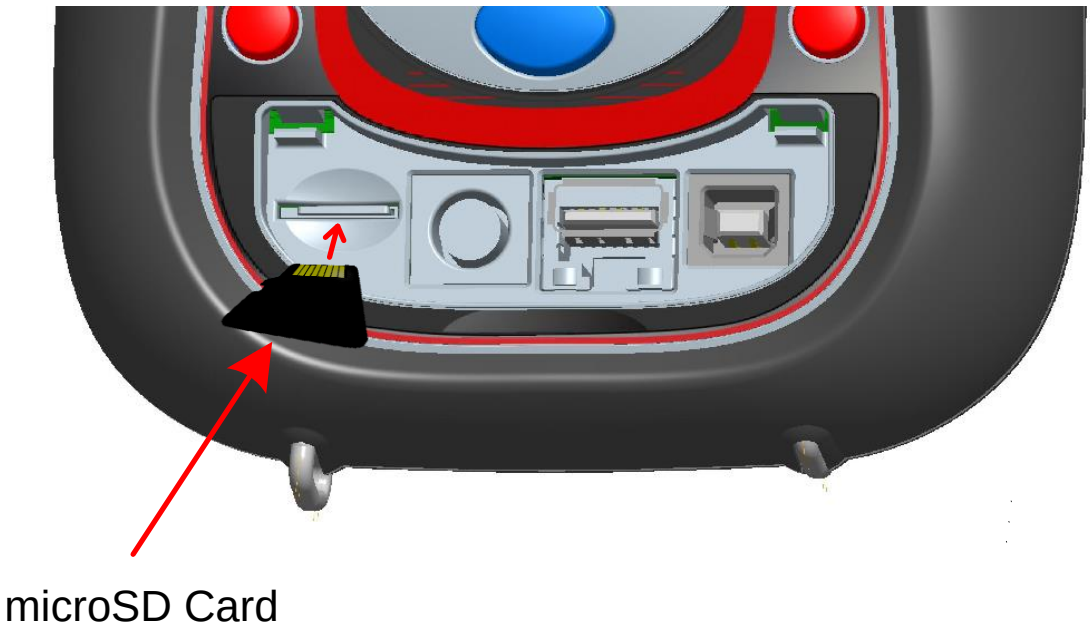


Figure 61: Inserting microSD card

1. Open instrument cover
2. Insert microSD card into a slot on the instrument (card should be putted upside down, as shown on figure)
3. Close instrument cover

Note: Do not turn off the instrument while microSD card is accessed:
Doing so may cause data corruption, and permanent data lost.

Note: SD Card should have single FAT32 partition. Do not use SD cards with multiple partitions.

Note: SD card is not a part of accessories.

3.13.1 Save/Recall signal parameters

Signal setup could be saved/recalled into the SD card by pressing the RECALL function key.

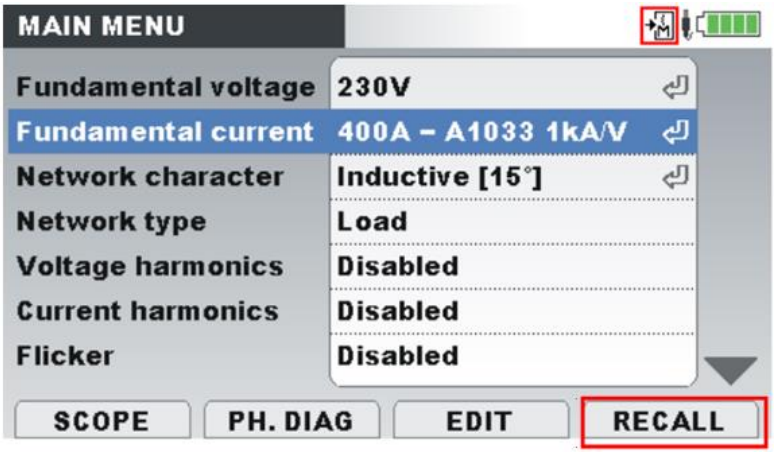
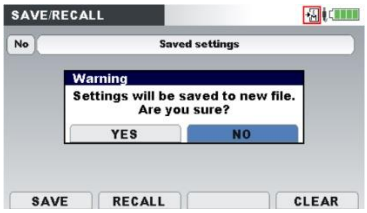


Figure 62: RECALL function key

Signal setup could be saved into the SD card by pressing the RECALL function key.

Figure 63: SAVE/RECALL window

Table 28: SAVE/RECALL screen

F1	**SAVE**	Save actual parameters setup under predefined name into SD card 	**YES** – save parameters setup **NO** – discard saving parameters setup

Saving parameters setup under selected name

Note: up to 8 setups could be saved

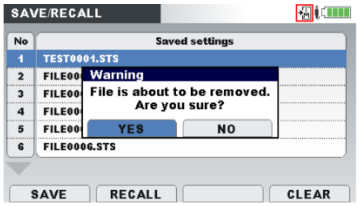
Recall selected parameters setup from the SD card

F2 **RECALL**

Recall selected parameters setup from the SD card → TEST0001 setup

Delete selected parameters setup from the SD card

F3 **CLEAR**



YES – Delete selected parameters setup
NO – discard deleting parameters setup

ENTER — Enters parameter value selection window.

Modifies parameter (in selection window).

ESC — Returns to the Main menu.
Exits from parameter value selection window.

4 General Setup

General setup menu can be accessed by using SETTINGS key from Main menu. 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 4.1: General setup menu

Table 4.1: Description of General setup options

Instrument info	Information about the instrument.
Colour Model	Select colours for displaying phase measurements.

Table 4.2: Keys in General setup menu

	Select submenu.
ENTER	Enters submenu.
ESC	Returns to the Main menu.

4.1.1 Instrument info

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

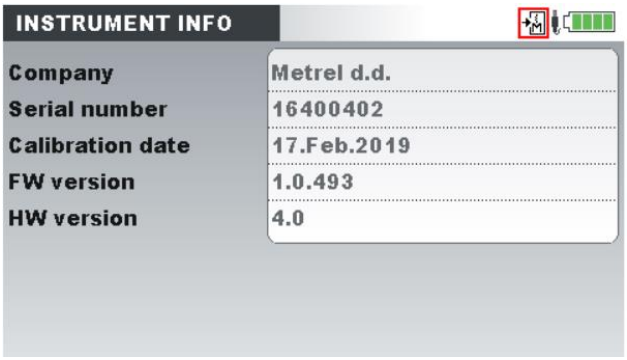


Figure 4.2: Instrument info screen

Table 4.3: Keys in Instrument info screen

ESC	Returns to the General setup menu.

4.1.2 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.

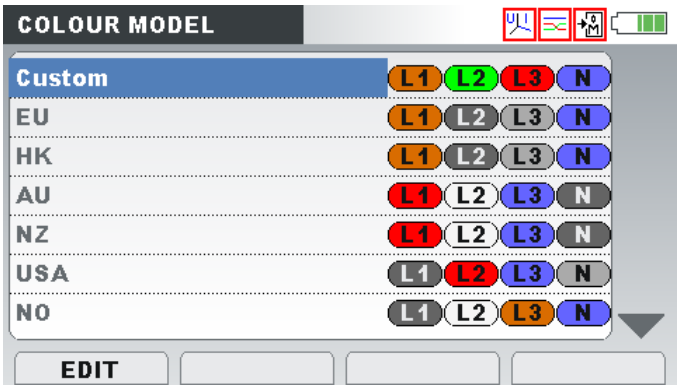
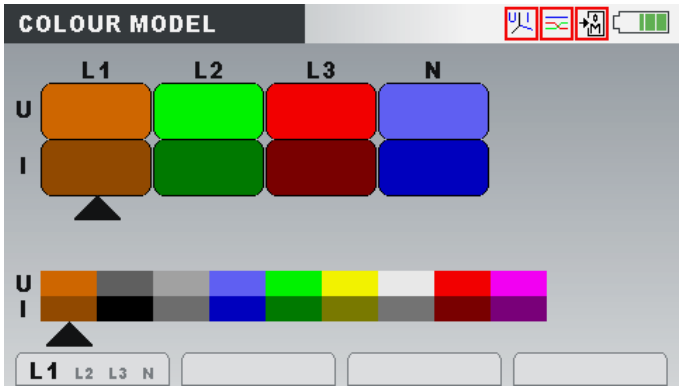


Figure 4.3: Colour representation of phase voltages

Table 4.4: Keys in Colour model screens

Opens edit colour screen (only available in custom model).



F1 **EDIT**

Keys in Edit colour screen:

F1	**L1** L2 L3 N	Shows selected colour for phase L1.
	L1 **L2** L3 N	Shows selected colour for phase L2.
	L1 L2 **L3** N	Shows selected colour for phase L3.
	L1 L2 L3 **N**	Shows selected colour for neutral channel N.
◄ ►		Selects colour.
ENTER ESC		Returns to the “COLOUR MODEL” screen.

▲	Selects Colour scheme.

	
	Returns to the General setup menu.

5 Instrument Connection

5.1 Wiring Power Simulator MI2981 to Power Master 2982

This section describes how to connect Power Simulator MI 2891 to Power Master MI 2892 using enclosed test leads.

All outputs from Power Simulator MI 2891 should be connected to adequate inputs of Power Master MI 2892.
Current leads should be connected as shown in *Figure 5.1*. I1 current output from Power Simulator should be connected to I1 input of Power Master.
Voltage leads should be connected as shown in *Figure 5.1*. L1 voltage output from Power Simulator should be connected to L1 input of Power Master.
N output from Power Simulator should be connected to N input of Power Master. Analogy applies to all other input/output combinations.

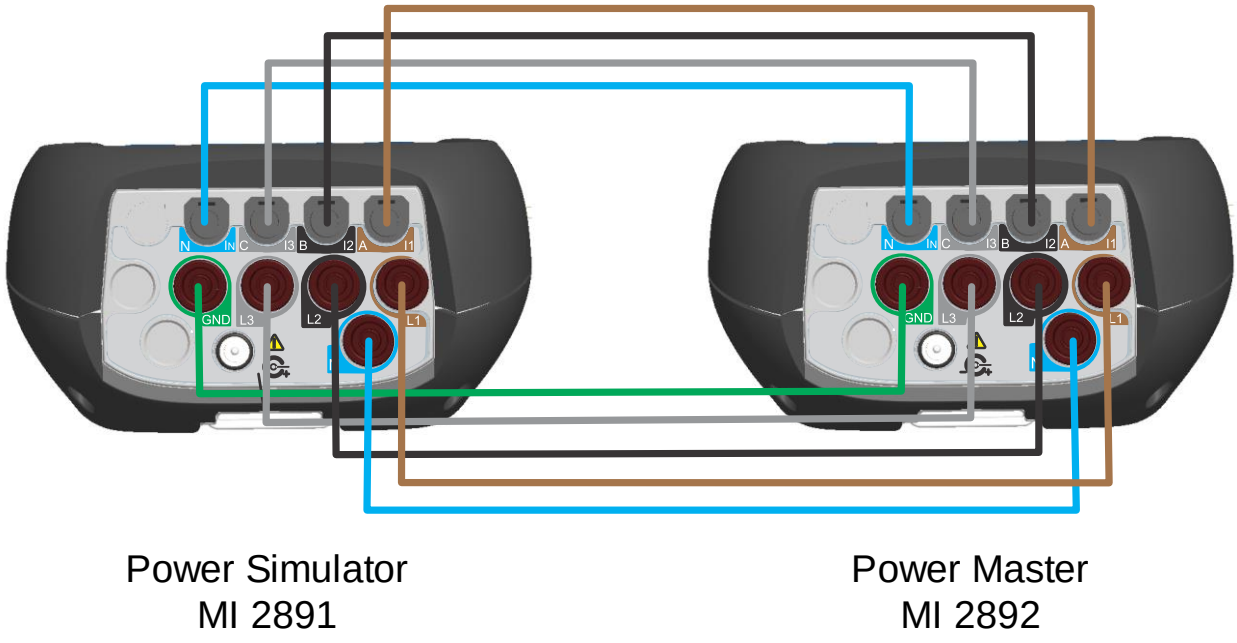


Figure 5.1: Recommended lead connection

After connecting all input/output ports, Power Simulator and Power Master may be turned on and are ready for use.

5.2 Simulation campaign

In following section recommended signal simulation is described. 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.

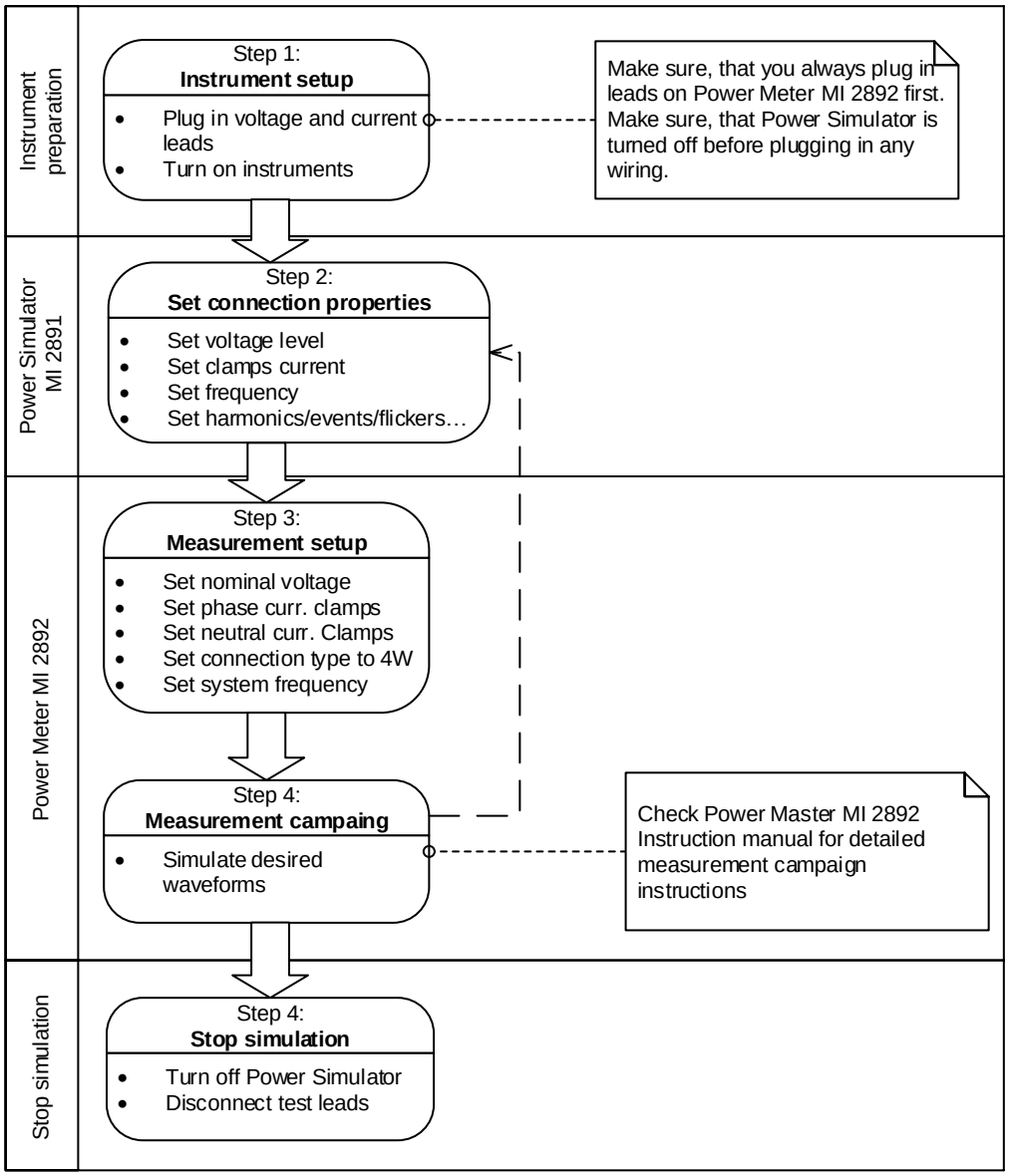


Figure 5.2: Recommended simulation practice

Step 1: Instrument setup

Preparation of Power Simulator MI 2891 and Power Master MI 2892 includes the following steps:

- Visually check both instruments and accessories.
- Make sure, that Power Simulator MI 2891 is turned off.
- Connect test leads as described in section *5.1 Wiring Power Simulator MI2981 to Power Master 2982*. Always plug in leads on Power Master first and only then on Power Simulator.

⚠ Warnings!

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

Step 2: Set connection properties

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.

Step 3: Measurement setup

On Power Master 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 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 Power Master.
- Set up alarms/events to fit your needs.
- Set up recorder.

Step 4: Measurement campaign

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

Step 5: Stop simulation

Safe removal of test leads is important for user's maximum safety.

⚠ Warning!

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

6 Technical specifications

6.1 General specifications

Working temperature range:	-20 °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* Given accuracy is guaranteed only when battery charger is present.
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 / 1.5 A (while charging batteries)
Battery charging time:	3 hours*

* The charging time and the operating hours are given for batteries with a nominal capacity of 2000 mAh.

6.2 Signal generator

6.2.1 General description

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

6.2.2 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 %

Note: The measurement accuracy is referred to U_{Nom}=230 V

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	± 2 %

6.2.3 Current

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

Range	Output voltage	Overall current accuracy
A 1033 (50 A … 1000 A)	50 mV, 100 mV	± 0.2 %
A 1033 (50 A … 1000 A)	200 mV … 2 V	± 0.1 %

6.2.4 Frequency

Frequency range	Resolution	Accuracy
45 Hz … 70 Hz	1 Hz	± 10 mHz

6.2.5 Flickers

Flicker type	Flicker range	Resolution	Accuracy
P_{st}	0.5 … 5.0	0.1	± 1 %

6.2.6 Voltage harmonics

Harmonics range	Resolution	Accuracy
Uh_N 1 % … 100 % of fundamental output voltage	1 %	± 5 % of Uh_N

Uh_N: generated harmonic voltage
$_N$: harmonic component 2^{nd} … 50^{th}

6.2.7 Current harmonics and THD

Harmonics range	Resolution	Accuracy
Ih_N 1 % … 100 % of fundamental current	1 %	± 5 % of Ih_N

Ih_N: measured harmonic current
$_N$: harmonic component 2^{th} … 50^{th}

6.2.8 Unbalance

	Unbalance range	Resolution	Accuracy
u^-	0.5 % … 5.0 %	0.1 %	± 0.15 %
u^0			± 0.15 %
i^-	0.0 % … 20 %	0.1 %	± 1 %
i^0			± 1 %

6.2.9 Time and duration uncertainty

Real time clock (RTC) temperature uncertainty

Operating range	Accuracy	
-20 °C … 70 °C	± 3.5 ppm	0.3 s/day
0 °C … 40 °C	± 2.0 ppm	0.17 s/day

Event duration uncertainty

	Measuring Range	Resolution	Error
Event Duration	1 s … 60 s	1 s	± 1 cycle

7 Maintenance

7.1 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 (*see Figure 2.4*).
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 7.1: Battery compartment

1	Battery cells
2	Serial number label

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

Figure 7.2: 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 2000 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.

7.2 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.

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.

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.

7.3 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.

7.3.1 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**

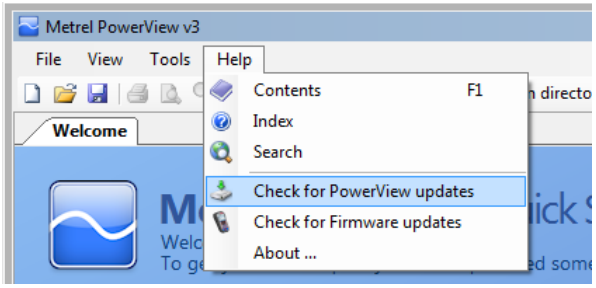


Figure 7.3: PowerView update function

7.3.2 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.

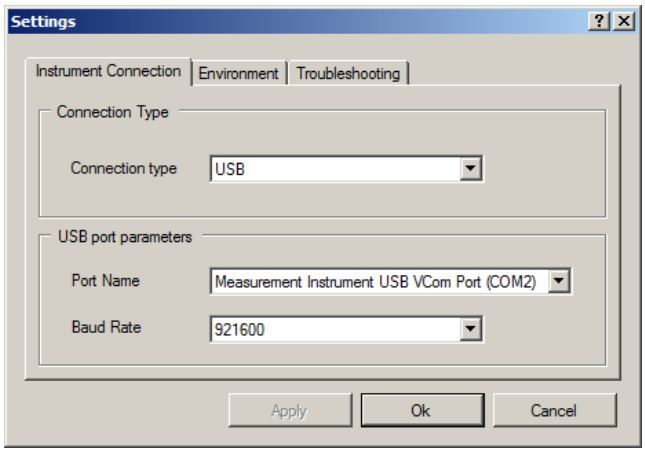


Figure 7.4: Selecting USB communication

3. Click on Help → Check for Firmware updates.

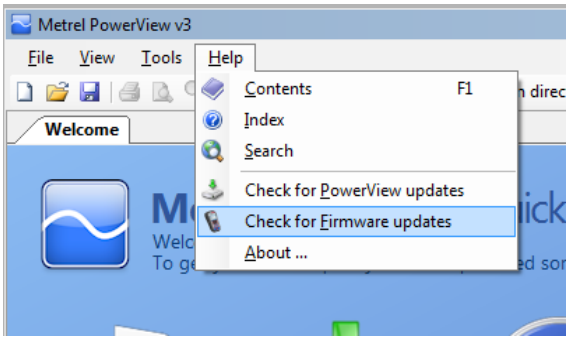


Figure 7.5: Check for Firmware menu

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

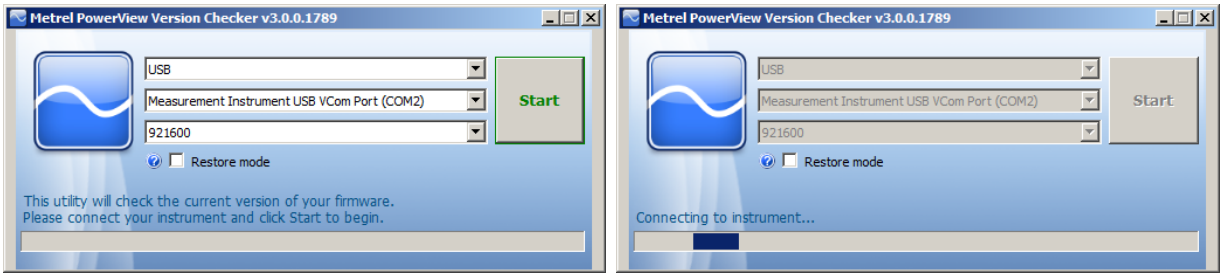


Figure 7.6: Version checker window

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

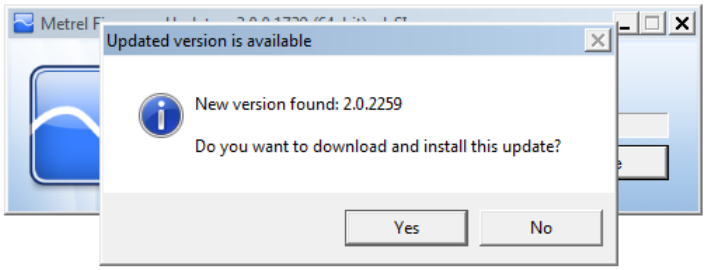


Figure 7.7: New firmware is available for download

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

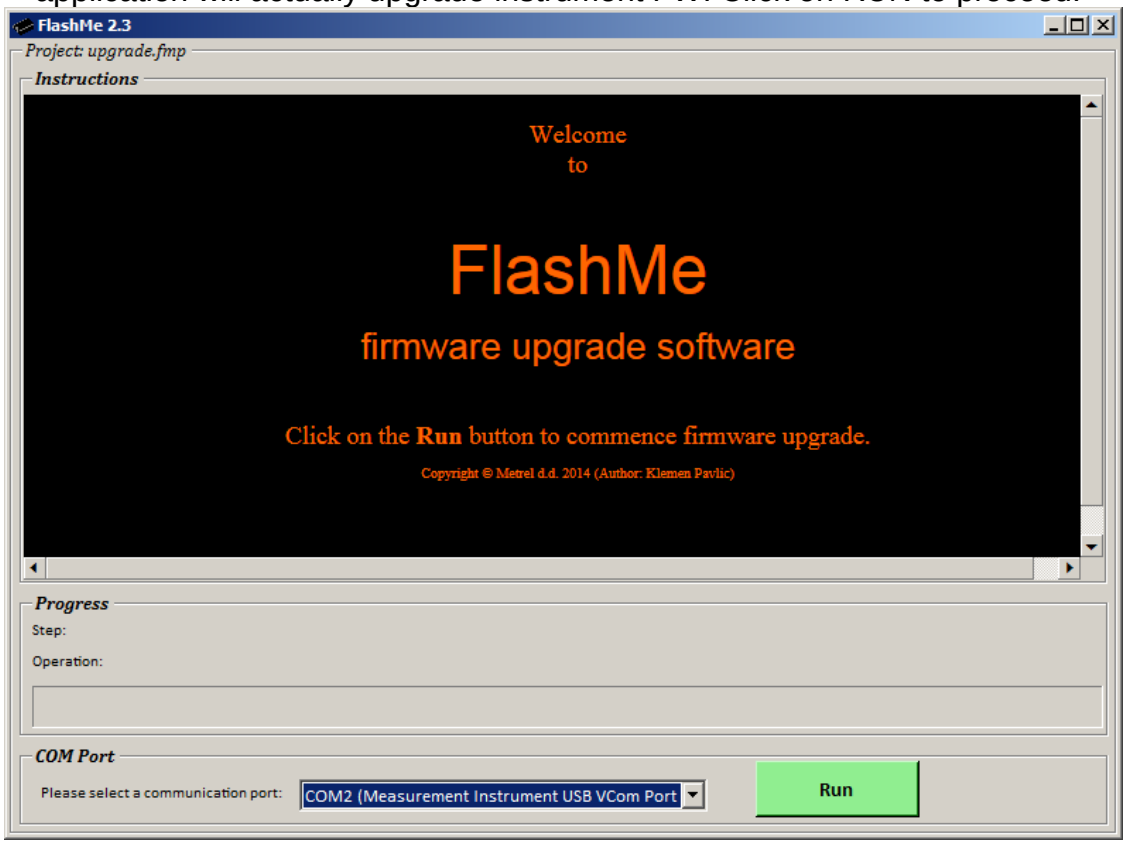


Figure 7.8: FlashMe firmware upgrade software starting screen

7. 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.

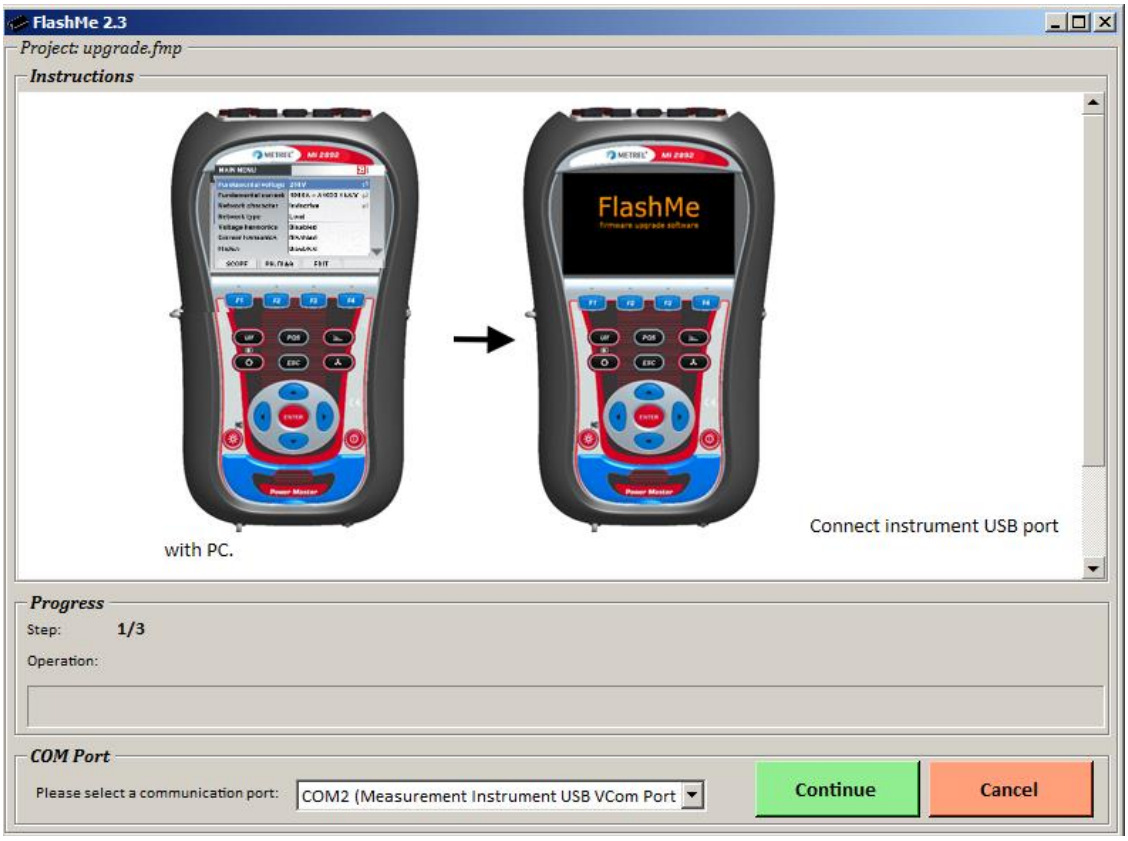


Figure 7.9: FlashMe configuration screen

8. 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.

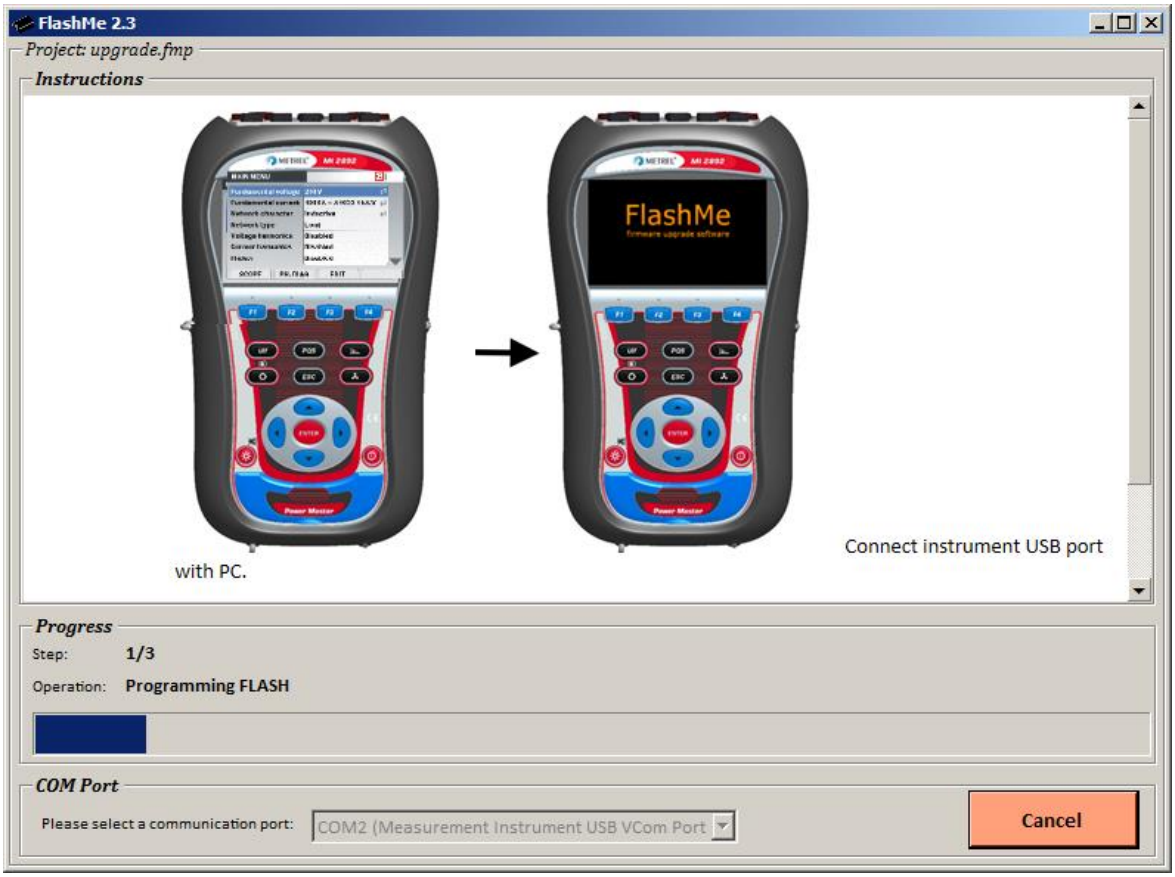


Figure 7.10: FlashMe programming screen

7.4 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 ^{0}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.**

7.5 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!**

7.6 Periodic calibration

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

7.7 Service

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

7.8 Troubleshooting

If *ESC* button is pressed while switching on the instrument, the instrument will not start. Batteries have to be removed and inserted back. After that the instrument will start normally.

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