

# MEASUREMENT & MONITORING IN POWER SYSTEMS

MULTIFUNCTIONAL POWER MEASUREMENT DEVICE FOR PANEL MOUNTING



## SINEAX AM-SERIES

SINEAX AM1000 • SINEAX AM2000 • SINEAX AM3000



Panel installation devices for  
a clear view into electrical  
networks



The SINEAX AM-SERIES devices are compact instruments to measure and monitor in heavy current grids. They excel in display quality and intuitive operation. The devices provide a wide range of functionalities which may even be extended by optional components. They are connected to the process environment by communication interfaces, via digital I/Os, analog outputs or relays. The devices have been designed for universal use in industrial plants, building automation or in energy distribution.

Nominal voltages of up to 690 V and measurement category CATIII can be directly connected in low voltage systems. The universal measuring system permits the direct use of the devices in any type of grid, from single-phase mains through to 4-wire unbalanced load systems. The AM series devices may be completely adapted to requirements on site via TFT display. Versions with an Ethernet interface permit webpage configuration without any special software.

## CLEAR

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High resolution, colour TFT display for the pin-sharp indication of measured data

Consistently visible status information (alarms, user management, data recording, time/date and much more)

Clear design

## INTUITIVE

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Easy device operation with language-specific plain text menu guidance

Topical arrangement of measured data information for quick access to desired data

Service area for maintenance and commissioning

## MULTIFUNCTIONAL

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Varied monitoring options via limit values and their logical linkage

Central alarm function via display or Webpage

Automatic data export of load profile data to SFTP server

## FLEXIBLE

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Universal measuring inputs for any type of grid

Freely selectable mean value and meter measuring variables

Comprehensive cyber security protection (RBAC, HTTPS, syslog, audit log)

## SCALABLE

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Combinable device version (functionality, interfaces, I/Os, power supply)

Front dimension options (96x96 or 144x144mm)

Integration as a standard object into the SMARTCOLLECT® SC² software



	AM1000	AM2000	AM3000
Input channels voltage / current Measurement interval [ #cycles ]	3 / 3 10/12 (50/60Hz); 1/2	3 / 3 10/12 (50/60Hz)	4 / 4 10/12 (50/60Hz); 1/2
<b>MEASURED VALUES</b>			
Instantaneous values	▪	▪	▪
Extended reactive power analysis	▪	▪	▪
Imbalance analysis	▪	▪	▪
Neutral current	calculated	calculated	measured / calculated
Earth wire current (calculated)	--	--	▪
Zero displacement UNE	calculated	calculated	measured / calculated
Energy balance analysis	▪	▪	▪
Harmonic analysis	▪	▪	▪ (incl. phase angle)
Operating hour counters device / general	1 / 3	1 / –	1 / 3
Monitoring functions	▪	▪	▪
Visualisation waveform U/I	▪	–	▪
<b>MEASUREMENT UNCERTAINTY</b>			
Voltage, current	±0.2%	±0.2%	±0.1%
Active, reactive, apparent power	±0.5%	±0.5%	±0.2%
Frequency	±10mHz	±10mHz	±10mHz
Active energy (IEC 62053-21/22)	Class 0.5S	Class 0.5S	Class 0.2S
Reactive energy (IEC 62053-24)	Class 0.5S	Class 0.5S	Class 0.2S
<b>DATA LOGGER</b> (Option, only with Ethernet)	internal (≥16GB)	Micro SD card (≥16GB)	Micro SD card (≥16GB)
Periodic recording	▪	▪	▪
Event recording	▪	▪	▪
<b>Disturbance recorder (option)</b>			
a) 1/2 cycle RMS progression U/I	≤3min.	–	≤3min.
b) Waveform U/I [ #cycles ]	5/6 (pretrigger) +10/12	–	5/6 (pretrigger) +10/12
<b>COMMUNICATION</b>			
Ethernet: Modbus/TCP, web server, NTP	(option)	(option)	(standard)
IEC 61850	(option)	(option)	(option)
PROFINET IO	(option)	(option)	(option)
RS485: Modbus/RTU	(option)	(option)	(option)
Standard I/Os	1 dig. OUT ; 1 dig. IN/OUT	1 dig. IN ; 2 dig. OUT	1 dig. IN ; 2 dig. OUT
Extension modules (optional)	max. 1 module	max. 4 modules	max. 4 modules
<b>POWER SUPPLY</b>			
	100-230V AC/DC 24-48V DC	110-230V AC/130-230V DC 110-200V AC/DC 24-48V DC	110-230V AC/130-230V DC 110-200V AC/DC 24-48V DC
Consumption	≤18 VA, ≤8 W	≤30 VA, ≤13 W	≤30 VA, ≤13 W
<b>DESIGN</b>			
Colour display	TFT 3.5" (320x240px)	TFT 5.0" (800x480px)	TFT 5.0" (800x480px)
Front dimensions	96 x 96 mm	144 x 144 mm	144 x 144 mm
Mounting depth	85 mm	65.2 mm	65.2 mm



## OPTIONAL EXTENSIONS

With extension modules, the functionality of the devices can be expanded and thus optimally adapted to the process environment.

### FAULT CURRENT DETECTION

- 2 channels with 2 measuring ranges each
- Residual current monitoring (RCM)
- Earth wire current monitoring

### ANALOG OUTPUTS (2 OR 4 CHANNELS)

- Bipolar  $\pm 20\text{mA}$ , up to 9 break points
- Connection to control systems
- Remote controllable

### TEMPERATURE MEASUREMENT

- 2 channels
- Pt100 or PTC sensor, 2-wire
- Short circuit / break monitoring of the sensors

### RELAY OUTPUTS (2 CHANNELS, CHANGEOVER CONTACT)

- Load capacity 230V AC / 2A; 30V DC / 2A
- Alarm or consumer control
- Remotely controllable

### IEC 61850 COMMUNICATION

- Standardized protocol for power distribution systems
- Automatic, configurable reporting of measurement data to a control system

### DIGITAL INPUTS (4 CHANNELS)

- Counter pulse acquisition
- Acquire external switching states
- Versions with active or passive inputs

### PROFINET IO COMMUNICATION

- Transmission of a cyclic process image with up to 62 measured values
- Applications in automation

### TIME SYNCHRONIZATION

- GPS or IRIG-B
- Highly accurate time base for events and consumption data
- Alternative to NTP

### UNINTERRUPTIBLE POWER SUPPLY

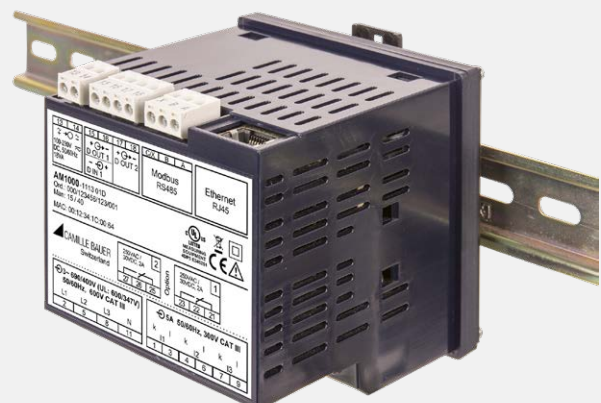
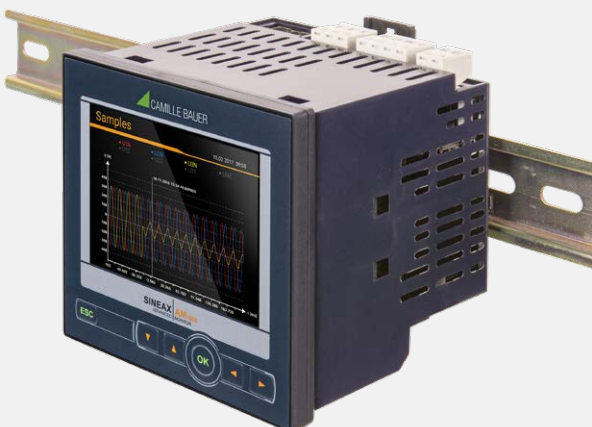
- Bridging of power failures of 3 times 5 minutes
- Safe detection of voltage dips with the optional fault recorder

### PME RADIO CENTER

- Connection of up to 33 PME radio sensors
- Energy center for feeder or consumption data
- Load flow monitoring

## ALTERNATIVE DESIGNS

The SINEAX AM1000 is also available in versions for DIN rail mounting, with or without display.

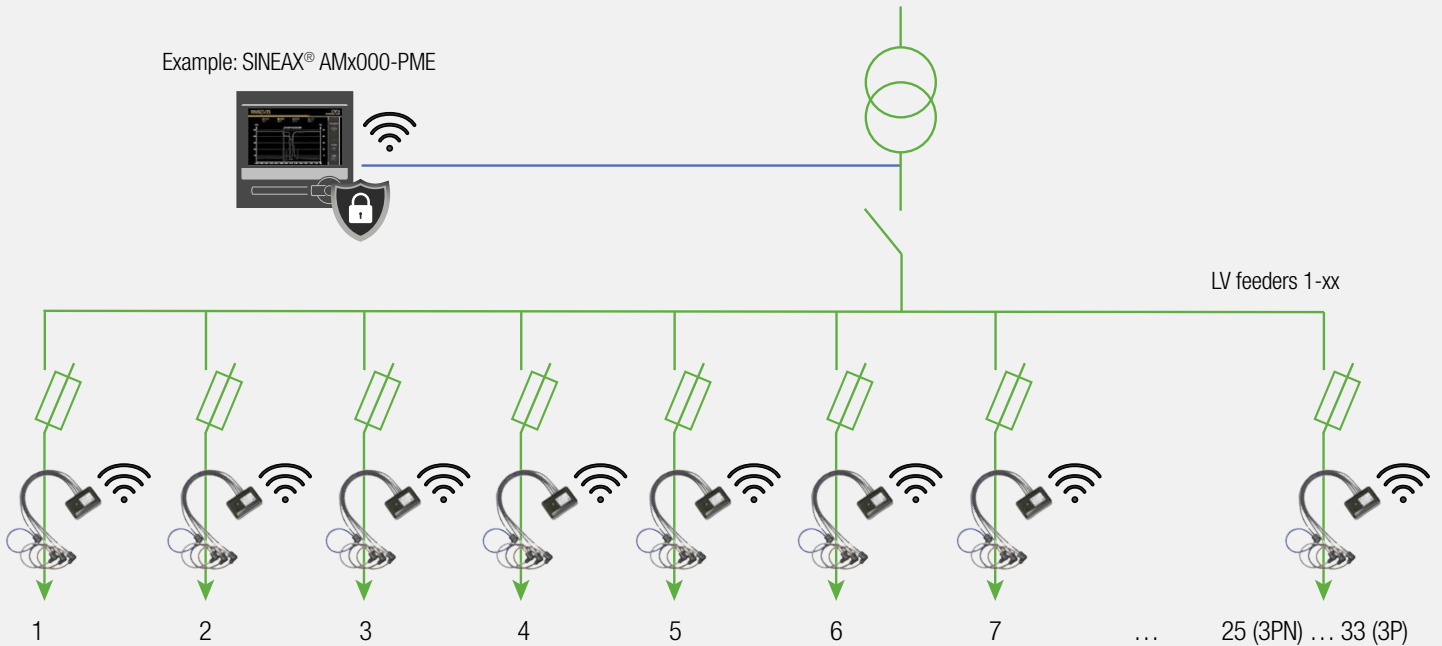




## OPTION PME RADIO CENTER

This option extends the functionality of the base unit into an energy center by collecting via radio communication additional information about the distribution of energy or the consumption of individual loads. This scalable solution makes energy flows transparent and creates the basis for comprehensive energy management. Radio modules based on Rogowski coils are used as sensors.

Without additional wiring effort, up to 100 currents can be monitored synchronized to the voltage measurement of the base unit. These currents are made up of PME sensors (Power Monitoring Energy) for 3 or 4 wire each. Current and power quantities are then determined once per second and load profiles and energy meter values are derived from them.



Base station with SINEAX® AM, SINEAX® DM5000, LINAX® PQ or CENTRAX® CU series, incl. integrated Power Monitoring Energy Module (PME) and PME sensors for acquisition of max. 100 currents via radio signal.

### PME characteristics

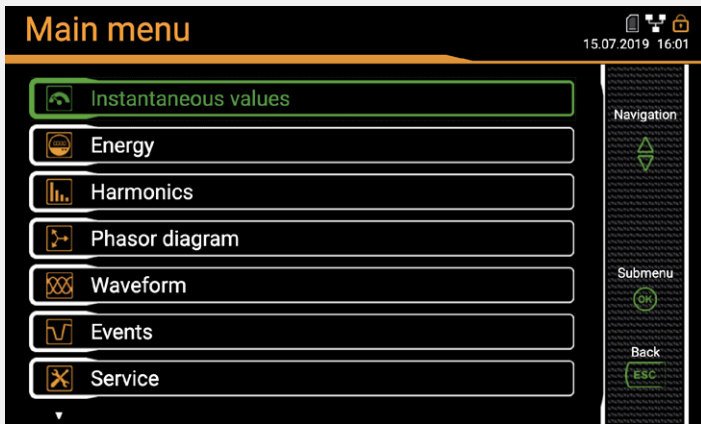
- Base unit SINEAX® AM, SINEAX® DM5000, LINAX® PQ or CENTRAX® CU
- PME sensors with 3 or 4 Rogowski coils each (max. 100 currents) and configurable measurement ranges (250A, 500A or 1000A)
- Radio frequency 2.4GHz, range 10m
- Secure protocol for communication between current sensors and central unit (Advanced Encryption Standard AES-128, standard for WLAN communication)
- Fast installation due to easy sensor registration via QR code
- Power supply via battery (runtime up to 10 years) or USB-C
- Thanks to anti-collision detection up to 5 PME systems at the same location
- Access to sensor data via Modbus/RTU, Modbus/TCP, REST API, CSV export
- Measurements: I, THD<sub>I</sub>, TDD<sub>I</sub>, P, Q, Q(H1), S, cosφ, PF
- Current measurement ± 0.5%, active / reactive energy class 3
- Measurement interval 1 s
- Sampling rate per sensor 6kHz



Daily load profile with previous day values for a PME sensor via web page of the base unit

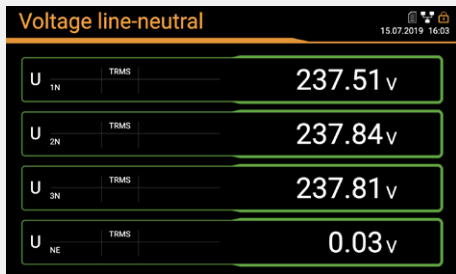


# DISPLAY OPTIONS



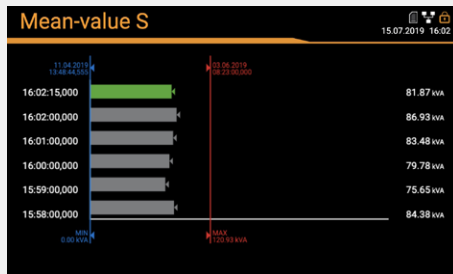
### MAIN MENU - accessible via ESC

The language-specific main menu arranges the available measured data in easily comprehensible groups. AM2000 and AM3000 also provide the lateral help bar with further information concerning operation. The status bar in the top right-hand corner is always available and displays the current statuses of alarm monitoring, the password protection system and data recording as well as time / date.



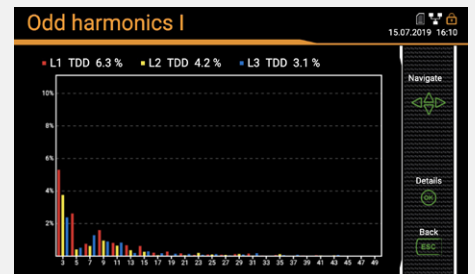
### INSTANTANEOUS VALUES

The instantaneous values of voltages, currents, power values, power factors as well as imbalance values and their min/max values are provided either in numbers or graphically in an x/y matrix.



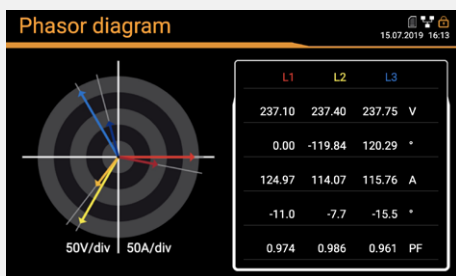
### ENERGY

Contains all values required for the preparation of the energy balance, in particular, energy meters as well a mean values with progression and trend.



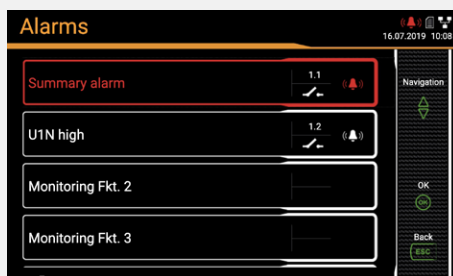
### HARMONICS

Graphic representation of harmonics of all currents and voltages with TDD/THD. Reading option for individual harmonics.



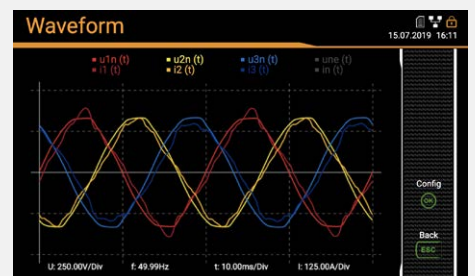
### PHASOR DIAGRAM

Time-correct display of voltage and current phasors and power factors of all phases. Incorrect phase sequences false senses of rotation or reverse currents can thus be safely recognised.



### ALARMS

This list displays the statuses of all monitoring functions, possibly including the status of the allocated output. The first entry is the higher-ranking collective alarm which can be reset here.



### WAVEFORM

AM1000 and AM3000 displays the waveform of voltages and currents in additionally.



# DATA RECORDING

The devices may be equipped with a high-performance data logger which has the following recording options in its comprehensive version:

### • PERIODIC DATA

This enables data to be collected at regular intervals, especially for energy management. Average power values and meter readings serve as a basis. Typical applications are the acquisition of load curves (intervals from 10s to 1h) or the determination of energy consumption from the difference of meter readings.

Mean values are recorded in each case with fluctuation bandwidth, i.e. the maximum and minimum RMS values per interval. Mean values can also be recorded for freely selectable basic variables.

Additional basic variables can also be monitored for meter readings, e.g. per phase or only in relation to the fundamental oscillation.

### • EVENTS

The occurrence of self-defined events or alarms is recorded here in list form with time information. In each case, the state transitions or the response and drop-out of limit value states or monitoring functions are registered, classified as alarm or event, or the violation of pre-alarm or alarm limits for the optional temperature and fault current inputs.

### • DISTURBANCE RECORDER (AM1000 / AM3000 ONLY)

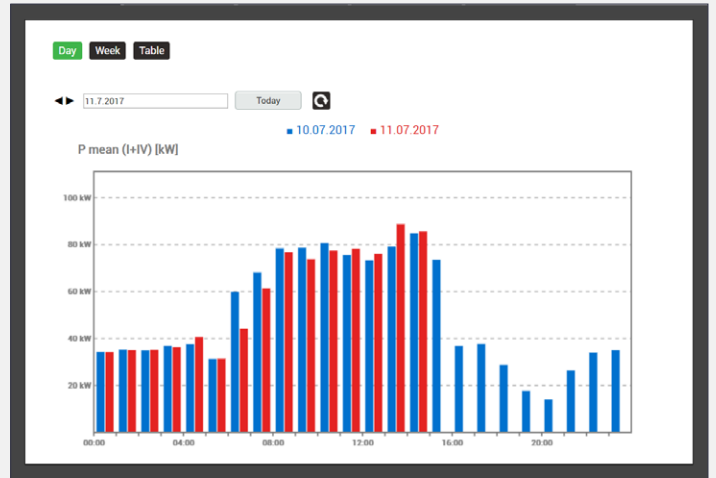
Recording of current and voltage waveforms during disturbances based on 1/2-period RMS values, with additional registration of the waveform during the disturbance. Voltage dips, swells and sags are monitored, according to the requirements of the power quality standard IEC 61000-4-30.

### • AUDIT-LOG

This list, located in the service area, logs all security-relevant operations that could either affect data consistency or endanger IT security. It replaces the operator list of older firmware versions and cannot be deleted or changed by the user. In the audit log, every connection to the device, every login attempt (whether successful or not), every logout (active or on timeout), every change to the device configuration, every reset of data, every firmware update, every display of the audit log, and much more is registered, each with user information.

The content of the audit log can also be sent to a central network monitoring server using the syslog protocol. An example of an audit log is shown in the Cyber Security section.

The memory used allows to save data for several years under normal conditions. If the memory portion allocated to the data groups is full, the oldest data of this group is deleted. Further analyses are possible via the web page of the device.



Current daily load profile with previous day values via web page of the device

Disturbance Logger

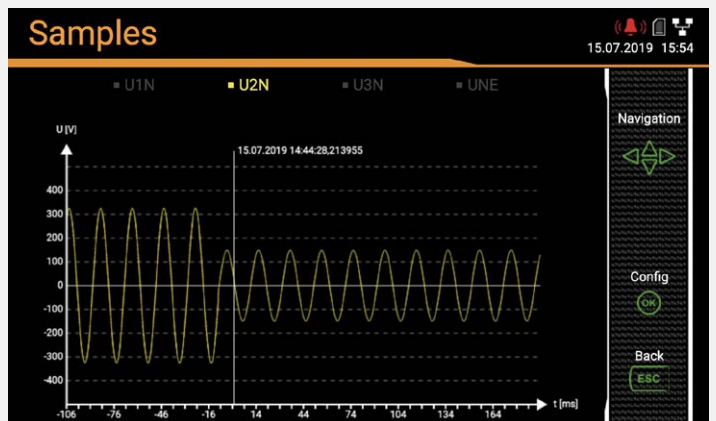
26.12.2020 → 25.01.2021 Latest events

Results per page 25

Filter Voltage swell Voltage dip Voltage interruption

time	Duration [s]	Event type	Trigger channel	Details
25.01.2021 14:52:18,736	9288.759	Voltage dip	U1, U2, U3	Residual voltage: 4342.95 V Depth: 7157.05 V
19.01.2021 16:59:06,310	139.738	Voltage interruption	U1, U2, U3	Residual voltage: 1.19297 V Depth: 11498.8 V
19.01.2021 16:59:06,287	139.785	Voltage dip	U1, U2, U3	Residual voltage: 1.19297 V Depth: 11498.8 V
19.01.2021 16:02:11,681	305.637	Voltage interruption	U1, U2, U3	Residual voltage: 1.20633 V Depth: 11498.8 V
19.01.2021 16:02:11,661	305.677	Voltage dip	U1, U2, U3	Residual voltage: 1.20633 V Depth: 11498.8 V

List of recorded disturbance letters



Indication of voltage dip on local display





# CYBER SECURITY

Critical infrastructures - and this undoubtedly includes the supply of electrical energy - are increasingly the target of cyber attacks. There is not only the attempt of stealing data by unauthorised access or eavesdropping of communication but also the limitation or even interruption of energy supplies by manipulating data or data traffic.

A comprehensive safety concept on plant level comprising each grid component is required to repel such attacks. The safety mechanisms integrated into the device support such concepts, thus contributing to safe energy supplies.

## SAFETY MECHANISMS

- **Role-Based Access Control (RBAC):** Allows different users to be granted individual rights or to restrict them to those activities that correspond to their role. Each available menu item, whether measured value, setting value or service function, can thus be displayed, hidden, changeable or locked. As soon as the RBAC is active, even software can only access data of the device via access keys. During the login process, information is never transmitted in plain text, and the latency time is constantly increased in the event of repeated, unsuccessful login attempts.
- **Encoded data transmission via HTTPS** using root certificates
- **Audit log:** Logging of all activities relevant to safety. Transfer option to central grid monitoring server by Syslog.
- **Client white list:** Limitation of computers with access authorisation
- **Digitally signed firmware files** for secure updates

Time	PID	Priority	IP address	User name	Message
13.01.2021, 14:38:03	cb-gui	Info	192.168.57.69:49270	admin	User logged out successfully
13.01.2021, 14:22:47	cb-gui	Notice	192.168.57.69:63931	admin	User reviewed latest security event log (allow)
13.01.2021, 14:22:32	cb-gui	Notice	192.168.57.69:63933	admin	User logged in successfully
13.01.2021, 14:20:28	cb-gui	Notice	192.168.57.69:63790	anonymous	User reviewed latest security event log (allow)
13.01.2021, 14:07:31	cb-gui	Info	195.49.116.212:62261	admin	User has been logged out due to inactivity
13.01.2021, 13:47:31	cb-gui	Notice	195.49.116.212:60235	admin	User reviewed latest security event log (allow)
13.01.2021, 13:33:11	cb-gui	Notice	195.49.116.212:60136	admin	User logged in successfully
07.01.2021, 11:51:09	cb-gui	Warning	46.126.246.147:1436	admin	Failed login attempt# 3
07.01.2021, 11:49:39	cb-gui	Warning	46.126.246.147:1417	admin	Failed login attempt# 2
07.01.2021, 11:49:30	cb-gui	Warning	46.126.246.147:1419	admin	Failed login attempt# 1

Audit log with filter option

	admin	localgui	anonymous	Operator1	Operator2	Operator3	[API]AccessKey
Local account (no weblogin)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Instantaneous values	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Energy	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Harmonics	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Phasor diagram	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Waveform	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Events	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PQ statistic	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Service	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Reset values	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Reset/Update device	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Audit Log	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Use IO simulation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Settings	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Basic device settings	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Measurement	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Communication	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Security system	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

RBAC access rights of different users



# COMMISSIONING AND SERVICE

A wide range of tools are available via the service menu for safe and simple commissioning and maintenance of the devices. Some are listed below:

### Vector diagram / phase sequence indicator

With these displays, you can easily verify whether the measuring inputs have been correctly connected. Non-conforming rotational directions of voltages and currents, reverse polarity current connections and interchanged current or voltage connections are immediately recognised.

### Simulation

Output values of analog and digital outputs can be simulated during commissioning to test downstream circuits.

### Communication tests

Permit the verification of effected network settings and provide quick answers to these questions:

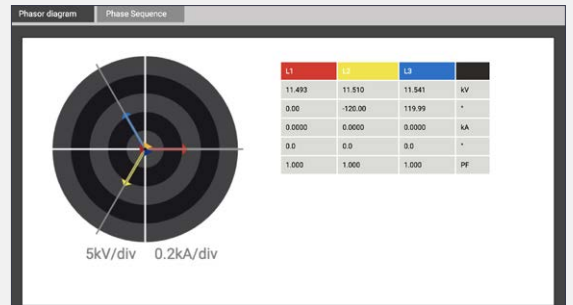
- Can the gateway be reached?
- Can the URL of the NTP server be resolved via DNS?
- Is NTP a time server and is the time synchronisation working?
- Does the data storage on the SFTP server work?

### Operating instructions

The operating instructions are stored in the device as a PDF file and can be opened in the browser or downloaded to a PC at any time. The instructions are respectively updated in any firmware update thus always documenting the implemented state.

### Deletion of data

Recordings of measured data may be selectively deleted or reset. Every one of these activities can be protected via the Role Based Access Control system (RBAC) and is logged with the user identification upon execution.



Vector diagram to control connections

IPv4: Ping

IPv6: Ping

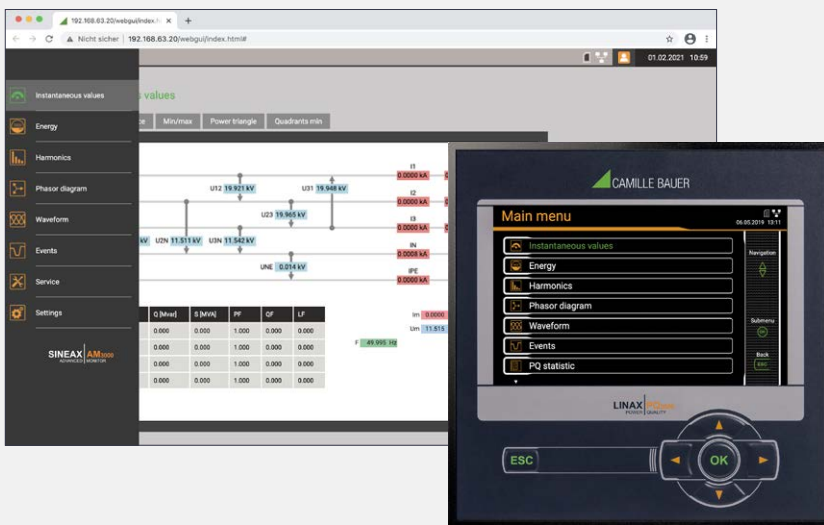
DNS

NTP

SFTP server

Communication tests: Control of network structure

# OPERATION



The local operation at the device itself and the access via web interface are structured identically. The access to

- Measured data
- Service functions
- Settings of the measuring device

can thus be intuitively effected via a topically arranged, language-specific menu structure. The extent of the indicated menu structure may be different for the local display and the device website, if this has been respectively determined via the access control system (RBAC). It might also be necessary that users first log in order to have a menu displayed.

The top-right status bar informs on the current states of alarm monitoring as well as network, access control system, data memory and UPS and also indicates the time and date of the device.



## DATA EXPORT

### Automated

If the device is equipped with a data logger, information about mean value curves (e.g. load curves) can be sent periodically to an SFTP server using the data export scheduler. This is done in the form of CSV files for a selectable time range. Files can alternatively or additionally also be stored locally in the device.

Tasks may be prepared for the generation of files which will then run automatically and are linked to the actions of store locally and / or push to SFTP server. Data locally saved in the device may be transferred to a computer via the device website or the REST interface.

The Secure File Transfer Protocol (SFTP) facilitates the encoded transfer of files. It may also be used for the transmission of measured value information via secured network structures, e.g. via Smart Meter Gateways.

### Manually

If the network structure is not available or for measurement data that cannot be exported automatically, measurement data can also be saved manually to CSV files on a PC via the device's website. This export option is available for event lists, mean value curves, the waveform display or events of the optional disturbance recorder.

Task for daily saving / forwarding of average data

*CSV: Comma Separated Value*

## MONITORING AND ALARMS

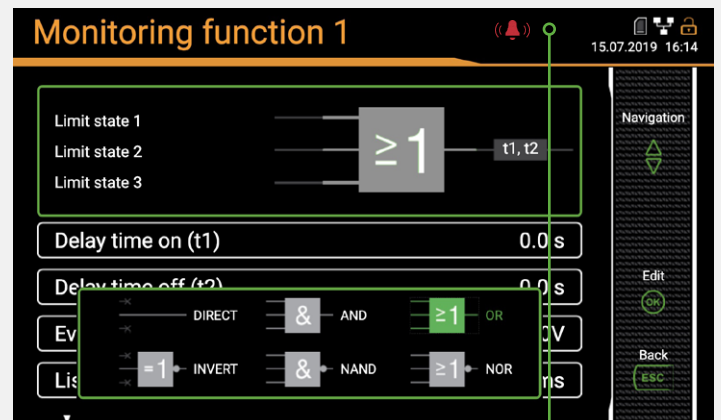
The instruments of the AM series support the on-site analysis of acquired measured data in order to initiate directly immediate or delayed measures without involving a separate control. This facilitates the protection of equipment and also monitoring of service intervals.

The following items are available:

- 12 limit values
- 8 monitoring functions with 3 inputs each
- 1 summary alarm as a combination of all monitoring functions
- 3 operating hour counters with definable running conditions

The available digital outputs may be used directly for the transmission of limit values and monitoring functions as well as the resettable summary alarm.

A text may be allocated to each monitoring function which is used both for the alarm list and the event entries in the datalogger.





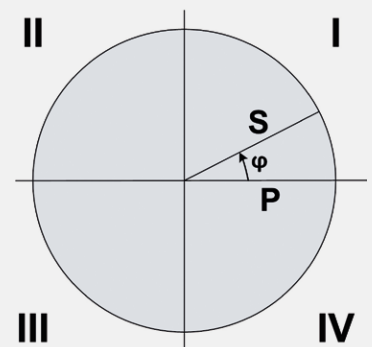
# MEASURED VALUES

MEASURED VALUE GROUP	APPLICATION
<b>INSTANTANEOUS VALUES</b> U, I, IMS, P, Q, S, PF, LF, QF ... Angle between voltage phasors Min/max of instantaneous values with time stamp	Transparent monitoring of present system state Fault detection, connection check, sense of rotation check Determination of grid variable variance with time reference
<b>EXTENDED REACTIVE POWER ANALYSIS</b> Total reactive power, fundamental frequency, harmonics $\cos\phi$ , $\tan\phi$ of fundamental frequency with min values in all quadrants	Reactive power compensation Verification of specified power factor
<b>HARMONICS ANALYSIS (ACCORDING TO EN 61 000-4-7)</b> Total harmonics content THD U/I and TDD I Individual harmonics U/I up to 50 <sup>th</sup>	Evaluation of the thermic load of equipment Analysis of system perturbation and consumer structure
<b>IMBALANCE ANALYSIS</b> Symmetrical components (positive, negative, zero sequence system) Imbalance (from symmetrical components) Deviation from U/I mean value	Equipment overload protection Fault/earth contact detection
<b>ENERGY BALANCE ANALYSIS</b> Meters for the demand/supply of active/reactive power, high/low tariff, meters with selectable fundamental variable Power mean values active/reactive power, demand and supply, freely definable mean values (e.g. phase power, voltage, current and much more). Mean value trends	Preparation of (internal) energy billing Determination of energy consumption versus time (load profile) for energy management or energy efficiency verification Energy consumption trend analysis for load management
<b>OPERATING HOURS</b> 3 operating hour counters with programmable running condition (only AM1000/AM3000) Operating hours of the device	Monitoring of service and maintenance intervals of equipments

## DEMAND / SUPPLY / INDUCTIVE / CAPACITIVE

The devices of the SINEAX AM-SERIES provide information for all of the four quadrants. Depending on whether the measured system is considered from a generator or consumer perspective, the interpretation of the quadrants changes: The energy formed from active power in Quadrants I+IV can then be regarded, e.g., as supplied or demanded active energy. In order to facilitate an independent

interpretation of the 4-quadrant information, the terms demand, supply as well as inductive or capacitive load are avoided in the display of data. They are expressed by stating Quadrant I, II, III or IV or a combination of these. The energy direction may be actively switched by selecting the generator or consumer arrow system. This inverts the direction of all currents.



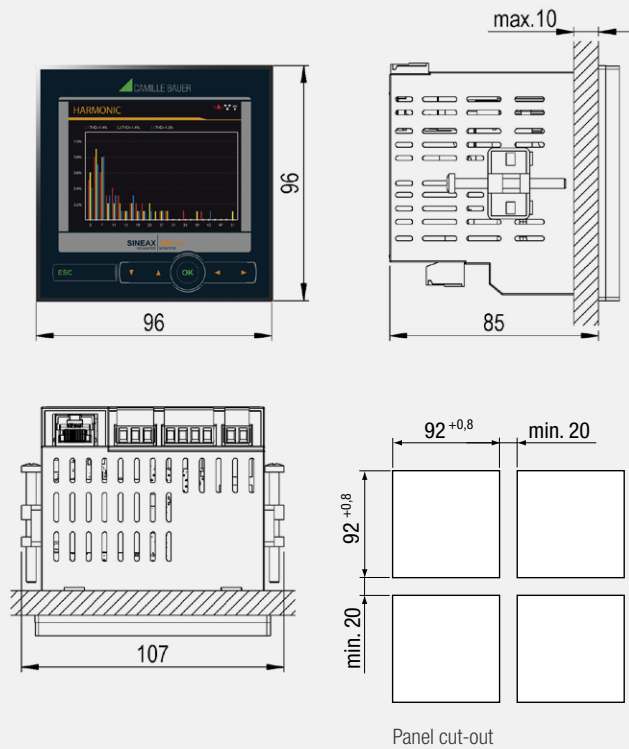


# TECHNICAL DATA

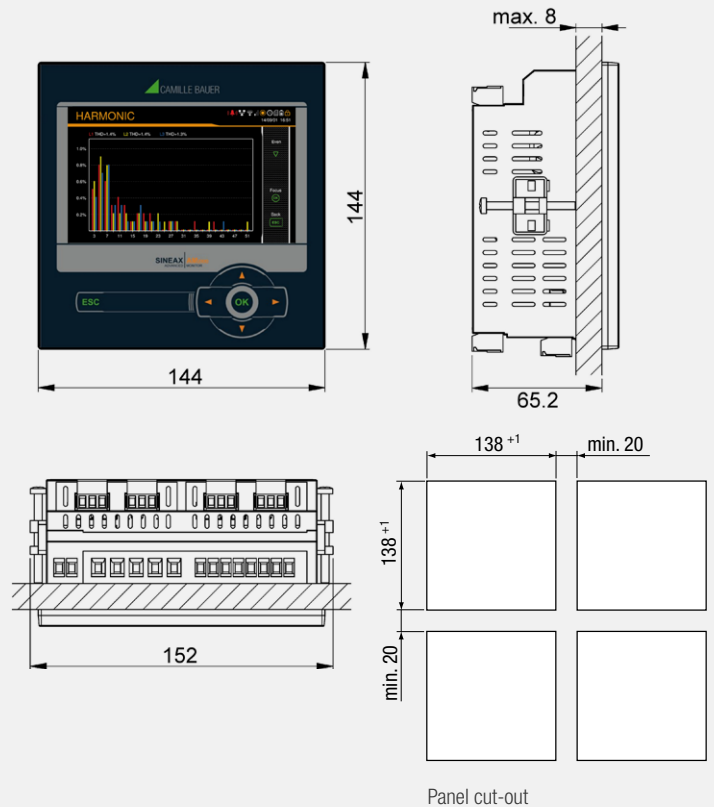
<b>INPUTS</b>		<b>BASIC UNCERTAINTY ACCORDING IEC/EN 60688</b>	
<b>NOMINAL CURRENT</b>	1 ... 5 A (max. 7.5 A)	<b>AM1000/2000</b>	<b>AM3000</b>
Maximum	7.5 A	Voltage, current	±0.2%      ±0.1%
Overload capacity	10 A permanent 100 A, 5x1 s, interval 300 s	Power	±0.5%      ±0.2%
		Power factor	±0.2°      ±0.1°
<b>NOMINAL VOLTAGE</b>	57.7 ... 400 V <sub>LN</sub> , 100 ... 693 V <sub>LL</sub>	Frequency	±0.01 Hz
Maximum	480 V <sub>LN</sub> , 832 V <sub>LL</sub> (sinusoidal)	Imbalance U, I	±0.5%
Overload capacity	480 V <sub>LN</sub> , 832 V <sub>LL</sub> permanent 800 V <sub>LN</sub> , 1386 V <sub>LL</sub> , 10x1 s, interval 10 s	Harmonic	±0.5%
Nominal frequency	42 ... <u>50</u> ... 58 Hz, 50.5 ... <u>60</u> ... 69.5 Hz	THD U, I	±0.5%
<b>SAMPLING RATE</b>	18 kHz	Active energy	Class 0.5S      Class 0.2S      (EN 62 053-22)
<b>POWER SUPPLY VARIANTS</b>		Reactive energy	Class 0.5S      Class 0.5S      (EN 62 053-24)
Nominal voltage	100 ... 230 V AC/DC (AM1000) 110 ... 230 V AC, 130 ... 230 V DC (AM2000/3000) 110 ... 200 V AC, 110 ... 200 V DC (AM2000/3000) 24 ... 48 V DC (AM1000/2000/3000)	<b>INTERFACES</b>	
<b>UNINTERRUPTIBLE POWER SUPPLY (UPS) (ONLY AM3000)</b>		<b>ETHERNET</b>	Standard (AM3000), optional (AM1000/AM2000)
Type (3,7 V)	VARTA Easy Pack EZPackL, UL listed MH16707	Physics	Ethernet 100Base TX; RJ45 socket
Bridging time	5 times 3 minutes	Mode	10/100 Mbit/s, full/half duplex, autonegotiation
		Protocols	Modbus/TCP, http, https, NTP, IPv4, IPv6
<b>TYPES OF CONNECTION</b>		<b>IEC61850</b>	<b>option</b>
Single phase or split phase (2-phase system)		Physics	Ethernet 100Base TX; RJ45 socket, 2 ports
3 or 4-wire balanced load		Mode	10/100 Mbit/s, full/half duplex, autonegotiation
Only AM1000/AM3000: 3-wire balanced load [2U, 1I]		Protocols	IEC61850, NTP
3-wire unbalanced load, Aron connection		<b>PROFINET IO</b>	<b>optional</b>
3 or 4-wire unbalanced load		Conformance class	CC-B
4-wire unbalanced load, Open-Y		Physics	Ethernet 100BaseTX, RJ45-Buchsen, 2 ports
		Mode	10/100 Mbit/s, full/half duplex, auto-negotiation
		Protocol	PROFINET, LLDP, SNMP
<b>I/O-INTERFACE</b>		<b>MODBUS/RTU</b>	Standard (AM2000), optional (AM1000 / AM3000)
<b>ANALOG OUTPUTS</b>	(optional)	Physics	RS-485, max. 1200 m (4000 ft)
Linearization	Linear, kinked	Baud rate	9.6 to 115.2 kBaud
Range	±20 mA (24 mA max.), bipolar	<b>TIME REFERENCE</b>	Internal clock
Accuracy	±0.2% of 20 mA	Clock accuracy	± 2 minutes/month (15 to 30 °C)
Burden	≤ 500 Ω (max. 10 V/20 mA)	Synchronisation	NTP server, GPS or IRIG-B (TTL)
<b>DIGITAL INPUTS PASSIVE</b>		<b>ENVIRONMENTAL CONDITIONS, GENERAL INFORMATION</b>	
Nominal voltage	12/24 V DC (30V max.)	Operating temperature	without UPS: -10 up to 15 up to 30 up to + 55 °C with UPS: 0 up to 15 up to 30 up to + 35 °C (Condition for battery pack loading)
<b>DIGITAL INPUTS ACTIVE</b>	(optional)	Storage temperature	Base device: -25 up to + 70 °C Battery pack UPS: -20 ... 60 °C (<1 month) -20 ... 45 °C (< 3 months) -20 ... 30 °C (< 1 year)
Open circuit voltage	≤ 15V	Temperature influence	0.5 x basic uncertainty per 10 K
<b>DIGITAL OUTPUTS</b>		Long-term drift	0.5 x basic uncertainty per year
Nominal voltage	12/24 V DC (30V max.)	Others	Application group II (EN 60 688)
Nominal current	50 mA (60 mA max.)	Relative air humidity	<95 % without condensation
<b>FAULT CURRENT MONITORING</b>	For grounded systems (optional)	Operating altitude	≤2000 m above MSL
Number of meas. channels	2 (2 measurement ranges each)	Only to be used in buildings!	
Measurement range 1 (1A)	Earth current measurement	<b>MECHANICAL PROPERTIES</b>	
• Measuring transformer	1/1 up to 1/1000 A	Installation position	Control panel installation
• Alarm limit	30 mA up to 1000 A	Housing material	Polycarbonate (Makrolon)
Measurement range 2 (2mA)RCM with connection monitoring		Flammability class	V-0 according UL94, self-extinguishing, not dripping, free of halogen
• Measuring transformer	Residual current transformer 500/1 up to 1000/1 A	Weight	800 g (AM2000/AM3000), 400 g (AM1000)
• Alarm limit	30 mA up to 1 A	<b>SAFETY</b>	
<b>TEMPERATURE INPUTS</b>	(optional)	Current inputs are galvanically isolated from each other.	
Number of channels	2	Protection class	II (protective insulation, voltage inputs via protective impedance)
Measurement sensor	Pt100 / PTC; 2-wire	Pollution degree	2
<b>RELAYS</b>	(optional)	Protection	IP54 (front), IP30 (housing), IP20 (terminals)
Contacts	Changeover contact	Measurement category	U: 600 V CAT III, I: 300 V CAT III
Load capacity	250 V AC, 2 A, 500 VA; 30 V DC, 2 A, 60 W		



**DIMENSIONAL DRAWINGS AM1000**



**DIMENSIONAL DRAWINGS AM2000 / AM3000**



**ORDER CODE**

ORDER CODE AM1000- ....			
3U/3I MEASURING INPUTS, 1 DIGITAL OUTPUT, 1 DIGITAL INPUT OR OUTPUT			
<b>1. BASIC DEVICE</b>		<b>6. EXTENSION</b>	
With TFT display, for control panel installation	1	Without	0
With TFT display, for rail mounting	2	2 relays	1
Without display, for rail mounting	3	2 analog outputs, bipolar (± 20 mA)	2
<b>2. INPUT   FREQUENCY RANGE</b>		4 analog outputs, bipolar (± 20 mA)	3
Current transformer inputs, 42 ... 50/60 ... 69.5 Hz	1	4 digital inputs passive	4
<b>3. POWER SUPPLY</b>		4 digital inputs active	5
Nominal voltage 100 ... 230 V AC/DC	1	Fault current detection, 2 channels	6
Nominal voltage 24 ... 48 V DC	2	GPS connection module	7
<b>4. BUS CONNECTION</b>		Profinet interface	A
Without	0	IEC61850 interface	B
Ethernet (Modbus/TCP + web server)	1	Temperature monitoring, 2 channels	C
RS485 (Modbus/RTU)	2	PME central unit	E
Ethernet (Modbus/TCP + web server) + RS485 (Modbus/RTU)	3	IRIG-B connection module	F
<b>5. DATA LOGGER</b>		<b>7. TEST PROTOCOL</b>	
Without	0	Without	0
Periodic Data + events <sup>1)</sup>	1	Test protocol in German	D
Disturbance recorder + events <sup>1)</sup>	2	Test protocol in English	E
Periodic Data + events + disturbance recorder <sup>1)</sup>	3		

<sup>1)</sup> Datalogger only possible for device variants with Ethernet

ACCESSORIES AM1000, AM2000, AM3000	ARTICLE NO
Interface converter USB <> RS485	163 189
GPS receiver 16x-LVS, configured	181 131
Transformers for fault current detection see accessory current transformers	
PME Rogowski wireless sensor 3P, 3-channel, Ø 75 mm, without batteries	189 281
PME Rogowski wireless sensor 3PN, 4-channel, Ø 75 mm, without batteries	189 273

**ORDER CODE AM2000- .... ..**

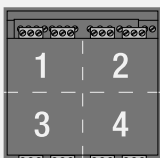
3U/3I MEASURING INPUTS, 1 DIGITAL INPUT, 2 DIGITAL OUTPUTS

<b>1. BASIC DEVICE</b>	
With TFT display, for control panel installation	1
<b>2. INPUT   FREQUENCY RANGE</b>	
Current transformer inputs, 42 ... 50/60 ... 69.5Hz	1
<b>3. POWER SUPPLY</b>	
Nominal voltage 110 ... 230 V AC, 130 ... 230 V DC	1
Nominal voltage 24 ... 48 V DC	2
Nominal voltage 110 ... 200 V AC, 110 ... 200 V DC	3
<b>4. BUS CONNECTION</b>	
Without	0
RS485 (Modbus/RTU slave)	1
RS485 (Modbus/RTU slave) + Ethernet (web server)	2
RS485 (Modbus/RTU slave) + Ethernet (Modbus/TCP protocol + web server)	3
RS485 (Modbus/RTU) + Ethernet (Modbus/TCP + web server) + data logger (periodic data + events)	4
<b>5. EXTENSION 1</b>	
Without	0
2 relays	1
2 analog outputs, bipolar ( $\pm 20$ mA)	2
4 analog outputs, bipolar ( $\pm 20$ mA)	3
4 digital inputs passive	4
4 digital inputs active	5
Fault current detection, 2 channels	6
GPS connection module	7
Temperature monitoring, 2 channels	C
IRIG-B connection module	F
<b>6. EXTENSION 2</b>	
Without	0
2 relays	1
2 analog outputs, bipolar ( $\pm 20$ mA)	2
4 analog outputs, bipolar ( $\pm 20$ mA)	3
4 digital inputs passive	4
4 digital inputs active	5
Fault current detection, 2 channels	6
GPS connection module	7
Profinet interface	A
IEC61850 interface	B
Temperature monitoring, 2 channels	C
PME central unit	E
IRIG-B connection module	F
<b>7. EXTENSION 3</b>	
Without	0
2 analog outputs, bipolar ( $\pm 20$ mA)	2
4 analog outputs, bipolar ( $\pm 20$ mA)	3
4 digital inputs passive	4
4 digital inputs active	5
Fault current detection, 2 channels	6
Temperature monitoring, 2 channels	C
<b>8. EXTENSION 4</b>	
Without	0
2 relays	1
2 analog outputs, bipolar ( $\pm 20$ mA)	2
4 analog outputs, bipolar ( $\pm 20$ mA)	3
4 digital inputs passive	4
4 digital inputs active	5
Fault current detection, 2 channels	6
Temperature monitoring, 2 channels	C
<b>9. TEST PROTOCOL</b>	
Without	0
Test protocol in German	D
Test protocol in English	E

**ORDER CODE AM3000- .... ..**

4U/4I MEASURING INPUTS, 1 DIGITAL INPUT, 2 DIGITAL OUTPUTS, MODBUS/TCP

<b>1. BASIC DEVICE</b>	
With TFT display, for control panel installation	1
<b>2. INPUT   FREQUENCY RANGE</b>	
Current transformer inputs, 42 ... 50/60 ... 69.5Hz	1
<b>3. POWER SUPPLY</b>	
Nominal voltage 110 ... 230 V AC, 130 ... 230 V DC	1
Nominal voltage 24 ... 48 V DC	2
Nominal voltage 110 ... 200 V AC, 110 ... 200 V DC	3
<b>4. BUS CONNECTION</b>	
Ethernet (Modbus/TCP + web server)	1
Ethernet (Modbus/TCP + web server) + RS485 (Modbus/RTU)	2
<b>5. DATA LOGGER</b>	
Without	0
Periodic data + events	1
Disturbance recorder + events	2
Periodic data + events + disturbance recorder	3
<b>6. EXTENSION 1</b>	
Without	0
2 relays	1
2 analog outputs, bipolar ( $\pm 20$ mA)	2
4 analog outputs, bipolar ( $\pm 20$ mA)	3
4 digital inputs passive	4
4 digital inputs active	5
Fault current detection, 2 channels	6
GPS connection module	7
Temperature monitoring, 2 channels	C
IRIG-B connection module	F
<b>7. EXTENSION 2</b>	
Without	0
2 relays	1
2 analog outputs, bipolar ( $\pm 20$ mA)	2
4 analog outputs, bipolar ( $\pm 20$ mA)	3
4 digital inputs passive	4
4 digital inputs active	5
Fault current detection, 2 channels	6
GPS connection module	7
Profinet interface	A
IEC61850 interface	B
Temperature monitoring, 2 channels	C
PME central unit	E
IRIG-B connection module	F
<b>8. EXTENSION 3</b>	
Without	0
2 analog outputs, bipolar ( $\pm 20$ mA)	2
4 analog outputs, bipolar ( $\pm 20$ mA)	3
4 digital inputs passive	4
4 digital inputs active	5
Fault current detection, 2 channels	6
Uninterruptible power supply	8
Temperature monitoring, 2 channels	C
<b>9. EXTENSION 4</b>	
Without	0
2 relays	1
2 analog outputs, bipolar ( $\pm 20$ mA)	2
4 analog outputs, bipolar ( $\pm 20$ mA)	3
4 digital inputs passive	4
4 digital inputs active	5
Fault current detection, 2 channels	6
Temperature monitoring, 2 channels	C
<b>10. TEST PROTOCOL</b>	
Without	0
Test protocol in German	D
Test protocol in English	E

**EXTENSIONS AM2000/AM3000**

Maximum one extension with analog outputs may be provided per device.

Extension 4 only possible for a variant without data logger.



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