GOSSEN METRAWATT

MAVOLOG | PRO

Power Quality Analyzer

3-349-761-03
2/8.18

Contents Page

1 Features

- Evaluation of the electricity supply quality in compliance with EN 50160 with automatic report generation
- Measurements of instantaneous values of more than 140 quantities including harmonics, flicker, power line signalling voltage, unbalance…
- Class A (0.1%) accuracy in compliance with EN61000-4-30
- Auto range of 4 current and 4 voltage channels (max. 12.5 A and 1000 V_{RMS}) with 31 kHz sampling rate
- Recording up to 128 measurands, 32 adjustable alarms, anomalies and quality reports in the internal memory
- Measurements of 40 minimal and maximal values in different time intervals (from 1 to 256 periodes)
- Frequency range from 16 Hz to 400 Hz
- Up to three independent communication ports (RS 232/485 up to 115,200 bit/s, Ethernet and USB 2.0)
- MODBUS and DNP3-communication protocols
- Support for GPS, IRIG-B (modulated and digital) and NTP real time synchronisation
- Up to 20 inputs and outputs (analogue inputs/outputs, digital inputs/outputs, alarm/watchdog outputs, pulse input/outputs, tariff inputs)
- Multilingual support
- Harmonic analysis up to the 50th harmonic
- 144 mm square panel mounting
- User-friendly setting and evaluation software, **MAVO-View**

2 Description

MAVOLOG | PRO is an important device for permanent monitoring of power quality from its production, transmission, distribution to final consumers, who are most affected by insufficient quality of voltage. Lack of information about supplied quality of voltage can lead to unexplained production problems and malfunction or even damage to equipment used in production process. Therefore, **MAVOLOG | PRO** can be used for utility purposes (evaluation against standards) as well as for industry purposes (monitoring supplied power quality).

MAVOLOG | PRO performs measurements in compliance with regulatory requested standard EN 61000-4-30 and evaluates recorded parameters for analysis according to parameters defined in European supply quality standard EN 50160:2011. Moreover **MAVOLOG | PRO** stores measurements and quality reports in internal memory for further analysis over recorded measurements from multiple instruments installed on different locations to gain the overall picture of systems' behaviour. This can be achieved with regard to **MAVOLOG | PRO** accurate internal real time clock and wide range of synchronization sources support, which assure accurate, time-stamped measurements from dislocated units.

All required measurements, weekly PQ reports and alarms can also be stored locally in an internal memory. Stored data can then be transferred to a memory card or accessed through communication for post analysis.

MAVOLOG | PRO features four recorders A, B, C, D which are independent of each other, alarms and 10 ms recorder für PQ events.

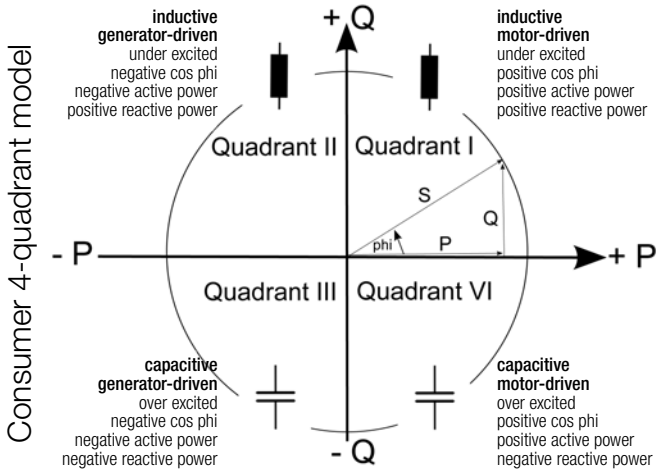
3 Application and Benefits

The **MAVOLOG | PRO** power quality analyzer can be operated either as a standalone monitoring device or within a network. It is designed for the monitoring of power quality parameters.
For this purpose it is normally positioned at the point-of-common-coupling (PCC) of small and medium industrial and commercial energy consumers to monitor quality of delivered electric energy or at medium or low voltage feeders to monitor, detect and record possible disturbances caused by operation of consumers.

Identifying relevant fixed measuring points is the most important task prior to complete system installation. This system itself will not prevent disturbances in network but it will help diagnose their origin and effects. And this is possible only with system approach by using time synchronized meters and predefined measuring parameters relevant for each individual measuring point.

Therefore the most extensive benefits are achieved when **MAVOLOG | PRO** is used as a part of an energy monitoring system comprising of strategically positioned meters connected to **MAVODatabase** software solution. **MAVODatabase** data collector with "push" communication system allows automatic records of all predefined measuring parameters. They are stored in **MAVODatabase** database, while leaving a copy of same parameters stored locally in memory of each device as a backup copy. Database records in XML format can be searched and viewed in tabular and graphical form using **MAVODatabase** client or used by third-party application software. Database records can involve numerous parameters of three-phase system, power quality parameters, physical paramaters (temp., pressure, wind speed…) as well as alarms and event logs.

Determination of energy flow direction in accordance with the 4-quadrant model Energy import ↔ energy export



4 Compliance with Standards

Measurements and reports of power (voltage) quality (PQ) indexes are only useful when can be compared with measurements and reports from other PQ measuring devices in the supply network and evaluated against agreed limits for assessment of measured PQ indexes to establish an overall view about PQ issues in the network.

For this purpose it is essential to follow guidelines described in series of international and local standards. Beside requirements for safe operation (LVD directive) and immunity against more and more demanding disturbances (EMC directive), PQ measuring depends on two levels of standardization:

Procedures for proper acquirement of PQ indexes, their timed aggregation and required accuracy are described in a standard IEC EN 61000-4-30 and two supplementary standards IEC EN 61000-4-7 (harmonics), IEC EN 61000-4-15 (flickermeter).

Procedures for evaluation of measured PQ indexes according to limit levels described in European standard EN 50160.

MAVOLOG | PRO Power Quality Analyzer follows required procedures and meets the precision requirements for class A measuring device as described in standard IEC EN 61000-4-30. It uses acquired measurements to perform automatic evaluation of PQ according to EN 50160 and issues weekly reports. In case if certain PQ indexes fail to meet required quality it also shows details of problematic measurements and time of occurrence of discrepancy.

Standard EN	Description
61010-1: 2010	Safety requirements for electrical equipment for measurement, control and laboratory use
61557-12:2008	Electrical safety in LV distribution systems up to 1kV a.c. and 1.5kV d.c. – Combined performance measuring and monitoring devices for electrical parametrs
61000-4-30:2011	Electromagnetic compatibility (EMC) – Power quality measurements methods
61000-4-7:2003 + A1:2009	Electromagnetic compatibility (EMC) – General guide on harmonics and interharmonics measurements
61000-4-15:2011	Electromagnetic compatibility (EMC) – Flickermeter
50160:2011	Voltage characteristics of electricity supplied by public distribution networks
62053-22:2003	Electricity metering equipment - Static meters for active energy (classes 0,2 S and 0,5 S)
62053-23:2003	Electricity metering equipment - Static meters for reactive energy (classes 2 and 3)
61326-1:2006	EMC requirements for electrical equipment for measurement, control and laboratory use
60529:1997/A1:2000	Degrees of protection provided by enclosures (IP code)
60068-2-1/ -2/ -6/ -27/-30	Environmental testing (-1 Cold, -2 Dry heat, -30 Damp heat, -6 Vibration, -27 Shock)
UL 94	Tests for flammability of plastic materials for parts in devices and appliances

Table 1 List of applicable standards

5 Voltage Quality

Voltage Quality is well defined term (sometimes also termed Power Quality – PQ) and is covered with a selection of parameters, each of which represents certain phenomenon. They represent only most common types of phenomena which can describe operation of electrical network with closest approximation.

MAVOLOG | PRO Power Quality Analyzer measures, detects, stores and evaluates parameters, which are defined in several standards. Evaluation is by default performed according to limits set in European standard EN50150. Beside that users can always alter parameters according to their requirements or according to immunity of their equipment which operates within analyzed power network.

5.1 PQ recording settings

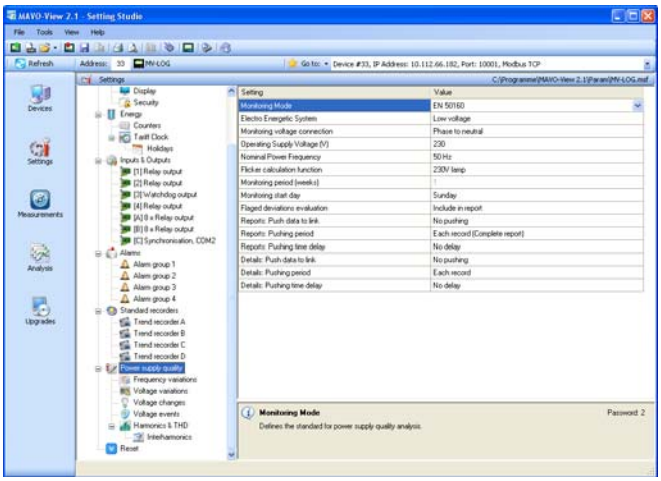


Figure 1 Settings for power quality parameters are set with setting and monitoring software **MAVO-View**

Characteristic parameters that describe power quality are shown in table 1:

Phenomena	PQ Parameters
Frequency variations	Frequency distortion
Voltage variations	Voltage fluctuation Voltage unbalance
Voltage changes	Rapid voltage changes Flicker
Voltage events	Voltage dips Voltage interruptions Voltage swells
Harmonics & THD	Harmonics Interharmonics Signaling voltage

Table 2 Voltage quality parameters as defined in EN50160

5.2 PQ reports

PQ report is issued on a basis of chosen PQ parameters as well as information about a period of tracking and place of tracking (type of network).

Each record is internally stored for later analysis. Settings software allows user to quickly view PQ report with limit lines and compliance results.

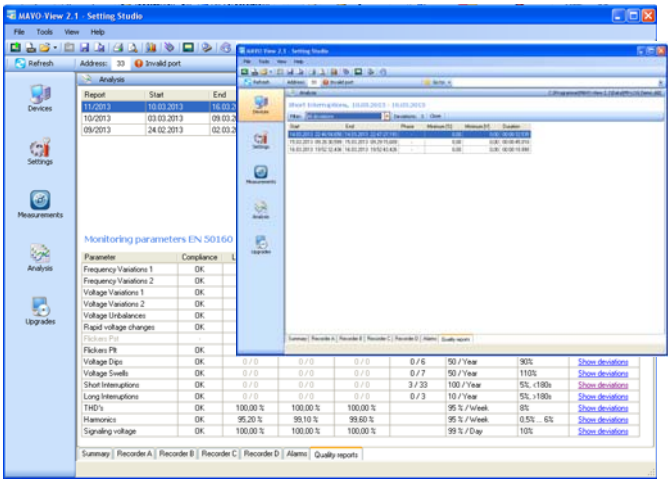


Figure 2 Viewing power quality report parameters and log details with setting software **MAVO-View**

To analyze in details which and when certain parameters are outside limit lines it is possible to view time stamped details and with that establish true origin of anomaly and its consequences.

6 Measurements

6.1 Online measurements

Online measurements are available on display or can be monitored with setting and monitoring software **MAVO-View**. Readings on display are performed continuously with refresh time dependent on set average interval whereas rate of readings monitored with **MAVO-View** is fixed and refreshed approx. each second.

For better overview over numerous readings, they are divided into several groups, which contain basic measurements, min. and max. values, harmonics, PQ parameters and alarms. Each group can represent data in visually favored graphical form or detailed tabular form. Latter allows freezing readings and/or copying data into various report generation software tools.

6.2 Interactive instrument

Additional communication feature of a device allows interactive handling with a dislocated device as if it would be operational in front of user.

This feature is useful for presentations or product training.

6.3 Selection of available quantities

Available online measuring quantities and their apperance can vary according to set type of power network and other settings such as; average interval, max. demand mode, reactive power calculation method. Complete selection of available online measuring quantities is shown in a table on the next page.

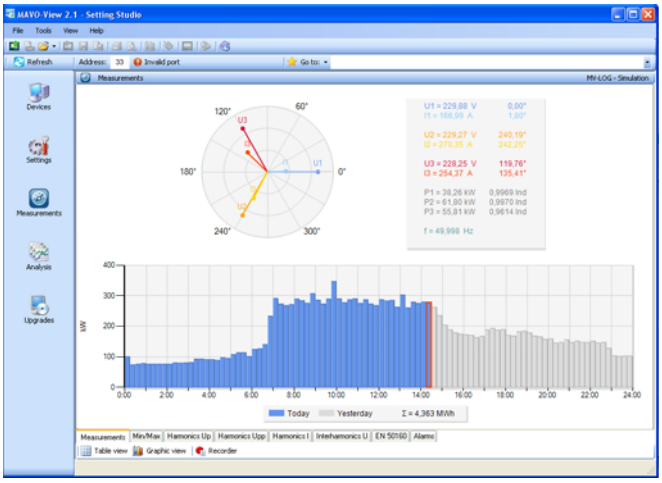


Figure 3 Online measurements in graphical form – phaser diagram and daily total active power consumption histogram

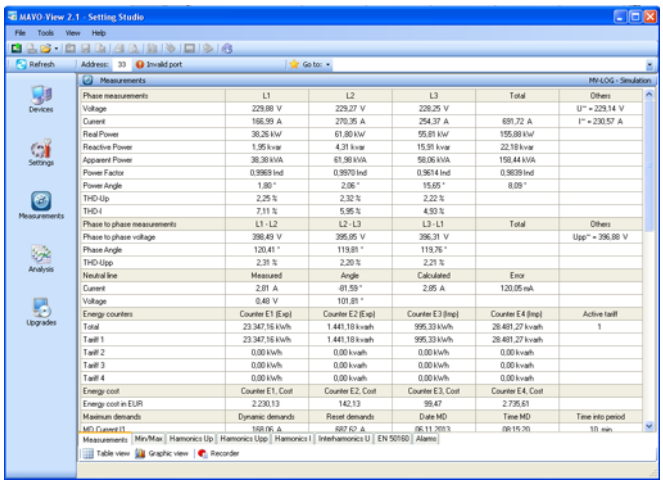


Figure 4 Online measurements in tabular form

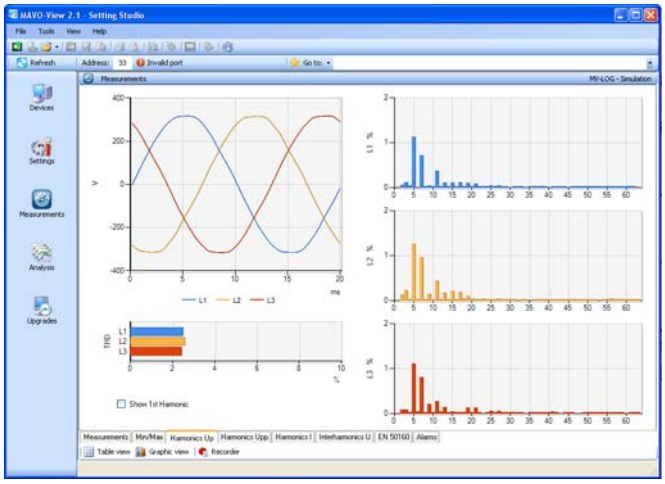


Figure 5 Online harmonic measurements in graphical form

Meas. type	Measurement	3-phase 4-wire	3-phase 3-wire	1-phase	Comments
Phase measurements	**Voltage**				
	$U_{1\text{-}3\_RMS}$	✓	✓	✓ 1ph	
	U_{AVG_RMS}	✓	✓	✓	
	$U_{unbalance\_neg\_RMS}$	✓	✓		
	$U_{unbalance\_zero\_RMS}$	✓			
	Current				
	$I_{1\text{-}3\_RMS}$	✓	✓	✓ 1ph	
	I_{TOT_RMS}	✓	✓	✓	
	I_{AVG_RMS}	✓	✓	✓	
	Power				
	$P_{1\text{-}3\_RMS}$	✓	✓	✓ 1ph	
	P_{TOT_RMS}	✓	✓	✓	
	$Q_{1\text{-}3\_RMS}$	✓	✓	✓ 1ph	reactive power can be calculated as a squared difference between S and P or as sample delayed
	Q_{TOT_RMS}	✓	✓	✓	
	$S_{1\text{-}3\_RMS}$	✓	✓	✓ 1ph	
	S_{TOT_RMS}	✓	✓	✓	
	$PF_{1\text{-}3\_RMS}$	✓	✓	✓ 1ph	
	$\varphi_{1\text{-}3\_RMS}$	✓	✓	✓ 1ph	
	Harmonic analysis				
	THD-$U_{1\text{-}3}$	✓	✓	✓ 1ph	
	THD-$I_{1\text{-}3}$	✓	✓	✓ 1ph	
	$U_{1\text{-}3\_harmonic\_1\text{-}63\_\%}$	✓	✓	✓ 1ph	% of RMS or % of base
	$U_{1\text{-}3\_harmonic\_1\text{-}63\_ABS}$	✓	✓	✓ 1ph	
	$U_{1\text{-}3\_harmonic\_1\text{-}63\_\varphi}$	✓	✓	✓ 1ph	
	$U_{1\text{-}3\_inter\text{-}harmonic\_\%}$	✓	✓	✓ 1ph	monitoring up to 10 different fixed frequencies. % of RMS or % of base
	$U_{1\text{-}3\_inter\text{-}harmonic\_ABS}$	✓	✓	✓ 1ph	
	$U_{1\text{-}3\_signaling\_\%}$	✓	✓	✓ 1ph	monitoring of signaling (ripple) voltage of set frequency. % of RMS or % of base
	$U_{1\text{-}3\_signaling\_ABS}$	✓	✓	✓ 1ph	
	$I_{1\text{-}3\_harmonic\_1\text{-}63\_\%}$	✓	✓	✓ 1ph	% of RMS or % of base
	$I_{1\text{-}3\_harmonic\_1\text{-}63\_ABS}$	✓	✓	✓ 1ph	
	$I_{1\text{-}3\_harmonic\_1\text{-}63\_\varphi}$	✓	✓	✓ 1ph	
	Flickers				
	$Pi_{1\text{-}3}$	✓	✓	✓ 1ph	Instantaneous flicker sensation measured with 150 samples / sec (original sampling is 1200 smpl/sec)
	$Pst_{1\text{-}3}$	✓	✓	✓ 1ph	10 min statistical evaluation (128 classes of CPF)
	$Plt_{1\text{-}3}$	✓	✓	✓ 1ph	derived from 12 Pst acc. to EN 61000-4-15
Phase to phase measurements	**Voltage**				
	$Upp_{1\text{-}3\_RMS}$	✓	✓		
	Upp_{AVG_RMS}	✓	✓		
	THD-$Upp_{1\text{-}3}$	✓	✓		
	$Upp_{1\text{-}3\_harmonic\_1\text{-}63\_\%}$	✓	✓	✓ 1ph	% of RMS or % of base
	$Upp_{1\text{-}3\_harmonic\_1\text{-}63\_ABS}$	✓	✓	✓ 1ph	
	$Upp_{1\text{-}3\_harmonic\_1\text{-}63\_\varphi}$	✓	✓	✓ 1ph	
	$U_{underdeviation}$	✓	✓	✓ 1ph	$U_{under.}$ and $U_{over.}$ are calculated for phase or phase-to-phase voltages regarding connection mode.
	$U_{overdeviation}$	✓	✓	✓ 1ph	
Metering	**Energy**	✓	✓	✓	
	Counter $E_{1\text{-}4}$	✓	✓	✓	each counter can be dedicated to any of four quadrants (P-Q, import-export, L-C). Total energy is a sum of one counter for all tariffs. Tariffs can be fixed, date/time dependent or tariff input dependent
	$E\_TOT\_1\text{-}4$	✓	✓	✓	
	Active tariff	✓	✓	✓	
Auxiliary channel measurements	**Aux. line**				
	$U_{NEUTRAL\text{-}EARTH}$	✓	✓	✓	aux. voltage is dedicated for neutral-earth meas. only
	$I_{NEUTRAL\_meas}$	✓	✓	✓	measured neutral current with 4th current input
	$I_{NEUTRAL\_calc}$	✓	✓	✓	calculated neutral current
	$I_{NEUTRAL\_err}$	✓	✓	✓	error neutral current (difference between measured and calculated)

Table 3 Selection of available measurement quantities

Meas. type	Measurement	3-phase 4-wire	3-phase 3-wire	1-phase	Comments
Maximum demand measurements	**Maximum demand**				
	MD_I_{1-3}	✓	✓	✓ 1ph	
	MD_P_{import}	✓	✓	✓	
	MD_P_{export}	✓	✓	✓	
	MD_Q_{ind}	✓	✓	✓	
	MD_Q_{cap}	✓	✓	✓	
	MD_S	✓	✓	✓	
Min and max measurements	**Min and max**				
	$U_{1-3\_RMS\_MIN}$	✓	✓	✓ 1ph	
	$U_{1-3\_RMS\_MAX}$	✓	✓	✓ 1ph	
	$Upp_{1-3\_RMS\_MIN}$	✓	✓	✓	
	$Upp_{1-3\_RMS\_MAX}$	✓	✓	✓	
	$I_{1-3\_RMS\_MIN}$	✓	✓	✓ 1ph	
	$I_{1-3\_RMS\_MAX}$	✓	✓	✓ 1ph	
	$P_{1-3\_RMS\_MIN}$	✓	✓	✓ 1ph	
	$P_{1-3\_RMS\_MAX}$	✓	✓	✓ 1ph	
	$P_{TOT\_RMS\_MIN}$	✓	✓	✓ 1ph	
	$P_{TOT\_RMS\_MAX}$	✓	✓	✓ 1ph	
	$S_{1-3\_RMS\_MIN}$	✓	✓	✓ 1ph	
	$S_{1-3\_RMS\_MAX}$	✓	✓	✓ 1ph	
	$S_{TOT\_RMS\_MIN}$	✓	✓	✓ 1ph	
	$S_{TOT\_RMS\_MAX}$	✓	✓	✓ 1ph	
	$freq_{MIN}$	✓	✓	✓	
	$freq_{MAX}$	✓	✓	✓	
Other measurements	**Miscellaneous**				
	$freq_{MEAN}$	✓	✓	✓	
	Internal temp.	✓	✓	✓	
	Date, Time	✓	✓	✓	
	Last Sync. time	✓	✓	✓	UTC
	GPS Time	✓	✓	✓	If GPS receiver is connected to dedicated RTC time synchronization input
	GPS Longitude	✓	✓	✓	
	GPS Latitude	✓	✓	✓	
	GPS Altitude	✓	✓	✓	

Table 3 Selection of available measurement quantities

7 Recorder

A built-in recorder (8 MB) enables storing measurements, detected alarms and PQ reports with details. It supports recording of up to 128 different quantities in 4 configurable partitions. For each partition is possible to set storage interval and other recording parameters.

Fifth partition is used for recording alarms. Each alarm triggered by preset limit lines is stored in a form of alarm i.d. and its time-stamp.

Sixth partition is used for PQ reports. Each report in recorder is identified by a monitoring interval (date).

Last partition is used for PQ report details. They represent time stamped PQ values that are outside PQ limit lines. Content of recorder can be viewed with monitoring software **MAVO-View** in a detailed tabular or visually favoured graphical form.

7.1 Memory card

MAVOLOG | PRO Power Quality Analyzer & Recorder is equipped with a front panel slot for full sized SD memory card that supports capacity up to 2 GB. It is intended for downloading internally stored data, uploading setting file and performing firmware upgrade.

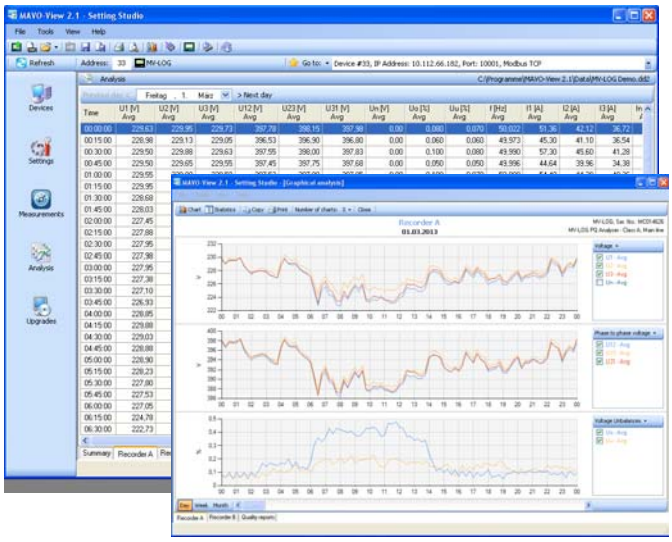


Figure 7 Viewing recorder content in tabular and graphical form

8 Alarms

Alarms are powerfull tool for **MAVOLOG | PRO Power Quality Analyzer** control and supervision features. Devices' performance can with this features reach beyond measuring and analyzing power network.

MAVOLOG | PRO Power Quality Analyzer supports recording and storing of 32 alarms in four groups. A time constant of maximal values in a thermal mode, a delay time and switch-off hysteresis are defined for each group of alarms.

For each parameter is possible to set limit value, condition and alarm activation action (sound signal and/or digital output switch if available).

All alarms are also stored in internal memory for post-analysis.

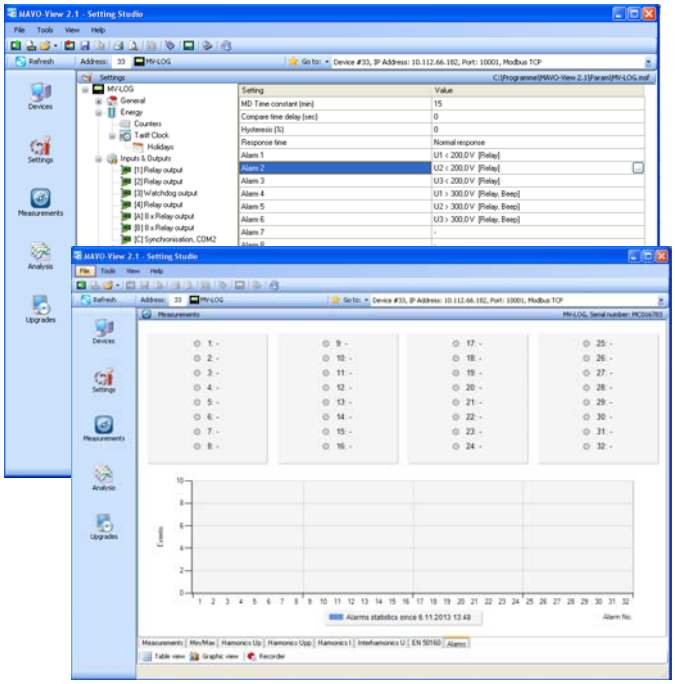


Figure 8 Setting and viewing alarms

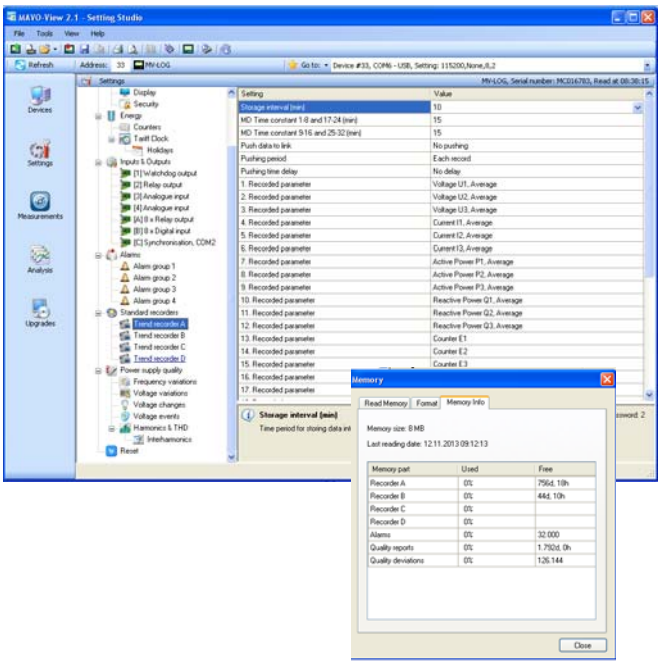


Figure 6 Setting recorder parameters and viewing memory consumption information

9 Real Time Synchronisation

Synchronized real-time clock (RTC) is an essential part of any Class A analyzer for proper chronological determination of various events. Without RTC synchronization **MAVOLOG | PRO** acts as a Class S device.

To distinct cause from consequence, to follow a certain event from its origin to manifestation in other parameters it is very important that each and every event and recorded measurement on one instrument can be compared with events and measurements on other devices. Even if instruments are dislocated, which is normally the case in electro distribution network events have to be time- comparable with accuracy better than a single period.

For this purpose instruments normally support highly accurate internal RTC. Still this is not enough, since temperature is location dependant and it influences its precision. For that reason it is required to implement periodical RTC synchronization.

MAVOLOG | PRO Power Quality Analyzer supports three types of RTC synchronization.

9.1 GPS time synchronization:

1pps and serial RS232 communication with NMEA 0183 sentence support.

GPS interface is designed as 5 pole plugable terminal (+5 V for receiver supply, 1 pps input and standard RS232 communication interface).

Proposed GPS receiver is GARMIN GPS18x

9.2 IRIG time code B (IRIG-B):

Unmodulated (DC 5V level shift) and modulated (1 kHz) serial coded format with support for 1 pps, day of year, current year and straight seconds of day as described in standard IRIG-200-04. Supported serial time code formats are IRIG-B007 and IRIG-B127.

Interface for modulated IRIG-B is designed as BNC-F terminal with 600 Ω input impedance. Interface for unmodulated IRIG-B is designed as pluggable terminal.

9.3 Network time protocol (NTP):

Synchronization via Ethernet requires access to a NTP server.

Note

NTP can usually maintain time to within tens of milliseconds over the public Internet, but the accuracy depends on infrastructure properties - asymmetry in outgoing and incoming communication delay affects systematic bias. It is recommended that dedicated network rather than public network is used for synchronisation purposes.

10 Communication

MAVOLOG | PRO Power Quality Analyzer has a wide variety of communication possibilities to suit specific demands. It is equipped with standard communication port COM1 and auxiliary communication port COM2. This allows two different users to access data from a device simultaneously and by using TCP/IP communication, data can be accessed worldwide.

Different configurations are possible (to be specified with an order).

Configuration	COM1	COM2[2]
1	RS232/485	/
2	RS232/485	RS232/485
3	USB	/
4	USB	RS232/485
5[1]	Ethernet & USB	/
6[1]	Ethernet & USB	RS232/485

[1] Galvanic separation between Eth. and USB is 1 kV AC RMS
[2] COM2 is NOT available if GPS time synchronization is used

Table 4 List of communication configurations

MAVOLOG | PRO Power Quality Analyzer supports standard communication protocols MODBUS RTU, TCP and DNP3 L1.

Additionally it supports proprietary PUSH communication mode, which is used in system applications where devices send predefined readings in predefined time intervals in XML format. Web based software **MAVODatabase** collects data and stores it into database. Stored data can then be viewed with **MAVODatabase** client software.

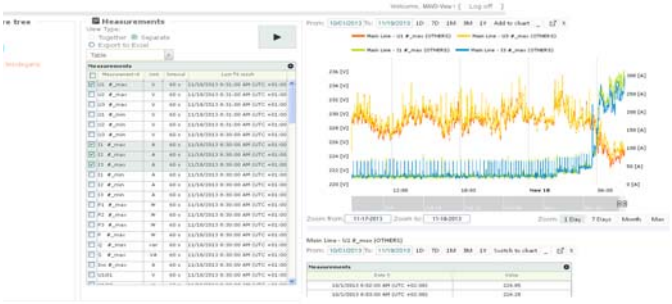


Figure 9 **MAVODatabase** *client window*

11 Technical Data

11.1 Measurement inputs

Nominal frequency range 50, 60 Hz
Measuring frequency range 16 ... 400 Hz

Voltage measurements

Number of channels 4 (1)
Sampling rate 31 kHz
Min. voltage for sync. 1 V_{rms}
Nominal value (U_N) 500 V_{LN} , 866 V_{LL}
Max. measured value (cont.) 600 V_{LN} ; 1000 V_{LL}
Max. allowed value 1.2 × U_N permanently
2 × U_N ; 10 s
Consumption < U^2 / 4.2 MΩ per phase
Input impedance 4.2 MΩ per phase
(1) 4th channel is used for measuring U

Current measurements

Number of channels 4
Sampling rate 31 kHz
Nominal value (I_N) 1 A, 5 A
Max. measured value 10 A sinusoidal
Max. allowed value (thermal) 15 A cont.
≤ 200 A; 1 s
Consumption < I^2 × 0.01 Ω per phase

System

Voltage inputs can be connected either directly to low- voltage network or via a voltage transformer to higher voltage network.

Current inputs can be connected either directly to low- voltage network or shall be connected to network via a corresponding current transformer (with standard 1 A or 5 A outputs).

For more information about different system connections see „Connection“ on page 13.

11.2 Basic accuracy under reference conditions

Accuracy is presented as percentage of reading of the measurand except when it is stated as an absolute value.

Measurand	Accuracy	Standard
Voltage L-N, L-L	± 0.1%	acc. to EN 61557-12
Current	± 0.1%	acc. to EN 61557-12
Active power (I_N = 5A)	± 0.2%	acc. to EN 61557-12
Active power (I_N = 1A)	± 0.5%	acc. to EN 61557-12
Active energy	Cl. 0.2S	acc. to EN 62053-22
Reactive energy	Cl.2	acc. to EN 62053-23
Frequency (f)	± 0.01 Hz	
Power factor (PF)	± 0.1	acc. to EN 61557-12
THD (U)	± 0.3%	acc. to EN 61557-12
THD (I)	± 0.3%	acc. to EN 61557-12
Real time clock (RTC)	< ± 1s / day	acc. to EN 61000-4-30

11.3 INPUT / OUTPUT modules

MAVOLOG | PRO Power Quality Analyzer is equipped with two main I/O slots, two auxiliary I/O slots and special time-synchronisation module. The following I/O modules are available:

Module type	Number of modules per slot	
	Main slot	Aux slot
Analogue output (AO)	2	/
Analogue input (AI)	2	/
Digital output (DO)	2	8
Digital input (DI)	2	8
Bistable Digital output (BO)	1	/
Status output (WO)	1 + 1xDO	/

Table 5 List of available I/O modules

Analogue input (AI)

Three types of analogue inputs are suitable for acquisition of low voltage DC signals from different sensors. According to application requirements it is possible to choose current, voltage or resistance (temperature) analogue input. They all use the same output terminals.

MAVO-View software allows setting an appropriate calculation factor, exponent and required unit for representation of primary measured value (temperature, pressure, wind speed…)

DC current input

Nominal input range 1 –20 … 0 … 20 mA (±20%)
Nominal input range 2 –2 … 0 … 2 mA (±20%)
input resistance 20 Ω
accuracy 0.5% of range
temperature drift 0.1% / °C (for range 2)
conversion resolution 16 bit (sigma-delta)
Analogue input mode internally referenced Single-ended

DC voltage input

Nominal input range1 –10 … 0 … 10 V (±20%)
Nominal input range 2 –1 … 0 … 1 V (±20%)
input resistance 100 kΩ
accuracy 0.5% of range
temperature drift 0.1% / °C (for range 2)
conversion resolution 16 bit (sigma-delta)
Analogue input mode internally referenced Single-ended

Resistance (temperature) input

Nominal input range (low)* 0 ... 200 Ω (max. 400 Ω)
PT100 (–200 °C ... +850 °C)
Nominal input range (high)* 0 … 2 kΩ (max. 4 kΩ)
PT1000 (–200 °C ... +850 °C)
connection 2-wire
accuracy 0.5% of range
conversion resolution 16 bit (sigma-delta)
Analogue input mode internally referenced single-ended

* Low or high input range and primary input value (resistance or temperature) are setby the **MAVO-View** setting software

Analogue output (AO)

Output range	0 … 20 mA
Accuracy	0.5% of range
Max. burden	150 Ω
Linearization	Linear, Quadratic
No. of break points	5
Output value limits	±120% of nominal output
Response time (measurement and analogue output)	< 300 ms
Residual ripple	< 0.5% p.p.

Outputs may be either short or open-circuited. They are electrically insulated from each other and from all other circuits.

Output range values can be altered subsequently (zoom scale) using the setting software, but a supplementary error results.

Digital input (DI)

Purpose	Tariff input, Pulse input, General purpose digital input
Max. current	8 mA (48 V), <0.6 mA (110, 230 V)
SET voltage	40 ... 120% of rated voltage
RESET voltage	0 ... 10% of rated voltage
Tariff input	Main slot only
Rated voltage	(5 … 48), 110, 230 ±20% $V_{AC/DC}$
Frequency range	45 … 65 Hz
Pulse input	Main slot only
Rated voltage	5 … 48 V_{DC}
Min. pulse width	0.5 ms
Min. pulse period	2 ms
Digital input	(5 … 48), 110, 230 ±20% $V_{AC/DC}$
Min. signal width	20 ms
Min. pause width	40 ms

Digital output (DO, BO)

Type	Relay switch
Purpose	Alarm output, General purpose digital output
Rated voltage	230 $V_{AC/DC}$ ±20% max
Max. switching current	1000 mA (main slot) 100 mA (aux. slot, DO only)
Contact resistance	≤ 100 mΩ (100 mA, 24 V)
Impulse	Max. 4000 imp/hour Min. length 100 ms
Type	Optocoupler open collector switch (main slot only)
Purpose	Pulse output
Rated voltage	40 $V_{AC/DC}$
Max. switching current	30 mA (R_{ONmax} = 8 Ω)
Pulse length	programmable (2 … 999 ms)

Status (watchdog) output (WO)

Type	Relay switch
Normal operation	Relay in ON position
Failure detection delay	≈ 1.5 s
Rated voltage	230 $V_{AC/DC}$ ±20% max
Max. switching current	1000 mA
Contact resistance	≤ 100 mΩ (100 mA, 24 V)

11.4 Time synchronisation input

Digital input	GPS or IRIG-B TTL
1pps voltage level	TTL level (+5V)
Time code telegram	RS232 (GPS) DC level shif (IRIG-B)
AM analog input	IRIG-B AM modulated
Carrier frequency	1 kHz
Input impedance	600 Ohms
Amplitude	2.5 V_{P-Pmin}, 8 V_{P-Pmax}
Modulation ration	3:1 ... 6:1

11.5 Universal Power Supply

Standard:	CAT III 300 V
Nominal voltage AC	80 … 276 V
Nominal frequency	40 … 65 Hz
Nominal voltage DC	70 … 300 V
Consumption (max. all I/O)	< 8 VA
Power-on transient current	< 20 A ; 1 ms

11.6 Safety:

Protection	protection class II functional earth terminal must be connected to earth potential!  Voltage inputs via high impedance Double insulation for I/O ports and COM ports
Pollution degree	2
Installation category	CAT IV; 300 V
(measuring inputs)	CAT III ; 600 V Acc. to EN 61010-1
Test voltages	U_{AUX} ↔ I/O, COM1: 3510 VAC_{rms} U_{AUX} ↔ U, I inputs: 3510 VAC_{rms} U, I inputs ↔ I/O, COM1: 3510 VAC_{rms} HV I/O ↔ I/O, COM1: 3510 VAC_{rms} U inputs ↔ I inputs: 3510 VAC_{rms}

11.7 Mechanical

Dimensions	144 × 144 ×100 mm
Mounting	Panel mounting 144 × 144 mm
Required mounting hole	137 × 137 mm
Enclosure material	PC/ABS
Flammability	Acc. to UL 94 V-0
Weight	550 g
Enclosure material	PC/ABS Acc. to UL 94 V-0

11.8 Ambient conditions

Ambient temperature	K55 temperature class Acc. to EN61557-12 -10 … 55 °C
Storage temperature	-40 to +70 °C
Average annual humidity	≤ 90% r.h. (no condensation)
Pollution degree	2
Enclosure protection	IP 40 (front plate) IP 20 (rear side)
Installation altitude	≤ 2000 m

11.9 Real time clock

A built-in real time clock is also without external synchronization very stable when device is connected to auxiliary power supply. For handling shorter power interruptions without influence on RTC, device uses high capacity capacitor. It ensures auxiliary supply (for internal RTC only) for more than two days of operation.

Type	Low power embedded RTC
RTC stability	< 1 sec / day

11.10 Connection cables

MAVOLOG | PRO Power Quality Analyzer is equipped with European style pluggable terminals for measuring voltages, auxiliary supply, communication and I/O modules. Measuring current cables shall be attached as through-hole connection without screwing.

Note
Stranded wire must be used with insulated end sleeve to assure firm connection.

Voltage inputs (4)	≤ 2.5 mm^2 , AWG 24-12 single wire
Current inputs (3)	≤ Ø 6 mm one conductor with insulation
Supply (3)	≤ 2.5 mm^2 , AWG 24-12 single wire
Com (5), I/O (6)	≤ 2.5 mm^2 , AWG 24-12 single wire

11.11 MAVO-View - setting and acquisition Software

MAVO-View software is intended for supervision of **MAVOLOG | PRO** and many other instruments on a PC. Network and the device setting, display of measured and stored values and analysis of stored data in the device are possible via the serial, Ethernet or USB communication. The information and stored measurements can be exported in standard Windows formats. Multilingual software functions on Windows XP, W7 operating systems.

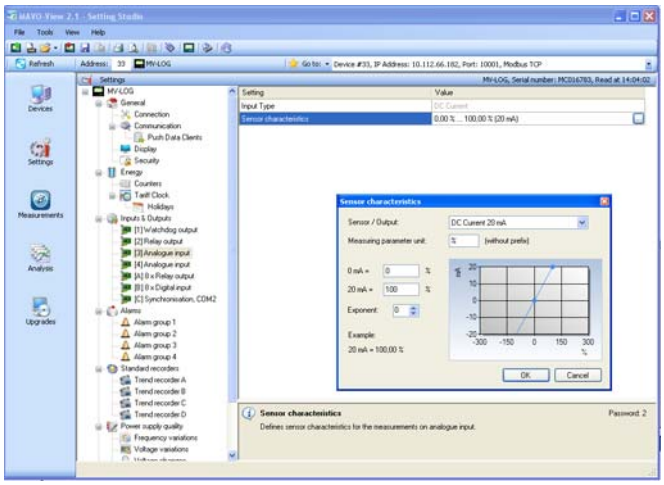
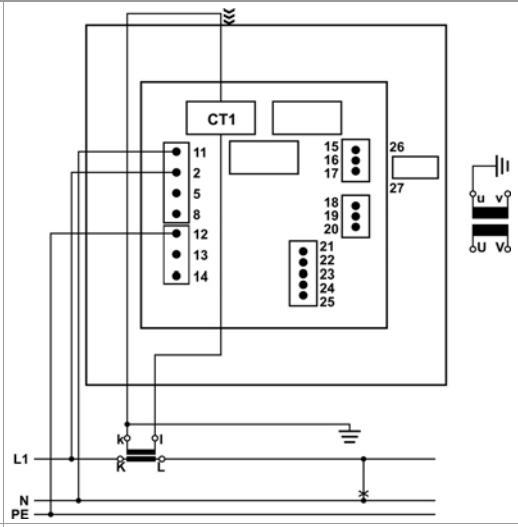
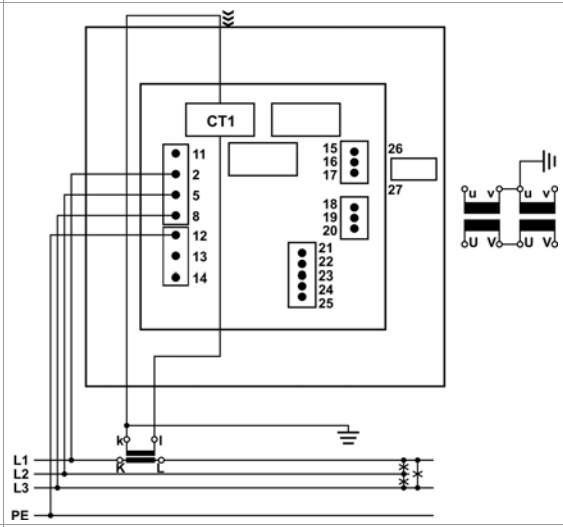
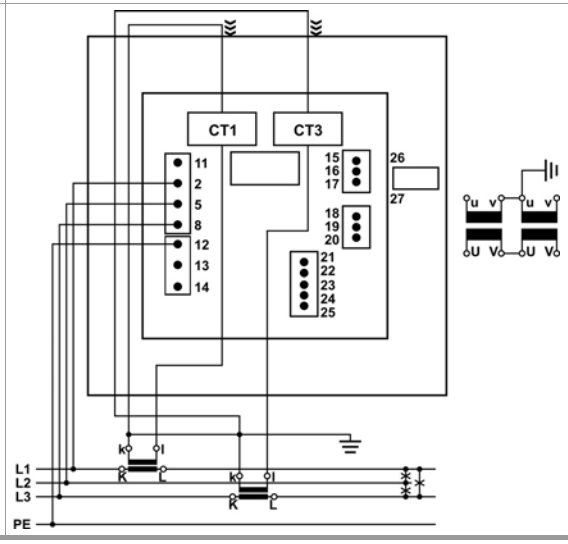


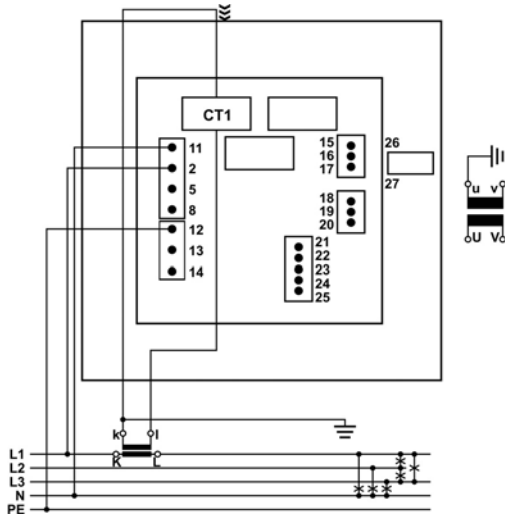
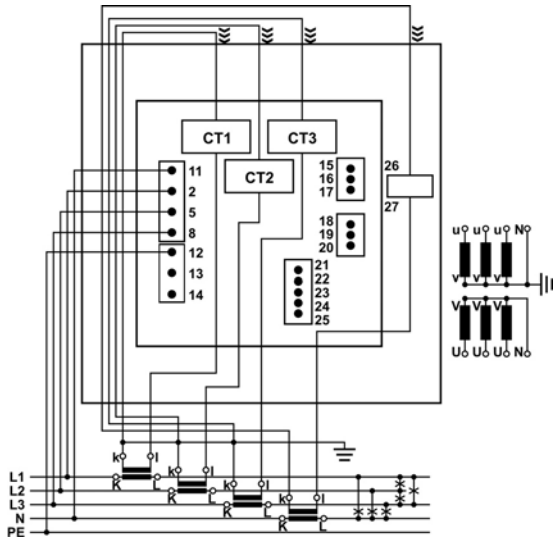
Figure 10 **MAVO-View** *setting and acquisition software*

MAVO-View software is intended for:

- Setting all of the instruments parameters (online and offline)
- Viewing current measured readings and stored data
- Setting and resetting energy counters Complete I/O modules configuration
- Evaluation of the electricity supply quality in compliance with SIST EN 50160
- Viewing and exporting time-stamped PQ anomaly details
- Upgrading instruments firmware
- Searching the net for devices
- Virtual interactive instrument
- Comprehensive help support

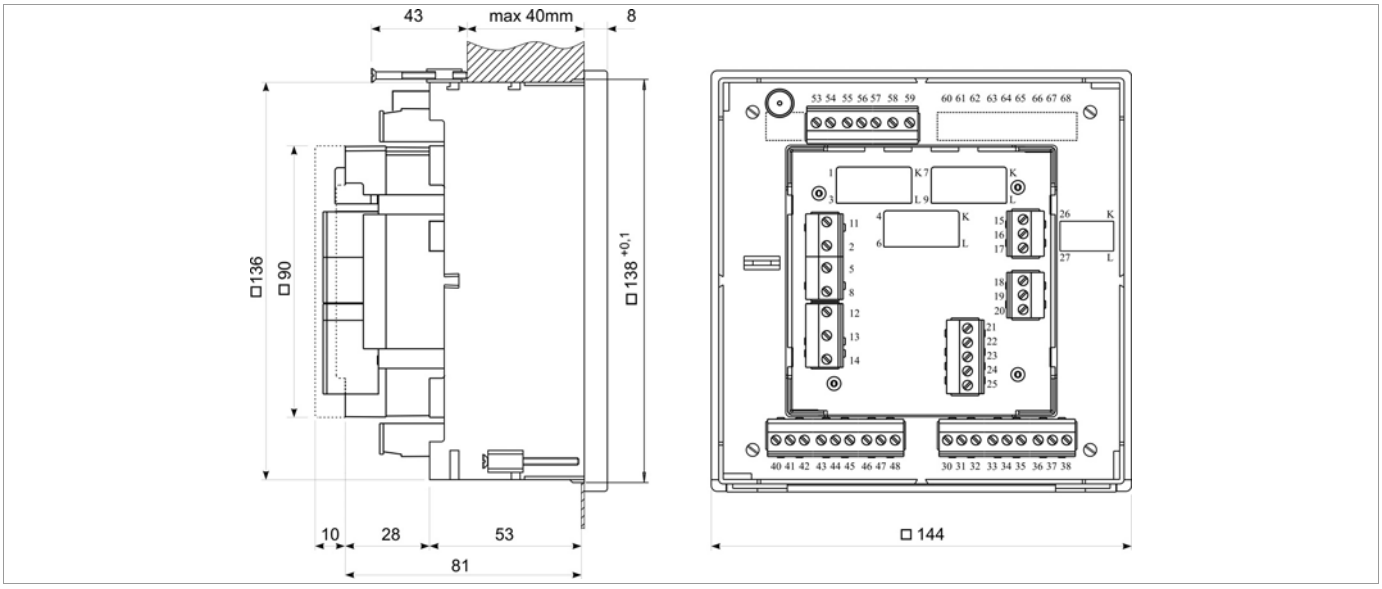
12 Connection

System / connection	Terminal assignment
1b (1W1b) Single-phase connection	
3b (1W3b) Three-phase, three-wire connection with balanced load	
3u (2W3u) Three-phase, three-wire connection with unbalanced load.	

System / connection	Terminal assignment
4b (1W4b) Three-phase, four wire connection with balanced load	
4u (3W4) Three-phase, four wire connection with unbalanced load. With this connection, a neutral current can be measured with 4th current sensor.	

Note
With all connection schemes, terminal 12 (PE) must ALWAYS be connected.
Fourth voltage channel is dedicated for measuring voltage between EARTH (PE, terminal 12) and NEUTRAL (N, terminal 2).

13 Dimensional Drawing



14 Connection table

Function			Connection	Comment
Measuring input:	AC current	IL1	1/3	CAT IV 300 V CAT III 600 V
		IL2	4/6	
		IL3	7/9	
		ILN	26/27	
	AC voltage	UL1	2	CAT IV 300 V CAT III 600 V
		UL2	5	
		UL3	8	
		UN 1	11	
Inputs / outputs:	Module 1/2	⊖➢ +	15	
		⊖➢ – (common)	16	
		⊖➢ +	17	
	Module 3/4	⊖➢ +	18	
		⊖➢ – (common)	19	
		⊖➢ +	20	
	Module A	⊖➢	30-38	
	Module B	⊖➢	40-48	
	Module C	⊖➢	52-58	
Auxiliary power supply:		+ / AC (L)	13	CAT III 300 V GROUND terminal must be always connected !!
		– / AC (N)	14	
		GROUND	12	
Communication:	RS485	A	21	RS232 and RS485 are both supported, but only one at the time can be used! In case of Ethernet / USB communication, terminals from 21 to 25 are not used (unconnected).
		B	22	
	RS232	RX	23	
		GND	24	
		TX	25	

Table 6 Connections

15 Data For Ordering

When ordering **MAVOLOG | PRO Power Quality Analyzer**, all required specifications shall be stated in compliance with the ordering code. Additional information could be stated.

15.1 General ordering code

The following specifications shall be stated:

	Aux. supply	Nominal frequency	Communication type	I/O1 module	I/O2 module	I/OA module	I/OB module		
M9200-	A	B	C	D	E	F	G		
						01		8× Relay output	
						02		8x Digital input (230 $V_{AC/DC}$)	
						03		8x Digital input (110 $V_{AC/DC}$)	
						04		8x Digital input (48 $V_{AC/DC}$)	
						00		Without	
				01				2× Analogue output	
				02				2× Pulse output	
				03				2× Relay (alarm) output	
				04				1× Bistable Relay (alarm) output	
				05				2× Analogue input (mA_{DC})	
				06				2× Analogue input (V_{DC})	
				07				2× Analogue input (R/Temp.)	
				08				2× Digital input (230 $V_{AC/DC}$)	
				09				2× Digital input (110 $V_{AC/DC}$)	
				10				2× Digital input (5 … 48 $V_{AC/DC}$)	
				11				2× Pulse input (5 ... 48 V_{DC})	
				12				2× Tariff input (230 $V_{AC/DC}$)	I/O1 only
				13				2× Tariff input (110 $V_{AC/DC}$)	I/O1 only
				14				2× Tariff input (5 … 48 $V_{AC/DC}$)	I/O1 only
				15				1× Status output + 1× Relay (alarm) output	
				00				Without	
			00	RS232/485					Pluggable terminals
			01	USB					
			02	Ethernet & USB					
		00	50, 60 Hz						
		01	400 Hz						
	00	Universal (70 ... 300 V_{DC}, 80 ... 276 V_{AC})							

15.2 Example of ordering:

MAVOLOG | PRO with a universal-HI supply is connected to a secondary phase voltage up to 500 V L-N and 5 A secondary current on 50Hz network. Ethernet & USB communication, watchdog output (plus one relay output) as I/O1, 2x digital input 230 V as I/O2, 4x analog output as I/OA and 8x relay output as I/OB.

Example ordering code:
M9200- 5A A00B00C02D15E08F02G01

15.3 Abbreviations:

PQ	Power Quality alias Voltage Quality
RMS	Root Mean Square
PA	Power angle (between current and voltage)
PF	Power factor
THD	Total harmonic distortion
Ethernet	IEEE 802.3 data layer protocol
MODBUS / DNP3	Industrial protocol for data transmission
MAVO-View	Setting and acquisition Software
AC	Alternating quantity
RTC	Real Time Clock
IRIG	Inter-range instrumentation group time codes
NTP	Network Time Protocol

16 Repair and Replacement Parts Service Calibration Center* and Rental Instrument Service

If required please contact:

GMC-I Service GmbH
Service Center
Beuthener Straße 41
90471 Nürnberg, Germany
Phone: +49-911-817718-0
Fax: +49-911-817718-253
e-mail service@gossenmetrawatt.com
www.gmci-service.com

This address is only valid in Germany. Please contact our representatives or subsidiaries for service in other countries.

* DAkkS calibration laboratory for electrical quantities,
registration no. D-K-15080-01-01,
accredited per DIN EN ISO/IEC 17025:2005
Accredited quantities: direct voltage, direct current value, direct current resistance, alternating voltage, alternating current value, AC active power, AC apparent power, DC power, capacitance, frequency and temperature

17 Product Support

If required please contact:

GMC-I Messtechnik GmbH
Product Support Hotline Industry
Phone +49 911 8602-500
Fax +49 911 8602-340
E-Mail support.industrie@gossenmetrawatt.com

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