

FCR013 Communicative controller for VAV systems



Summary FCR013 is a communicative controller of heating and cooling panels and an EC (electronic commutator) motor or a VAV (variable air volume) damper. It measures room temperature using a room unit and it may either work autonomously, or be connected to a primary controller (markPLC), any other Modbus compatible control system, or SCADA. As a room unit, UC013 is used.

Application ■ Individual room control for systems with heating and cooling panels and EC fancoils
 ■ Control of VAV dampers in heating / cooling systems

Function The controller communicates with a room unit UC013 over a dedicated bus (K2+, K2-). The room unit UC013 reads room temperature, setpoint correction by a knob, and operating status, which is selected by a short push of the button. Measured temperature range is 0 to +50 °C. Read and entered values are processed in a PI (temperature) control algorithm. On the outputs there are analogue 0..10 V sequences to control the valve actuators and EC motor or VAV controller.

The controller incorporates real time clock with weekly scheduler (6 events per day). It switches between the Comfort, Precomfort, and Off operation modes. There are two binary inputs on the controller for access card reader, PIR sensor, window contact etc. The binary input DI1 switches between Comfort and Standby operating modes. The DI2 switches to Off mode. Both NO and NC contact may be used, the selection follows in the configuration software. Each operation mode has separate setpoints for heating and cooling which are used as basis setpoints for setpoint calculation: to the basic setpoint, the manual setpoint correction is added, and the result is used as actual setpoint for heating or cooling. The triac outputs DO1 and DO2 are controlled as PWM outputs using the AO1 and AO2 signals, or they can be controlled over the bus as independent outputs.

Three LEDs indicate correct function: green (PWR) – power OK, red (TX1) – transmit data to the building bus, and red (TX2) – transmit data to the room unit. On the top there are

four DIP switches: K1 bus end, and init switch to set communication to factory defaults (Modbus address 1, communication 9600 bps, N, 8, 1).

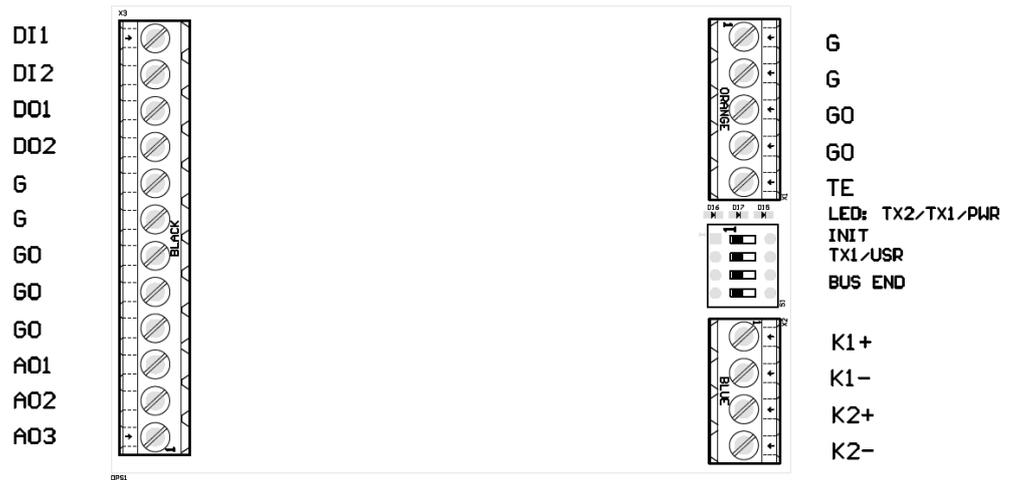
The controller communicates with the building management system or PLC over RS485 bus with Modbus RTU and therefore can be used in many control systems. See the variable list (Modbus table) in a separate document [FCR013 Modbus table](#). Another bus, K2, communicates with the room unit. To configure and commission the controller use **ModComTool**, which is free to [download at our website](#).

The controllers operate in a non-aggressive environment. No maintenance is necessary. They are mounted with two screws on any flat surface, e.g. installation board. The holds can be removed and replaced by an optional DIN rail adapter fixed on the bottom of the controller.

Technical data

| | |
|-------------------------|---|
| Power | 24 V AC, ±20 %, 0.5 A (G, G0, TE) |
| Consumption | 3 W |
| Galvanic insulation | 1 kV |
| Communication | RS485, Modbus RTU, 1200 až 115200 bit/s |
| SW | ModComTool (4.2.4.6 and above) |
| Terminals | Screw terminals M3, recommended wire 0,14 – 1,5 mm ² |
| Housing | elbox 4U low |
| Protection degree | IP20 (EN 60529) |
| Dimensions | 70,4 × 98,7 × 35,2 mm |
| Digital inputs | 2× DI for dry contact, 24 V AC, 15 mA |
| Digital outputs | 2× solid state relay for AC load, zero switching, 24 V AC against G0, max. current 0,4 A, non-inductive load according to EN 60947 |
| Analog outputs | 3× analogue output 0...10 VDC, max. current 10 mA, permanent short-circuit proof, short-circuit 50 mA |
| Ambient conditions | External conditions: EN 60721-3-3. climatic class 3K5 (-5 - 45 °C; 5 % - 95 % relative humidity, non-condensing gases and chemically non-aggressive conditions). Storage: EN 60721-3-1 climatic class 1K3 (-5 - 45 °C; 5 % - 95 % relative humidity, non-condensing gases and chemically non-aggressive conditions). |
| Standards of conformity | EMC EN 61000-6-2 ed.3:2005, EN 61000-6-4 ed.2:2006 + A1:2010 (industrial environment) electrical safety EN 60950-1 ed.2:2006 + A11:2009 + A12:2011 + A1:2010 + A2:2014 + Opr.1:2012 + Z1:2016 hazardous substances reduction EN 50581:2012 |

Terminals



Terminals and connectors:

| | |
|------------|--|
| G | power |
| G0 | power - common wire |
| TE | technical ground - shielding |
| K1+ | serial line RS485 +, BMS communication |
| K1- | serial line RS485 -, BMS communication |
| K2+ | serial line RS485 +, room unit communication |
| K2- | serial line RS485 -, room unit communication |
| DI1 | presence input (switches Comfort - Precomfort) against G0 |
| DI2 | window contact input (switches Comfort/Precomfort – Off) against G0 |
| DO1 | heating valve output (G, against G0) |
| DO2 | cooling valve output (G, against G0) |
| G | power supply of outputs and inputs (internally connected to G in the upper row) |
| G0 | power supply of outputs and inputs - reference point (internally connected to G0 in the upper row) |
| AO1 | output for heating valve (0..10 V DC against G0) |
| AO2 | output for cooling valve (0..10 V DC against G0) |
| AO3 | output for VAV damper/EC motor (0-10V DC against G0) |

LED indication:

| | |
|------------|---|
| PWR | green LED – power (ON: power OK; OFF: no power applied, weak or damaged power supply, ...) |
| Tx1 | red LED – RS485 transmitting data to the building bus (flashing: transmitting data; OFF: no data traffic, ON: bus shortcircuited or overloaded) |
| Tx2 | red LED – RS485 transmitting data to the room unit (flashing: transmitting data; OFF: no data traffic, ON: bus shortcircuited or overloaded) |

DIP switches:

INIT

INIT (DIP1): if ON at power-up, configuration parameters are brought to defaults. Default parameters are: Modbus address 1, baud rate 9600 bps, data bits 8, parity None, number of stop bits 1.

Another function of the INIT switch is to bring EEPROM into default factory settings. To init the EEPROM, proceed as follows:

- connect the device over RS485 to a PC with **ModComTool** (Modbus Configuration Tool)
- set INIT to ON
- apply power
- find the controller in the tool (Scan)
- set INIT to OFF
- in the **ModComTool**, open the controller window
- click the Initialisation button in the tool
- remove and apply power.

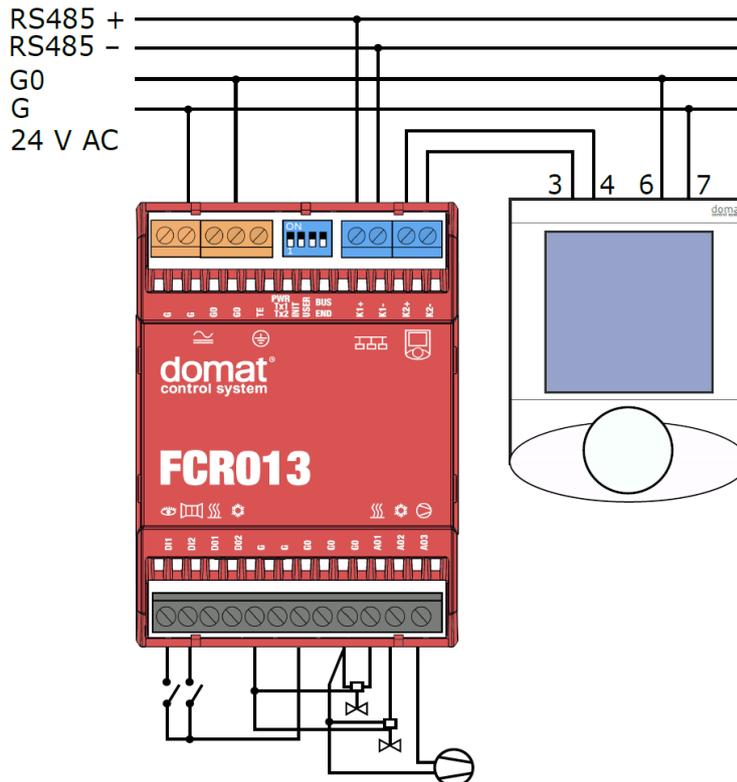
USER

(DIP2) not used

BUS END

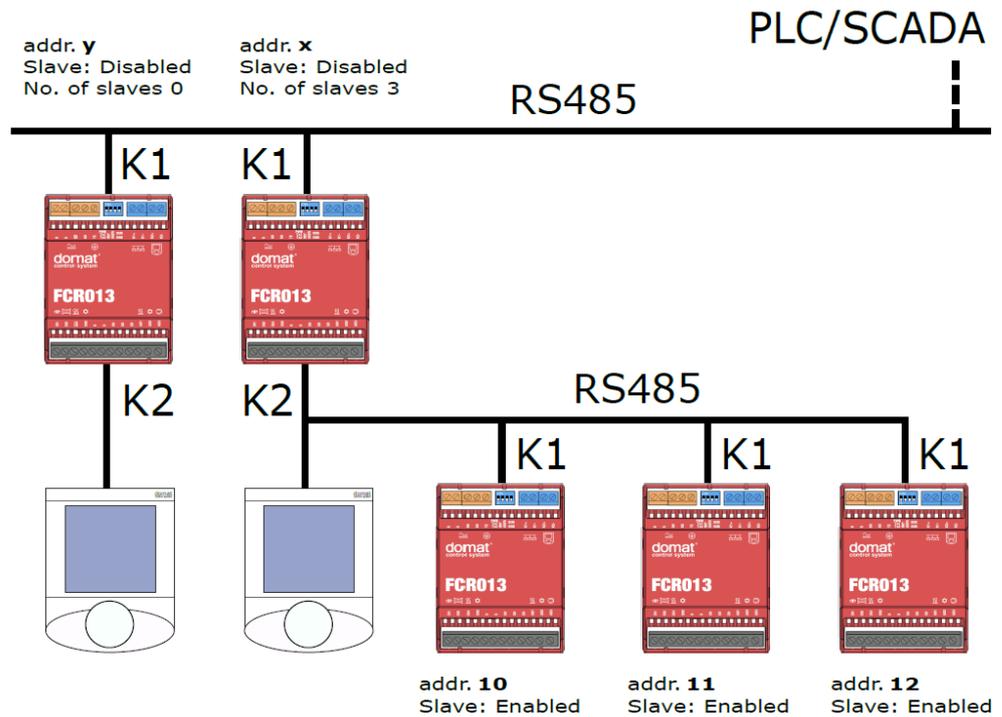
(DIP3 and DIP4) if both ON = K1 bus end, the first and last devices on the bus should have bus end ON

Connection



Power supply G and G0 terminals are internally connected with G and G0 terminals on the input/output terminals block (lower row).

Master-slave



In this connection, controllers with addresses x, 10, 11, and 12 are in one zone and all of them are controlled by one room unit. The controller addressed x is a master. Outputs of controllers addressed 10, 11, and 12 are controlled by the same signals as the master controller addressed x.

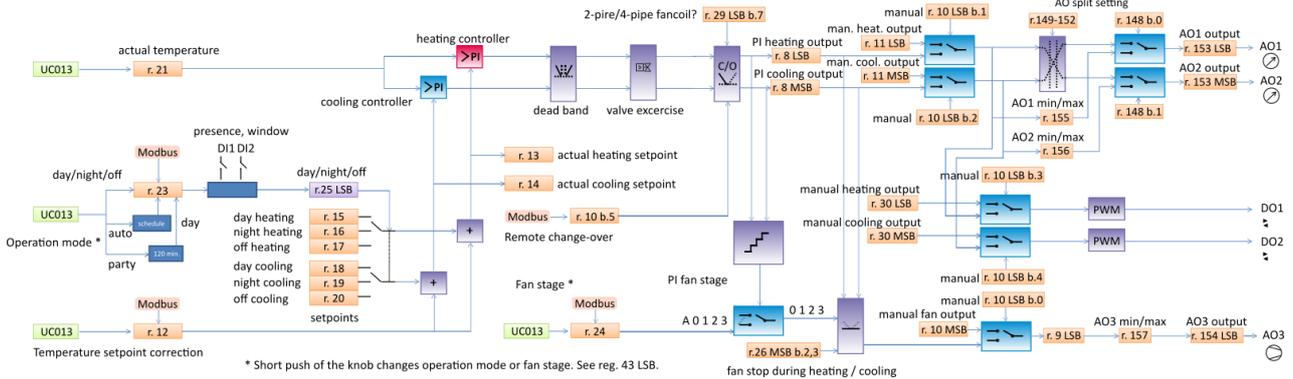
The Slave controllers are connected to the building bus (K1+, K1-). They must be addressed starting with 10 and all the other controllers belonging to one zone (on the same K1 bus) must be addressed 11, 12, 13, 14... etc, with no gaps. Maximum number of slave controllers is not limited (or, is limited only by the upper Modbus addressing range, which is 250), however, the technology and room layout should be considered.

There may be more slave groups in the same system, each starting with address 10. The addressing of master controllers at the building bus (K1+, K1), however, must be unique.

Parameters Slave (Enabled / Disabled), No. of slaves (integer 0..240) and controller address are set in the configuration software **ModComTool**.

Function description

The register numbers in the text below refer to the FCR013 Modbus table which is supplied as a separate document and is part of this function description.



Operation mode

The main selector of heating and cooling setpoints is the operation mode, which is one of the following states:

- Comfort (Day)
- Standby (Night)
- Off.

The operating mode is determined by those events:

- push of the UC013 button if the controller is set up so as to change the operation mode
- states of the digital inputs DI1 and DI2
- Modbus setting in **register 23**.

In the register, either the operating mode can be set directly, or a time-dependent state Party or Time schedule. The last written value applies. If Time schedule (the clock symbol) is set, the operating mode is determined by the setting of the internal time scheduler. After the controller is set to Party, it goes to Comfort for another 2 hours, and then sets back to the previous state.

The sets Comfort, Standby, Off, and Day, Night, Off have only this difference: if Residential mode (Day, Night, Off) is selected, it is possible to use the time scheduler. The Hotel mode (Comfort, Standby, Off) does not allow the time scheduler function.

The operation mode is also controlled by the digital inputs for window contact (switches between Off and the two other modes), and presence sensor or card reader (switches between Comfort (Day) and Standby (Night)). The inputs must be enabled (**reg. 26**). The inputs have higher priority than all events described above (pushbutton, Modbus, weekly scheduler). The resulting operation mode is in **Register 25 LSB**.

Setpoints

Based on the operation mode (Comfort, Standby, Off), a pair of basic setpoints for heating and cooling is selected (**registers 15 to 20**). A setpoint correction is added to the setpoints. The correction influences all three pairs of setpoints.

The user correction is available in **register 12**. The same register can be written over Modbus. The setpoint correction thus may be changed by two ways: after the value is set over Modbus, the user is allowed to set it back to a value from allowed range. The last written value is active.

Display of setpoint value

The setpoint correction is determined by the UC013 knob. The setpoint displays either as absolute or as relative value.

Relative display: a deviation against the basic setpoints, like „-3.5 ... +3.5“ (default values)

Absolute display: The correction is added to the basic setpoint, and the result is displayed as the current calculated setpoint in °C. The current setpoint depends on the controller mode – if it is heating or in the dead zone between the heating and cooling setpoint, and the last energy used was heating (then the heating setpoint + correction is displayed), or if the controller is cooling or in the dead zone, and the last energy used was cooling (then the cooling setpoint + correction is displayed). It may thus happen that e.g. for the heating setpoint of 21 °C and cooling setpoint 24 °C the user sets correction of -1.5 K and the controller is heating. The display shows $21 - 1.5 = 19.5$ °C when setting. Then, without any control intervention, the heat gains in the room increase, temperature increases to 24 °C (which is above the current cooling setpoint of $24 - 1.5 = 22.5$ °C) and the controller starts cooling. As soon as the user turns the knob, the actual cooling setpoint displays, which is 22.5 °C. This also is the value to be changed (of course, the heating setpoint shifts as well). The current cooling setpoint is displayed until the controller starts heating again – then the display shows the current heating setpoint. The user may suppose that the setpoint changed automatically from 19.5 to 22.5 °C. This is not correct: the controller mode changed from heating to cooling, and the current setpoint changed from the heating setpoint to the cooling setpoint. The values of both setpoints remain unchanged.

Measured temperature

The measured temperature is read by the room unit UC013.

Control functions

In the following text, the functions below have higher priorities, i.e. the signals are processed in the order as described in the text.

PI controllers

Current setpoint incl. correction and measured room temperature are sent to a pair of PI controllers. These controllers calculate the output signal once per second. If the P or I constants are changed during the operation, the controllers are reset, old integrated I-parts are deleted, and the integration starts at 0.

Dead zone

If the difference between actual temperature and actual setpoint is less than 0.5 K, both outputs of the PI controllers are set to 0. This function prevents the controller from frequent switching between the heating and cooling mode, and defines the dead zone.

Valve exercise

If this function is enabled, the valves are opened and closed once per week regardless of the heating and cooling demands to prevent seizing.

The resulting controller values are available in **register 8**, PID output heat and PID output cool.

Change-over (C/O)

If the controller is configured as two-pipe, the next step is to calculate the change-over logic. The change-over signal informs the controller that there is cold water in the piping rather than hot water, and the valve should open on cooling demand rather than on heating demand. The change-over state is read according to settings in **register 29 bit 7**: if C/O function is allowed, then state can be set over the bus, using **register 10 bit 5**.

After the C/O changes, there is a safety time gap of 30 minutes (configurable in **register 43 MSB**) between the stop of heating and the start of cooling (and vice versa), so that the water in the piping is not mixed.

The resulting sequences are used for control of analogue outputs AO1 and AO2, triac PWM outputs DO1 and DO2, and AO3 for fan control.

Control of analogue outputs

The heating and cooling signals on the output of the C/O function are used for control of outputs AO1 (heating) and AO2 (cooling). The outputs can be overridden manually. The manual override is enabled in **reg. 10 bits 1 to 2** and if the respective bit is active, the sequence is controlled by analogue values from **registers 11 MSB and 11 LSB** rather than from the heating and cooling sequences.

Analog outputs AO1 and AO2 can be split (**AO range split, reg. 148**) for heating and cooling for controlling of 6-way valves (0...10 V). Range of analog outputs are splitted in two parts. One for heating and another for cooling. Limits for both parts of divided range can be set (reg. 149 – 152, default values are 0.5...4.5 V for heating and 5.5...9.5 V for cooling). If no heating nor cooling is active, the output is in the dead band between heat 0 and cool 0. Value of the output then is 5 V (in default setting).

From FW version 110 minimal and maximal value of analogue outputs can be set in **reg. 155 to 157**. For the outputs AO1 and AO2 this function will not be used if AO split function is active.

Value of the AO1 and AO2 outputs is in the register 153. Value of the AO3 output is in register 154 LSB.

Control of PWM valve outputs

The digital outputs DO1 and DO2 basically copy the analogue output AO1 and AO2 signals as PWM (pulse-width modulation). **Register 26 bit 7** defines if the valves are NC (normally closed, default setting) or NO (normally open). In case of NO configuration, the PWM signal is inverted. The resulting PWM signals are brought to DO1 (heating) and DO2 (cooling) to control valves with thermic actuators. The triac outputs can be overridden manually. The manual override is enabled in **reg. 10 bits 3 to 4** and if the respective bit is active, the sequence is controlled by PWM signals (according to values in registers for manual override 30 LSB and 30 MSB) rather than from the heating and cooling sequences.

Fan control

The resulting sequences are also used for control of the fan stages. At first, it is specified if a sequence shall influence the fan stage control (**register 26, bits 2 and 3**):

- bit 2: Stop fan when heating, i.e. for cooling fancoils. The heating output can be used e.g. for radiator valve control.

- bit 3: Stop fan when cooling, i.e. for heating convectors. The cooling output can be used e.g. for cooling panel valve control.

Stop fan when heating / cooling works with any operation mode set by writing over Modbus into **register 24** or by setting by user over short push of the room controller, the last written value is active. This means that user is not able to manually override the fan motor at a cooling fancoil in case the controller needs to heat.

The fan is controlled according to the room unit setting or writing into **register 24**. The last writing counts. If the fan is blocked by Stop fan when heating / cooling parameters, it can be overridden only by manual override directly at the outputs.

If the fan is set to Auto, the fan stage is derived from the control sequence output.

The fan relays can be manually overridden at any time, regardless of manual or automatic fan stage control, by enabling manual override in **reg. 10 LSB bit 0** and setting of **reg. 10 MSB**.

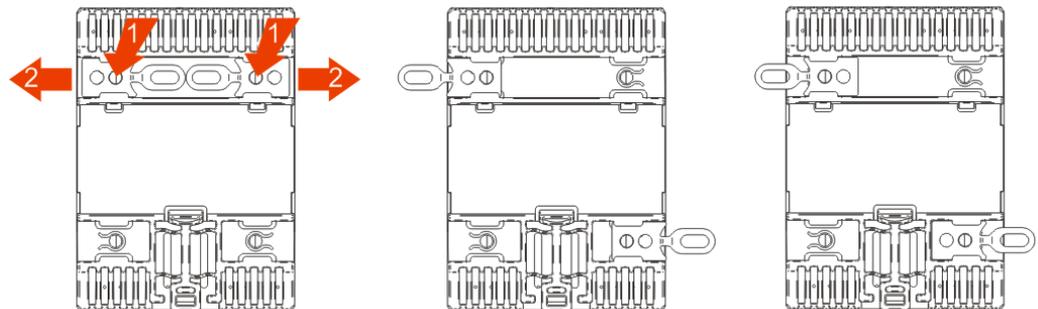
During manual override these voltage levels are used for fan stages:

Stage 0 ... 0 % ... 0 V
 Stage 1 ... 30 % ... 3 V
 Stage 2 ... 70 % ... 7 V
 Stage 3 ... 100% ... 10 V

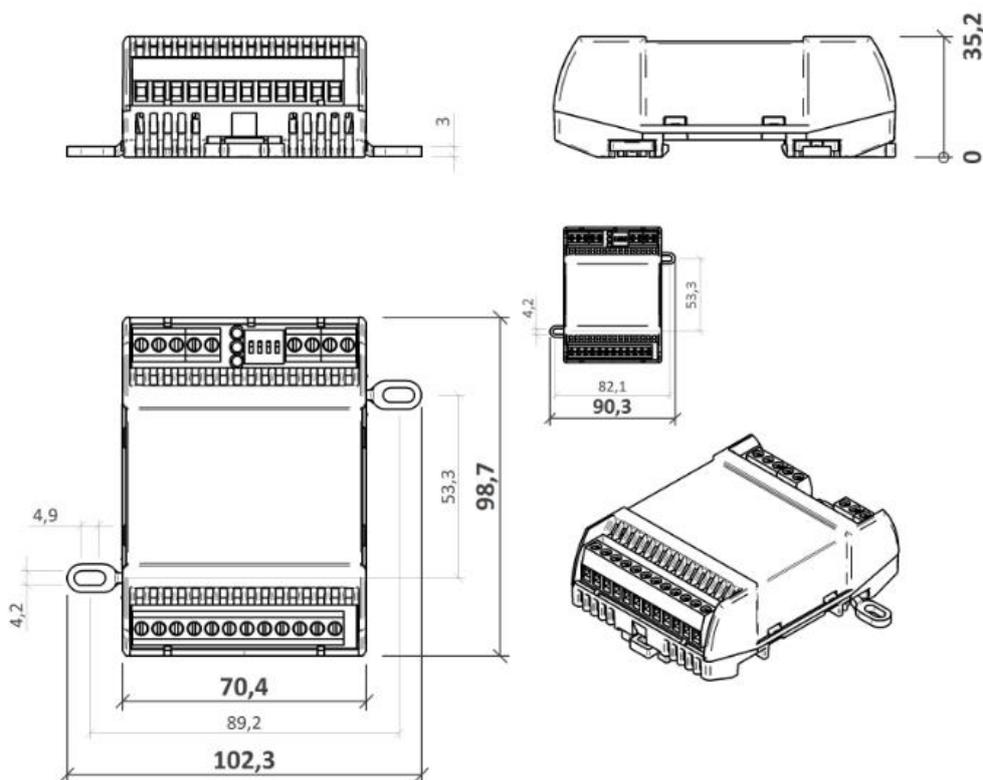
Installation

The module is fixed on standard DIN console or is fixed by mounting spots.

Mounting spots are attached to the rear side of module. Push mounting spots out (2) while simultaneously pressing safety lock which is located under the inner round hole (1). For module attachment, carefully push mounting spots back but reversed (the rings must face out). You can choose between two lock positions.



Dimensions



Dimension are in *mm*.

WEEE notice

The device contains a non-rechargeable battery which backups the real-time clock and part of the memory. After the device is not operable, please return it to the manufacturer or dispose of it in compliance with local regulations.

Safety note

The device is designed for monitoring and control of heating, ventilation, and air conditioning systems. It must not be used for protection of persons against health risks or death, as a safety element, or in applications where its failure could lead to physical or property damage or environmental damage. All risks related to device operation must be considered together with design, installation, and operation of the entire control system which the device is part of.

**Changes in
versions**

12/2017 – First datasheet version.

05/2018 – Added the *Function description* part.

08/2018 – Change of function description, change of picture.

12/2019 – Description of AO3 terminal amended.

04/2020 – *Function description* (Control of analogue outputs, fan stages) part amended.

05/2021 – Function scheme changed, AO descr. changed, logo changed.