Top hat rail device
for the comprehensive
power analysis



The SINEAX DM5000 is a compact instrument to measure and monitor in heavy current grids. It provides a wide range of functionalities which may even be extended by optional components. The connection of the process environment may be performed by communication interfaces, via digital I/Os, analog outputs or relays. The optional display excels in display quality and intuitive on-site operation.
The device has 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 device may be completely adapted to the requirements on site either via web server or the optional TFT display. A special software is neither needed for configuration nor for data visualization.



Version: with display, with UPS



Version: without display, without UPS

	DM5000
Input channels voltage / current	4 / 4
Measurement interval [#cycles]	10/12 (50/60Hz); 1/2
MEASURED VALUES	
Instantaneous values	▪
Extended reactive power analysis	▪
Imbalance analysis	▪
Neutral current	measured / calculated
Earth wire current (calculated)	▪
Zero displacement voltage UNE	measured / calculated
Energy balance analysis	▪
Harmonic analysis	▪ (incl. phase angle)
Operating hour counters device / general	1 / 3
Monitoring functions	▪
Visualisation waveform U/I	▪
MEASUREMENT UNCERTAINTY	(for version with CT inputs)
Voltage, current	±0.1%
Active, reactive, apparent power	±0.2%
Frequency	±10mHz
Active energy	Class 0.2S
Reactive energy	Class 0.5S
DATA LOGGER (Option)	≥16GB
Periodic recording	▪
Event recording	▪
Disturbance recorder (with pretrigger)	
a) 1/2 cycle RMS progression U/I	≤3min.
b) Waveform U/I [#cycles]	5/6 (pretrigger) +10/12
COMMUNICATION	
Ethernet: Modbus/TCP, web server, NTP	(standard)
IEC61850	(option)
PROFINET IO	(option)
RS485: Modbus/RTU	(standard)
Standard I/Os	1 dig. IN ; 2 dig. OUT
Extension modules (optional)	See order codes
POWER SUPPLY	
Nominal voltage	100-230V AC/DC or 24-48V DC
UPS (optional)	5 times 3 minutes
DESIGN	
Colour display	TFT 3,5“ (320x240px)

OPTIONAL EXTENSIONS

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

ANALOG OUTPUTS (4 CHANNELS)
- Bipolar ±20mA, 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

IEC 61850 COMMUNICATION
- Standardized protocol for power distribution systems
- Automatic, configurable reporting of measurement data to a control system

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

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

RELAY OUTPUTS (2 CHANNELS, CHANGEOVER CONTACT)
Special design only on request and for large quantities

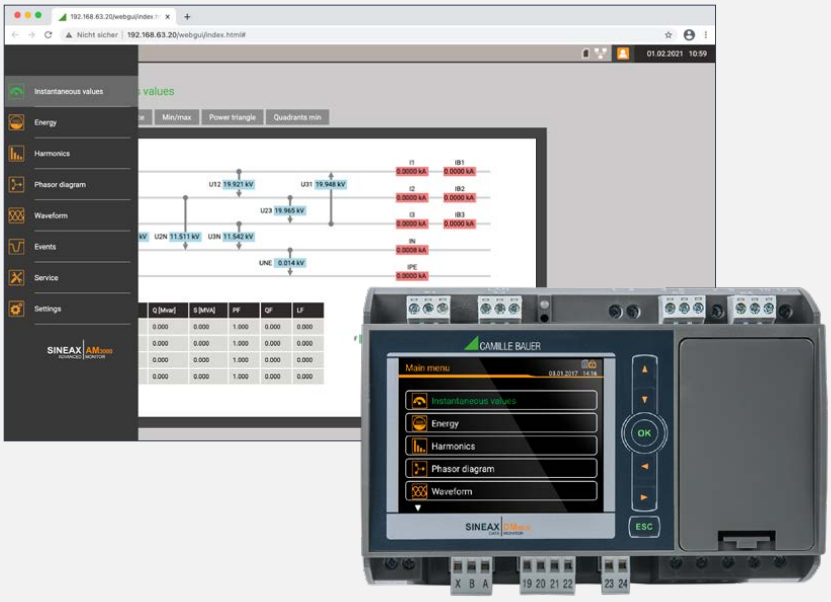
DIGITAL INPUTS (4 CHANNELS)
- Counter pulse acquisition
- Acquire external switching states
- Versions with active or passive inputs

TIME SYNCHRONIZATION
- NTP (standard)

Special version only on request and for large quantities:
- GPS
- IRIG-B

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

OPERATION



The local operation at the device itself (for versions with display) 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.

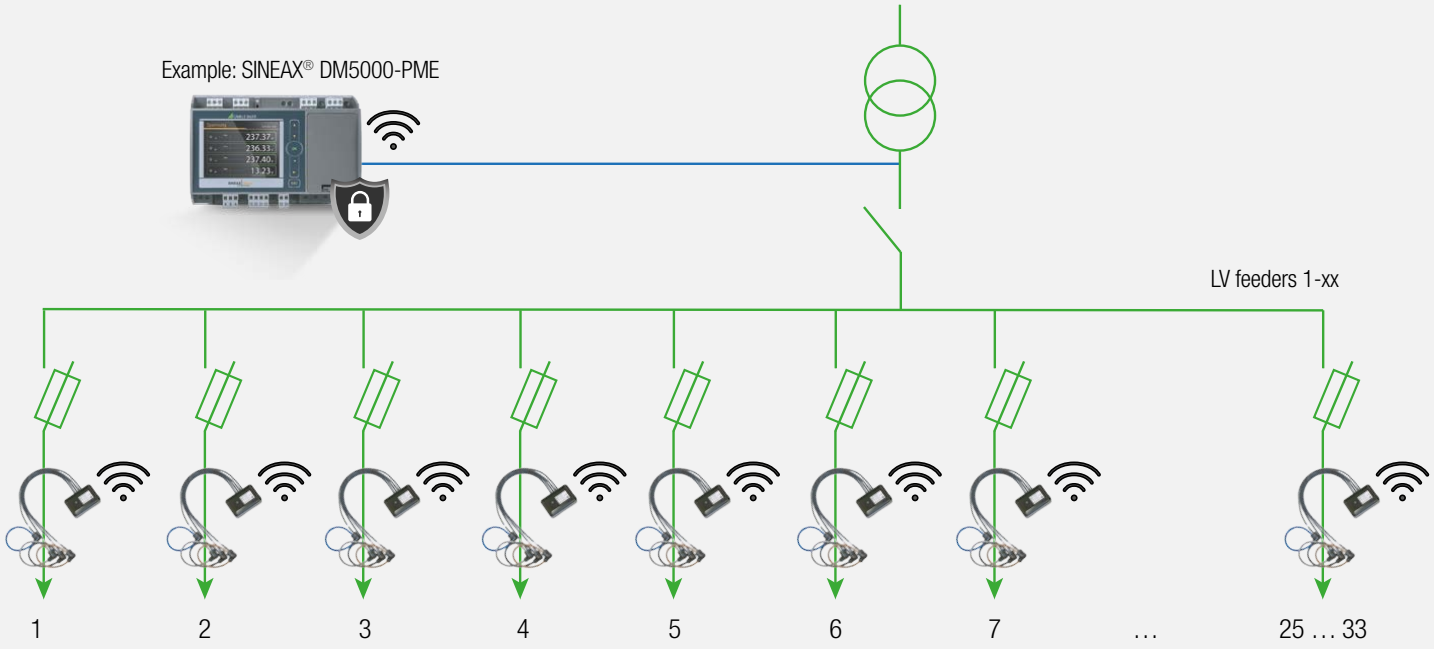
The extent of the indicated menu structure may be different for the local display and the device website, if this has been respectively determined via the access control system (RBAC). It might also be necessary that users first log in order to have a menu displayed.

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.

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 (250 A, 500 A or 1000 A)
- Radio frequency 2.4 GHz, range 10 m
- 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_I, TDD_I, P, Q, Q(H1), S, cosϕ, PF
- Current measurement ± 0.5%, active / reactive energy class 3
- Measurement interval 1 s
- Sampling rate per sensor 6 kHz



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

DATA RECORDING

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

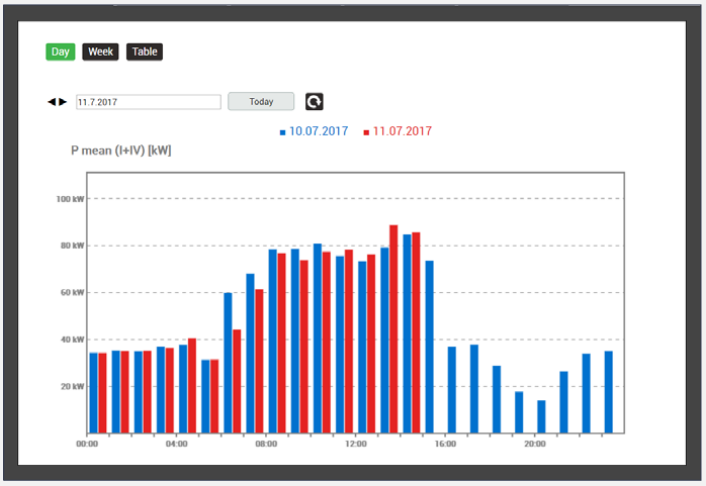
- **PERIODIC DATA**
  This enables data to be collected at regular intervals, especially for energy management. Average power values and meter readings serve as a basis. Typical applications are the acquisition of load curves (intervals from 10s to 1h) or the determination of energy consumption from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

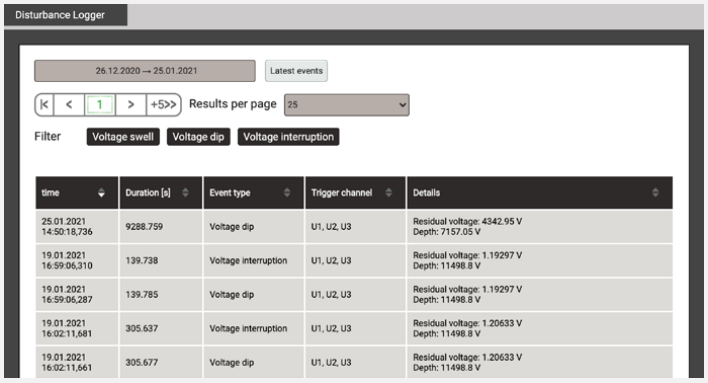
- **DISTURBANCE RECORDER**
  Recording of current and voltage waveforms during disturbances based on 1/2-cycle RMS values, with additional registration of the waveform during the disturbance. Voltage dips, swells and sags are monitored, according to the requirements of the power quality standard IEC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

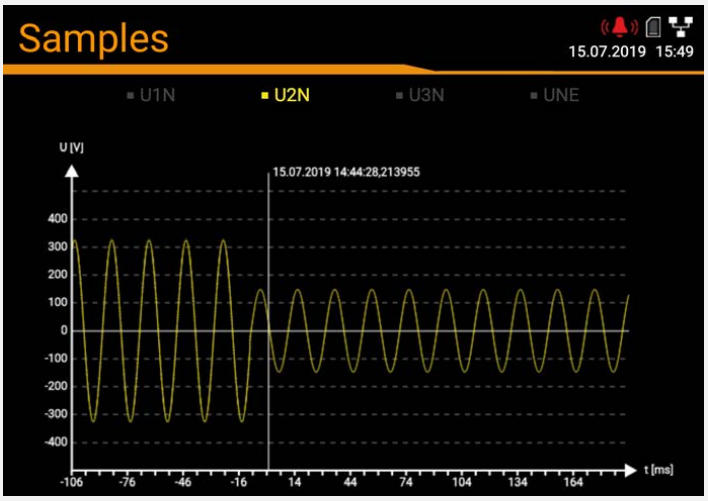
The memory used allows to save data for several years under normal conditions. If the memory portion allocated to the data groups is full, the oldest data of this group is deleted. Further analyses are possible via the web page of the device.



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



List of recorded disturbance letters



Indication of voltage dip on local display

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

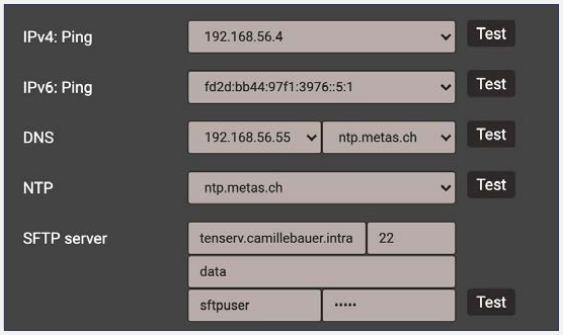
The operating instructions are stored in the device as a PDF file and can be opened in the browser or downloaded to a PC at any time. The instructions are respectively updated in any firmware update thus always documenting the implemented state.

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



Communication tests: Control of network structure

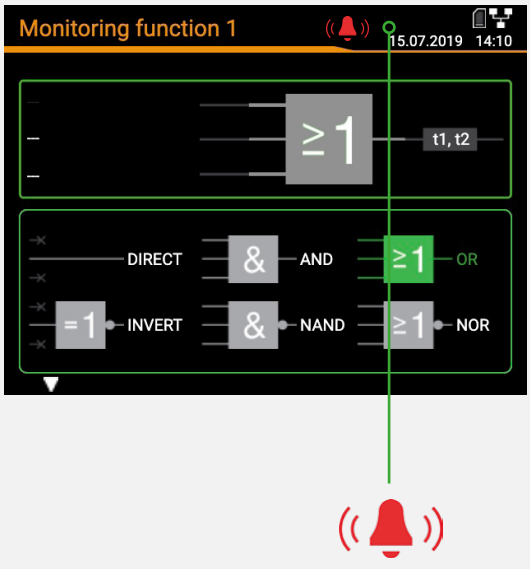
MONITORING AND ALARMS

The instruments of the DM5000 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 collective 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 collective 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.



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

MEASURED VALUES

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

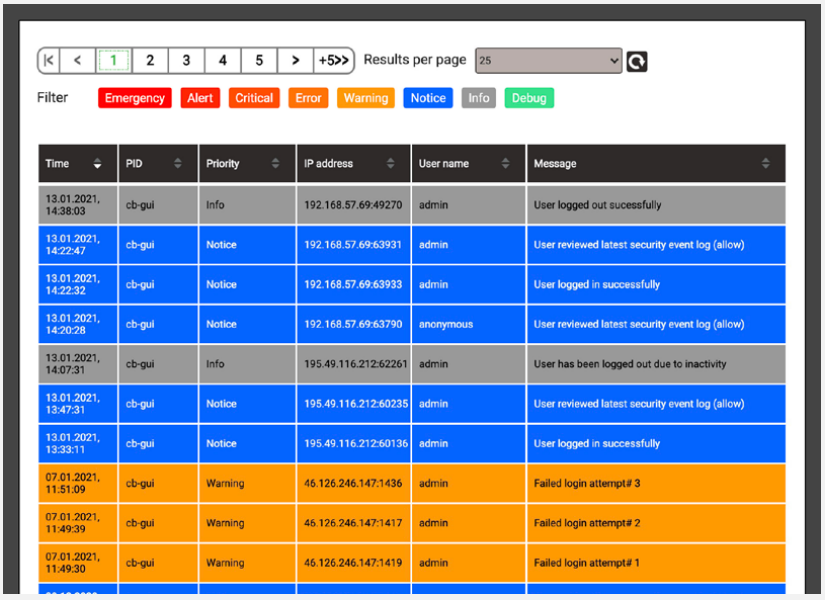
CYBER SECURITY

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.

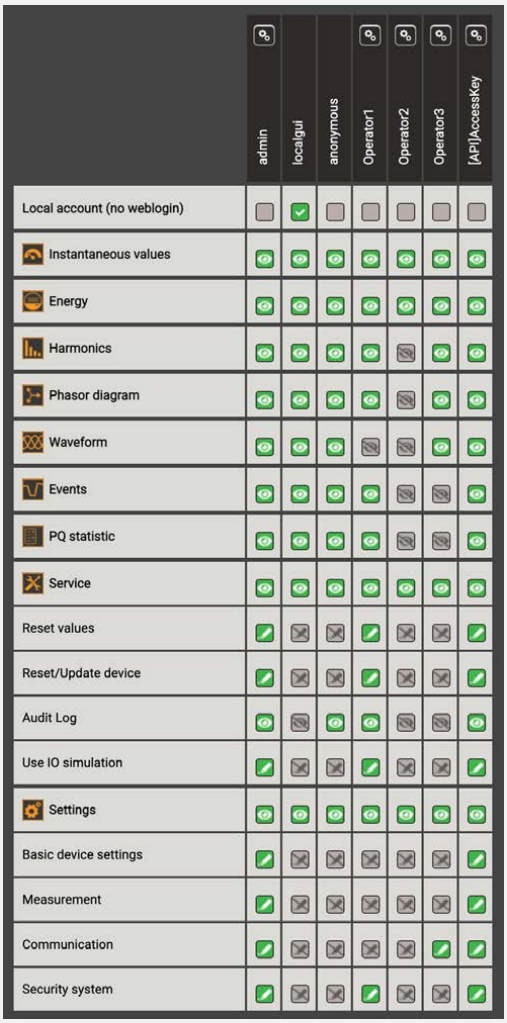
A comprehensive safety concept on plant level comprising each grid component is required to repel such attacks. The safety mechanisms integrated into the device support such concepts, thus contributing to safe energy supplies.

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



Audit log with filter option



RBAC access rights of different users

TECHNICAL DATA

Some of the technical features are only available on request.

INPUTS

NOMINAL CURRENT	1 … 5 A (max. 7.5 A)
Maximum	7.5 A
Overload capacity	10 A permanent 100 A, 5x1 s, interval 300 s

Current measurement via Rogowski coils

Measurement range	0…3000A (max. 3800A)

See operating instructions of Rogowski coil ACF 3000 for further information

NOMINAL VOLTAGE	57.7 … 400 V_{LN}, 100 … 693 V_{LL}
Maximum	520 V_{LN}, 900 V_{LL} (sinusoidal)
Overload capacity	520 V_{LN}, 900 V_{LL} permanent 800 V_{LN}, 1386 V_{LL}, 10x1 s, interval 10 s
Nominal frequency	42 … 50 … 58 Hz, 50.5 … 60 … 69.5 Hz
SAMPLING RATE	18 kHz

POWER SUPPLY VARIANTS

Nominal voltage	100 … 230 V AC/DC or 24 … 48 V DC
Consumption	≤ 27 VA, ≤ 12 W

UNINTERRUPTIBLE POWER SUPPLY (UPS) (optional)

Type (3,7 V)	VARTA Easy Pack EZPAckL, UL listed MH16707
Bridging time	5 times 3 minutes

TYPES OF CONNECTION

Single phase or split phase (2-phase system)
3 or 4-wire balanced load
3-wire balanced load [2U, 1I]
3-wire unbalanced load, Aron connection
3 or 4-wire unbalanced load
4-wire unbalanced load, Open-Y

I/O-INTERFACE

ANALOG OUTPUTS	(optional)
Linearization	Linear, kinked
Range	±20 mA (24 mA max.), bipolar
Accuracy	±0.2% of 20 mA
Burden	≤ 500 Ω (max. 10 V/20 mA)

DIGITAL INPUTS PASSIVE

Nominal voltage	12/24 V DC (30 V max.)

DIGITAL INPUTS ACTIVE	(optional)
Open circuit voltage	≤ 15 V
Short circuit current	< 15 mA
Current at R_{ON} = 800 Ω	≥ 2 mA

DIGITAL OUTPUTS

Nominal voltage	12/24 V DC (30 V max.)
Nominal current	50 mA (60 mA max.)

FAULT CURRENT MONITORING	For grounded systems (optional)
Number of meas. channels	2 (2 measurement ranges each)
Measurement range 1 (1A)	Earth current measurement
• Measuring transformer	1/1 up to 1/1000 A
• Alarm limit	30 mA up to 1000 A
Measurement range 2 (2mA)	RCM with connection monitoring
• Measuring transformer	Residual current transformer 500/1 up to 1000/1 A
• Alarm limit	30 mA up to 1 A

TEMPERATURE INPUTS	(optional)
Number of channels	2
Measurement sensor	Pt100 / PTC; 2-wire

RELAYS	(optional)
Contacts	Changeover contact
Load capacity	250 V AC, 2 A, 500 VA; 30 V DC, 2 A, 60 W

BASIC UNCERTAINTY ACCORDING IEC/EN 60688

VERSION WITH ROGOWSKI CURRENT INPUTS
The additional uncertainty of the Rogowski coils ACF 3000 is not included in the following specifications: See operating instructions of Rogowski coil ACF 3000_x/24.

Voltage, current	±0.1 %
Power	±0.2 %
Power factor	±0.1°
Frequency	±0.01 Hz
Imbalance U, I	±0.5 %
Harmonic	±0.5 %
THD U, I	±0.5 %
Active energy	Class 0.2S (IEC 62053-22: 2003)
Reactive energy	Class 0.5S (IEC 62053-24: 2014)

INTERFACES

ETHERNET	Standard
Connection	RJ45 socket
Physics	Ethernet 100Base TX
Mode	10/100 MBit/s, full/half duplex, autonegotiation
Protocols	Modbus/TCP, http, https, NTP, IPv4, IPv6
IEC61850	**optional**
Physics	Ethernet 100BaseTX, RJ45 sockets, 2 ports
Mode	10/100 Mbit/s, full/half duplex, auto-negotiation
Protocols	IEC 61850, NTP
PROFINET IO	**optional**
Conformance class	CC-B
Physics	Ethernet 100BaseTX, RJ45-Buchsen, 2 ports
Mode	10/100 Mbit/s, full/half duplex, auto-negotiation
Protocols	PROFINET, LLDP, SNMP
MODBUS/RTU	Standard
Physics	RS-485, max. 1200 m (4000 ft)
Baud rate	9.6 to 115.2 kBaud
TIME REFERENCE	Internal clock
Clock accuracy	± 2 minutes/month (15 to 30°C)
Synchronisation	NTP server, GPS or IRIG-B (TTL)

ENVIRONMENTAL CONDITIONS, GENERAL INFORMATION

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)
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)

Temperature influence	0.5 x basic uncertainty per 10 K
Long-term drift	0.5 x basic uncertainty per year
Others	Application group II (EN 60 688)
Relative air humidity	<95 % without condensation
Operating altitude	≤2000 m above MSL

Only to be used in buildings!

MECHANICAL PROPERTIES

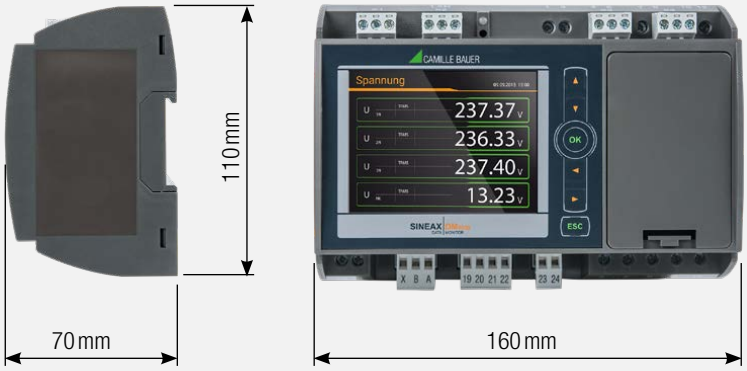
Mounting	Top hat rail 35 x 15 or 35 x 7.5 mm
Housing material	Polycarbonate (Makrolon)
Flammability class	V-0 according UL94
Weight	600 g

SAFETY

Current inputs are galvanically isolated from each other.

Protection class	II (protective insulation, voltage inputs via protective impedance)
Pollution degree	2
Protection	IP40 (front), IP30 (housing), IP20 (terminals)
Measurement category	U: 600 V CAT III, I: 300 V CAT III

DIMENSIONAL DM5000



ORIENTATION DM5000



Not allowed for device versions with uninterruptible power supply

ORDER CODE

SINEAX® DM5000, Multifunctional Power Monitoring Device (PMD)

Basic device		Input frequency range		Power supply		Bus interface	Standard protocol	Uninterruptible power supply		Standard I/Os		Data logger		Extension 1							Type code	Test certificate	Article number
Whitout display, for top-hat rail mounting	With TFT display, for hat-rail mounting	4 current inputs, 42..50/60..69.5Hz	Rogowski inputs, 50/60 Hz	Nominal voltage 100...230 V AC/DC	Nominal voltage 24...48 V DC	Ethernet (TCP/IP) + RS485 (RTU)	REST Interface + Modbus	Without UPS	With UPS	1 Digitaler Eingang passiv	2 Digitale Ausgänge passiv	Without data logger	Periodical data + events	Without extesion 1	4 analog outputs +/-20mA	Profinet interface	IEC61850 interface	Temperature monitoring, 2 channels	PME central unit	IRIG-B connection module	Without Extension 2	Test certificate English	
•	-	-	•	•	-	•	•	•	-	•	•	•	-	•	-	-	-	-	-	-	•	•	193145
•	-	-	•	•	-	•	•	•	-	•	•	-	•	-	-	-	-	-	•	-	•	•	193153
-	•	•	-	•	-	•	•	•	-	•	•	•	-	-	•	-	-	-	-	-	•	•	193161
-	•	-	•	•	-	•	•	•	-	•	•	-	•	-	-	-	-	-	•	-	•	•	193169
•	-	•	-	•	-	•	•	•	-	•	•	•	-	-	•	-	-	-	-	-	•	•	193177
-	•	•	-	•	-	•	•	•	-	•	•	•	-	-	-	-	•	-	-	-	•	•	193185

ACCESSORIES		ARTICLE NO.
Rogowski coil, single-phase, ACF3000_4/24,	Ø 200mm, 2m	172 718
Rogowski coil, single-phase, ACF3000_4/24,	Ø 200mm, 2m	173 790
Rogowski coil, single-phase, ACF3000_67/13_L1,	Ø 100mm, 2.5m	191 585
Rogowski coil, single-phase, ACF3000_67/13_L2,	Ø 100mm, 2.5m	191 593
Rogowski coil, single-phase, ACF3000_67/13_L3,	Ø 100mm, 2.5m	191 601
Rogowski coil, single-phase, ACF3000_67/13_N,	Ø 100mm, 2.5m	191 609

ACCESSORIES	ARTICLE NO.
Interface converter USB <> RS485	163 189
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