UNIVERSAL MEASURING UNIT FOR HEAVY CURRENT VARIABLES

CONTROLLING ANALYZING METERING

SINEAX CAM
THE UNCOMPROMISING MEASUREMENT SOLUTION

The universal measurement system of the CAM is designed for a high-precision and disturbance insensitive measurement in multi-phase heavy current systems. The consistent (uninterrupted) measurement records reliably each change in the monitored mains. With its unique combination of hardware and software modules this measuring device provides a solution for each measurement task. The adaption to this task is performed quick and easy by means of the CB-Manager software.

**MEASUREMENT ADAPTABLE TO APPLICATION**

The speed CAM is working with resp. is relaying measured data to the corresponding outputs, can be configured almost freely. But it has to be adapted to the specific application. Broadly spoken: The more the signal differs from the ideal sine wave, the longer the averaging interval of the measurement should be selected.

**RESPONSE TIMES (AT 50HZ, 1 CYCLE AVERAGING)**

<table>
<thead>
<tr>
<th>RESPONSE TIMES</th>
<th>MIN.*</th>
<th>MAX.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured data at Modbus-/USB interface</td>
<td>37 ms</td>
<td>57 ms</td>
</tr>
<tr>
<td>Analogue outputs</td>
<td>47 ms</td>
<td>67 ms</td>
</tr>
<tr>
<td>Digital outputs (via logic module)</td>
<td>45 ms</td>
<td>65 ms</td>
</tr>
<tr>
<td>Relay outputs (via logic module)</td>
<td>67 ms</td>
<td>87 ms</td>
</tr>
</tbody>
</table>

* Response time to changes of the input. But: Refreshing of the values after each system cycle.

The accuracy (IEC/EN 60 688), the device can achieve under reference conditions, amounts to:

**CONTROLLING - ANALYZING - METERING**

The evaluation and analysis functions of the CAM provide a huge number of measured quantities, which may be grouped as follows:

- Instantaneous values: An image of the present system state. External quantities (like temperatures or circuit states) can be acquired via the I/O interface. The logic module provides comprehensive analysis and alarming facilities for these data.
- System analysis: To determine the additional burden for operating resources due to harmonics (originating from non-linear loads) or heating effects which occur due to unbalanced system load.
- Energy consumption: Active and reactive energy as well as mean-values with trend are provided. Using the data logger also the variance of the load in the course of time may be recorded, perhaps in terms of load profiles or as extreme values within a billing interval.
- Recording with time: Alarms, events, operator actions, extreme values (minimum + maximum).
FREE COMPOSITION OF THE REQUIRED FUNCTIONS

CAM BASIC DEVICE AS INITIAL POSITION

- Measurement system: 3 voltages and 4 currents
- Modbus/RTU- and USB interface for service, configuration and measurement acquisition
- 2 relay outputs
- Logic module for monitoring/control
- Security system for granting access rights for up to 3 users
- Synchronizable real-time clock as time base
- Operating hours counter

CUSTOMER SPECIFIC ADAPTION WITH OPTIONS

- I/O interface: analog and digital I/Os
- Data logger for measurement recordings for longer time periods
- Lists: Recording of alarms, events and system messages
- Graphic display: for measurement display and alarm handling
- Modbus/TCP communication via Ethernet
- IEC 61850 communication via Ethernet

ADAPTED FREQUENCY RANGE

The more exact the fundamental frequency can be measured the more stable and more precise are the measurement results. Superimposed lower frequency components (as flicker), harmonics and ripple control signals can make the determination quite difficult. The best possible results can be achieved by using narrow-edged bandpass filters to filter out disturbing components. To do so the frequency range of the application must be restricted. Three different ranges are available:

- 45...50/60...65 Hz
  Application in the energy supply of distribution networks or in industrial plants. Rated frequencies of 50 and 60 Hz are covered, with the possible variations which may occur during steady operation.

- 10...50/60...70 Hz
  Using this version also the dynamic behaviour of aggregates can be monitored, which are used for distributed energy supplies, e.g. on ships. Due to its high dynamic this version is predestined for the application in test stands, to monitor e.g. the behaviour during start-up or load changes. Another application field is the measurement behind frequency converters.

- 10...50/60...140 Hz
  This version covers the full application range of frequency converters, as they are used nowadays for different purposes in drive engineering.

ROGOWSKI VERSION

Current measurement: Voltage inputs with rated value 5 V AC, measurement up to max. 10 V AC
PARAMETRIZATION, SERVICE AND MONITORING

The CB-Manager software provides to the user the following functions:
• Complete parametrization of the CAM (also offline)
• Acquisition and recording of measured quantities
• Archiving of configuration and measurement files
• Setting or resetting of meter contents
• Selective reset of extreme values
• Setting of interface parameters
• Adjustment of analog inputs
• Simulation of all I/O module functions
• Comprehensive help system

A security system can be activated to restrict the access to the device. This way e.g. the simulation or setting of limit values may be granted for selected users only.

MONITORING AND ALARMING USING THE LOGIC MODULE

The logic module is a unique system, which allows to combine any logic state and to derive desired actions. It consists of up to 32 logic functions with 3 inputs each. Here an overview of the possibilities:

- up to 64 limit values
- States of digital inputs
- Predefined states via bus
- Results of logic functions

POSSIBLE APPLICATIONS

- Changeovers of operating modes like local/remote (day/night) or normal/test
- Peak load optimization
- Recording: Alarms, events, acknowledgments, switching of consumers ON/OFF etc.
- Complex measurement analysis including external measurement data and state information
- Remote control: digital and relay outputs may be used for alarming or control functions via bus interface, independent of the normal device function.
I/O INTERFACE

POSSIBILITIES AND APPLICATIONS
I/O modules can be assembled according to individual needs. Up to 4 modules with selectable functionality may be used. Five different hardware modules are available.

ANALOGUE OUTPUTS
- ±20 mA
  - 2 outputs per module
  - 0/4...20 mA
  - 2 outputs per module
    - On-site display via analog display units
    - Heavy-current measurements for PLC

ANALOGUE INPUTS
- 0/4...20 mA
  - 2 outputs per module
    - Acquisition of ext. quantities, e.g. temperature
    - Automatic metering of input quantity
    - Scalable, e.g. 4…20 mA to 0…100 °C
    - Scaled measurement displayable on graphic display and requestable via interface

DIGITAL OUTPUTS
- 12/24 VDC
  - 3 outputs per module (switchable to inputs)
    - Alarming output of the logic module
    - State reporting
    - Pulse output (S0) to external counter
    - Remote controllable

DIGITAL INPUTS
- 48/125 VDC
  - 3 inputs per module (only in position 4)
    - Acquisition of external state information
    - Trigger or release signal for logic module
    - Pulse input for metering

ACCESSOIRES

EX-FACTORY ROGOWSKI CURRENT SENSORS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>ARTICLE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single phase, ACP FLEX 3000_5, 2m, Ø194mm, measurement ranges 30/300/3000 A, 9 V supply via CAM</td>
<td>169 426</td>
</tr>
<tr>
<td>Three-phase, ACP FLEX 3003_5, 2m, Ø194mm, measurement ranges 30/300/3000 A, 9 V supply via CAM</td>
<td>169 434</td>
</tr>
</tbody>
</table>

The connection wires of these current sensors are equipped with end splices and therefore can be directly connected to the screw terminals of the CAM.
LONG-TERM RECORDINGS AND LOGGING

The data logger allows to perform long-term recordings of measurement progressions or load profiles, e.g. to monitor the variable load of transformers, feeders or transmission lines. In addition to the recording of mean-values, fluctuations of instantaneous values may be registered to recognize load peaks at the earliest possible moment.

By means of the automatical meter reading a time synchronous reading of the meter contents of all devices may be performed, e.g. on a weekly, monthly or three months base. These values can be stored for any desired time, thus allow determining the energy consumption per time for billing purposes.

APPLICATION

- Recording of energy demands based on billing interval (load profiling)
- Acquisition of measurement fluctuations per billing interval
- Monitoring of feeders and transformers
- Gathering energy consumption by time synchronous meter readings
- Summary analysis using the CB-Analyzer software
- Recording of disturbances

LISTS: LOGGING OF ALARMS AND EVENTS

Lists allow a chronological recording of events, alarms and system messages. Each change of the system state and each access to the device can thus be reproduced and analyzed at a later time in a correct sequence. Each entry in the lists is time stamped.

Alarms and events can be defined in the logic module. A text can individually be assigned and is used for the list entry and for the display on the graphic display.

System events, such as power supply failure, changes of the device configuration or simulation of outputs, are predefined events. Their occurrence will be recorded automatically.

All lists are protected against manipulations. Therefore the user has no possibility to delete them directly.

The provided memory can be freely allocated to lists and logger. A modification of the configuration, such as adding alarms, events or more mean-values, has no impact on the consistency of the logger. By no means previous logged data get lost.

Operator list example in the CB-Analyzer software
VISUALIZATION, ALARM HANDLING AND DATA ANALYSIS

MEASUREMENT DISPLAY
The display is intended for the visualization of measured data and entries of the alarm, event or operator list. Also state information or measurement information of the I/O interface may be displayed. The user can customize the display almost freely to his individual needs. If necessary a preference display or an automatic sequence of different pages can be defined as well. The navigation is done using the easy to operate keypad.

ALARM HANDLING ON-SITE
Alarms can be configured to be displayed on-site and, if desired, to be acknowledgeable. This way a production may be monitored and controlled or an overload protection of operating resources may be realized. By means of the logic module the alarming can be redirected to a headquarter if no operators are on-site.

RESET FUNCTIONS
Via keypad meters and extreme values may be reset. The right to perform such operations can be restricted using the security system integrated in the device. If the system is activated, users must log-on first via display.

FAST COMMUNICATION VIA ETHERNET (MODBUS/TCP)
To be able to analyze the huge amount of measured data in real-time, a transmission medium with high bandwidth is necessary. Ethernet provides this high performance. CAM supports the protocols Modbus/TCP and NTP.

Modbus/TCP is a commonly used protocol for an easy access to configuration or measurement data. It is supported by a large number of visualization software tools and thus allows a fast implementation of the device. Via the Modbus/TCP interface all functions are supported, which are possible using the Modbus/RTU or USB interface.

So in addition to the measurement acquisition also the configuration of the device, as well as simulation, setting and resetting functions for measured data and I/Os are supported.

For the time synchronization of devices via Ethernet, NTP (Network Time Protocol) is the standard. Respective time servers are used in computer networks and are at free disposal via Internet as well. By means of NTP all devices can be used with a common time base.

APPLICATIONS
• Test stands for aggregates. Recording of the dynamic behaviour of motors and generators
• Remote monitoring and acquisition of power distribution systems via Intranet/Internet
• Recording of the dynamic loading of energy supply systems

POSSIBLE SETTINGS
The user can modify display features, interface parameters and settings of the clock via keypad. This way the device may be adapted optimally to the environmental conditions on-site.

User specific display
Display of harmonics
Alarm list entry
The communication standard IEC 61850 ("Communication networks and systems in substations") is the new standard for substation automation. Each possible device or system function is standardized and mapped in so-called logical nodes (LN's). Also the complete communication and the engineering process are stated. So a high grade of independence from manufacturers is achieved. The field of application is situated in switchgears and transformer substations in the medium and high voltage area.

The group Metering and Measurement includes those nodes, which are specific for a measuring device like the CAM. As far as applicable also the node GGIO (Generic process I/O) is provided. Along with the measured data intended by the standard further values are attached in terms of private extensions.

**MEASURED DATA**

CAM provides the following logical nodes:

**MMXU / MMXN:** Instantaneous values of voltages, currents, frequency, powers and load factors as well as their maximum and minimum values. MMXU is used for asymmetrical 3 and 4 wire systems, MMXN for single phase and balanced load 3 and 4 wire systems.

**MHAI / MHAN:** Individual harmonics for voltages and currents, THD (total harmonic distortion) and TDD (total demand distortion) and their maximum values. MHAI is used for asymmetrical 3 and 4 wire systems, MHAN for single phase and balanced load 3 and 4 wire systems.

**MMTR:** Active and reactive energy meters for incoming and outgoing power. One instance for both high and low tariff.

**MSTA:** Mean values of voltage, current, active, reactive and apparent power as well as their maximum and minimum values on instantaneous values base. All measured within the same interval. These values are provided for each phase as well.

**MSQI:** Imbalance of voltages and currents, calculated in accordance with two different methods.

**GGIO:** Maps the information of assembled analog and digital input modules. For each input an instance of GGIO processes state information, a measured quantity or metering pulses from an external device.

**APPLICATION FIELD**

The CAM with IEC 61850 support is a measuring device which bases on the use of conventional current and voltage transformers. Therefore it is most suitable for the modernization of substations, not touching the already installed conventional transformers.

**GATEWAY FUNCTIONALITY**

CAM not only provides measured data of the monitored system. It may be used as an IEC 61850 gateway as well. By means of GGIO instances state information (e.g. ON/OFF or a self-monitoring signal), analog measurements (e.g. a temperature) or metering pulses (kWh/kVArh) of non IEC 61850 capable external devices can be handled. These measurement data then can be accessed via the IEC 61850 interface.
**TECHNICAL DATA**

**Rated frequency:** 50/60 Hz  
**Measurement TRMS:** Up to the 63rd harmonic  
**Measurement category:** 300 V CATIII, 600 V CATII

### CURRENT MEASUREMENT
- **Rated current:** 1 A (+ 20 %), 1 A (+ 100 %), 5 A (+ 20 %), 5 A (+ 100 %)  
- **Overriding max.:** 10 A (sinusoidal)  
- **Consumption:** ≤ I<sub>2</sub> x 0.01 Ω per phase  
- **Thermal ratings:** 12 A continuous, 100 A, 10 x 1 s, interval 100 s

Instead of current inputs, the version for Rogowski coils provides voltage inputs of nominal 5 V (max. 10 V).

### VOLTAGE MEASUREMENT
- **Rated voltage:** 57.7 ... 400 VLN, 100 ... 693 VLL  
- **Overriding max.:** 600 V LN, 1040 VLL (sinusoidal)  
- **Consumption:** ≤ U<sub>2</sub>/3 MΩ per phase  
- **Input impedance:** 3 MΩ per phase  
- **Thermal ratings:** 480 V LN, 832 VLL continuous, 600 V LN, 1040 VLL, 10 x 10 s, interval 10 s, 800 V LN, 1386 VLL, 10 x 1 s, interval 10 s

### TYPES OF CONNECTION
- **Single-phase, 1L**  
- **Split phase (2 phase system), 2L**  
- **3-wire system, balanced load, 3Lb**  
- **3-wire system, unbalanced load, 3Lu**  
- **3-wire system, unbalanced load (Aron), 3Lu.A**  
- **4-wire system, balanced load, 4Lb**  
- **4-wire system, unbalanced load, 4Lu**  
- **4-wire system, unbalanced load (Open-Y), 4Lu.O**

### BASIC ACCURACY UNDER REFERENCE CONDITIONS IEC/EN 60 688
- **Voltage, current:** ± 0.1 % FS a)  
- **Power:** ± 0.2 % FS b)  
- **Power factor:** ± 0.1°  
- **Frequency:** ± 0.01 Hz  
- **Voltage unbalance U:** ± 0.2 %  
- **Harmonics:** ± 0.5 %  
- **THD Voltage:** ± 0.5 %  
- **TDI Current:** ± 0.5 %  
- **Active energy:** Class 1 / EN 62 053-21 (direct connection)  
- **Active energy:** Class 2 / EN 62 053-21 (transformer connection)  
- **Reactive energy:** Class 2 / EN 62 053-23

a) FS: Maximum value of the input configuration (Full Scale)  
b) FS: Voltage x FS-CURRENT

### POWER SUPPLY
- **Option 1**  
  - **AC, 50 - 400 Hz:** 100 ... 230 V ± 15 %  
  - **DC:** 100 ... 230 V ± 15 %  
  - **Consumption:** ≤ 10 W resp. ≤ 20 VA
- **Option 2**  
  - **DC:** 24 ... 60 V ± 15 %  
  - **Consumption:** ≤ 10 W

### INTERFACES
- **Modbus connection (plug-in screw terminals 1, 2, 3)**  
  - **Protocol:** Modbus RTU  
  - **Physics:** RS-485, max. 1200 m (4000 ft)  
  - **Baudrate:** configurable 1.2 till 115.2 kBaud  
  - **Number of bus stations:** ≤ 32
- **USB connection (USB Mini-B, 5 contacts)**  
  - **Protocol:** USB 2.0  

### ENERGY METERS (HIGH AND LOW TARIFF)

#### ACTIVE ENERGY
<table>
<thead>
<tr>
<th></th>
<th>Incoming</th>
<th>Outgoing</th>
</tr>
</thead>
</table>

#### REACTIVE ENERGY
<table>
<thead>
<tr>
<th></th>
<th>Incoming</th>
<th>Outgoing</th>
<th>Inductive</th>
<th>Capacitive</th>
</tr>
</thead>
</table>

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Universal measuring unit for heavy current variables
**I/O-INTERFACE**

**RELAYS**
- Contacts: Changeover contact
- Load capacity: 250 V AC, 2 A, 500 VA
  - 30 V DC, 2 A, 60 W

**ANALOG OUTPUTS**
- Active
- Linearization: Linear, quadratic, kinked
- Range:
  - 0/4...20 mA (24 mA max.), unipolar
  - ± 20 A (24 mA max.), bipolar
- Accuracy: ± 0.1 % of 20 mA
- Burden: ≤ 500 Ω (max. 10 V / 20 mA)
- Burden influence: ≤ 0.1 %
- Residual ripple: ≤ 0.2 %
- Galvanic isolation: From all other connections (connected within group of terminals)

**ANALOG INPUTS**
- Range: 0/4...20 mA (24 mA max.) unipolar
- Accuracy: ± 0.1 % von 20 mA
- Input resistance: < 40 Ω
- Galvanic isolation: From all other connections (connected within group of terminals)

**DIGITAL INPUTS/OUTPUTS**

Via software configurable as passive inputs or outputs

**Inputs (acc. EN 61 131-2 DC 24V Type 3):**
- Rated voltage: 12/24 V DC (30 V max.)
- Input current: < 7.0 mA
- Counting frequency (S0): ≤ 50 Hz
- Logical ZERO: – 3 till + 5 V
- Logical ONE: 8 till 30 V
- Switching limit: approx. 6.5 V / 2.6 mA

**Outputs (partly acc. EN 61 131-2):**
- Rated voltage: 12/24 V DC (30 V max.)
- Rated current: 50 mA (60 mA max.)
- Switching frequency (S0): ≤ 20 Hz
- Leakage current: 0.01 mA
- Voltage drop: < 3 V
- Load capacity: 400 Ω ... 1 MΩ
- Fuse: Self-regulating

**DIGITAL INPUTS 125 V DC**
- Rated voltage: 48/125 V DC (157 V max.)
- Input current: < 2.5 mA
- Counting frequency (S0): ≤ 50 Hz
- Logical ZERO: – 6 till + 20 V
- Logical ONE: 30 till 157 V
- Switching limit: approx. 25 V / 0.8 mA

**INTERNAL CLOCK (RTC)**
- Accuracy: ± 2 minutes / month (15 till 30 °C), trimmable via PC software
- Synchronisation via: Measurement input, HV-input, synchronization pulse
- Running reserve: > 10 years

**MECHANICAL ATTRIBUTES**
- Orientation: Any
- Housing material: Polycarbonate (Makrolon)
- Flammability class: V-0 acc. UL94, self-extinguishing, non-dripping, free of halogen
- Weight: 500 g

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**SYSTEM ANALYSIS QUANTITIES**

### MEASURED QUANTITY

<table>
<thead>
<tr>
<th>Present</th>
<th>1L</th>
<th>2L</th>
<th>3LB</th>
<th>3LU</th>
<th>4LB</th>
<th>4LU</th>
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</tbody>
</table>

**THD U (Total Harmonic Distortion):** Harmonic content related to the fundamental of the RMS value of voltage.

**TDD I (Total Demand Distortion):** Harmonic content related to the fundamental of the RMS value of the rated current.

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**DIMENSIONAL DRAWING**

*SINEAX CAM in housing clipped onto a top-hat rail (35 x 15 mm or 35 x 7.5 mm). Terminals partly pluggable.*

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**AMBIENT CONDITIONS, GENERAL INFORMATION**

- Operating temperature: – 10...15...30...55 °C
- Storage temperature: – 25 till + 70 °C
- Variations due to ambient temperature: 0.5 x basic accuracy per 10 K
- Long term drift: 0.2 x basic accuracy per year
- Others: Usage group II according IEC/EN 60688
- Relative humidity: < 95 % no condensation
- Altitude: ≤ 2000 m max.
- Indoor use statement!
ORDER CODE

SINEAX CAM, PROGRAMMABLE, MODBUS INTERFACE, USB CAM -

1. BASIC DEVICE CAM, FOR TOP-HAT RAIL MOUNTING
   Without display 1
   With graphic display 2
   Without display, with Rogowski current inputs (3V) 3
   With graphic display and Rogowski current inputs (3V) 4
   Without display, with Rogowski current inputs (4.5V) 5
   With graphic display and Rogowski current inputs (4.5V) 6
   Without display, with Rogowski current inputs (6V) 7
   With graphic display and Rogowski current inputs (6V) 8
   Without display, with Rogowski current inputs (9V) 9
   With graphic display and Rogowski current inputs (9V) A

2. INPUT FREQUENCY RANGE
   45 … 50/60 … 65 Hz 1
   10 … 50/60 … 70 Hz 2
   10 … 50/60 … 140 Hz 3

3. POWER SUPPLY
   Nominal range 100 … 230 V AC/DC 1
   Nominal range 24 … 60 V DC 2

4. I/O-MODUL 1 (TERMINALS 41-44)
   Not used 0
   2 analogue outputs, unipolar (0/4…20 mA) 1
   2 analogue inputs (0/4…20 mA) 2
   3 digital outputs or 3 digital inputs 24 V DC 3
   2 analogue outputs, bipolar (± 20 mA) 5

5. I/O-MODUL 2 (TERMINALS 51-54)
   Not used 0
   2 analogue outputs, unipolar (0/4…20 mA) 1
   2 analogue inputs (0/4…20 mA) 2
   3 digital outputs or 3 digital inputs 24 V DC 3
   2 analogue outputs, bipolar (± 20 mA) 5

6. I/O-MODUL 3 (TERMINALS 61-64)
   Not used 0
   2 analogue outputs, unipolar (0/4…20 mA) 1
   2 analogue inputs (0/4…20 mA) 2
   3 digital outputs or 3 digital inputs 24 V DC 3
   2 analogue outputs, bipolar (± 20 mA) 5

7. I/O-MODUL 4 (TERMINALS 71-74)
   Not used 0
   2 analogue outputs, unipolar (0/4…20 mA) 1
   2 analogue inputs (0/4…20 mA) 2
   3 digital outputs or 3 digital inputs 24 V DC 3
   2 Analogausgänge, bipolar (± 20 mA) 5

8. TEST CERTIFICATE
   without 0
   Test certificate in german D
   Test certificate in english E

9. OPTION DATA LOGGER
   Without data logger 0
   With data logger 1

10. OPTION LISTS
    Without alarm, event, operator list 0
    With alarm, event, operator list 1

11. BUS INTERFACE
    Without 0
    Ethernet, Modbus/TCP protocol 1
    Ethernet, IEC 61850 protocol 2

Universal measuring unit for heavy current variables