# PLA 44

Power quality analyzer class A

User and service instruction manual

version 1.9

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# 1. Introduction

Power quality analyser PLA44 is designed for measurement of voltage network quality in LV and MV according the norm EN 50160.

Technology of the measurement is performed according the norm “IEC 61000-4-30: Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods”, measurement class “Class A”.

Power quality analyser PLA44 is designed for measurement and monitoring of electrical parameters in 2, 3 and 4 conductor networks and in TN and TT grids.

# 2. Variants

PLA 44 X3 U 230

# 3. Safety instructions

Instrument comply the standard EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use.

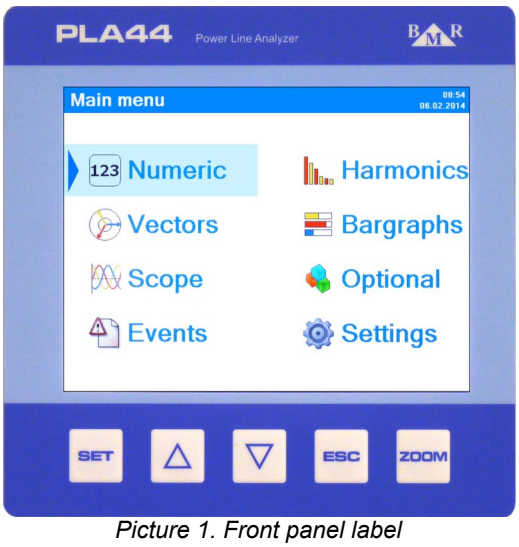
- Installation of the instrument can be done by qualified and authorised person only.
- Instrument should not be installed in the environment with increased humidity and close to explosive gases.
- Use the instrument in accordance instructions written in the user manual.
- Before the disconnection of CT measuring circuits assure that terminals of CT are short circuited.
- Installation and connection changes can be done without supply voltage only.
- Do not apply supply, measuring voltage and current higher that allowed.

# 4. Packaging content

- Power quality analyser PLA44
- Mounting holders – 2 pieces
- Temperature sensor
- User manual
- Test report

# 5. Device description

## 5.1. Front panel




*Picture 1. Front panel label*

SET – key for entering the menu and parameters

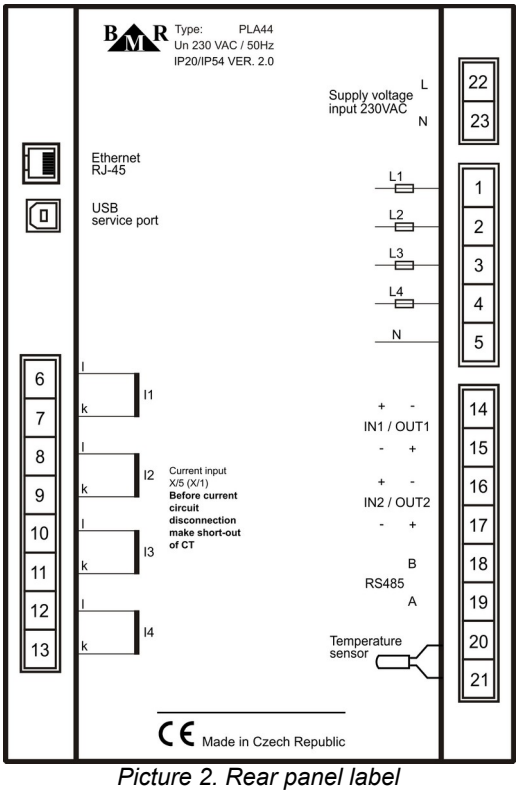
– ESC key for canceling or return

– cursor key for moving up in menu and parameter value increase

Fn – Fn (zoom) key change function of other buttons

– cursor key for moving down in menu and parameter value decrease

## 5.2. Rear panel




*Picture 2. Rear panel label*

# 6. Measured parameters

Power quality analyser PLA44 is designed for measurement and monitoring of electrical parameters in 2, 3 and 4 conductor networks and in TN and TT grids. PLA44 power quality analyser architecture is based on fast 32 bits RISC microprocessor which provides high computing power to assure the device being fully according the norm IEC 61000-4-30 class A.

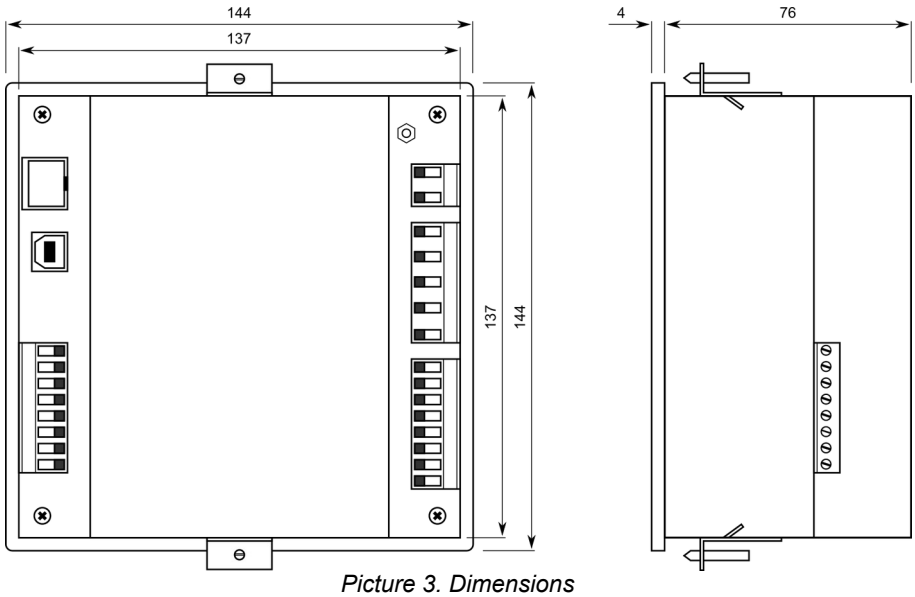
| Parameter | L1 | L2 | L3 | L4 | L1-2 | L2-3 | L3-1 | ΣL1-3 | ΣL1-4 | Max | Min | AVG | Measuring range | Displaying range | Accuracy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phase voltage | • | • | • | • | | | | | | • | • | • | 2 ... 600 V | 0 ... 1 MV | ± 0.1 % |
| Line voltage | | | | | • | • | • | | | • | • | • | 4 ... 1000 V | 0 ... 1 MV | ± 0.1 % |
| Frequency | • | | | | | | | | | • | • | • | 40 ... 70 Hz | 40 ... 70 Hz | ± 10 mHz |
| Current | • | • | • | • | | | | • | • | • | • | • | 0.001 ... 6 A | 0 ... 1 MA | ± 0.1 % |
| cosφ | • | • | • | • | | | | | | • | • | • | 0.01 L ... 0.01 C | 0.01L ... 0.01C | ± 1 % |
| Power factor | • | • | • | • | | | | | | • | • | • | 0.01 L ... 0.01 C | 0.01L ... 0.01C | ± 1 % |
| THDU L-N | • | • | • | • | | | | | | • | • | • | 0 ... 99.9 % | 0 ... 99.9 % | ± 1 % |
| THDU L-L | | | | | • | • | • | | | • | • | • | 0 ... 99.9 % | 0 ... 99.9 % | ± 1 % |
| THDI | • | • | • | • | | | | | | • | • | • | 0 ... 99.9 % | 0 ... 99.9 % | ± 1 % |
| Harmonics of voltage | • | • | • | • | | | | | | • | • | • | 0 ... 99.9 % | 0 ... 99.9 % | Class 1 |
| Group of interharmonics U | • | • | • | • | | | | | | | | | 0 ... 99.9 % | 0 ... 99.9 % | Class 1 |
| Group of harmonics U | • | • | • | • | | | | | | | | | 0 ... 99.9 % | 0 ... 99.9 % | Class 1 |
| Harmonics P | • | • | • | • | | | | | | | | | 0 ... 99.9 % | 0 ... 99.9 % | Class 1 |
| Harmonics Q | • | • | • | • | | | | | | | | | 0 ... 99.9 % | 0 ... 99.9 % | Class 1 |
| Harmonics I | • | • | • | • | | | | | | • | • | • | 0 ... 99.9 % | 0 ... 99.9 % | Class 1 |
| Group of interharmonics I | • | • | • | • | | | | | | | | | 0 ... 99.9 % | 0 ... 99.9 % | Class 1 |
| Group of harmonics I | • | • | • | • | | | | | | | | | 0 ... 99.9 % | 0 ... 99.9 % | Class 1 |
| Short-term flicker | • | • | • | • | | | | | | • | • | • | 0 ... 20.0 Pst | 0 ... 20.0 Pst | Class A |
| Long-term flicker | • | • | • | • | | | | | | • | • | • | 0 ... 20.0 Plt | 0 ... 20.0 Plt | Class A |
| Under-voltage | • | • | • | • | • | • | • | | | • | • | • | 0 ... 100 % | 0 ... 100 % | ± 0.2 % |
| Over-voltage | • | • | • | • | • | • | • | | | • | • | • | 0 ... 100 % | 0 ... 100 % | ± 0.2 % |
| Unbalance U | | | | | | | | | | • | • | • | 0 ... 100 % | 0 ... 100 % | ± 0.15 % |
| Neutral point displacement | | | | | | | | | | • | • | • | 10 ... 600 V | 0 ... 1 MV | ± 0.2 % |
| K-factor | • | • | • | • | | | | | | | | | | | |
| Unbalance I | | | | | | | | | | • | • | • | | | ± 0.5 % |
| Transients | • | • | • | • | | | | | | | | | | | 25 µs |
| Events | • | • | • | • | | | | | | | | | | | 10 ms |
| Ripple control signal | • | • | • | • | • | • | • | | | • | • | • | | | |
| Active power | • | • | • | • | | | | • | • | • | • | • | 0 ... 10.8 kW | 0 ... 999 GW | ± 0.4 % |
| Reactive power | • | • | • | • | | | | • | • | • | • | • | 0 ... 10.8 kvar | 0 ... 999 Gvar | ± 0.4 % |
| Apparent power | • | • | • | • | | | | • | • | • | • | • | 0 ... 10.8 kVA | 0 ... 999 GVA | ± 0.2 % |
| Distortion power | • | • | • | • | | | | • | • | • | • | • | | | ± 0.5 % |
| Active energy +/- | • | • | • | | | | | • | | | | | 0 ... 999 GWh | 0 ... 999 GVh | class 0.2 |
| Inductive energy +/- | • | • | • | | | | | • | | | | | 0 ... 999 Gvarh | 0 ... 999 Gvarh | class 0.2* |
| Capacitive energy +/- | • | • | • | | | | | • | | | | | 0 ... 999 Gvarh | 0 ... 999 Gvarh | class 0.2* |
| Temperature | | | | | | | | | | • | • | • | | | ± 1 °C |

* fundamental

*Table 1. Measured and displayed parameters*

# 7. Installation

PLA44 is prepared for wall mounting in the fixed switch boards. In order to assure well ventilation, the PLA44 has to be installed vertically. There has to be empty space at least 60 mm at the top and bottom and 20 mm at the sides.




*Picture 3. Dimensions*

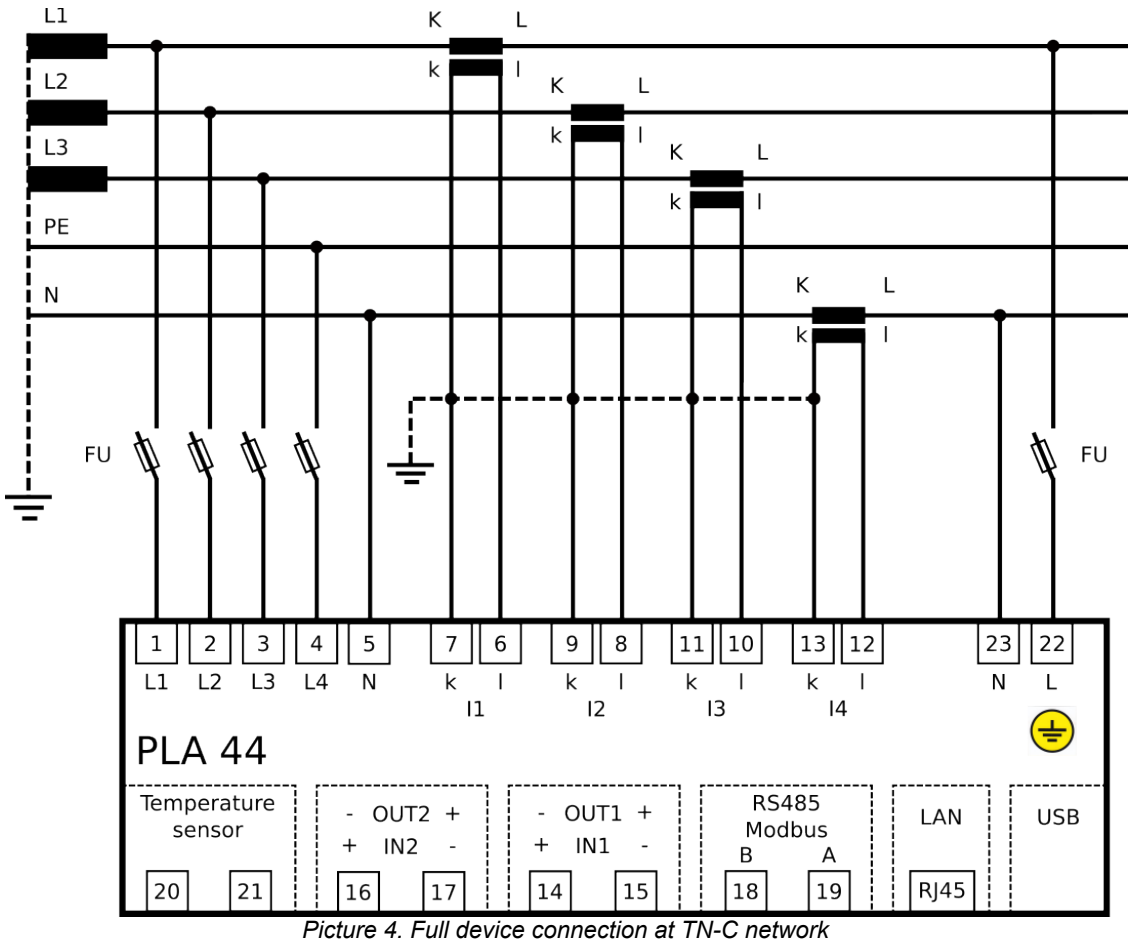
PLA44 is fixed into switchboard wall by two clips that are placed on the device at the bottom and top.

## 8. Connection

The level and type of used power supply voltage has to be the same as it is written on the terminal plate label. By default the power supply voltage is 230 VAC 50 Hz (+10%, -15%).

Voltage measurement circuits as well as power supply input have to be connected via circuit breaker or power switch and fuse (2 ... 10 A) which are placed close to the device for easy access.

Current measurement circuits have to be connected via current transformers, either ../5A or ../1A ratio.




*Picture 4. Full device connection at TN-C network*

## 8.1. Grounding conductor

The grounding terminal has to be connected as a first terminal. Grounding terminal is realized by threaded pole with 3 mm diameter and it is marked by symbol ⏚.

## 8.2. Supply voltage

Supply voltage is required to operate the PLA44. The type and level of the necessary supply voltage is written on the back label. Before applying the supply voltage, make sure that the voltage level and system frequency match the details on the label. The connection cables for the supply voltage must be connected using a fuse. Use a fuse (6A characteristic C).

## 8.3. Voltage measuring inputs

Instrument has four voltage measuring inputs with input impedance 4 MΩ suitable for measurement according the category CATIII 600 V.

Each voltage measuring input have to be connected via circuit breaker or switch and fuse (10 A characteristic C) which are placed close to the device.

**Important**

*Supply voltage has to be from the same grid as measuring voltages*

**Notice**

*PLA44 is not designed for measuring of DC voltage!*

*PLA44 is not designed for usage in SELV grids!*

**Notice**

*If the voltage measuring inputs are connected over the voltage measuring transformers the power of measuring transformer power must be at appropriate level. Voltage measuring inputs have 5 mW self consumption. Recommendation from measuring transformer producers is to have loaded voltage measuring transformer on 70% of maximum power for the best accuracy.*

## 8.4. Current measuring inputs

Instrument has four current measuring inputs for indirect measurement via current measuring transformers, either ../5A or ../1A ratio. CT ratio is freely adjustable from an instrument or via PC software.

**Important**

*Current inputs maximum permanent capability is 8.5A.*

**Important**

*Before opening the current circuit be sure that measuring terminals of current transformer are connected together.*

**Notice**

*PLA44 is not designed for DC current measurement!*

## 8.5. RS485

The PLA44 has built-in one RS485 interface supporting Modbus RTU protocol. Connection of the RS485 bus to the device is on the separate terminal by two wires A and B. Shielding is not required.

**Notice**

*PLA44 does not have built in termination resistor. If the instrument is at the end of the RS485 bus it should be terminated by 120 Ω resistor.*

*RS485 interface is fully galvanic insulated.*

## 8.6. Ethernet

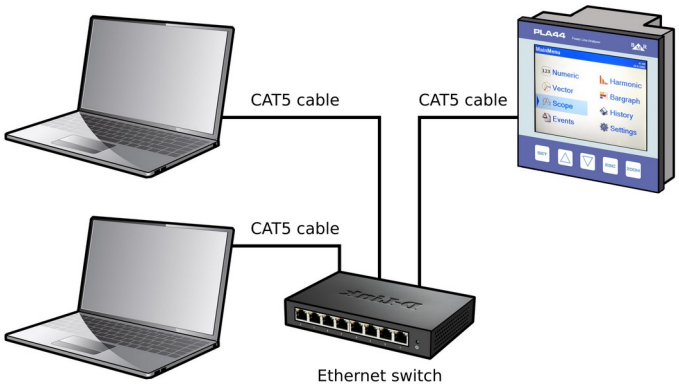
Instrument is equipped by Ethernet interface 10/100Mbit/s with RJ45 connector. For connection use the cable CAT5 type. The configuration of Ethernet are defined by the network administrator and have to be set on the PLA44 correspondingly. See chapter 9.3.1.

**Important**

*If the network configuration is not known, the Ethernet cable should not be plugged into the device.*

### 8.6.1. Connection of PLA44 into LAN

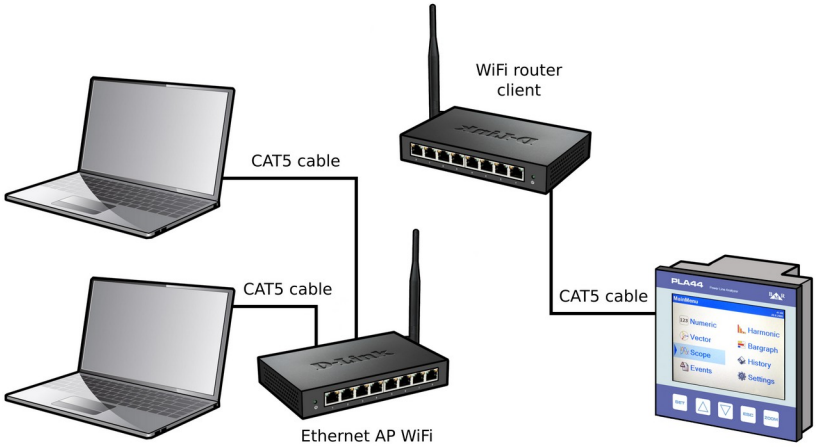
Make a connection to the active network item (Switch, Hub, Router) via UTP cable.




**Notice**

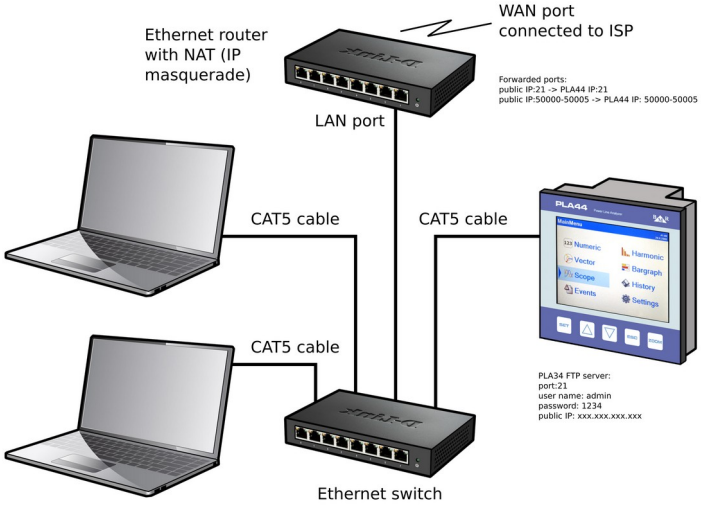
*PLA44 does not support the DHCP. Instrument IP address has to be configured manually at the instrument side.*

### 8.6.2. Connection of PLA44 to WiFi




### 8.6.3. Connection of PLA44 to LAN with NAT server

If there is request for remote access (from Internet) to PLA44, which is place in the local network behind the router with active NAT server, the following parameters configuration to be defined on the router.



For access to web server of PLA44 there has to be created port forwarding (virtual server):

- `router public IP address:port 80 --> IP address of PLA44:port 80`

For access to FTP server of PLA44 (needed for PMS software) there has to be created port forwarding (virtual server):

- `router public IP address:port 21 --> IP of PLA44:port 21`
- `router public IP address:port 50000...50005 --> IP of PLA44:port 50000...50005`

**Notice**

*Number of port of 80, 21 is possible change on router. Range of ports 50000 ... 50005 is fixed and it is not possible to change it.*

On the PLA44 device it is necessary set following parameters in:

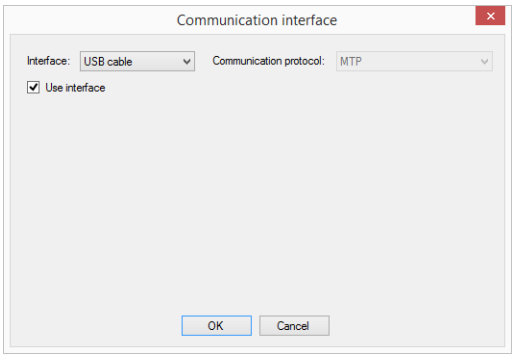
- IP - public
- FTP: 21 (factory value)
- user name: admin (factory value)
- password: 1234 (factory value)

**Notice**

*For communication with FTP server of PLA44 within local network is IP-public parameter set on the same as IP of the device. For communication with FTP server of PLA44 from the internet is the IP-public parameter set on public IP obtained from Internet provider.*

## 8.7. USB

Device has one USB interface of type B for direct connection of PLA44 to the PC. After connection of PLA44 via USB cable to the PC it is necessary select correct communication interface at PMS software.

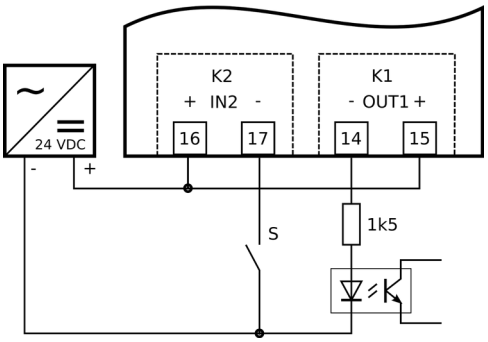



## 8.8. Temperature sensor

Temperature sensor is connected directly to PLA44 inputs 20 and 21 according to the picture 2. The sensor is NTC type with resistance 10 kΩ / 25°C.

## 8.9. Digital inputs / outputs

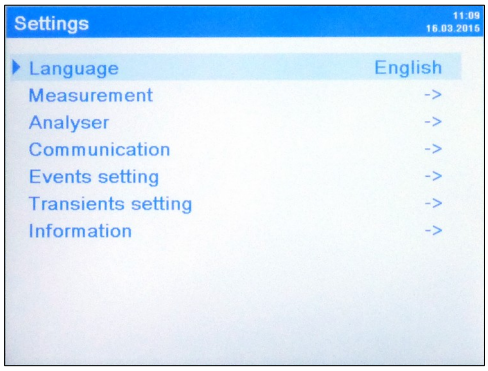
The instrument is equipped by two optically-isolated transistor outputs inputs. The outputs working mode is fully adjustable as an alarm output, remotely controlled output or pulse output.




*Picture 5. Connection of input / output*

# 9. Device settings

PLA44 device can be configured from panel screen for most of the essential parameters. All settings available at the instrument screen and several others are available also in Power Monitoring Software (PMS). In this chapter the settings of the instrument will be completer by appropriate settings at PMS side.



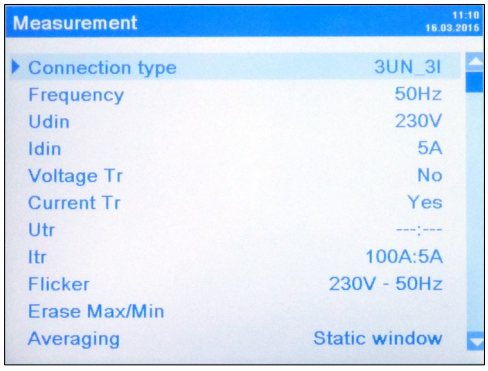

At main screen move to parameter **Settings** to open device various configuration sub-menu. Some of the device parameters and functions can be enabled and configured only by PC and software PMS.

## 9.1. Language

Menu of PLA44 is localized to several languages. Default device language is English. Select the appropriate language from the list and confirm it. Device menu will turn immediately to the selected language.

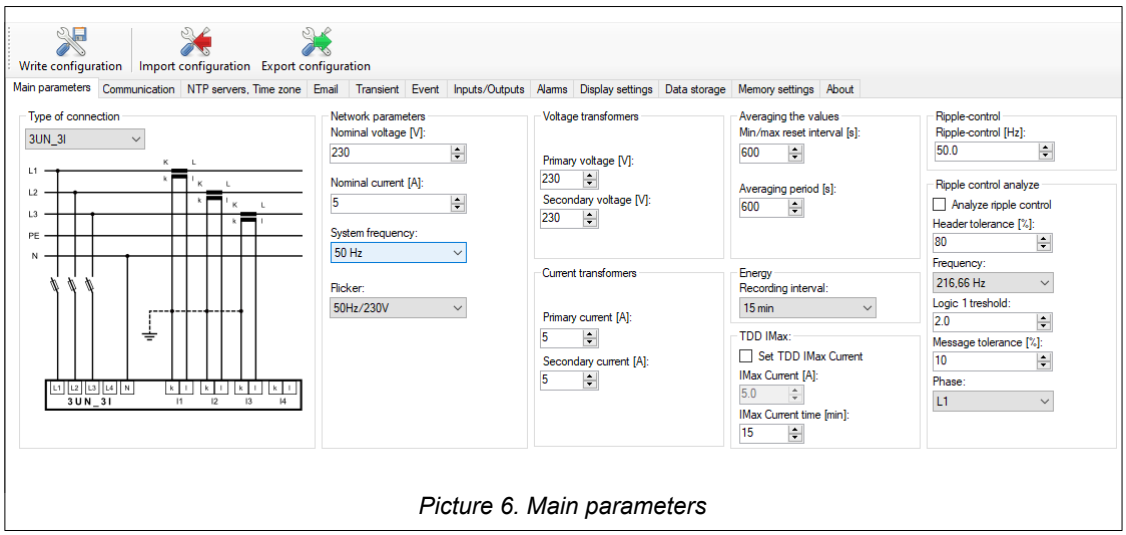
## 9.2. Measurement – Main parameters

Setting "Measurement" gathers all settings related to measuring circuits connection type, measuring transformers and type of parameters calculation.




| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| Network type | Defines the type of network and measuring circuit connection | 4UN_4I | chapter 9.2.1 |
| Frequency | Defines the nominal system frequency | 50 Hz | 45 ... 75 Hz |
| Udin | Network nominal phase voltage | 230 V | 1 V ... 750 kV |
| Idin | Network nominal phase current | 5 A | 1 A ... 750 kA |
| Voltage Tr | Enable the usage of measuring voltage transformer | No | No / Yes |
| Current Tr | Enable the usage of measuring current transformer | No | No / Yes |
| Utr | Primary and secondary voltage of measuring voltage transformer | 230 V / 230 V | 1 ... 750 kV |
| Itr | Primary and secondary current of measuring current transformer | 5 A / 5 A | 1 ... 750 kA |
| Flicker | Settings of the nominal voltage and frequency for flicker calculation | 230 V – 50 Hz | 120/230 V, 50/60 Hz |
| Erase Max/Min | Deletes all saved maximums and minimums of measured parameters | No | Yes / No |
| Averaging | Type of averaging method | Static | Static / Sliding |

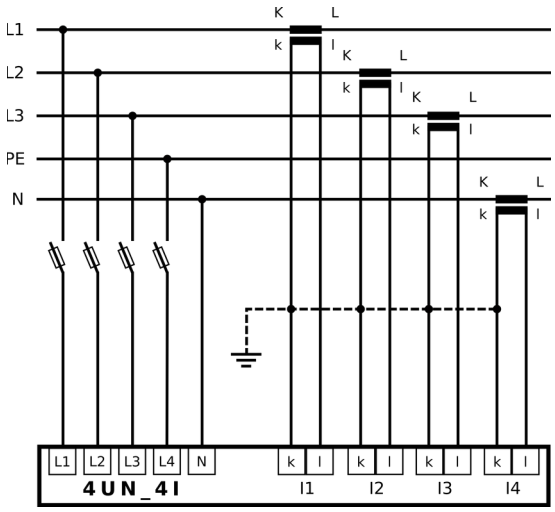
| | | | |
|---|---|---|---|
| Averaging period | Time for averaging period setting | 5 s | 1 ... 3600 s |
| Ripple -control | Adjustable by PMS | 50 Hz | 50 Hz ... 3 kHz |



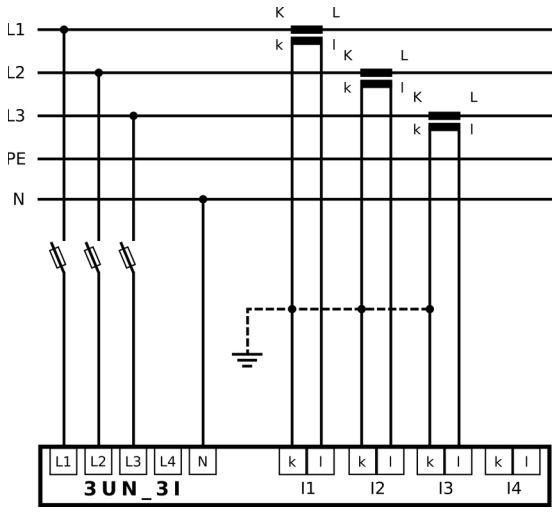

*Picture 6. Main parameters*

### 9.2.1. Network type

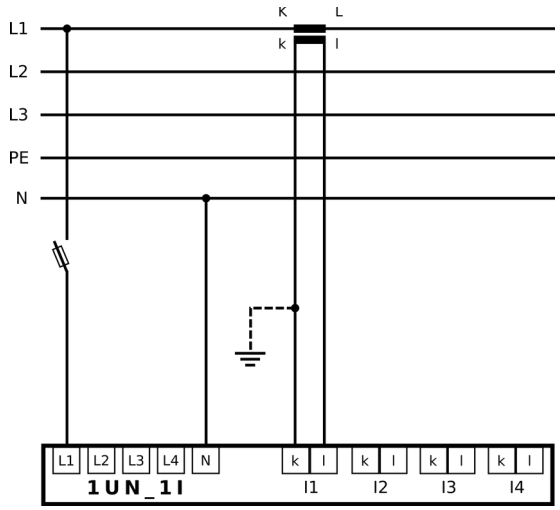
PLA44 is designed for various connections according to the grid type or measurement needs. Network settings defines the types network system in which the PLA44 is connected The main connection diagram of PLA44 is shown in chapter 8.3. In the following table are shown all possible connection variants that can be defined in the device menu.



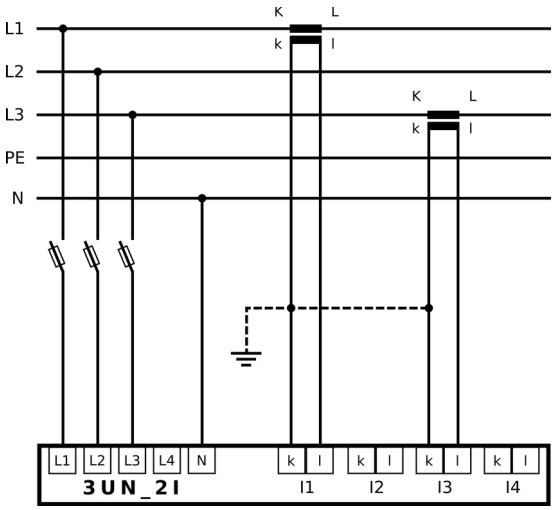

*Connection for asymmetric loads in TN-C-S grids*



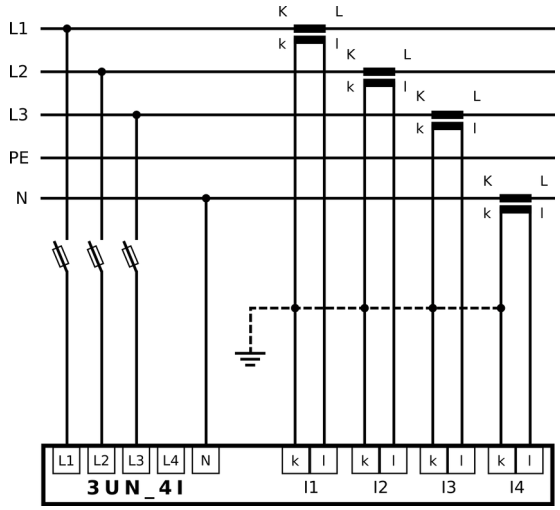

*Asymmetric loads in TN-C or TN-C-S grids*



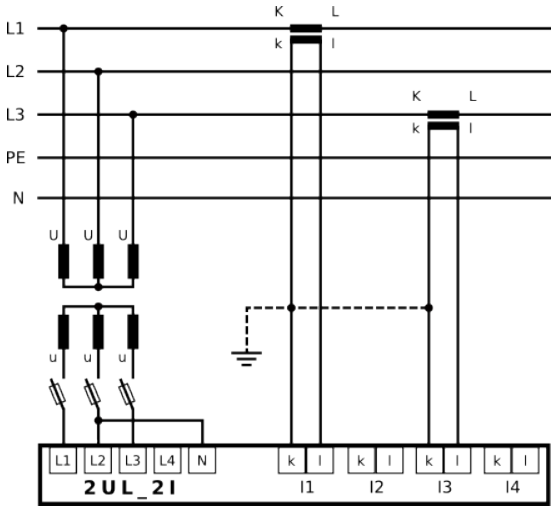

*Connection for single-phase loads*



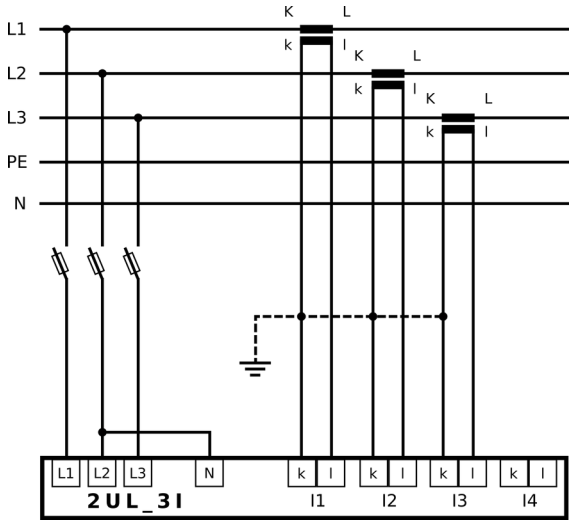

*Connection for symmetric loads with two CTs only*




*Connection for asymmetric loads in TN-C-S grids*




*Connection for MV grid (Aron connection)*




*Connection for IT networks*

*Table 2. Connection diagrams*

### 9.2.2. Nominal voltage

Nominal voltage setting is fundamental setting used for thresholds calculation for voltage events and transients. Appropriate

value of phase nominal voltage has to be set.

### 9.2.3. Nominal current

Nominal current setting is fundamental value setting used for threshold calculation for current events.

### 9.2.4. Flicker

Device calculates flicker according to the norm EN 61000-4-15. It provides values for short-term flicker (10 minutes), long-term flicker (2 hours). For correct calculation of both flickers it is necessary set correct nominal values used in the country standards. Available settings are:

- 230 V – 50 Hz
- 230 V – 60 Hz
- 120 V – 50 Hz
- 120 V – 60 Hz

### 9.2.5. Ripple control

Ripple control offers feature that provides information about effective voltage value for particular harmonic frequency of measured signal. The frequency of ripple control is adjustable from 50 Hz till 3000 Hz with decimal setting option.

### 9.2.6. Voltage transformers

If the voltage measuring transformers are used the settings of primary and secondary voltage has to be configured. Both voltage levels (primary and secondary) are set in volts.

### 9.2.7. Current transformers

PLA44 instrument has 4 current inputs for indirect measurement via current transformers with secondary current 5A or 1A. In case of measuring current transformer usage the primary and secondary current value of CT has to be set.

### 9.2.8. Averaging

This setting defines type of averaging and period of average values calculation. Average values are available on the display of an instrument and in Power Monitoring Software.

There are two types of averaging method:

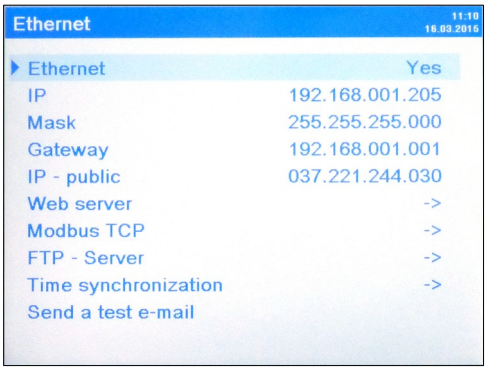
- **Static window** method cumulates measured values over the defined period. After the period ends the average values are calculated and shown. Cumulated values are erased and new period is measured again.
- **Sliding window** method continually cumulates measured values over the defined period and over this period shows calculated average values. While the time is moving the oldest values are erased and new values added.

### 9.2.9. Energy

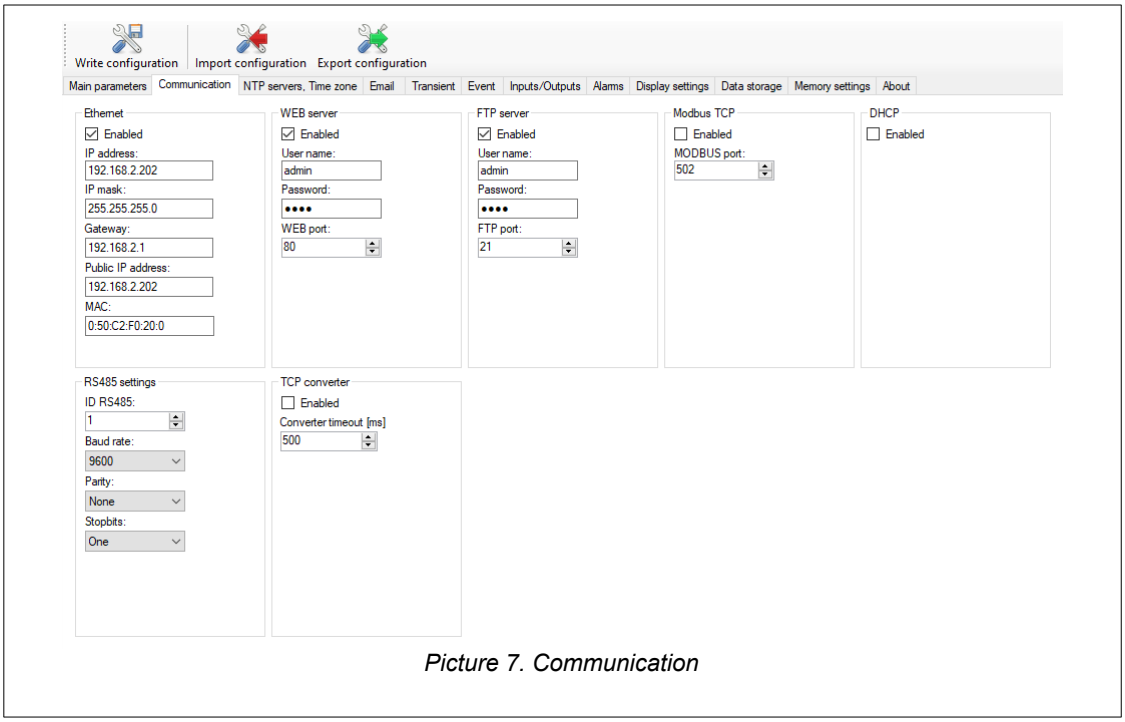
Provides setting of recording interval for historical values of energy counters available in PLA44.

## 9.3. Communication settings

Instrument is equipped by one Ethernet interface 10/100Mbit/s and RS485.




In the PMS software, settings of all available communication interfaces are grouped in cart called “Communication”.




*Picture 7. Communication*

### 9.3.1. Ethernet

Defines the configuration of Ethernet interface of instrument for visibility and accessibility on LAN and Internet.

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| Ethernet | Enable or disable Ethernet interface | Yes | Yes / No |
| IP | PLA44 IP address in the local network | 192.168.001.201 | |
| Mask | Mask of the Ethernet network | 255.255.255.0 | |
| Gateway | IP address of PC or router used as a gateway to parent network | 192.168.001.001 | |
| IP - public | Public IP address of router | 192.168.001.001 | |
| Web server | Web-server settings advance menu | ► | |
| Modbus TCP | Modbus TCP settings advance menu | ► | |
| FTP server | FTP server settings advance menu | ► | |

**Important**

*Public IP address is necessary to set for these cases when instrument is accessed from different network, for example Internet, while it is located in the Ethernet behind the NAT server.*

### 9.3.2. Web-server

Instrument has build in web-server for remote on-line monitoring via Internet or local network. Following table describes settings related to web server configuration of PLA44.

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| Web server | Enable or disable web server | Yes | Yes / No |
| Web port | Port on which the web-server is accessible | 80 | 0 ... 3850 |
| Web name | User name for access to PLA44 device web-server | admin | |
| Web password | Password for access to PLA44 device web-server | 1234 | |

**Notice**

*Web server is optimized for portable instruments such as mobile phones and tablets.*

### 9.3.3. Modbus TCP

Communication protocol Modbus TCP is used for communication with PLA44 over the Ethernet interface.

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| Modbus TCP | Enable or disable Modbus TCP feature | Yes | Yes / No |
| Modbus TCP - port | Defines the port on which the Modbus TCP is accessible | 502 | 1 ... 65535 |

### 9.3.4. FTP server

FTP server is a fundamental communication protocol for reading the measured data, recorded data and configuration of the instrument. Enabled FTP is server is an essential setting needed for correct work of PLA44 with Power Monitoring Software.

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| FTP server | Reference voltage level type | Yes | Yes / No |
| FTP port | Port of the FTP service | 21 | 1 ... 65535 |
| FTP name | User name for access to FTP server of PLA44 device | admin | |
| FTP password | Password for access to FTP server of PLA44 device | 1234 | |

### 9.3.5. TCP converter

PLA44 is equipped by function of Modbus TCP converter so it can provide access to instruments connected on RS485 bus of PLA44.

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| TCP converter | Activates the Modbus TCP converter of PLA44 | Yes | Yes / No |
| Converter timeout | Converter timeout | 500 ms | 100 ... 5000 ms |

Modbus TCP converter function has allowed Modbus user functions so it is suitable for transmission of long data packets such as recorded data from flash memory of PLA33CMB instruments.

### 9.3.6. RS485

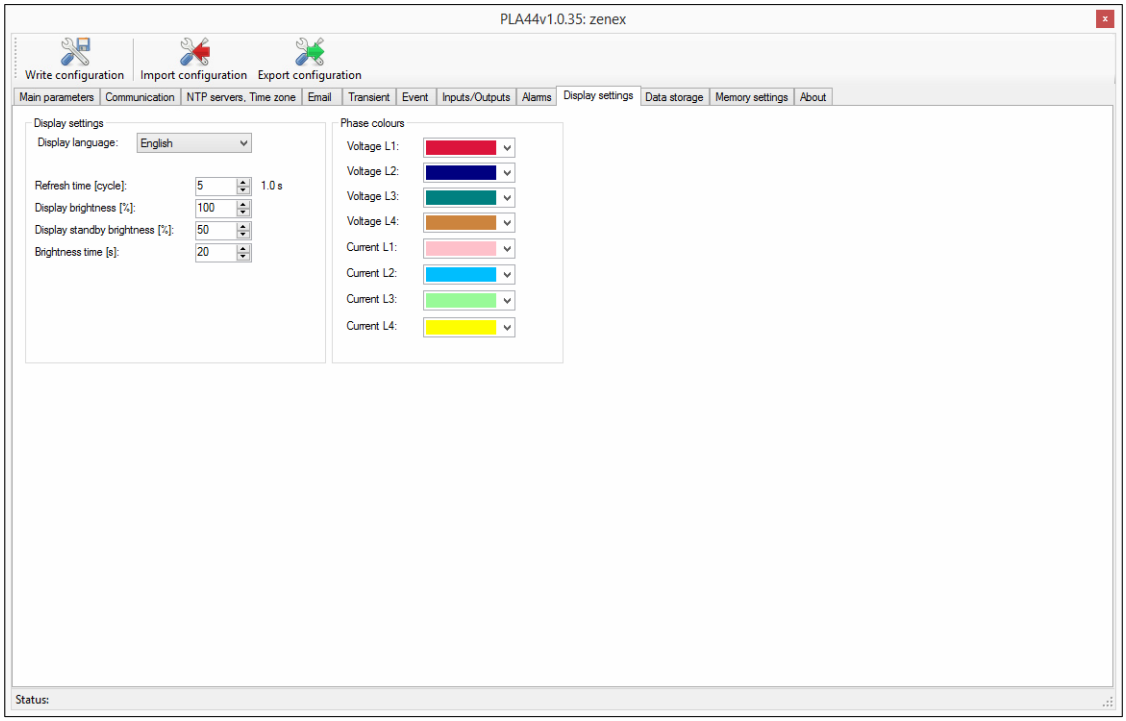
Serial port RS485 configuration is essential for the usage of PLA44 as a TCP/IP converter.

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| ID | Unique identification number in RS485 network | 0 | 0 ... 255 |
| Transfer rate | Communication speed of RS485 interface is adjustable in speed | 9.6 kBd | 9.6 kBd ... 115 kBd |
| Parity | RS485 interface parity | odd | odd / even |
| Stop bit | RS485 interface stop-bit | 1 | 1 / 2 |

## 9.4. Analyser

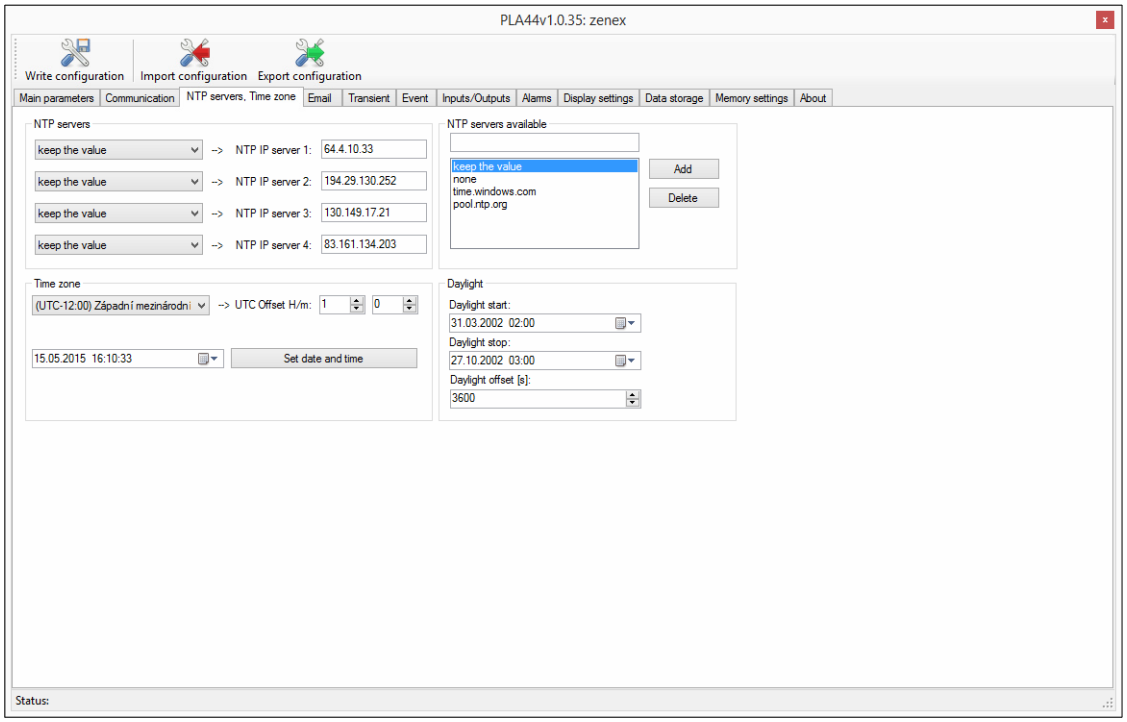
Settings related to the device itself such as display parameters, colours, time, password protection and reset of all settings.

| Parameter | Description | Factory settings | Settings range |
|---|---|---|---|
| Display refresh | Speed of display refreshing. The optimal setting is 5 cycles. | | |
| Brightness | Brightness of display for operation while buttons are touched | | 0 … 100% |
| Standby brightness | Defines level of brightness when device is not pressed at any button | | |
| Standby time | Time delay after that device turns to standby level of display brightness. | | |
| Password | Four digit password for access to device settings menu | | |
| Date and time | Device internal clock configuration sub-menu | ► | |
| Colors | Colours template of particular voltages and currents of phases for graphs | | |
| Reset | Reset device to the factory settings | | |



## 9.5. NTP server, Time zone

| Parameter | Description | Factory settings | Settings range |
|---|---|---|---|
| Device time | Date and UTC time in format for date YYYY.MM.DD and HH:MM for time. | | |
| UTC time offset | Time offset of the local time against to UTC. Offset is set in seconds. | | |
| Daylight start | Beginning of the summer time season | | |
| Daylight stop | End of the summertime season | | |
| Daylight offset | Time shift for summertime season | | |

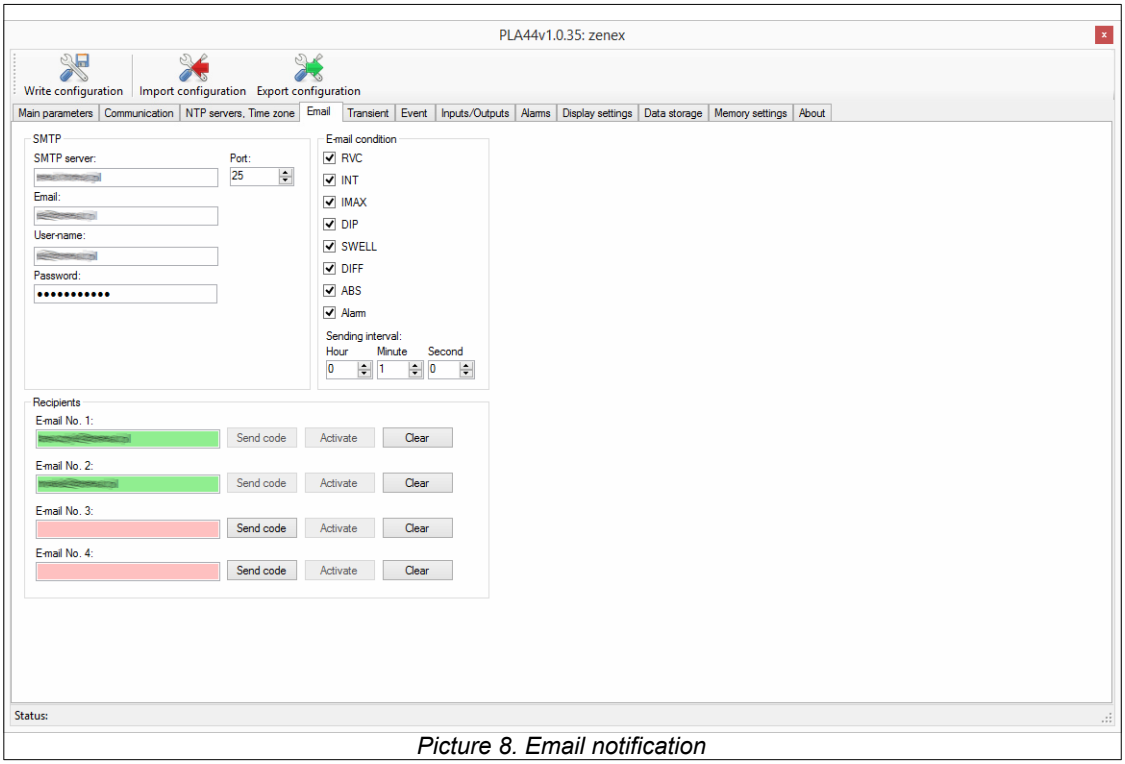



PLA44 corrects internal clock according to NTP servers while it is connected to Internet. NTP time synchronization has always priority above the manual clock settings. Clock synchronization by NTP is fully automatic and there is no need to set anything.

The selection of closest NTP server is adjustable in software PMS. For the finding the closest NTP server refer to the following link http://support.ntp.org/bin/view/Servers/StratumOneTimeServers.

## 9.6. Email

PLA44 can notice several events and alarms by sending an e-mail up to 4 different e-mail addresses. The email notification setting is available only from Power Monitoring Software.




*Picture 8. Email notification*

For correct setting obtain the SMTP server address from your provider. If the SMTP server requires authentication enter the user name and password.

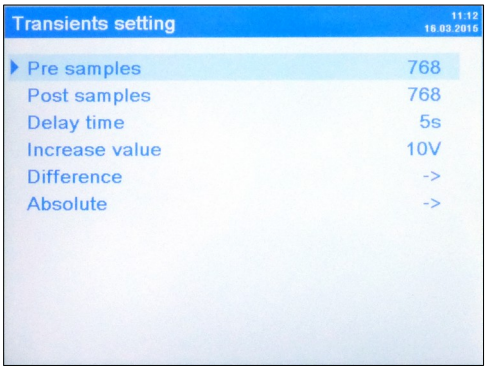
Select the requested e-mail notification and sending interval. Sending interval defines how often the emails are sent in order to prevent

Sending interval defines how often the email is sent. Factory setting is 1 hour which means that all events and alarms that appears during that hour are sent in one email. This interval prevents the instrument to send too many e-mails.

For most recent 5 events and transients the graphs are sent in the e-mail too. Other events and transients are shown as a recording in table.

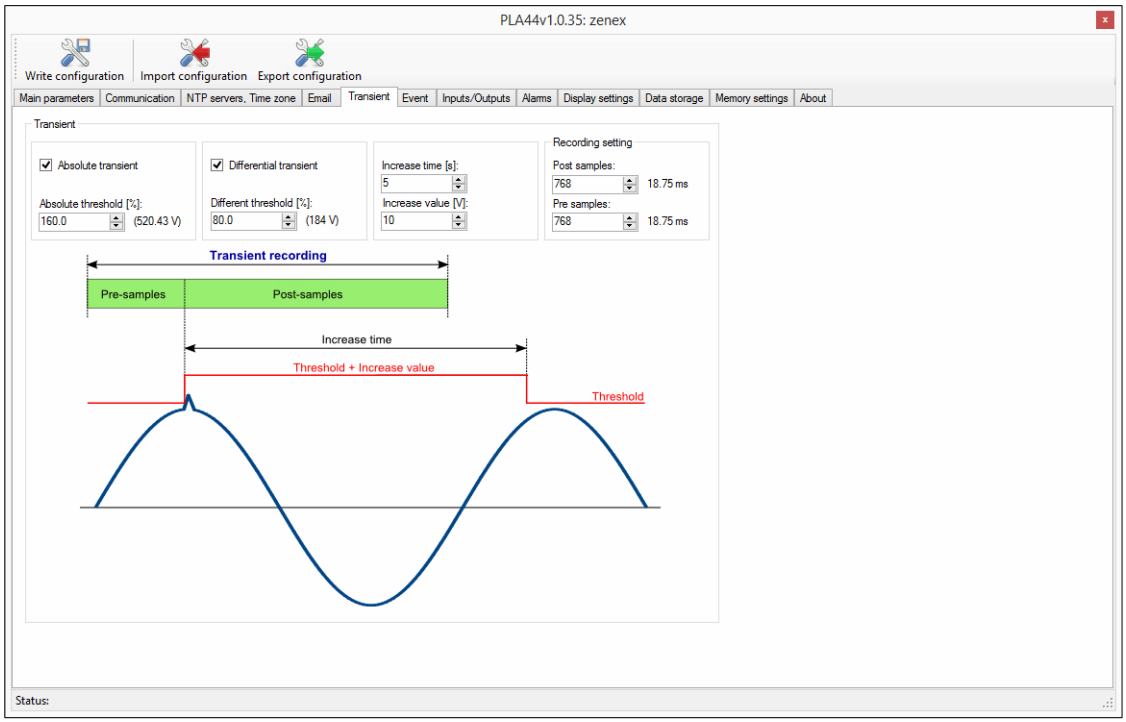
## 9.7. Transient

Voltage transients are short commutation, impulse or oscillatory events in electrical grid. Their source can be inductive load switching, power factor correction instruments, atmospheric events, protection instruments action or malfunction of switching elements in the grid.



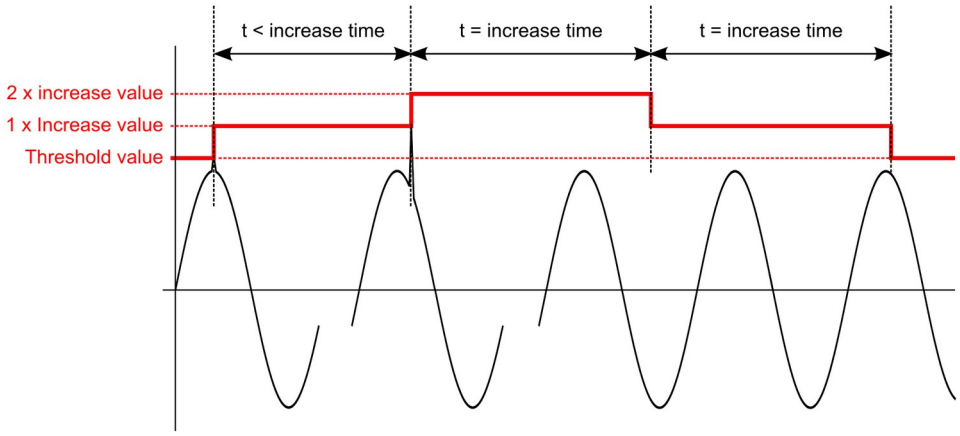

PLA44 analyser detects two types of transients. Absolute transients and differential transients.

- **Absolute transients** are detected according to override of defined voltage level. The trigger for detection of the absolute transients is defined by absolute threshold (percentage of Udin).
- **Differential transients** are detected according to the difference between two consecutive voltage measurements. The difference between measurement is defined by differential threshold (percentage of Udin).




Common settings for absolute and differential transients is for the parameters used for tuning the transients detection and transients recording.

If the transient is detected and being recorded the instrument increase the absolute and differential thresholds to prevent of misled transient detection. It prevents instrument against wrong recordings. This is defined by two user adjustable parameters. Increase value and increase time.



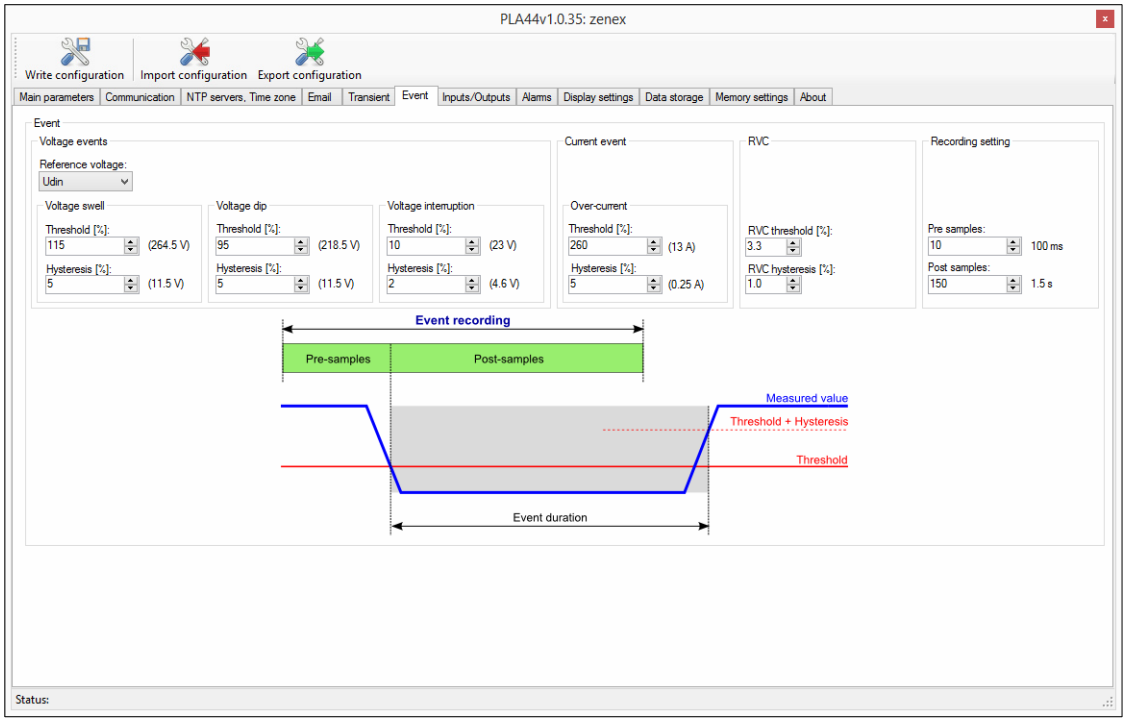

- Increase value is the value that is used for increasing the absolute and differential threshold while transient is detected. Set value increase the threshold level for the defined time.
- Increase time is a time delay for which the increased value of threshold is valid. After the increase time expires the value of threshold is returned back the user set value.

If another transient appears while the increase time is still not expired the threshold is increased once again. After the increased time expires the threshold is recovered to the previous level and after another period of increase time it is threshold recovered to the user defined level of absolute and differential thresholds.

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| Absolute transient | Absolute transient activation | No | Yes / No |
| Absolute threshold | Threshold absolute transient setting | 110 % | 100 ... 500 % |
| Difference transient | Difference transient activation | No | Yes / No |
| Difference threshold | Threshold difference transient setting | 20 % | 1 ... 100 % |
| Increase time | Time delay before next transient recording after transient start | 5 s | 1 ... 20 s |
| Increase value | Increment value for transient insensitivity after recording start | 10 V | 1 ... 750000 V |
| Post samples | Number of recorded samples after the transient start | 768 | 0 ... 8000 |
| Pre samples | Number of recorded samples before the transient start | 768 | 0 ... 8000 |

Memory space for capturing of the particular transients is fixed on the maximum of 8000 samples. Definition of number Pre and Post samples is limited by this maximum samples memory space.

## 9.8. Events




Events captured by PLA44 are fully adjustable by the parameters described in the table beneath.

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| Reference | Reference voltage level type | Udin | Udin / Sliding |
| Over-voltage ▶ | Threshold | 110 % | 100 ... 500 % |
| | Hysteresis | 5 % | 1 ... 20 % |
| Under-voltage ▶ | Threshold | 90 % | 1 ... 100 % |
| | Hysteresis | 5 % | 1 ... 20 % |
| Interruption ▶ | Threshold | 5 % | 1 ... 100 % |
| | Hysteresis | 2 % | 1 ... 20 % |
| Over-current ▶ | Threshold | 110 % | 100 ... 500 % |
| | Hysteresis | 5 % | 1 ... 20 % |
| Pre Samples | Number of recorded half periods Urms1/2 (10 ms = 1) before event | 10 | 0 ... 4000 |
| Post Samples | Number of recorded half periods Urms1/2 (10 ms = 1) after event | 150 | 0 ... 4000 |

Memory for capturing the samples of RMS curve is fixed on the maximum of 4000 samples. Definition of number Pre and Post samples is limited by this maximum samples memory space.

### 9.8.1. Voltage dip detection

The dip threshold is a percentage of either Udin or the sliding voltage reference. The user shall declare the reference voltage in use.

- On single-phase systems a voltage dip begins when the Urms voltage falls below the dip threshold, and ends when the Urms voltage is equal to or above the dip threshold plus the hysteresis voltage.
- On poly-phase systems a dip begins when the Urms voltage of one or more channels is below the dip threshold and ends when the Urms voltage on all measured channels is equal to or above the dip threshold plus the hysteresis voltage.

The dip threshold and the hysteresis voltage are both set by the user according to the use.

### 9.8.2. Voltage swell detection

The swell threshold is a percentage of either Udin or the sliding reference voltage. The user shall declare the reference voltage in use.

- On single-phase systems a swell begins when the Urms voltage rises above the swell threshold, and ends when the Urms voltage is equal to or below the swell threshold minus the hysteresis voltage.
- On poly-phase systems a swell begins when the Urms voltage of one or more channels is above the swell threshold and ends when the Urms voltage on all measured channels is equal to or below the swell threshold minus the hysteresis voltage.

The swell threshold and the hysteresis voltage are both set by the user according to the use.

### 9.8.3. RVC

A Rapid Voltage Change (RVC) is an event characterized by a quick transition from one steady-state voltage to another. Typically, RVC events are counted for a period of one hour, or for each day. Mains signalling voltage, called "ripple control signal" in certain applications, is a burst of signals, often applied at a non-harmonic frequency, that remotely control industrial equipment, revenue meters, and other devices.

If the change in voltage is sufficient to cross the dip threshold or the swell threshold, then the event shall not be recorded as an RVC event. It is a dip or a swell.

The RVC threshold (or thresholds) and the RVC hysteresis are both set by the user according to the use. The RVC threshold is a percentage of Udin. The RVC hysteresis is a smaller percentage of Udin.

**Notice**

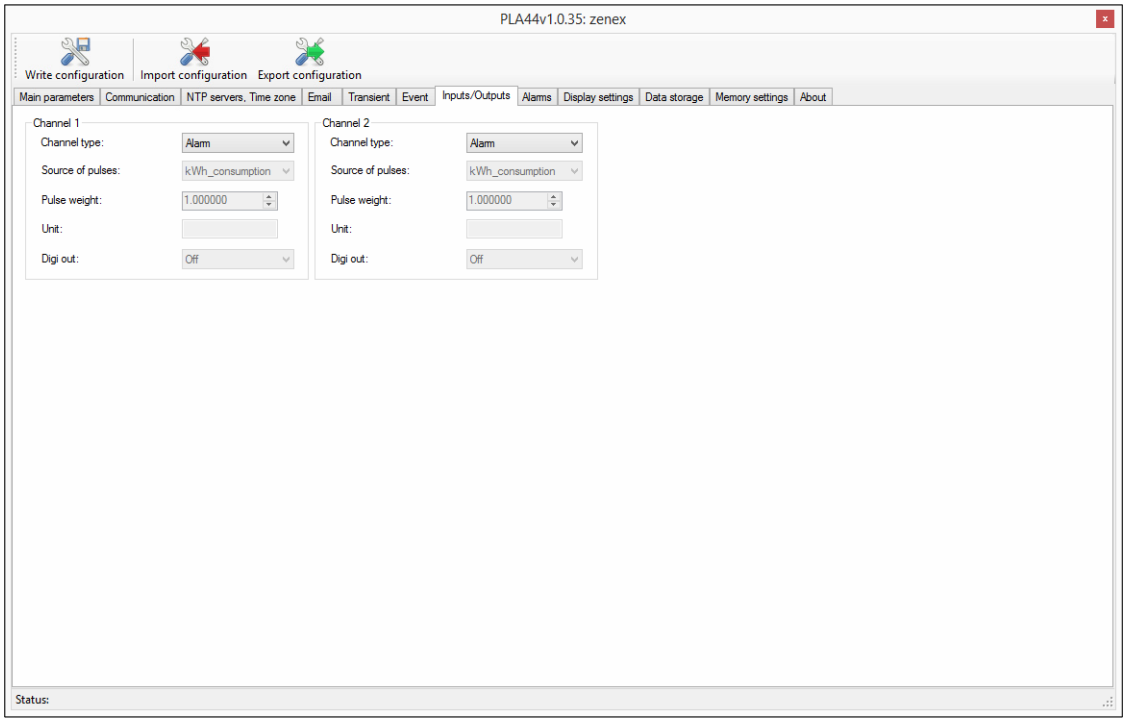
*Although RVC and Flicker both may cause changes in illumination levels that irritate people, the two are different in concept. RVC is a discrete event, while flicker is a quasi-stationary condition.*

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| RVC threshold | The RVC threshold is a percentage of Udin | 3.3 % | 1 ... 100 % |
| RVC hysteresis | The RVC hysteresis is a smaller percentage of Udin | 1 % | 1 ... 20 % |

According to the norm the ideal settings is RVC threshold on 3.5% of Udin and hysteresis on 1% of Udin.

## 9.9. Inputs/Outputs

Analyser PLA44 has two user configurable inputs/outputs. Connection of the inputs and outputs is displayed in the chapter 8.9.

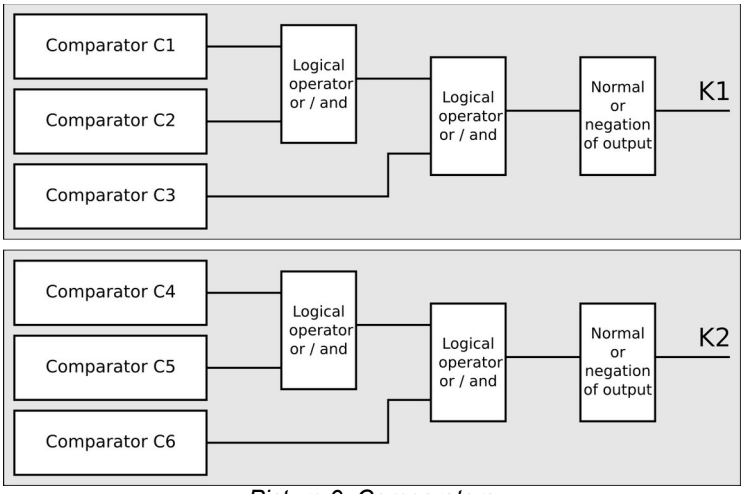


| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| Channel type | Defines the usage of the input and output interface | Digi_in | Digi_in / Digi_out / Pulse_in / Pulse_out / Alarm |
| Source of pulses | Setting available only for **Pulse_out** channel type | | |
| Pulse weight | Setting available only for **Pulse_out** and **Pulse_in** channel type | 0 | |
| Unit | Setting available only for **Pulse_in** channel type. Defines the unit of pulses | | |
| Digi out | Available only for **Digi_out** channel type. Defines fundamental state of output. | Off | |

## 9.10. Alarms

Instrument is equipped by two input / output terminals which can be programmed to the four different states. Terminal one or two can be set to work as an alarm output.

Each output, while it is set to behave as an alarm, consists from three comparators. Comparators are sorted into logical function according to following diagram.

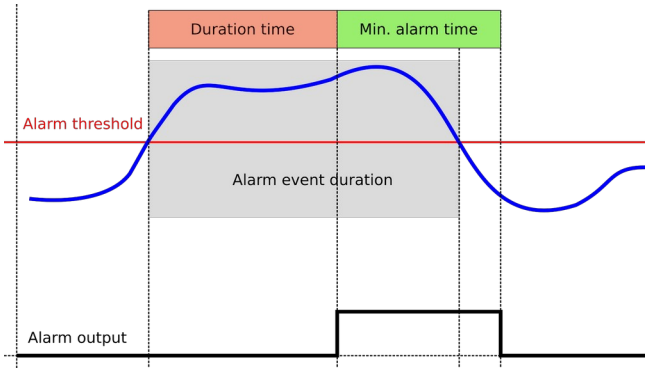



*Picture 9. Comparators*

Comparators C1, C2 and C3 belong to the output K1 and comparators C4, C5 and C6 to output K2.

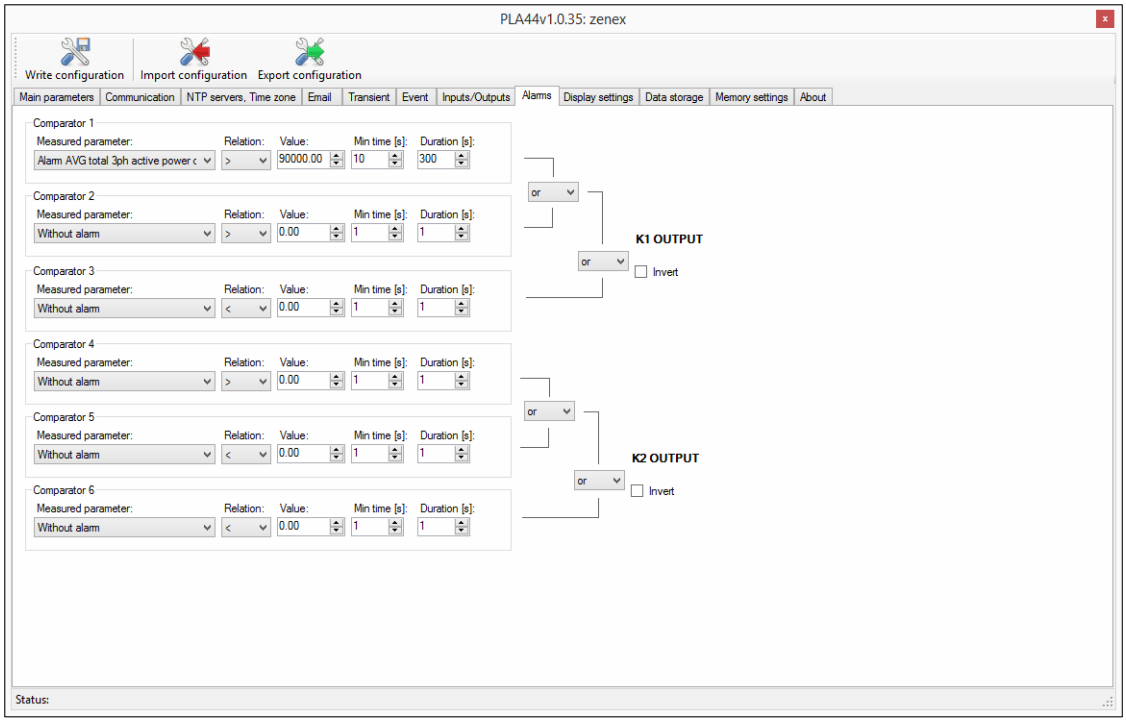
From the picture is visible that there are logical function between first two comparators of the group and between their result and last comparator of the group. There are two logical operators available, logical conjunction – AND and logical disjunction – OR.

Each comparator has several available settings.




- Measured parameter – controlled parameter for an alarm
- Value – alarm threshold value of controlled parameter
- Relation – comparator type (<, >)
- Duration – duration time of an alarm event before the output reaction

- Min. time – minimum output reaction time



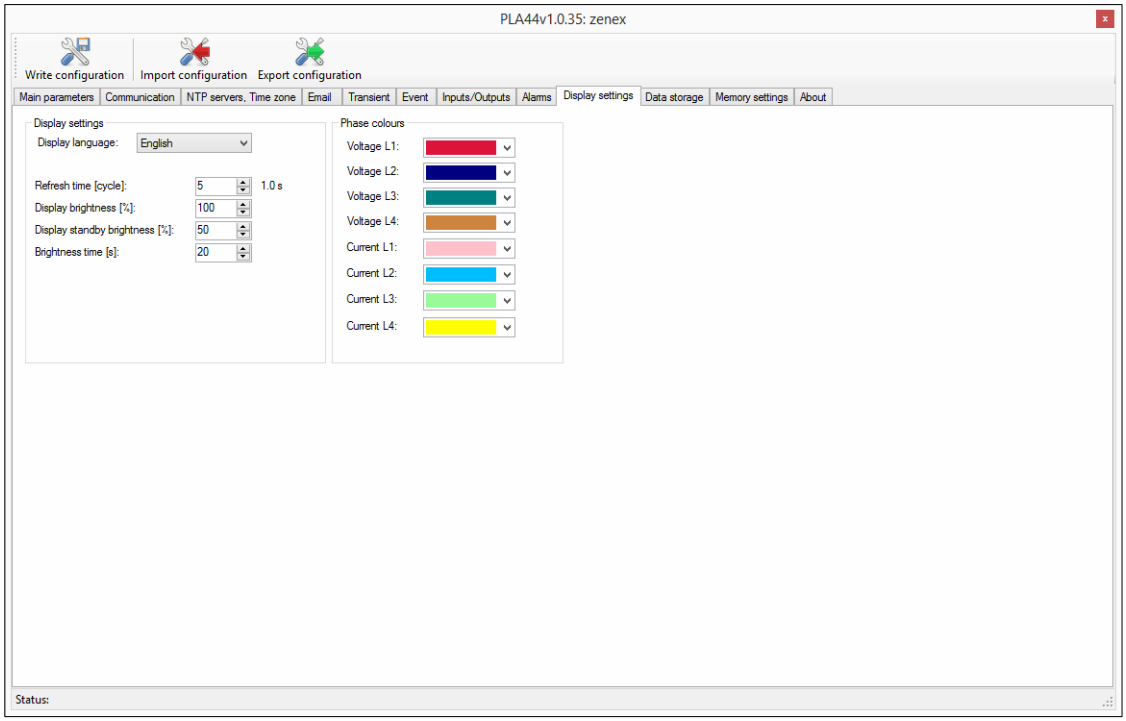

## Important

*For correct work of an alarm it is necessary set the instrument outputs to behave as an alarm outputs. See the chapter 9.9. Proper connection of outputs is described in chapter 8.9.*

## 9.11. Analyser - Display settings

Settings related to the device itself such as display parameters, colours, time, password protection and reset of all settings.

| Parameter | Description | Factory settings | Settings range |
|---|---|---|---|
| Display refresh | Speed of display refreshing. The optimal setting is 5 cycles. | | |
| Brightness | Brightness of display for operation while buttons are touched | | |
| Standby brightness | Defines level of brightness when device is not pressed at any button | | |
| Standby time | Time delay after that device turns to standby level of display brightness. | | |
| Password | Four digit password for access to device settings menu | | |
| Date and time | Device internal clock configuration sub-menu | ► | |
| Colors | Colors template of particular voltages and currents of phases for graphs | | |
| Reset | Reset device to the factory settings | | |



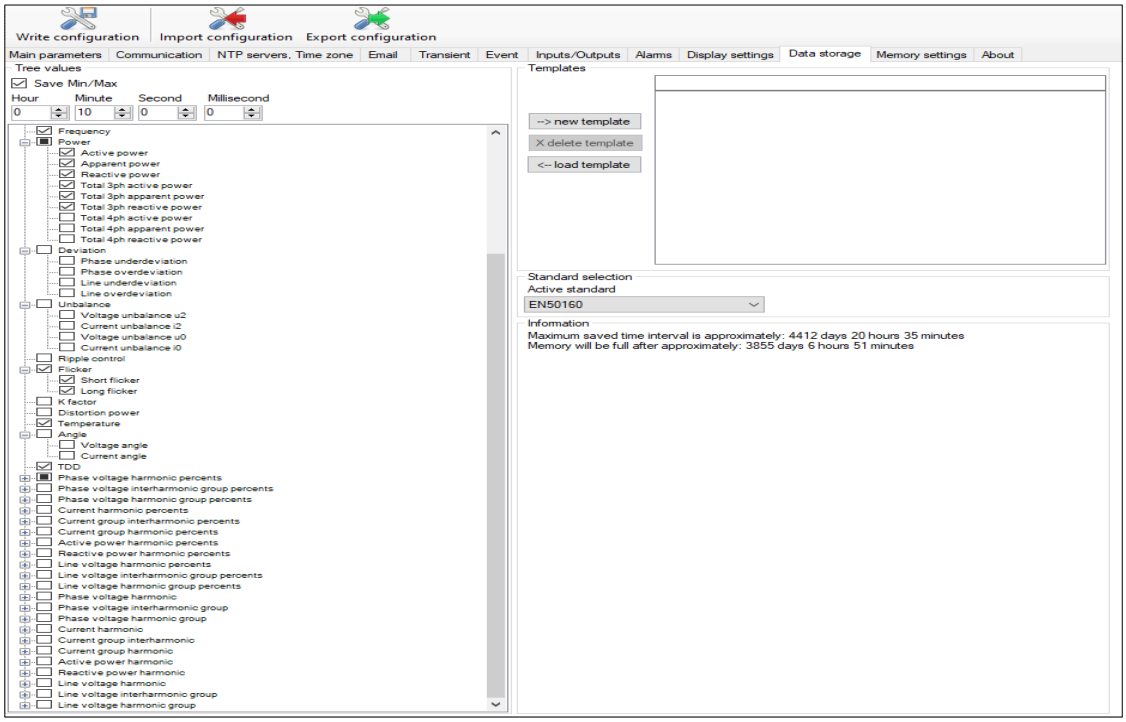

| Parameter | Description | Factory setting | Setting range |
|---|---|---|---|
| Display language | Language used for an email notifications. | English | English, Czech, Chinese |
| Refresh time [cycle] | Refresh time of the displayed values. | 5 | 1 ... 50 |
| Backlight [%] | Backlight intensity of instrument LCD display. | 50 | 0 ... 100 |

Without any action on keyboard of an instrument the device backlight will turn off in 120 seconds.

It is possible to set permanent ON of the display backlight. This case the backlight will light on 50%. Permanent OFF keeps the backlight with 5%.

## 9.12. Data storage

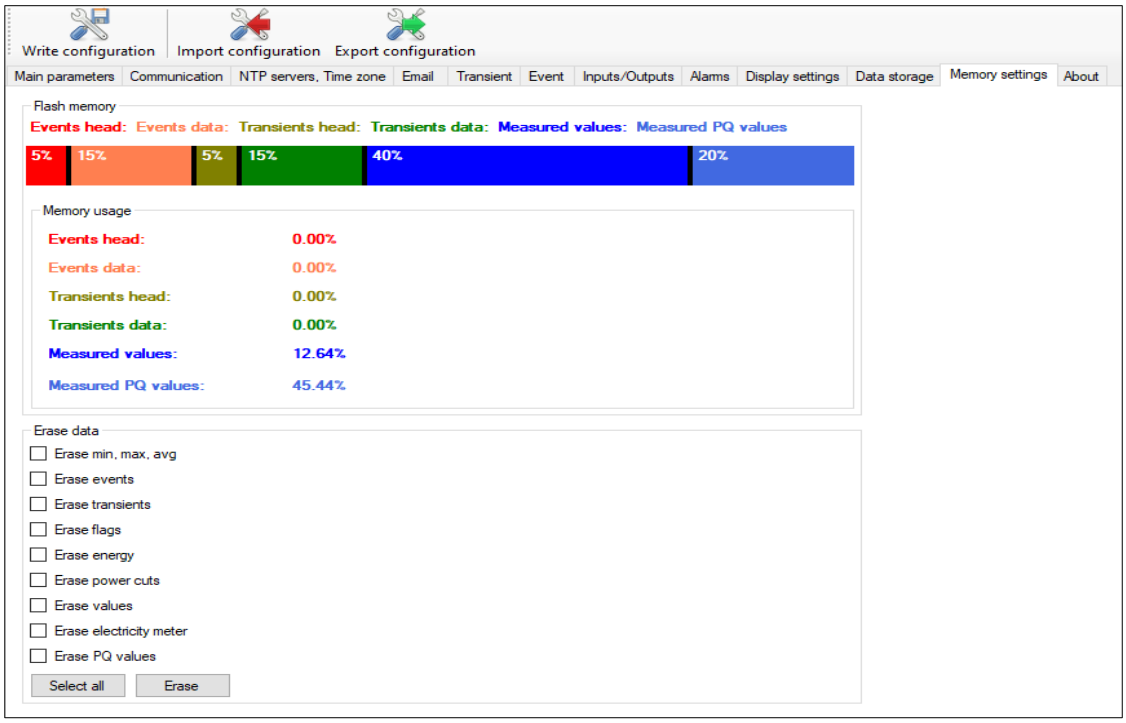
Measured parameters can be recorded in the internal flash memory. For this purposes cart Data storage offers the list of all parameters that can be stored. PLA44 allows to define 5 different time intervals with adjustable time and recorded parameters.




List of recorded parameters of all intervals can be saved as a template for further usage. There is also predefined template according the power quality norm EN 50160.

## 9.13. Memory settings

Memory of the PLA44 is possible be managed to obtain more space for preferred recordings. Simple move of particular memory are borders modify the size of available space.



### 9.13.1. Memory usage

Each parameter for each recording interval takes 16 B + 18 B at the memory where the 16 B is the information about the time of the recording and 18 B is for recorded parameter.

$$Memory\,usage = \frac{T}{RI} * (16 + N\,x\,18)$$

Where:

T – total recording time interval in seconds

RI – recording interval in seconds

N – number of recorded parameters for defined recording interval

For example if all phase voltage harmonics will be recorded with an recording interval 200ms then for 24 hours of recording there will written about 481 MB in the flash memory of the instrument.

## 9.14. About

Information about the vendor and device firmware version.

# 10. Operation

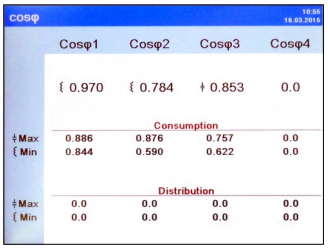
PLA44 allows comfort operation by easy graphic Main menu which is divided to groups of related features and functions. For the navigation in menu us the cursor buttons ▲ and ▼. To enter the selected menu or parameter press button **SET**. Returning back to previous menu or parameter level press button **ESC**.

## 10.1. Numeric

Menu Numeric contains measured parameters in numeric form. Parameters are grouped to separate screens according logical order.

Summary

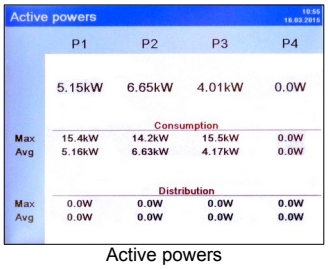
Short flicker




cosφ

Phase voltage

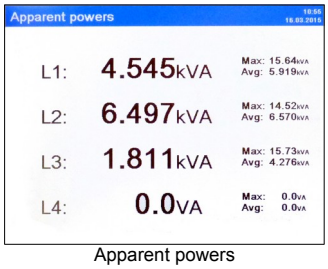
Long flicker




Active powers

Line voltage - frequency

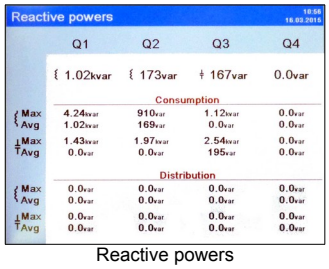
Current



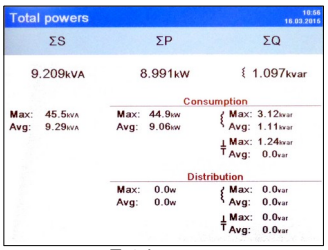

Apparent powers

THDU

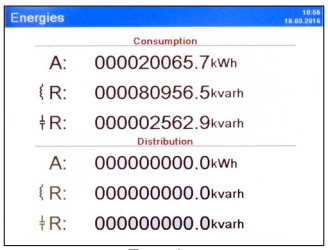
THDI



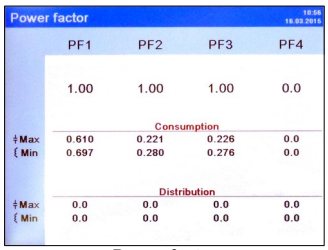

Reactive powers




Total powers




Energies




Power factor

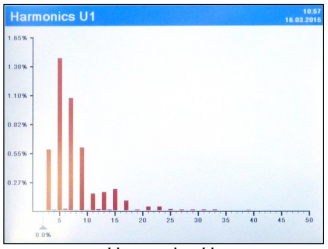
Temperature

### 10.1.1. Flicker

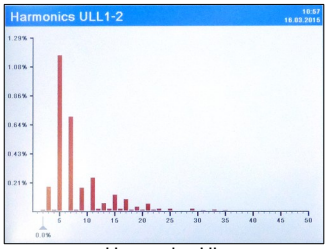
Device calculates flicker according to the norm EN61000-4-15. It provides values for short-term flicker (10 minutes), long-term flicker (2 hours).

## 10.2. Harmonics

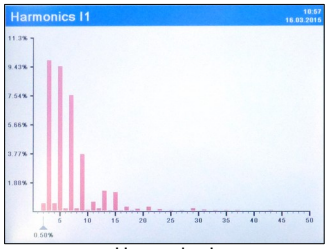
High harmonics frequencies of measured voltage and current are shown in the form of bar graph for harmonics till 50$^{th}$ order.




Harmonics U




Harmonics UL

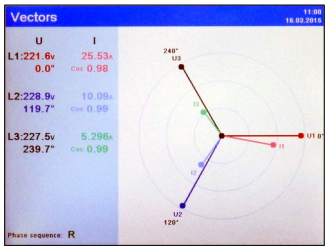



Harmonics I

By pressing the button **SET** the cursor with value of particular harmonic is activated. Via cursor buttons the cursor pointer can be moved to display another harmonic details.

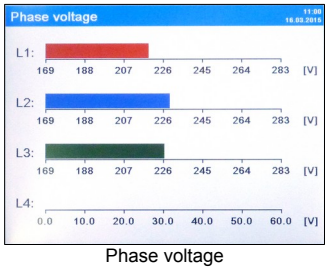
## 10.3. Vectors

This screen shows the voltage and current vectors of all phases including the instantaneous values of voltage and current and phase angles of voltage and current vectors.

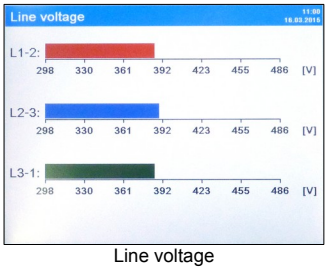



## 10.4. Bar-graphs

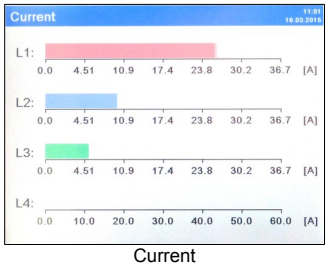
Voltage, current and power values can be shown in bar-graph form as well. Bar graphs have synchronized automatic scale which is adjusted according to min and max displayed values to provide fast and clear comparison of measured values in all phases.



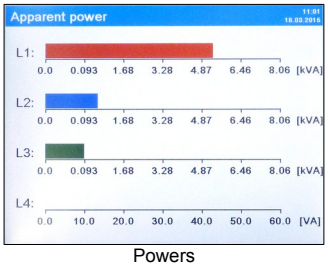

Phase voltage




Line voltage



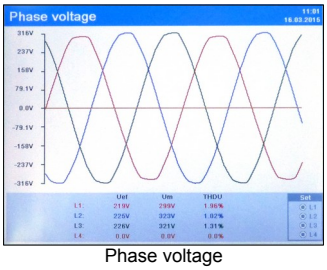

Current



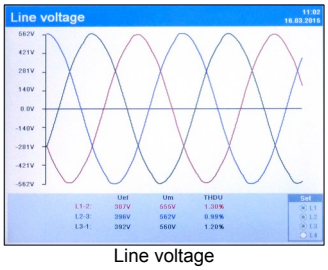

Powers

## 10.5. Scope

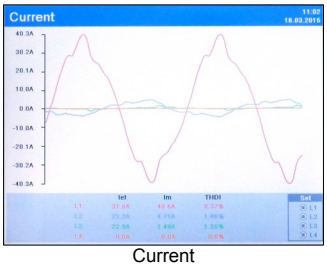
PLA44 shows scope of measured signal for voltage and current in all four phases. It is possible to select displayed phase or phases by pressing the button **SET** and selecting the appropriate phase or phases. Escaping back from the phase selection is by pressing the button **ESC**.



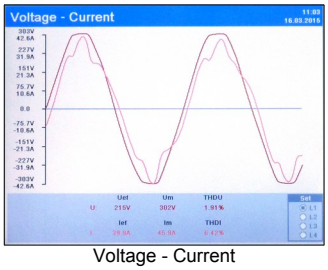
Phase voltage



Line voltage



Current



Voltage - Current

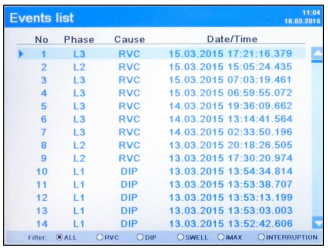
In order to show or hide curve of the phase or phases on graph press button **SET** and select the phase or phases by cursor buttons.

## 10.6. Events

PLA44 captures and records voltage and current events as well as voltage transients. Detail information and signal waveform are displayed on the device screen and also web-server (if enabled).

### 10.6.1. List of events

Last 50 events of each type are captured in the non-volatile memory with information about the start and end of the event and graph of the event. On the device screen the event graph can be displayed with all detail information.

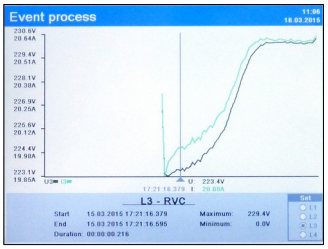



There are following type of events recorded in the PLA44 memory.

| Type of event | Description |
|---|---|
| Interruption | Voltage interruption |
| DIP | Under voltage |
| SWELL | Over voltage |
| RVC | Rapid voltage changes |
| IMAX | Over current |

On the screen of Events list it is possible filter events according to their type. Press button **Fn** (**Zoom**) to apply appropriate filter on list of events.

By cursor buttons ▲ and ▼ move to event of your interest and pressing the button **SET** will display the event details.




Moving the graph left or right use the buttons ▲ and ▼. In order to select the phase or phases to be shown on graph press button **SET** and select the desired phase.

### 10.6.2. Rapid Voltage Change (RVC)

A Rapid Voltage Change (RVC) is an event characterized by a quick transition from one steady-state voltage to another.

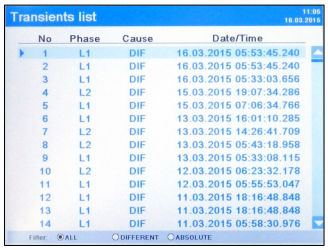
Typically, RVC events are counted for a period of one hour, or for each day.

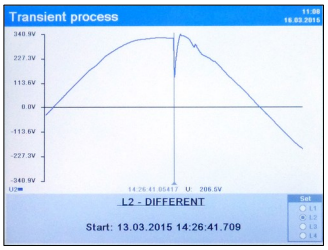
If the change in voltage is sufficient to cross the dip threshold or the swell threshold, then the event shall not be recorded as an RVC event. It is a dip or a swell.

### 10.6.3. List of transients

PLA44 captures transients of voltage as short as 25 µs and keeps last 50 transients of each type in the non-volatile memory.

| Type of event | Description |
|---|---|
| Different | Transients started by differential threshold defined by zone |
| Absolute | Transients started by threshold absolute value defined by set value of voltage |




Waveform of transient event is possible be zoomed to the detail view by pressing the button **Fn** (**Zoom**). The detailed zoom view can be moved forward and back by cursor buttons ▲ and ▼.

### 10.6.4. Power cuts

Power cuts of an instrument supply voltage are recorded into the memory. Each recording is stored with date and time of power cut start and end.

Last 15 supply voltage power cuts are captured in the non-volatile memory and displayed on the list.

## 11. Web interface

PLA44 has build in web server to show measured parameters in the internet browsers. For enabling the web server see the chapter 9.3.2. Web server is designed web browsers compatible with HTML5 specification.

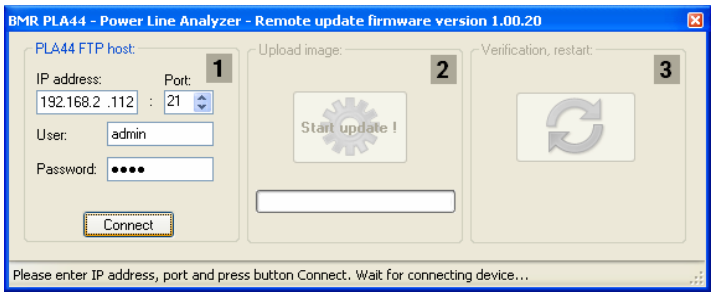
Web server of an instrument is available after setting the instrument IP address to the web browser. Access to the web page is protected by user name and password.

**Notice**

*Factory setting of user name is **admin**. Password factory setting is **1234**.*

# 12. Firmware update

Device firmware can be updated when the new firmware is released. Visit the www.bmr-trading.com for to verify availability of new firmware. Firmware file is prepared as an exe file that is directly run on Windows PC.




For the successful firmware update connect the PLA44 via Ethernet to PC where the Update software will run. Enter the IP address of the PLA44 and user name and password. Pressing button Connect will verify accessibility of PLA44 and prepare connection for firmware update start.

**Important**

*While firmware update, device should be on the stable power supply and Ethernet connection should not be removed or interrupted.*

# 13. Technical features

| Parameter | Value |
|---|---|
| Supply voltage for variants PLA44 U230<br>PLA44 U60 | 85 ... 250 VAC/DC (±10%)<br>24 ... 60 V AC/DC (±10%) |
| System frequency | 50 Hz or 60 Hz |
| Power consumption | < 8 VA |
| Voltage measuring range L - N | 2 ... 600 $V_{AC}$ |
| Voltage measuring range L - L | 4 ... 1000 $V_{AC}$ |
| Current measuring range | 0.001 ... 6 A (8.5 A) |
| Frequency measuring range | 40 ... 70 Hz |
| Clock accuracy | < 1 s per day |
| Number of output / input | 2 |
| Output type | NPN transistor free potential optical insulated |
| Maximum voltage for output usage | 24 $V_{DC}$ |
| Maximum output load capability | 100 mA |
| Pulse length of pulse output | 70 ms (10 ms minimum pause) |
| Input type | optical insulated free potential |
| Maximum input voltage | 24 $V_{DC}$ |
| Maximum input consumption | 10 mA |
| Voltage transformer ratio | 1 ... 750 000 |
| Current transformer ratio | 1 ... 750 000 |
| Supply voltage power cuts memory | 15 events |
| Sampling rate | 40 kHz |
| Events trigger | 10 ms |
| Data memory for measured parameters | 1 GB |
| Display type and size | VGA TFT 5.6” |
| Temperature input | NTC sensor 10 kΩ / 25°C |
| RS485 port | RS485 (optional) / Modbus RTU / 9.6; 19.2; 38.4 ... 115 kBd |
| Ethernet | RJ45 / 10 / 100 Mbit |
| USB | Type B |
| Over-voltage class | 600 V CATIII |
| Pollution degree | 2 |
| Working ambient temperature limit | -25°C ... +70°C |
| Front panel | 144 x 144 mm |
| Panel cut-out | 136.5 x 136.5 mm |
| Site depth | 75 mm |
| Weight | 1350 g |
| Protection degree | IP20 rear cover / IP54 front panel |
| Related standards | IEC 61000-4-30 class A, IEC 61000-4-7, IEC 61000-4-15, IEC61557-12 |