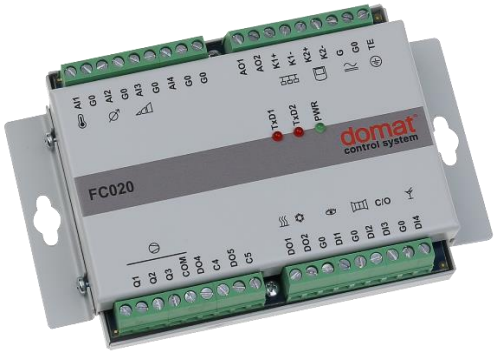
FC020 Communicative fancoil controller



Summary

FC020 is a communicative fan coil controller (up to 3 fan stages, thermic or 0...10V heating and cooling valves, analogue inputs and outputs). It may either work autonomously, or be connected to a primary controller (MiniPLC or SoftPLC) or SCADA (RcWare Vision or any other SCADA which is able to act as Modbus master). For manual intervention and room temperature measuring, an analogue room unit is used.

Application

- **Individual room control for systems with 2 and 4 pipe fancoils**

Function

The controller communicates with analogue room unit (a Pt1000 temperature sensor, setpoint shift, fan stage switch) for rooms where the UI... room unit with display is not acceptable. Recommended type is RTF-DP with resistor fancoil switch.

As an alternative, a communicative room unit UC010 on a dedicated bus (K2+, K2 -) can be used. The room unit reads room temperature, 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 -20 to +50 °C.

Read and entered values are processed in a PI control algorithm. On the output there are 0..10 V signals for analogue actuators, and 24 V AC PWM modulating sequences for triacs to control the thermic actuators.

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

The controller incorporates real time clock with weekly scheduler (6 events per day). The clock switches between the Comfort, Precomfort, and Off operation modes. There are two digital inputs on the controller for presence sensor (access card reader, PIR sensor etc.) and for window contact or dew point sensor (switches to the Off mode). Both NO and NC contact may be used, the selection follows in the configuration software.

Analogue inputs

There are four passive analogue inputs:

- room temperature (Pt1000 sensor)
- setpoint correction (potentiometer 0...500 Ohm)
- fancoil stage switch

  – Auto: 500 Ohm or more (disconnected)
  – Off: 100 Ohm or less (short-circuit)
  – St1: 180 Ohm
  – St2: 270 Ohm
  – St3: 390 Ohm

- spare (for a Pt1000 sensor) – this value has no influence on control functions, however, it can be read and displayed on the BMS.

If the setpoint correction input reads more than 1500 Ohm (disconnected), the correction is 0 K. In the range of 0...500 Ohm the correction can be set in the configuration software; default values are –3.5...+3.5 K.

Analogue outputs

The analogue outputs provide 0...10 V signal to control heating and cooling valves. The ground of 0...10V is common with 24 V AC ground G0. The same signal recalculated as 24 V AC PWM with optimization for thermic valves is available at DO1 (heating), and DO2 (cooling).

Digital inputs

There are four potential-free digital inputs which operate at 24 V AC (the G – G0 voltage):

- presence input – switches between Comfort (Day) and Standby (Night).
- window contact input – switches to Off (Depression) if window is open or a dewpoint sensor answers at cooling panel application.
- change-over input – at 2-pipe applications, provides information that cold water is supplied instead hot water to the fancoil. Connects to a mechanical thermostat installed on the water inlet. The change-over signal can also be set remotely over the bus instead.
- party button input - connects to the Party button. If active for a short while, the controller goes from Standby (Night) to Comfort (Day) for a period of 2 hours. Then it goes back to Standby (Night). This function overrides the time scheduler and is overridden by the window contact input.

Digital outputs

The three fan stages are either controlled automatically (according to control deviation, or rather PI controller output) or manually (if this function is enabled). In the configuration software, 1 to 3 stage fan can be selected. There is maximum one stage active at the same time, with a safety pause of 1 s between the stages.

Auxiliary solid state relay outputs DO4 and DO5 are designed for future applications. However, they can be controlled remotely over the bus – see Modbus table for their Modbus addresses.

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. Inside on the board there are four DIP switches: 2x K1 bus end, spare, and INIT switch to set to factory defaults.

The controller communicates with a management system over a RS485 bus K1 with Modbus RTU and therefore can be used in many control systems. See the variable list (Modbus table) in a separate document *Room units and controllers – Communication protocol description.* Another bus, K2, communicates optionally with the room unit. To configure and commission the unit use **ModComTool**, which is free to download *at* ***www.domat-int.com/en/downloads/software***

Technical data

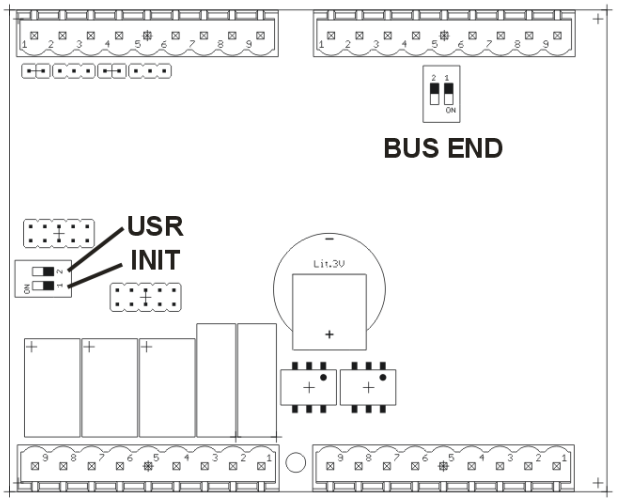
Power	24 V AC +/- 10%
Consumption	700 mVA + peripherials (ca. 5VA)
Protection	IP20
Inputs	4x DI for a dry contact, 24 V AC, 15 mA (presence, window contact, change-over, party mode)
	4x AI 20...1600 Ohm (room temperature, setpoint, fan stage, spare)
Outputs	2x solid state relay for AC load, zero switching, 24 V AC, max. current 0,4 A.
	2x triac, 24 V AC, max. current 0,4 A. Recommended actuators are STA71 (Siemens), TWA (24V types, Danfoss).
	3x relay 230V / 5A (3-stage fan)
	2x AO 0...10 V, max. output current 10 mA, short-circuit limitation to 20 mA.
Load on analogue outputs	typical 10kOhm, max. current 10mA, outputs are short-circuit proof – limited to 20 mA.
Communication	K2 to room unit: RS485 - Modbus RTU, 9600, N, 8, 1, master
	K1 to BMS: RS485 - Modbus RTU, 9600, N, 8, 1, slave
Installation	2 screws, optionally DIN rail adapter
Terminals	screw terminals for wire 0,14 – 1,5 mm^2
Weight	0,13 kg
Dimensions	113 mm (104 mm with the installation holds) x 90 mm x 24 mm

Terminals

AI1	room temperature sensor, Pt1000
G0	ground
AI2	temperature correction, potentiometer 0...500 Ohm
G0	ground
AI3	fancoil stage switch

G0	ground
AI4	temperature input – not used
G0	ground
G0	ground
AO1	heating valve output 0..10V
AO2	cooling valve output 0..10V
K1+	BMS communication, RS485 +
K1-	BMS communication, RS485 -
K2+	room unit communication, RS485 +
K2-	room unit communication, RS485 –
G	power 24 V AC
G0	power – common 24 V AC
TE	technical ground
Q1	fan coil relay stage 1
Q2	fan coil relay stage 2
Q3	fan coil relay stage 3
COM	common contact for Q1, Q2, Q3
DO4	solid state relay output DO4
C4	solid state relay output DO4
DO5	solid state relay output DO5
C5	solid state relay output DO5
DO1	heating valve PWM output (G, against G0)
DO2	cooling valve PWM output (G, against G0)
G0	power, inputs and outputs - common
DI1	presence input (switches Comfort - Precomfort)
G0	power, inputs and outputs – common
DI2	window contact input (switches Comfort/Precomfort – Off)
DI3	change-over contact input
G0	power, inputs and outputs – common
DI4	party button input

DIP switches



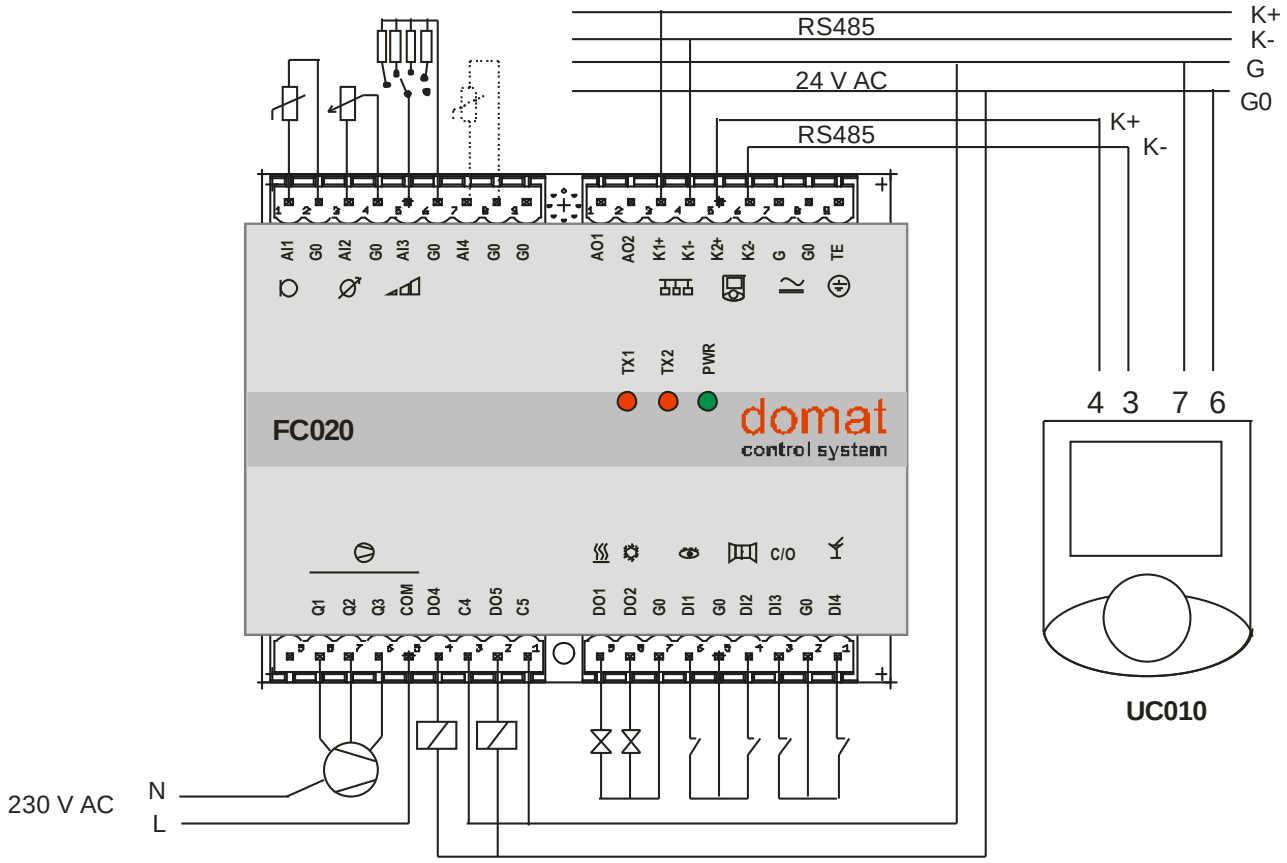
The switches are accessible after the cover is removed.

BUS END: termination of the K1 (BMS) bus

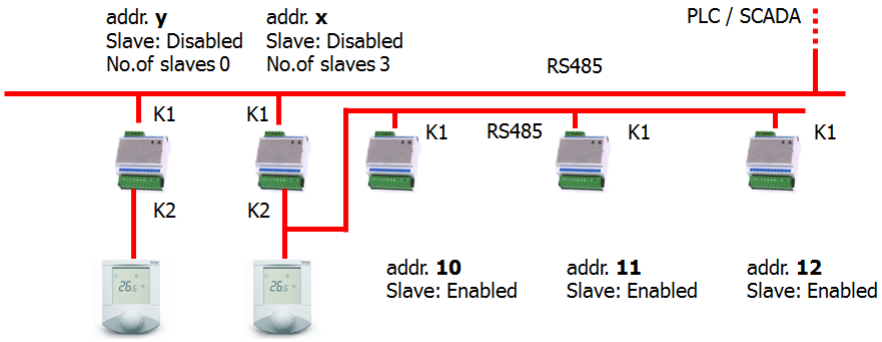
USR: user switch, not implemented

INIT: sets comm to 9600,N,8,1 and address to 1 at the BMS bus

Connection


RS485
K+
K-
G
G0
24 V AC
RS485
K+
K-
AI1 G0 AI2 G0 AI3 G0 AI4 G0 G0
AO1 AO2 K1+ K1- K2+ K2- G G0 TE
TX1 TX2 PWR
FC020
domat
control system
Q1 Q2 Q3 COM DO4 C4 DO5 C5
DO1 DO2 G0 DI1 G0 DI2 DI3 G0 DI4
C/O
4 3 7 6
UC010
230 V AC
N
L

Master - slave



Function master – slave is supported from fw101.

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.

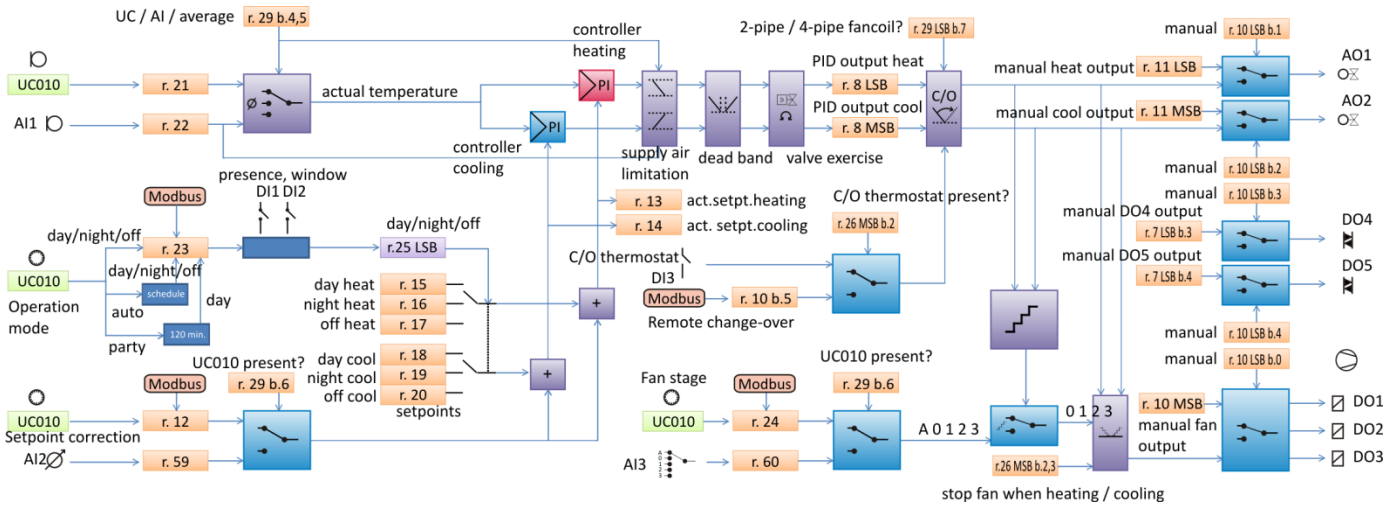
The Slave controllers are connected to the building bus (K1+, K1-). They must be addressed starting with 10 and all the other controllers belonging to one zone (on the same K1 bus) must be addressed 11, 12, 13, 14... etc, with no gaps. Maximum number of slave controllers is not limited (or is limited 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 FC010 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 UC010 button, if the room unit is connected and set so as to influence the operating 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 calculation of setpoint correction depends on the presence of the UC010 room unit (must be set in **register 29** bit 6):

- If the UC010 is not connected, correction is given by the AI2 potentiometer position. The potentiometer value read on AI2 is available in **reg. 59**. If the potentiometer is not connected, the correction value is 0 K.
- If the UC010 is connected, 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. The AI2 input is not taken into account, however its value can be read over the bus in **register 147**.

Display of setpoint value

If the UC010 room unit is connected, the setpoint correction is determined by the 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 defined by combination of **bits 4 and 5 in reg. 29** as

- temperature measured by the external sensor at the analogue input AI1
- temperature measured in the room unit UC010 if the UC010 is connected
- average of the AI1 temperature and room unit sensor (used for larger rooms)

Control

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.

Limitation

The PI controller outputs are limited in case the AI1 sensor is used as the limitation sensor on the fancoil output. This function prevents the fancoil from supplying air which is too hot or too cold. Limitation only works in case the room temperature is set as the UC010 temperature (see Measured temperature), and the AI1 sensor is connected, or, shows less than 140 °C. Limitation cuts the setpoint over the sum of actual room temperature (UC010) and parameter in **reg. 56** Limitation temp. heating, or below the difference of actual room temprature and **register 57** Limitation temp. cooling.

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 signal is acquired according to settings in **reg. 26 MSB bit 3**: if the C/O function is enabled, the digital input DI3 where the C/O thermostat is connected determines the C/O status. If the C/O function is disabled, the DI3 input is not taken into account, and the C/O 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 **reg. 43**) 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 DO4 and DO5, and three fan relays.

Control of analogue and PWM outputs

The heating and cooling signals on the output of the C/O function are brought to the analogue outputs 0...10 V AO1 (heating) and AO2 (cooling). The triac outputs DO4 and DO5 are not controlled by the algorithm, they can be set over the bus. Both analogue outputs and triac outputs can be overridden manually. The manual override is enabled in **reg. 10 bits 1 to 4** and if the respective bit is active,

- analogue outputs AO1 and AO2 are controlled according to the values written over the bus to **registers 11 LSB a 11 MSB** rather than by the sequences, and
- triac outputs DO4 and DO5 can be controlled as on/off outputs in **reg. 7, bits 3 a 4**.

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 fan stage switch at AI3 or by writing over Modbus or by setting by user over short push of the knob. This means that user is not able to manually override the fan motor at a cooling fancoil in case the controller needs to heat.

At second, the manual fan setting is considered – according to **reg. 29 bit 6** (presence of UC010):

- **UC010 not present**: the fan is controlled by the switch wit resistor cascade or potentiometer at AI3. Open input sets the fan to Auto, short-circuited input sets the fan to Off. This means that it is possible to switch between Auto and Off using a dry contact at AI2.

  Vstup má následující prahové hodnoty:

  - R < 140 Ohm - Off
  - R >= 140 Ohm and R < 225 Ohm - Stage 1
  - R >= 225 Ohm and R < 330 Ohm - Stage 2
  - R >= 330 Ohm and R < 450 Ohm - Stage 3
  - R > 450 Ohm - Auto

- **UC010 present:** the fan is controlled according to the room unit settings or writing over bus into **register 24**. The last written or changed value is valid.

If the fan is blocked by Stop fan when heating / cooling parameters, it can be overriden 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. Based on the number of fan stages entered in **reg. 26, bits 4 and 5**, the sequence is recalculated among the number of stages. The three-stage control is set as follows:

- Stage 1: On 8 %, Off 0 %
- Stage 2: On 40 %, Off 25 %
- Stage 3: On 80 %, Off 65 %.

When on Auto, there is a short time delay between the switching of the stages to prevent the motor from shocks.

The fan relays can be 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, bits 0 to 3**.

History of changes

04/2016 Function description incl. schema added.

03/2017 Master - slave description added.

04/2017 Added version fw from which is supported function master – slave.