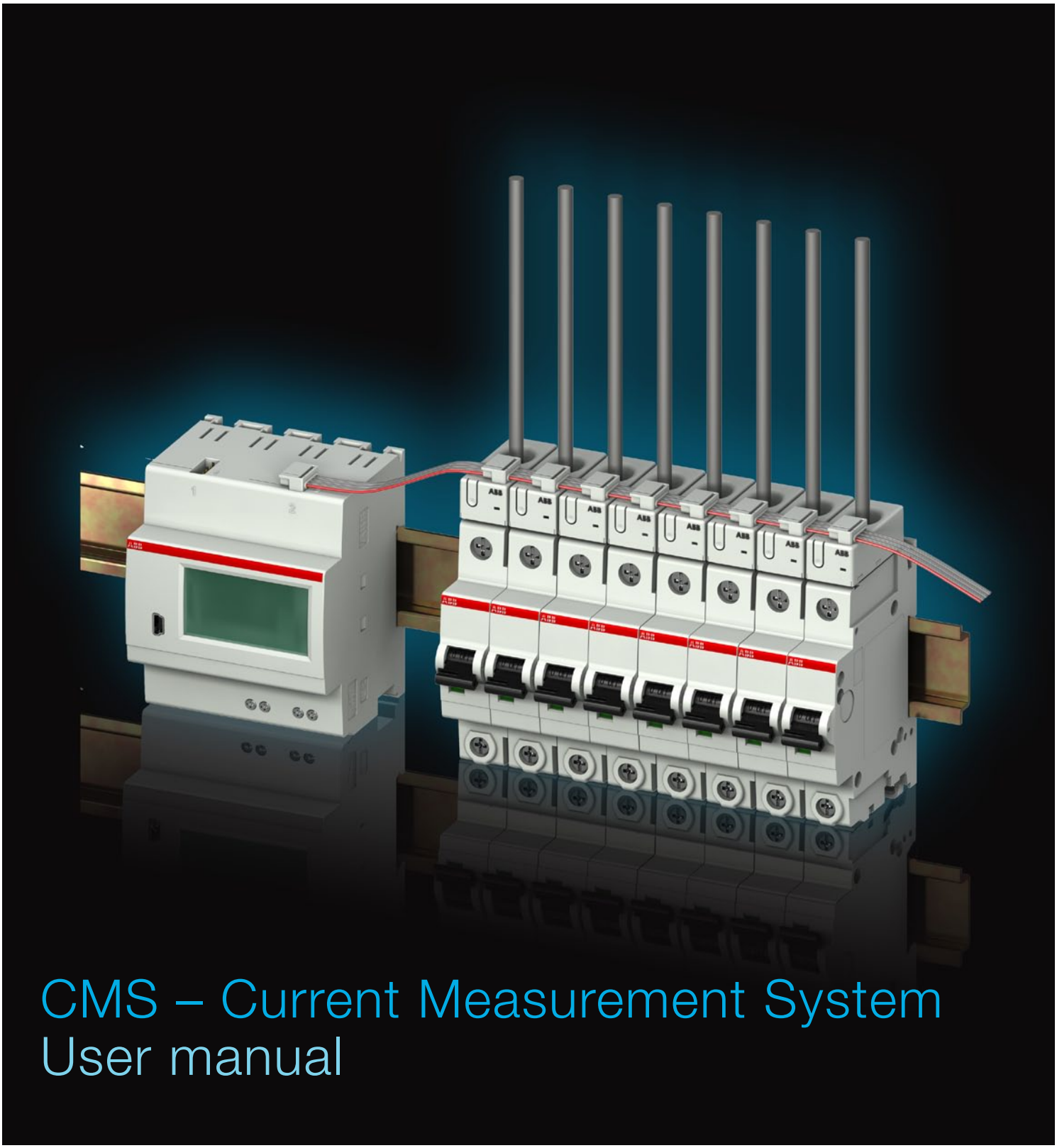


CMS – Current Measurement System
User manual

Power and productivity
for a better world™

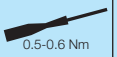
Safety Precautions

Warning
Failure to follow these instructions could result in death, personal injury or property damage. The device should be installed by a qualified person only. If the components or devices do not appear to be in a proper condition, they must be replaced.

Disposal

Faulty products should be treated as hazardous waste and disposed of in an appropriate manner. National or regional regulations regarding the disposal of hazardous waste should be adhered to.

Meaning of symbols

	Warning May cause death or serious injury
	Information that is useful or important but not relevant to safety
	European conformity mark
	Torque
	Mind the instructions in the user manual
	Disposal

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Trademark

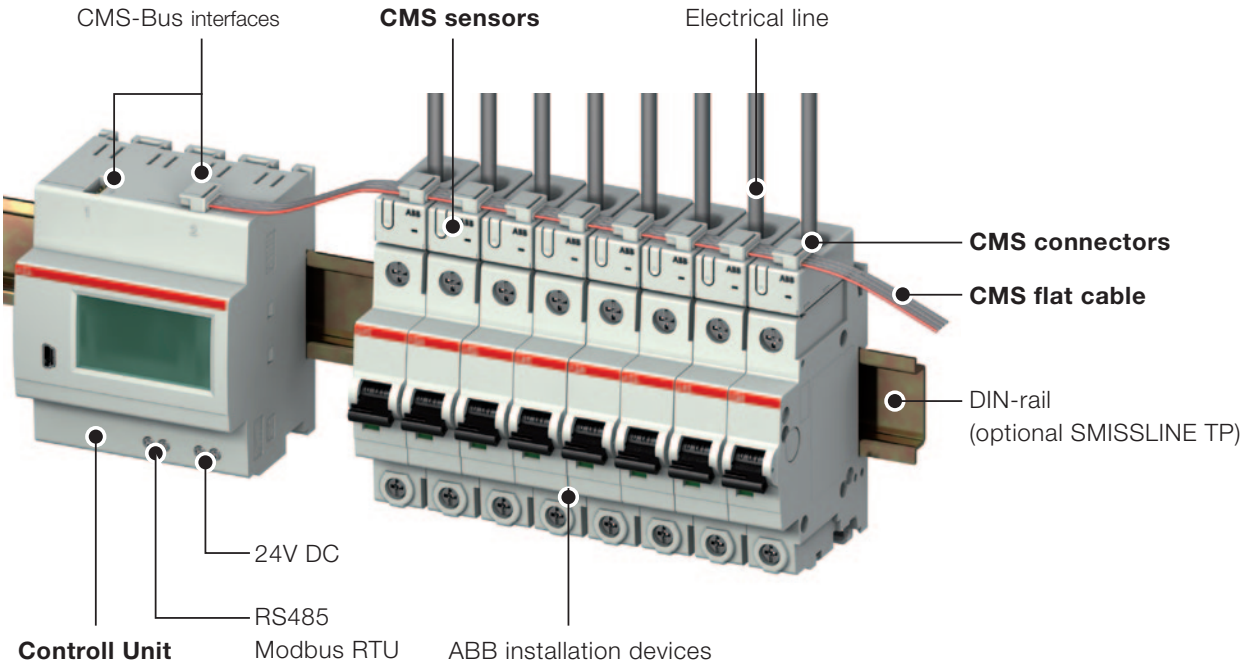
Table of content

Intended use

The CMS is a system for current measurement of electrical lines.

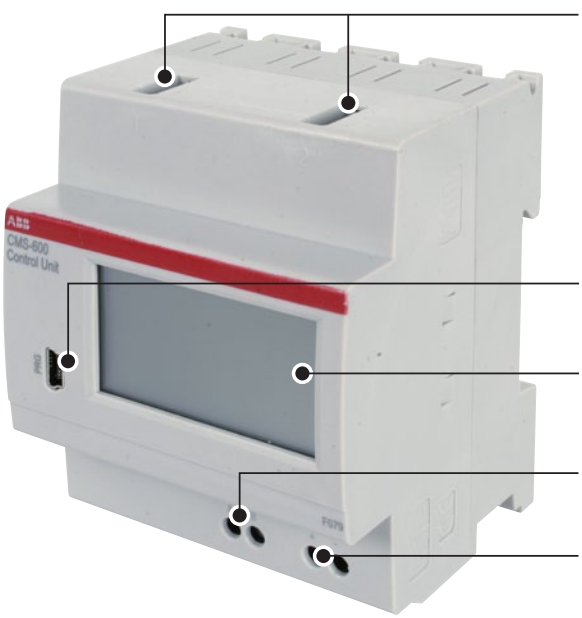
The system consists of a Control Unit and sensors with different measurement ranges (20 A, 40 A 80 A). The sensors measure alternating, direct and mixed currents (TRMS). The sensors get connected to the Control Unit by a flat cable. You can remotely query the measurement data via a RS485 interface (Modbus RTU).

System overview

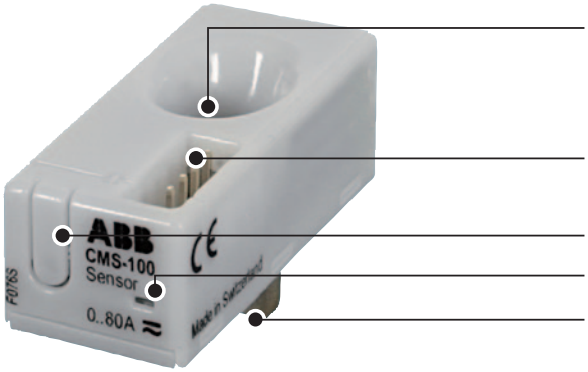


Scope of delivery

Control Unit CMS-600



Sensors CMS-100PS, CMS-101PS, CMS-102PS



i

LED status

• on	normal operation
• slow blinking	sensor is not added to the system
• fast blinking	sensor is selected, ID is shown on touch display

Flat cable CMS-800

Connector set CMS-820

35 x Connector housing

35 x Connector

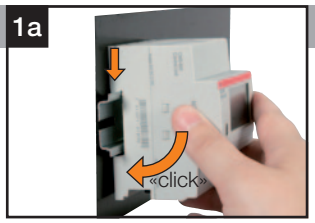
Mounting and cabling

Mounting the Control Unit

i

- remove rapid fixation (RAFIX) before mounting on SMISSLINE TP

1a



DIN-rail mounting

oder **1b**

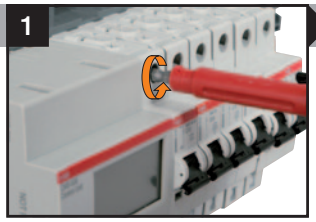
SMISSLINE TP mounting

Mounting the sensors

i

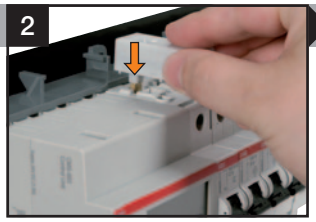
- sensors fit to all the ABB installation devices with twin terminals
- The cable should not exert force to the sensor, otherwise measuring errors are possible

1



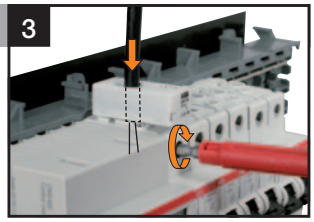
Unscrew the terminal of the installation device

2



Plug in the metal pin of the sensor into the rear terminal connection

3



Put cable through opening of sensor into installation device. The cable has to be isolated within the range of the sensor. Then tighten the srew.

Compatible devices for the sensors

Device	MCB	RCBO	RCCB
			
pro M compact	S200	F200	DS201
SMISSLINE TP	S400	F400	FS400

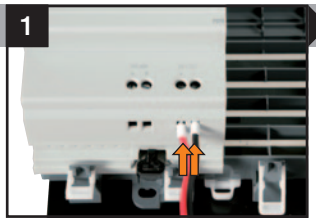
Mounting and cabling

Cabling the Control Unit

i

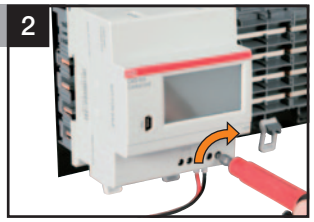
Connecting terminals for 24 V DC and RS485
- max. cable cross-section 2,5 mm²
- stripping length 13 mm
- current consumption of Control Unit max. 1.5 A

1



Insert cables into the connecting terminals

2



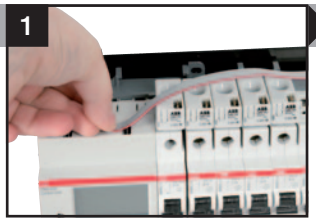
Tighten the screws

Cabling the sensors

i

- use the connectors only once
- connect a max. number of 32 sensors to each Control Unit CMS-Bus interface
- do not exceed a maximum line length of 2m (CMS-800)

1

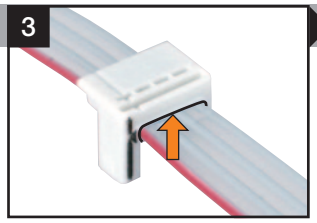


Put the flat cable onto the CMS-Bus interfaces

2

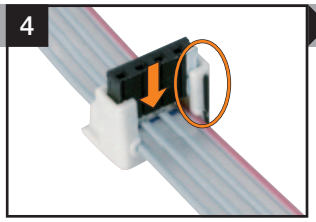
Mark the desired placement of the connectors with a pen

3



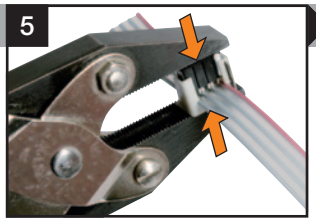
Press the flat cable into the cable duct of the connector housing

4



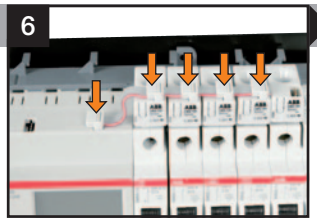
Put the connector at the position of the marking into the connector housing. Mind the white/black markings.

5



Press togehter the connector and the connector housing with a parallel pliers tool. Repeat that process at the other markings.

6



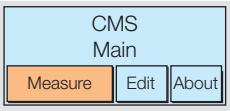
Plug the connectors to the Control Unit and the sensors

7 ✓ **7** ✗

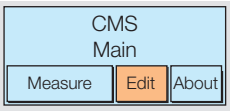
Plug the connectors to the sensors with the longer side to the left

Control Unit

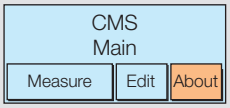
Menu overview



Measurement functions of Control Unit

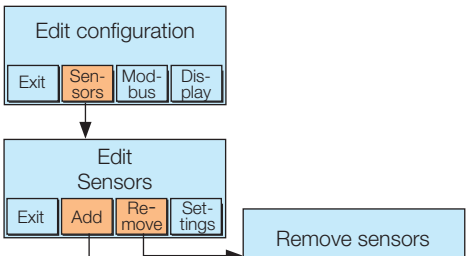


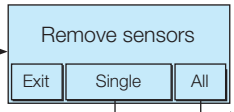
Add and remove sensors, change DC-polarity, Modus configuration, Display configuration

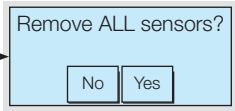


Shows serialnumber, hard- and softwareversion of Control Unit

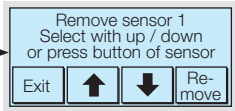
Add and remove sensors



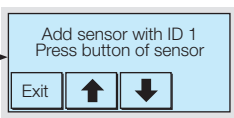




«Yes» to remove all sensors



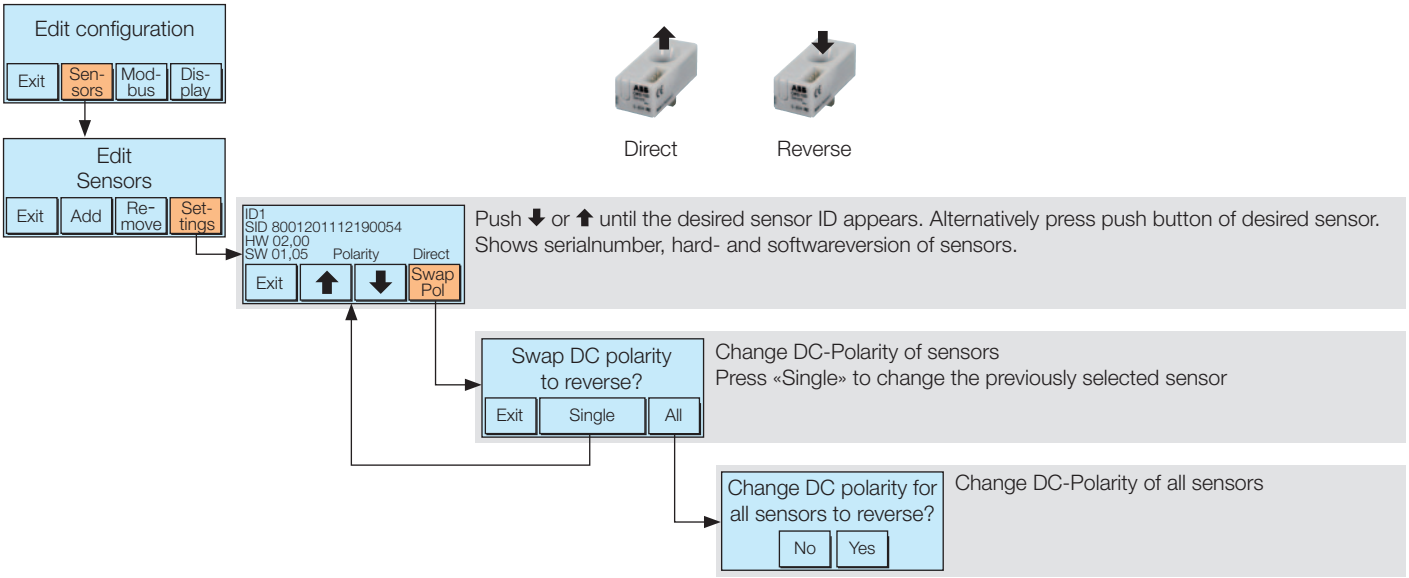
Remove single sensors
Push ⬇ or ⬆ until the desired sensor ID appears. Alternatively press push button of desired sensor.
Press «Remove» to remove the selected sensor.



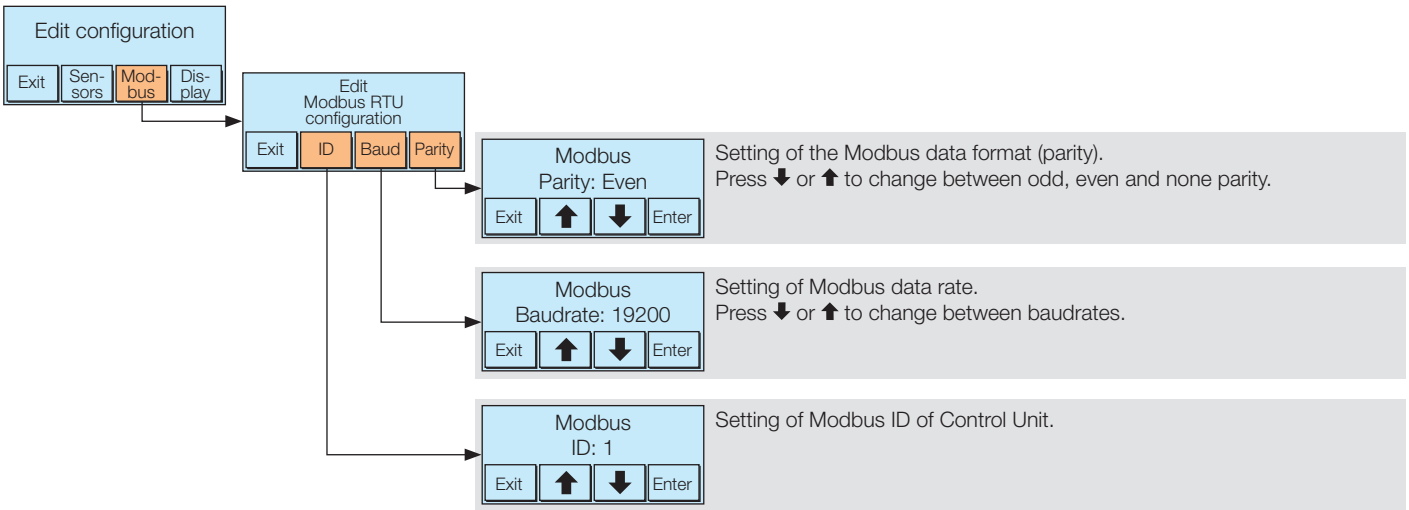
Push ⬇ or ⬆ until the desired sensor ID appears. Press push button of desired sensor to add sensor to the system.
ℹ If sensor has an ID already, ID will be replaced.

Control Unit (continued)

Change DC-Polarity of sensors

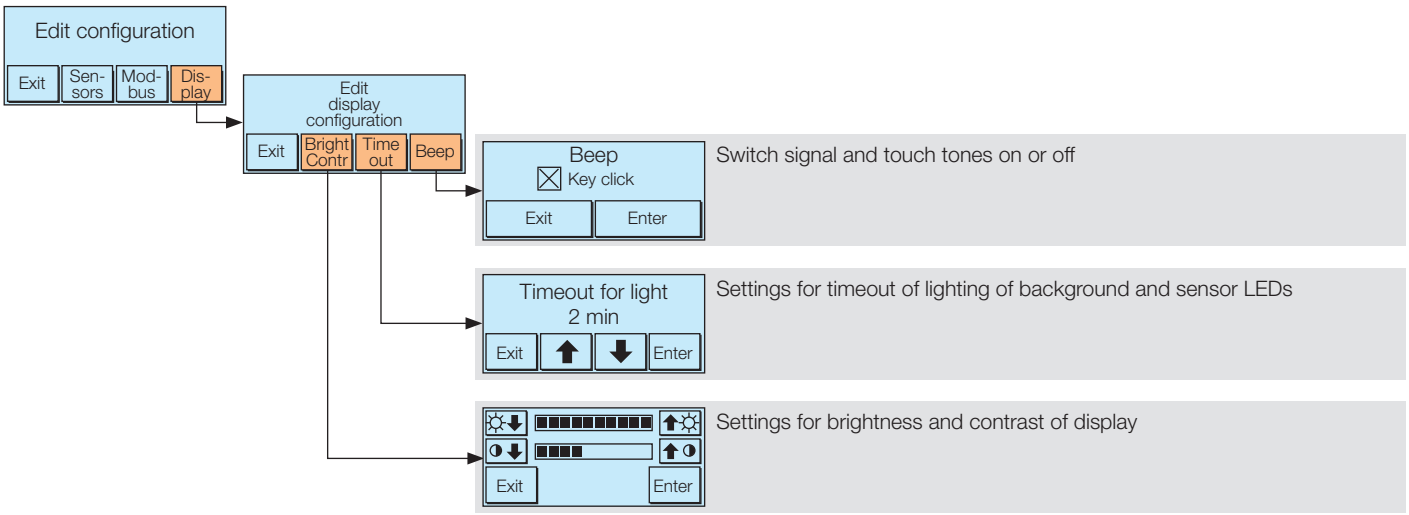


Modbus configuration



Control Unit

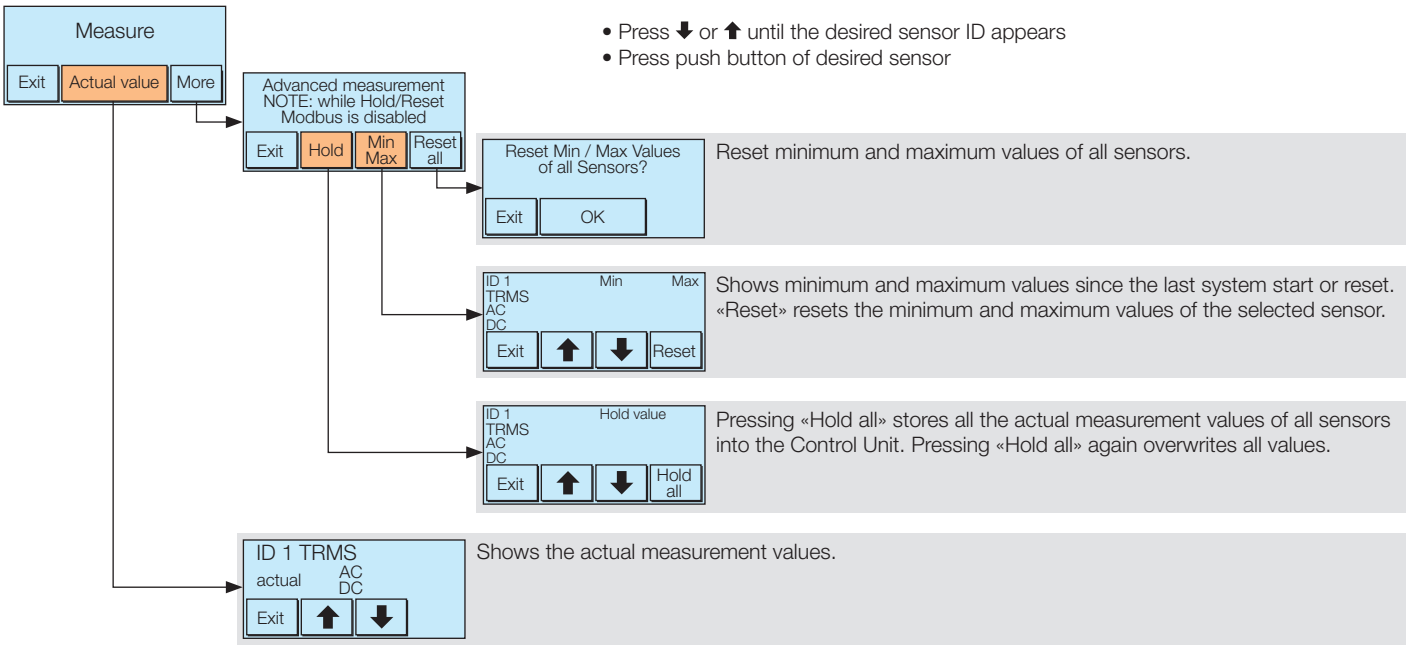
Display configuration



Measurement functions

Selection of desired sensor ID

- Press ⬇ or ⬆ until the desired sensor ID appears
- Press push button of desired sensor



Modbus communication protocol

Introducing Modbus protocol

The Modbus serial line protocol is a Master-Slaves protocol. This means that only one master is connected to the bus, and one or several (247 maximum number) slaves nodes are also connected to the same serial bus. A Modbus communication is always initiated by the master and there is only one transaction at the same time.

Further information: www.Modbus.org

Modbus frame description (RTU mode)

ADU frame			
Additional address	PDU frame		Error check
Address field	**Function code**	**Data**	**CRC**
1 byte	1 byte	0 up to 252 byte(s)	2 bytes CRC_L, CRC_H

ADU: Application Data Unit
PDU: Protocol Data Unit

Field:
Address field: it contains the slave address.
Function code: it indicates what kind of action to perform.
Data: it contains request and response parameters.
CRC: it contains the Cyclical Redundancy Checking value (16-bits) standard CRC-16 defined by CCITT

The maximum size of a Modbus RTU frame is 256 bytes.

NOTE:
- In RTU mode, message frames are separated by a silent interval of at least 3.5 character times.
- The entire message frame must be transmitted as a continuous stream of characters.
- If a silent interval of more than 1.5 character times occurs between two characters, the message frame is declared incomplete and should be discarded by the receiver.

Modbus data encoding

Modbus uses a 'Big-Endian' representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first.
So for example:

Register size	Value	
16-bit	1234h	the first byte sent is 12h then 34h

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Communication to CMS

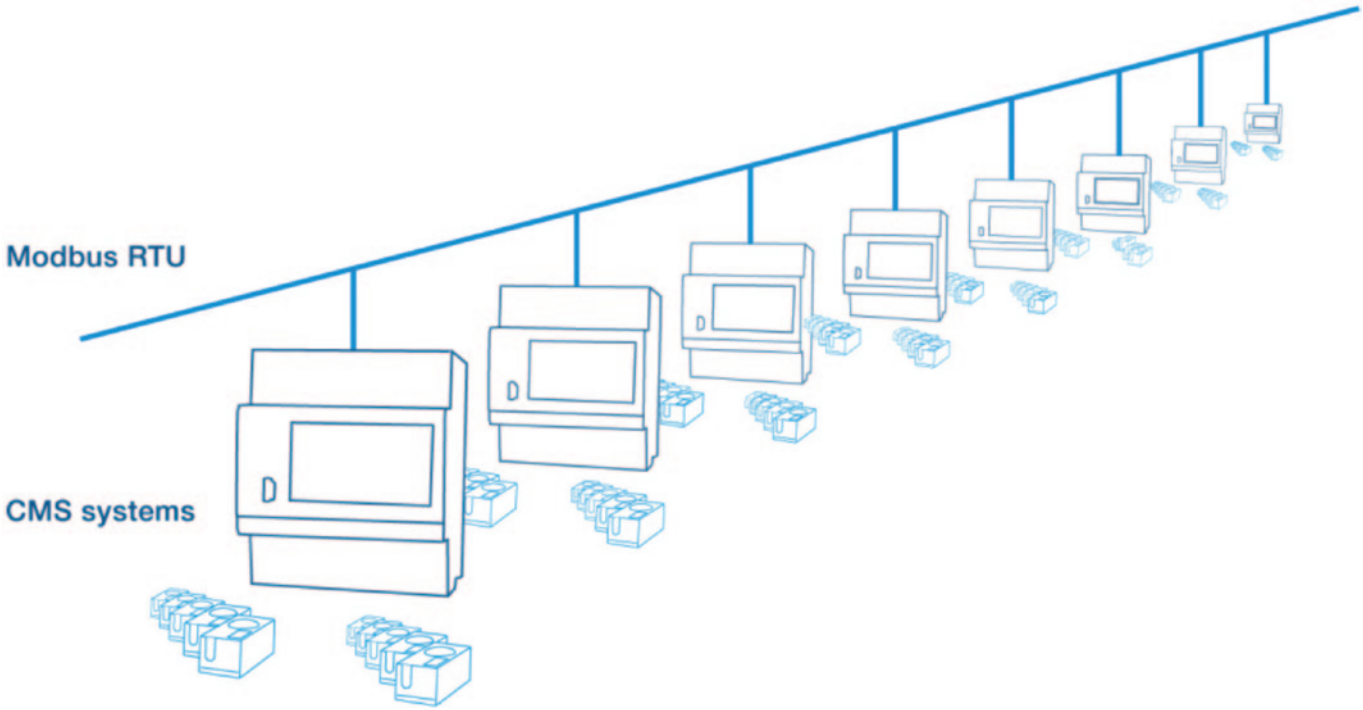
Physical interface RS-485

To communicate with the CMS by an upper system all devices (masters & slaves) must have the same data rate and data format. These settings are done over the Control Unit's touch display.

Parameter	Values
Data rate	2400, 4800, 9600, 19200, 38400, 57600, 115200 bit/s
Data format	even parity, odd parity, without parity

Default parameters: 19200baud, even parity
Line termination: external

Control Unit ID



It is possible to connect up to 247 Control Units to one Modbus RTU line. Each Control Unit must have an own Modbus ID (address).

These IDs can be set over the Control Unit's touch display. Default ID (address): 1

Function Codes

- Read operation on registers with access code «R» or «RW» is defined for function **03h «Read Holding Registers».**
- Write operation on registers with access code «W» or «RW» is defined for functions **06h «Write Single Register»**

Functions other than specified must not be applied.

Communication to CMS

Data and control registers

A register is always a two-byte (16-bit) value, which can be interpreted as either signed or unsigned values, or which have special format.
In case of data represented in more than one register the concatenated registers will contain information with MSB in lowest address and LSB in highest address within concatenated addresses.

Registers other than specified here must not be used.

Remark 1 format
unsigned = 16-bit unsigned integer notation
signed = 16-bit signed integer notation
0000h .. 7FEFh = 0.00 .. 327.51A
8000h .. FFFFh = –327.66 .. –0.01A

Special values	Meaning
7FF0h	Data pending, acquisition in progress
7FF1h .. 7FFCh	Reserved
7FFDh	Data type (TrueRMS / AC / DC) is disabled
7FFEh	Overload (beyond full range)
7FFFh	Forbidden (no Sensor with ID xx)

bit mask = bit-wise operation
special = as specified at register description

Remark 2 access
R (03) = Register can read by function 03.
W (06) = Register can be written by function 06.

Ongoing measurement values

These registers contain the actual measured data.

Addr (hex)	Words (16bit)	Description	Resolution and unit	Format [1]	Access [2]
0000	1	TrueRMS value of SENSOR 1	0.01 A	unsigned	R (03)
0001	1	TrueRMS value of SENSOR 2	0.01 A	unsigned	R (03)
…	1		0.01 A	unsigned	R (03)
003E	1	TrueRMS value of SENSOR 63	0.01 A	unsigned	R (03)
003F	1	TrueRMS value of SENSOR 64	0.01 A	unsigned	R (03)
0100	1	AC value of Sensor 1	0.01 A	unsigned	R (03)
0101	1	AC value of Sensor 2	0.01 A	unsigned	R (03)
…	1	…	0.01 A	unsigned	R (03)
013E	1	AC value of Sensor 63	0.01 A	unsigned	R (03)
013F	1	AC value of Sensor 64	0.01 A	unsigned	R (03)
0200	1	DC value of Sensor 1	0.01 A	signed	R (03)
0201	1	DC value of Sensor 2	0.01 A	signed	R (03)
…	1	…	0.01 A	signed	R (03)
023E	1	DC value of Sensor 63	0.01 A	signed	R (03)
023F	1	DC value of Sensor 64	0.01 A	signed	R (03)

Communication to CMS

Measured minimal values

These registers contain the minimal measured values since last system start / reset or since last request «reset minimal value».

Addr (hex)	Words (16bit)	Description	Resolution and unit	Format [1]	Access [2]
0400	1	TrueRMS min value of Sensor 1	0.01 A	unsigned	R (03)
0401	1	TrueRMS min value of Sensor 2	0.01 A	unsigned	R (03)
…	1		0.01 A	unsigned	R (03)
043E	1	TrueRMS min value of Sensor 63	0.01 A	unsigned	R (03)
043F	1	TrueRMS min value of Sensor 64	0.01 A	unsigned	R (03)
0500	1	AC min value of Sensor 1	0.01 A	unsigned	R (03)
0501	1	AC min value of Sensor 2	0.01 A	unsigned	R (03)
…	1	…	0.01 A	unsigned	R (03)
053E	1	AC min value of Sensor 63	0.01 A	unsigned	R (03)
053F	1	AC min value of Sensor 64	0.01 A	unsigned	R (03)
0600	1	DC min value of Sensor 1	0.01 A	signed	R (03)
0601	1	DC min value of Sensor 2	0.01 A	signed	R (03)
…	1	…	0.01 A	signed	R (03)
063E	1	DC min value of Sensor 63	0.01 A	signed	R (03)
063F	1	DC min value of Sensor 64	0.01 A	signed	R (03)

Measured maximal values

These registers contain the maximal measured values since last system start / reset or since last request «reset maximal value».

Addr (hex)	Words (16bit)	Description	Resolution and unit	Format [1]	Access [2]
0800	1	TrueRMS max value of Sensor 1	0.01 A	unsigned	R (03)
0801	1	TrueRMS max value of Sensor 2	0.01 A	unsigned	R (03)
…	1		0.01 A	unsigned	R (03)
083E	1	TrueRMS max value of Sensor 63	0.01 A	unsigned	R (03)
083F	1	TrueRMS max value of Sensor 64	0.01 A	unsigned	R (03)
0900	1	AC max value of Sensor 1	0.01 A	unsigned	R (03)
0901	1	AC max value of Sensor 2	0.01 A	unsigned	R (03)
…	1	…	0.01 A	unsigned	R (03)
093E	1	AC max value of Sensor 63	0.01 A	unsigned	R (03)
093F	1	AC max value of Sensor 64	0.01 A	unsigned	R (03)
0A00	1	DC max value of Sensor 1	0.01 A	signed	R (03)
0A01	1	DC max value of Sensor 2	0.01 A	signed	R (03)
…	1	…	0.01 A	signed	R (03)
0A3E	1	DC max value of Sensor 63	0.01 A	signed	R (03)
0A3F	1	DC max value of Sensor 64	0.01 A	signed	R (03)

Communication to CMS

Measured hold values

These registers contain the hold values captured at a time given by request «trigger hold measurement».

Addr (hex)	Words (16bit)	Description	Resolution and unit	Format [1]	Access [2]
0C00	1	TrueRMS hold value of Sensor 1	0.01 A	unsigned	R (03)
0C01	1	TrueRMS hold value of Sensor 2	0.01 A	unsigned	R (03)
…	1		0.01 A	unsigned	R (03)
0C3E	1	TrueRMS hold value of Sensor 63	0.01 A	unsigned	R (03)
0C3F	1	TrueRMS hold value of Sensor 64	0.01 A	unsigned	R (03)
0D00	1	AC hold value of Sensor 1	0.01 A	unsigned	R (03)
0D01	1	AC hold value of Sensor 2	0.01 A	unsigned	R (03)
…	1	…	0.01 A	unsigned	R (03)
0D3E	1	AC hold value of Sensor 63	0.01 A	unsigned	R (03)
0D3F	1	AC hold value of Sensor 64	0.01 A	unsigned	R (03)
0E00	1	DC hold value of Sensor 1	0.01 A	signed	R (03)
0E01	1	DC hold value of Sensor 2	0.01 A	signed	R (03)
…	1	…	0.01 A	signed	R (03)
0E3E	1	DC hold value of Sensor 63	0.01 A	signed	R (03)
0E3F	1	DC hold value of Sensor 64	0.01 A	signed	R (03)

Trigger hold, reset min and max values

Write operation on this register
- triggers the hold measurement of all Sensors, and / or
- resets the minimal and maximal values of all Sensors.

Addr (hex)	Words (16bit)	Description	Resolution and unit	Format [1]	Access [2]
3010	1	Trigger hold, reset min and max values		bit mask	W (06)

Value	Description
xx1x	Trigger hold measurement
xxx1	Reset min and max values

Show Sensor

Write operation on this register starts or stops fast LED blinking of one specified Sensor for diagnosis purpose.

Addr (hex)	Words (16bit)	Description	Resolution and unit	Format [1]	Access [2]
3011	1	Show Sensor		special	W (06)

Value	Description
xx1x	Trigger hold measurement
xxx1	Reset min and max values

Communication to CMS

Show Sensor

Write operation on this register starts or stops fast LED blinking of one specified Sensor for diagnosis purpose.

Addr (hex)	Words (16bit)	Description	Resolution and unit	Format [1]	Access [2]
3011	1	Show Sensor		special	W (06)

Start / stop command is in the following bit format position:

000S 0000 0CCC CCCC

- C Sensor ID
- S 0 = stop fast LED blinking
  1 = start fast LED blinking

Data written has to specify a known Sensor ID.
Touch display is locked while showing Sensor, unlocked by stop blinking.

Example: 0x1017 means «Start fast LED blinking of Sensor with ID 23»

- When Sensor is addressed correctly, common response will follow.
- When Sensor ID is not used in system, exception response with Modbus exception code 03h «illegal data value» will follow.

Error codes

Modbus protocol defines a common way of error reporting. Every request (read or write) sent in unicast mode is expected to return a value in packet of the same structure. In case of error in handing message (not CRC problems but message execution problems), generated response contains function code with MSB set (80h) and single byte representing error code, called «exception code».

The following default exception codes are provided:

Code	Name	Description
01h	Illegal function	Function is not supported
02h	Illegal data address	Register address is out of Control Unit's range, or trying to write into a read only register
03h	Illegal data value	Value is out of range
04h	Slave device failure	Unrecoverable error occurred while Control Unit was attempting to perform the requested action, e.g. time-out
06h	Slave device busy	Control Unit is currently in User-Interface-Configuration-Mode. The requested action is not possible.

Examples

To introduce basics of the communication scheme, the most common use cases are described.
Note: The described use cases do not cover all possibilities but only shows example communication schemes

Read ongoing measurement values of Sensor 5-16

	frames	**comment**
M→S	D 03h 00h, 04h 00h, 0Ch CRC_{LSB}, CRC_{MSB}	MBID address of Control Unit Function code (Read Holding Registers) Starting address (TrueRMS value of Sensor 5) Quantity of registers (12) CRC
S→M	ID 03h 18h $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ $VALUE_H$, $VALUE_L$ CRC_L, CRC_H	MBID address of Control Unit Function code (Read Holding Registers) Quantity of bytes (24) Register value (TrueRMS value of Sensor 5) Register value (TrueRMS value of Sensor 6) Register value (TrueRMS value of Sensor 7) Register value (TrueRMS value of Sensor 8) Register value (TrueRMS value of Sensor 9) Register value (TrueRMS value of Sensor10) Register value (TrueRMS value of Sensor11) Register value (TrueRMS value of Sensor12) Register value (TrueRMS value of Sensor13) Register value (TrueRMS value of Sensor14) Register value (TrueRMS value of Sensor15) Register value (TrueRMS value of Sensor16) CRC

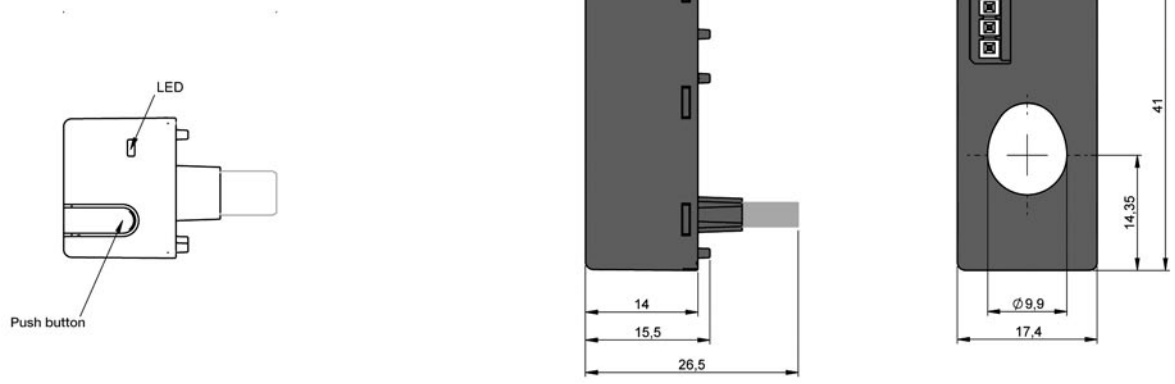
Trigger hold function of all Sensors

	frames	**comment**
M→S	ID 06h 30h, 10h 00h, 10h CRC_{LSB}, CRC_{MSB}	MBID address of Control Unit Function code (Write Single Register) Register address (Trigger hold, reset min / max) Register value (Trigger hold) CRC
S→M	ID 06h 30h, 10h 00h, 10h CRC_{LSB}, CRC_{MSB}	MBID address of Control Unit Function code (Write Single Register) Register address (Trigger hold, reset min / max) Register value (Trigger hold) CRC

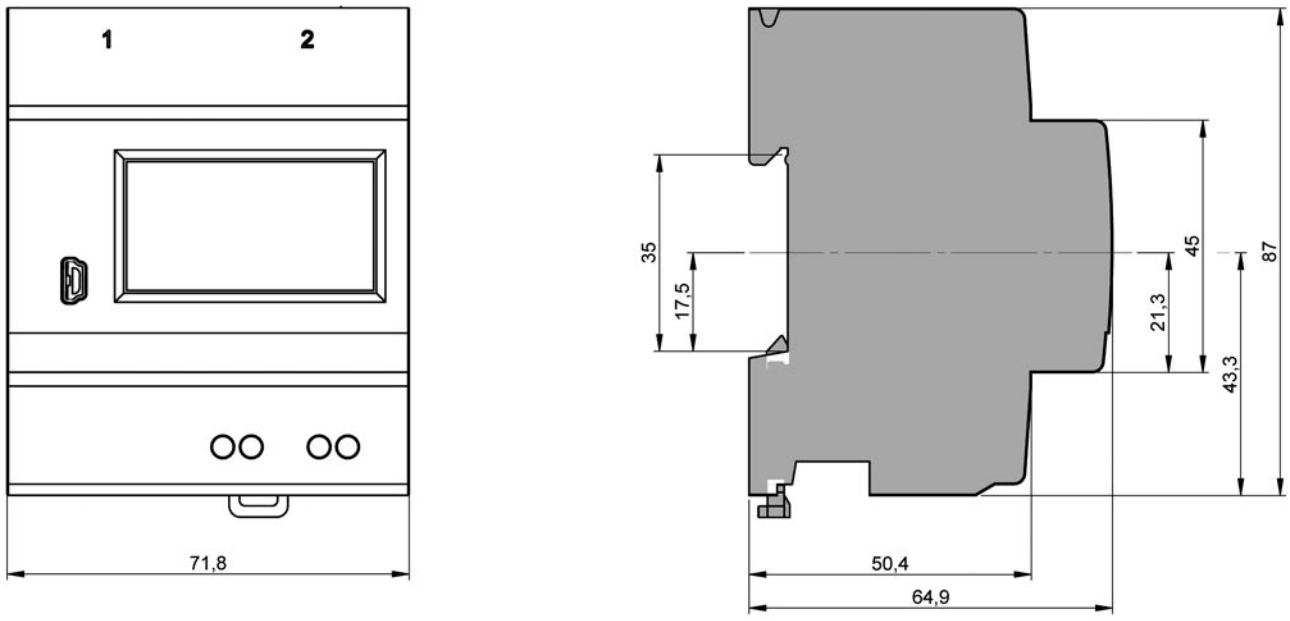
Technical data

Sensors	**CMS-100PS**	**CMS-101PS**	**CMS-102PS**
Measurement range	0 .. 80A	0 .. 40A	0 .. 20A
Measurement method	TRMS, AC 50/60Hz, DC		
Crest factor of distorted wave forms	≤ 1.5	≤ 3	≤ 6
AC Accuracy (TA = +25°C)	≤ ±0.5%		
AC Temperature coefficient	≤ ±0.036%/K		
DC Accuracy (TA = +25°C)	≤ ±0.7%	≤ ±1.0%	≤ ±1.7%
DC Temperature coefficient	≤ ±0.047%/K	≤ ±0.059%/K	≤ ±0.084%/K
Resolution	10mA		
Sampling rate internal	5 kHz		
Settling time (±1%)	typ. 0.25sec		
Cable feed through	10mm Ø		
Insulation voltage	690V AC / 1500V DC		
Weight	12g		
Dimensions W×H×D	17.4mm × 15.5mm × 41.0mm (1TE)		
Control Unit	**CMS-600**		
Supply voltage	24V DC (±10%)		
Power dissipation	min. 0.4W; max. 24W (with 64 sensors)		
Interface	RS485 2-wire		
Protocol	Modbus RTU		
Data rate	2400 .. 115'200 Baud		
Data refresh time	< 1sec for 64 sensors‘ results		
Insulation voltage	400V AC		
Screw-type terminals	0.5 .. 2.5mm², max. 0.6 Nm		
Mounting	DIN-rail 35 mm acc. DIN 50022 or SMISSLINE TP busbar system		
Weight	153g		
Dimensions W×H×D	71.8mm x 87.0mm x 64.9mm (4TE)		
General Data	**Sensors and Control Unit**		
Operating temperature	–25°C .. +70°C		
Storage temperature	–40°C .. +85°C		
Shock resistance	5g, 6 shocks, duration 30ms, acc. IEC 60068-2-27 Ea		
Vibration resistance	1g, 20 cyclus, 5…150…5Hz, acc. IEC 60068-2-6 Fc		
Overvoltage category	Cat. II, acc. EN 50178		
Pollution degree	Class 3 - Ui 690V AC / Class 2 - Ui 1500V DC, acc. EN 50178		
Environment class	Type B, acc. EN 50178, 6.1		
Rated impulse withstand capability	4kV, acc. EN 50178		
Electrostatic discharge (ESD)	8kV air discharge, 6kV contact discharge, acc. IEC/EN 61000-4-2, crit. b		
EMC	IEC/EN 61000-4-3, -4-4, -4-5, -4-6, -6-3, -6.4		
Immunity to radiated electromagnetic fields (RFI	10V/m, acc. IEC/EN 61000-4-3, crit. a		
Immunity to fast transient burst	4kV power cables, 2kV signal cables, acc. IEC/EN 61000-4-4, crit. b		
Immunity to high-energy pulses (surge)	0.5kV DC power cable line-to-earth, 0.5kV DC power cable line-to-line, 2kV signal cable line-to-earth, 1kV signal cable line-to-line, acc. IEC/EN 61000-4-5, crit. b		
Immunity to line-conducted interference	10V, acc. IEC/EN 61000-4-6, crit. b		
Emission	acc. IEC/EN 61000-6-3 and IEC/EN 61000-6-4		

Technical drawings



Sensor CMS-100PS series



Control Unit CMS-600

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Date: 25.05.2012

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