

MAVOLOG | PRO

Power Quality Analyzer

3-349-791-03
3/8.18

- **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 (Type B), RS232/RS485; TCP / IP, Modbus and DNP3
- **Advanced Flicker according to EN 61000-4-15**
For various voltage levels
- Device supports latest Class A standard in accordance with **EN 61000-4-30, 3. Edition** (we are one of the first worldwide)



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 signaling voltage, unbalance...
- Class A (0.1%) accuracy in compliance with EN61000-4-30
- Recording of disturbance, trend and Power Quality (PQ) events in trigger related recorders
- Periodic measurements in 4 standard trend recorders A through D each containing up to 32 arbitrarily evaluated (maximum, minimum, average, maximum demand, minimum demand, actual) quantities with periods ranging from 1 min to 60 min
- 32 adjustable alarms in 4 alarm groups each containing up to 8 alarms. Alarms relate to a particular quantity over/under threshold and serve the purpose of controlling on-device relay outputs as well as informing the server about the occurrence of alarm events
- Recording and on-board evaluation of PQ anomalies and PQ reports based on EN 50160
- 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 periods)
- 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 synchronization
- 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**

Additional Functions Waveform and Transient Recorder (Feature H01)

- On-board Web server support for basic measurement overview
- Oscillography capability for recording waveforms and transients with up to 625 samples/cycle sampling frequency
- All trigger related recorder data available on-demand through FTP and automatically on the MiSMART server via autonomous push communication or on demand
- A sophisticated triggering mechanism to register and record events of various nature:
- Transient event generated triggers based on hold-off time (in ms), absolute peak value, fast change (in %Un/μs)

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- PQ event generated triggers based on the following events: voltage dip, voltage swell, voltage interruption, end of voltage interruption, rapid voltage change and inrush current
- External ethernet triggers enabling trigger events with up to 8 different devices within the network
- External digital triggers based on logical/digital inputs
- Up to 16 combined triggers enabling logical operation on previously configured triggers of various nature
- Recording a wide variety of data in the internal device 8GB flash memory based on trigger settings:
- A list of all activated triggers together with time stamp, duration, condition as well as a reference to an (optionally) generated transient, waveform, disturbance and fast trend record
- Waveform recorder for waveform and transient recording with PQDIF/COMTRADE data format selection, selectable recorded channels (4xVoltage, 4xCurrent, 16xLogical input), 19 sample/cycle to 256 sample/cycle resolution, pretrigger time from 10ms to 1s, post trigger time up to 40 s.
- Disturbance recorder with PQDIF/COMTRADE data format selection, selectable recorded channels (4xP-N Voltage, 3xP-P Voltage, 4xCurrent, 8xLogical inputs), half/full cycle averaging interval, pretrigger time up to 3000 cycles, post trigger time up to 60000 cycles
- Periodic measurements in advanced fast trend recorders 1 through 4 each containing over 700 arbitrarily evaluated (maximum, minimum, average, actual) quantities with periods ranging from 1s to 60min. The recorder can be set to PQDIF data format selection
- MODBUS, DNP3 and **FTP**-communication protocols Webserver inclusive (embedded Linux-Board)
- MODBUS-, DNP3- and **FTP**-communication protocols upgradeable to EN 61850 (optional)

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 for PQ events.

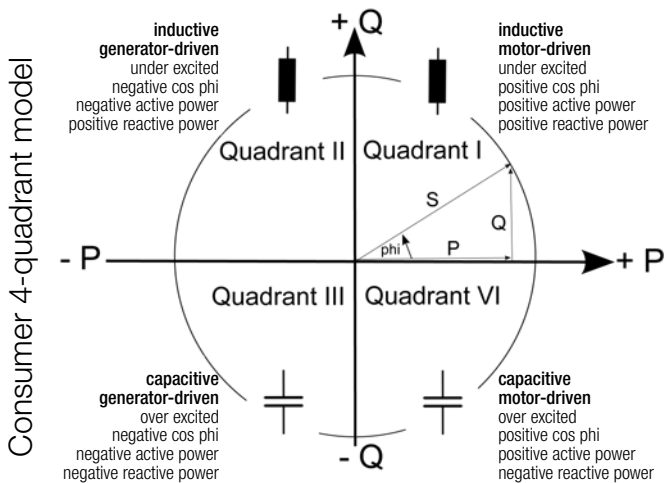
Application and Benefits

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 parameters (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 (flicker meter).

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 parameters
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) – Flicker meter
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

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Technical Data

Measurement inputs

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

Voltage measurements

Number of channels 4 ¹⁾
 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 < U² / 4.2 MΩ per phase
 Input impedance 4.2 MΩ per phase

¹⁾ 4th channel is used for measuring U_{PE-N}

Current measurements

Number of channels 4
 Nominal value (I_N) 1 A, 5 A
 Max. measured value (I₁-I₃ only) 12.5 A sinusoidal
 Max. allowed value (thermal) 15 A cont., ≤ 300 A max. 1 s
 Consumption < I² × 0.01 Ω per phase

Sampling and resolution

Waveform sampling 32 μs (625 Samples per Cycle)
 ADC resolution 24 bit 8-ch simultaneous inputs
 Reading refresh rate 100 ms ... 5 s (User defined)

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 6.

Basic accuracy under reference conditions

Accuracy is presented as percentage of reading of the measurement 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	acc. to EN 61557-12
Power factor (PF)	± 0.5	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 + 1xD0	/

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 -20 ... 0 ... 20 mA (±20%)
 input resistance 20 Ω
 accuracy 0.5% of range
 temperature drift 0.01% / °C (for range 2)
 conversion resolution 16 bit (sigma-delta)
 Analogue input mode internally referenced Single-ended

DC voltage input

Nominal input range -10 ... 0 ... 10 V (±20%)
 input resistance 100 kΩ
 accuracy 0.5% of range
 temperature drift 0.01% / °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 set by 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	$\pm 120\%$ of nominal output
Response time (measurement and analogue output)	depends on set general average interval (0.1s – 5s)
Residual ripple	< 1% 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	60 ... 120% of rated voltage
RESET voltage	0 ... 10% of rated voltage
Tariff input	Main slot only
Rated voltage	(5 ... 48), 110, 230 $\pm 20\%$ $V_{AC/DC}$
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 $\pm 20\%$ $V_{AC/DC}$
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 $V_{AC/DC} \pm 20\%$ max
Max. switching current	1000 mA (main slot) 100 mA (aux. slot, DO only)
Contact resistance	≤ 100 m Ω (100 mA, 24 V)
Impulse	Max. 4000 imp/hour Min. length 100 ms

Pulse output (PO)

Type	Optocoupler open collector switch (main slot only)
Purpose	Pulse output
Rated voltage	40 $V_{AC/DC}$
Max. switching current	30 mA ($R_{ONmax} = 8 \Omega$)
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 $V_{AC/DC} \pm 20\%$ max
Max. switching current	1000 mA
Contact resistance	≤ 100 m Ω (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 Ω
Amplitude	2.5 V_{P-Pmin} , 8 V_{P-Pmax}
Modulation ration	3:1 ... 6:1

Universal Power Supply

Standard	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 typical < 12 VA max. loaded I/O options
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 (measuring inputs)	CAT IV; 300 V CAT III; 600 V Acc. to EN 61010-1



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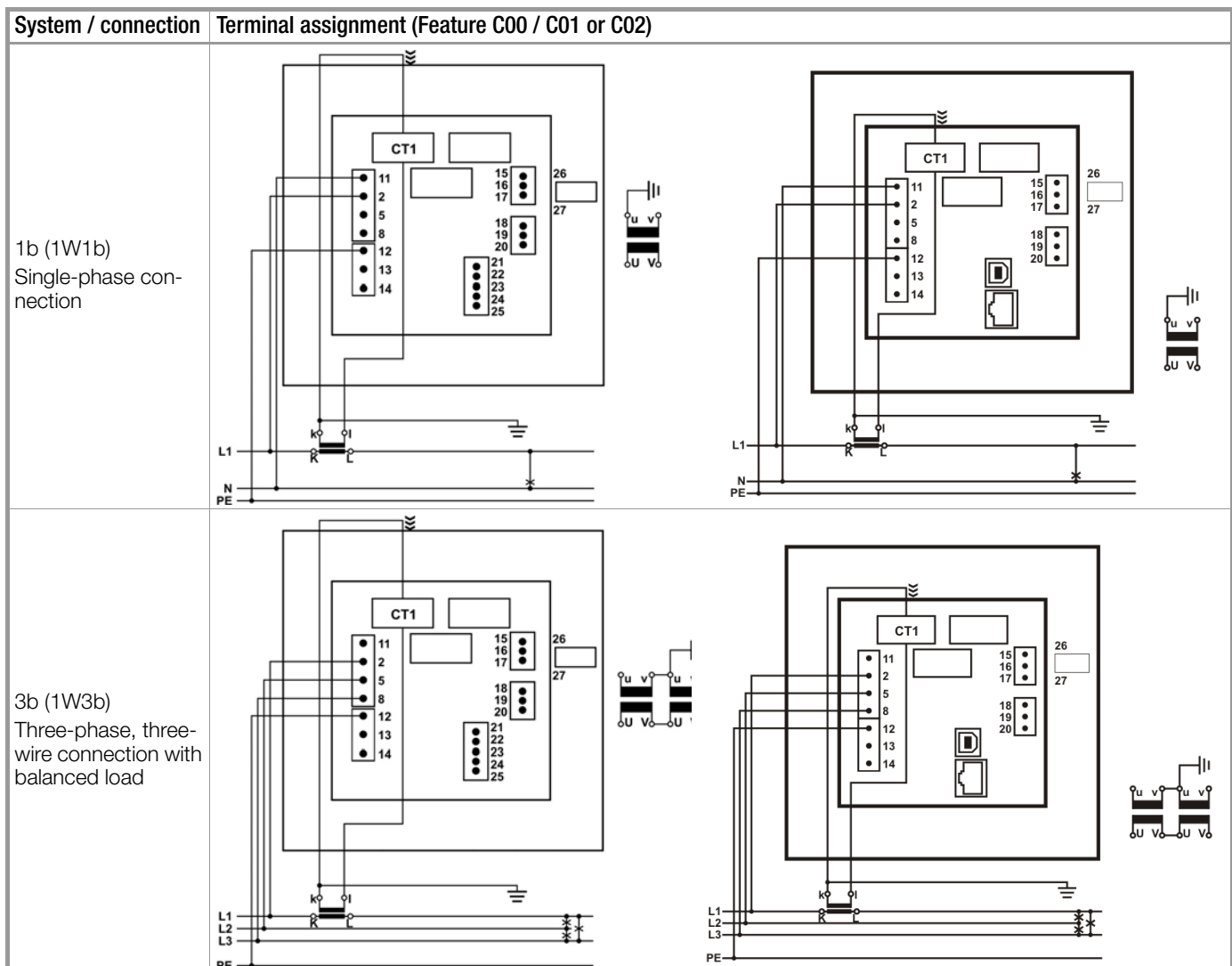
Mechanical

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



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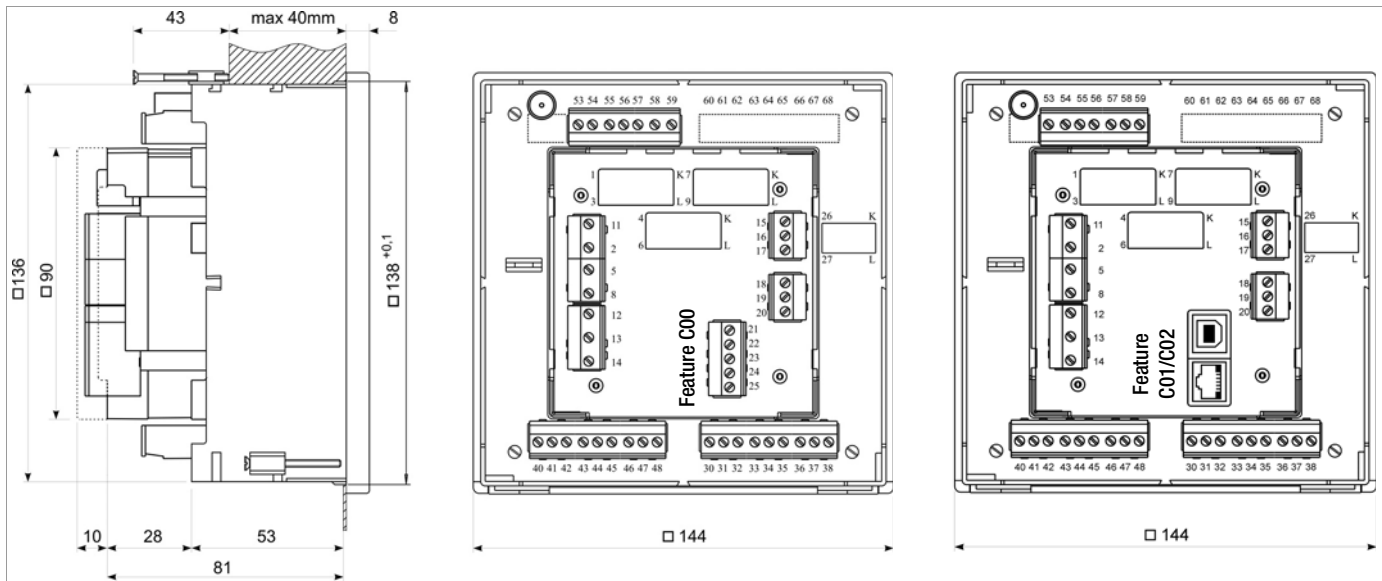
System / connection	Terminal assignment (Feature C00 / C01 or C02)
<p>3u (2W3u) Three-phase, three-wire connection with unbalanced load.</p>	
<p>4b (1W4b) Three-phase, four wire connection with balanced load</p>	
<p>4u (3W4) Three-phase, four wire connection with unbalanced load. With this connection, a neutral current can be measured with 4th current sensor.</p>	

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).













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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		
Inputs / outputs:	Module 1/2	 +	15	I/O function depends on type of I/O module	
		 - (common)	16		
	Module 3/4	 +	17		
		 - (common)	18		
	Module A	 +	19		
		 -	20		
	Modul C	 BNC-Eingang	53 ... 58		IRIG-B modulated (1 kHz) time sync. signal
		 1 pps	53		TTL level 1 pps time sync. Signal or IRIG-B digital
		RS485	54, 55		54: A, 55: B
		MODEM/RS232	56 ... 59		56: Rx, 57: GND, 58: Tx, 59: +5 V
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, the terminal block 21 to 25 is not available.	
		B	22		
	RS232	RX	23		
		GND	24		
		TX	25		
USB		Typ B	USB 2.0		
ETHERNET		RJ-45	10/100BASE-TX Ethernet		

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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	Waveform and transient recorder
M9200-	A	B	C	D	E	F	G	H
						01		01
						02		
						03		
						04		
						00		
				01				
				02				
				03				
				04				
				05				
				06				
				07				
				08				
				09				
				10				
				11				
				12				I/O1 only
				13				I/O1 only
				14				I/O1 only
				15				
				00				
			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})				

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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-A00B00C02D15E08F02G01H00

Standard Models

Standard Models	Article number	Features
MAVOLOG PRO	M9200-V001	A00B00C02D05E00F00G00H00 Basic unit with 4 current and voltage inputs: Universal High 50, 60 Hz Ethernet & USB 2x analog inputs (mA DC)
MAVOLOG PRO	M9200-V002	A00B00C02D05E07F01G02H00 Basic unit with 4 current and voltage inputs: Universal High 50, 60 Hz Ethernet & USB 2x analog inputs (mA DC) 2x analog inputs (R / Temp) 8x relay output 8x digital input
MAVOLOG PRO	M9200-V003	A00B00C00D01E03F00G00H00 Basic unit with 4 current and voltage inputs: Universal High 50, 60 Hz RS232/485 2x Analog output 2x Relay output
MAVOLOG PRO	M9200-V004	A00B00C02D05E00F00G00H01 Basic unit with: Universal High 50, 60 Hz Ethernet & USB 2x analog inputs (mA DC) H01: Waveform and transient recorder
MAVOLOG PRO	M9200-V005	A00B00C02D05E07F01G02H01 Basic unit with: Universal High 50, 60 Hz Ethernet & USB 2x analog inputs (mA DC) 2x analog inputs (R / Temp) 8x relay output 8x digital input H01: Waveform and transient recorder
MAVOLOG PRO	M9200-V006	A00B00C00D01E03F00G00H01 Basic unit with: Universal High 50, 60 Hz RS232/485 2x Analog output 2x Relay output H01: Waveform and transient recorder

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
VT	Voltage transformer
CT	Current transformer
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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[DM61](#) [U270B](#)