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Mounting and operating instructions

Multi-sensor Modbus AMSxx-Modbus

Modbus RTU output

AMS01-Modbus LCD – humidity, temperature, CO2, VOC, fine dust, CO
AMS02-Modbus LCD – humidity, temperature, CO2, VOC, fine dust, atmospheric pressure
AMS03-Modbus LCD – humidity, temperature, CO2, VOC, fine dust, CO, atmospheric pressure
AMS04-Modbus LCD – humidity, temperature, CO2, VOC, CO, differential pressure
AMS05-Modbus LCD – humidity, temperature, CO2, VOC, atmospheric pressure, diff. pressure
AMS06-Modbus LCD – humidity, temperature, CO2, VOC, CO, atmospheric pressure, diff. pressure

Application

The maintenance-free microprocessor-controlled meter combines a variety of measurands in many possible combinations. It is the perfect device for achieving demand-oriented climate control based on the relevant measurands. Products can be combined for measuring humidity, temperature, carbon dioxide, carbon monoxide, air quality (VOC), fine dust, atmospheric/barometric air pressure and differential pressure.

The detection range of the sensors is designed for standard HVAC applications for monitoring living and meeting rooms, workplaces and production facilities. Special designs, other measuring ranges and measurands can also be implemented upon request. Room ventilation on an as-needed basis, improved well-being and customer benefit, increased comfort as well as reduced operating costs through energy conservation are just some of the benefits of employing this compact device. The high-quality housing series BoCube® with hinge closure technology and the approx. 4-inch graphic LCD display perfectly match the design and quality standards of this device. Configuration (bus address, transmission mode, baud rate, etc.) is made comfortably and quickly via a self-explanatory menu. The corresponding registers can be used for many things, for example to fine-tune individual measurands, initiate VOC and/or CO_2 calibrations and to make changes to the display.

These instructions must be read before installation and putting into operation and all instructions contained therein must be observed!

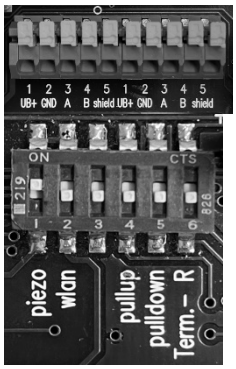
Mounting/installation:

Opening: The device has two hinged latches; the left latch is locked to secure the internal cabling and must not be used. Insert a suitable slotted screwdriver into the slot of the right hinge on the top side. The right hinge pops open by applying pressure, preferably in the direction of the centre of the housing.

Closing: Press the housing cover firmly onto the lower part and close the hinge. The engagement is audible and noticeable, indicating that the housing is closed evenly to the full extent. Pay attention to sensor cables, the cabling between the electronic assemblies and the connection cables.

Mounting: When the housing is open, you can see two through holes with a diameter of 4 mm under each of the hinge guides. This allows the device to be mounted on a flat surface via suitable screws (max. head diameter 9 mm). This device group is designed for indoor mounting. When operating outdoors, appropriate measures must be taken to protect against condensation and to comply with other operating conditions.

Installation: The device is electrically connected via the two PG cable glands, which also serve for strain relief. Any unused cable glands must be sealed off. The pin assignment of the device is printed on the PCB under the terminals. The device has a push-in terminal mechanism. The terminals have the same numbering and are connected 1:1 on the circuit board.



Configuration: In a Modbus system, each Clint address may only be used once. We recommend using a low baud rate for long connection cables. The optional hardware connection of pull-up, pull-down or terminating resistors is done via DIP switches. The function of the respective DIP switch is printed on the PCB.

- DIP "pullup" ON = connection of a pull-up resistor
- DIP "pulldown" ON = connection of a pull-down resistor
- DIP "Term.-R" ON = connection of a terminating resistor (220 Ohm). The terminating resistor may only be connected if this device has been installed at the end of the Modbus line. Connecting several terminating resistors in one BUS line can lead to transmission errors.
- DIP "piezo" = OFF, hardware deactivation of the piezo buzzer
- DIP "wlan" is in the experimental stage, not included in the scope of functions, do not use, default = OFF

For all other configuration settings, the device has a self-explanatory menu. To activate the menu, press the rotary-push incremental encoder on the right-hand side. To switch between the menu items, turn the knob, to confirm, press the knob.

Exit:	exit the menu
Modbus – parameter:	baud rate setting. Mode and address
Measurement – parameter:	offset setting for humidity and temperature, initiation of manual CO_2 and/or VOC calibration

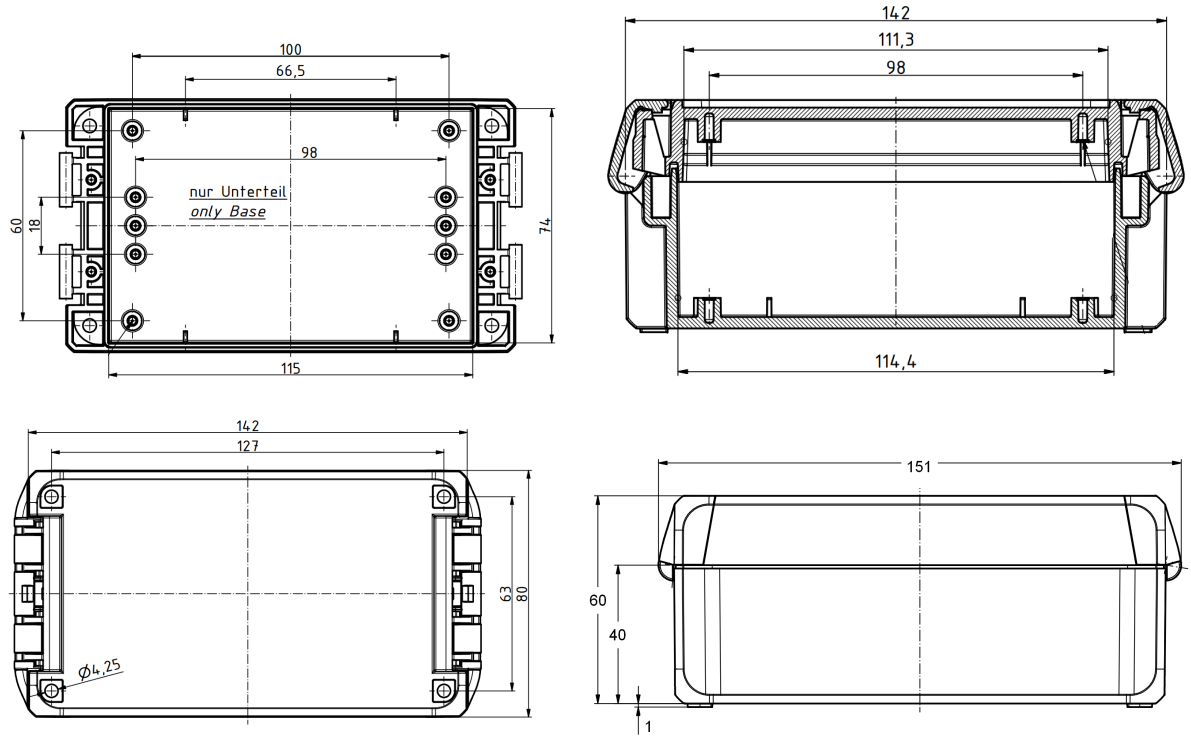
Display backlight and contrast:	adjustment of brightness & contrast, experimental inverse display
Register read-write:	direct access to registers, experimental stage / deactivated, do not use
Display-screen setup:	direct access to registers for display-screen layout, experimental stage / deactivated, do not use
Display-screen activation:	direct access to registers for display-screen layout, experimental stage / deactivated, do not use
Delete pages and factory:	deletes display views, experimental phase / deactivated, do not use
WLAN/BT settings:	experimental phase / deactivated, do not use
Password:	experimental phase / deactivated, do not use

Technical data of the individual measurands:

CO_2	
Measuring range	0…10,000 ppm, optionally 20,000 ppm or 50,000 ppm
Accuracy	0…2,000 ppm: ±50 ppm + 2 % measured value, 0…5,000 ppm: ±50 ppm + 3 % measured value, otherwise: ±100 ppm + 5 % measured value (@ 50 % RH / 20 °C / 1,013 mbar, auto-calibration activated)
Temperature dependence	CO_2: ±5 ppm / K
Pressure dependence	is compensated if air pressure sensor option is selected, otherwise 0.16 % of measured value/hPa difference to 1,013 mbar
Long-term stability	± 1 % final value / year
Sensor	infra-red sensor (NDIR)
Calibration	auto/manu (per register), default, automatic calibration ON
VOC sensor	
Measuring range	0…100 % referred to calibration gas CO
Accuracy	± 10 % final value (at 20 °C, 50 % RH and auto-calibration = ON)
Temperature dependence	±0.2 % final value / K
Long-term stability	±5 % final value / year (auto-calibration activated)
Sensor	metal-oxide VOC sensor
Calibration	auto/manu (per register), default, automatic calibration ON
Sensitivity	adjustable in three levels via register
Particulate sensor	
Particulate matter measuring range	PM2.5/PM10 → 0…1,000 µg/m³
Accuracy	±5 µg/m³ + max. ±4 % final value (@ 20 °C, 45 % RH, 1,013 mbar)
Temperature dependence	±1 % final value / 10 K
Long-term stability	± 1 % final value / year
Humidity/temperature sensor	
RH measuring range	0…100 % RH
Humidity accuracy	±3 % RH (30–70 % RH, otherwise ±5 % RH, at 20 °C)
Temperature measuring range	-20…50 °C
Temperature accuracy	± 0.5 K
Calculated values	dew point temperature, absolute humidity, mixing ratio, wet bulb temperature, steam pressure
Long-term stability	± 1 % / year
Sensor	combined digital humidity and temperature sensor
Pressure sensor	
Differential pressure measuring range	-100…+100 Pa (P100) or -500…+500 Pa (P500) or -5,000…+5,000 Pa (P5000)
Accuracy	differential pressure: ± 3.0 % of final value (at 20 °C)
Temperature dependence	differential pressure: ±2.5 % final value / 10 K
Linearity error	differential pressure / atmospheric pressure: ±1.0 % final value
Offset, gradient, attenuation	per register
Zero point calibration	per register
Compressive strength	5 times measuring range
Air pressure sensor	
Measuring range atm. / bar.	500–1,150 mbar
Accuracy	±3 mbar (at 20 °C)
Temperature dependence	1 mbar / 10 K
Linearity error	±1.0 % final value
Offset and attenuation	per register
CO sensor	
Measuring range	0…1,000 ppm
Accuracy	±10 ppm + max. ±5 % of measured value (@ 50 % RH / 20 °C / 1,013 mbar)
Temperature dependence	±5 ppm / K
Long-term stability	± 2% final value / year
Sensor	electrochemical gas sensor, only for trend monitoring
Gas exchange	diffusion / housing flow, depending on device configuration
Response time	<10 min (tendency measurement Sensor in housing)
Technical data	
Supply voltage	24 V DC +/-5 %
Current consumption	150 mA (depending on backlight) plus approx. 20 mA/sensor (peak CO_2 200 mA, 50 ms)
Output	Modbus RTU, not galvanically isolated
Electrical connection	push-in terminals, double version for IN/OUT
Housing	PC UL with hinged latches, light grey
Cable entry	M16 x 1.5 cable gland with strain relief
Dimensions	housing: L 150 x W 80 x H 62 mm, without probes
Protection type	housing/electronics: IP65/IP20 depending on sensor configuration
Attachment probes:	V2A D16 mm, V2A D25 mm depending on configuration
Protection class	III
Operation and storage temperature	-20…+50 °C
Range of application	Room air monitoring, pollutant-free, non-condensing air up to max. 95 % RH

Dimensional drawing (without attachments)

Source, Bopla:
https://www.bopla.de/en/enclosure-technology/bocube/pc-ul-94-v0-crystal-clear-lid/enclosures-polycarbonate-ul-94-v0-crystal-clear-lid/b-140806-pc-v0-g-7035



General notes

The General Terms and Conditions of our company, which can be viewed at www.consens-electronic.de, and the "General Terms and Conditions for the Supply of Products and Services of the Electrical and Electronics Industry" (ZVEI Conditions) along with the supplementary clause "Extended Retention of Title" shall apply exclusively as General Terms and Conditions

The following points must also be complied with:

- These instructions must be read before installation and putting into operation and all instructions contained therein must be observed!
- Devices must only be connected to safety extra-low voltage.
- Use shielded cables to avoid damage and faults to the device (e.g. resulting from voltage induction); avoid parallel routing with live lines and comply with the EMC directives.
- This device must be used for its intended purpose only. Respective safety regulations issued by the VDE, the states, their control authorities, the TÜV and the local energy supply company must be observed. The purchaser must ensure that the relevant building and safety regulations are complied with, and must avoid hazards of all kinds.
- No warranties or liabilities will be assumed for defects and damage arising from improper use of this device.
- Consequential damage caused by a fault in this device is excluded from warranty or liability.
- The devices must be installed by authorised specialists only.
- The technical data and connecting conditions of the mounting and operating instructions delivered together with the device are exclusively valid. Deviations from the catalogue representation are not explicitly mentioned and are possible in terms of technical progress and continuous improvement of our products.
- In case of any modifications made to the devices by the user, all warranty claims are forfeited.
- This device must not be installed close to heat sources (e.g. radiators) or be exposed to their heat flow. Direct solar irradiation or heat irradiation by similar sources (powerful lamps, halogen spotlights) must be avoided.
- Operating this device close to other devices that do not comply with EMC directives may influence functionality.
- This device must not be used for monitoring purposes for protecting persons against hazards or injury, as an emergency stop switch on systems or machinery, or for any other similar safety-related purposes.
- Dimensions of housings or housing accessories may show slight tolerances on the specifications provided in these instructions.
- It is not permitted to modify these documents.
- In case of complaints, only complete units returned in original packing will be accepted.

Special notes

- If the sensor technology and/or attachments are contaminated, we recommend sending the unit to the factory for cleaning and recalibration.
- The working range of the device is 10…95 % relative humidity or -20…50 °C with otherwise pollutant-free, non-condensing air. Higher deviations of the individual measurands may occur outside this working range.
- The device performs an automatic calibration for the CO_2 and VOC measurands at an interval of 7 days. To ensure this function, the device must be supplied with fresh air (CO_2 content of 300…400 ppm, min. to no VOC load) for at least 10 minutes within the period of 7 days.
- The CO measurement is based on an electrochemical sensor and is used exclusively to display the trend of the CO concentration.
- The current consumption and thus the intrinsic heating of the device may vary slightly depending on the configuration, the mode of the backlight, the supply voltage and the BUS load. This has an influence on the humidity and temperature measurands, as well as the thermodynamic variables calculated from them.
- If this device is operated beyond the specified range, all warranty claims are forfeited.

MODBUS system description / protocol, abridged version for the Multi AMSxx-Modbus

BUS protocol for the ConSens Modbus system, system-specific register structure

Abbreviations used:

Rreg	(read) Read register (cannot be written to)
Rreg_mw	Rreg with specific measured values
RWreg	(read/write) Read and write register (can also be written to, with partial storage)
Wreg	(write) Write register (can only be written to, no storage)
Fcode	Function code
Adr	Address
Reg	Register
H_Byte	(high) byte (the higher-order 8 bits; 0xHH00)
L_Byte	(low) byte (the lower-order 8 bits; 0x00LL)
0x0000	Number in 16 bits HEX format (2 bytes)
0x00	Number in 8-bit HEX format (1 byte)

1. Sensor systems

1.1 Register assignment for sensor systems

The following register structure is specific to all ConSens sensor systems with Modbus. Register contents are measured values and device-specific data for calibration or for determining the operating mode. In some cases, not only measured values but also fixed units are assigned to the registers. This ensures clear display of the measured value including the corresponding units on a device-specific display or in the overall system.

Note: The specified value range within the following register descriptions does not simultaneously reflect the measuring range of the sensor system (refer to the specific device description). The use of registers also depends on the measuring system (see also system code).

Table of Read registers [sensors]

Rreg No. (Fcode 0x04)	***Value range***	***Assigned size and partial unit***	***Measured value property***
00	0…0xffff		See system code used
01	0…999	0.0…99.9 % RH	Relative humidity (with decimal place)
02	-999…2,999	-99.9…299.9 °C	Temperature (with decimal place)
03	0…999	0…99.9 g/m³	Absolute humidity (with decimal place)
04	0…999	0…99.9 g/kg	Mixing ratio (with decimal place)
05	-999…999	-99.9…99.9 °C	Dew point temperature (with decimal place)
06	-999…999	-99.9…99.9 °C	Wet bulb temperature (with decimal place)
07	0…999	0…99.9 kJ/kg	Enthalpy (with decimal place)
10	0 …9,999	0…9,999 ppm	CO_2 concentration
11	0…999	0…99.9 %	VOC contamination (with decimal place)
12	0…9,990	0…9,999 ppm	CO concentration or
16	0…9,999	0…9,999 µg/m³	Particulate > 2.5 µm
17	0…9,999	0…9,999 µg/m³	Particulate > 10 µm
19	0…0x007f	Bit_2…Bit_0 Bit_6…Bit_4	With '1' CO_2 (Bit_0); VOC (Bit_1); O_2 (Bit_3), sensor will be calibrated With '1' CO_2 (Bit_4); VOC (Bit_5); O_2 (Bit_6) on auto-calibration
20	750…1,150	750…1,150 mbar	Atmospheric pressure
21	750 …1,500	750…1,500 mbar	Barometric pressure
22	-9,999…9,999	-999.9…999.9 Pa	Differential pressure (with decimal place with 500 PA device)
23	-9,999…9,999	-9,999…9,999 Pa	Differential pressure (with 5,000 Pa device)
50	0…1	0 / 1	Internal piezo buzzer OFF/ON
78	0…65535	Device number	
79	0…65535	Software version	E.g. 01059 for 01.05.2019
80	0…0xffff	Error code	Error code (bits are set with error)

Note: Rreg_mw have a grey background

Table of Read/Write registers [sensors]

Rwreg No. (Fcode: 0x03, 0x06)	***Value range***	***Assigned size and unit***	***Measured value property***
01	0…999 [11111]	0.0…99.9 % RH	Write relative humidity
02	-999…2,999 [11111]	-99.9…299.9 °C	Write temperature
03	0…999 [11111]	0…99.9 g/m³	Write absolute humidity
04	0…999 [11111]	0…99.9 g/kg	Write mixing ratio
05	-999…999 [11111]	-99.9…99.9 °C	Write dew point temperature
06	-999…999 [11111]	-99.9…99.9 °C	Write wet bulb temperature
07	750…1,500 [1013]	750…1,500 mbar	Pre-define atmospheric pressure (Influence on mixing ratio. & CO_2)
08	**-100…100/999 [0]**	**-10.0…10/99.9 % RH**	**Offset for relative humidity measurement (actual value input possible)** *
09	**-100…100/999 [0]**	**-10.0…10/99.9 °C**	**Offset for the temperature measurement (actual value input possible)** *
10	0…9,999 [11111]	0…9,999 ppm	Write CO_2
11	0…999 [11111]	0…99.9 %	Write VOC
12	0…9,999 [11111]	0…9,999 ppm	Write CO
16	0…9,999 [11111]	0…9,999 µg/m³	Write particulate > 2.5 µm
17	0…9,999 [11111]	0…9,999 µg/m³	Write particulate > 10 µm
18	**0…2 [1]**	**0, 1, 2**	**VOC amplification: '0' low; '1' medium; '2' high** *
19	**0…0x007f [v]**	**Bit_6 to Bit_4** Bit_3 to Bit_0 **set correspondingly**	Bit_0 = 1: CO_2 calibr. ON; Bit_1 = 1: VOC calibr. ON Bit_2 = 1: O_2 calibr. ON (are reset after completion) **Bit_4 = 0/1: CO_2 AUTO-calibr. OFF/ON** **Bit_5 = 0/1: VOC AUTO-calibr. OFF/ON** **Bit_6 = 0/1: O_2 AUTO-calibr. OFF/ON** *
20	750…1,150 [11111]	750…1,150 mbar	Pre-define atmospheric pressure
21	750…1,500 [11111]	750…1,500 mbar	Pre-define barometric pressure
22	-9,999…9,999 [11111]	-999.9…999.9 Pa	Write differential pressure
23	-9,999…9,999 [11111]	-9,999…9,999 Pa	Write differential pressure
25	**800…1,200 [1000]**	**800…1,200**	**Gradient for pressure measurement (factor 0.800 to 1.200)** *
26	**0, 1 [0]**	**-100…100** 1	**Zero point offset for pressure measurement (0 => delete value)** * with 1 => set the zero point offset once
27	**1…50 [10]**	**1…50**	**Attenuation for pressure measurement** *
28	**-50…50 [0]**	**-50…50 mbar**	**Offset for atmospheric pressure (actual value input possible)** *
29	**0…3,000 [0]**	**0…3,000 m**	**Altitude above zero (sea level)** *
50	0…1 [11111]	11111 '0' OFF / '1' ON	Piezo control according to register progr. (Rwreg_51) Piezo buzzer: Fixed OFF/ON
51	**0…255 [0]**	**Rreg: 0…255**	**Assign piezo buzzer to a Rreg_x (zero => none)** * only measured value register (Rreg_mw) Bit_15 is set after deleting (Off) by pressing the Enter button
52	**-9,999…9,999 [0]**	**Value**	**OFF switching value for piezo buzzer** *
53	**-9,999…9,999 [0]**	**Value**	**ON switching value for piezo buzzer** *
61	**100…180 [135]**	**100…180**	**Display contrast** *
62	**0…1 [1]**	**'0' OFF; '1' ON**	**Display backlight** *
78	**0…0xffff [0xc201]**	**Modbus** **[38400, 8N1, Adr:1]**	**Bit_0…Bit_7: Modbus address 0…255** * **Bit_9: two stop bits** **Bit_10/Bit_11: [0, 0] 8E1; [1, 0] 8N1; [0, 1] 8O1** **Bit_15/Bit_16: [0, 0] 2400; [1, 0] 9600; [0, 1] 19200; [1, 1] 38400**
79	0…0xffff [0]	10 20	Restart Restart with factory settings

Notes:

- * values entered in (**bold**) are also saved *(Attention: do not write continuously!)*
- [x] Value after switching on or with default setting (factory setting)
- [v] Value at default setting (factory setting), depends on the device type
- Customer code
  High_Byte: ASCII character A … Z [0x41 … 0x5a], a … z [0x61 … 0x7a]
  LOW_Byte: Number [0…255(0xff)]
- For registers with default register value [11111], the measured value is output in the corresponding read register, otherwise the volatile value is entered here

1.2. Specifics for individual sensor measurement parameters

1.2.1 Specifics for humidity/temperature

The basic values (humidity and temperature) from Rreg_1 and Rreg_2 are used to determine the other humidity measurands for registers Rreg_3 to Rreg_7. This means that the measuring system can also be used as a "humidity calculator" with value specifications in Rwreg_1 and Rwreg_2. The following formulas are used:

$$Dew\ point\ temperature\ [°C] = \frac{243.12 * (\log\left(\frac{R.H.}{100}\right) + \frac{17.62 * t}{243.12 + t})}{17.62 - \log\left(\frac{R.H.}{100}\right) - \frac{17.62 * t}{243.12 + t})}$$

$R.H. = relative\ humidity\ in\ \%$, $t =$ $temperature\ in\ °C$

The steam pressure is needed for further calculations:

$$steam\ pressure[Pa] = 611.2 * \exp\left(\frac{17.62 * t_d}{243.12 + t_d}\right)$$

$t_d = dew\ point\ temperature\ in\ °C$

$$Absolute\ humidity\left[\frac{g}{m^3}\right] = \frac{steam\ pressure}{461.51\left[\frac{J}{kgK}\right] * (273.15 + t)} * 1000$$

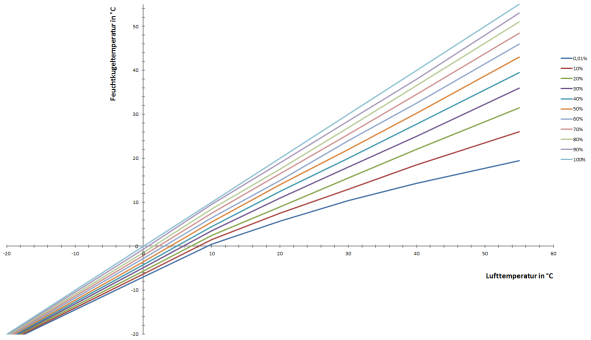
When calculating the mixing ratio, the atmospheric pressure(p) from the Wrreg_7 register is also taken into account. This is 1,013 mbar by default and can be written with other values.

$$Mixture\ ratio\left[\frac{g}{kg}\right] = 0.622 * \frac{e}{p * 100 - e}$$

$e = steam\ pressure$

$$Enthalpy\left[\frac{kJ}{kg}\right] = 1.005\left[\frac{kJ}{kg\ k}\right] * \mathrm{t} + \text{mixing ratio}\left[\frac{kg}{kg}\right] * (2500\left[\frac{kJ}{kg}\right] + 1.86\left[\frac{kJ}{kg\ k}\right] * t)$$

The determination of the wet bulb temperature is derived from the following diagram.



1.2.2.Specifics for differential pressure

The Rreg_22 or Rreg_23 is used, depending on the final measured value (up to 500 Pa or up to 5,000 Pa).

1.2.3 Specifics for CO_2 measurement

An NDIR sensor is used to determine the CO_2 content in the air in ppm. Since this sensor is subject to an ageing process over a longer period of time, an automatic calibration is recommended. Bit_4 of Rwreg_19 is set for this purpose. The CO_2 concentration is analysed over 7 days and the internal calibration data is tracked. This is based on the statement that the general CO_2 concentration is 400 ppm and that this value is reached at least once within the 7 days. If the measured value is constantly above 400 ppm, it is possible to perform a one-time manual calibration via Bit_0 of Rwreg_19 or by pressing the >UP< button and display screen (hold down for 3 sec). "Fresh air" must be available when performing this. In AUTO mode, calibration is also carried out at less than 300 ppm, but at the earliest 10 min after switching on.

1.2.4 Specifics for VOC measurement

A metal oxide sensor is used to determine the air pollution caused by volatile organic compounds (VOC). An output value of 0–100 % is obtained. However, this is not an absolute value for a single gas, but for a gas mixture and is perception-dependent. It is possible to set the sensitivity (low/medium/high) via the Rwreg_18. Since this sensor is subject to an ageing process over a longer period of time, an automatic calibration is recommended. Bit_5 of Rwreg_19 is set for this purpose. The VOC concentration is analysed over 7 days and the internal calibration data is tracked. This is based on the statement that the general VOC concentration is 10 % and that this value is reached at least once within the 7 days. If the measured value is constantly above 10 %, it is possible to perform a one-time manual calibration via Bit_1 of Rwreg_19 or by pressing the >DOWN< button and display screen (hold down for 3 sec). "Fresh air" must be available when performing this. In AUTO mode, a positive correction to 10 % is also carried out at less than 5 %, but at the earliest 10 min after switching on.

Note: The sensor for VOC measurement is heated. This results in a low heat influence on the circuit board. With combination devices, e.g. with temperature measurement, it can lead to inaccurate temperature measurements.

Table of system codes used

The measuring system is programmed by the manufacturer with regard to the measurement properties. A defined system code is stored with this and can also be called up via Rreg_0. The measurement properties are bit-coded. One or more set bits in Rreg_0 define the system code and thus the measurement property.

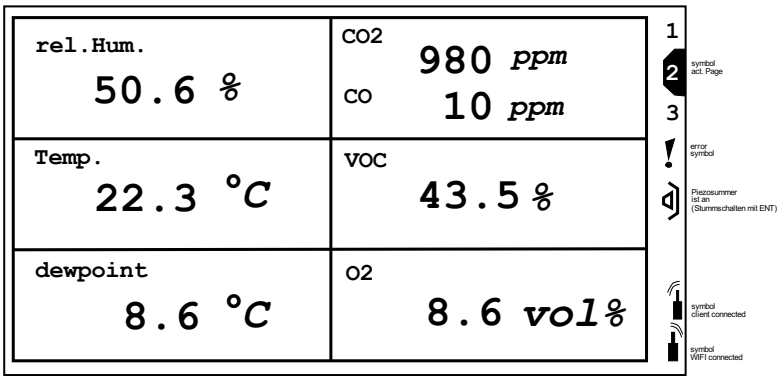
System code	*Measurement property*
Bit_0	Humidity and temperature measurement
Bit_1	CO_2 measurement
Bit_2	VOC measurement
Bit_3	CO measurement
Bit_4	O_2 measurement
Bit_5	Atmospheric and barometric pressure
Bit_6	Differential pressure measurement (excludes PT100 temperature measurement)
Bit_7	Brightness sensor
Bit_8	Motion sensor (excludes heated humidity sensor)
Bit_9	Flow sensor
Bit_10	Fine dust (particulate) measurement
Bit_11	PT100 temperature measurement if Bit_0 = 1, then humidity sensor is heated (excludes differential pressure measurement and motion sensor)
Bit_12	And Bit_3 = 1: OZONE measurement instead of CO
Bit_14	90° rotated display for top-hat rail mounting
Bit_15	Always on 1

Example:

Rreg_0 (system code) = 0x8007 → It is a universal measuring and indication system (Uni-MuA), sensors: humidity and temperature, CO_2, VOC

1.3 Operation

If the measuring system is in general measuring mode, no further operation is necessary. There is a push-and-turn switch on the right-hand side. Many settings can be made with this. Rotate to switch between the additional optional display pages. The figure shows an example in the general measuring/display mode with three manufacturer-configured pages and optional extensions of the experimental phase.



ROTARY SWITCH: page selection
SET button: switching to the Setup menu

1.4 Setup

The following settings can be made in the setup. They are described in more detail below.

- MODBUS parameters
- MEASUREMENT parameters
- DISPLAY backlight and contrast
- Display-screen setup, DISPLAY-screen activation, Delete pages and factory settings, WLAN settings, PASSWORD: ----

1.4.1 MODBUS parameters

The following Modbus parameters are set within this menu item:

- Baud rate: 2,400, 9,600, 19,200, 38,400
- Mode: 8N1 (8 data bits, no parity, 1 stop bit)
- Mode: 8E1 or 2 (8 data bits, even parity, 1 or 2 stop bits)
- Mode: 8O1 or 2 (8 data bits, uneven parity, 1 or 2 stop bits)
- MB address: 0…255

The individual parameters can be adjusted with the TURN and SET switch. The SET button is used to save the parameter at the same time.

1.4.2 MEASUREMENT parameters

The universal measuring and display system has various internal sensors (according to factory configuration). In this setup menu, some important parameters typical for the sensor can be set directly for the measurement (e.g. offset values, calibrations, zero point setting). All values can be activated and changed via the TURN and SET switch. Some parameters are also saved with the change!

1.4.3 DISPLAY backlight and contrast

Display settings are made in this menu item. The white backlight can be adjusted in 15 steps. Furthermore, it is possible to adjust the contrast and invert the display. All points are adjustable via the TURN and SET switch.

1.4.4 Delete pages and factory settings

In this point, there is the possibility of deleting the contents of the display pages or the actions or resetting the entire system to the factory settings. All points can be found via the TURN and SET switch. However, the "DOWN" button must be pressed to acknowledge the delete function (open the housing). A general restart of the system is also possible.

2. Modbus transmission structure

Start	Slave address	Function	Data	Checksum	End
3.5* character time	8 bits	8 bits	N* 8 bits	16 bits	3.5* character time

Start/end:

If there is no data on the Modbus or if there is a data pause of 3.5 * in the character time, the data acquisition is reset.
A new character on the bus is thus recognised and evaluated as the first character (address).
Example: 9,600 baud, no parity, one stop bit → 0.93 ms/character => approx. 3.3 ms for the starter identifier

Slave address (8 bits = 1 byte):

The address is set via the menu (see above) the following addresses can be set:
Address 0: no function, must not be used
Address 1–247: specific device address (may only be used once in the system)
Address 248–254: no function
Address 255: may not be used

Function code (8 bits = 1 byte):

The following function codes from the general Modbus protocol are implemented.
Code 03: Read register content (16 bits) (of a read and write register)
Code 04: Read register content (16 bits) (of a read register)
Code 06: Write register (16 bits) – one register
Code 16: Write register (16 bits) – several successive registers (max. 10)

Register (16 bits = 2 bytes):

For a description, see chapter 'Register structure'

Register number (16 bits = 2 bytes):

For a limitation of the transmission time/strings, the register number is limited to a maximum of 10 [0x0001 to 0x000a]

Checksum (16 bits = 2 bytes):

The checksum is determined according to the guidelines of a Modbus protocol.
This creates a 16-bit value that is appended to the string with the LO and HI bytes.

2.1 Function code 03 – read from read/write registers (16 bits)

Request:

Slave address	0x00…0xff
Function code	**0x03**
Start register	HI register
Start register	LO register
Register number	HI register number
Register number	LO register number
Checksum	LO check
Checksum	HI check

Response:

Slave address	0x00…0xff
Function code	**0x03**
Number of bytes	Number [n] of the register values (bytes = n * 2)
1. Register value	HI value
1. Register value	HO value
n. register value	HI value
n. register value	LO value
Checksum	LO check
Checksum	HI check

If the register has errors (see register assignment)

Slave address	0x00…0xff
Function code	**0x83**
Error code	**0x02**
Checksum	LO check
Checksum	HI check

If the register number has errors (>= 0x000a) [max. 10*]

Slave address	0x00…0xff
Function code	**0x83**
Error code	**0x03**
Checksum	LO check
Checksum	HI check

2.2 Function code 04 – read from read only registers (16 bits)

Request:

Slave address	0x00…0xff
Function code	**0x04**
Start register	HI register
Start register	LO register
Register number	HI register number
Register number	LO register number
Checksum	LO check
Checksum	HI check

Response:

Slave address	0x00…0xff
Function code	**0x04**
Number of bytes	Number [n] of the register values (bytes = n * 2)
1. Register value	HI value
1. Register value	HO value
n. register value	HI value
n. register value	LO value
Checksum	LO check
Checksum	HI check

If the register has errors (see register assignment)

Slave address	0x00…0xff
Function code	**0x84**
Error code	**0x02**
Checksum	LO check
Checksum	HI check

If the register number has errors (>= 0x000a) [max. 10*]

Slave address	0x00…0xff
Function code	**0x84**
Error code	**0x03**
Checksum	LO check
Checksum	HI check

2.3 Function code 06 – write single register (16 bits)

Request:

Slave address	0x00…0xff
Function code	**0x06**
Register	HI register
Register	LO register
Register value	HI value
Register value	LO value
Checksum	LO check
Checksum	HI check

Response:

Slave address	0x00…0xff
Function code	**0x06**
Register	HI register
Register	LO register
Register value	HI value
Register value	LO value
Checksum	LO check
Checksum	HI check

If the register has errors (see register assignment)

Slave address	0x00…0xff
Function code	**0x86**
Error code	**0x02**
Checksum	LO check
Checksum	HI check

If the value range contains errors

Slave address	0x00…0xff
Function code	**0x84**
Error code	**0x03**
Checksum	LO check
Checksum	HI check

If the values transmitted are outside the measuring range, they are limited to the measuring range and used accordingly. The error message (error code 0x03) is still sent.

2.4 Function code 16 – write multiple registers (16 bits)

Request:

Slave address	0x00…0xff
Function code	**0x10**
Start register	HI register
Start register	LO register
Register number	HI register number
Register number	LO register number
Number of bytes	Number of registers (n) multiplied by 2
1. Register value	HI value
1. Register value	LO value
n. register value	HI value
n. register value	LO value
Checksum	LO check
Checksum	HI check

Response:

Slave address	0x00…0xff
Function code	**0x10**
Start register	HI register
Start register	LO register
Register number	HI register number
Register number	LO register number
Checksum	LO check
Checksum	HI check

If the register has errors (see register assignment)

Slave address	0x00…0xff
Function code	**0x90**
Error code	**0x02**
Checksum	LO check
Checksum	HI check

If the register number has errors (>= 0x000a) [max. 10*] or the value range contains errors

Slave address	0x00…0xff
Function code	**0x90**
Error code	**0x03**
Checksum	LO check
Checksum	HI check

If the values transmitted are outside the measuring range, they are limited to the measuring range and used accordingly. The error message (error code 0x03) is still sent.

Note: The response time after a correct request has been made depends on the measuring system. Generally this is below 250 ms (usually less than 50 ms). If it is not possible for the system to respond within 250 ms, there will be no response. It is recommended to set a maximum response time of 300 ms in the master.