

CO₂ concentration, temperature, humidity
and other calculated humidity variables regulator

with RS485 serial output

H5421

H5424

H6420

H6421

Instruction Manual

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General safety rules

The following summary is designed to prevent injury hazards or device damage. Operate the instrument in accordance with this manual to prevent electric trauma.

Service should be performed by a qualified person only.

Connect and disconnect correctly. Do not connect and disconnect a lead-in cables if the device is under electric voltage.

Do not use the instrument without the cover.

Do not use the instrument, if it does not work correctly. If the instrument seems not to work correctly, have it checked by a qualified service person.

Do not use the instrument in an explosive environment.

Read instruction manual before the first device connection, please.

Models marked HxxxxZ are non-standard versions of the devices. Description is not included in this manual.

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COMET SYSTEM, Ltd makes constant development and improvement of all its products. That is why it reserves the right to make any technical changes on the device/product without previous notice.

Manufacturer is not responsible for damages caused by using the device in conflict with this manual. To damages caused by using the device in conflict with this manual cannot be provided free repairs during the warranty period.

Contact the manufacturer of this device:

COMET SYSTEM, s.r.o.
Bezrucova 2901
756 61 Roznov pod Radhostem
Czech Republic
www.cometsystem.com

1. General description

The regulators are designed for online measurement of temperature (°C or °F), relative humidity and carbon dioxide concentration of air without aggressive ingredients. Measured temperature and relative humidity are recomputed to following humidity expression: dew point temperature, absolute humidity, specific humidity, mixing ratio and specific enthalpy.

The regulators are designed to be operated in a chemically non-aggressive environment.

Type	Temperature	Humidity	CO ₂	Computed value
H5421	-	-	✓	-
H5424	-	-	✓	-
H6420	✓	✓	✓	✓
H6421	✓	✓	✓	✓

The device is equipped with two relay outputs for alarming or controlling of external devices. It is possible to assign any input value to each relay, to set comparing limit, delay, hysteresis, acoustic alarm or change its status by far control with using of Modbus communication protocol. The device communicates via link RS485.

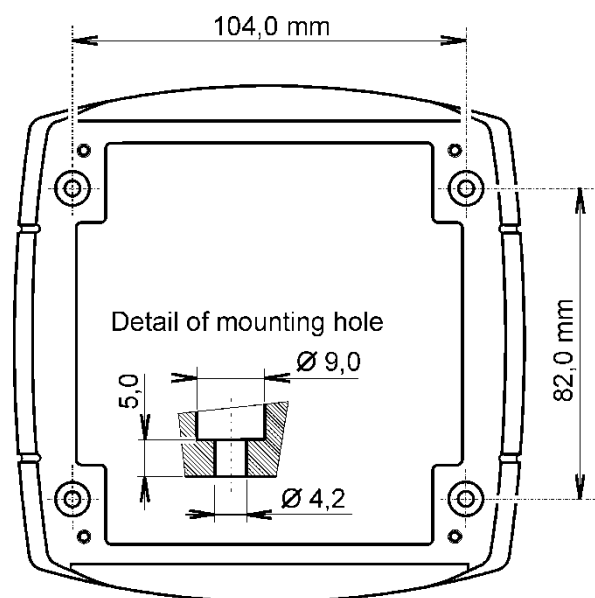
Supported communication protocols are Modbus RTU and protocol compatible with standard Advantech-ADAM. Devices are preset from manufacturer to Modbus RTU communication protocol. If you would like to use different communication protocol then Modbus RTU, it is necessary preset them – see latter. Measured and computed values are displayed on dual line LCD. It is also possible to display both readings with cyclic overwriting in 4 seconds interval. Display can be also switched OFF totally. On the left LCD side there are placed three LEDs for CO₂ zone level indication.

2. Regulator mounting and connection

Regulators are designed for wall mounting. Device must be mounted on the plane surface to prevent its deformation. Mounting holes and connection terminals are accessible after demounting of four screws in the corners of the box and removing the lid. There is recommended to use screws with half round head with cross-recessed screw ST 3.9 (DIN 7981). External probe for measuring the concentration of CO₂ unpack and connect to the device.

Lace the lead-in cable with outer diameter of 3 to 6.5 mm through the glands at the case wall and connect them according schematic below. Terminals are self-clamping and can be opened by a suitable screwdriver. For the opening, insert the screwdriver to smaller terminal hole and lever by him. Do not forget to tighten glands and case lid with inserted packing after cables connecting. Insert attached plug into unused cable glands too. Do not connect the regulator under voltage.

It is not recommended to use the device H6420 and external RH+T probe of H6421 regulator for long time under condensation conditions. It could be the cause of water steam condensation inside the sensor's cover into water



phase. This liquid phase stays inside sensor's cover and can't escape from the cover easily. It can dramatically increase response time to relative humidity change. If water condensation occurs for longer time it can cause sensor damage. Similar effect can occur under water aerosol conditions.

For devices with RS485 output there is recommended to use shielded twisted copper cable, maximal length 1200m. The cable must be located at indoor rooms. Nominal cable impedance should be 100Ω , loop resistance max. 240Ω , cable capacity max. 65 pF/m . Outside diameter of the cable for regulator connection must be from 3 to 6.5 mm. Suitable cable is e.g. SYKFY $2 \times 2 \times 0.5 \text{ mm}^2$, where one wire pair serves for device powering and the other pair for communication link.

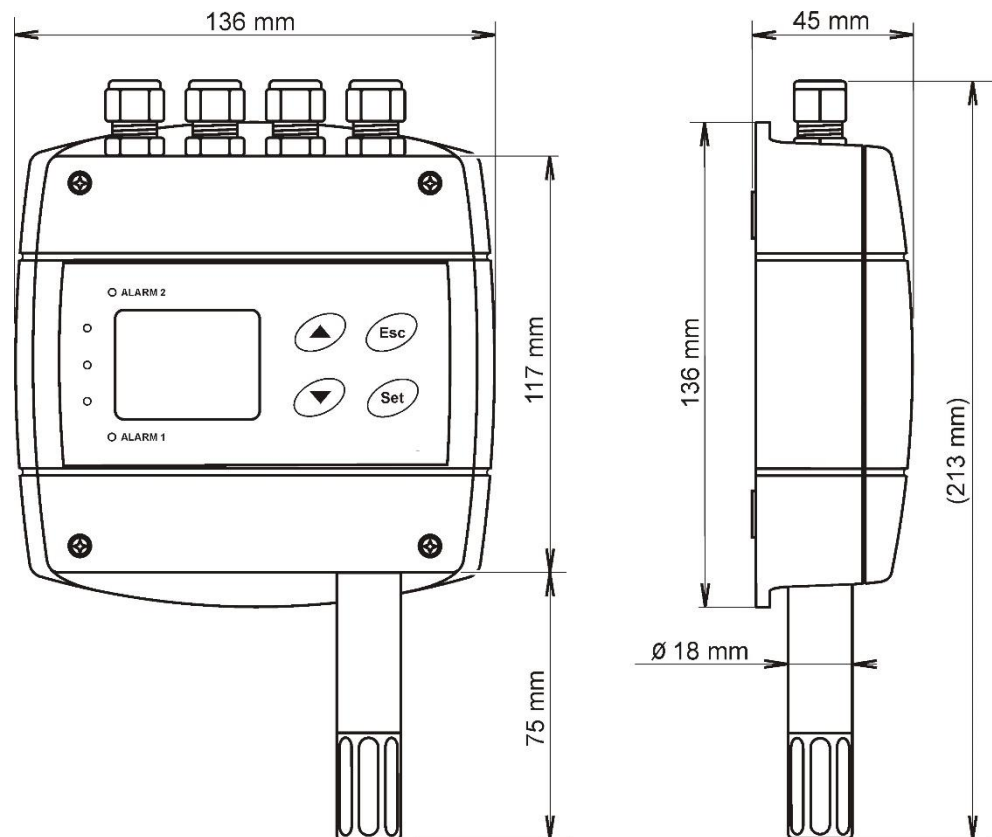
The cable should be led in one line, i.e. NOT to „tree“ or „star“. Termination resistor should be located at the end. For short distance other topology is allowed. Terminate the network by a termination resistor. The value of the resistor is recommended about 120Ω . For short distance termination resistor can be left out.

The communication cable must be placed as far as possible from potential interference sources.

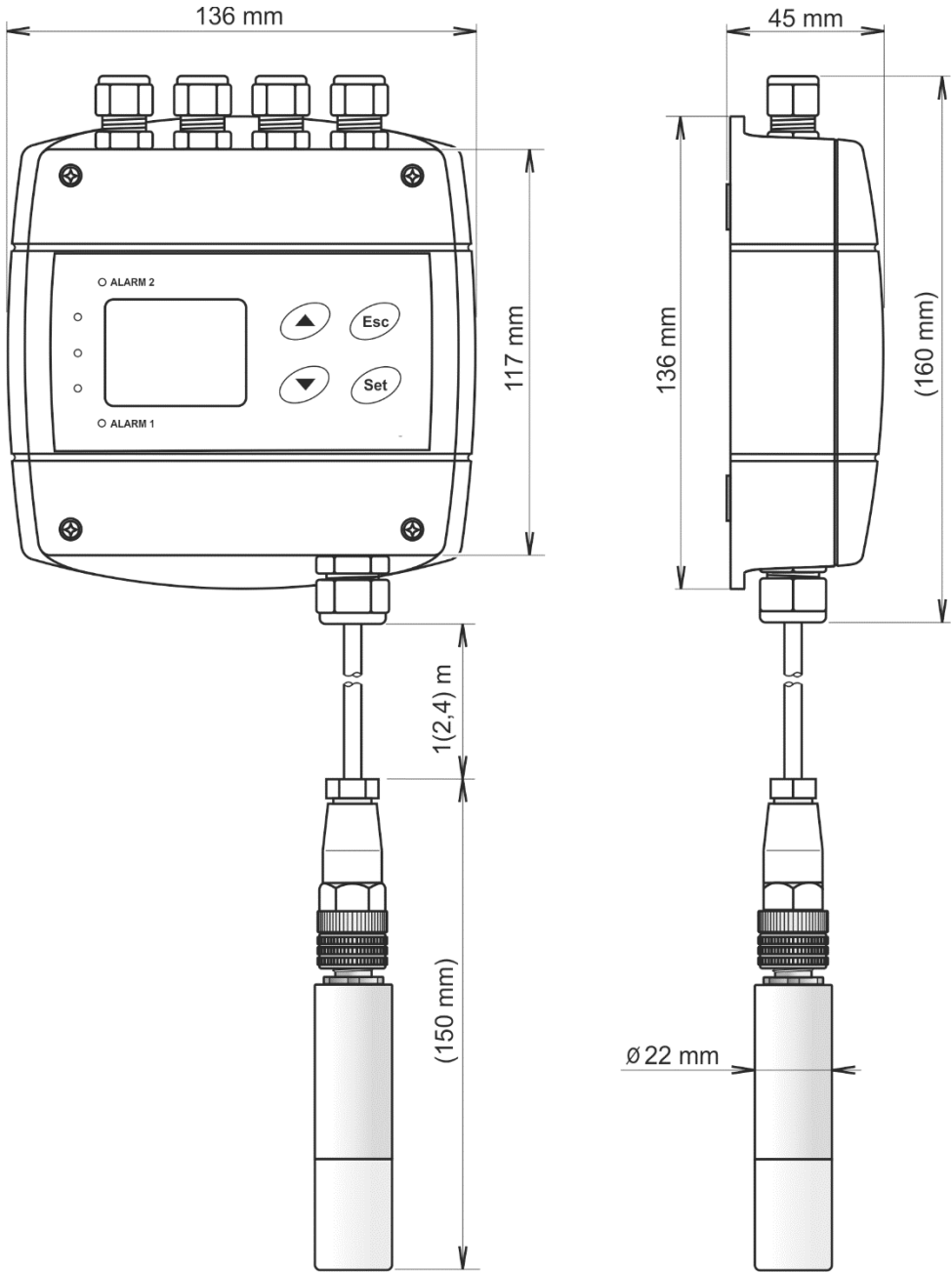
Electrical system (wiring) may do only worker with required qualification by rules in operation.

3. Dimensions

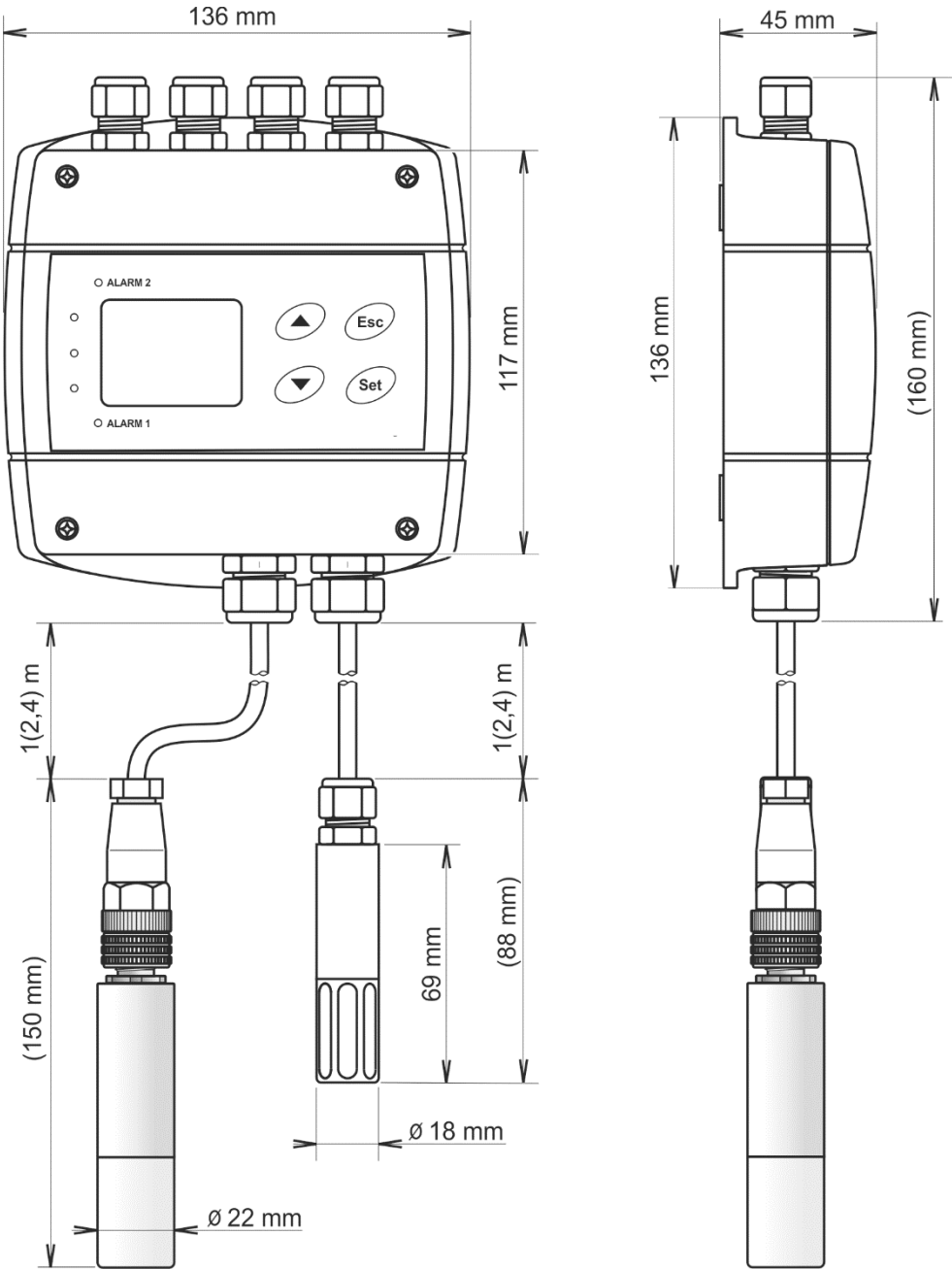
H6420



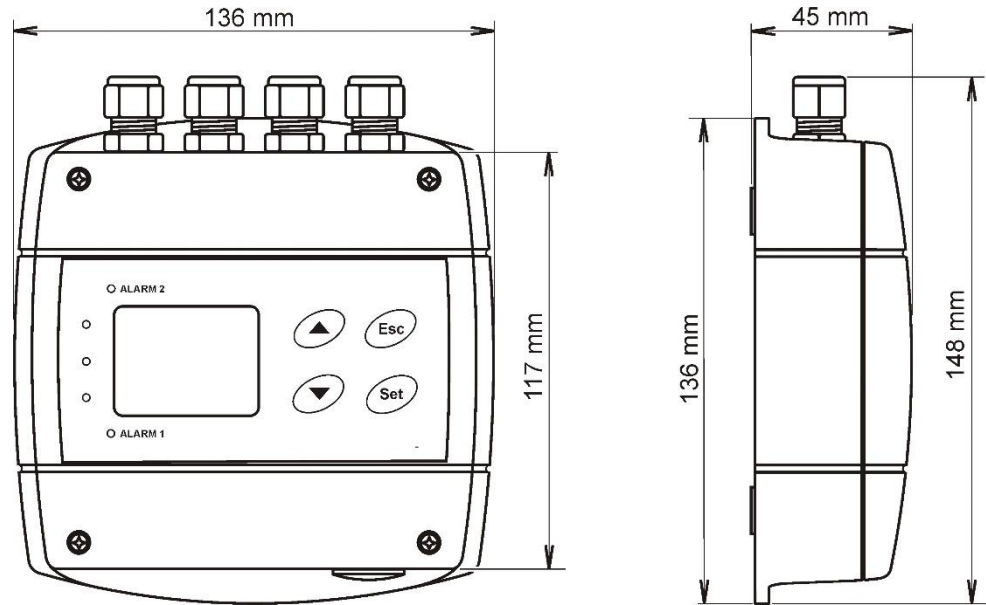
H5421



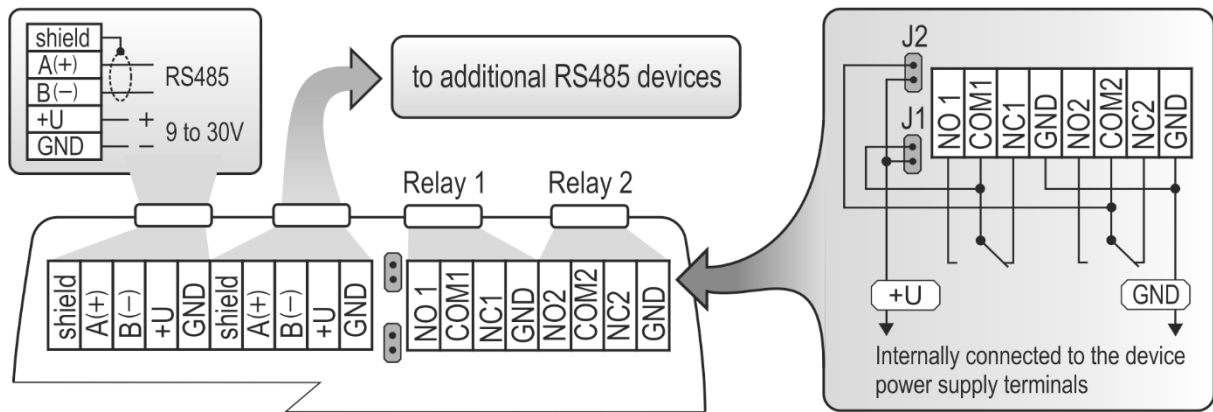
H6421



H5424



4. Typical application wiring, connection of terminals



5. Description of device function and setting

Information from regulator is available directly through LCD or you can read them with one of next communication protocols (Modbus RTU, Advantech-ADAM).

5.1. Device setting from the manufacturer

communication protocol:	Modbus RTU
regulator address:	1
communication speed:	9600Bd, no parity, 2 stop bits
Value assigned to Relay1 and Relay2:	none
Password for setting through keys (PASS):	0000
LCD display:	on
value shown at first LCD line:	temperature / CO2 - by device type
value shown at second LCD line:	relative humidity / dew point temp. - by device type
temperature unit:	°C
computed value preset:	dew point temperature
relay response for error:	stay unchanged at previous condition
acoustic alarm:	off
LED indication of CO ₂ concentration	up to 1000 ppm lights green LED, between 1000 and 1200 ppm lights yellow LED and over 1200 ppm lights red LED

5.2. Relay outputs

Regulator is equipped with two relay outputs. It is possible to assign any input or computed value or “Far condition” (see chapter “*Far controlling of output relays status*” at page 19) to each relay, to set comparing alarm limit, if the relay may close if measured value is higher (Hi) or lower (Lo) than preset limit, delay for while must be preset condition true before relay close its contact and hysteresis for return to open status. For binary inputs: if it is preset to „HI“ then output relay is closed when input contact is opened, if it is preset to „Lo“ then output relay is closed when input contact is closed. Each relay status is indicated with LED diode and shown on LCD with corresponding symbols „**ALARM 1**“ or „**ALARM 2**“.

Terminal block for connecting the relays is equipped with terminals GND, which are connected to the power supply of the device (see chapter “*Typical application wiring, connection of terminals*”). When you need to use relays to switching the voltage identical with the supply voltage of the device, you can use jumpers J1 and J2 for interconnection the power supply of the device directly with the common contacts of the relays. **This modification is used in devices with serial number higher than 16981000** (the wiring diagram of the relay contacts for devices with serial number lower than 16981000 is given in the “*Appendix B*”).

The devices are equipped with two relays that are not intended for direct switching power circuits or mains voltage. If necessary, use suitable type of external relay (an example of wiring is given in the “*Appendix A*”).

5.3. Carbon dioxide concentration measurement

A multiple point CO₂ and temperature adjustment procedure leads to excellent CO₂ measurement accuracy over the entire temperature working range; this is a must for process control and outdoor applications. The dual wavelength NDIR CO₂ sensing procedure compensates automatically for ageing effects. The CO₂ module is highly resistant to pollution and offers maintenance free operation and outstanding long term stability. Measured values can be read in „SLOW mode“ (filtered, averaged) or in „FAST mode“ (current values without averaging). SLOW mode has advantages in applications like climate control because of filtering short time peaks. As an example exhaled air from an employee passing the sensor could affect the climate control negatively with a short response time because the control would trigger a change of the ventilation based on this one-time measurement. On the contrary in „FAST mode“ no software filter is used for calculating the output value. This fact adds a noise of typ. ±30ppm which has to be considered in terms of accuracy.

After power up there is internal check in progress and takes about 20 s. During this time LCD display shows (---) instead of CO₂ concentration value.

Parameter setting description is into chapter “Regulator setting change” at page 12.

5.4. Actual regulator preset

It is possible to display actual regulator preset on its LCD display by pressing of „▲“ key. If far controlling of output relays status is active (see chapter 6.1.4 at page 19), then device’s LCD display shows text „bloc“. It means, device’s keyboard is disabled for time of remote control (setting change), see chapter 6.1.5 at page 20. LCD shows information about Relay1 and then Relay2 setting step by step. Information about Relay1 are indicated with symbol „ALARM 1“, for Relay2 with symbol „ALARM 2“ (at right top corner of LCD). It is possible to edit parameters after pressing „SET“ key and entering of correct password „PASS“ – see chapter “Change of “Password for setting through keys” (PASS)” at page 14. Following examples are for Relay1 setting, similarly are displayed values for Relay2. Pressing of „ESC“ key ends this mode and switch to actual value displaying, the same occur if more than 20 s is not pressed any key.



5.4.1. Value assigned to output relay

None, relay is still off



Temperature at °C



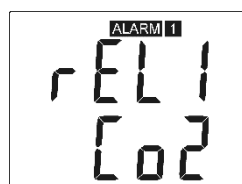
Relative humidity



Computed value – dew point temperature



CO₂ concentration



Far condition 0



Far condition 1



FAR0 – „far condition 0“: after device’s power on the relay is open
 FAR1 – „far condition 1“: after device’s power on the relay is close
 If “far condition” is assigned to output relay, then there is possible to change the output relay status by Modbus communication protocol only. See chapter “Far controlling of output relays status” at page 20.

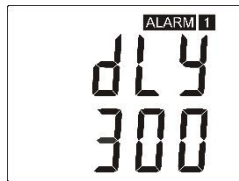
5.4.2. When close output relay

High limit „HI“ – the relay closes when measured value exceeds preset „high limit” for longer time than preset „delay time“. Relay goes open when measured value decrease under „high limit“ value minus the „hysteresis” value. See example.

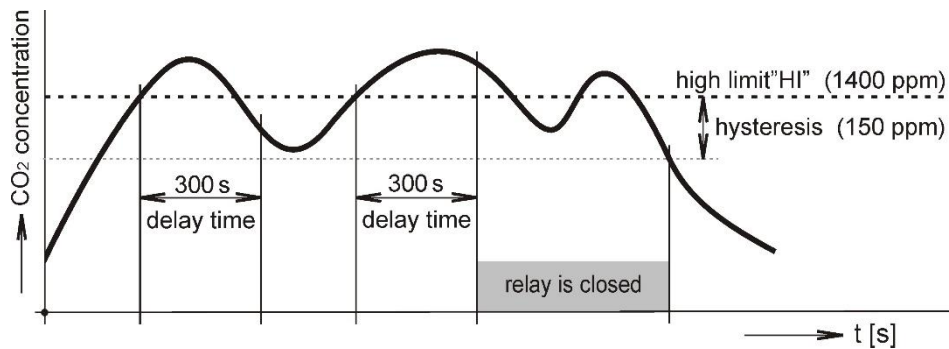
High limit „HI“



Delay [s]

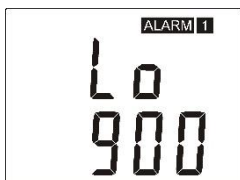


Hysteresis

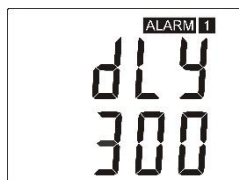


Low limit „Lo“ – the relay closes when measured value falls below preset „low limit” for longer time than preset „delay time“. Relay goes open when measured value exceeds „low limit“ value plus the „hysteresis” value. See example.

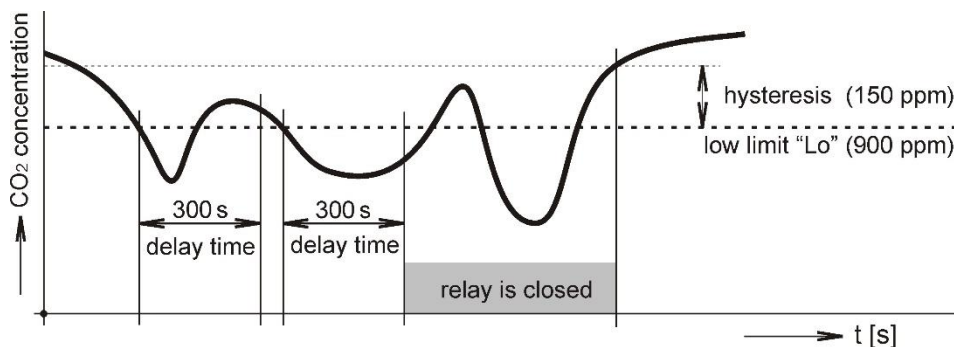
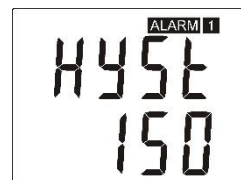
Low limit „Lo“



Delay [s]



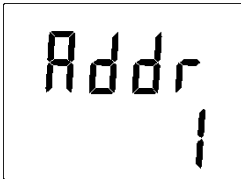
Hysteresis



5.4.3. Regulator address setting

Regulator address for preset communication protocol.

RS485 network regulátor address



5.5. Regulator setting change

5.5.1. Setting with PC and TSensor software

User's software **TSensor** provides **setting of all regulator parameters**. The program is available free to download at web page www.cometsystem.com. Run the TSensor program and follow the program instructions. Regulator includes hardware write protection of internal setting, new setting is possible to write only while:

1. during write period press „SET“ key – do requested setting in TSensor software, press „SET“ key on regulator and keep it down, then click on the button „Save Changes“ into TSensor software and after end of write release „SET“ key, or
2. jumper placed nearby keys is closed (jumper is accessible after demounting of four screws in the corners of the box and removing the lid). This jumper is suitable e.g. until device adjustment is in process and regulator is placed into calibration box and keys are not accessible. Don't forget to remove (open) jumper after procedure finish (restore write protection)

TSensor software supports to make the adjustment of the regulator too. This procedure is described at file „*Calibration manual.pdf*“ which is installed commonly with the software.

5.5.2. Setting with using regulator keys

If „Actual regulator preset“ is displayed (see chapter „*Actual regulator preset*“ at page 10), it is possible to enter into edit mode and edit displayed value by pressing „SET“ key. Then you are asked for valid password (PASS). You can edit selected value if right password is entered. During value editing there is range check executed and edited value is still compared with limits for corresponding value (range). If inserted value is higher or lower then edited number is automatically changed to its maximum / minimum value – for possible range see chapter „*Technical parameters*“ at page 24. Value can be changed with using „▲“ and „▼“ keys. Edited value is switched in “round” -9, -8, -7, ...-2, -1, 0, 1, 2, ...8, 9. To edit next number digit press „SET“ key, for moving back to previous digit press „ESC“ key. Edited value is stored by next „SET“ key pressing. It is possible to cancel editing by pressing „ESC“ key if necessary. If valid password is once inserted right, then there is possible to edit next items without asking for password insertion again, till “Actual regulator preset” is left (till actual measured values are shown). With new entering into edit mode it is necessary to enter Password again. Default password setting is preset from manufacturer to 0000, password change is possible into „Extended setting“. During edit mode regulator still works and changes are valid immediately after its storing – it is not necessary to restart regulator.

5.5.3. Setting with using of Modbus communication protocol

See chapter “Output relay alarm condition configuration with using of Modbus communication protocol” at page 20.

5.6. Extended setting mode

During regulator operation it is possible to change parameters available through “Actual regulator preset” only (see chapter 5.4 at page 10). Rest of regulator parameters are available through “Extended setting mode”. **In this mode regulator does NOT communicate, does NOT do any measurements and does NOT service output relays. To leave this mode press „ESC“ key and open jumper nearby keys. To enter into Extended setting mode do following steps:**

1. disconnect power supply
2. demount four screws in the corners of the box and remove the lid
3. closed jumper placed nearby keys
4. press „▲“ and „▼“ keys together and keep them down
5. connect power supply to regulator – you should see message „SEL“ on the top line of LCD and on the bottom line you should see number of Firmware version (e.g. 0404)
6. release „▲“ and „▼“ keys – you are into “Extended setting mode” now

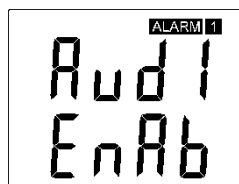
Use „▲“ and „▼“ keys to inspect each items. If you want to change some shown item then press „SET“ key, item starts blink. Now you can edit setting with using „▲“ and „▼“ keys. To store preset value press „SET“ key. Press „ESC“ key to leave editing (changing) without save – last stored value is kept.

Acoustic alarm assign to Relay1

acoustic indication of Relay1 is OFF

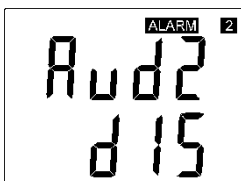


close of Relay1 contact starts acoustic indication



Acoustic alarm assign to Relay2

acoustic indication of Relay2 is OFF

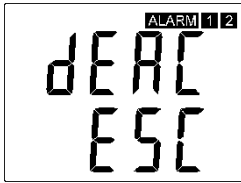


close of Relay2 contact starts acoustic indication



Acoustic alarm deactivation

activated acoustic alarm is possible to deactivate by pressing „ESC“ key



acoustic alarm is still activated for all time and it is impossible to deactivate it



Relay response for error

Regulator continuously checks its state during operation. In case error of assigned value measurement is found then output Relay1 (Relay2):

stays unchanged (in previous status)



Relay1 switch OFF



Relay1 switch On



stays unchanged (in previous status)



Relay2 switch OFF



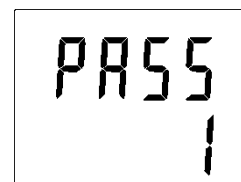
Relay2 switch On



Change of “Password for setting through keys” (PASS)

This item shows actual password setting. It is possible to change it after „SET“ key pressing. It is number from range - 19999 to +19999

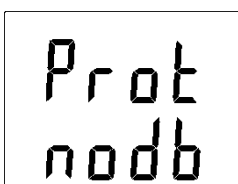
password setting



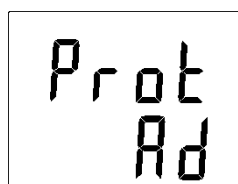
Choice of communication protocol

Choice of communication protocol for communication with master device

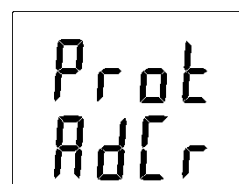
protocol Modbus



protocol Advantech-Adam without check sum



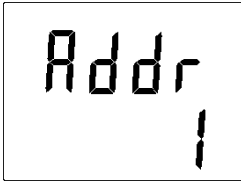
protocol Advantech-Adam with check sum



Regulator address setting

Regulator address for preset communication protocol

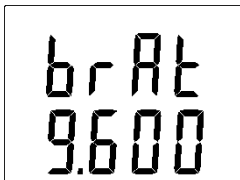
RS485 network regulator address



Communication speed

Communication speed for preset communication protocol

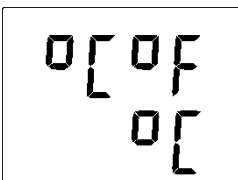
communication speed setting



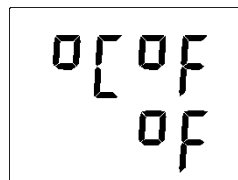
Temperature unit choice

It is possible to measure temperature at °C or °F. There is shown preset unit. It is possible to change it after „SET“ key pressing.

preset to °C



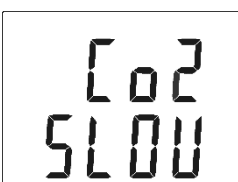
preset to °F



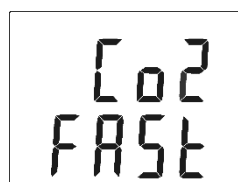
CO₂ measurement mode selection

This item provides to choice if measured value is displayed and read in “SLOW” or “FAST” mode. “FAST” mode provides last measured value without averaging; this means that no software filter is used for calculating the output value. “SLOW” mode provides value averaged from last 11 “FAST” measured values.

averaged value „SLOW“ mode

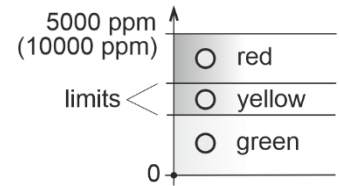


current value without averaging „FAST“ mode

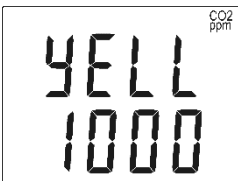


CO₂ zone level indication setup

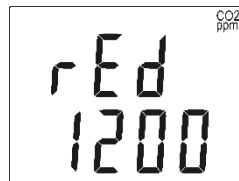
Whole measuring range can be divided into three areas. Each active area there is indicated by green, yellow or red LED depends on actual measured value. It is done by two boundary limits setting. „YELL“ limit sets boundary between green and yellow indication. It means that if actual measured value is lower than „YELL“ limit, there is green LED active. If actual measured value is higher than „YELL“ limit, then there is yellow LED active. Yellow LED lights until actual measured value exceeds „RED“ limit. If actual value is higher than „RED“ limit, red LED is active. If you don't want to use this indication then set “YELL” limit to 0.



„YELLOW“ limit setting



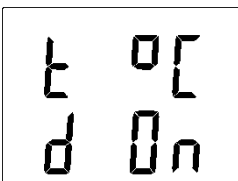
„RED“ limit setting



Show temperature at LCD display

This item provides to choice if actual measured temperature may be displayed at LCD display or not. It is possible to change it after „SET“ key pressing.

show value on LCD



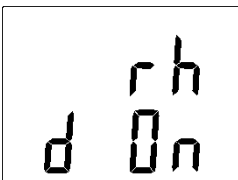
don't show value on LCD



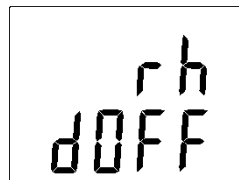
Show relative humidity at LCD display

This item provides to choice if actual measured relative humidity may be displayed at LCD display or not. It is possible to change it after „SET“ key pressing.

show value on LCD



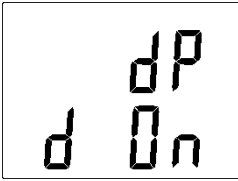
don't show value on LCD



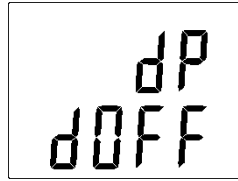
Show computed value at LCD display

This item provides to choice if actual computed value may be displayed at LCD display or not. There is shown the name of computed value on the top LCD line – see “Computed value selection“ below. It is possible to change it after „SET“ key pressing.

show value on LCD



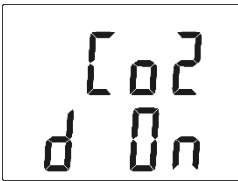
don't show value on LCD



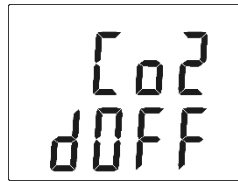
Show CO₂ concentration at LCD display

This item provides to choice if CO₂ value may be displayed at LCD display or not. It is possible to change it after „SET“ key pressing.

show value on LCD



don't show value on LCD



Computed value selection

It shows the actually selected computed value name. It is possible to change it after „SET“ key pressing. There is possible choice one of the following computed values:

dew point temperature



absolute humidity



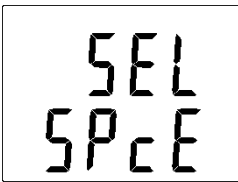
mixing ratio



specific humidity



specific enthalpy



5.7. Restore to „Factory default“

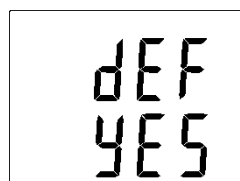
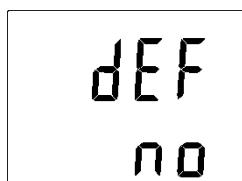
This item provides regulator restoring to factory setting. Press „SET“ key, select „YES“ and confirm it by pressing of „SET“ key. It reset regulator parameters to following values:

communication protocol:	Modbus RTU
regulator address:	1
communication speed:	9600Bd, no parity, 2 stop bits
value assigned to Relay1 and Relay2:	none
password for setting through keys:	0000
display:	on

value shown at first LCD line:
value shown at second LCD line:
temperature unit:
computed value preset:

temperature / CO₂ - by device type
relative humidity / dew point temp. – by device type
°C
dew point temperature

obnova nastavení regulátoru od výrobce



6. Description of communication protocols

Detailed description of each communication protocols including examples of communication is available into document “*Description of communication protocols*”, which is available to download at www.cometsystem.com, see detailed description of appropriate device type. After switching ON the power of the device it can last up to 3 s before the device starts to communicate and measure !!!

6.1. Modbus RTU

Control units communicate on master-slave principle in half-duplex operation. Only master can send request and only addressed device responds. During sending of request no other slave station should respond. During communication, data transfer proceeds in binary format. Each Byte is sent as eight bit data word in format: 1 start bit, data word 8 bit (LSB first), 2 stop bits¹, without parity. Device supports communication speed from 110Bd to 115200Bd.

Sent request and response have syntax: ADDRESS OF DEVICE – FUNCTION – Modbus CRC

6.1.1. Supported functions

- 03 (0x03):** Reading of 16-bit registers (Read Holding Registers)
- 04 (0x04):** Reading of 16-bit input gates (Read Input Registers)
- 06 (0x06):** Setting of one 16-bit register (Write Register)
- 16 (0x10):** Setting of more 16-bit registers (Write Multiple Registers)

6.1.2. Jumper

Jumper (placed nearby keys) is accessible after demounting of four screws in the corners of the box and removing the lid. If communication protocol Modbus is selected the function of jumper is as follows:

- Jumper opened – device memory is protected from writing, from device side it is only enabled to read measured value, writing to memory is disabled (no change of settings is enabled)
- Jumper closed – writing to regulator memory is enabled

¹ Device sends two stop bits, for receive one stop bit is enough.

6.1.3. Modbus registers of the regulator

Variable	Unit	Address [hex] ^x	Address [dec] ^x	Format	Size	Status
measured temperature	[°C/°F]*	0x0031	49	Int*10	BIN16	R
measured relative humidity	[%]	0x0032	50	Int*10	BIN16	R
computed value*		0x0033	51	Int*10	BIN16	R
CO ₂ concentration displayed on LCD	ppm	0x0034	52	Int	BIN16	R
Relay1 status [0/1] (Alarm 1)	[-]	0x003B	59	Int	BIN16	R
Relay2 status [0/1](Alarm 2)	[-]	0x003C	60	Int	BIN16	R
CO ₂ concentration „FAST“ mode	ppm	0x0054	84	Int	BIN16	R
CO ₂ concentration „SLOW“ mode	ppm	0x0055	85	Int	BIN16	R
status word (described below)	[-]	0x0007	7	Int	BIN16	R
device serial number Hi	[-]	0x1035	4149	BCD	BIN16	R
device serial number Lo	[-]	0x1036	4150	BCD	BIN16	R
firmware version Hi	[-]	0x3001	12289	BCD	BIN16	R
firmware version Lo	[-]	0x3002	12290	BCD	BIN16	R
device address	[-]	0x2001	8193	Int	BIN16	R/W**
communication speed code	[-]	0x2002	8194	Int	BIN16	R/W**

Legend:

- * depends on device setting (by User's software)
- Int*10 register is in format integer *10 (likewise *100, *1000)
- R register is designed only for reading
- W** register is designed for writing, but direct write is not available, for details see description of communication protocols
- x at transmit are register addresses indexed from zero - „zero based addressing“. For example „measured temperature“ with Modbus address 0x31 is physically sent along data bus as value 0x30. You make sure of correct addressing with the aid of Master device documentation or experimentally (e.g. for „measured temperature“ try to use address 0x31 or 0x30).
- Status word: 16b value return, bite description:

Bit0	0/1	jumper open/closed
Bit1	-	unused
Bit2	0	always 0
Bit3	0/1	Relay1 open/closed
Bit4	0/1	Relay2 open/closed
Bit5	0/1	internal acoustic alarm status
Bit6 to 15	-	unused

Note: In case there is a need for reading of measured values from the device with higher resolution than one decimal, measured values in device are stored also in „Float“ format, which is not directly compatible with IEEE754.

6.1.4. Far controlling of output relays status

There is possible to control output relay status (open/close) with using of Modbus communication protocol. To this function enable, there is necessary to assign one of following options to relay:

- FAR0 – „Far condition 0“, it means, after power up output relay will be open, or
- FAR1 – „Far condition 1“, it means, after power up output relay will be close.

Then there is possible to change relay status by Modbus communication protocol command by requested value writing to following addresses:

Function	Address [hex] ^X	Address [dec] ^X	Description	Status
Far condition for Relay1	0x0042	66	0 - relay open, 1 - relay closed	R/W
Far condition for Relay2	0x0043	67	0 - relay open, 1 - relay closed	R/W

6.1.5. Output relay alarm condition configuration with using of Modbus communication protocol²

With Modbus communication protocol there is possible to set regulator’s parameters described at chapter “*Actual regulator preset*” at page 10. Follow next steps:

- 1) To address 0x0044 (68) write value1 – it enables Modbus setting. By the way it blocks regulator’s keyboard – local keyboard is blocked during remote control setting change.
- 2) Write the desired settings / changes to the addresses from 0x0045 (69) to 0x004E (78). New setting can be done simultaneously or each register can be written alone
- 3) To address 0x004F (79) write value 1. Once this step is done, new setting is physically stored into device memory (confirm change). Then registers 0x004F (79) and 0x0044 (68) are automatically cleared (zero). It automatically unlocks the keyboard too.

Whole setting process can be cancelled by writing value 0 to address 0x0044 (68). At this time no changes are stored and last setting stays valid.

Function	Unit	Address [hex] ^X	Address [dec] ^X	Description	Status
Modbus Remote Control	[-]	0x0044	68	0 ... disable 1 ... enable (for this time device’s keyboard is blocked, if key is pressed, message BLOC is shown)	R/W
Value assigned to output Relay1	by value	0x0045	69	0 ... Off 1 ... temperature 2 ... relative humidity 3 ... atmospheric pressure (CO ₂ concentration) 4 ... computed value 5 ... unused 6 ... unused 7 ... unused 8 ... Far condition 0 9 ... Far condition 1	R/W
When close Relay1	[-]	0x0046	70	0 ... alarm occurs, when measured value is LOWER than preset alarm value 1 ... alarm occurs, when measured value is HIGHER than preset alarm value	R/W

² This function is available from firmware version 04.06. If older firmware used, update your firmware or contact device’s distributor.

Function	Unit	Address [hex] ^X	Address [dec] ^X	Description	Status
Alarm value for Relay1	by value	0x0047	71	preset alarm value (threshold)	R/W
Delay for Relay1	[sec]	0x0048	72	Time in seconds Time in seconds that the condition must be valid to evaluate alarm	R/W
Hysteresis of Relay1	by value	0x0049	73	Value which must be set back below / above a given threshold in order to open the relay	R/W
Value assigned to output Relay2	by value	0x004A	74	0 ... Off 1 ... temperature 2 ... relative humidity 3 ... atmospheric pressure (CO ₂ concentration) 4 ... computed value 5 ... unused 6 ... unused 7 ... unused 8 ... Far condition 0 9 ... Far condition 1	R/W
When close Relay2	[-]	0x004B	75	0 ... alarm occurs, when measured value is LOWER than preset alarm value 1 ... alarm occurs, when measured value is HIGHER than preset alarm value	R/W
Alarm value for Relay2	by value	0x004C	76	preset alarm value (threshold)	R/W
Delay for Relay2	[sec]	0x004D	77	Time in seconds Time in seconds that the condition must be valid to evaluate alarm	R/W
Hysteresis of Relay2	by value	0x004E	78	Value which must be set back below / above a given threshold in order to open the relay	R/W
Confirm changes	[-]	0x004F	79	Read always as 0 write 1 ... physically stores new setup into device's memory, at the end the register is automatically reset to zero.	R/W

All registers contains 16b number. Communication examples are listed in a separate document entitled "Description of communication protocols“.

6.2. Protocol compatible with Advantech-ADAM standard

Control units communicate on master-slave principle in half-duplex operation. Only master can send requests and only addressed device responds. During sending request any of slave devices should respond. During communication data is transferred in ASCII format (in characters). Each Byte is sent as two ASCII characters. Device supports communication speed from 1200Bd to 115200Bd, parameters of communication link are 1 start bit + eight bit data word (LSB first) + 1 stop bit, without parity.

6.2.1. Jumper

Jumper (placed nearby keys) is accessible after demounting of four screws in the corners of the box and removing the lid. If communication protocol compatible with standard Advantech-ADAM is selected, its function is the following:

- If jumper during switching ON the power is closed, device always communicates with following parameters regardless stored setting in the device: communication speed 9600 Bd, without check sum, device address 00h
- If jumper during switching ON the power is not closed, device communicates in accordance with stored setting.
- If jumper is closed during device operation, device temporarily changes its address to 00h, it will communicate in the same communication speed as before closing jumper and will communicate without check sum. After jumper is opened setting of address and check sum is reset in accordance with values stored in the device.
- Communication speed and check sum are possible to change only if jumper is closed.
- Jumper closed and button pressed for longer than six seconds – causes restoring of manufacturer setting **of communication protocol**, i.e. sets Modbus RTU communication protocol, device address sets to 01h and communication speed to 9600Bd (after button press there is “dEF” message blinking at LCD display. Six seconds later message “dEF” stays shown, it means manufacturer setting **of communication protocol** is done).

For communication with device which measure more than one value, there is necessary to add at the end of command, number of communication channel, where the measured value is mapped. Command for value reading is #AAx(CRC) CR, where AA is device address and x is number of communication channel by next table:

Measured value	Number of communication channel
temperature	0
relative humidity	1
computed value	2
barometric pressure (CO ₂ concentration)	3
status word (described below)*	4
Relay1 status [0/1]	5
Relay2 status [0/1]	6

* Status word: 16b value return, bite description:

Bit0	0/1	jumper open/closed
Bit1	-	unused
Bit2	0	always 0
Bit3	0/1	Relay1 open/closed
Bit4	0/1	Relay2 open/closed
Bit5	0/1	internal acoustic alarm status
Bit6 -15	-	unused

7. Error States of the device

Device continuously checks its state during operation. In case error is found LCD displays corresponding error code:

Error 0 - first line of LCD displays „Err0“. Check sum error of stored setting inside device's memory. This error appears if incorrect writing procedure to device's memory occurred or if damage of calibration data appeared. At this state device does not measure and calculate values. It is a serious error, contact distributor of the device to fix.

Error 1 - measured or calculated value (except concentration of CO₂) is over upper limit of allowed full scale range. There is a reading „Err1“ on LCD display. Value read from the device is +999.9. This state appears in case of:

- Measured temperature is higher than approximately 600°C (i.e. high non-measurable resistance of temperature sensor, probably opened circuit).
- Relative humidity is higher than 100%, i.e. damaged humidity sensor, or humidity calculation of humidity is not possible (due to error during temperature measurement).
- Computed value – calculation of the value is not possible (error during measurement of temperature or relative humidity or value is over range).

The value of CO₂ concentration 9999 ppm is correct value!

Error 2 - there is a reading „Err2“ on LCD display. Measured or calculated value is below lower limit of allowed full scale range or CO₂ concentration measurement error occurred. Value read from the device is -999.9. This state appears in case of:

- Measured temperature is lower than approximately -210°C (i.e. low resistance of temperature sensor, probably short circuit).
- Relative humidity is lower than 0%, i.e. damaged sensor for measurement of relative humidity, or calculation of humidity is not possible (due to error during temperature measurement).
- Computed value – calculation of computed value is not possible (error during measurement of temperature or relative humidity).

Error 3 - there is a reading „Err3“ on LCD display upper line. Error of internal A/D converter appeared (converter does not respond, probably damage of A/D converter). At this state device does not measure temperature and relative humidity. This error does not affect CO₂ concentration measurement. It is a serious error, contact distributor of the device.

Error 4 - there is a reading „Err4“ on LCD display. It is internal device error during CO₂ concentration sensor initialization. Under this condition device does not measure concentration of CO₂. Value read from device is -9999 (concentration of CO₂). CO₂ sensor is probably damaged. It is a serious error, contact distributor of the device. For devices with an external probe CO₂G-10 the “Err4” indicates that the probe is not connected.

Error 5, 6 - there is problem with assigned value to output relay, there is some wrong setting (mismatch). This error appears if incorrect writing procedure to device's memory occurred.

Error 9 - inserted password is not valid, there is shown for short time message “Err9” on LCD display.

8. Readings on LCD display

°C, °F reading next to this symbol is measured temperature or error state of value

%RH reading next to this symbol is measured relative humidity or error state of value

CO₂ ppm reading next to this symbol is measured concentration of CO₂ or error state of value.

°C / °F DP reading next to this symbol is calculated dew point temperature or error state of value

g/m³ reading next to this symbol is calculated absolute humidity or error state of value

g/kg reading next to this symbol is calculated specific humidity or mixing ratio (depends on device setting) or error state of value

3 this symbol is on if jumper is closed

If specific enthalpy is selected, there is shown only value (number) without corresponding unit.

9. Preventive maintenance and calibration

Pay heed to recommended calibration interval. Do not subject the device to mechanical stress.

10. Technical specification

10.1. Technical parameters

10.1.1. Common parameters

Power voltage: 9 to 30 V DC

Power consumption: 1W during normal operation
4W for 50ms with 15 s period

Measuring interval: temperature, relative humidity0,5s
concentration of CO₂ 15s

Display switching interval: 4 s (when more than two values are displayed)

RS485 interface: receiver – input resistance 96kΩ
max. 256 devices on bus

Relay outputs: Amount: 2
Maximal voltage: 50 V
Maximal current: 2A
Maximal power: 60 VA
Relays contact is not designed for direct control of line voltage!
(relay contact parameters: max 220Vdc, 125Vac, 2A, 60 W, 62.5 VA)

EMC: EN 61326-1, EN 55011

10.1.2. H5421 - CO₂ regulator

Concentration of CO₂:

Accuracy: $\pm (100 \text{ ppm} + 5 \% \text{ of measuring value})$ at 25°C (77°F) and 1013 hPa
Range: 0 to 10000 ppm
Temp. dependence: $\pm (1 + \text{measured value [ppm]}/1000) \text{ ppm} / ^\circ\text{C}$ (-20...45 °C) (-4...113°F)
Resolution: 1 ppm

Response time: $t_{63} < 140 \text{ s}$ in „SLOW“ measurement mode
 $t_{63} < 75 \text{ s}$ in „FAST“ measurement mode

10.1.3. H5424 - CO₂ regulator

Concentration of CO₂:

Accuracy: $\pm (50 \text{ ppm} + 3 \% \text{ of measuring value})$ at 25°C (77°F) and 1013 hPa
Range: 0 to 5000 ppm
Temp. dependence: $\pm (1 + \text{measured value [ppm]}/1000) \text{ ppm} / ^\circ\text{C}$ (-20...45 °C) (-4...113°F)
Long term stability: typ. 20 ppm / year
Resolution: 1 ppm

Response time: $t_{90} < 195 \text{ s}$ in „SLOW“ measurement mode
 $t_{90} < 75 \text{ s}$ in „FAST“ measurement mode

10.1.4. H6420 - temperature, relative humidity and CO₂ regulator

Temperature:

Accuracy: $\pm 0,4 \text{ }^\circ\text{C}$ ($\pm 0,7 \text{ }^\circ\text{F}$)
Range: -30 to +60 °C (-22 to 140 °F)
Resolution: 0,1 °C (0,2 °F)

Relative humidity:

Accuracy: $\pm 2,5 \% \text{RH}$ from 5 to 95 %RH at 23 °C (73,4 °F)
Range: 0 to 100 %RH
Resolution: 0,1 %RH

Concentration of CO₂:

Accuracy: $\pm (50 \text{ ppm} + 3 \% \text{ of measuring value})$ at 25°C (77°F) and 1013 hPa
Range: 0 to 5000 ppm
Temp. dependence: $\pm (1 + \text{measured value [ppm]}/1000) \text{ ppm} / ^\circ\text{C}$ (-20...45 °C) (-4...113°F)
Long term stability: typ. 20 ppm / year
Resolution: 1 ppm

Measuring temperature and humidity range is limited in accordance with the graph below.

Response time measurement of temperature and relative humidity with stainless steel mesh sensor cover (F5200B) and bronze sensor cover (F0000 - selectable option), air flow 1 m/s:

temperature: $t_{90} < 6 \text{ min}$ (temperature step 20 °C (36 °F))
relative humidity: $t_{90} < 30 \text{ s}$ (humidity step 65 %RH, constant temperature)

Response time measurement of CO₂ concentration:

$t_{90} < 195 \text{ s}$ in „SLOW“ measurement mode
 $t_{90} < 75 \text{ s}$ in „FAST“ measurement mode

10.1.5. H6421 - temperature, relative humidity and CO₂ regulator

Temperature:

Accuracy: $\pm 0,4$ °C ($\pm 0,7$ °F)

Range: -30 to +105 °C (-22 to 221 °F), includes probe cable

Resolution: 0,1 °C (0,2 °F)

Relative humidity:

Accuracy: $\pm 2,5$ %RH from 5 to 95 %RH at 23 °C (73,4 °F)

Range: 0 to 100 %RH

Resolution: 0,1 %RH

Concentration of CO₂:

Accuracy: $\pm (100 \text{ ppm} + 5 \% \text{ of measuring value})$ at 25°C (77°F) and 1013 hPa

Range: 0 to 10000 ppm

Temp. dependence: $\pm (1 + \text{measured value [ppm]}/1000) \text{ ppm} / ^\circ\text{C}$ (-20...45 °C) (-4...113°F)

Resolution: 1 ppm

Measuring temperature and humidity range is limited in accordance with the graph below.

Response time measurement of temperature and relative humidity with stainless steel mesh sensor cover (F5200B) and bronze sensor cover (F0000 - selectable option), air flow 1 m/s:

temperature: $t_{90} < 6$ min (temperature step 20 °C (36 °F))

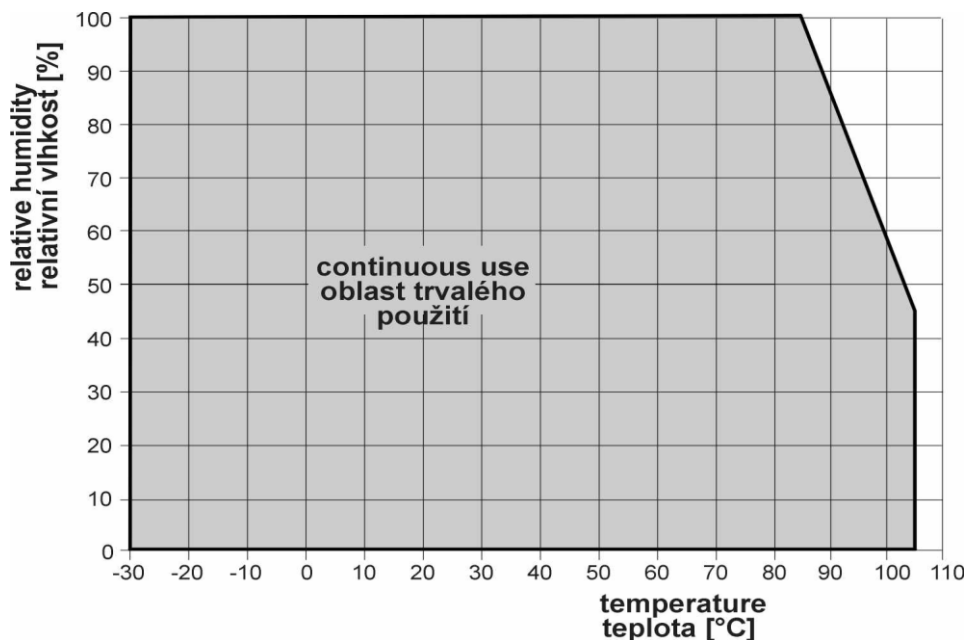
relative humidity: $t_{90} < 30$ s (humidity step 65 %RH, constant temperature)

Response time measurement of CO₂ concentration:

$t_{63} < 140$ s in „SLOW“ measurement mode

$t_{63} < 75$ s in „FAST“ measurement mode

10.1.6. Relative humidity and temperature restriction

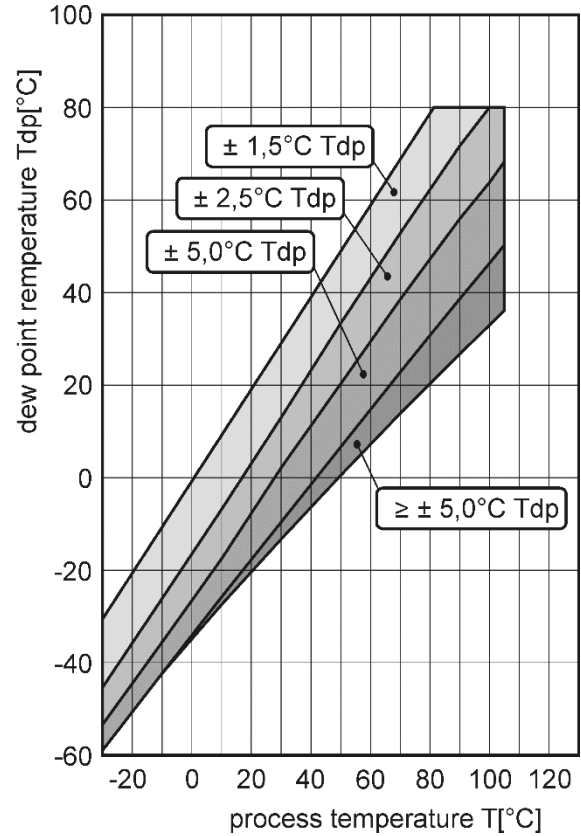
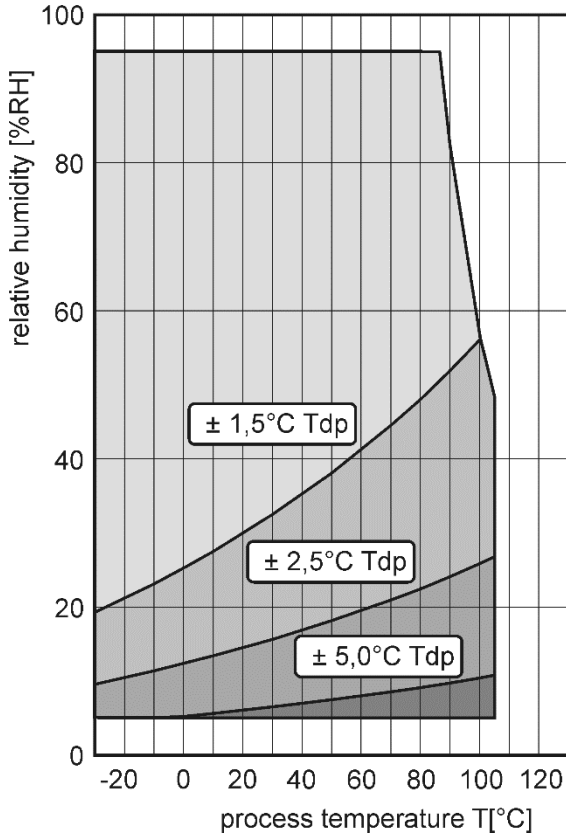


10.1.7. Value computed from measured relative humidity and temperature

Dew point temperature

Range: -60 to +80 °C (-76 to 176 °F)

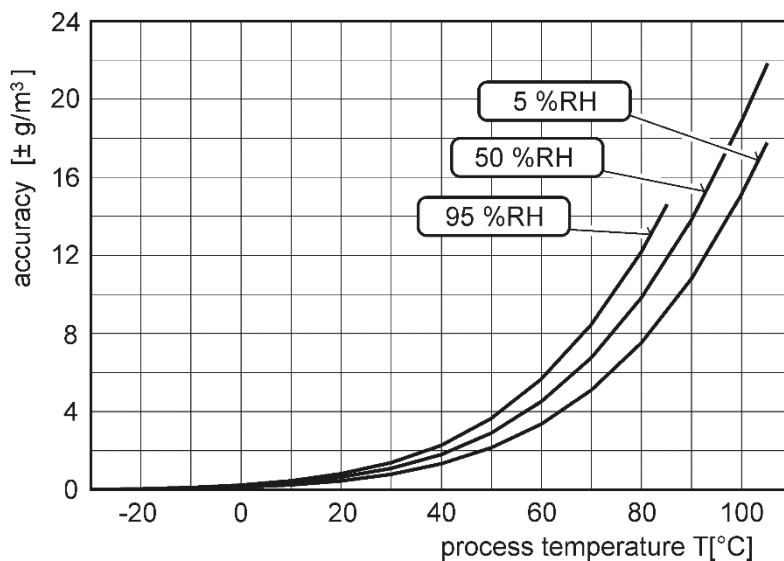
Accuracy: $\pm 1,5^{\circ}\text{C}$ ($\pm 2,7^{\circ}\text{F}$) at ambient temperature $T < 25^{\circ}\text{C}$ (77°F) and relative humidity $\text{RH} > 30\%$, for more details see graphs below



Absolute humidity

Range: 0 to 400 g/m³

Accuracy: $\pm 1,5 \text{ g/m}^3$ at ambient temperature $T < 25^{\circ}\text{C}$ (104°F), for more details see graph below



Specific humidity³

Accuracy: ± 2 g/kg at ambient temperature $T < 35^{\circ}\text{C}$ (95°F)

Range: 0 to 550 g/kg

Mixing ratio³

Accuracy: ± 2 g/kg at ambient temperature $T < 35^{\circ}\text{C}$ (95°F)

Range: 0 to 995 g/kg

Specific enthalpy³

Accuracy: ± 3 kJ/kg at ambient temperature $T < 25^{\circ}\text{C}$ (77°F)

Range: 0 to 995 kJ/kg⁴

The values computed from ambient temperature and relative humidity including their accuracy you can exactly determine by the program **Conversions**. It is free to download at www.cometsystem.com.

10.2. Operating conditions

Operating temperature range:

electronics H5421, H6421: -30 to $+80^{\circ}\text{C}$ (-22 to 176°F)

electronics H5424, H6420: -30 to $+60^{\circ}\text{C}$ (-22 to 140°F)

measuring end of stem H6420: -30 to $+80^{\circ}\text{C}$ (-22 to $+176^{\circ}\text{F}$)

CO₂ probe H5421, H6421: -25 to $+60^{\circ}\text{C}$ (-13 to $+140^{\circ}\text{F}$) (fixed installation)
-5 to $+60^{\circ}\text{C}$ ($+23$ to $+140^{\circ}\text{F}$) (moving use)

RH+T probe H6421: -30 to $+105^{\circ}\text{C}$ (-22 to $+221^{\circ}\text{F}$)

It is recommended to switch off the LCD display at ambient temperatures above 70°C (158°F) around electronics.

Operating humidity range:

H5421, H6421: 0 to 100 % RH (no condensation)

H5424, H6420: 5 to 95 % RH (no condensation)

CO₂ probe H5421, H6421: 0 to 95 % RH (no condensation)

Operating barometric pressure range 850 to 1100 hPa

Protection:

H5421 IP65 (electronics), IP65 (CO₂ probe)

H5424 IP30 (electronics)

H6420 IP30 (electronics), IP40 (measuring end of stem)

H6421 IP65 (electronics), IP65 (CO₂ probe), IP40 (RH+T probe)

Other environmental conditions (external influences) according to HD 60364-5-51: normal

Recommended calibration interval:

H5421 5 years (CO₂)

H5424 5 years (CO₂)

H6420 5 years (CO₂), 1 year (relative humidity), 2 years (temperature)

H6421 5 years (CO₂), 1 year (relative humidity), 2 years (temperature)

Working position:

H5421, H6421: negligible

H5424: with cable glands upwards

H6420: with sensor cover downwards

³ This value depends on the atmospheric pressure. For computing is used constant value stored in device memory. Default value preset by manufacturer is 1013hPa and can be changed by user's software.

⁴ This maximum is reached under conditions about $70^{\circ}\text{C}/100\%\text{RH}$ or $80^{\circ}\text{C}/70\%\text{RH}$

Not allowed manipulations: It is not allowed to operate the device under conditions other than specified in technical parameters. Devices are not designed for locations with chemically aggressive environment. Temperature and humidity sensors must not be exposed to direct contact with water or other liquids. It is not allowed to remove the sensor cover to avoid any mechanical damage of the sensors.

Storage conditions:

- temperature:** -40 to +60 °C (-40 to 140 °F)
CO₂ external probe -25 to +60 °C (-13 to 140 °F)
- relative humidity:** 5 to 95 % RH (no condensation)
CO₂ external probe 0 to 95 %RH (no condensation)
- atmospheric pressure:** 700 to 1100 hPa

Dimensions: see dimensional drawings

Weight: approximately:

- H5421/1m probe** 440 g
- H5421/2m probe** 470 g
- H5421/4m probe** 530 g
- H5424** 340 g
- H6420** 360 g
- H6421/1m probe** 520 g
- H6421/2m probe** 590 g
- H6421/4m probe** 730 g

Material of the case: ASA/ABS

10.3. End of operation

Disconnect the device and dispose it according to current legislation for dealing with electronic equipment.

10.4. Technical support and service

The adjustment procedure is described at file „*Calibration manual.pdf*“ which is installed commonly with the TSensor software.

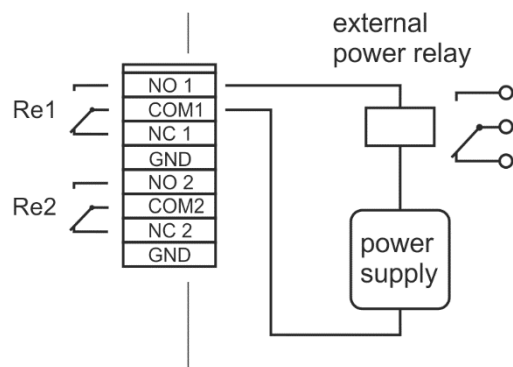
Technical support and service is provided by distributor. For contact see the warranty certificate.

11. Appendix A

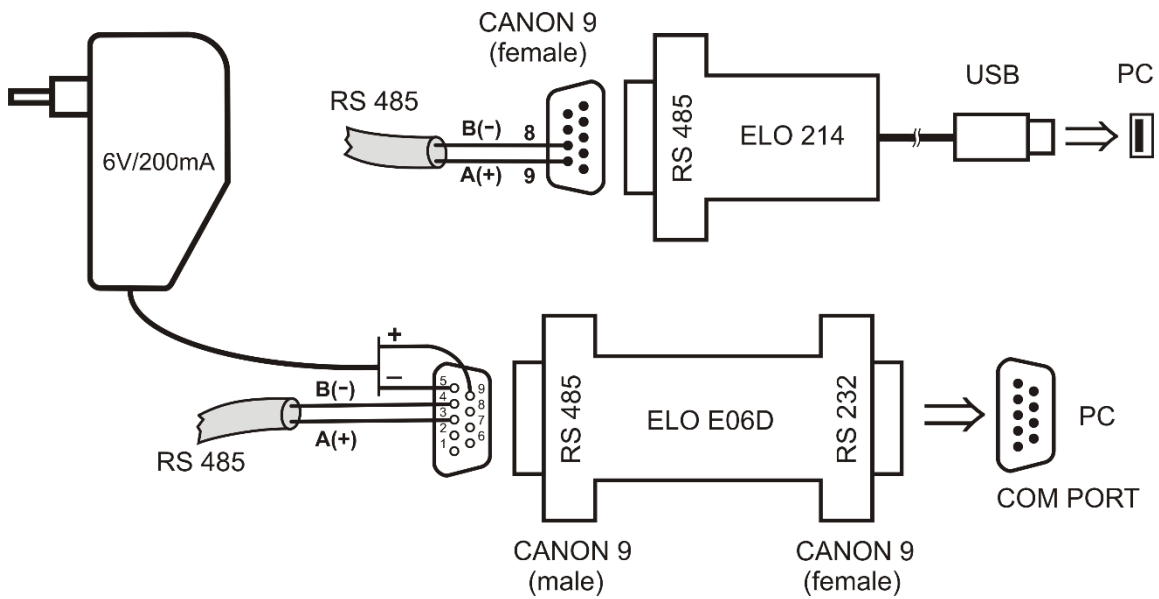
Connection of external power relay

Coil data chart of external power relay:

- nominal voltage : max 50V
- nominal power: max 60VA
- current: max 2A



Connecting transmitters with RS485 interface to a PC



To connect a transmitter with an RS485 interface to a computer, you can use a suitable commercially available converter. Connect the converter according to the converter's manual. In case of communication problems, check whether it is necessary to configure the resistor connections for defining the idle state, the termination resistor or the time delay. The above figure shows examples of connection using the ELO E214 converters (connects to the computer's USB interface) and ELO E06D (for a computer with an RS232 interface).

12. Appendix B

Wiring diagram of relay contacts for devices with serial number lower than **16981000**.

