Power Quality

Measurement preparations

Version 1.0, Code No. 20 xxx xxx

METREL®

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1 Introduction

Power Master is handheld multifunction instrument for power quality analysis and energy efficiency measurements.

Figure 1.1: Power Analyser instrument

2 Operating the instrument

This section describes how to operate the instrument. The instrument front panel consists of a colour LCD display and keypad. Measured data and instrument status are shown on the display. Basic display symbols and keys description is shown on figure below.

Figure 2.1: Display symbols and keys description

During measurement campaign various screens can be displayed. Most screens share common labels and symbols. These are shown on figure below.

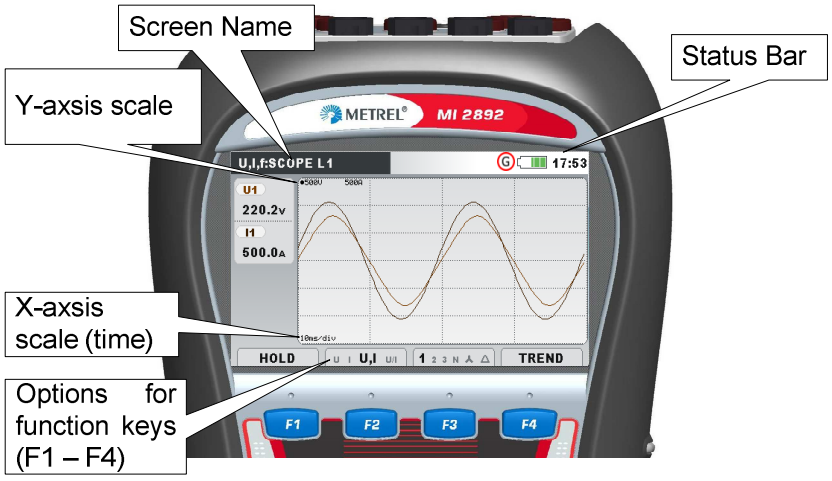

Figure 2.2: Common display symbols and labels during measurement campaign

2.1 Instrument status bar

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

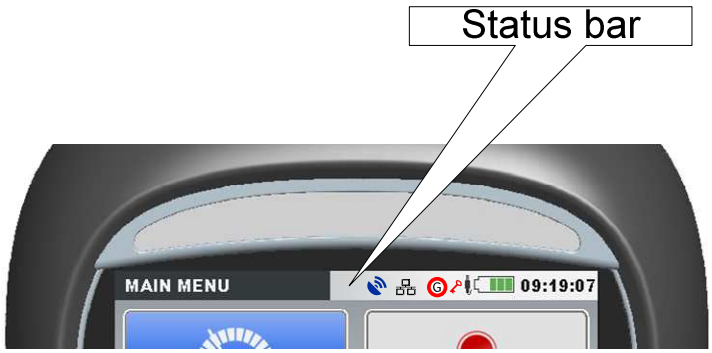

Figure 2.3: Instrument status bar

Table 2.1: 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.
	Instrument is locked (see section **Error! Reference source not found.** for details).
	AD converter over range. Selected Nominal voltage or current clamps range is too small.
09:19	Current time.
	GPS module status (Optional accessory A 1355):
	GPS module detected but reporting invalid time and position data. (Searching for satellites or too weak satellite signal).
	GPS time valid – valid satellite GPS time signal.
	*Internet connection status (see section **Error! Reference source not found.** for details):*
	Internet connection is not available.
	Instrument is connected to the internet and ready for communication.
	Instrument is connected to the PowerView.
	Recorder status:
	General recorder is active, waiting for trigger.
	General recorder is active, recording in progress.
	Waveform recorder is active, waiting for trigger.
	Waveform recorder is active, recording in progress.
	Transient recorder is active, waiting for trigger.
	Transient recorder is active, recording in progress.
	Memory list recall. Shown screen is recalled from instrument memory.

2.2 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.

Shortcut keys are shown in table below. They provide quick access to the most common instrument functions.

Table 2.2: Shortcut Keys functions

	Shows UIF Meter screen from MEASUREMENT submenu
	Shows Power meter screen from MEASUREMENT submenu
	Shows Harmonics meter screen from MEASUREMENT submenu
	Shows Connection Setup screen from MEASUREMENT SETUP submenu
	Shows Phase diagram screen from MEASUREMENT submenu
	Hold  key for 2 seconds to trigger WAVEFORM SNAPSHOT. Instrument will record all measured parameters into file, which can be then analysed by PowerView.
	Hold  key for 2 s to disable/enable sound signals.

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.

 key is used to set backlight intensity (low/high). Additionally, by holding  key pressed, user can enable/disable beeper.

 key is used to switch On/off the instrument.

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3 Initial Instrument Preparation

Perform the following steps before starting measurement for the first time.

3.1 Colour coding

Attach colour coded labels to the supplied current sensors A 1227

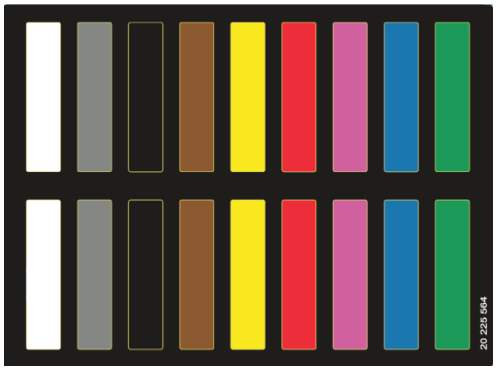


Figure 3.1: Colour coded labels

Apply labels to both ends of the current clamp sensor lead.

*Before applying the input cable labels clean the surface of the clamp sensor cord.

Figure 3.2: Colour coded Current sensor

3.2 Installing the batteries

The batteries are used to power the instrument during power outages and as backup power supply.

Note: In problematic PQ environment where dips and interrupts frequently occurs instrument power supply fully depends on batteries! Keep your batteries in good condition. Fully charged batteries can provide backup power for approximately 300 minutes.

Figure 3.3: Back side view layout:

1. Battery compartment cover.
2. Battery compartment screw (unscrew to insert the batteries).
3. Insert Battery cells (Size AA, rechargeable NiMH/NiCd)
4. Closing the battery compartment cover (screw back after closing the battery compartment).

3.3 Installing the instrument memory (microSD card)

Power analyser use microSD card for storing records. 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.

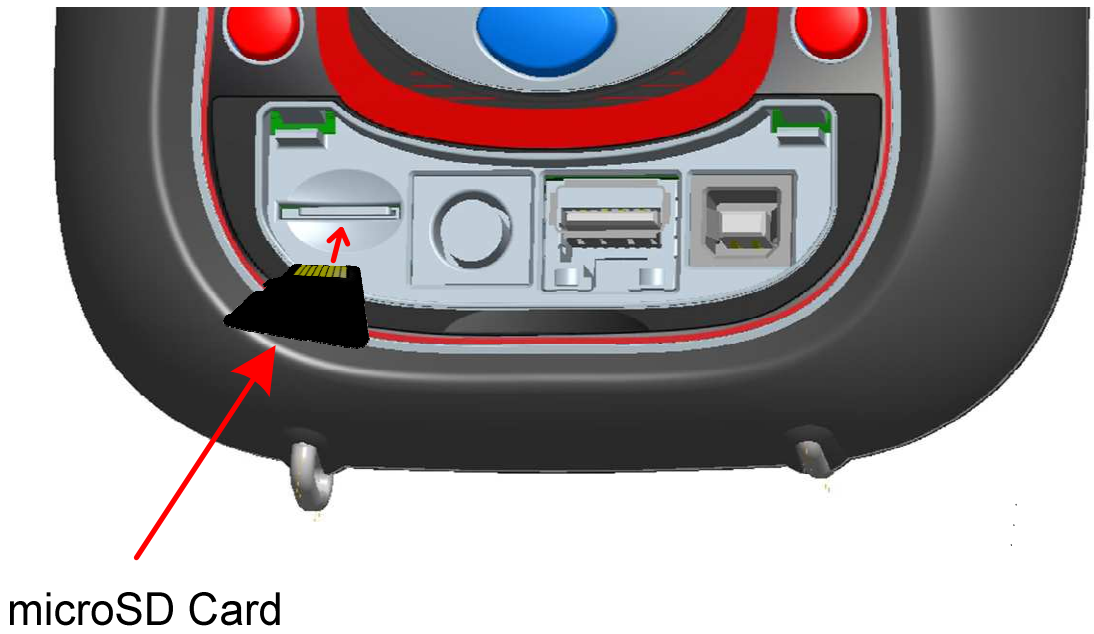


Figure 3.4: Inserting microSD card

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 miroSD card is accessed:
- during record session
- observing recorded data in MEMORY LIST menu

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

3.1 Connect the AC adapter

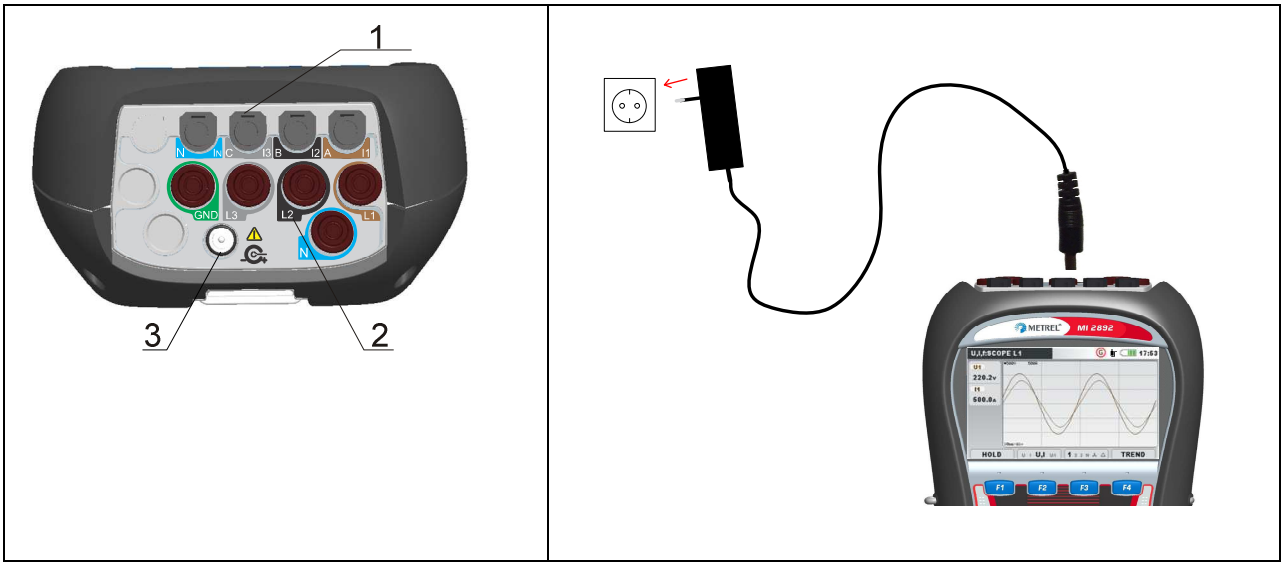


Figure 3.5: Connecting the external power supply

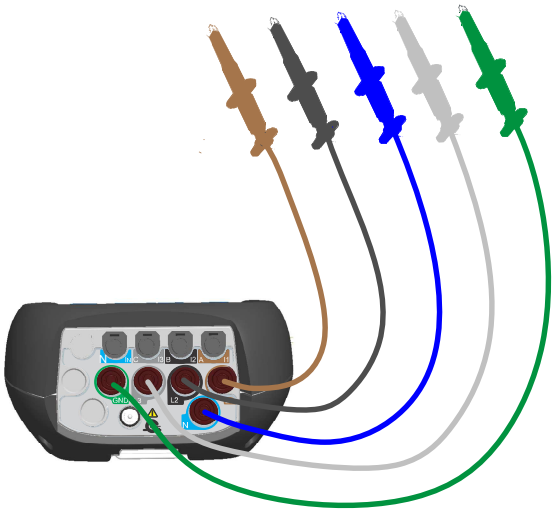
1 Clamp-on current transformers (I_1, I_2, I_3, I_N) input terminals.
2 Voltage (L_1, L_2, L_3, N, GND) input terminals.
3 12 V external power socket.

Note

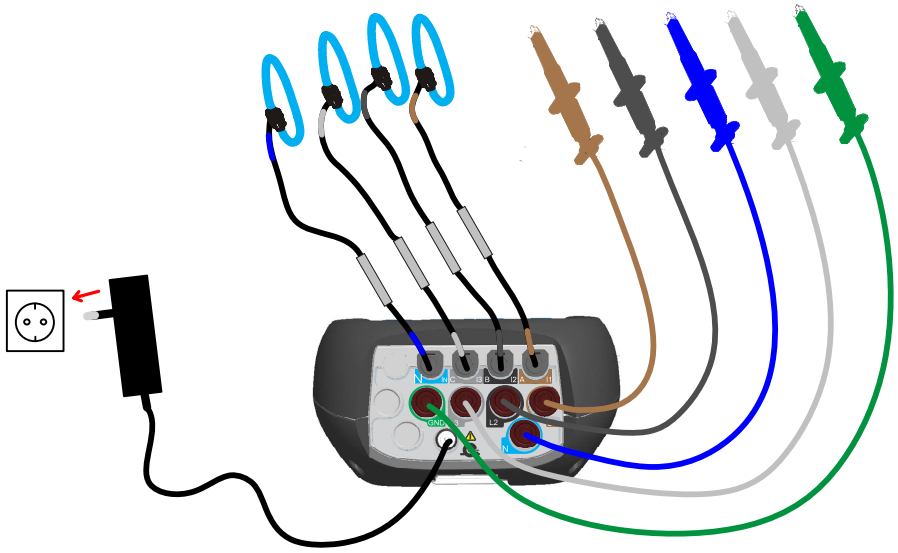
When using the original power supply adapter/charger the instrument is fully operational immediately after switching it on. The batteries are charged at the same time, nominal charging time is 2.5 hours.
The batteries are charged whenever the power supply adapter/charger is connected to the instrument. Inbuilt protection circuit controls the charging procedure and assure maximal battery lifetime.

3.2 Connect the voltage leads and current clamp sensors

1. Connect current sensors



2. Connect voltage leads



3. Ready for connection to 3-Phase 4-wire system

Figure 3.6: Connecting the voltage cords and current clamp sensors

3.3 Connection diagrams

Following connection diagrams are supported by the instrument. Be sure that the instrument is connected correctly before performing any measurement.

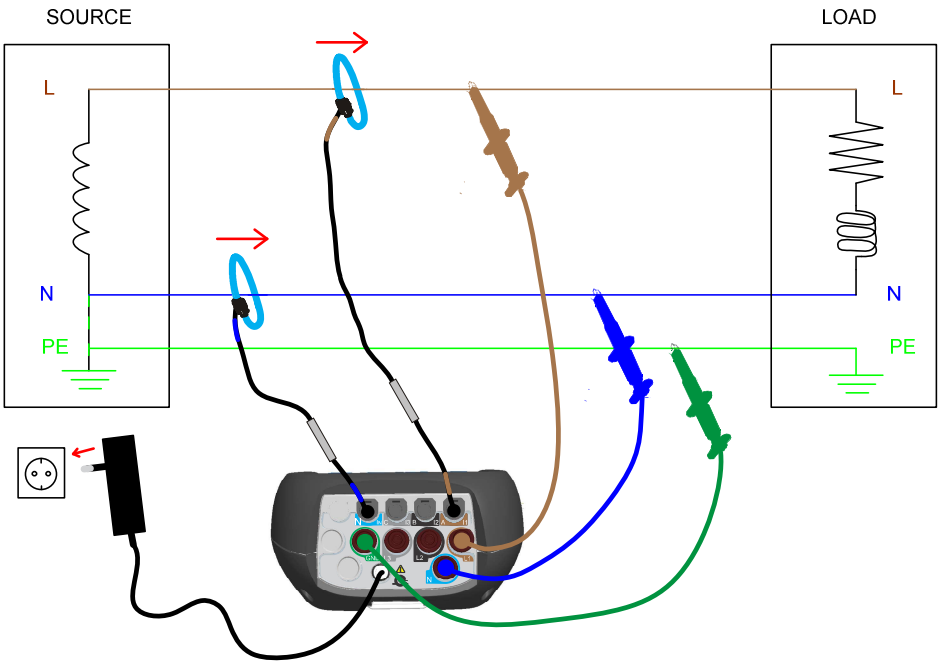


Figure 3.7: 1-phase 3-wire system

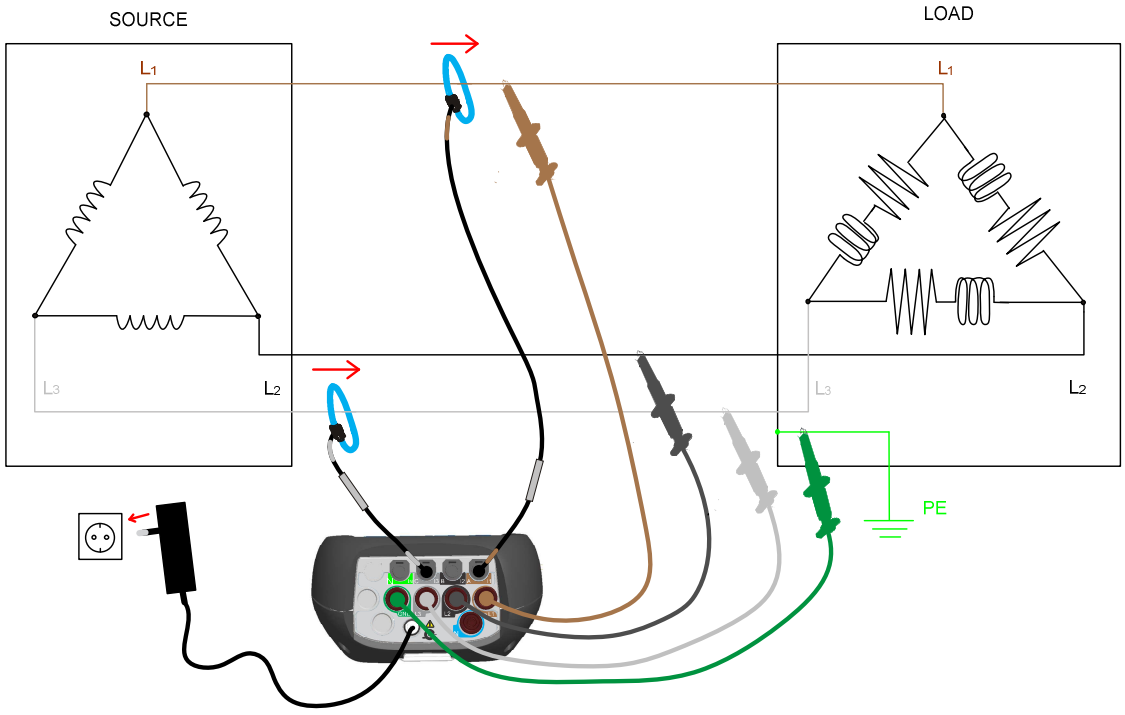


Figure 3.8: Open Delta (Aaron) 3-wire system

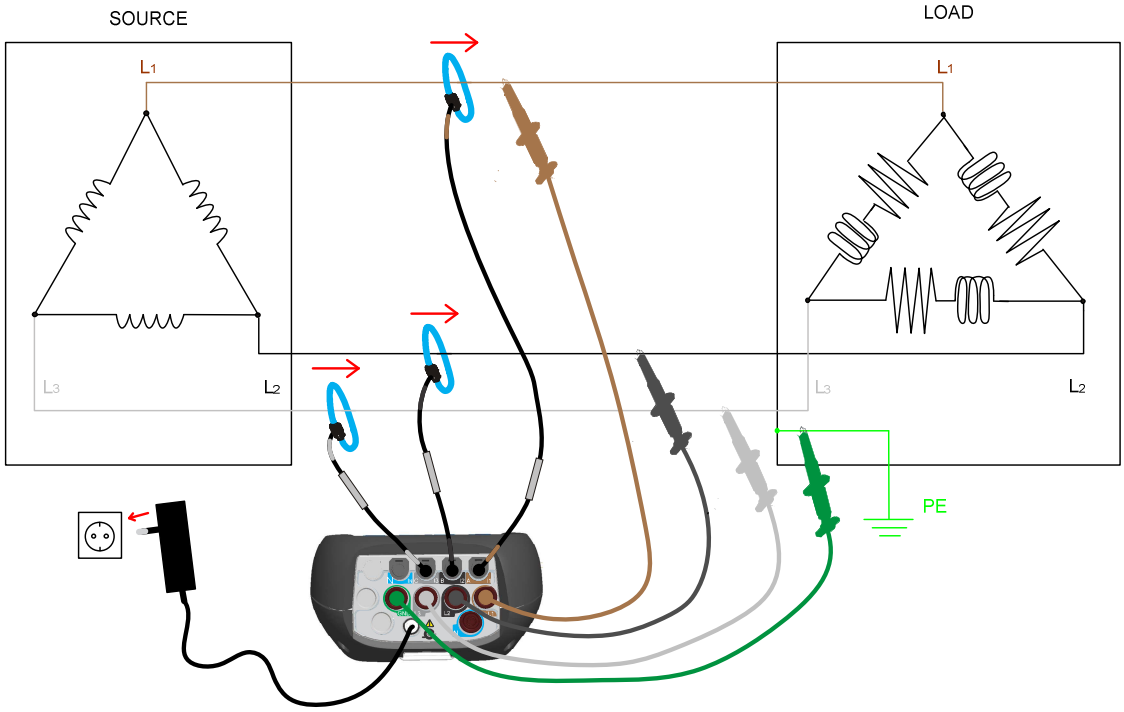


Figure 3.9: 3-phase 3-wire system

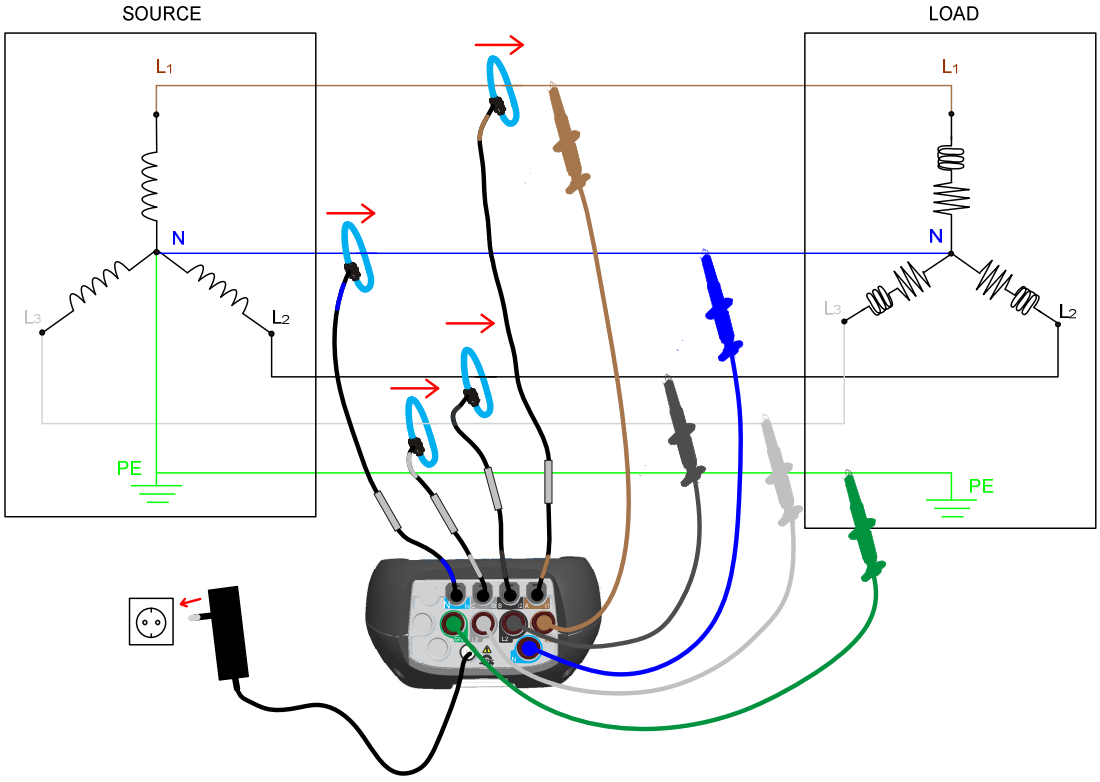
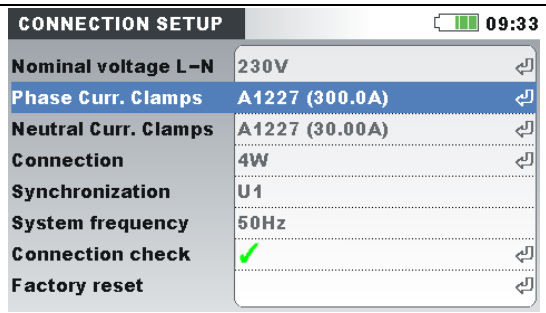


Figure 3.10: 3-phase 4-wire system

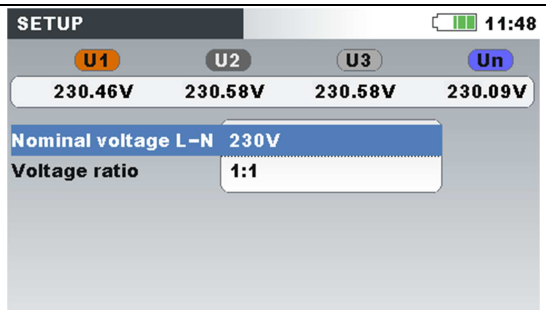
3.4 Instrument Setup

In order to measure power parameters correctly it is essential to properly setup instrument. To perform recording on 230V / 50Hz, 4W system, use following configuration.

Procedure how to do this is described in next figures. First go to MEASUREMENT SETUP menu and select CONNECTION SETUP submenu. CONNECTION MENU is shown on figure below.



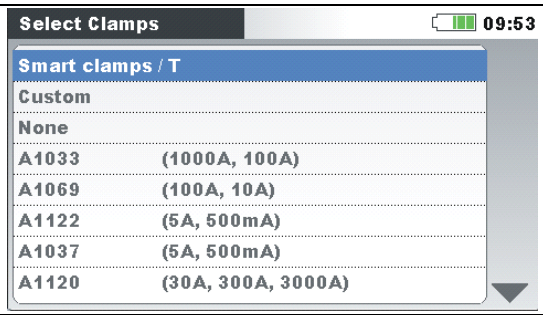
Connection setup menu



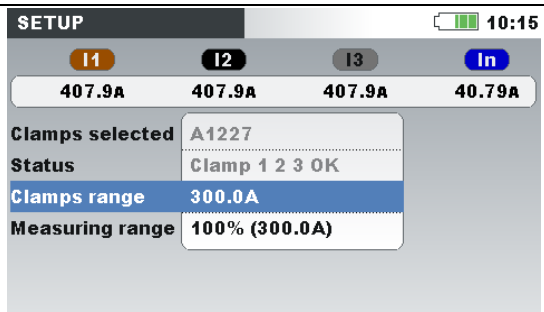
Set nominal voltage

Figure 3.11: Setting nominal voltage and voltage ratio

1. Select Nominal voltage L-N and press ENTER key
2. Set nominal voltage and ratio as shown on figure above



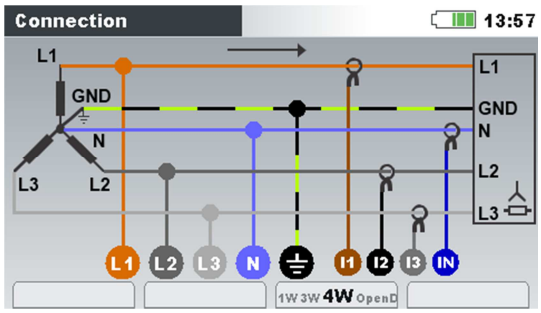
Clamp selection menu



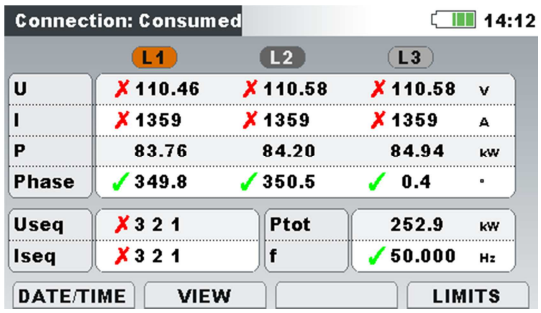
Clamp measuring range menu

Figure 3.12: Setting current clamps and measuring range

1. Select Phase Current Clamps menu and press ENTER key
2. Select Smart clamps / T and press ENTER key
3. Select appropriate measuring range and press ESC key.
4. Select Neutral Current Clamps and repead procedure above.
5. Select Connection menu and press ENTER key
6. Selectr 3 phase / 4 wire connection (4W) and press ESC key.



7. Select synchronisation channel: U1
8. Select System frequency: 50 Hz.
9. Check Conenction check status. If it's marked with OK sign (✓), then you set up instrument correctly. If status mark is fail (✗) then press ENTER and details will be shown. Check each parameter which is out of limit and try to troubleshoot connection problem.



12 Press F1 and check if Date/Time is set up correctly.

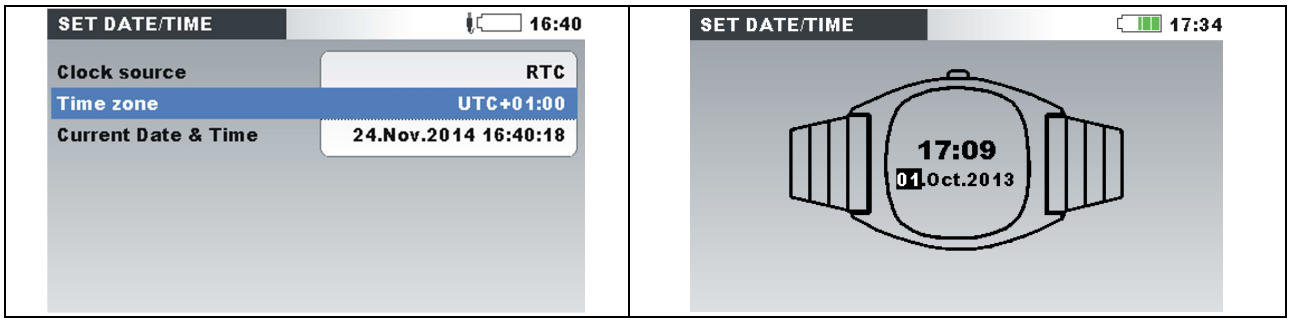
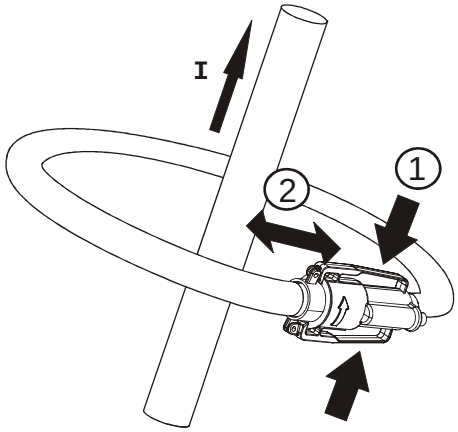


Figure 3.13: Setting correct date and time

In practice, when connecting the instrument to the network, it is essential that both current and voltage connections are correct. In particular the following rules have to be observed:
Clamp-on current clamp-on transformers

- The arrow marked on the clamp-on current transformer should point in the direction of current flow, from supply to load.



- If the clamp-on current transformer is connected in reverse the measured power in that phase would normally appear negative.

Phase relationships

- The clamp-on current transformer connected to current input connector I_1 has to measure the current in the phase line to which the voltage probe from L_1 is connected.

3.4.1 Current sensors and optimal current range selection

Depending on the used clamps the user can select between different ranges, from the following diagrams explaining the optimal range selection for measured current.

Note:

- Pure sin wave, reduced crest factor (< 3),
- Effective measuring range - Sin wave with harmonics, full (complete) crest factor (> 3)

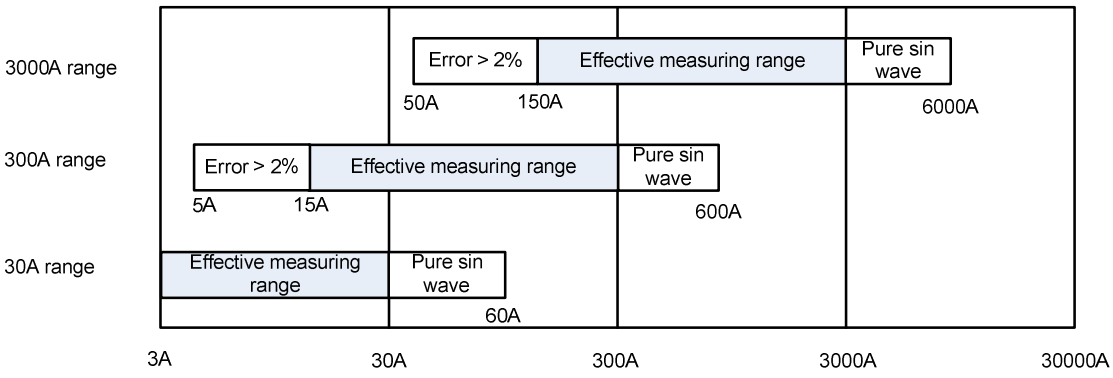


Figure 3.14: A 1227 flexible current clamps

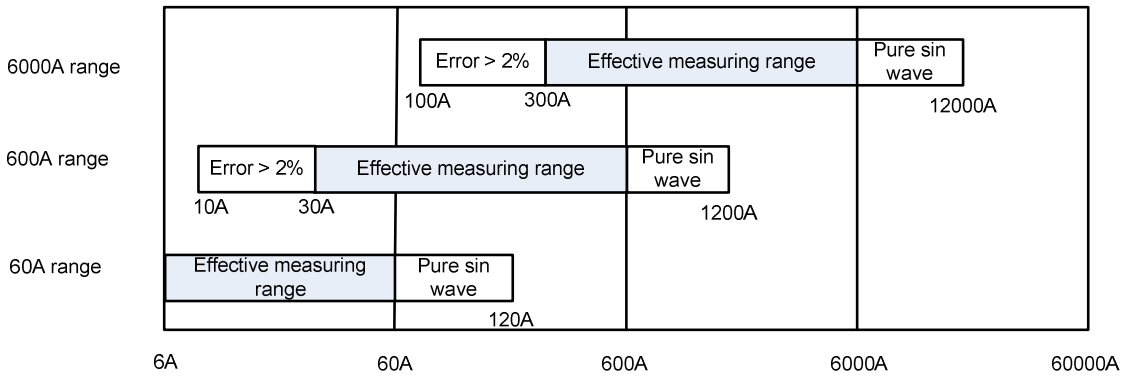


Figure 3.15: A 1446 flexible current clamps

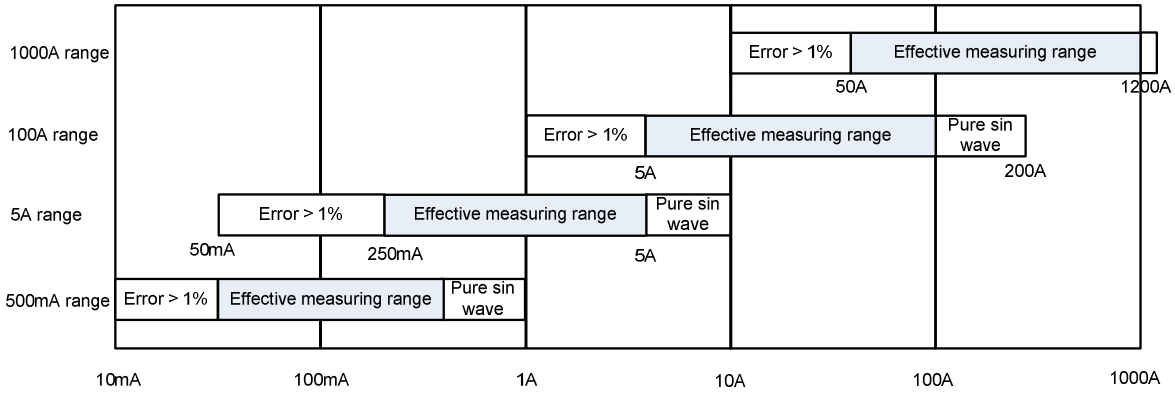


Figure 3.16: A 1281 iron current clamps

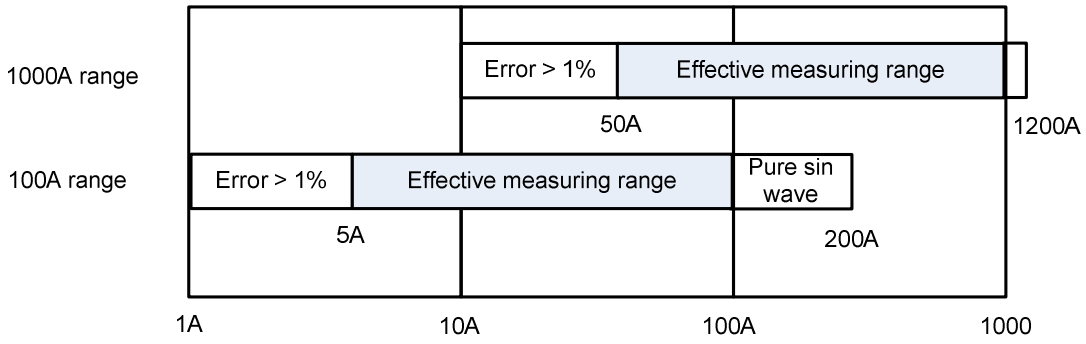


Figure 3.17: A 1033 iron current clamps

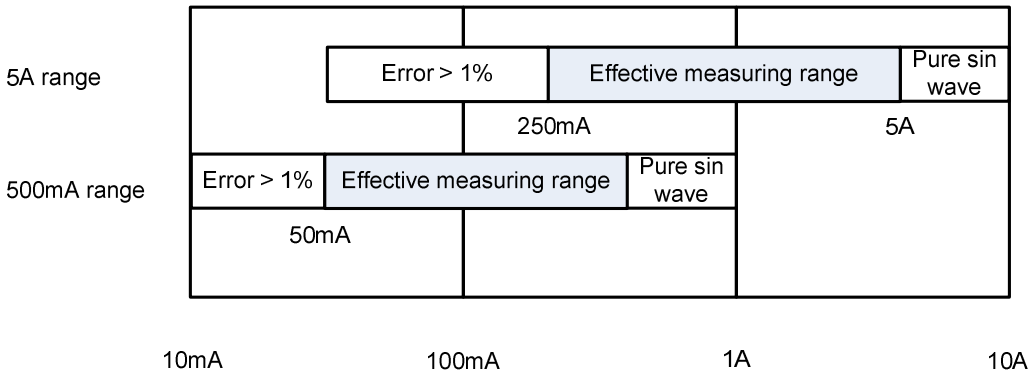


Figure 3.18: A 1122 mini iron current clamps

3.5 Set appropriate time and date

3.5.1 RTC – internal real time clock

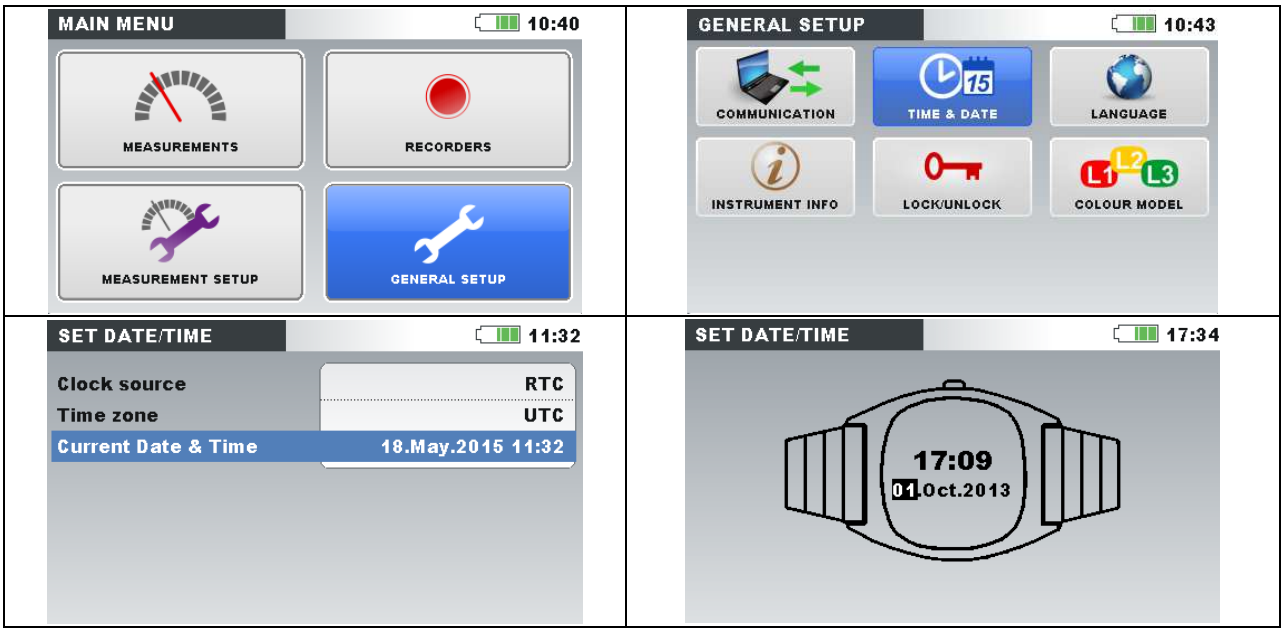


Figure 3.19: Setting appropriate time and date- RTC

Clock source	Show clock source: RTC – internal real time clock GPS – external GPS receiver **Note:** GPS clock source is automatically set if GPS is enabled and detected.
Time zone	Selects time zone. **Note:** Power Master has the ability to synchronize its system time clock with Coordinated Universal Time (UTC time) provided by externally connected GPS module. In that case only hours (time zone) should be adjusted. In order to use this functionality, see **Error! Reference source not found.**.
Current Time & Date	Show/edit current time and date (valid only if RTC is used as time source)

Note

Set correct time and date, which will be used when recording and managing data. Be sure to set time and date before starting the recorder.

3.5.2 UTC – external GPS receiver

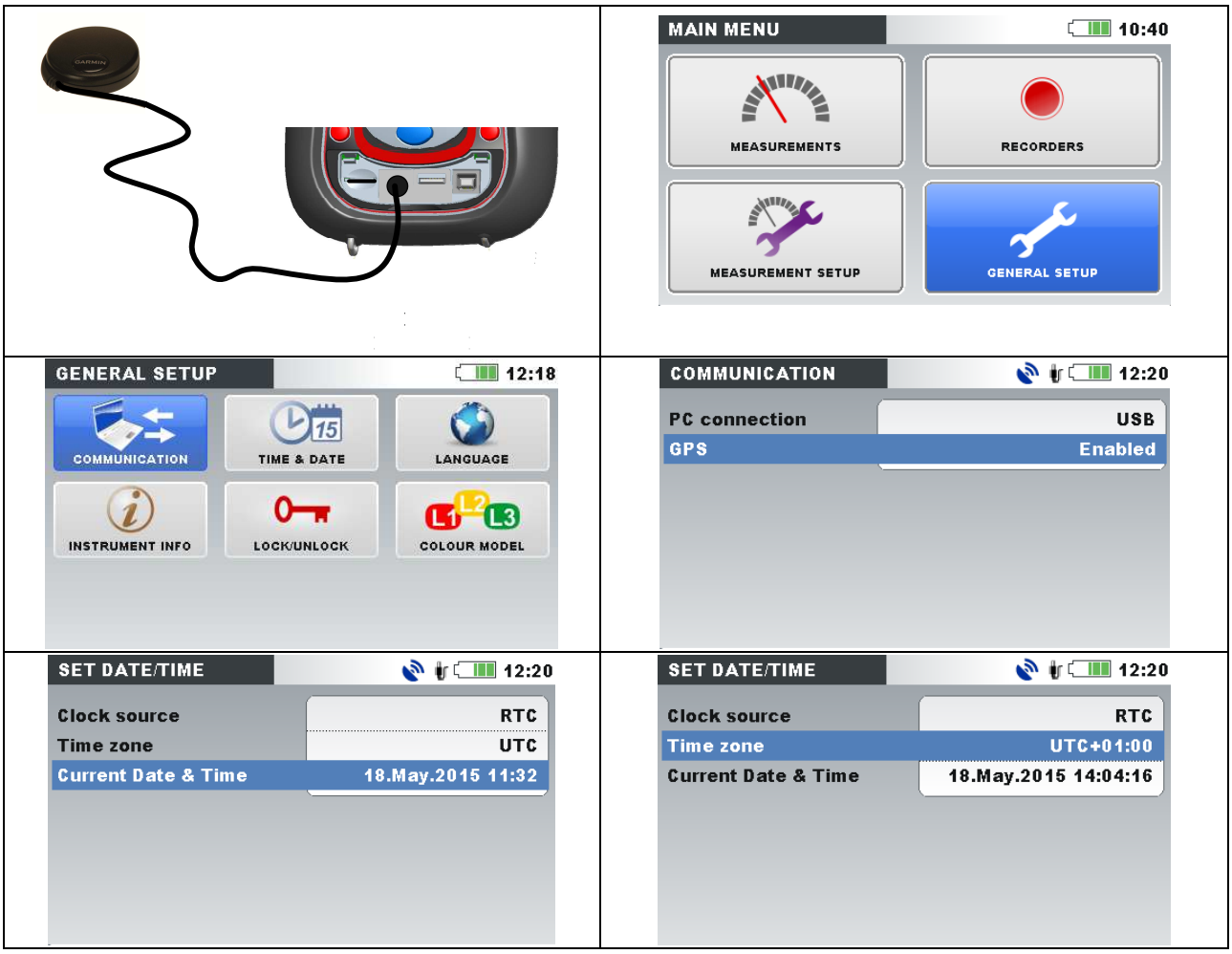


Figure 3.20: Setting appropriate time and date- GPS

Note

A 1355 GPS Synchronization unit guaranties that the time clock uncertainty of the Metrel power quality analyzer does not exceed ±10 ms for 50 Hz signals, according to IEC 61000-4-30 Class A.
This performance is necessary to ensure that instruments produce the same aggregation results when connected to the same signal.

4 Explanation of available recorders

4.1 General recorder (enables periodic recording)

The General Recorder records approximately 4000, of various parameters with resolution 138 samples / cycle, for the selected time interval. Sampling frequency used for General recorder is 7kSamples/sec.

Setup: Preferred time interval, start time of record, end time of record, optional (include voltage events, include alarms, include signalling frequency). Available intervals: 1s, 3s, 5s, 10s, 1min, 2min, 5min,10min, 15min, 30min, 60min, 120min.

Figure 4.1: General recorder menu

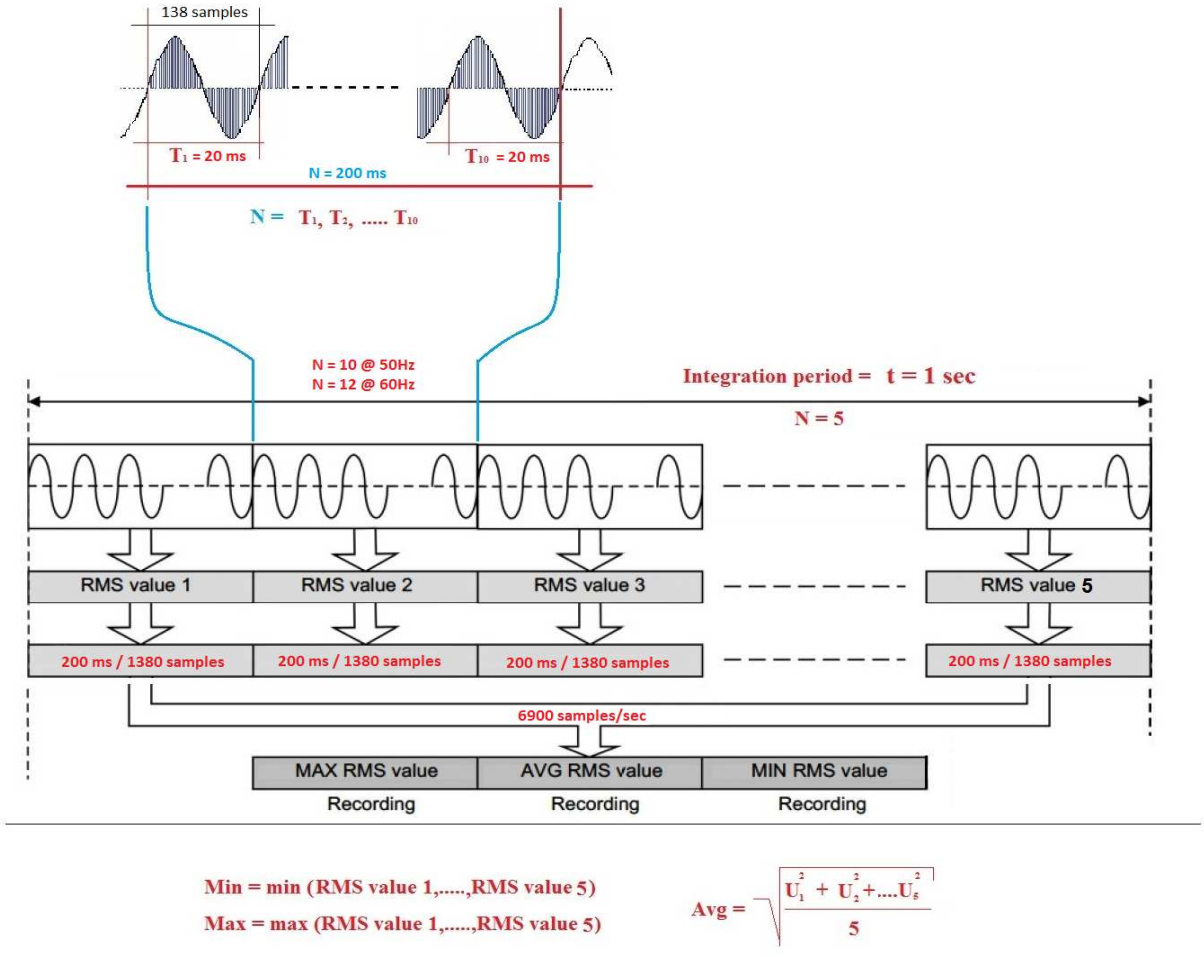


Figure 4.2: General recorder sampling

Set of 3 dots represents the result obtained based on 1500, 200ms recorded windows from which we take min & max values and calculate avg value, integration period 5 min.

Example: 5min time interval, N= 1500, 5min = 300 sec * (5N / sec) = 1500 @50Hz

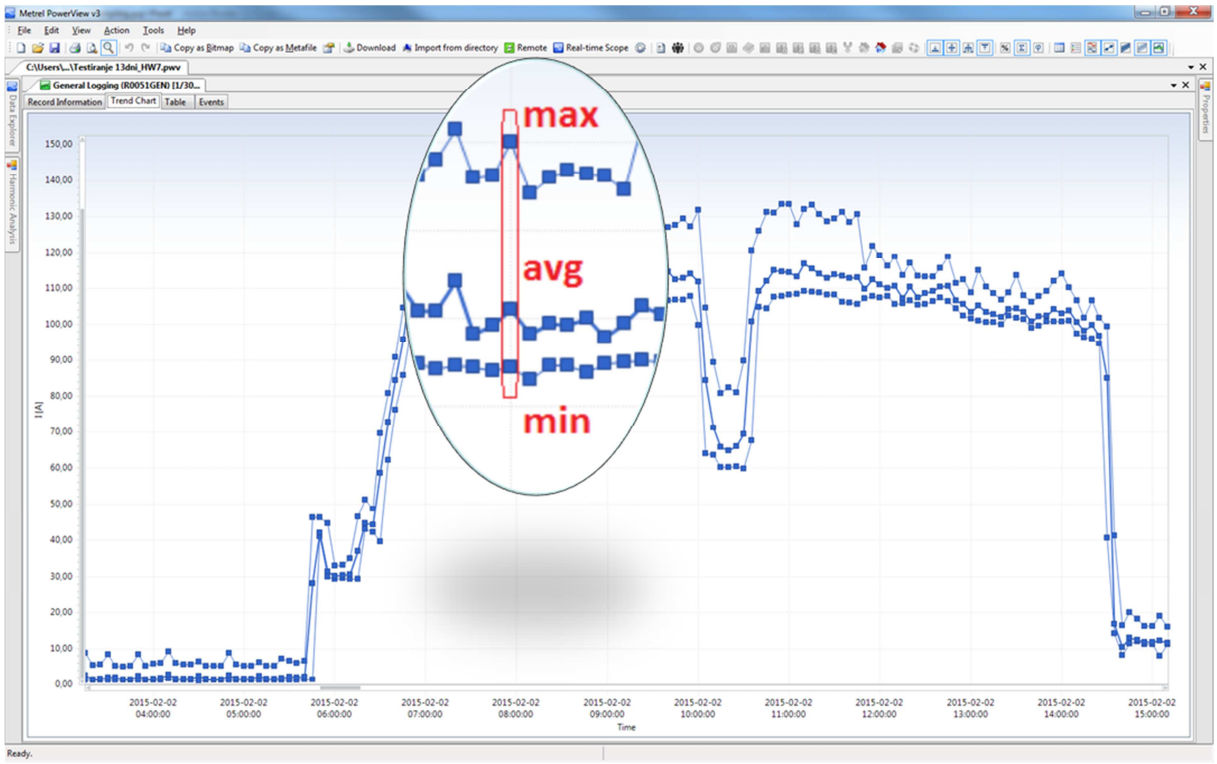


Figure 4.3: Example of trend graph obtained by periodic recording IP 5 min

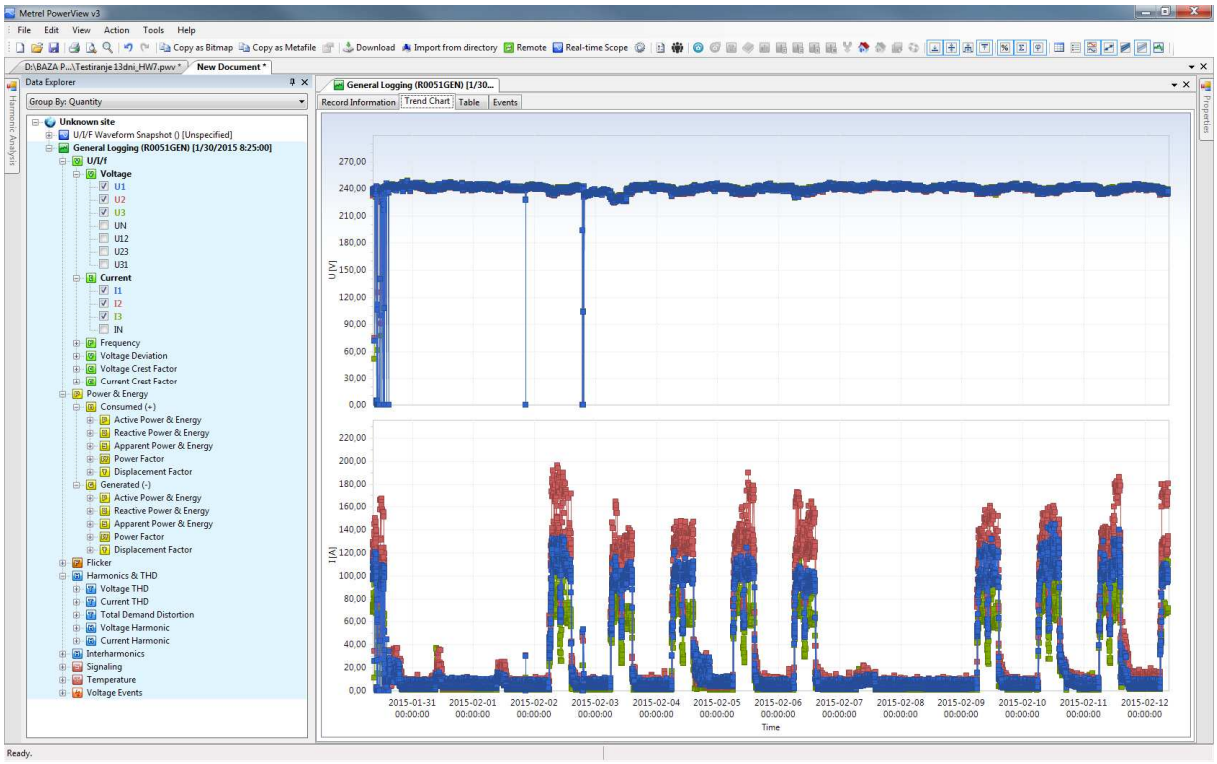


Figure 4.4: Example of trend graph obtained by periodic recording over 13 days

4.2 Waveform recorder (enables waveforms recording)

All recorder waveforms can be presented as trend graph of the event or as an actual waveform of the signal. Depending on the selection, several trigger sources are possible:

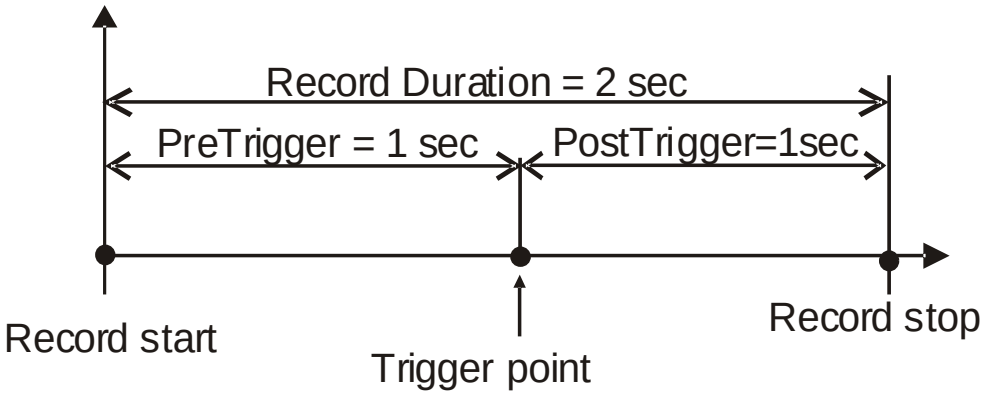


Figure 4.5: Triggering and pre-triggering description

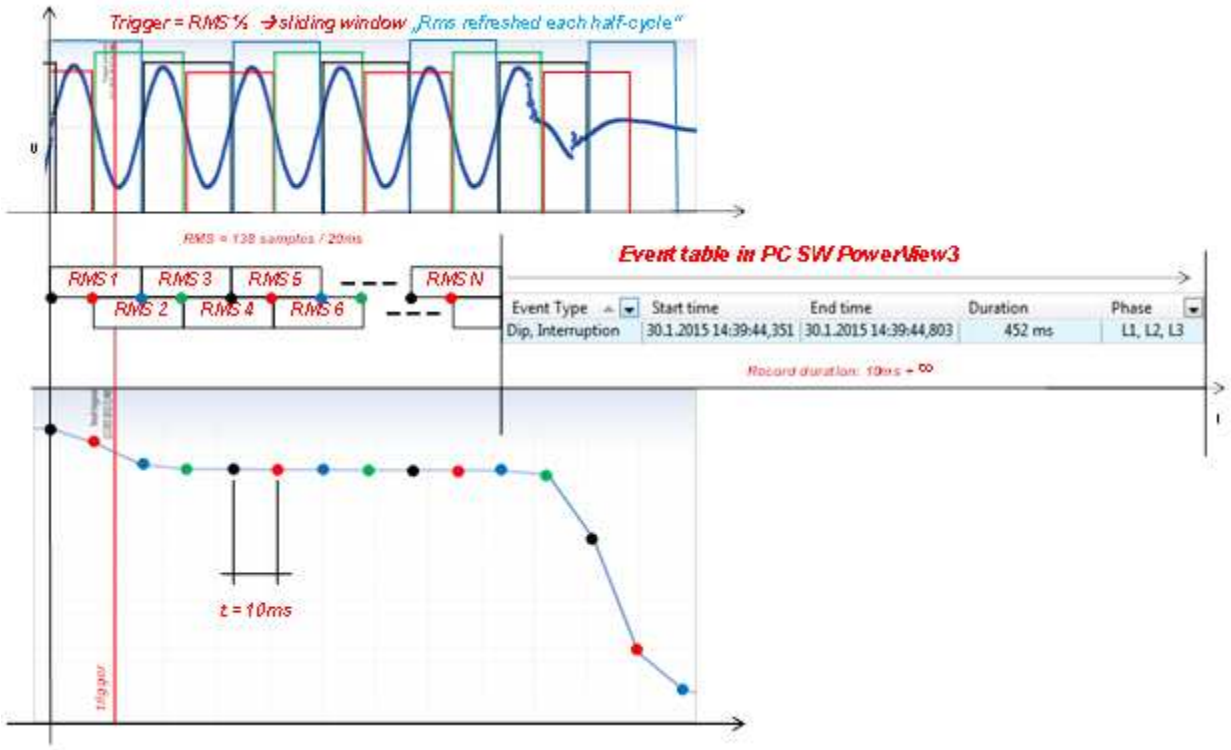


Figure 4.6: Sliding window / explanation of waveform recorder

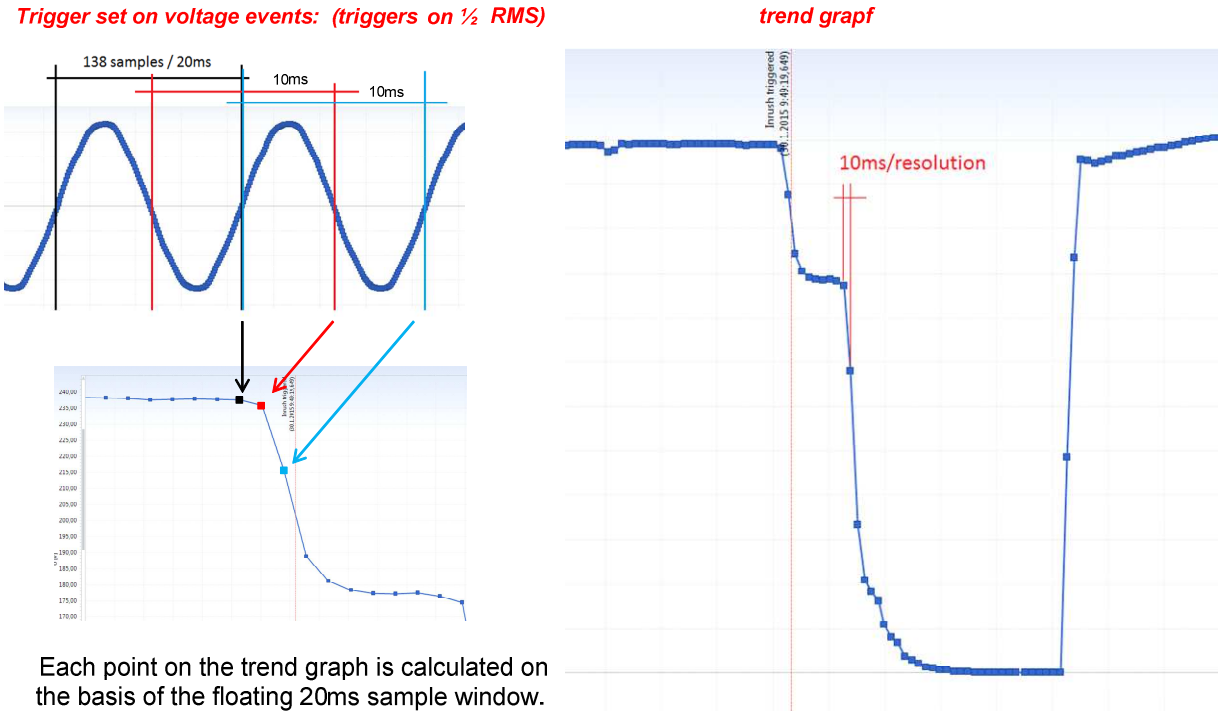


Figure 4.7: Interpretation of trend graph

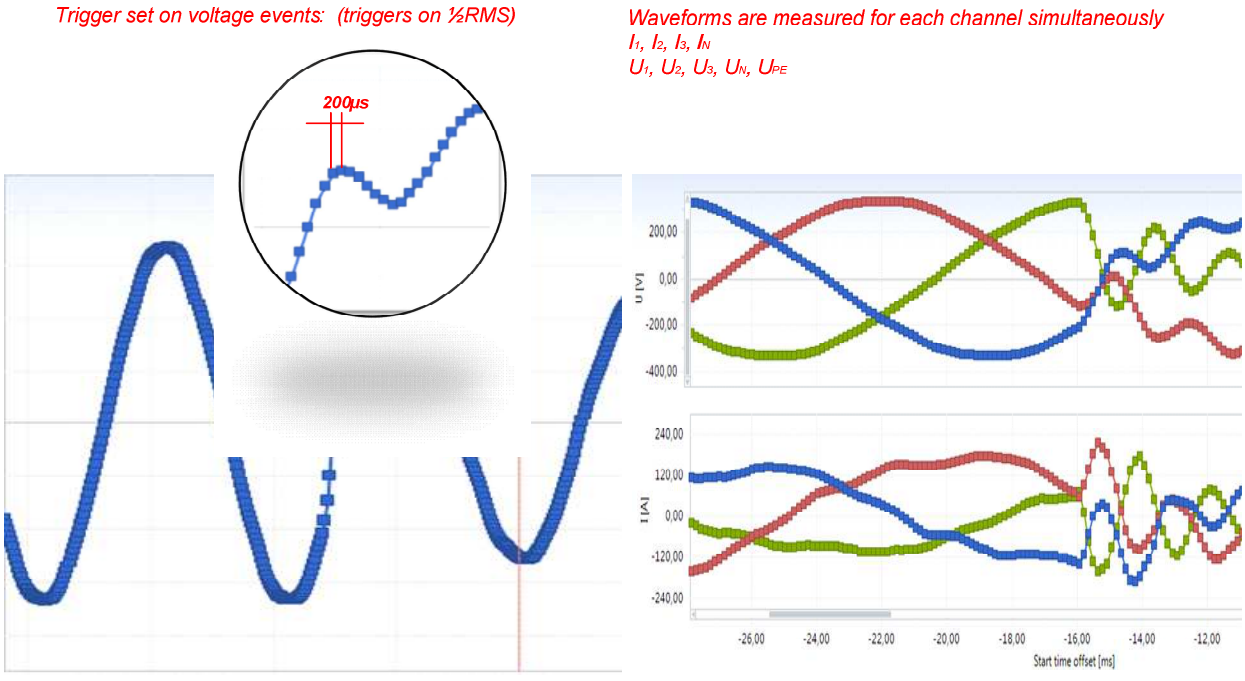


Figure 4.8: Interpretation of waveform

4.2.1 Voltage events

Standardized values for nominal voltage of 230V according to standard EN 50160 are: Voltage dip, 90% (207V), swell 110% (253V), interruption 5% (11.5 V), recorder triggers on [½ Rms] change.

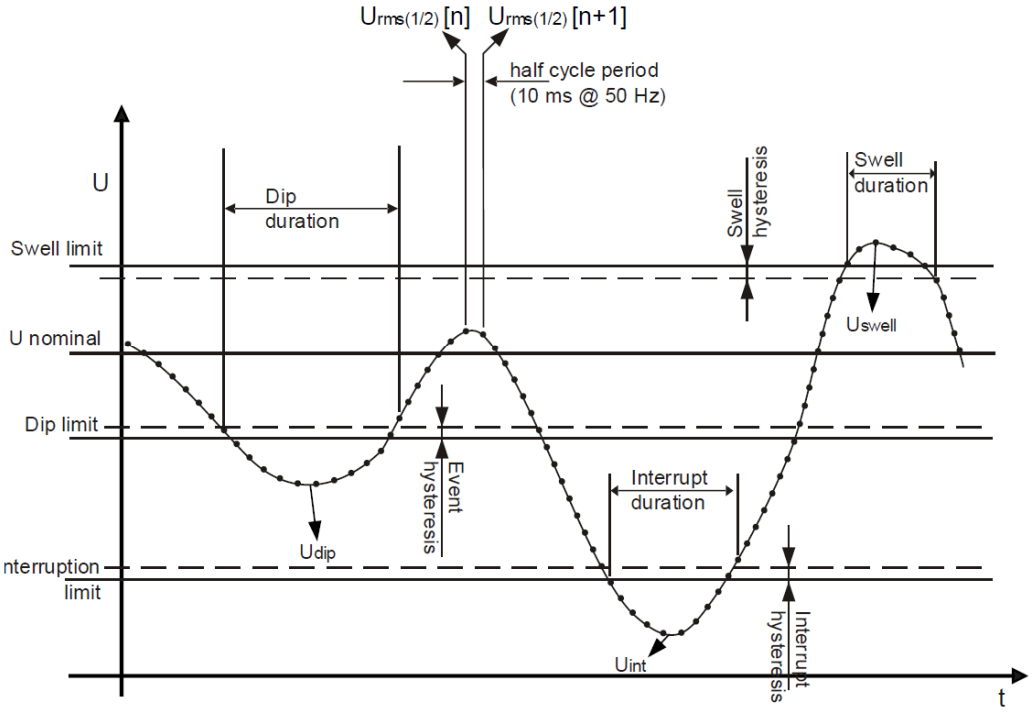


Figure 4.9: Definition of voltage events

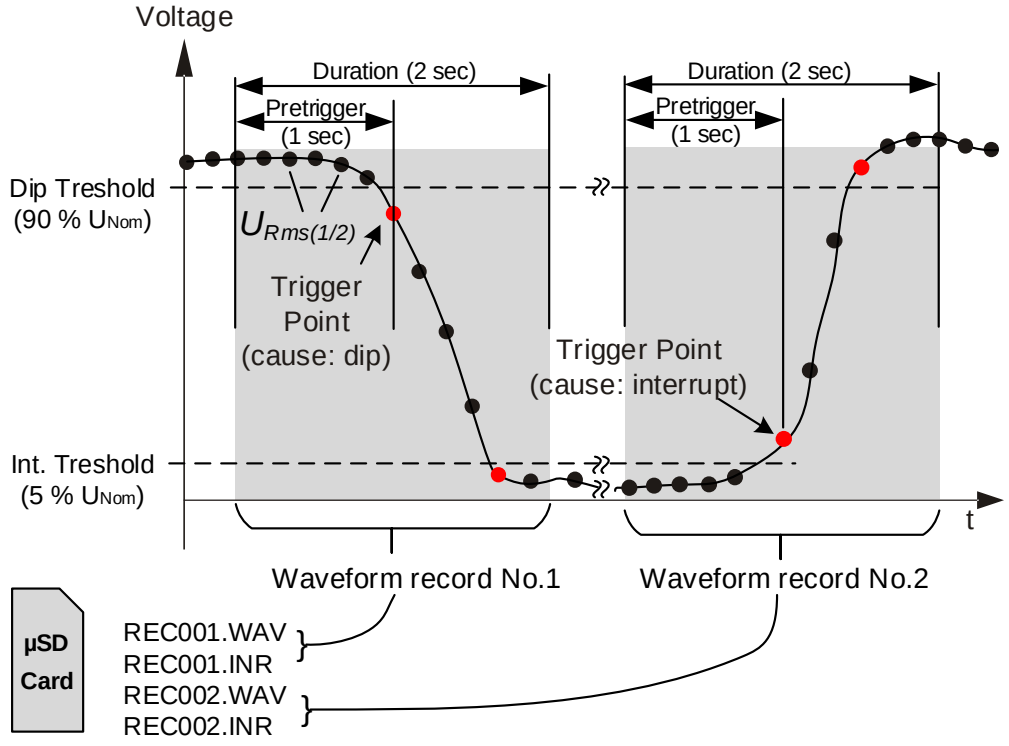


Figure 4.10: Voltage Event Triggering

4.2.2 Level on Voltage or Current / Inrush redcorder

- **Voltage level,** based on the nominal value of selected voltage, trigger can be set for values between 0.1% - 110% of nominal voltage value ±. triggers on [½ Rms]. Voltage level – instrument starts waveform recorder when measured RMS voltage reaches given voltage threshold.

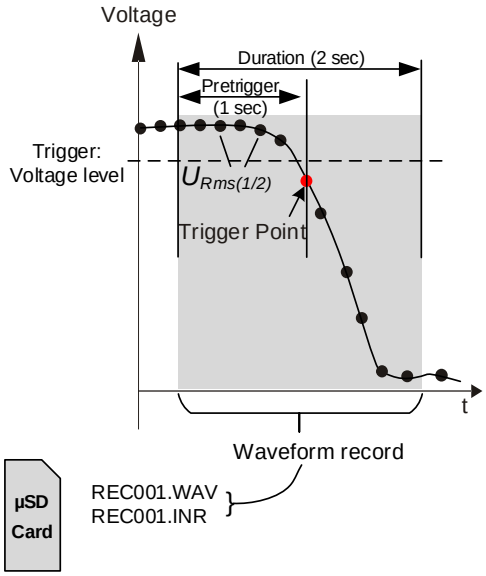


Figure 4.11: Voltage Level Triggering

- **Current level,** based on the nominal level of selected current clamp range, trigger can be set for values between 0.1% - 250% of selected range value ±. triggers on [½ Rms]. Instrument starts waveform recorder when measured current reaches given current threshold. Typically this type of triggering is used for capturing inrush currents.

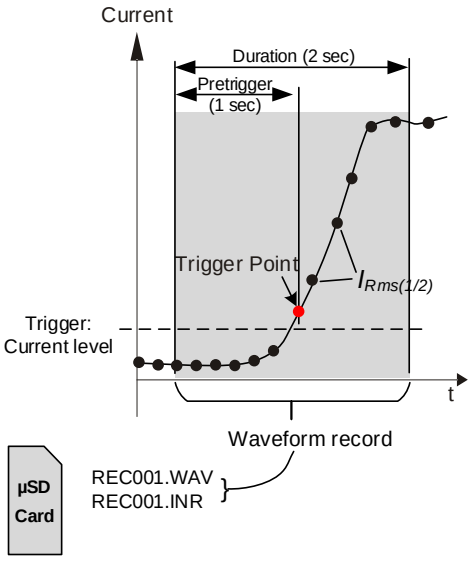


Figure 4.12: Current Level Triggering (Inrush)

Setup: Duration of record after trigger and duration of pre-trigger. Length of record duration is specified in seconds. For trigger: 1, 2, 5, 10, 20, 30, 60s can be set. For pre-trigger: 1, 2, 5, 10, 20, 30s can be set.

4.2.3 Interval

Based on the selected time interval, the instrument starts the waveform recorder.

Setup: Duration of record after trigger and duration of pre-trigger. Length of record duration is specified in seconds. Following intervals can be selected: 5, 10, 15, 30, 60, 120min.

4.2.1 Alarm

Alarms, trigger enables set up of following criteria (Quantity, Phase, Condition, Level, Duration) for all parameters available to measure with the instrument (up to 7 different triggers can be set), alarm triggers on [200ms Rms, samples].
Instrument starts waveform recorder when any alarm from alarm list is detected. If alarm is not enabled in waveform recorder it will only be a part of general recorder, presented in a table including information about (time stamp, duration, quantity, etc.).

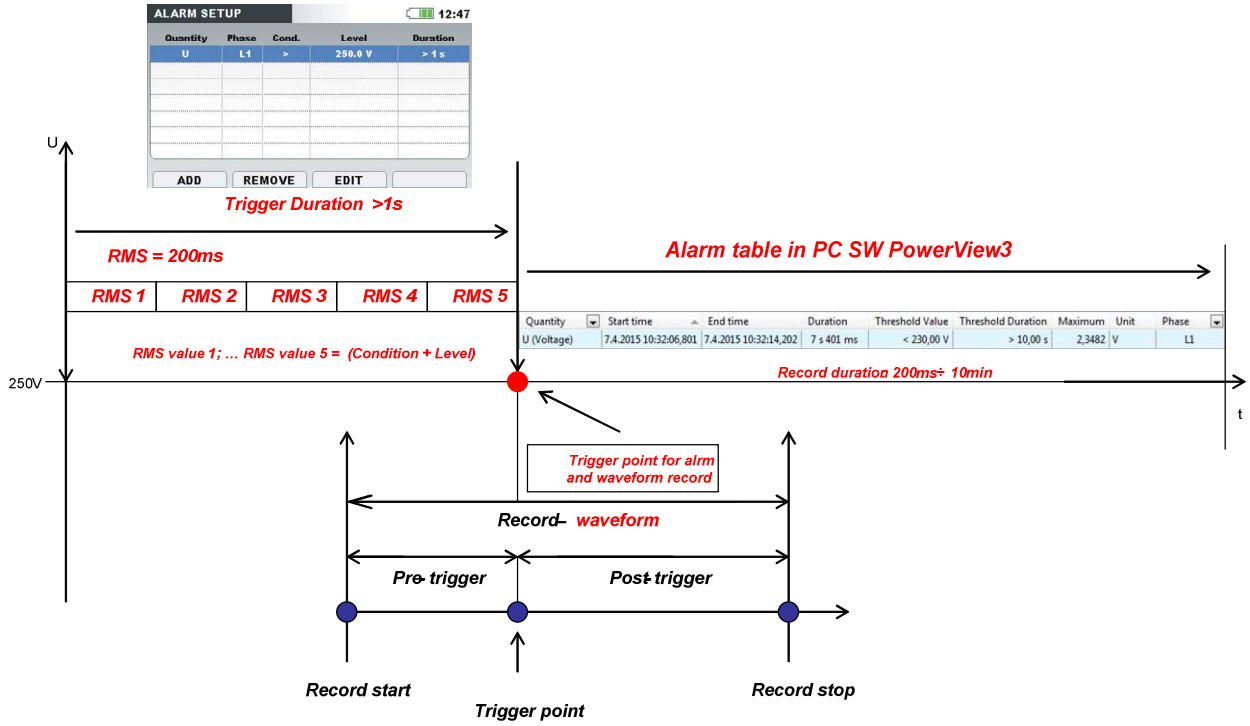
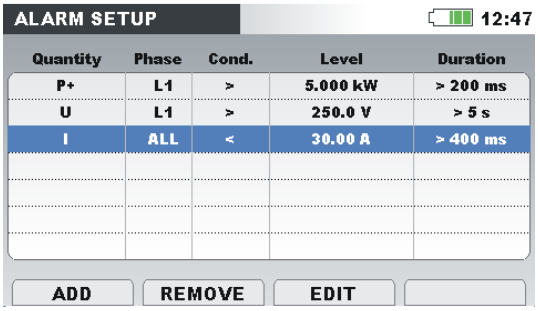


Figure 4.13: Alarm setup / explanation of alarm waveform recorder

- **How to set up an alarm (example):**



To record an alarm, trigger conditions have to be fulfilled:

- P+ (Power at phase 1 has to be > 5.000kW, for the period > 200ms). In case that P+ exceeds 5.000kW for period of > 200ms instrument record an alarm in the alarm table.
- U (Voltage at phase 1 has to be > 250.0V, for the period > 5s). In case that U exceeds 250.0V for all 200ms time windows for period of > 5s, instrument record an alarm in the alarm table.
- I (current on one of the phases has to be < 30.00A, for the period > 400ms). In case that I on one of the phases doesn't meet the criteria < 30.00A for the period of > 400ms, the instrument will not record an alarm in the alarm table

4.3 Transient recorder (enables high resolution waveforms recording)

Transient recorder is similar to waveform recorder. It stores a selectable set of pre- and post-trigger samples on trigger activation, but with 10 times higher sampling rate.
Recorder can be triggered on envelope or level.
Envelope trigger is activated if difference between same samples on two consecutive periods of input voltage signals, is greater than given limit.

Depending on the selected trigger waveforms can be recorded:
Envelope based on nominal (Rms) value of selected voltage, trigger can be set for values between 1% – 110% of nominal voltage value.
Voltage level based on the nominal (Rms) value of selected voltage the trigger can be set for values between 1% – 110% of absolute voltage value.

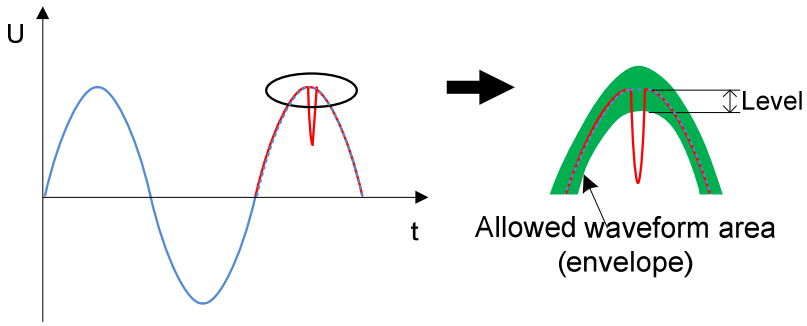


Figure 4.14: Transients trigger detection (envelope)

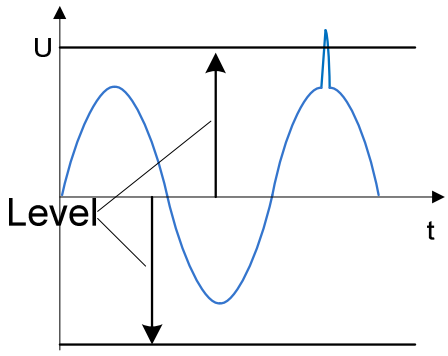


Figure 4.15: Transients trigger detection (level)

Note: Saving to the instrument data memory induces dead time between consecutive transient records. Dead time is proportional to record duration, and in worst case for 50 sec long transient it will take 4 seconds, before new transient can be captured.

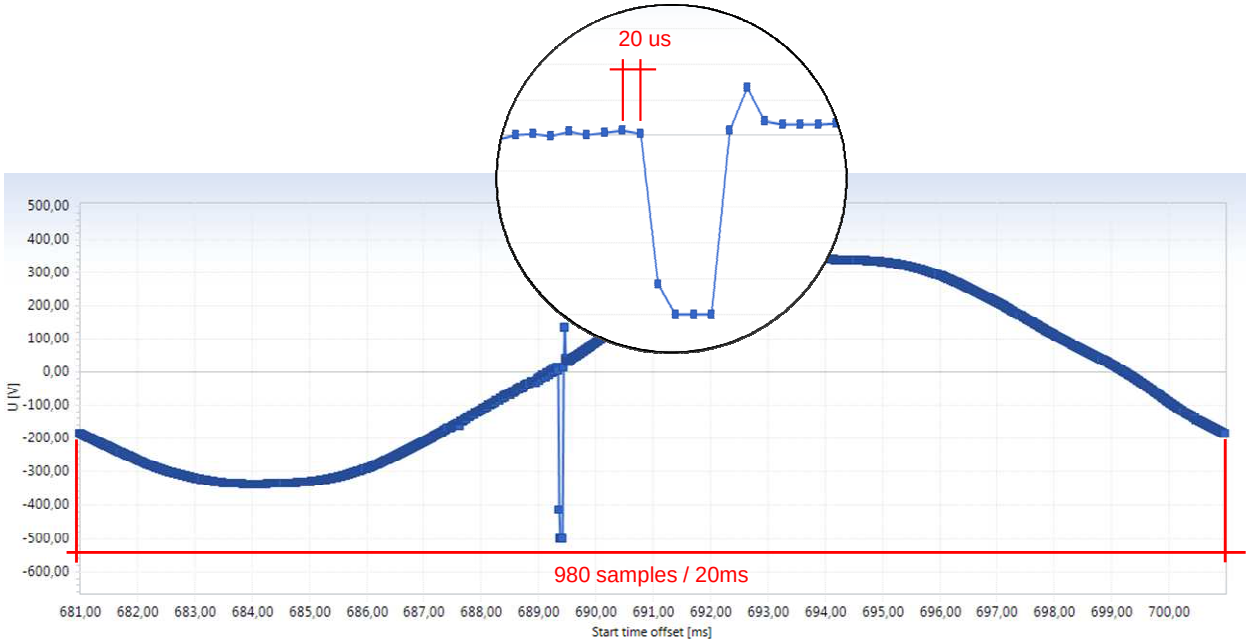
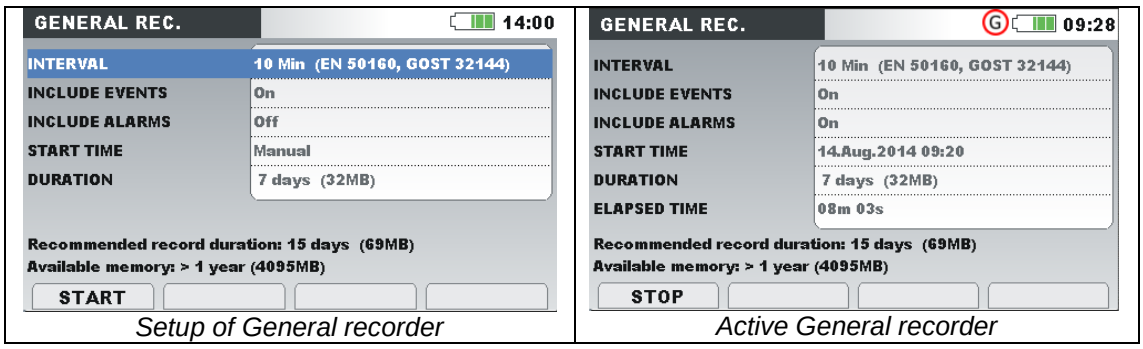


Figure 4.16: Interpretation transient waveform

5 Typical applications for PQ monitoring:

5.1 Generic Voltage quality evaluations (EN 50160)

Only GENERAL RECORDER needed (time interval is set to 10 min with recording period over 7 days), analysis and evaluation of data are a part of post processing performed with PowerView3 PC SW.



Setup of General recorder *Active General recorder*

This application is normally used in facilities before and after installing some new loads, to see that the loads are not causing/ generating any pollution back to the grid.

Result of such recording is normally EN 50160 reporting which can be automatically generated / performed with PC SW PowerView3.

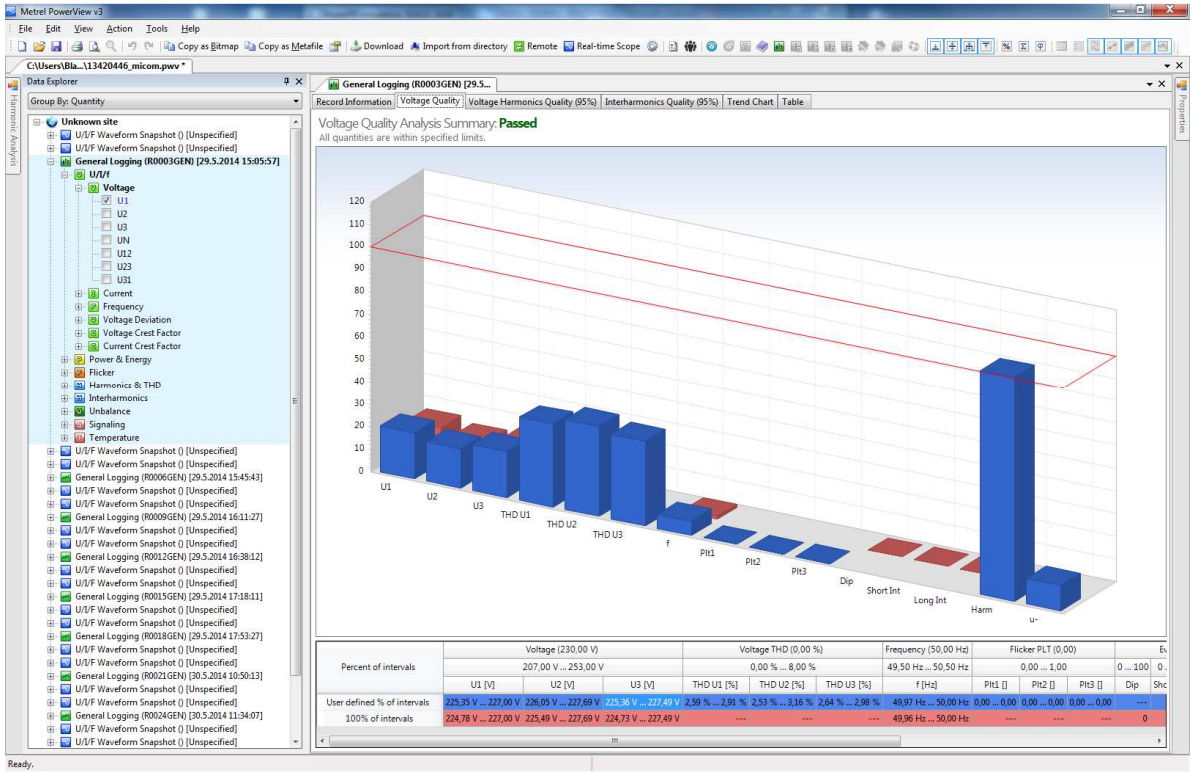
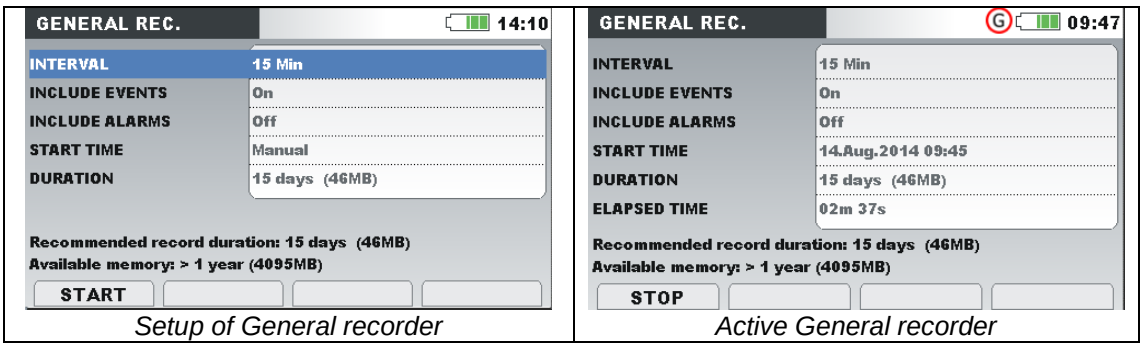


Figure 5.1: *Evaluation of Voltage quality in accordance to EN 50160*

5.2 Consumption profile/Energy management

Time interval is typically set to 15 min with recording period over 14 days or one month. If you don't know the average interval, select 5 minutes. You can recalculate other interval lengths later using the PowerView3 PC software. Analysis and evaluation of data is a part of post processing performed with PowerView3 PC SW.



Setup of General recorder *Active General recorder*

The main aim of this application is to perform optimization of production/consumption and of course to lower costs for electricity bills.

Results of such recordings are normally different graphical presentations of data equipped with different cost tariffs which can be performed with PC SW.

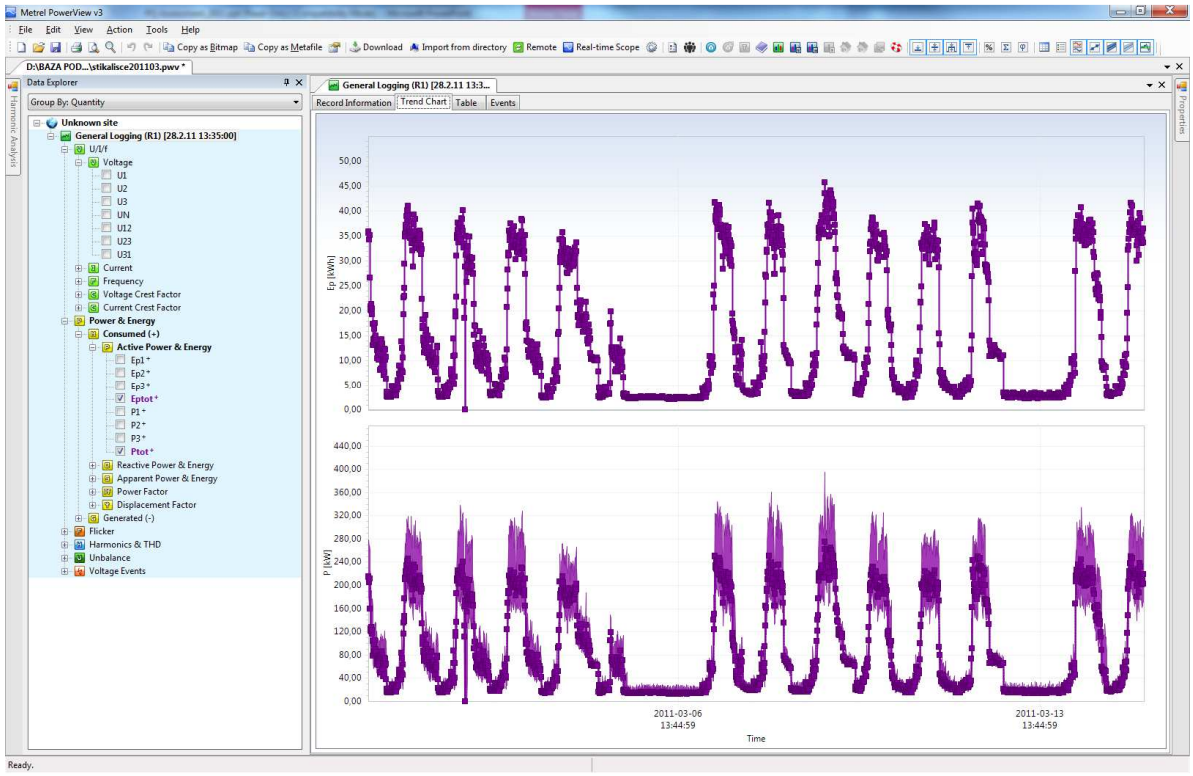
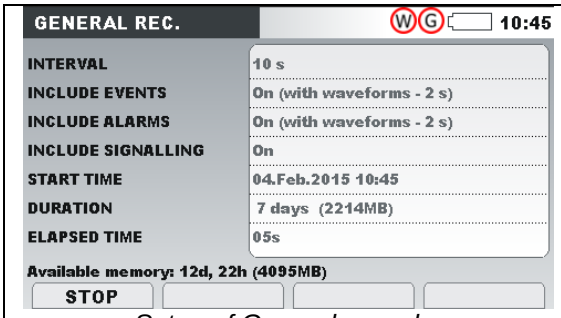


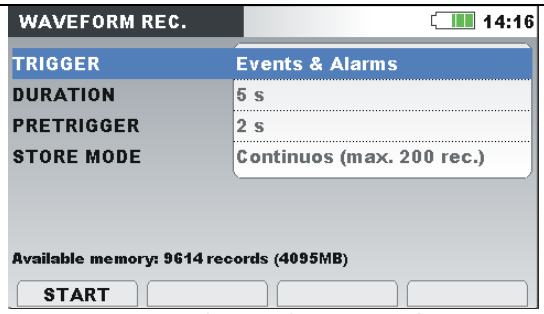
Figure 5.2: *Consumption / Load profile over a period of 15 days*

5.3 Troubleshooting

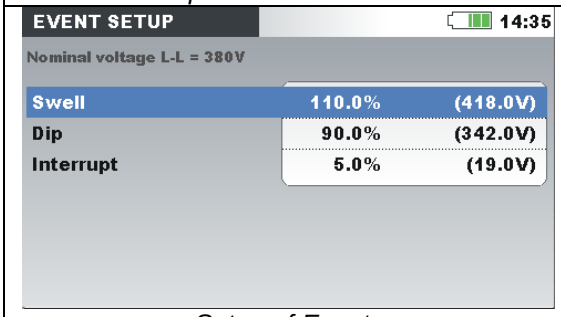
GENERAL RECORDER (time interval is typically set short integration period and recording period over 7 days or less) + WAVEFORM RECORDER with Included events & Alarms or Trigger set to Level I (for current), Level U (for voltage) .



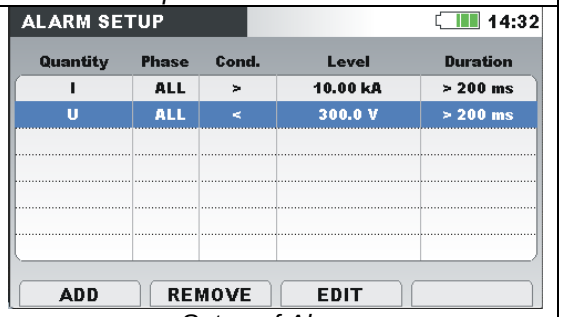
Setup of General recorder



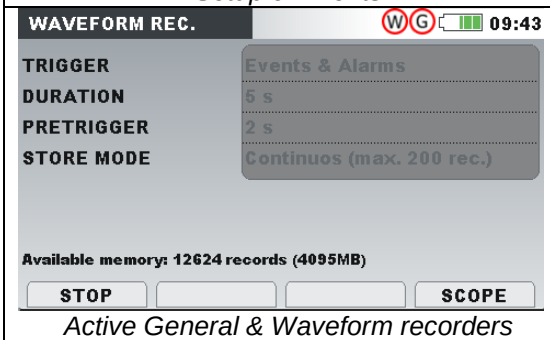
Setup of Waveform recorder



Setup of Events



Setup of Alarms



Active General & Waveform recorders

In this case user will record/catch:

1. *Periodic (min, max, avg values)*
2. *Events (Dip, Swell, Interruption)*
3. *Waveforms of Events*
4. *Waveforms of Alarms*

If customer need detailed monitor of problematic intervals, use Waveform recorder simultaneously with General recorder. For example if user wants to have detailed view if voltage failure (dip or interrupt) occur: set waveform recorder to trigger on Voltage events, set appropriate voltage event threshold values (in measurement setup).

This application offers the user to catch periodic (min / max /avg, values for 1 min time intervals) + to get waveforms (pictures of signals) of anomalies caught with predefined triggers for EVENTS and ALARMS.
ALARM menu allows the user to set 7 custom alarms for any quantity possible to measure with MI 2892.

Results of such recordings are normally different graphical presentations of corrupted data waveforms of signals, phase diagrams PC SW.

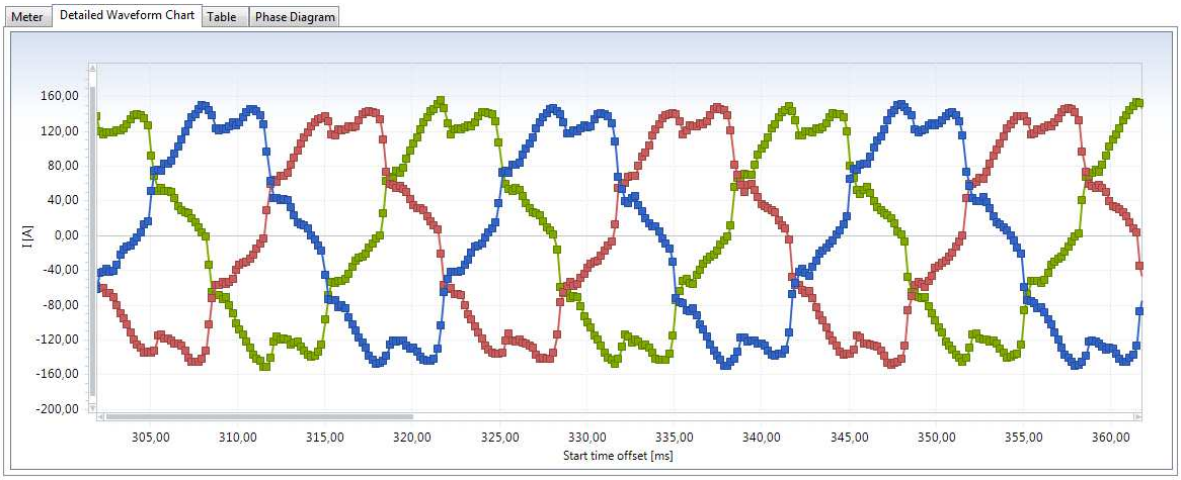


Figure 5.3: *Waveforms*

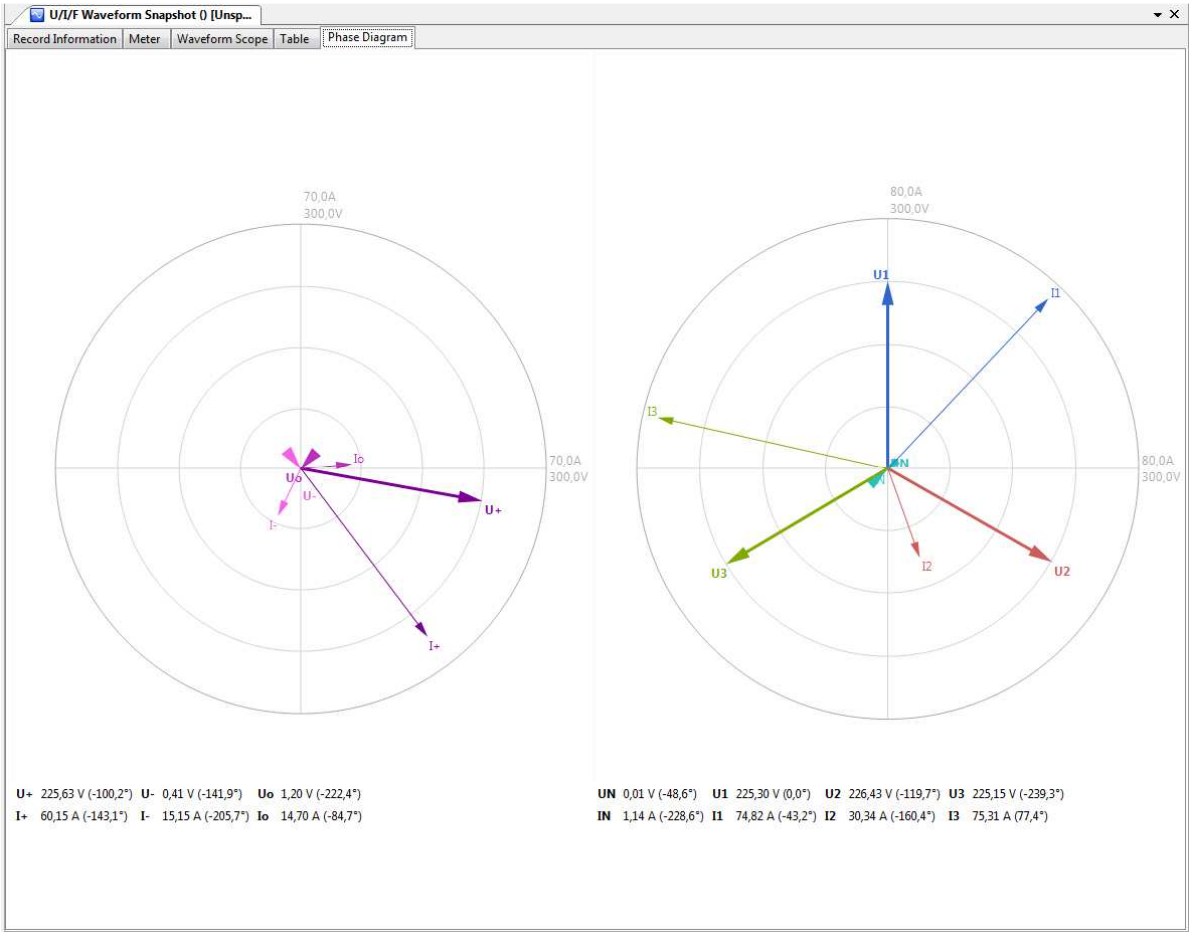
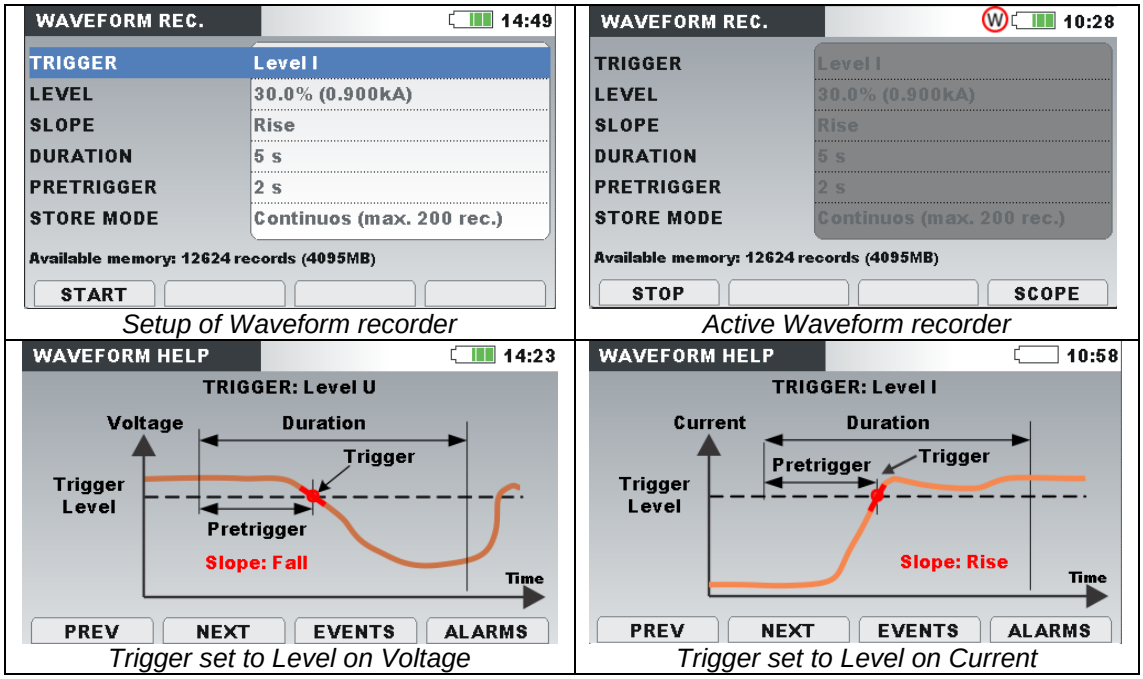


Figure 5.4: *Phase diagram*

Figure 5.5: *Periodic including voltage Events / Alarms*

5.4 Start-up of the motors monitoring

WAVEFORM RECORDER needed, user defines trigger criteria for Current or Voltage. Waveforms with predefined duration and pre-trigger duration are recorded.



Setup of Waveform recorder | *Active Waveform recorder*

Trigger set to Level on Voltage | *Trigger set to Level on Current*

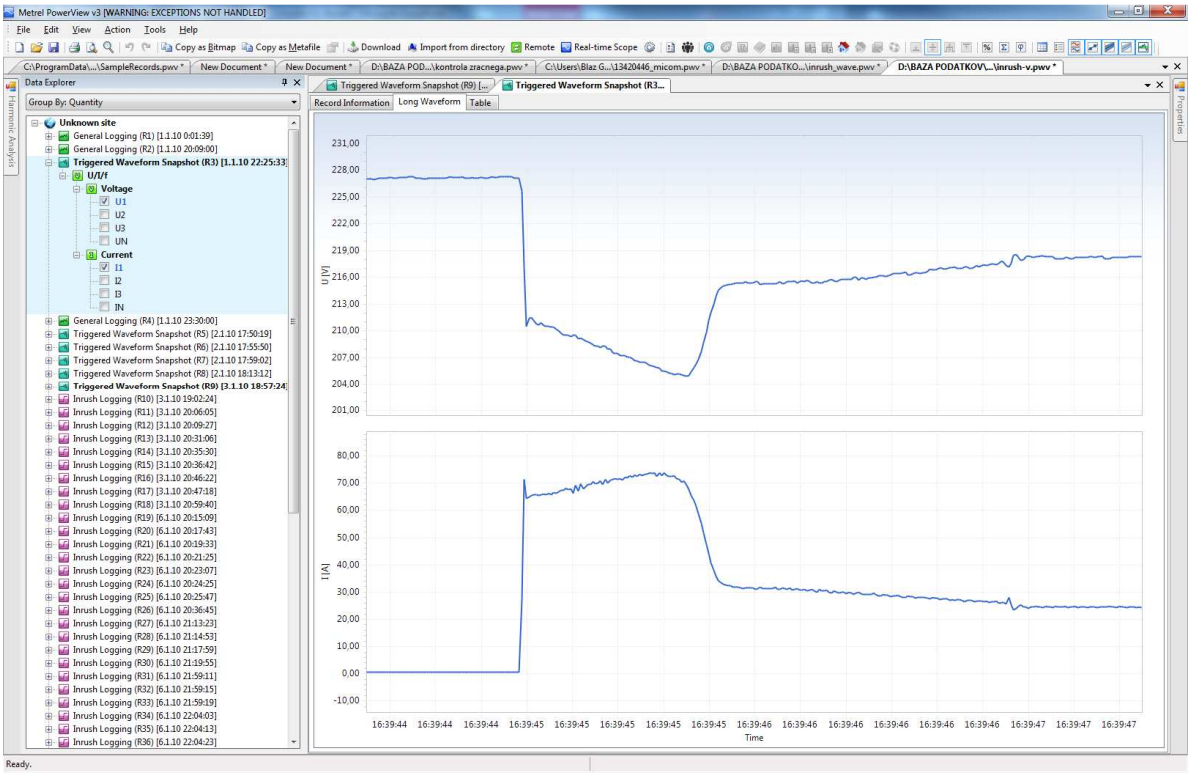
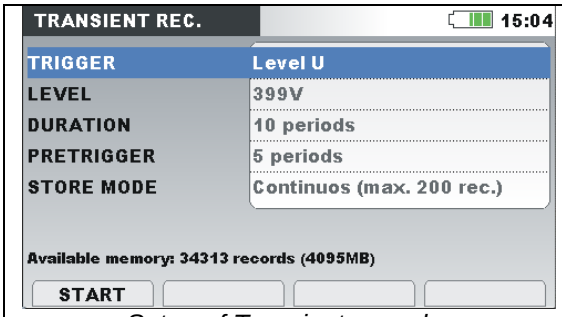


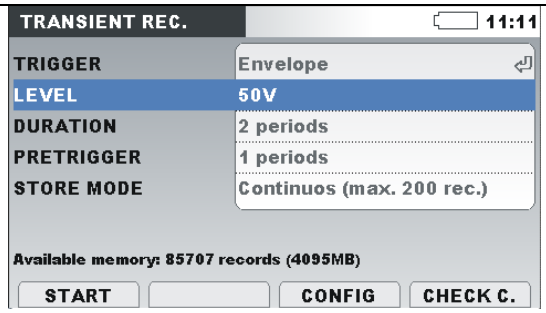
Figure 5.6: *Waveform of a start-up of motor*

5.5 Transient recorder

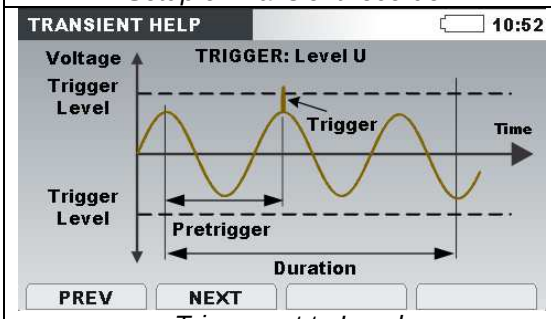
49kHz sampling frequency used enough to capture transients of 2us long.
User can choose between two trigger options Envelope or Level U.



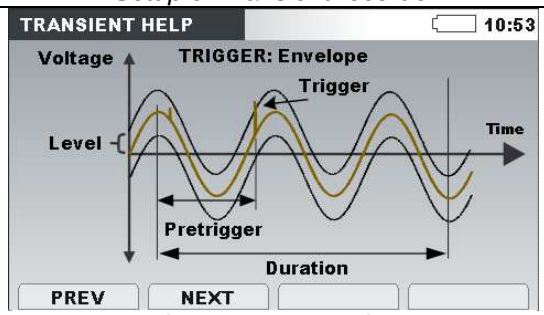
Setup of Transient recorder



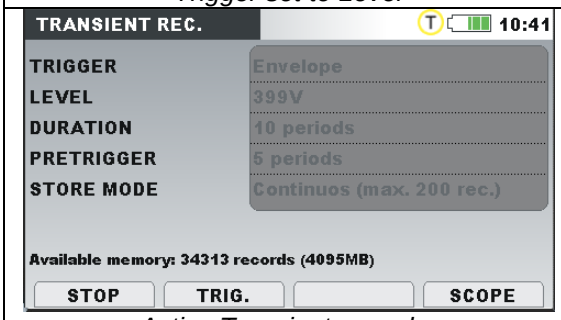
Setup of Transient recorder



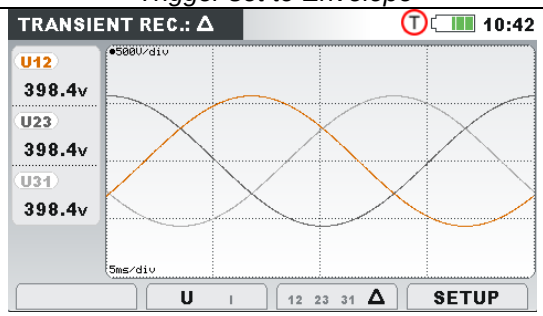
Trigger set to Level



Trigger set to Envelope



Active Transient recorder



Active Transient recorder with scope

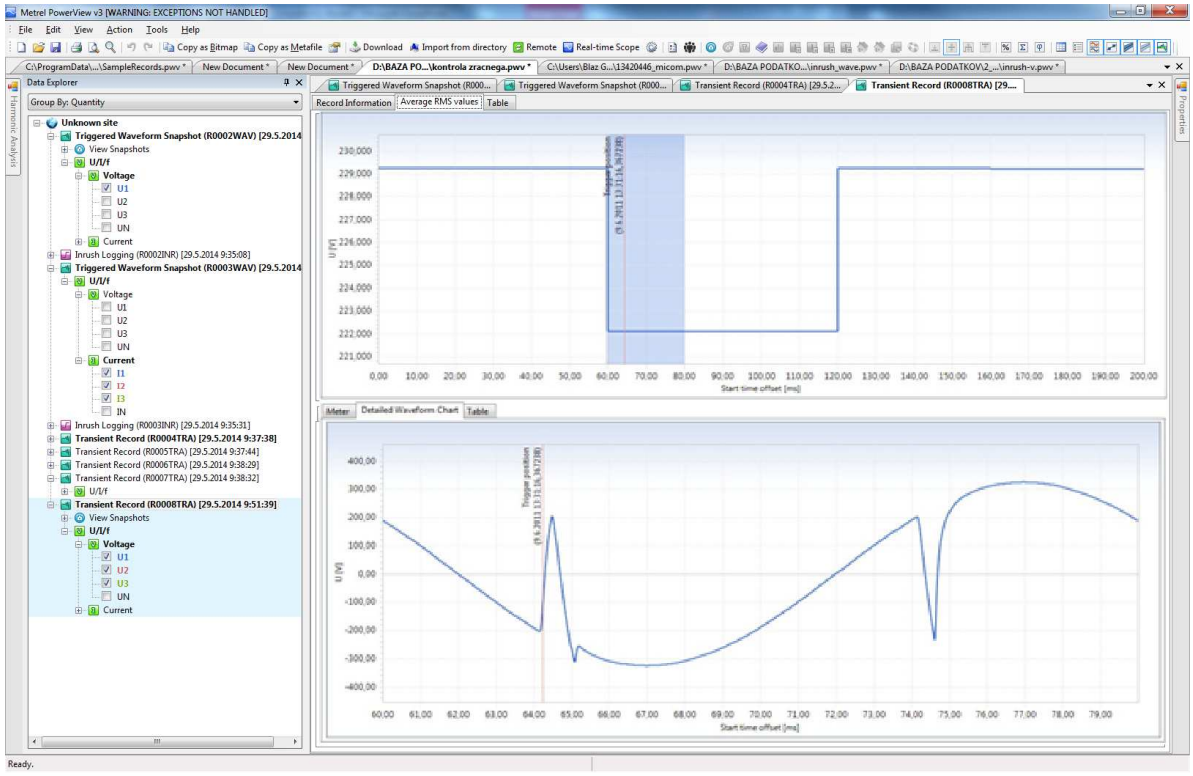


Figure 5.7: *Waveform of a recorded transient*

6 Data import into PowerView3 PCSW,

The best option to import/download the data into the PC SW is to take the microSD card out of the instrument and insert it directly to computers card reader, in case there isn't one installed use the one provided in standard set. Downloading of data via RS232, USB or ETHERNET connection will take much more time and it is not recommended. To import the data from microSD card or from specific location on your HD perform following actions:

- Select: Tools / Import / From directory

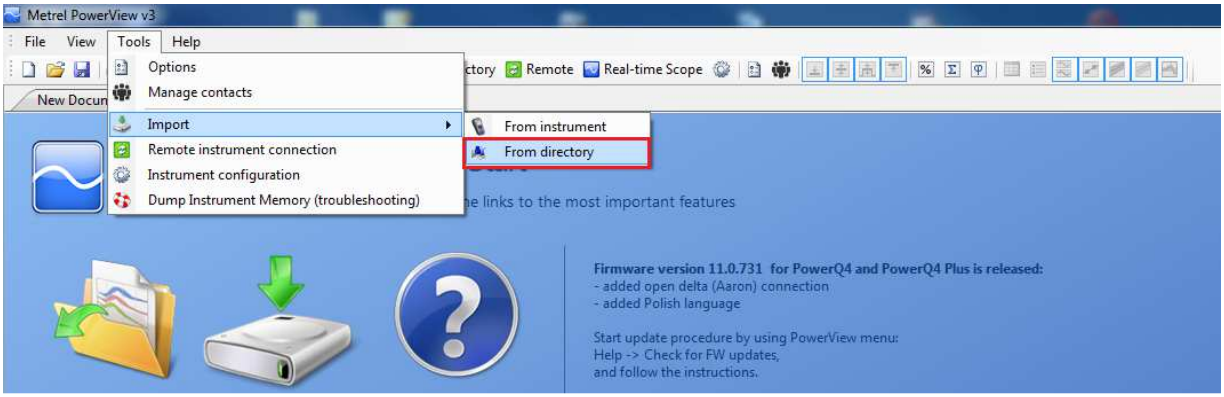


Figure 6.1: Import from directory

- Import dialog window will appear, in the left bottom corner is a filter to choose between different types of recordings.

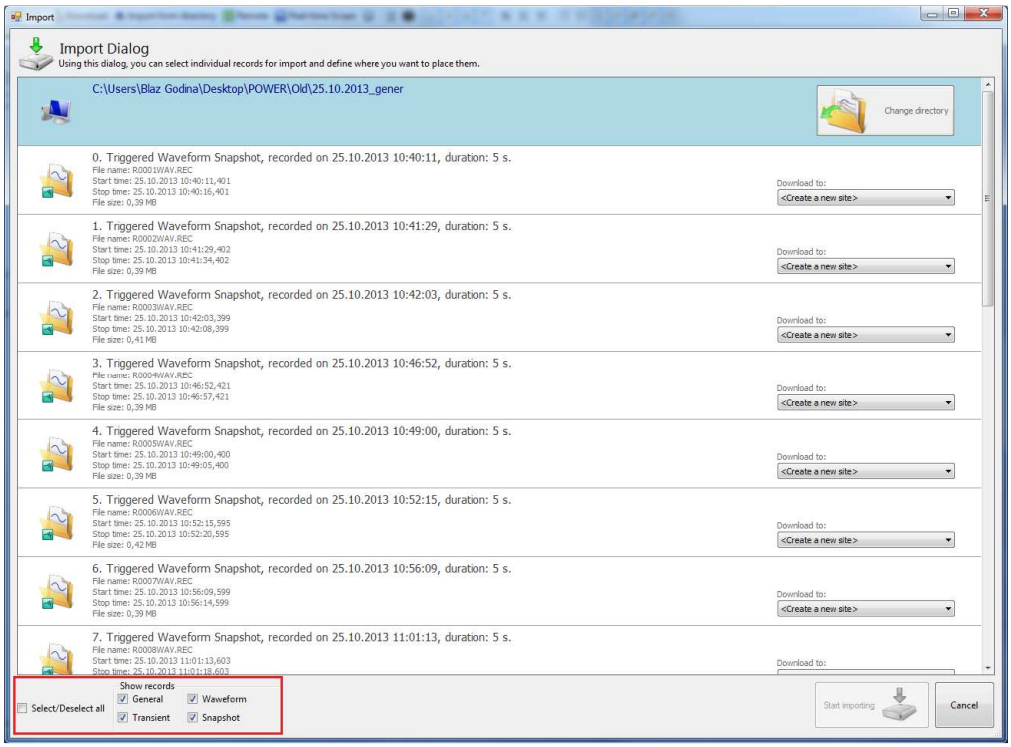


Figure 6.2: Import dialog window

- In case of a very big file, the PC SW offers the user to import the data per-partes.

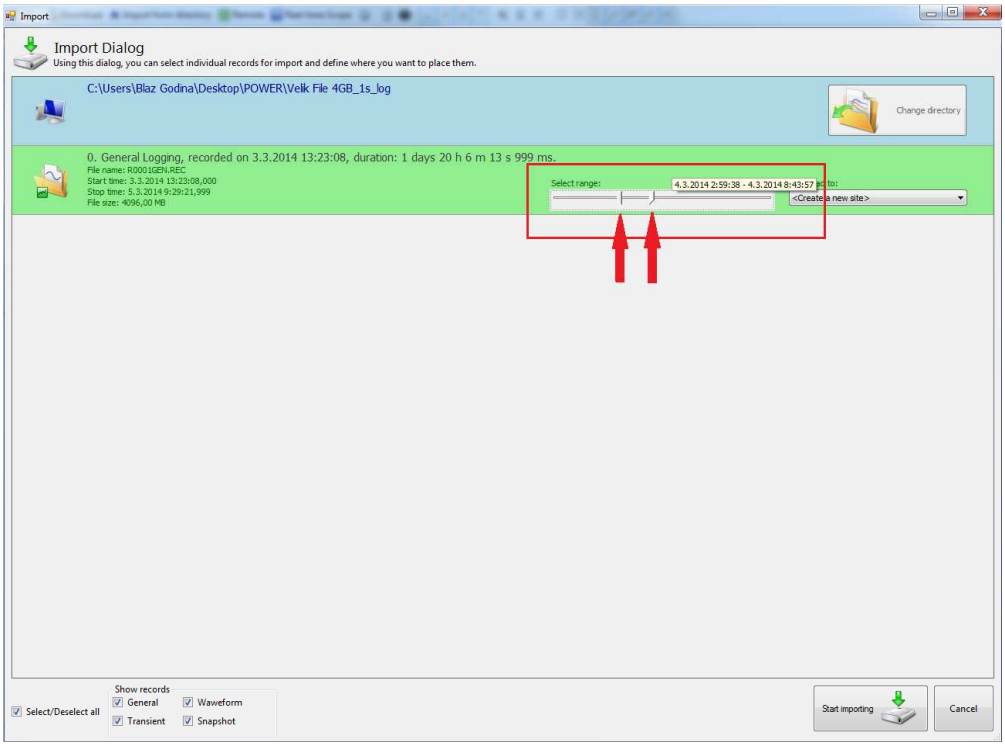


Figure 6.3: Large file, small part selection