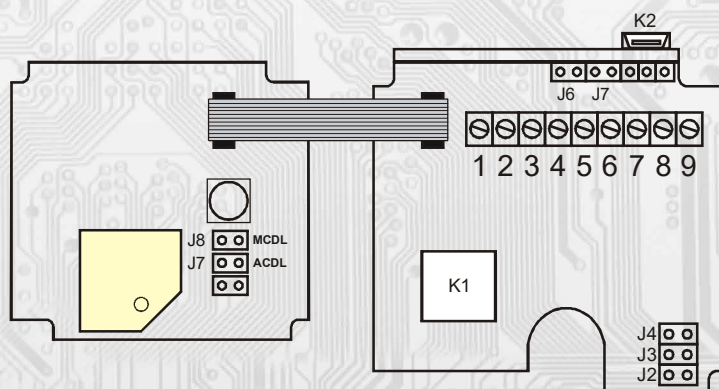


These sensors are intended for general-purpose application in control and regulation systems for the temperature, humidity and CO2 concentration measurement in airflows. The communication with superior system is led in the line RS485 by the protocol Modbus RTU and the device always operates in the "slave" mode. The temperature and humidity sensor is located in the plastic ABS stop. The CO2 sensor is located inside the plastic head, into which the measured air is fed through the openings in the stem. Therefore, the openings must be directed in the direction of the airflow in the air-conditioning duct, as shown on the lid of the head. The electronics with the terminals are located on the board connector inside the plastic, polycarbonate, grey head. The sensors include a plastic central holder for mounting the sensors on the wall of the air-conditioning duct. In air-conditioning ducts with an increased level of dust, it is advisable to sometimes clean the inside of the head with the electronics and the cavities of the plastic stop from accumulated dust using dry, compressed air.

The common chemically non-aggressive environment suits working conditions under which the sensors require no maintenance or service. Device configuration is performed by connecting a standard USB mini B cable to PC using Windows free USB_SET application.

By standard, the sensors are supplied in pass-through design with two glands. Only sensors ordered as end pieces (type PCxM12x/K) are equipped with a single gland.

Connection plan (fig.1):



K1...connection of an external part with sensors
K2...connector USB mini B

J2...definition of still stand (conductor A)
J3...definition of still stand (conductor B)
J4...terminal resistor 120R
J6...device configuration
J7...reset
J8...manual recalibration (MCDL)
J9...automatic calibration (ACDL)

Terminal 1....+Ucc, positive pole
Terminal 2.....GND, negative pole
Terminal 3....+Ucc, positive pole
Terminal 4.....GND, negative pole
Terminal 5....RS485 -A
Terminal 6....RS485 - B
Terminal 7....RS485 - A
Terminal 8....RS485 - B
Terminal 9....RS485 - common pole (shielding)

List of available types:

CO2 range	CO2 = 0 ÷ 2000ppm	CO2 = 0 ÷ 5000ppm	CO2 = 0 ÷ 10000ppm
Measured quantities			
CO2 + temperature + RH	PCHM12 - 2K - L1	PCHM12 - 5K - L1	PCHM12 - 10K - L1
Only CO2	PCNM12 - 2K - L1	PCNM12 - 5K - L1	PCNM12 - 10K - L1

Standard length L1: 180 mm, 240 mm

Basic technical parameters

Supply voltage (U _{cc})	10 to 30 VDC
Power consumption/ peak <200ms)	0,5VA / 4VA
CO ₂ /temperature/humidity resolution	1ppm / 0,1°C / 0,1%RH
Accuracy - CO ₂ (range 0 - 2000ppm)	±30ppm ±3%
Sampling interval for the measurement of CO ₂ concentration	3s
Type of sensor T+RH	SHT31
Accuracy - temperature	± 0,5°C (20 ÷ 40°C), ± 1°C (0 ÷ 60°C)
Accuracy - humidity (+25°C)	± 3% (20 ÷ 80 %RH)
Communication	RS485, protocol ModBus RTU, 8bits, 1 stop bit, without parity
Baud rate	1200 ÷ 57600Bd
Input impedance of the RS485 receiver	min. 96 kΩ, typ. 150 kΩ
Max. number of sensors on the line	254
Galvanic separation RS485	yes, < 50V
Range of working temperature and humidity	-10 ÷ 60°C/ 0 ÷ 95 % RH without condensation
Recommended calibration interval RH	2 years
Range of recommended storage temp. / RH	10 ÷ 50 °C/ 20 ÷ 60%RH
Protection type of input sensor CO ₂	IP20
Protection type of sensor T+RH	IP40
Cable gland	PG9 / 8 mm
FW upgrade program	USB_BOOT; freeware; www.regmet.cz
Terminal board	CPP (wires max. 1 mm ²)
Configuration and FW upgrade	USBset; freeware; www.regmet.cz

1. Because the device has some own power consumption (especially the CO₂ measurement module) and the temperature sensor is part of it, the measured temperature is affected by the energy emitted by the device. After installation of the sensor and tempering for min. 2h, the measured and actual temperature stabilizes at a constant value. For types with temperature measurement, the offset is preset to -2.0 °C. (this means that at the moment of connecting the supply voltage, the value on the line will be 2 °C lower than the actual value).

2. The sensor operates steadily in the recommended measuring range, which is 5 ÷ 60 °C and 20 ÷ 80% RH. Long-term exposure to high humidity, especially > 80% RH, resulting in gradually increasing deviation reading RH (+ 3% RH after 60 hours > 80% RH). After returning to the normal range, the RH will slowly return to the calibrated values. Long-term exposure to extreme conditions can accelerate the aging of the sensor.

Detailed information on conditions of long-term use of the sensor SHT31 under conditions out of the standard range, especially at the relative humidity >80% RH, are shown directly at the producer's website at:
<http://www.sensirion.com>

1.1 Properties of communication protocol:

Protocol Modbus RTU with adjustable Baud rate 1200 - 57600 Bd, 8 bits, no parity, 1 stop bit, line RS485, half-duplex operation.

Supported features:

- 03 (0x03): Read Holding Registers
- 04 (0x04): Read Input Registers
- 06 (0x06): Write Single Register
- 16 (0x10): Write Multiple Registers

The communication protocol description is available at www.regmet.cz, in the document named the Implementation of Modbus protocol in devices Regmet of second generation.

2.1 Description of registers of the device:

1 Modbus registr = 2 Byte

During the transfer the register addresses are indexed from zero, i.e. register 0x0001 is physically sent through the busbar as 0x0000... (zero based addressing). The Holding registers will be mentioned in the description together with the function code field 4xxxx and the Input registers including 3xxxx. Thus the Holding register 40001 is physically sent through the busbar as register 0000 and the Input register 30001 as 0000.

Examples of communication are shown in Chapter 2.8.

The registers are divided in four basic memory zones:

Operational registers are situated at addresses 40001, 40002 and 40006. To read these registers use command no. 03 "register reading" (0x03 Read Holding Registers)

The configuration registers are situated in the zone of Holding registers at addresses 40041 to 40082. They are used for configuration of the device. The registration in registers is protected and allowed under the configuration mode, i.e. when the jumper shorts out the link J6. In this mode the device communicates at dedicated address 255 of the Baud rate 19200 Bd. The configuration registers can be rewritten only using the communication protocol and under the above stated conditions. The change of setting and at the same time the registration in FLASH is done only after writing 0xC003 (49155 dek) to 40029 – the Register Status

The information registers are situated in the zone of Input registers at addresses 30001 to 30032. They serve for unchanged preservation of device identification data.

The Status Register serves for two-way communication between the device and the superior system. The device notifies the superior system of the internal status and the superior system sends requests for performance of commands.

STATUS Information messages from the device to the superior system:

- Normal Run, 0x0000 (0 dek) the device works in normal operational mode
- Menu Active, 0xB000 (45056 dek) the user has opened the manual menu
- Memory Read, 0xB001 (45057 dek) the device is reading from FLASH
- Memory Write 0xB002 (45058 dek) the device is registering to FLASH

STATUS Error messages from the device to the superior system:

- CRC Error 0xBE00 (48640 dek) Application program is damaged in the FLASH memory
- LCD Error 0xBE01 (48641 dek) Error of communication with LCD
- Sensor Error 0xBE02 (48642 dek) Error of communication with the sensor
- Memory Error 0xBE03 (48643 dek) Error of communication with FLASH

STATUS Commands for the device issued from the superior system:

- Clear STATUS 0x0000 (0 dek) writes 0 to the register
- Write Area 3 0xC003 (49155 dek) it rewrites the Configuration registers to FLASH

In brackets behind the registers described, abbreviations of possible features may appear:

- R Read for reading
- W Write for writing
- WP Write protect for protected writing
- M Parallel manual access from the device menu

Description of operational registers:

				Modbus registr [dek]
Measured temperature	Measured humidity	-	-	1 - 4
-	Measured CO2	-	-	5 - 8

4001 (R) – Measured temperature

is detected with an inbuilt digital sensor that is built in the plastic stem of the sensor. The value is sent in °C in form of 16-bit number with sign (signed integer) multiplied by the constant 10:

0x00FB = 251dek = 25.1°C.

Measured relative humidity of air:

is detected with an inbuilt digital sensor that is built in the plastic stem of the sensor. The value is sent in % in form of 16-bits number with sign (signed integer) multiplied by the constant 10: 0x0164 = 356dek = 35.6%.

Measured CO2 concentration:

is detected with an a module that is embedded under the cover. The value is sent in ppm in form of 16-bits number with sign (signed integer): 0x0237 = 567dek = 567ppm.

Description of the Status Register:

Status registr				Modbus registr [dek]
				29

40029 (R,W) - Status Register:

It provides the superior system with information on the internal status of the device, for example the current error statuses or information that the manual setting menu is currently activated by the user. At the same time it serves as the receiving register for special commands, for example rewrite/backup of working registers to FLASH.

The number format is 16-bit unsigned integer.

See the detailed description in the Status Register in Chapter 2.1 Description of device registers.

Description of configuration registers

Saving into EEPROM is done after writing 0xC003 (49155 dec) to 40029 - Register Status !!!

Text_1	Text_2	Text_3	Text_4	41 - 44
Text_5	Text_6	Text_7	Text_8	45 - 48
Network address	Baud rate	-	-	49 - 52
-	-	-	-	53 - 56
-	-	-	-	57 - 60
-	-	-	-	61 - 64
-	-	-	-	65 - 68
-	-	-	-	69 - 72
-	-	-	-	73 - 76
Measured temp., Offset	Measured hum., Offset	-	-	77 - 80
-	Measured CO2, Offset	-	-	81 - 84

40041 ÷ 40048 (R,WP) - Text

The custom text field. It is determined for the client's identification of the device. The number format is 16-bit unsigned integer. Two ASCII signs can be in one Modbus Register

40049 (R,WP) - Network address

The network address of the sensor. The number format is 16-bit unsigned integer. It acquires the values 0 ÷ 255 dek, whereas the address 0 is reserved for the broadcast and the sensor does not respond to it, the address 255 is reserved for the controller configuration. Thus the range of available addresses is 1 ÷ 254

40050 (R,WP) - Baud rate

The Baud rate. The number format is 16-bit unsigned integer. It acquires the values 0 ÷ 6 dek.

value [dek]	0	1	2	3	4	5	6
rate [Bd]	1200	2400	4800	9600	19200	38400	57600

40077 (R,WP) - Measured temperature, Offset

Setting the measured temperature offset.

The value is in °C in form of 16 bit number with a sign (signed integer) multiplied by the constant 10.

For example, when it seems that the device shows a value 1°C higher (for example due to the inappropriate location, heating caused by frequent communication with the loaded line...), value - 10 will be set in this register and the device will display and send the temperature value decreased by 1°C than the actually measured value is.

40078 (R,WP) - Measured humidity, Offset

Setting the measured humidity offset.

The value is in % in form of 16 bit number with a sign (signed integer) multiplied by the constant 10.

40082 (R,WP) - Measured CO2, Offset

Setting the measured CO2 offset.

The value is in ppm in form of 16 bit number with a sign (signed integer).

Description of information registers

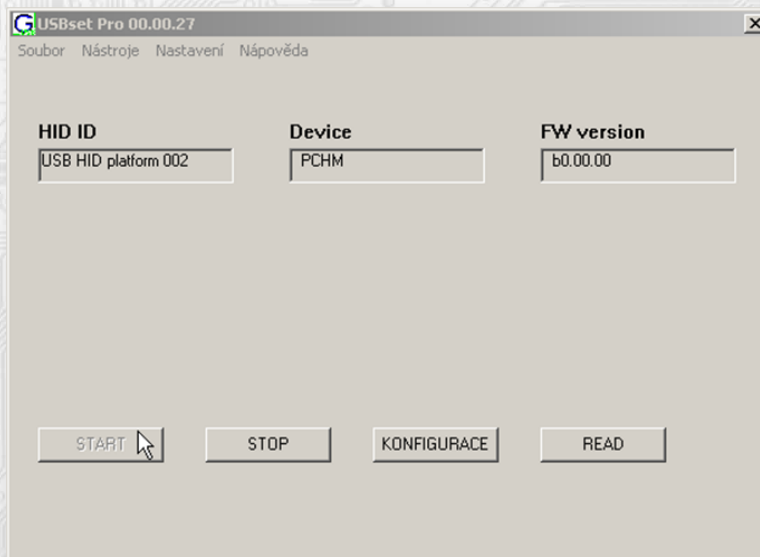
HW_Platform_1	HW_Platform_2	HW_Platform_3	HW_Platform_4	Modbus registr [dek]
HW_Platform_5	HW_Platform_6	HW_Platform_7	HW_Platform_8	1 - 4
HW_Version_1	HW_Version_2	HW_Version_3	HW_Version_4	5 - 8
FW_Boot_Version_1	FW_Boot_Version_2	FW_Boot_Version_3	FW_Boot_Version_4	9 - 12
ID_Device_1	ID_Device_2	ID_Device_3	ID_Device_4	13 - 16
ID_Device_5	ID_Device_6	ID_Device_7	ID_Device_8	17 - 20
FW_Applic_Version_1	FW_Applic_Version_2	FW_Applic_Version_3	FW_Applic_Version_4	21 - 24
0x0000	0x0000	0x0000	0x0000	25 - 28
				29 - 32

Information on HW and SW of the device, commands 04 (Read Input Registers) are counted at the addresses 30001 to 30032 (including the function code field 3xxxx, i.e. register 30001 is sent through the bus bar as register 0000). The number format is 16 bit unsigned integer. One Modbus register contains two ASCII signs.

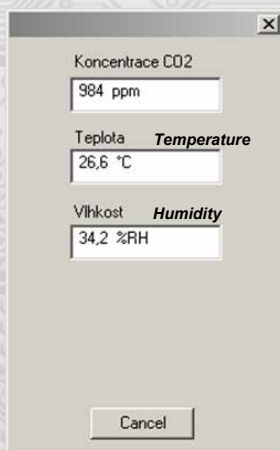
SW configuration of sensor using the USBset program:

The configuration application USBset is freely available at producer's web pages. The controlled can be configured only when the jumper J6 is inserted before the connection of supply voltage (reset). The sensor is connected with PC using the cable of USB mini B type. With connected cable the USB communication has the priority over the line RS485.

After the launching of USBset program, the basic window is opened and the connected sensor is automatically connected with the hosting PC.



With clicking on the "READ" button opens the window with the current input values.



With clicking on the button "SET" the configuration window gets opened.

With clicking on the button "READ" the configuration values from the flash memory of sensor are read.

Shift of measured value (T, RH, CO2)

For example, when it seems the device measures over by 1° C (for example due to the inappropriate location, own heating at often communication with loaded line...), the value - 1,0 is set and the device will display and send the temperature value lower by 1°C than the really measured value is.

Text field ...intended for the client's identification of the controller (title, location...).

Address ...selection of network address in the range 1 ÷ 254 for the operation of sensor in the serial line

Baud rate ...selection of Baud rate in the range 1200 ÷ 57600 Bd for the operation of sensor in the serial line

After setting of required values and quantities the new configuration values are saved in the flash memory of the device by clicking on the button "Write"

The writing into the flash memory is conditioned by insertion of jumper J6 (authorisation for configuration values recording) before the clicking on the button "Write"

By clicking on the button "Cancel" the configuration windows gets closed.

After USB cable disconnection the jumper J6 is pulled out and the device is ready for operation

Variation of the application part FW:

After the USBset program launching click on the Tools – BootLoader and the windows gets opened:

The work with application is conditioned by insertion of the jumper J6 (authorisation for configuration values recording). Using the button "OpenFile" the new application FW is chosen and using the button "DownLoad" the FW variation gets started, being automatically controlled by PC and the device.

For the maximum simplicity and safety every device has unambiguous identification of HW platform. This designation describes HW topology and also defines what application FW can be used for the specific type of HW. This information can be read through the button "HW info".

The application FW are distributed in data format “reg”. In case of application variation the information on HW platform and HW version are always read after the connection of PC with the device. At the same time, the HW platforms descriptors and HW versions from the file “reg” are read. Provided HW platform and HW version are not compatible, the FW variation cannot be done. Provided the communication failure occurs during the application FW variation, for example due to the supply voltage drop, the application SW will not be functional. In such case the automatic launching of “bootload” process as well as the automatic reading of HW info will not work. The Bootloader in the device gets always activated after the reset, thus it is necessary to reset manually. Using the RESET jumper or the simple disconnection and subsequent connection of supply voltage.

Provided the automatic sequence of FW variation launching is damaged:

- switch off the device or connect the jumper at RESET pins
- launch the bootloader process using the button "Download"
- switch on the supply voltage or release the RESET jumper
- delay between the activation of button "Download" and the switching on or by the RESET shall be shorter than 2s.

After the USB cable disconnection the jumper J6 is pulled out and the device reset is performed using the short shorting of RST jumper (J7).

The integrity check of content of memory:

The bootloader as well as the application are protected by control total sums. Provided the data integrity is broken, the content of FLASH memory MCU is damaged and the damaged program will not be launched.

Examples of communication controller frames

Frame "03" reading N-registers

Master:

02 03 00 04 00 03 Crc Crc

| | | | L L Number of read registers (3 registers)

| | | Address of initially read register (0x0004 hex)

| Command (Reading N registers)

L Module address (module with address 2)

Slave:

02 03 06 00 FF FF FF 00 01 Crc Crc

| | | L L L L L Data from register (0x00FF hex,
| | | Number of bytes (6) 0xFFFF hex,
| | Command (Reading N registers) 0x0001 hex
| Module address (module with address 2)

The address of the initial register is 0x0005 hex, which is the address of the measured temperature register, the number of read registers is three. Serviceable data is the before: Measured temperature 0x00FF hex = 25.5°C, required correction 0xFFFF hex = -0.1°C, push button position 0x0001 hex = P/B final position active. LED is ON.

Command 06 (0x06) Write Single Register:

Master:

FF 06 00 1C C0 03 Crc Crc

- Registered data (0xC003 = 49155dek)
- Address of registered register (0x001D**)
- Command (Write Single Register)
- Address of device (with inserted jumper J6 - address 255)

Slave:

FF 06 00 1C C0 03 Crc Crc

- Registered data (0xC003 = 49155dek)
- Address of registered register (0x001D**)
- Command (Write Single Register)
- Address of device (with inserted jumper J6 - address 255)

By writing the value 49155dek in register 0x001D** (40029 - Status Register), the configuration registers are saved in the flash memory of the device. If, for example, the communication address and rate pursuant to the previous example are changed through the network, then after this registration in the Status Register this change will be valid even after the device is reset or switched off.

Command "16" (0x10) write multiple registers

Master:

FF 10 20 09 00 01 02 09 04 Crc Crc

└─ Data written (0x0904)

└─ Number of bytes (2)

└─ Number of written registers (1)

└─ Address of first written register (0x200A**)

└─ Command (Preset Multiple Register)

└─ Address module
(module with embedded jumper "service" - address 255)

Slave:

FF 10 20 09 00 01 Crc Crc

- Number of written registers (1)
- Address of first written register (0x200A**)
- Command(Preset Multiple Registers)
- Address module
(module with embedded jumper "service" - address 255)

Writing data 0x0904 to the register 0x200 A** is set address 9 and communication speed of 19200 Bd.

****** During sending of query to device initial register address and number of registers to read are sent.
Register addresses are indexed from zero - register 0x0005 is physically send as value 0x0004... (zero based addressing)

** During the transfer the addresses of registers are indexed from zero, i.e. register 0x0001 is physically sent through the bus bar as 0x0000 ... (zero based addressing).

Content Modbus Holding Registers (Table 2):

Description of operational registers:

				Modbus registr [dek]
Measured temperature	Measured humidity	-	-	1 - 4
-	Measured CO2 concentration	-	-	5 - 8

Description of the Status Register

Status registr				29
----------------	--	--	--	----

Description of configuration registers The saving in FLASH is done only after writing 0xC003 (49155 dek) to 40029 – the Register Status.

Text_1	Text_2	Text_3	Text_4	41 - 44
Text_5	Text_6	Text_7	Text_8	45 - 48
Network address	Baud rate	-	-	49 - 52
-	-	-	-	53 - 56
-	-	-	-	57 - 60
-	-	-	-	61 - 64
-	-	-	-	65 - 68
-	-	-	-	69 - 72
-	-	-	-	73 - 76
Measured temp., Offset	Measured hum., Offset	-	-	77 - 80
-	Measured Co2 concentration., Offset	-	-	81 - 84

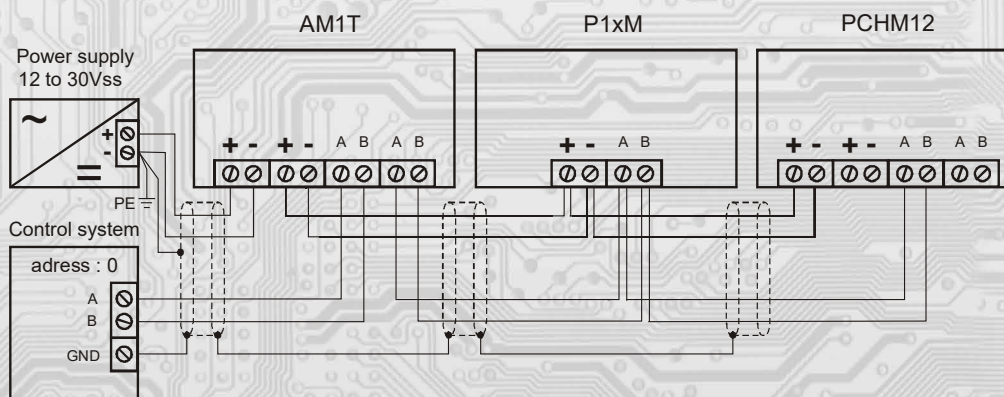
The function of the automatic calibration (ACDL) and the manual recalibration (MCDL):

The CO2 sensor contains optical elements, which "age" during operations and the sensor loses its accuracy. In normal living rooms, where occasional complete air exchange of the room is assumed, ageing is compensated by setting the ACDL mode, which is the automatic calibration function. This function is activated by a permanent short-circuit of the J7 connector, when the first automatic calibration takes place after 3 days and then after every week.

In areas, where it is not possible to use the automatic calibration function, it is advisable to occasionally use the manual recalibration function. This is done by placing sensors with a connected voltage supply into the ventilated area, preferably into an outdoor environment (CO2 content = approx. 400ppm) for at least 30 minutes. Then, the J8 connector is short-circuited for 10 minutes. After 10 minutes, the connector is disconnected and the sensor works with modified values. The sensor must be placed in a ventilated area for the duration of the recalibration.

The instrument is supplied calibrated from the manufacturer without any set mode. It is up to the user to choose how the calibration will take place. The majority of the users use the optimal automatic calibration function (ACDL), thereby connected to J9.

Example of wiring the sensors in the system:



Assembly and connection

The sensors are designed to be assembled into air-conditioning ducts using the attached consoles. The air flow direction must be maintained according to the sticker on the lid in order to ensure air supply to the CO2 sensor inside the box.

The wires are connected to a terminal strip (Fig. 1), which can be accessed by removing the screws and head cap.). The signal terminals A and B on the sensors are connected to the serial line as per the rules for connection of devices in RS485 serial lines. The use of A, B, ZAK. jumpers is subject to general rules for communication through RS485 lines (note: at end points of the RS485 line, it is necessary to connect a terminating resistor through the ZAK. jumper). The sensors are supplied from a single 12 to 30 VAC power supply, while the supply voltage is connected to the terminals marked by (+) Ucc and (-)GND. It is recommended to interconnect the devices using a multi-core shielded cable, which hosts data as well as power supply wires. The cable shield must be interconnected between individual segments of the line and only connected to the lowest potential (PE terminal) in the switchboard. When you are done, install the cap by mounting all the four screws.

Dimensions and accessories

