FCR015 Communicative controller for VAV systems

Summary **FCR015 is a communicative controller for heating and cooling panels and a VAV (variable air volume) damper. It measures temperature and CO_2 concentration in the room air using a room unit and it may either work autonomously, or be connected to a primary controller (markPLC) or SCADA. As a room unit, UC905 is used.**

Application

- **Individual room control for systems with heating and cooling panels and VAV controllers**

Function

The controller communicates with a room unit UC905 over a dedicated bus (K2+, K2-). The room unit UC905 reads room temperature, CO_2 concentration in the room air, setpoint correction by a knob, and operating status, which is selected by a short push of the button or in the menu. Measured temperature range is 0 to +50 °C, CO_2 range 0 to 2000 ppm. Read and entered values are processed in PI (temperature) and proportional (CO_2) control algorithms. On the outputs, there are 3 analogue 0...10 V sequences to control the valve actuators and VAV controller.

Analogue and digital outputs can be manually controlled independently of regulation sequence.

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 2 binary inputs on the controller for access card reader, PIR sensor 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 manual setpoint correction is added, and the result is used as actual setpoint for heating or cooling.

The air volume setpoint (0..10 V output signal for the VAV controller) is derived from the CO_2 concentration in the air, and operation status:

- Comfort: the CO_2 concentration is controlled with a proportional controller so as to achieve the setpoint (default is 800 ppm), with minimum air volume as set in a parameter of the configuration tool
- Standby: there is minimum air volume required as set in the minimum air volume parameter
- Off: the VAV output goes to 0 V.

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 factory defaults (Modbus address 1, communication 9600 bps, N, 8, 1).

The controller communicates with the management system 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 *FCR015 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 on a DIN rail or using two screws on any flat surface, e.g. installation board or fan coil body.

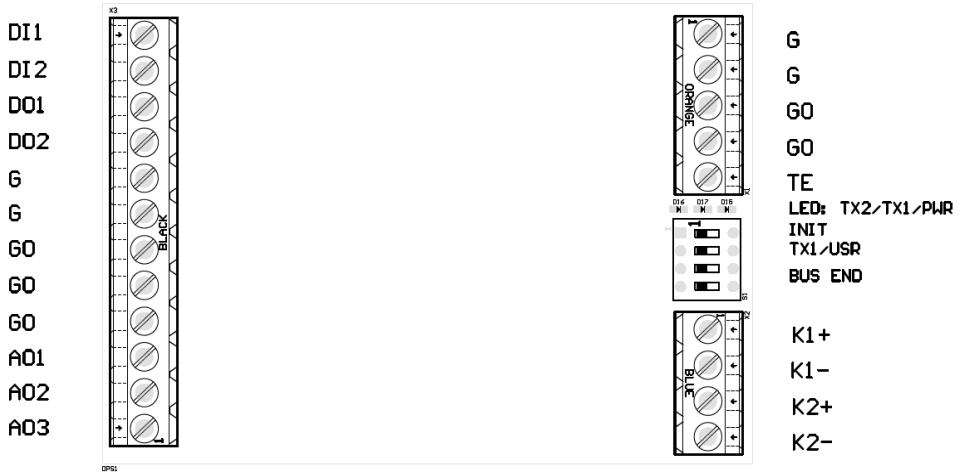
Mirroring of heating and cooling outputs at the DO outputs as PWM is not enabled by default, it must be enabled in the register 141 bits 0 and 1.

Technical data

Power	24 V AC, +/- 20%, 0.5 A (G, G0, TE)
Consumption	3 W
Galvanic insulation	1.5 kV
Communication	RS485, Modbus RTU, 1200…115200 bit/s
SW	ModComTool (4.2.4.6 and above)
Recommended wire	0.14…1.5 mm^2 (screw terminals M3)
Housing	elbox 4U low profile
Protection degree	IP20 (EN 60529)
Dimensions	70.4 × 98.7 × 35.2 mm
Digital inputs	2× DI, for dry contact against G0, load 24 V AC, 15 mA
Analogue outputs	3× analogue output 0…10 V DC, max. current 10 mA, permanent shot-circuit proof, short-circuit 50 mA
Digital outputs	2× solid state relay for AC load, zero switching, 24 V AC against G0, max. current 0,4 A

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 terminal
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 (0…10V DC against G0)

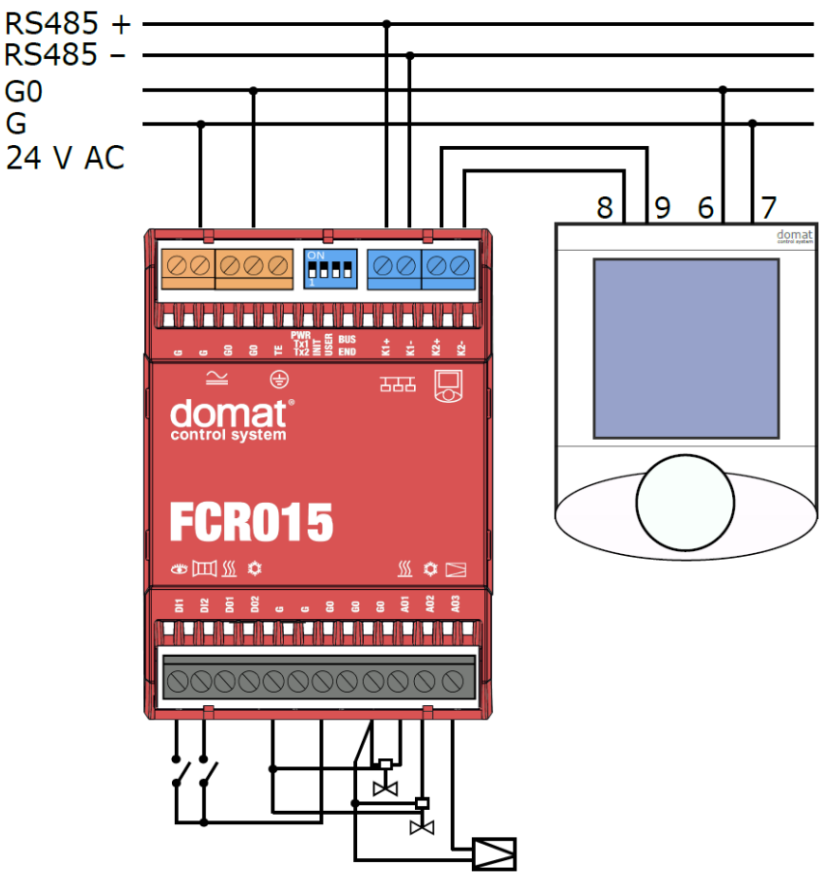
LED indication

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 overload or short-circuited)
Tx2	red LED – RS485 transmitting data to the room unit (flashing: transmitting data; OFF: no data traffic, ON: bus overload or short-circuited)

DIP switches

INIT	INIT (DIP1): if ON at power-up, configuration parameters are brought to defaults. Default parameters are: Modnus 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 Initialization button in the tool - remove and apply power.
USER	(DIP2) not used
BUS END	(DIP 3 and 4) if both ON = bus termination, the first and last devices on the bus should have bus end ON

Connection

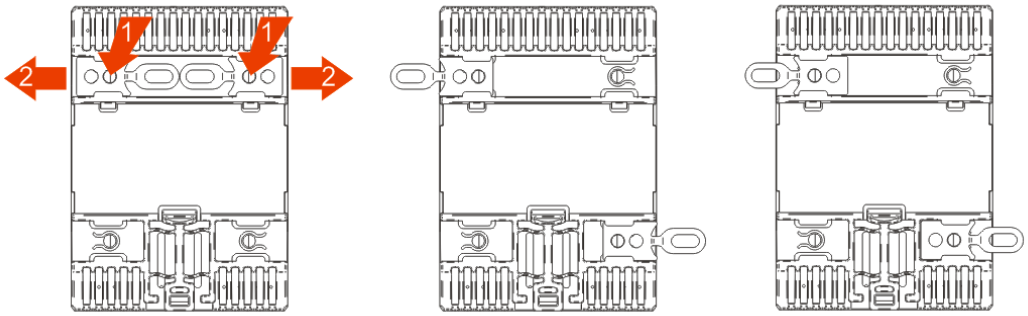


Power supply G and G0 terminals are internally connected with G and G0 terminals on the lower terminals block.

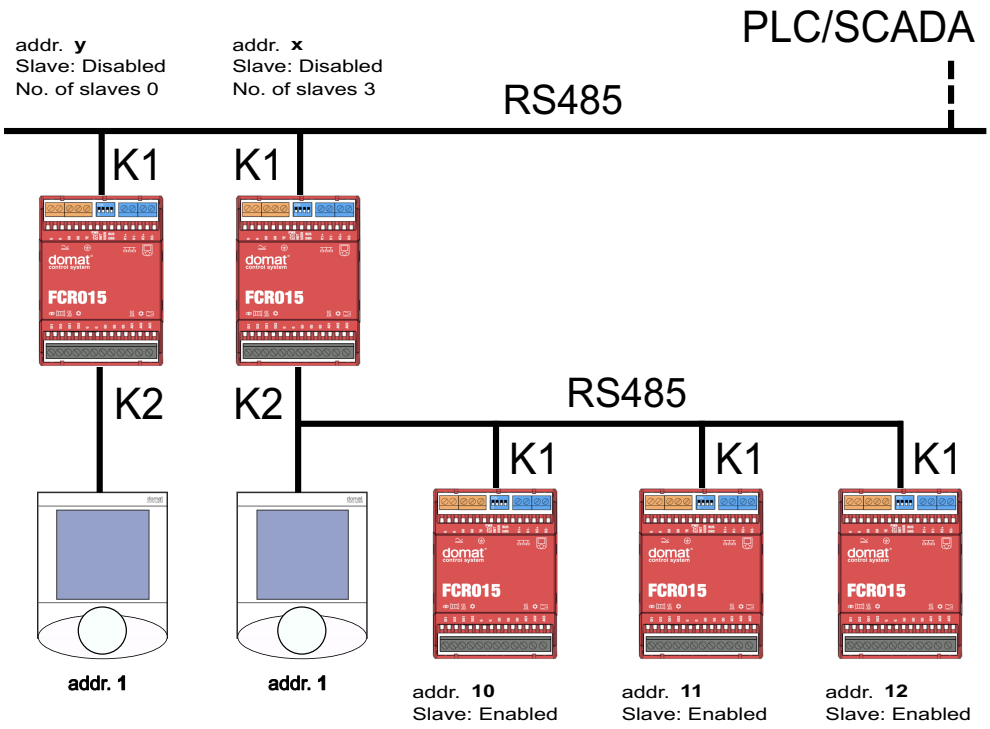
Installation

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 the mounting spots out (2) while simultaneously pressing the 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.



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 room unit must be set to address 1. 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.

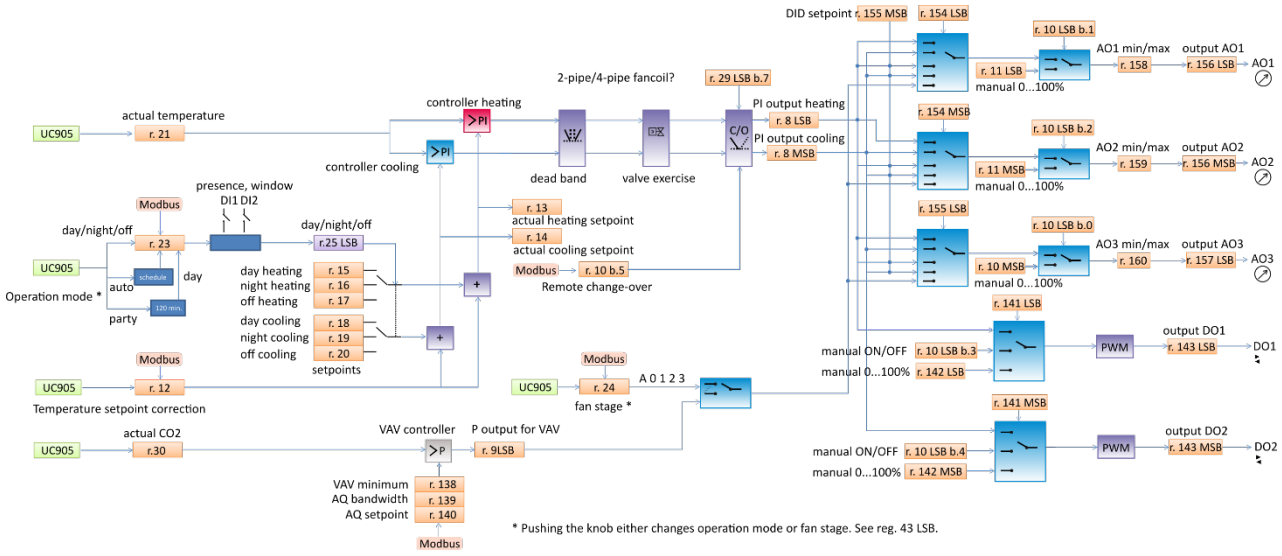
The Slave controllers are connected only to their main bus K1+ and K1-. They must be addressed starting with 10 and all the other controllers belonging to one zone (on the same K2 bus from master) must be addressed 11, 12, 13, 14... etc., with no gaps. The maximum number of slave controllers is limited only by the upper Modbus addressing range, which is 247. 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-) must be unique.

Parameters Slave (Enabled / Disabled), No. of slaves (integer 0...237) and controller address are set in the configuration software **ModComTool**.

Function description

The register numbers in the text below refer to the FCR015 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 UC905 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 the value from allowed range. The last written value is active.

Display of setpoint value
The setpoint correction is determined by the UC905 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 internal sensor of the room unit UC905.

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, and 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 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 signal 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, AO2 and AO3 according to the setting in **reg. 141**, eventually for control of triac PWM outputs DO1 and DO2.

Control of analogue outputs
The heating and cooling signals on the output of the C/O function are used for controlling outputs AO1 and AO2. 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.

Minimal and maximal value of analogue outputs can be set in **reg. 158 – 160** (from FW version 104).
Value of the outputs AO1 – AO3 can be read in the reg. 156 LSB – 157 LSB.

From FW version 103 it is possible to copy output from heating, cooling and fan regulation on every analogue output. Function is set in **reg. 154 LSB – 155 LSB.** Another possibility is to use it for DID unit settings.

DID unit function (Active Chilled Beam) – here is flap for fresh air inflow for CO2 regulation and after this flap are registers H and C. **If there is demand for H or C** sequence > 5 %, then this **flap must set** to value set in "DID Volume Setpoint" reg. 155 MSB (default value 100 % = 10 V), **otherwise heating or cooling would not be effective**. If there is no H or C demand, flap is controlled according to CO2 concentration.

Control of PWM valve outputs
The digital outputs DO1 and DO2 by default **do not copy** heating and cooling regulation state on output. This function is enabled in **reg. 141, bit 0 and 1. 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. 141** and if the respective bit is active, then in **reg. 10 bit 3 and 4** for ON/OFF mode, or in **reg. 142** for 0...100 % mode. During manual override the outputs are not controlled by heating and cooling resulting sequences.
Fan control, CO2 regulation
The FCR015 module fan is controlled according to CO2 concentration, or manually according to room unit setting, or over Modbus by writing into **register 24**. If the fan is set to Auto, the fan stage is derived from the control sequence output.

The current setpoint and measured value is sent to a PI controller. This controller calculates the output signal once per second.

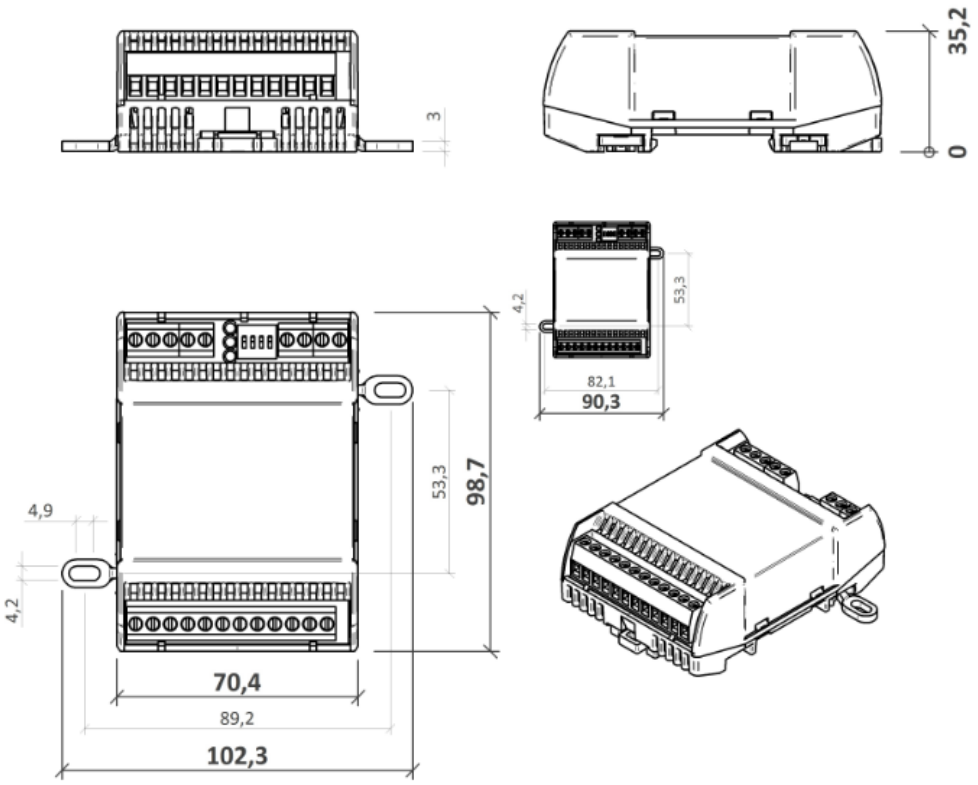
The resulting value is available in **register 9 LSB**, VAV output.

The fan output 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

Dimensions



Dimensions are in *mm.*

Versions compatibility

Some combinations of FCR015 and UC905/UX905 may cause issues. For avoiding problems (e. g. while replacing devices) pay attention to possible combinations:

New FCR015 (with FW 107 or later) and new UC905/UX905 (FW 205 or later) is functional combination. New FCR015 are supplied since 04/2025. Combination of older FCR015 (FW 105) and older UC905 (FW 203) is also possible.
Older FCR015 (FW 105) with new UC905/UX905 (FW 205) is also possible combination. Additionally, it shows CO_2 in ppm.

New FCR015 (FW 107) and old UC905 (FW 203) is non-functional combination. It can be solved by ordering FCR015 with FW version 105.

Upgrading UC905 (FW 203) to FW (v205) or vice versa CANNOT BE PERFORMED.
Upgrading FCR015 (FW 105) to newer FW (v107): Free of charge upon delivery to the company's address.

PN of new room controllers: UC905BL → PN 10392; UC905 → PN 10394
More information is available at Release notes | Domat Control System.

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.
02/2018 – DO function note added.
05/2018 – *Function description* part added, minor corrections done.
08/2018 – Function schema changed.
07/2019 – Expanded description of AO and DO function.
04/2020 – *Function description* (Control of analogue outputs, fan stages) part amended.
05/2020 – *Measured temperature*: room unit name changed.
05/2021 – Function scheme changed, AO descr. changed, logo changed.
08/2021 – Fixed minor error in *Function scheme*.
07/2022 – Clarification of the description of DI.
05/2025 – Added information about versions compatibility.