GOSSEN METRAWATT

MAVOLOG | PRO
Power Quality Analyzer

3-349-791-03
1/7.14

- **4 current and 4 voltage inputs with Auto-Range**
  12.5 A and 1000 V_{rms}
- **Frequency range 16 Hz to 400 Hz**
  Can be used in railway, power grid and on-board networks
- **High Resolution**
  Continuous sampling of voltage and current inputs at 32 kHz per channel
- **Up to 20 additional inputs and outputs**
  2 analog inputs, e.g. for temperature, direct sunlight and wind speed
  2 analog outputs for selectable measured quantities
  8 digital inputs, e.g. for switching statuses
  8 digital outputs, e.g. for rate meter pulses and masked alarms
- **Spectral analysis in accordance with EN 61000-4-7**
  Up to 63 harmonic
  Acquisition of 10 custom interharmonics
- **Communication interfaces and protocols**
  Ethernet, USB (TypeB), RS232/RS485; TCP / IP, Modbus and DNP3
- **Advanced Flicker according to EN 61000-4-15**
  For various voltage levels

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 63th harmonic
- 144 mm square panel mounting
- User-friendly setting and evaluation software, **MAVO-View**

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.

MAVOLOG | PRO
Power Quality Analyzer

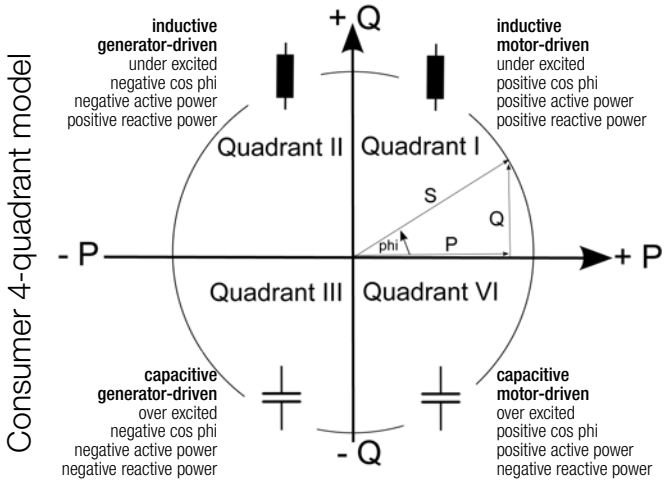
Application and Benefits

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-sized industrial and commercial energy consumers to monitor the quality of delivered electric energy or at medium or low voltage feeders to monitor, detect and record possible disturbances caused by the 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 **MAVO-Database** software solution. **MAVO-Database** data collector with "push" communication system allows automatic records of all predefined measuring parameters. They are stored in **MAVO-Database** 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 **MAVO-Database** 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



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

Technical Data

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 5.

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

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	/

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)

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

Universal Power Supply

Standard (high):	CAT III 300V
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
Optional (low):	CAT III 300V
Nominal voltage AC	48 … 77 V
Nominal frequency	40 … 65 Hz
Nominal voltage DC	19 … 70 V
Consumption (max. all I/O)	< 8 VA
Power-on transient current	< 20 A ; 1 ms

Electrical 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
Measuring 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}

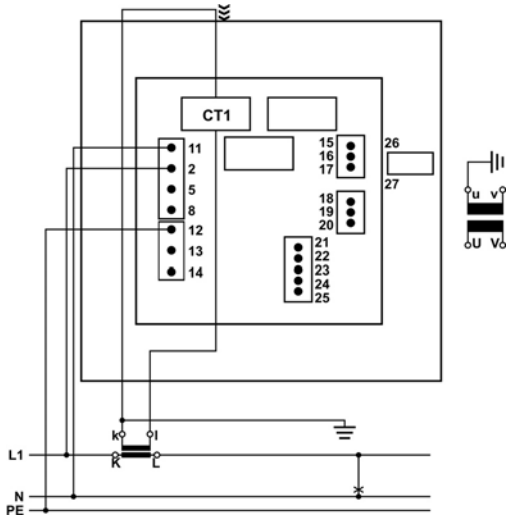
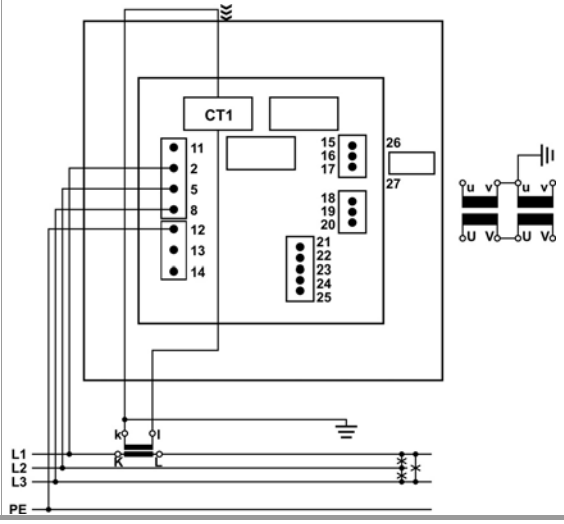
Mechanical

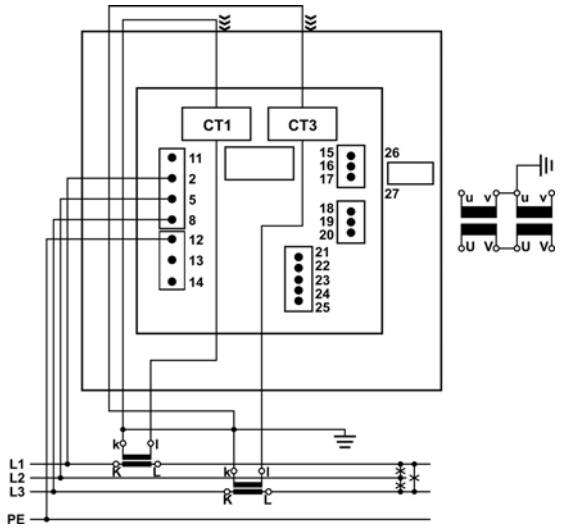
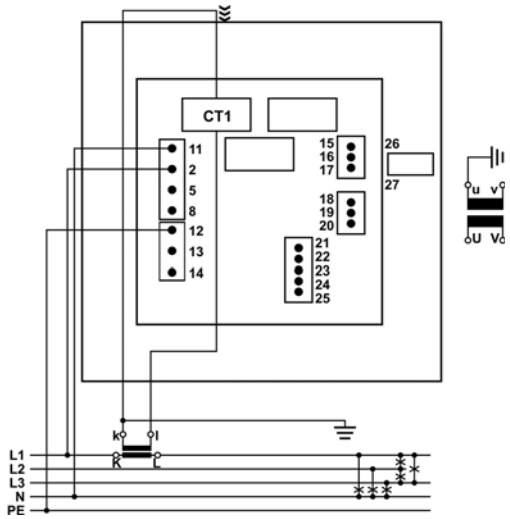
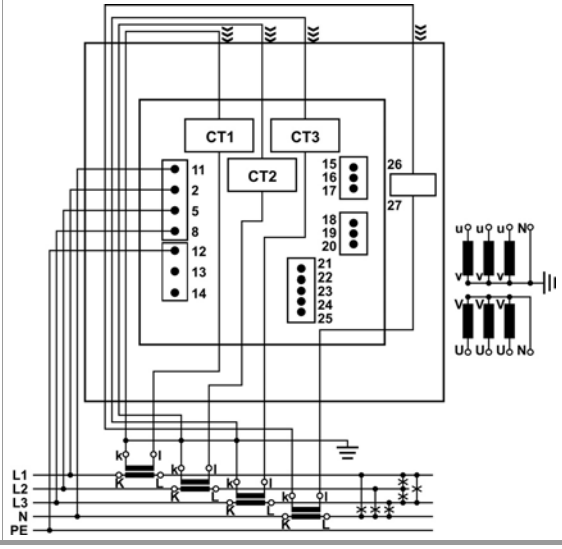
Dimensions	144 × 144 ×100 mm
Mounting	Panel mounting 144 × 144 mm
Required mounting hole	137 × 137 mm
Enclosure material	PC/ABS
Flammability	Acc. to UL 94 V-0
Weight	550 g
Enclosure material	PC/ABS Acc. to UL 94 V-0

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

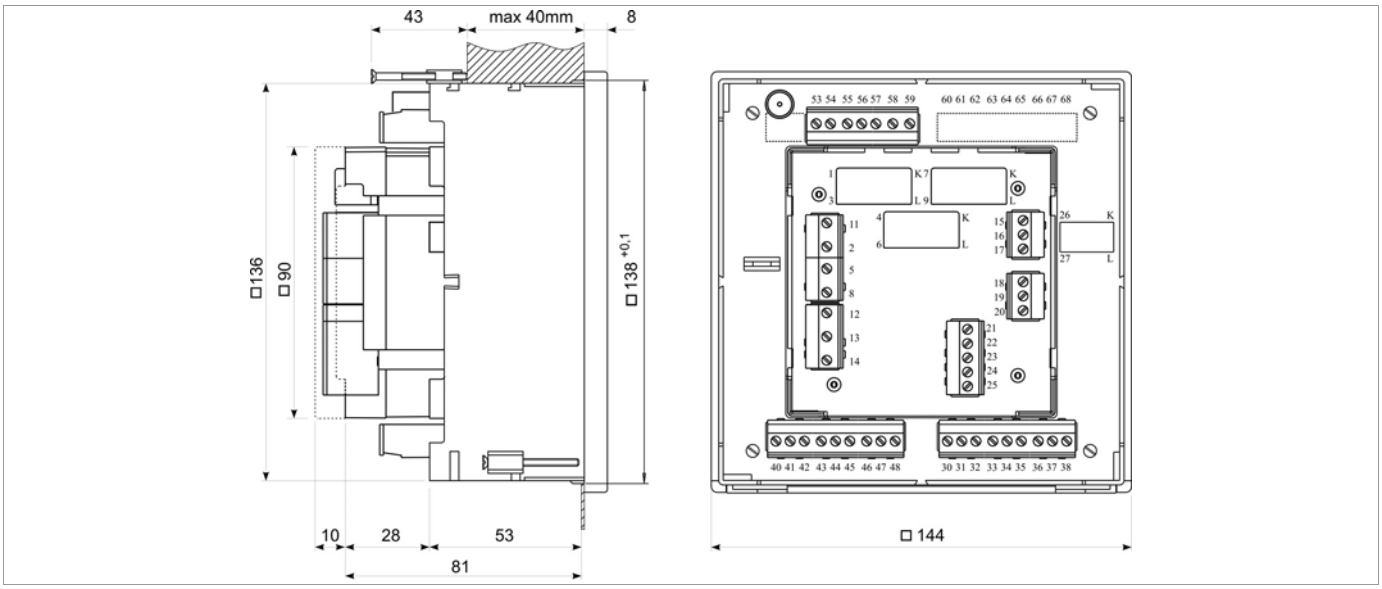
Connection

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

System / connection	Terminal assignment
3u (2W3u) Three-phase, three-wire connection with unbalanced load.	
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.	

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).

Dimensional Drawing



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
		– / AC (N)	14	
		GROUND	12	⚠ GROUND terminal must be always connected !!
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	

MAVOLOG | PRO
Power Quality Analyzer

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.

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 HIGH (70 ... 300 V_{DC}, 80 ... 276 V_{AC})							
	01	Universal LOW (19 ... 70 V_{DC}, 48 ... 77 V_{AC})							

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-A00B00C02D15E08F02G01

Standard Models

Standard Models	Article number	Features
MAVOLOG PRO	M9200-V001	**A00B00C02D05E00F00G00** Basic unit with 4 current and voltage inputs: Universal High 50, 60Hz Ethernet & USB 2x analog inputs (mAdc)
MAVOLOG PRO	M9200-V002	**A00B00C02D05E07F01G02** Basic unit with 4 current and voltage inputs: Universal High 50, 60Hz Ethernet & USB 2x analog inputs (mAdc) 2x analog inputs (R / Temp) 8x relay output 8x digital input
MAVOLOG PRO	M9200-V003	**A00B00C00D01E03F00G00** Basic unit with 4 current and voltage inputs: Universal High 50, 60Hz RS232/485 2x Analog output 2x Relay output

Accessories

Description	Type	Article number
MS-SQL database software **MAVO-Database** (for a fee) for PQ Analyser **MAVOLOG PRO** for visualization, analysis and storage of measured values.		
Up to 10 devices can be enabled	MAVO-Database Software	Z849A
Up to 10 devices can be enabled	MAVO-Database Software	Z849B
Up to 10 devices can be enabled	MAVO-Database Software	Z849C

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

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