iSMA-B-FCU

User Manual

FCU Application

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1 Introduction

This document contains information about iSMA-B-FCU device default application.

1.1 Document change log

Rev	Date	Description
1.0	20.12.2016	• First edition
1.1	01.02.2017	• Outputs manual override option added • Network parameters list updated
1.2	21.04.2017	• Information about Simple Panel added • Network parameters list updated
1.3	13.03.2018	• Network parameters list updated • Fixed mistake in Modbus and BACnet value of HTG Relays Enable register in Table 4

1.2 Safety rules

- **Note:** incorrect wiring of this product can cause its damage and may result in other hazards. Make sure the product has been correctly wired before turning the power ON.

- Before wiring, or removing/mounting the product, be sure to turn the power OFF. Failure to do so might cause electric shock.

- Do not touch electrically charged parts such as the power terminals. Doing so might cause electric shock.

- Do not disassemble the product. Doing so might cause electric shock or faulty operation.

- Use the product within the operating ranges recommended in the specification (temperature, humidity, voltage, shock, mounting direction, atmosphere etc.). Failure to do so might cause fire or faulty operation

- Tighten the wires firmly to the terminal. Insufficient tightening of the wires to the terminal might cause fire.

2 FCU inputs and outputs

This section describes using of all inputs and outputs with default application loaded on iSMA-B-FCU device.

2.1 Special Inputs

iSMA-B-FCU device has four Special Inputs. In default application, dedicated temperature sensors and/or potentiometer have to be connected to each input. The figure below presents the way all Special Inputs are connected.
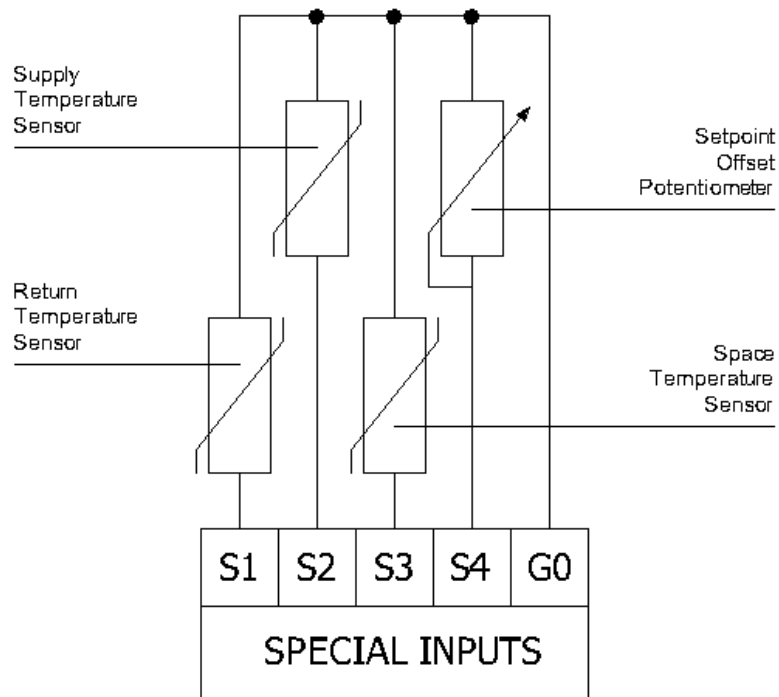
Figure 1 Connection of Special Inputs terminal

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
S1_Return_Temperature	ºC	RO	-	113	-	213	-
S2_Supply_Temperature	ºC	RO	-	114	-	214	-
S3_Space_Temperature	ºC	RO	-	115	-	215	-
S1_Sensor_Type	N/A	RW	-	43	-	143	1
S2_Sensor_Type	N/A	RW	-	44	-	144	1
S3_Sensor_Type	N/A	RW	-	45	-	145	1

Table 1 Special Inputs network parameters

2.2 Digital Inputs

iSMA-B-FCU device is equipped with four Digital Inputs. The way of connecting all signals to the inputs is presented in the figure below. Digital Inputs from 1 to 3 can be inverted, depending on is the type of sensors connected to the device.
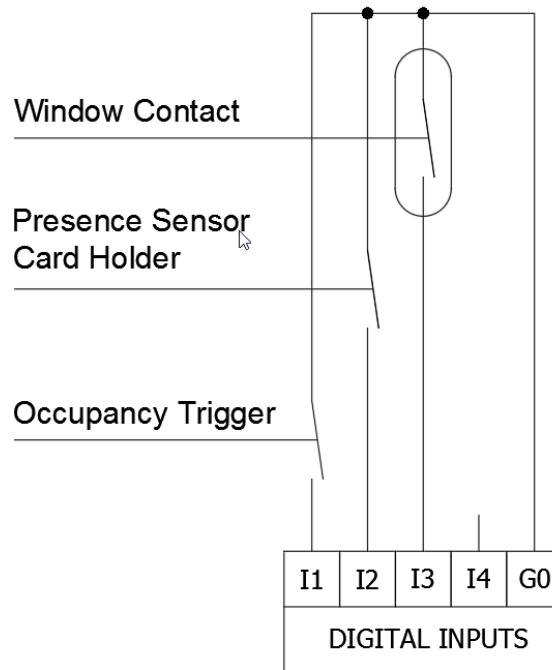
Figure 2 Connection of Digital Inputs terminal

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
I1_Remote_Occuapancy_Trigger	-	RO	82	-	1282	-	-
I2_Presence_Sensor_Card_Holder	-	RO	83	-	1283	-	-
I3_Window_Conntact	-	RO	84	-	1284	-	-
I1_Remote_Occuapancy_Trigger_Invert	-	RW	6	-	1206	-	Off
I2_Presence_Sensor_Card_Holder_Invert	-	RW	7	-	1207	-	Off
I3_Window_Conntact_Invert	-	RW	8	-	1208	-	Off

Table 2 Digital Inputs network parameters

2.3 Triac Outputs

iSMA-B-FCU device has two Triac Outputs to connect the actuators of heating and cooling valves. Both can work as typical binary outputs (for Binary Temperature Control) or with PWM modulation. In PWM modulation mode output is working in the period when two states are used (low state 0 V and high state 24 V AC or 230 V AC, depending on hardware version). The periods are defined by PWM_Heating_Period network variable for TO1 output and PWM_Cooling_Period network variable for TO2 output (both are set to 300 seconds by default). The control signal defines in percentage output of high state in working period. Depending on hardware version, Triac Outputs can work with 230 V AC thermal valve actuators (iSMA-B-FCU-HH) or with 24 V AC thermal valve actuators (iSMA-B-FCU-HL and iSMA-B-FCU-LL).

The way of connecting the actuators to the Triac Outputs in 4 pipe application is presented in the figure below.
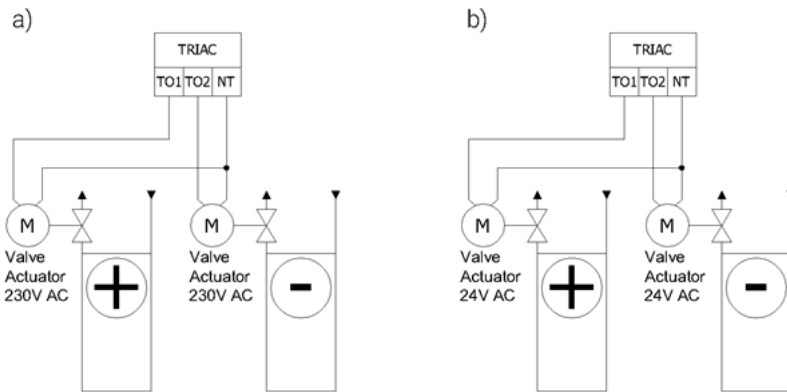
Figure 3 Connection of thermal valves actuators to Triac Outputs: a) iSMA-B-FCU-HH; b) iSMA-B-FCU-HL and iSMA-B-FCU-LL

Note: In case of iSMA-B_FCU-HH and iSMA-B-FCU-LL devices, actuators connected to each Triac Output may consume up to 0.5 A. In case of iSMA-B-FCU-HL device, the sum of power consumption of both Triac Outputs and 24 V AC output cannot exceed 0.3 A (7 VA):

$I_{max} = 0.3A = I_{TO1} + I_{TO2} + I_{24VOut}$.

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
Heating_Valve	%	RO	-	110	-	210	N/A
Coolling_Valve	%	RO	-	111	-	211	N/A
PWM_Heating_Period	s	RW	-	15	-	115	300
PWM_Cooling_Period	s	RW	-	16	-	116	300

Table 3 Triac Output network parameters

2.4 Digital Outputs

2.4.1 Fan Outputs

iSMA-B-FCU device is equipped with three relay outputs designed for connecting with the Fan. The way of connecting with the Fan (depending on the number of speeds) is presented in the figure below. These outputs have internal connection to power supply terminal and are protected by an in-built 6 A fuse. Total load for Digital Outputs O1-O3, O5, and Triac cannot extend 6 A in both 230 V AC and 24 V AC power supply versions.

Note: In iSMA-B-FCU-HL the Triacs Outputs are supplied with power by build-in transformer and a minimal part in power supply is input current.

WARNING! Please note that the inductive load of the relays is limited to 75 VA.
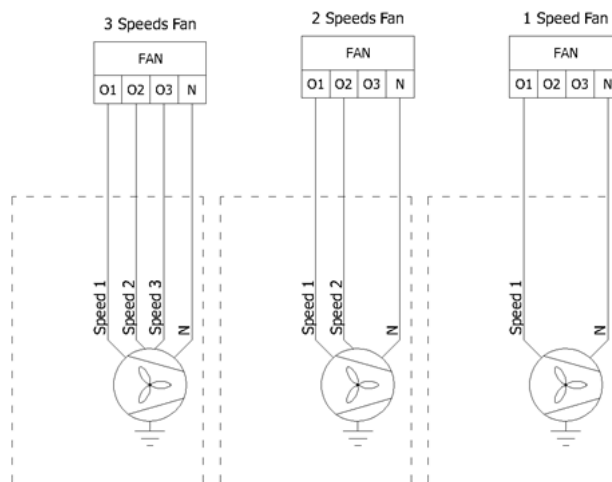
Figure 4 Fan connections

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
Fan Value	%	RO	-	112	-	212	N/A
Fan Type	N/A	RO	-	103	-	203	0

2.4.2 Electrical Heater (HTG)

iSMA-B-FCU device is equipped with a relay output for connecting with the Electrical Heater. This output can be used for 1st or 2nd stage of heating, depending on CFG DIP switch configuration. This output is not internally connected to the power supply, so it is necessary to use external supply. Relay current cannot exceed 10 A for resistance load at 250 V AC power supply. The way of connecting the Electric Heater to O4 HTG is presented in the figure below.

Note: The HTG relay voltage is always limited to 250 V AC, irrespectively of FCU controller power supply.
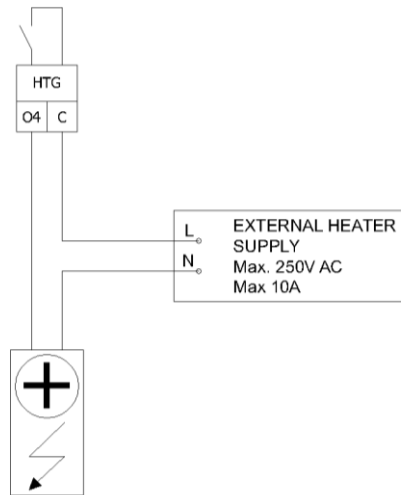
Figure 5 Electrical Heater connection

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
Heating_Second_Stage	-	RO	80	-	1280	-	N/A
HTG Relays Enable	-	RW	4	-	1204	-	True

Table 4 Network parameters of O4 HTG Digital Output

2.4.3 Electrical Cooler (CLG)

iSMA-B-FCU device is equipped with a relay output for connecting with the Electrical Cooler. This output can be used as 1st or 2nd stage of cooling, depending on CFG DIP switch configuration. Relay output is connected with the power supply internally, therefore it is not necessary to connect an external supply. In iSMA-B-FCU-HH and iSMA-B-FCU-HL, the output voltage in high state is 230 V AC, whereas in iSMA-B-FCU-LL version the high state output voltage is 24 V AC. In total, relay current with fan and Triac Outputs cannot exceed 6 A. The way of connecting the Electric Cooler to O5 CLG is presented in the figure below.
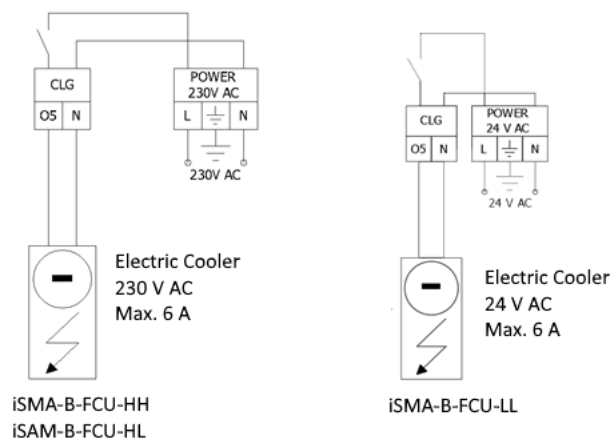
Figure 6 Electrical cooler connection

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
Cooling_Second_Stage	-	RO	81	-	1281	-	N/A
CLG Relays Enable	-	RW	5	-	1205	-	True

Table 5 Network parameters of O5 CLG Digital Output

2.5 Analog Outputs

iSMA-B-FCU device has 3 Analog Outputs 0-10 V DC which can be used for controlling the following fan coil unit devices:

- A1 (HTG) – Analog heating valve actuator control,
- A2 (CLG) – Analog cooling valve actuator control,
- A3 (FAN) – Analog fan speed control.

The way of connecting all the Analog Outputs is presented in the figures below.
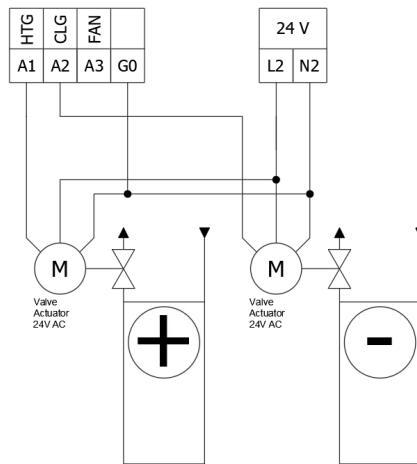
Figure 7 Connection of analog valve actuators
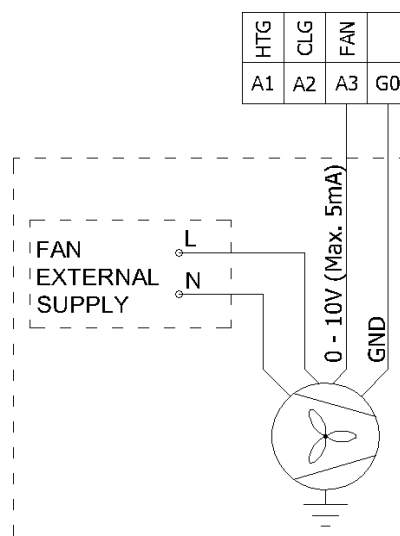
Figure 8 Connection of Analog Fan control

Analog Outputs status network parameters are presented in the table below.

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
Heating_Valve	%	RO	-	110	-	210	-
Cooling_Valve	%	RO	-	111	-	211	-
Fan Value	%	RO	-	112	-	212	-

Table 6 Analog Outputs status network parameters

2.6 Simple Panel connection

Simple Panel is a device designed for working with room temperature controllers. The device is fully passive and does not require any power supply. Simple Panel consists of the following parts:

- Temperature Sensor – 10K3A1,
- Resistance potentiometer – 0-10 kΩ,
- Push button – NO, max 50 mA,
- LED diode – blue, max 5 mA.

Simple Panel internal connection and connection with FCU controller are presented in the figures below.
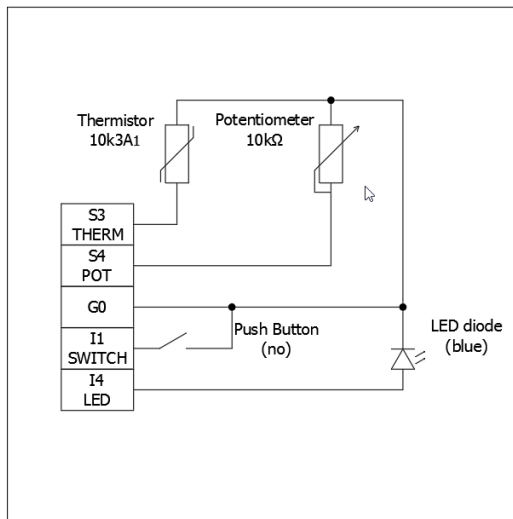
Figure 9 Diagram of the internal connections of the Simple Panel
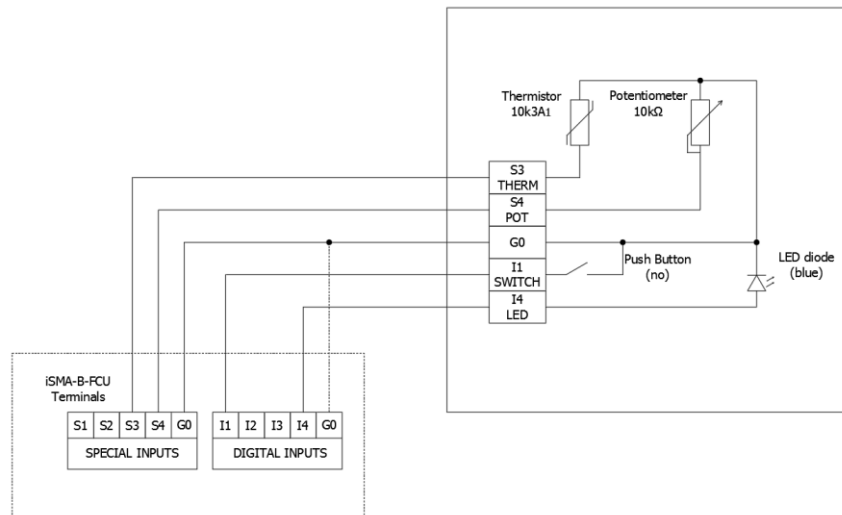
Figure 10 Connection diagram of iSMA-B-FCU controller

3 FCU DIP switch configuration

The default application has been designed to run with a wide range of typical fan coil units. Application adjustments are made with CFG DIP switch. FCU application provides the following list of configurable modes:

- Pipe mode
- 2nd stage of heating
- 2nd stage of cooling
- Heating/cooling control mode
- CV temperature source
- Fan type
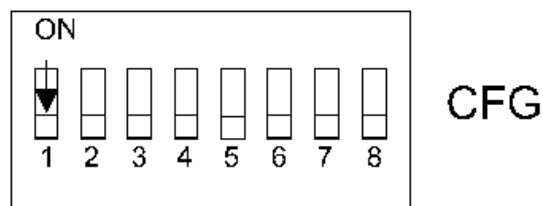
Figure 11 DIP switch CFG

The status of DIP switch configuration is presented in "Dip_Switch_Configuration" network variable.

The DIP switch function is presented in the table below:

No.	Name	On		Off	Default
1	Pipe Mode	2 Pipe		4 Pipe	4 Pipe
2	Heating 2nd Stage	Enable		Disable	Disable
3	Cooling 2nd Stage	Enable		Disable	Disable
4	Heating/cooling control mode	Analog		Digital	Digital
No.	Name	Switches configuration		Function	Default
5	CV temperature source	5-Off	6-Off	LCD Panel	LCD Panel
		5-Off	6-On	Room Sensor SI3	
6		5-On	6-Off	Air Return Temp SI1	
		5-On	6-On	Slave	
7	Fan type	7-Off	8-Off	Analog 0-10V	3 Speed
		7-Off	8-On	1 Speed	
8		7-On	8-Off	2 Speed	
		7-On	8-On	3 Speed	

Table 7 CFG DIP switch particular switch configuration

3.1 Fan coil unit pipe mode system (switch number 1)

3.1.1 4 pipe system

In 4 pipe system mode switch number 1 has to be set in "OFF" position as shown in figure below. In default this mode is ON.
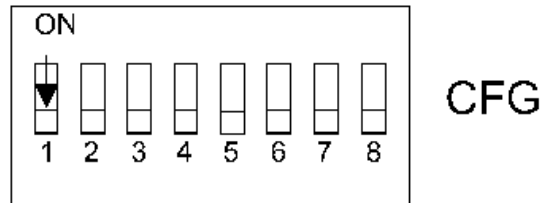
Figure 12 4-pipe system DIP switch configuration

In this configuration, fan coil unit is equipped with two separate heating and cooling devices. Electrical connection for the actuators of 24 V AC Heating and Cooling valves controlled by analog signal (0-10 V DC) is presented in the figure below.
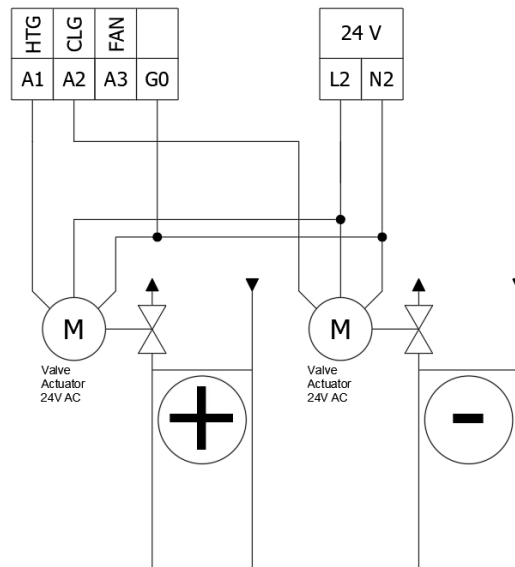
Figure 3 Connection of heater/cooler valve actuators in 4-pipe mode with Analog signals 0-10 V DC

FCU controller can work with thermal valves actuators. For this option, FCU controller is equipped with 2 built-in Triac Outputs. The Triac Outputs can work in digital (open/close) or PWM mode, selected by CFG DIP switch number 4. Depending on hardware version, FCU controller can work with 230 V AC thermal valve actuators (iSMA-B-FCU-HH) or with 24 V AC thermal valve actuators (iSMA-B-FCU-HL and iSMA-B-FCU-LL). In both cases, thermal valve actuators are supplied with power from FCU controller.
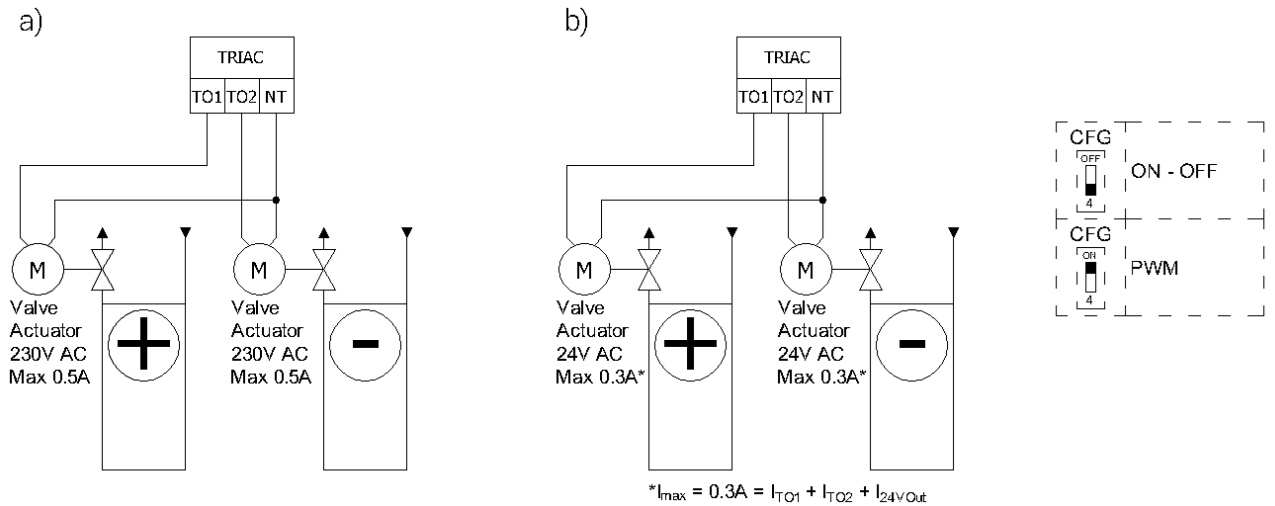
Figure 3 Connection of heating/cooling valve actuators with Triac Outputs in 4pipe mode

3.1.2 2 pipe system

In 2 pipe system mode, switch number 1 has to be set in "ON" position as presented in the figure below. In default, this mode is OFF.
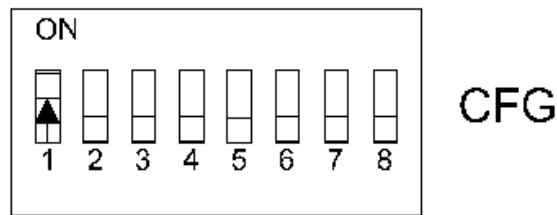
Figure 4 Configuration of 2pipe system DIP switch

In this configuration, fan coil unit is equipped with single device for heating and/or cooling. In this case, valve actuator has to be connected to Analog Output (A1) or Triac Output (TO1), as presented in the figure below.
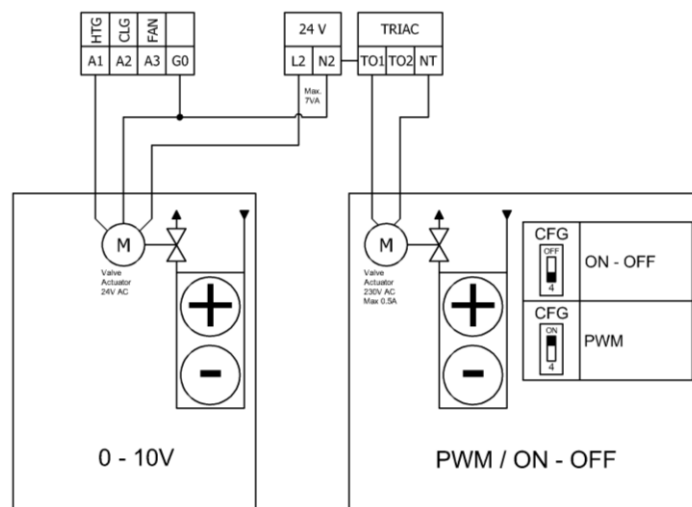
Figure 5 Connection of heating/cooling valve actuators in 2-pipe mode

3.2 1st and 2nd stage of heating (switch number 2)

iSMA-B-FCU device can work with single heating device (1st stage only) or with two heating devices (basic – 1st stage and additional 2nd stage). The type of operating stages is chosen by CFG DIP switch number 2.

3.2.1 1st stage of heating – general information

For 1st stage only, depending on control mode, the user can choose 1 of 3 outputs:

- A1 Analog Output (only Analog Control Mode),
- TO1 Triac Output (Digital and Analog Control Modes),
- O4 relay output (only Digital Control Mode).

The connections of heating devices, in example version iSMA-B-FCU-HH, is presented in the figure below.
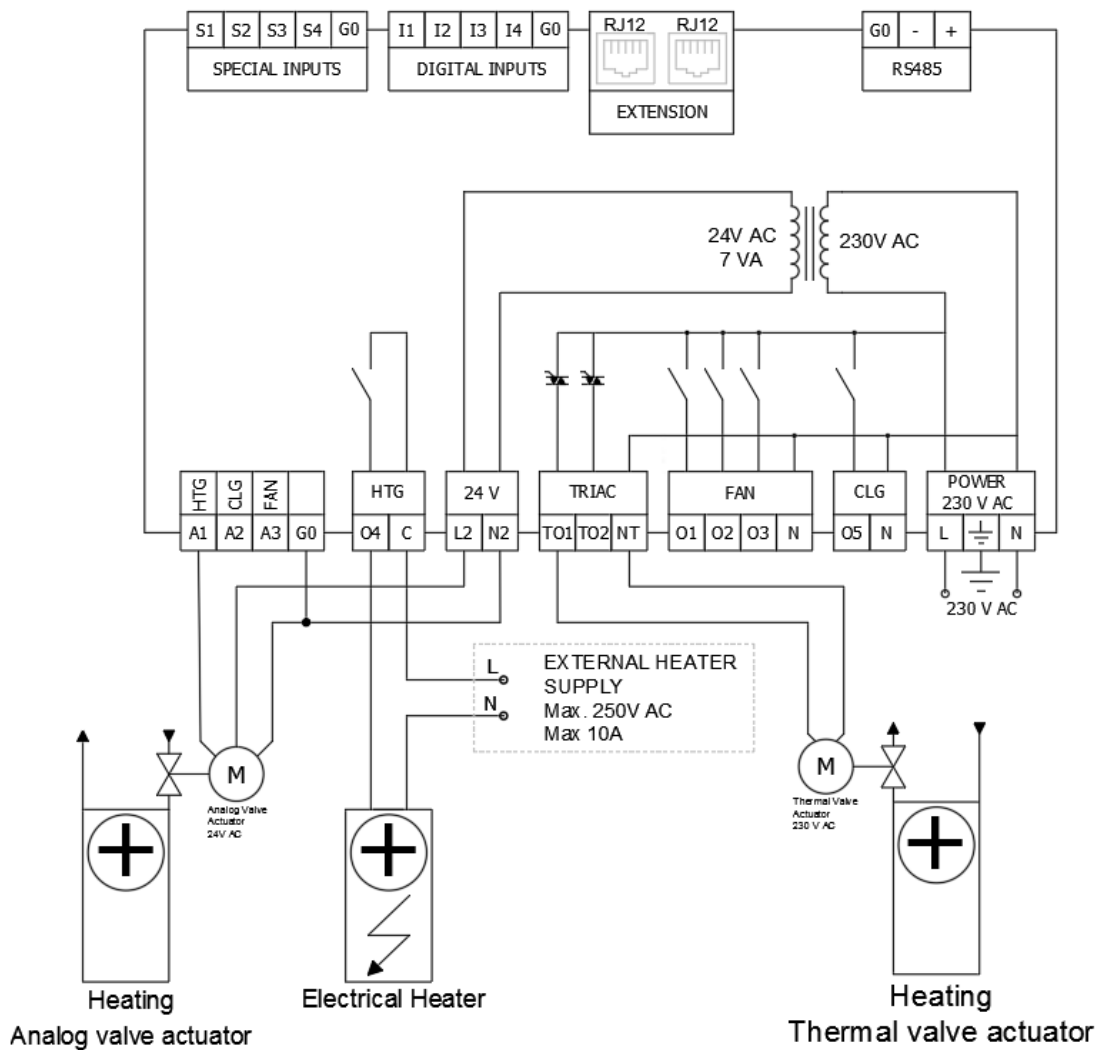
Figure 13Exemplary connections of iSMA-B-FCU-HH heating devices

3.2.2 1st stage of heating Digital Control Mode

In this mode, the control algorithm works as a typical thermostat, based on Effective Setpoint and Control Value with heating Diff parameter defined in "Heating_Binary_Diff" network parameter. The output signal works in 2 states, low and high. In the 1st stage of heating only, the user can choose 1 of 2 outputs: TO1 Triac Output or O4 relay output. The A1 output is disabled. The high value of thermostat output also enables the operation of the fan. The algorithm of heating digital control mode is presented in the chart below.
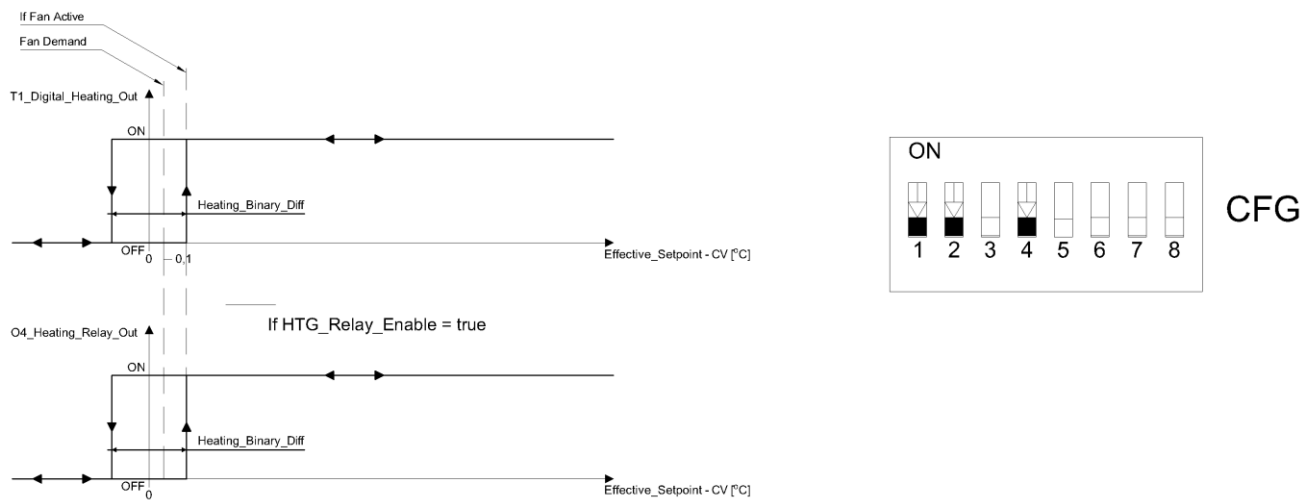
Figure 14 Digital control mode of the heating and CFG DIP switch configuration

Note: The O4 HTG output relay can be enabled/disabled with "HTG_Relays_Enable" network parameter, and in default this relay is enabled. When the output is not in use, it is recommended to disable it.

3.2.3 1st stage of heating Analog Control Mode

In this mode, the algorithm is controlled by PI regulator which calculates the output value in the range from 0 to 100%, basing on "Effective_Setpoint" and CV (room temperature) values. PI regulator can be adjusted by network parameters "Kp" and "Ti". In the 1st stage of heating, the user can choose 1 of 2 outputs: A1 Analog Output or TO1 Triac Output PWM. The O4 relay output is disabled. The A1 Analog Output value and the TO1 PWM signal is proportional to PI regulator output. When PI regulator output is equal or higher than 5%, it activates the fan (Fan Demand). The algorithm of heating analog control mode is presented in the chart below.
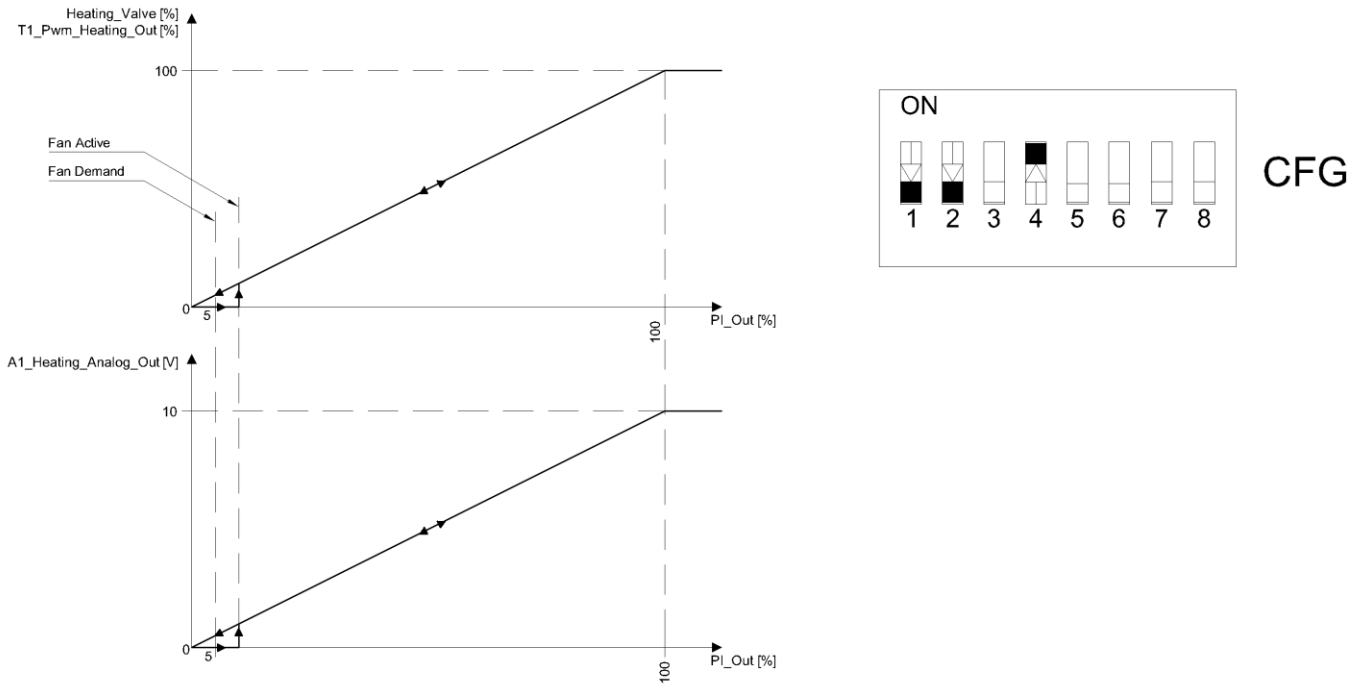
Figure 15 1st stage Analog Control Mode and CFG DIP switch configuration

3.2.4 2nd stage of heating – general information

As an additional 2nd stage of heating, the default application can operate only with O4 relay. The 2nd stage of heating is activated by setting CFG DIP (switch number 2 in On position).
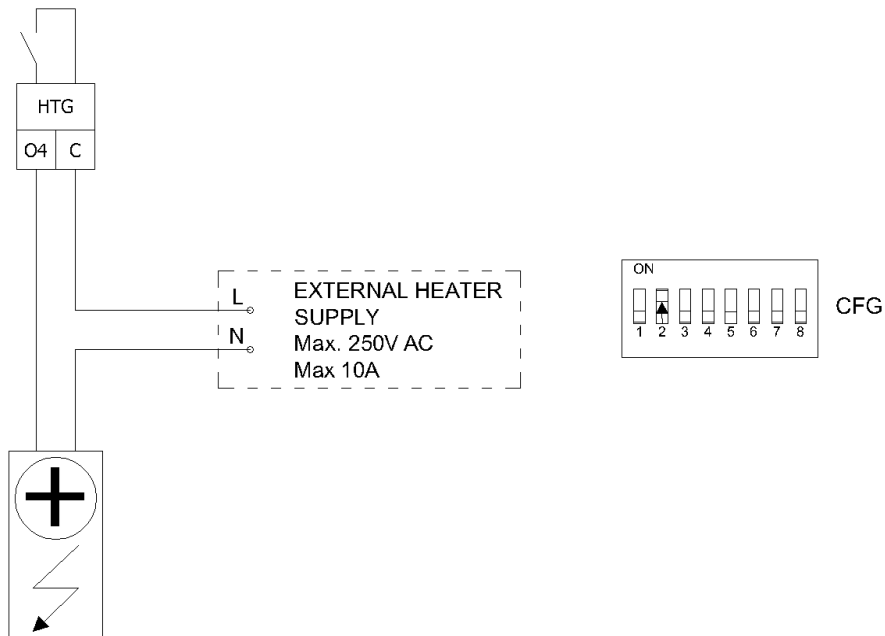
Figure 16 2nd stage Electrical heater connection and Heating 2nd stage of heating activated CFG DIP switch configuration

3.2.5 2nd stage of heating Digital Control Mode

In this mode, the control algorithm operates with 2 typical thermostats. 1st stage thermostat is based on the Effective Setpoint and Control Value with heating Diff parameters defined in "Heating_Binary_Diff" network parameter. 2nd stage thermostat works with shifted Effective Setpoint and Control Value with heating Diff parameters defined in "Second_Stage_Diff_Binary" network parameter. 2nd stage setpoint shifting value is defined in "Second_Stage_Threshold_Binary" network parameter. 1st stage thermostat output high value also activates the fan. The output signals are working in 2 states, low and high.   In   the 1st stage of heating, the user can use TO1 Triac Output only and in the 2nd stage O4 relay output only. The A1 output is disabled. The heating Digital Control Mode algorithm of the
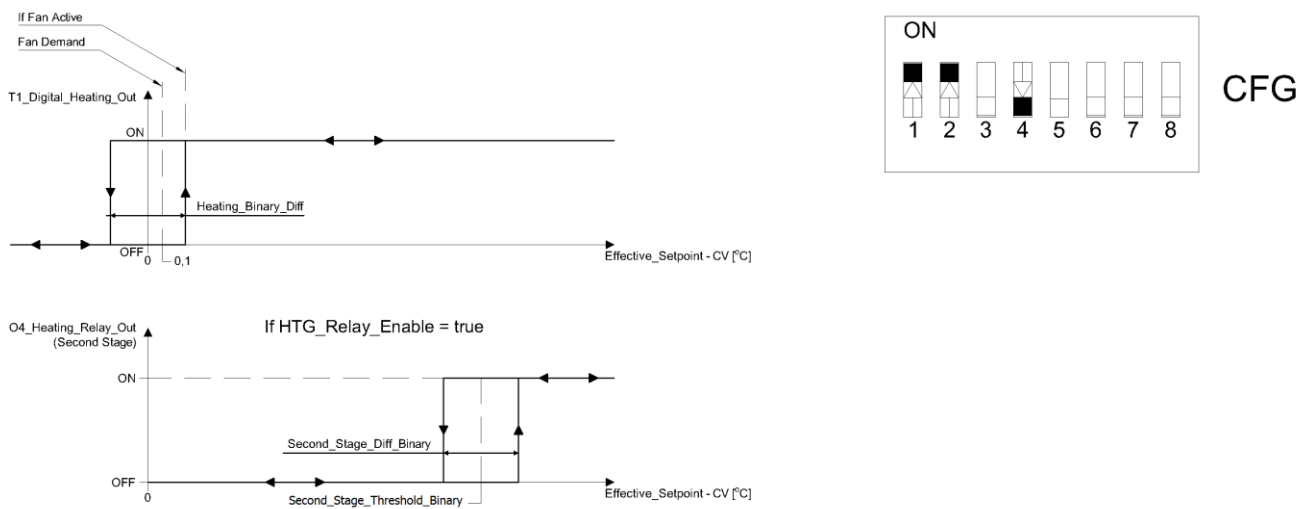
2nd stage is presented in the chart below.

Figure 17 Digital Control Mode of the 2nd stage of heating and CFG DIP switch configuration

3.2.6 2nd stage of heating Analog Control Mode

In this mode, the algorithm is controlled by PI regulator which calculates the output value in the range from 0 to 100%, basing on Effective_Setpiont and CV (room temperature) values. PI regulator can be adjusted by network parameters "Kp" and "Ti". 1st stage analog signal is scaled from 0 to "Second_Stage_Threshold_Analog" network parameter value. When PI regulator output achieves "Second_Stage_Threshold_Analog" value, 1st stage analog signal achieves value of 100%. The 2nd stage works as a thermostat, basing on "Second_Stage_Treshold_Analog" as Setpoint, PI regulator output as Control Value and Diff parameters defined in "Second_Stage_Diff_Analog" network parameter. In the 1st stage of heating, the user can choose 1 of 2 outputs: A1 Analog Output or TO1 Triac Output PWM. O4 relay output is dedicated to the 2nd stage. A1 Analog Output value and TO1 PWM signal are proportional to PI regulator output. When PI regulator output is equal or higher than 5%

of the fan, it activates the fan (Fan Demand). Analog Control Mode of the 2nd stage of heating is presented in the charts below.
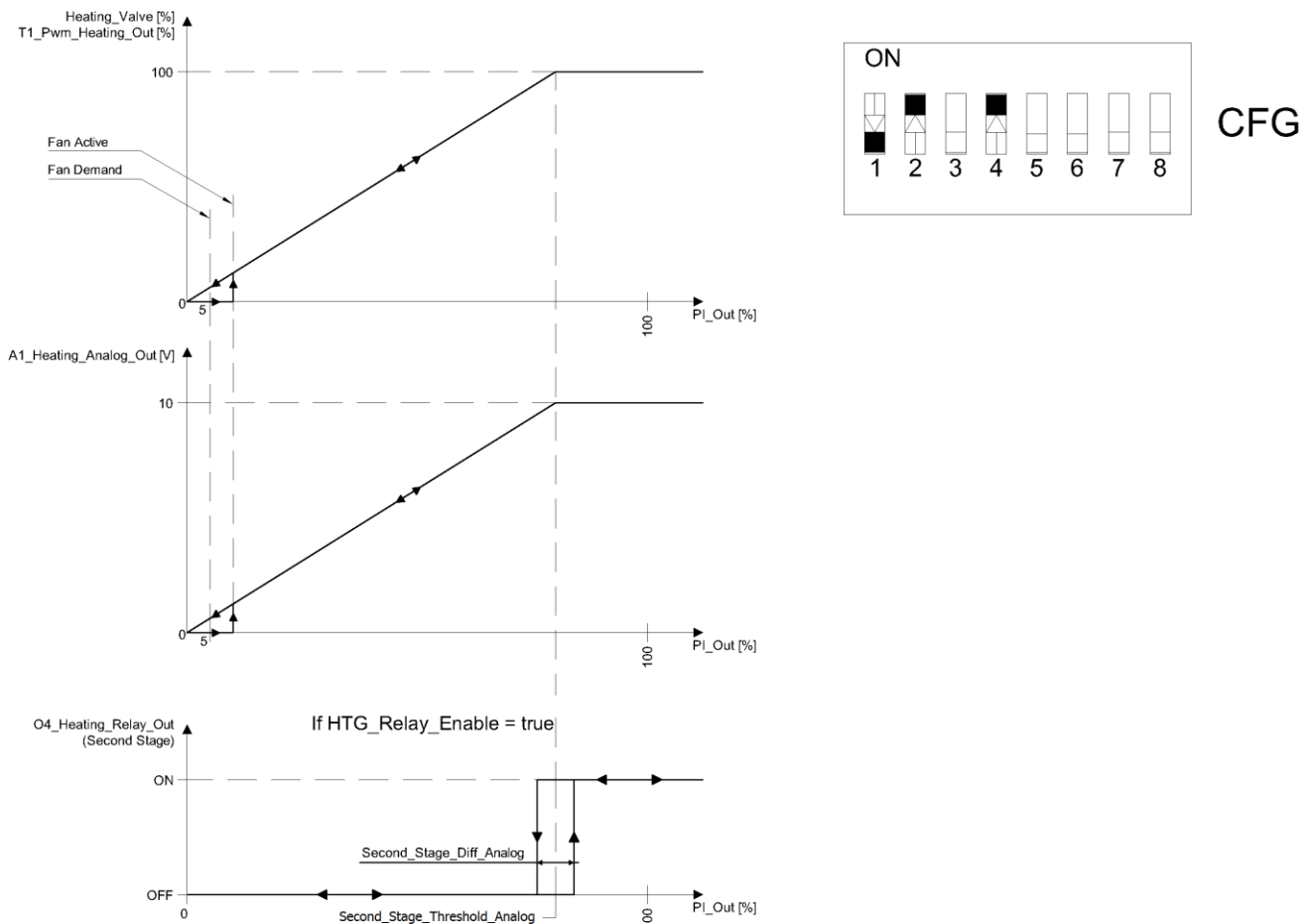
Figure 18 Configuration of Analog Control Mode of the 2nd stage of heating and CFG DIP switch

3.3 1st and 2nd stage of cooling (switch number 3)

iSMA-B-FCU device can work with single cooling device (1st stage only) or with two cooling devices (basic – 1st stage and additional 2nd stage). The type of operating stages is chosen with CFG DIP switch number 3.

3.3.1 1st stage of cooling – general information

For 1st stage only, depending on control mode, the user can choose 1 of 3 outputs:

- A2 – in 4 pipe mode Analog Output (only Analog Control Mode),
- A1 – in 2 pipe mode Analog Output (only Analog Control Mode),
- TO2 - in 4 pipe mode Triac Output (Digital and Analog Control Modes),
- TO1 - in 2 pipe mode Triac Output (Digital and Analog Control Modes),
- O5 relay output (only Digital Control Mode).

The connections of heating devices in example iSMA-B-FCU-HH are presented in the figure below.
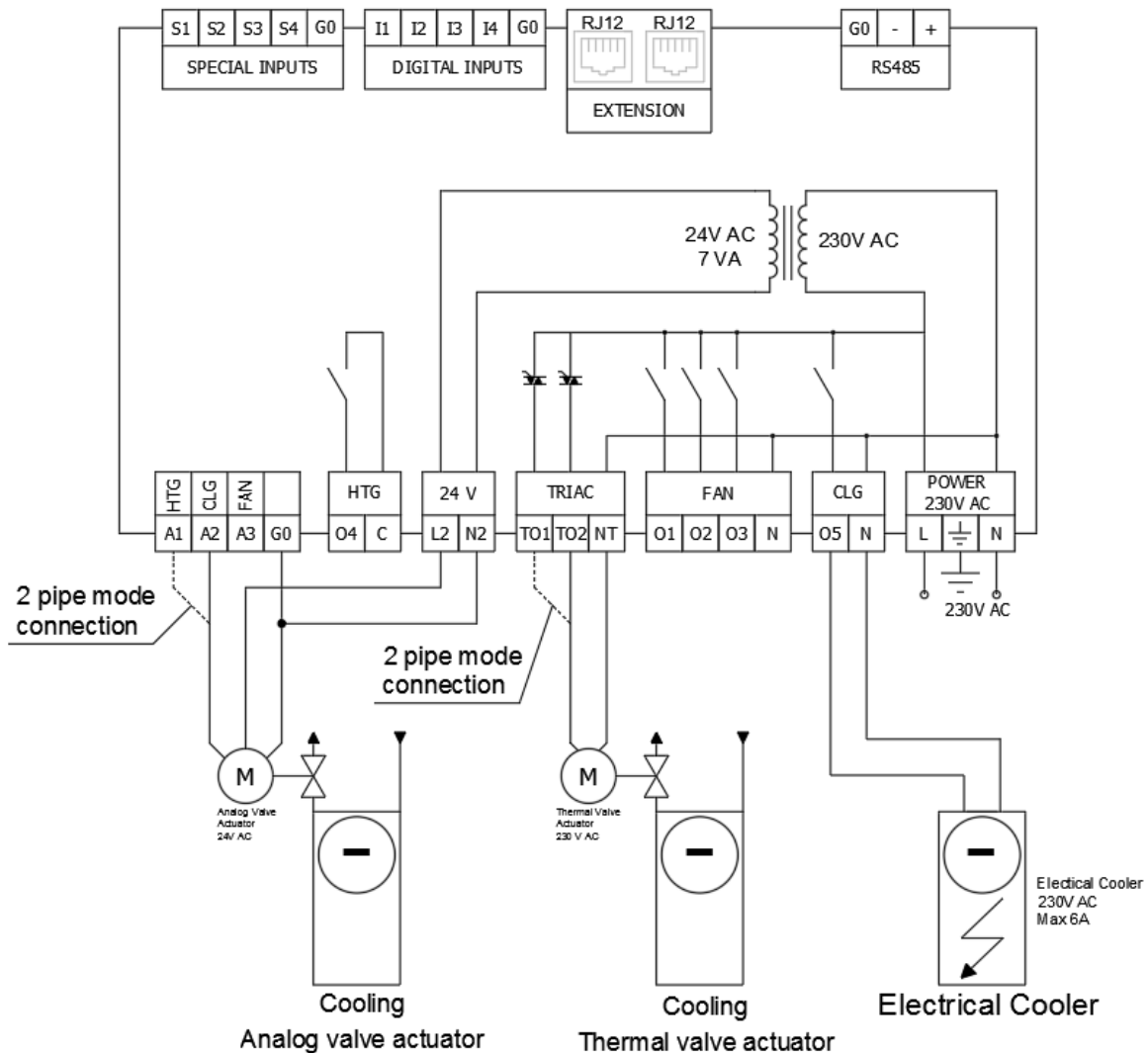
Figure 19 Exemplary connections of iSMA-B-FCU-HH cooling devices

Note: O5 CLG output relay can be enabled/disabled with "CLG_Relays_Enable" network parameter; in default this relay is enabled.

Note: In 2 pipe mode, cooling and heating signals are on the same outputs, A1 and TO1.

3.3.2 1st stage of cooling Digital Control Mode

In this mode, the control algorithm works as a typical thermostat, basing on the Effective Setpoint and Control Value with heating Diff parameters defined in "Cooling_Binary_Diff" network parameter. The output signal works in 2 states, low and high. In the 1st stage of cooling only, the user can choose 1 of 2 outputs: TO2 (or TO1 in 2 pipe mode) Triac Output or O5 relay output. The A1 and A2 outputs are disabled. The high value of thermostat output

also activates the fan. The digital control mode algorithm of cooling is presented in the chart below.
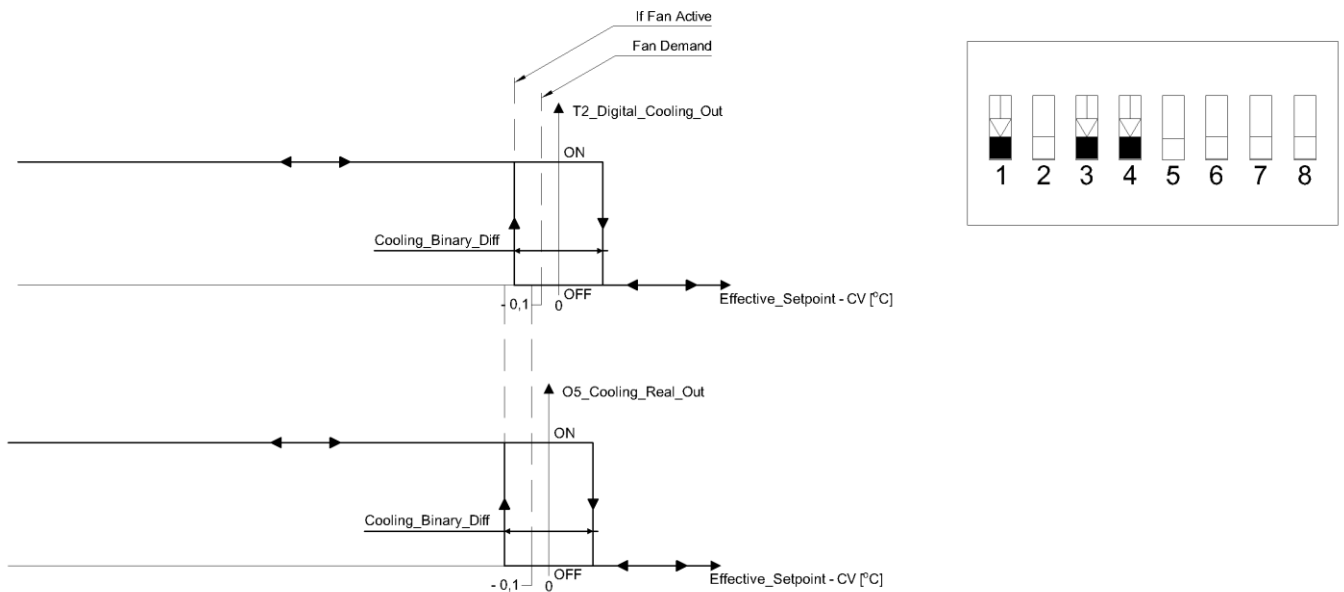
Figure 20 Configuration of digital control mode of cooling and CFG DIP switch

Note: In 2 pipe mode (CFG DIP switch number 1 in On position), cooling and heating signals are on the same outputs, A1 and TO1.

Note: O5 CLG output relay can be enabled/disabled by "CLG_Relays_Enable" network parameter; in default this relay is enabled. When output is not in use, it is recommended to disable it.

3.3.3 1st stage of cooling Analog Control Mode

In this mode, the algorithm is controlled with PI regulator which calculates the output value in the range from -100% to 0 basing on Effective_Setpiont and CV (room temperature) values. The PI regulator can be adjusted with network parameters "Kp" and "Ti" network. In the 1st stage of cooling, the user can choose 1 of 2 outputs: A2 (or A1 in 2 pipe mode) Analog output or TO2 (or TO1 in 2 pipe mode) Triac Output PWM. O5 relay output is disabled. Analog Output value and Triac PWM signal are proportional to PI regulator output. When PI regulator output is equal or higher than 5, the fan is activated. Analog Control Mode algorithm of cooling is presented in the charts below.
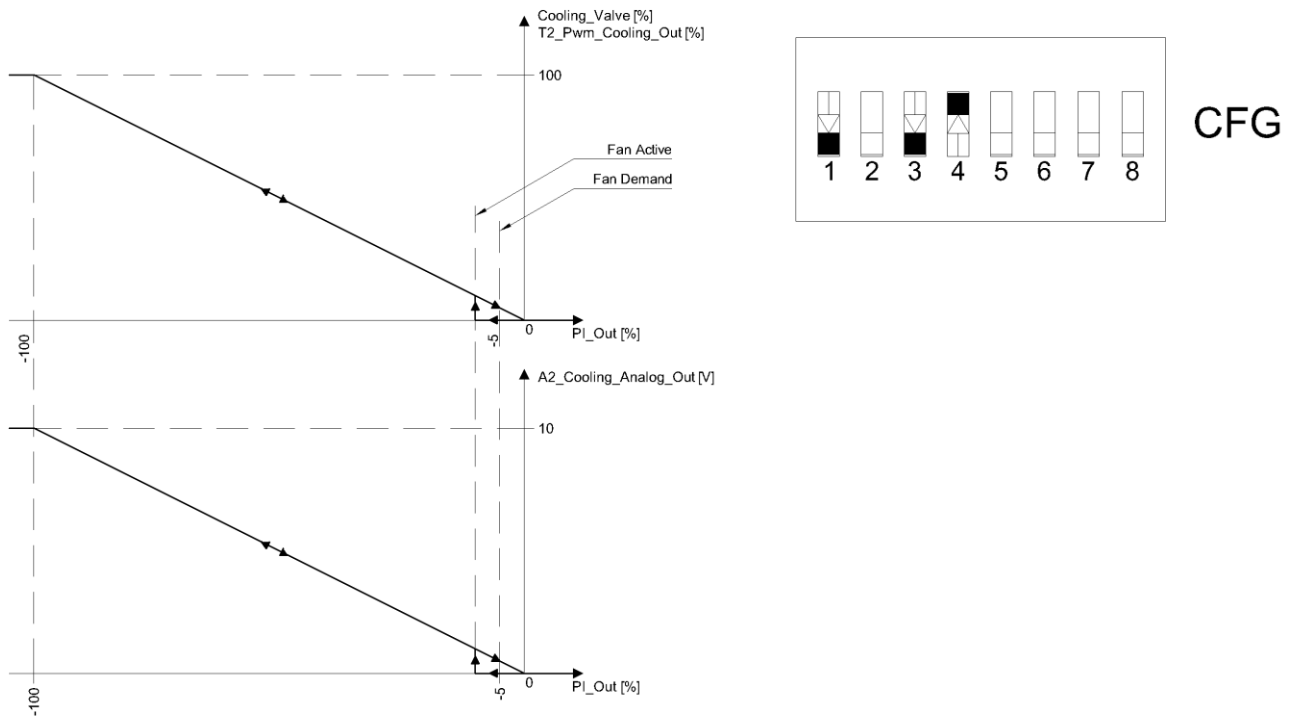
Figure 21 Configuration of the 1st stage Analog Control Mode and CFG DIP switch

3.3.4 2nd stage of cooling – general information

As an additional 2nd stage of cooling, the default application can operate only with O5 relay. The 2nd stage of cooling is enabled with CFG DIP setting (switch number 3 in On position).

The connection and the 2nd stage activating CFG DIP switch in high voltage version are presented in the figure below.
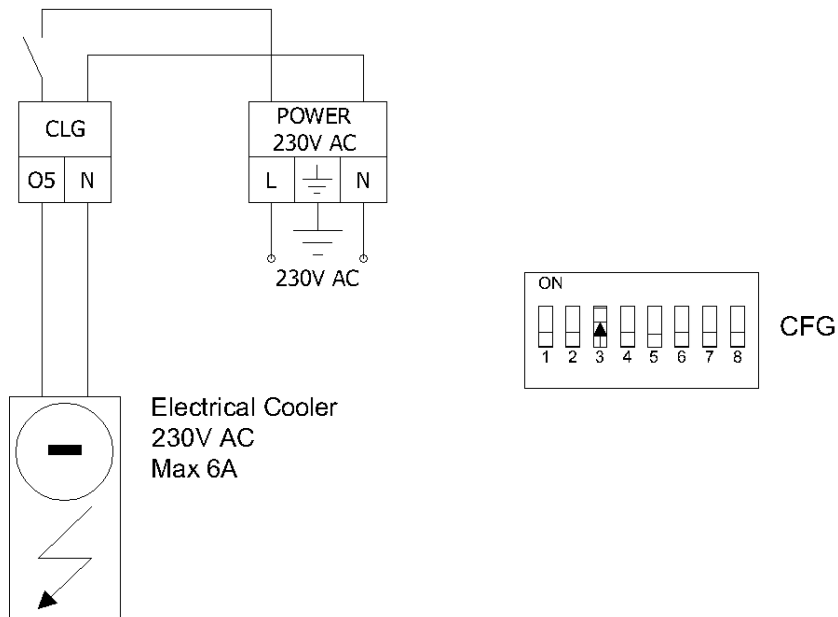
Figure 22 Configuration of the 2nd stage Electrical Cooler and the 2nd stage of cooling activating CFG DIP switch

Note: In iSMA-B-FCU-HH and iSMA-B-FCU-HL this high state the output has 230 V AC, in iSMA-B-FCU-LL the high state output is 24 V AC.

3.3.5 2nd stage of cooling Digital Control Mode

In this mode, the control algorithm operates with 2 typical thermostats. 1st stage thermostat is based on Effective Setpoint and Control Value with cooling Diff parameter defined in "Cooling_Binary_Diff" network variable. 2nd stage thermostat works with shifted Effective Setpoint and Control Value with cooling Diff parameters defined in "Second_Stage_Diff_Binary" network parameter. 2nd stage setpoint shifting value is defined in "Second_Stage_Threshold_Binary" network variable. 1st stage thermostat output high value also activates the fan. The output signals operate in 2 states low and high. In the 1st stage of cooling, the user can only use TO1 Triac Output and in the 2nd stage only O5 relay output. Outputs A1 and A2 are disabled. Digital Control Mode algorithm of the 2nd stage of cooling is presented in the chart below.
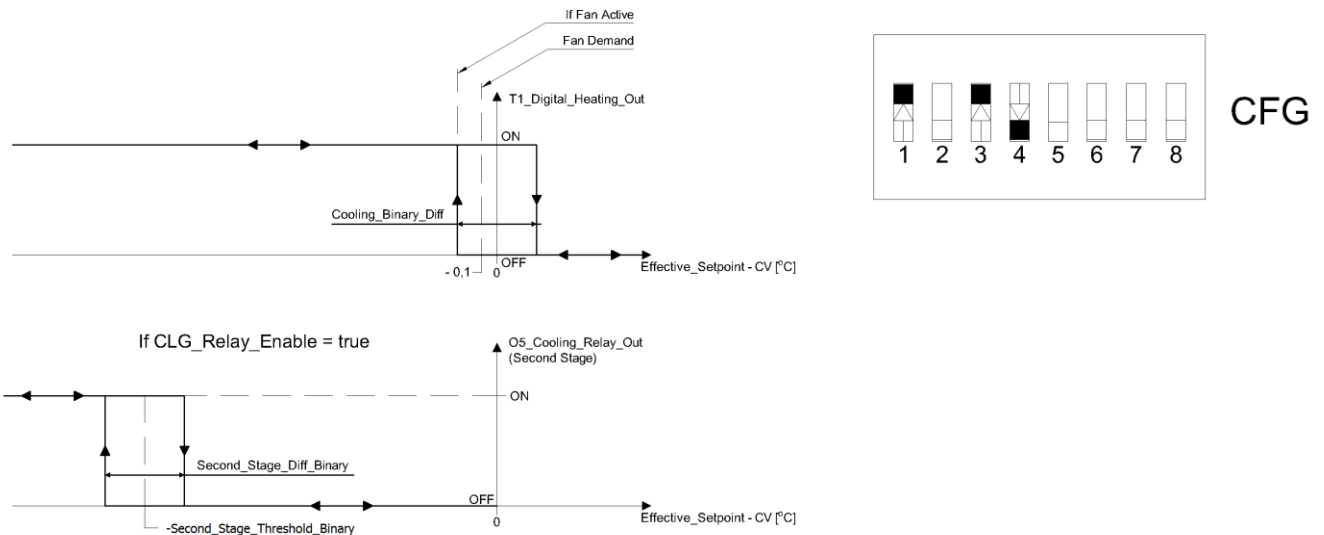
Figure 23 Configuration of Digital Control Mode of the 2nd stage cooling and CFG DIP switch

3.3.6 2nd stage of cooling Analog Control Mode

In this mode, the algorithm is controlled by PI regulator which calculates the output value in the range from -100% to 0, basing on Effective_Setpoint and CV (room temperature) values. The PI regulator can be adjusted by network parameters "Kp" and "Ti". The 1st stage analog signal is scaled to "Second_Stage_Threshold_Analog" network parameter. In range from
0 to "Second_Stage_Threshold_Analog", the analog signal is proportional to PI regulator output in range from 0 to 100%. When PI regulator output is equal or higher than "Second_Stage_Threshold_Analog", the analog signal value is set to 100%. The 2nd stage works as a thermostat, basing on "Second_Stage_Threshold_Analog" as Setpoint, PI regulator output as Control Value and Diff parameters defined in "Second_Stage_Diff_Analog" network parameter. In the 1st stage of cooling, the user can choose 1 of 2 outputs: A2 Analog Output or TO2 Triac Output PWM. The O5 relay output is dedicated to the 2nd stage. The A2 Analog Output value and the TO2 PWM signal is proportional to PI regulator output. When PI regulator output is equal or higher than 5%, it activates the fan (Fan Demand). Analog Control Mode of the 2nd stage of cooling is shown in charts below.

Figure 24 Configuration of the Analog Control Mode of the 2nd stage of cooling and CFG DIP switch
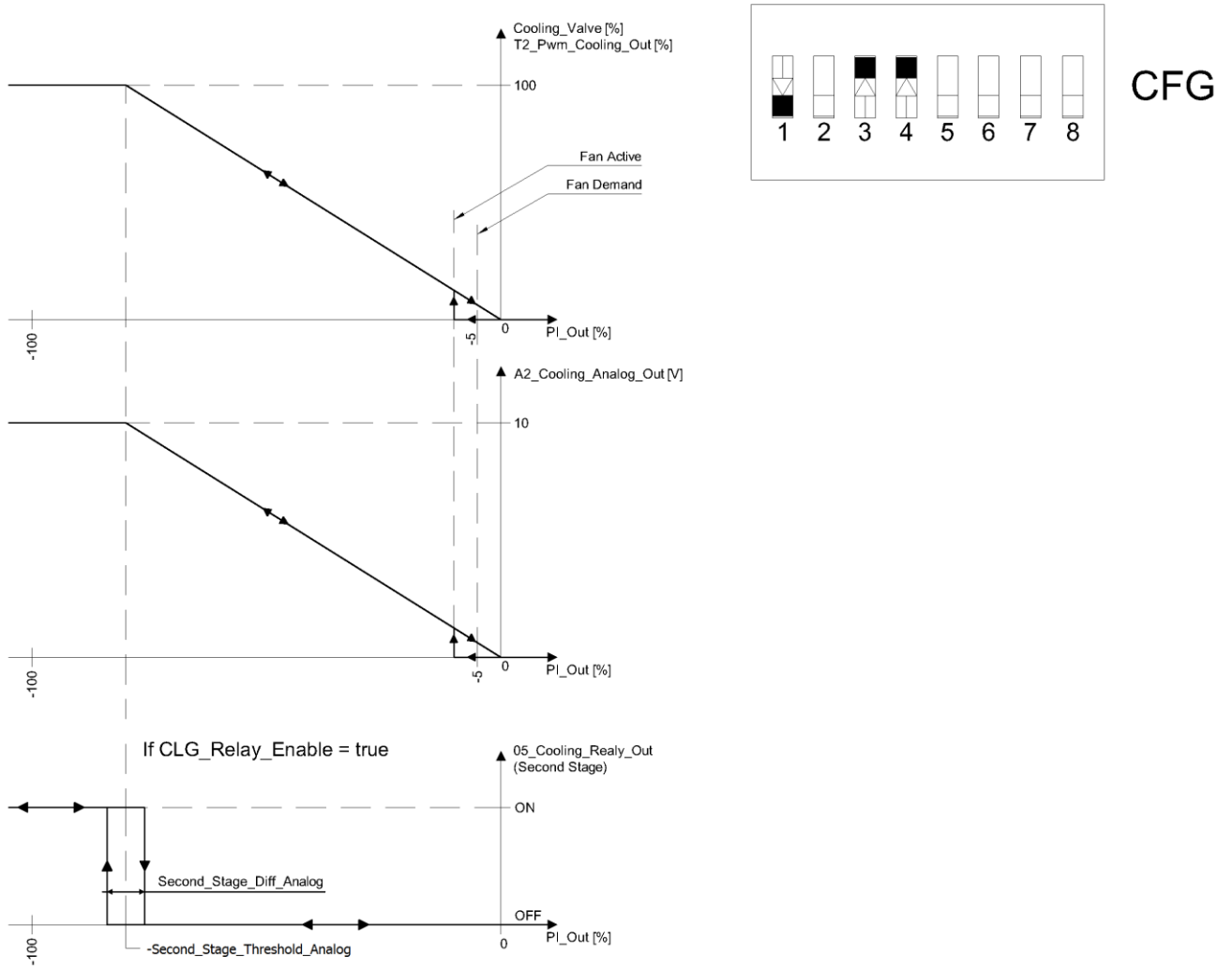
3.4 Heating/Cooling control mode (switch number 4)

FCU application is designed to cooperate with two types of heating/cooling devices (Analog or Digital). The type of control is selected with CFG DIP switch number 4 where Off position corresponds to Digital Control and On position corresponds to Analog Control.

Analog control mode

In this mode, the algorithm is controlled by PI regulator which calculates the output value in the range from -100% to 100%, basing on Effective_Setpoint and CV (room temperature) values. Range from -100% to 0 is for cooling control and range from 0 to 100% is for heating control. Basing on this output, FCU controller controls actuators in binary or analog control. The PI regulator can be adjusted with network parameters "Kp" and "Ti". In order to prevent the algorithm from activating heating and cooling in rapid succession Valves_dead_band value can be adjusted. It defines temperature deviation from setpoint, where PI regulator will not activate neither heating or cooling mode.
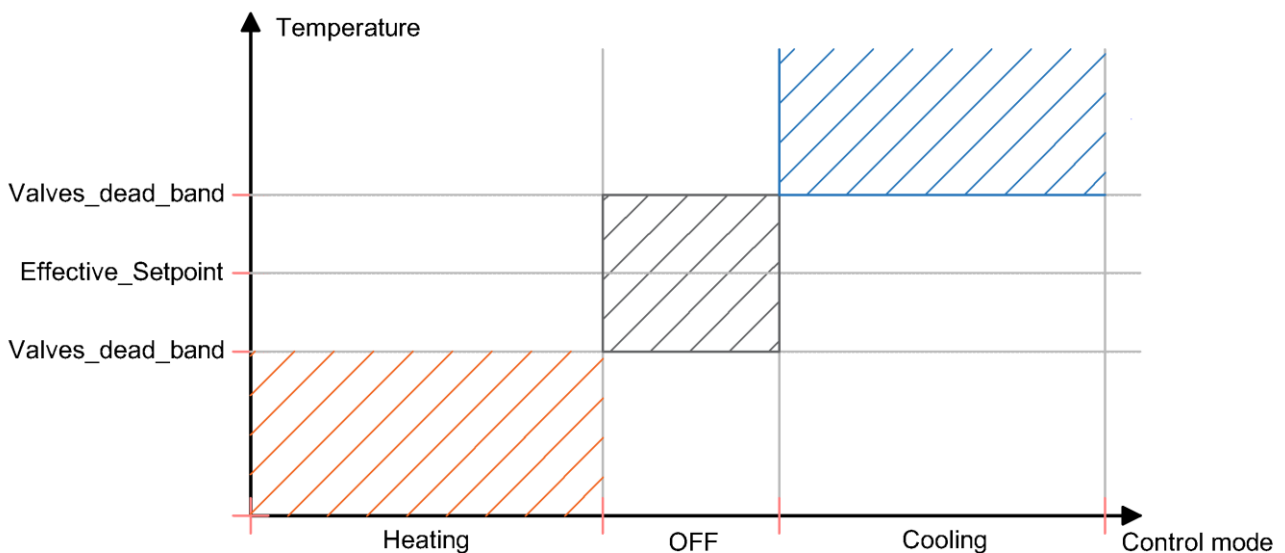
Figure 25 Valves_dead_band operation chart

Digital control mode

In this mode, the control algorithm works as a typical thermostat, basing on Effective Setpoint and Control Value with heating/cooling Diff parameters.

Note: This mode affects also outputs enabled/disabled in the 1st stage. In the first stage, outputs O4 and O5 can work only in "Binary Control" mode. If the user wants to run "Binary Control" mode without operating these outputs, he can disable them by the setting corresponding to network parameter in false state (O4: "HTG_Relays_Enable", O5: "CLG_Relays_Enable").

3.5 CV temperature source (switches number 5 and 6)

The default application can work with 4 different CV temperature sources. CV temperature source is selected by CFG DIP switches number 5 and 6. The configuration table is presented below.

No.	Name	On		Off	Default
5	Temp. Control Value Source	5-Off	6-Off	Room Panel (iSMA-B-LP)	LCD Panel
		5-Off	6-On	Room Sensor SI3	
6		5-On	6-Off	Air Return Temp SI1	
		5-On	6-On	Network Temp	

Table 8 Control Value CV source select CFG DIP switch configuration

Source description:

- Room Panel – temperature is taken from iSMA-B-LP room panel connected to FCU controller by RJ12 socket,
- Room Sensor - temperature is taken from sensor connected to Special Input S3,
- Air Return Temp - temperature is taken from sensor connected to Special Input S1, for more information about Air Return Temp please see section "4.3.4 Return Temperature sensor control"
- Network Temp – temperature is taken from network variable, this source is dedicated for slave device in Master – Slave working mode.

3.6 Fan type (switches number 7 and 8)

The default application is designed to control 1 of 4 different fan types. Fan type is chosen by CFG DIP switches number 7 and 8 which is presented in the table below.

Name	Switch position		Fan type	Default
Fan type	7-Off	8-Off	Analog type	3 Speed type
	7-Off	8-On	1 Speed type	
	7-On	8-Off	2 Speed type	
	7-On	8-On	3 Speed type	

Table 9 Configuration of the fan type CFG DIP switch

Connection of supported fan types is shown in figure below.
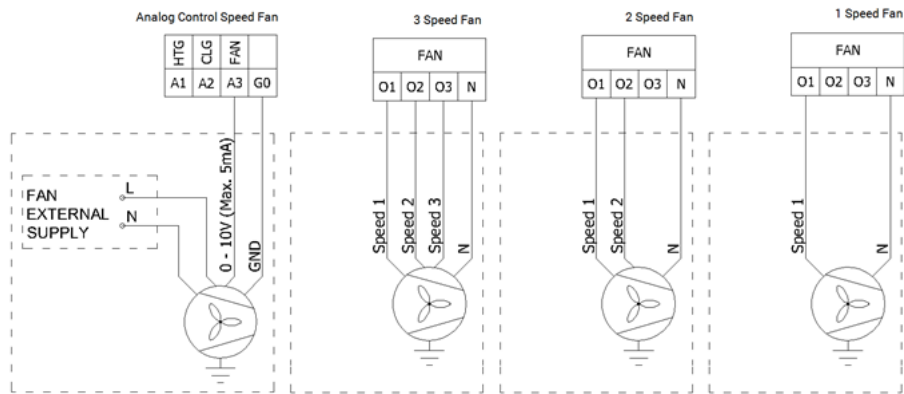
Figure 26 Fan motor connection according to fan control mode

Note: For digital fan speed control, FCU application is equipped with an in-built protecting function to prevent parallel speed switching. There is also 1 second delay between the changes of speed. During the delay, all fan Digital Outputs are switched off.

3.6.1 Fan control algorithm

FCU application has an in-built fan speed control algorithm. The internal variable "Fan Control Value" is scaled by difference between CV and Effective Setpoint. The difference is calculated according to linear conversation where 100% speed is in "Fan_Scale" network parameter. For example: in default network variable "Fan_Scale" value is set to 3, so it means when difference between CV and SP is equal or higher than 3°C the internal parameter "Fan_Control_Value" is 100%, when the difference is half of "Fan_Scale" (in this case 1.5°C) "Fan_Control_Value" is 50%. The algorithm chart is presented in the figure below.
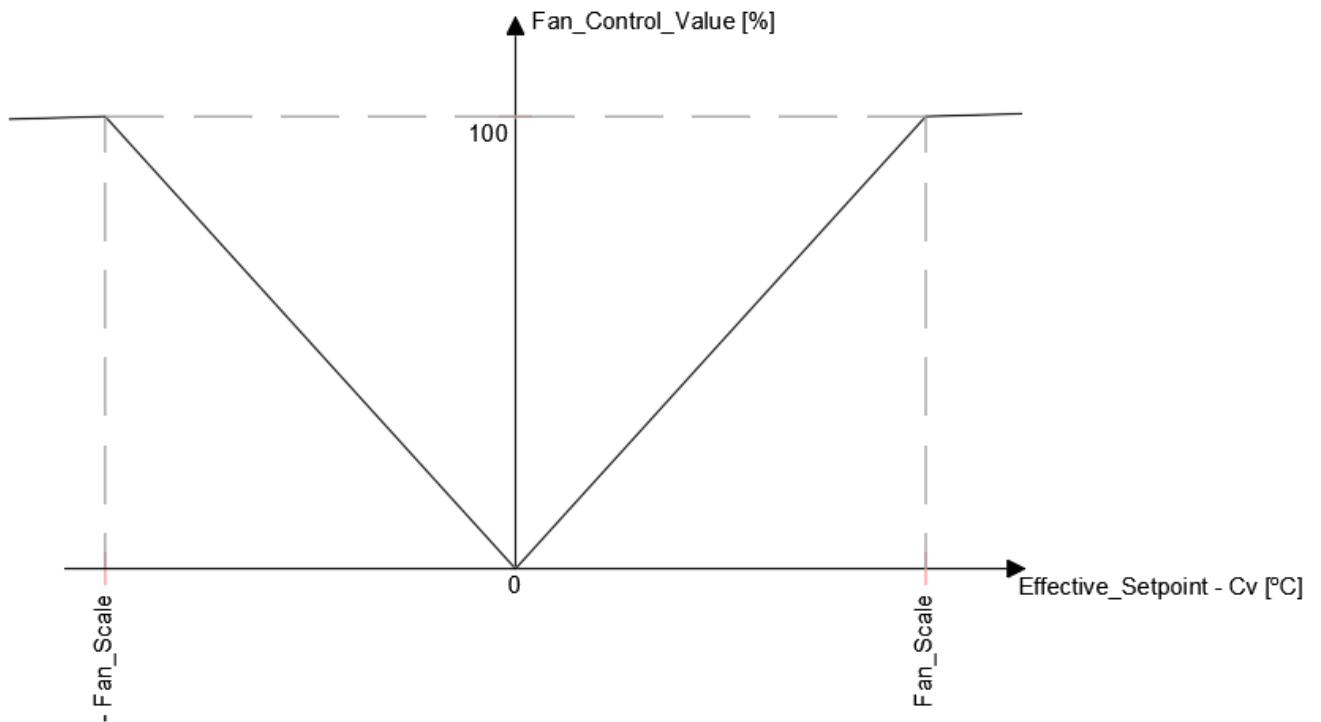
Figure 27 Fan Control Value conversion chart

The fan can operate in 3 modes: Off, Manual, Auto. These modes can be changed from the room panel or remotely from BMS by "Fan_Mode" network variable. Current Fan status is shown in read only network variable "Fan_Status". "Fan_Mode" and "Fan_Status" functions and corresponding values are presented in the table below.

Name	BACnet ID	Modbus Address	Value	Function
Fan Mode	3	103	0	Off
			1	Speed 1 (Manual)
			2	Speed 2 (Manual)
			3	Speed 3 (Manual)
			4	Auto
Fan Status	102	202	0	Off
			1	Speed 1 (Manual)
			2	Speed 2 (Manual)
			3	Speed 3 (Manual)
			4	Speed 1 (Auto)
			5	Speed 2 (Auto)
			6	Speed 3 (Auto)

Table 10 Fan Mode and Fan Status network variable description

3.6.1.1 Fan Soft Start

This function is designed for analog fan type control supply by motor driver to support fan motor start. When fan is starting with small control value, the fan motor might not start or starting process will take a long time. These two situations could make the driver or the fan motor overheat. The Fan Soft Start function overrides fan control signal for time defined in "Fan Soft Start Time" network variable with value defined in "Fan Soft Start Value" network variable. After "Fan Soft Start Time", the control signal switches to application fan control

signal.

WARNING! For correct values time and control value, please read the manufacture instructions of motor and driver. Electrical and thermal parameters cannot exceed the values defined by manufacturer.

3.6.1.2 Fan Off Delay

The Fan Off Delay function was designed to keep air flow for defined time after fan switch off signal. The delay time is defined in "Fan Delay Off" network variable. This function is dedicated to protect heating or/and cooling devices after switch off.

3.6.2 Fan Analog type control algorithm

For Fan Analog Control, the Fan is controlled with A3 Analog Output signal 0-10 V DC basing on "Fan_Value" network variable (0-100%).

In default application, "Fan_Value" network variable is calculated according to internal variable "Fan_Control_Value" and Fan Thresholds network parameters. When the fan starts and "Fan_Control_Value" is within the range from 0 to "Fan_Speed1_Threshold" the fan will be "switched off". When "Fan_Control_Value" is equal or higher than "Fan_Speed1_Threshold", the fan is "switched on" and start working according to "Fan_Control_Value" or according to Soft Start algorithm. The fan will be "switched off" when "Fan_Value" drops below "Fan_Off_Threshold".

The fan control algorithm has an in-built function which keeps fan running with "Fan_Speed1_Threshold" network variable value when there is no fan demand. This function works only in Occupied mode and has 2 separate network parameters for cooling "Fan_Cooling_Occupied_Active" and for heating "Fan_Heating_Occupied_Active". The fan working algorithm is presented in the figure below.

The value of "Fan_Value" network variable depending on "Fan_Control_Value" and "Fan_Off_Threshold" is presented in the figure below.
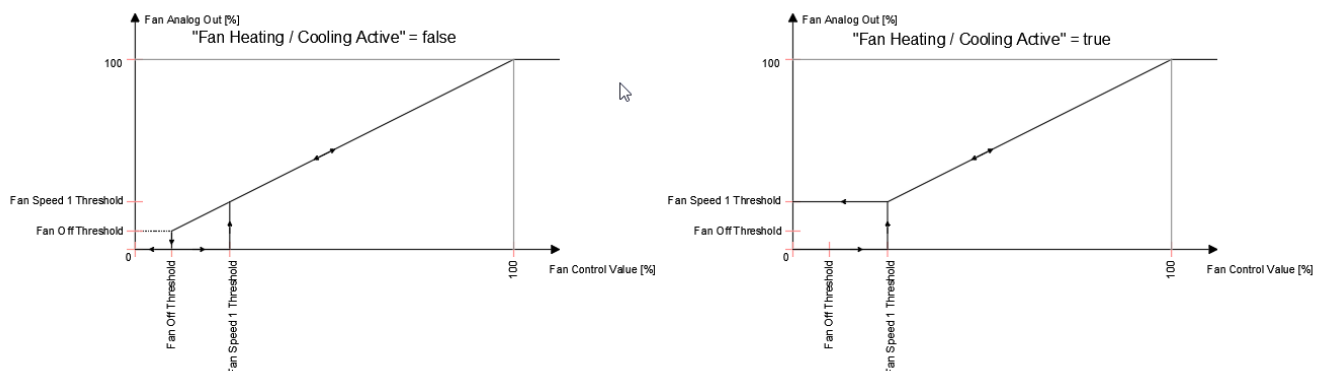
Figure 28 Fan Analog type control algorithm

3.6.3 Fan 1 Speed type control algorithm

For Fan 1 Speeds Control the Fan is controlled by O1 Digital Output only, basing on "Fan_Value" network parameter (0-Off; 1 – speed 1).

In default application, "Fan_Value" network variable is calculated according to internal variable "Fan_Control_Value" and Threshold function defined by 2 network parameters:

- Fan Off Threshold
- Fan Speed 1 Threshold

The fan control algorithm has an in-built function which keeps fan running with low value when there is no fan demand. This function works only in Occupied mode and has 2 separate network parameters for cooling "Fan_Cooling_Occupied_Active" and for heating "Fan_Heating_Occupied_Active". The fan working algorithm is presented in the figure below.
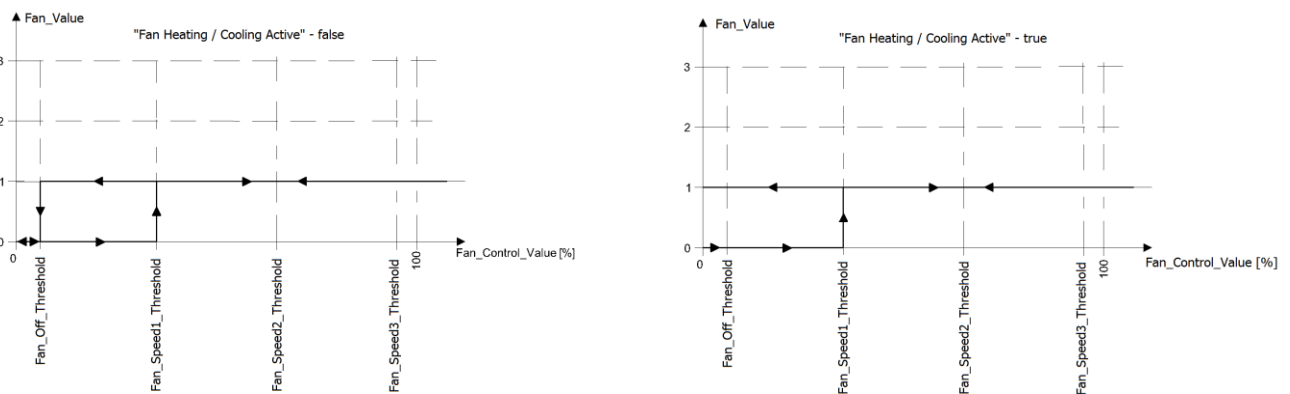
Figure 29 Fan 1 Speed type control algorithm

3.6.4 Fan 2 Speeds type control algorithm

For Fan 2 Speeds Control the Fan is controlled with Digital Outputs O1 and O2 basing on "Fan_Value" network variable (0 –Off; 1 – speed 1; 2 – speed 2).

In default application, "Fan_Value" network variable is calculated according to internal variable "Fan_Control_Value" and Threshold function defined by 3 network parameters:

- Fan Off Threshold
- Fan Speed 1 Threshold
- Fan Speed 2 Threshold

The fan control algorithm has an in-built function which keeps fan running with low value when there is no fan demand. This function works only in Occupied mode and has 2 separate network parameters for cooling "Fan_Cooling_Occupied_Active" and for heating

"Fan_Heating_Occupied_Active". The fan working algorithm is presented in the figure below.
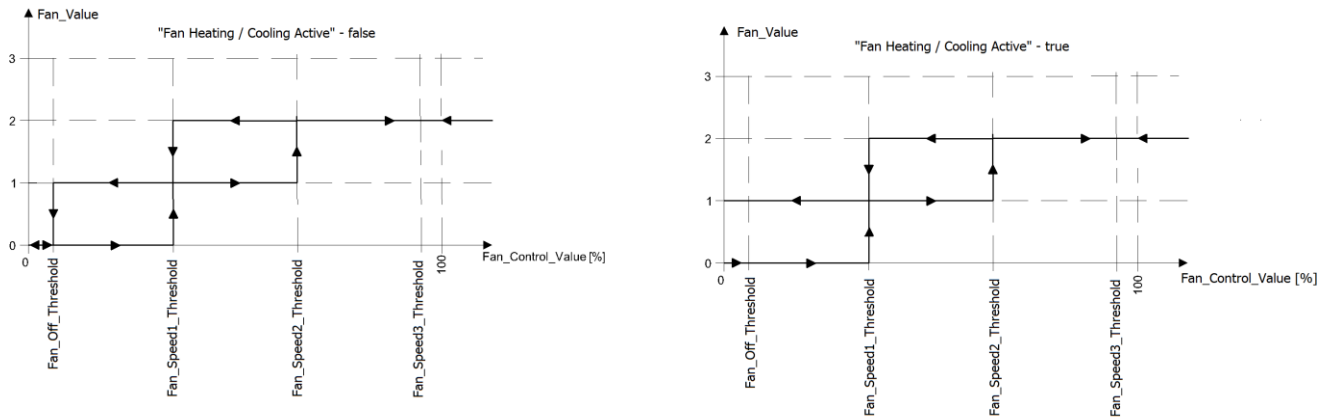
Figure 30 Control algorithm of Fan 2 Speed type

3.6.5 Fan 3 Speed type control algorithm

For Fan 3 Speeds Control the Fan is controlled by O1, O2 and O3 Digital Outputs based on "Fan_Value" network variable (0-Off; 1 – speed 1; 2 – speed 2; 3 – speed 3).

In default application, "Fan_Value" network variable is calculated according to internal variable "Fan_Control_Value" and Threshold function defined by 4 network parameters:

- Fan Off Threshold
- Fan Speed 1 Threshold
- Fan Speed 2 Threshold
- Fan Speed 3 Threshold

The fan control algorithm has an in-built function which keeps fan running with low value when there is no fan demand. This function works only in Occupied mode and has 2 separate network parameters for cooling "Fan_Cooling_Occupied_Active" and for heating "Fan_Heating_Occupied_Active". The fan operating algorithm is presented in the figure below.
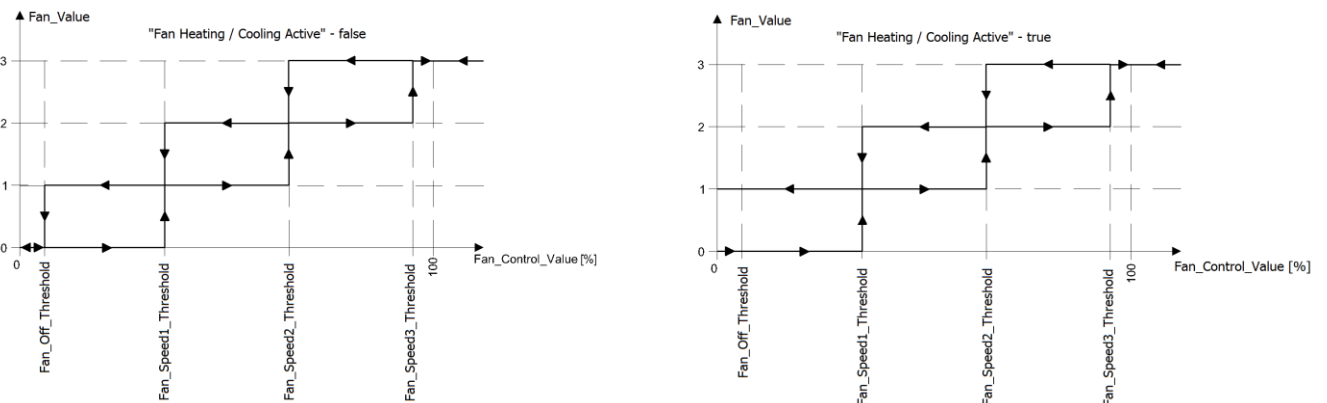
Figure 31 Control algorithm of Fan 3 Speed type

4 Control algorithm

The default application has been designed to run with wide range of typical fan coil units. The application allows to work with typical fan coil units equipped with heating and/or cooling devices and wide range of fans. The main function of default application is designed to control room temperature.

4.1 FCU Occupancy modes

To allow maximum comfort and energy saving at the default, the application has got 4 implemented operating modes. These modes are used to switch between user temperature when space is occupied and energy saving when space is unoccupied/standby. There are 4 different modes:

- Occupied mode,
- Unoccupied mode,
- Standby mode,
- Forced Occupied.

Each mode can be set by the following sources:

- Room panel or Digital Inputs (Occupancy Button, Presence Sensor, Card Holder) for setting 'Forced Occupied' mode only.
- BMS using 'Occupancy Mode' network variable for setting any mode. The mode is changed immediately after changing the value of variable. "Occupancy Mode" values and corresponding functions are presented in the table below.

The FCU Occupancy modes and status with corresponding values are presented in the table below.

Name	BACnet ID	Modbus address	Value	Function
Occupancy Mode	0	100	0	Unoccupied
			1	Occupied
			2	Standby
Occupancy Status	101	201	0	Unoccupied
			1	Occupied
			2	Standby
			3	Forced Occupied

Table 11 Description of Occupancy Mode and Occupancy Status network parameters

4.1.1 Occupancy Mode

In this mode, the controller is operating to keep room temperature set by the user.

4.1.1.1 Occupied Effective Setpoint

The Effective Setpoint is calculated based on 2 parameters Setpoint and Offset. The Setpoint parameter defines real user room temperature value. The Setpoint Offset parameter defines value which user can only add or subtract to the setpoint. The Offset

range is limited by network variable "Offset_Range", in default to 3 so the user can add or subtract max 3 degrees to Setpoint value.

4.1.1.2 Occupied Fan control

In Occupied mode fan can run with auto algorithm (see section "3.6.1 Fan control algorithm") or with user manual value. By setting fan in Off mode, the user can switch off device.

4.1.1.3 Occupied Heating / Cooling FCU mode switching

In this mode (when "FCU_Mode" network variable is set in Auto), the application can automatically switch between heating and cooling. The switching point is based on Effective Setpoint and CV with Diff parameters defined in "Heating_Cooling_Switching_Diff".

4.1.2 Unoccupied Mode

This mode is designed to change temperature setpoint level when the space is temporary not in use, for example after office working hours. It allows to reduce energy consumption. Energy saving is done by changing the Effective Setpoint (lower for heating, increase for cooling). From this mode, room temperature can quickly get back to user temperature level.

4.1.2.1 Occupied Effective Setpoint

The Effective Setpoint is calculated based on 3 parameters: Setpoint, Setpoint_Offset and Unoccupied_Offset. In this mode, the Setpoint_Offset parameter can be disabled in Effective Setpoint calculation by "Offset_In_Occupied_Only" network variable. The Effective Setpoint calculation according to FCU mode and settings is shown in table below.

Occupancy Mode	FCU Status	Offset_In_Occupied_Only	Calculation
0 (Unoccupied)	Heating	False	Effective_Setpoint = Setpoint + Setpoint_Offset − Unnocupied_Offset
0 (Unoccupied)	Cooling	False	Effective_Setpoint = Setpoint + Setpoint_Offset + Unnocupied_Offset
0 (Unoccupied)	Heating	True	Effective_Setpoint = Setpoint − Unnocupied_Offset
0 (Unoccupied)	Cooling	True	Effective_Setpoint = Setpoint + Unnocupied_Offset

Table 12 Effective Setpoint calculation table in Unoccupied mode

4.1.2.2 Unoccupied Fan control

In Unoccupied mode fan runs in Auto Mode, the value of which value is calculated by the application. (See section "3.6.1 Fan control algorithm"). In this mode Fan Manual Modes are disabled and user cannot switch off or define fan speed. When Unoccupied mode changes to Occupied, the Fan Mode is switched to previous mode (Auto or user settings).

4.1.2.3 Occupied Heating / Cooling FCU mode switching

In this mode (when "FCU_Mode" network variable is set in Auto), the application remains in last running mode (heating or cooling) in Occupied mode. The control algorithm does not change and depends of CFG DIP switch configuration.

4.1.3 Standby Mode

This mode is designed to change temperature setpoint level with a higher value in the Unoccupied mode, when the space is not in use for a longer time, for example weekends or holidays. It allows to reduce energy consumption. Energy saving is done by changing the Effective Setpoint (lower for heating, increase for cooling). The Standby_Offset is bigger than Unoccupied_Offset.

4.1.3.1 Standby Effective Setpoint

The Effective Setpoint is calculated based on 3 parameters Setpoint, Setpoint_Offset and Unoccupied_Offset. In this mode, the Setpoint_Offset parameter can be disabled in Effective Setpoint calculation by "Offset_In_Occupied_Only" network parameter. The Effective Setpoint calculation according to FCU mode and settings is presented in the table below.

Occupancy Mode	FCU Status	Offset_In_Occupied_Only	Calculation
2 (Standby)	Heating	False	Effective_Setpoint = Setpoint + Setpoint_Offset − Standby_Offset
2 (Standby)	Cooling	False	Effective_Setpoint = Setpoint + Setpoint_Offset + Standby_Offset
2 (Standby)	Heating	True	Effective_Setpoint = Setpoint − Standby_Offset
2 (Standby)	Cooling	True	Effective_Setpoint = Setpoint + Standby_Offset

Table 13 Effective Setpoint calculation table in Standby mode

4.1.3.2 Unoccupied Fan control

In Unoccupied mode fan is automatically switch to Auto mode and can run only with value calculated in application. (See section 3.6.1 Fan control algorithm). In this mode, FCU manual mode is disabled and the user cannot switch off or define fan speed. When Unoccupied mode is changed to Occupied, the Fan Mode is switched to previous mode (Auto or user settings).

4.1.3.3 Occupied Heating/Cooling FCU mode switching

In this mode (when "FCU_Mode" network variable is set in Auto), the application stays in the last running mode (heating or cooling) in Occupied mode. The control algorithm does not change and it depends on CFG DIP switch configuration.

4.1.4 Forced Occupied

This mode is called by external devices connected to FCU Digital Inputs or from room panel. This mode runs by time defined in network parameters. The Forced Occupied behavior is the same as Occupied mode.

4.1.4.1 Switching to Forced Occupancy Mode by Occupancy Button DI1

Digital Input I1 is dedicated to connect presence button or sensor which will remotely run

Forced Occupancy mode. This input is active only in Unoccupied or Standby mode (in Occupied mode this input is inactive). If the application detects rising edge on I1 input, it switches to Forced Occupied mode. When the application detects falling edge on I1 input, it starts counting time defined in "Occupancy_Time_Remote_Trigger" network variable. During that time, the application is in Forced Occupied mode, and the user cannot switch it off before the time elapses. After the defined time elapses, the application returns to the previous mode, Unoccupied or Standby. By changing "I1_Remote_Occ_Trigger_Invert" network variable, the application can be connected to the devices with normal open NO or normal close NC outputs. The function time chart is presented in the figure below.
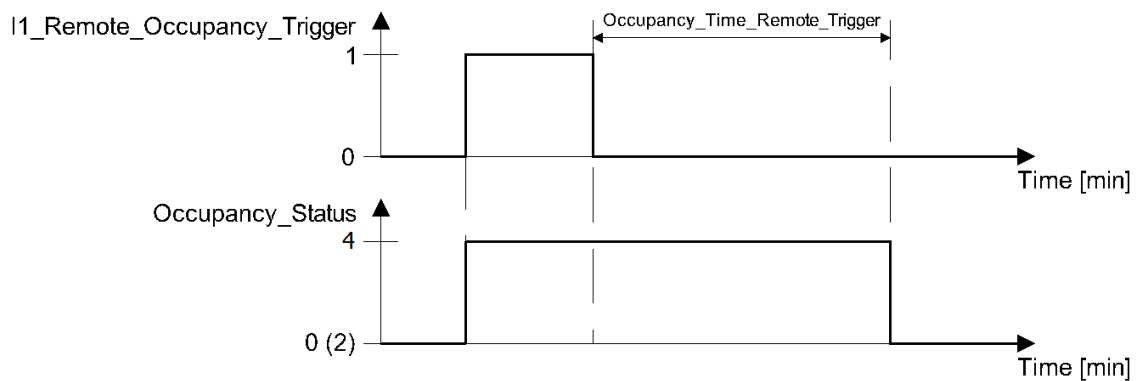
Figure 32 Occupancy Triger time function

4.1.4.2 Switching to Forced Occupancy Mode with Digital Input DI2

Digital Input I2 is dedicated to connect presence button or card holder which will remotely run Forced Occupancy mode. This input is active only in Unoccupied or Standby mode (in Occupied mode this input is inactive). If the application detects rising edge on I2 input, it switches to Forced Occupied mode. When the application detects falling edge on I2 input, it starts counting time defined in "Occupancy_Time_Presence_Sensor" network variable. During that time, the application is in Forced Occupied mode and the user cannot switch it off before the time elapses. After defined time elapsed, the application returns to the previous mode, Unoccupied or Standby. By changing "I2_Presence_Sensor_Invert" network variable the application can be connected to the devices with normal open NO or normal close NC outputs. The function time chart is presented in the figure below.
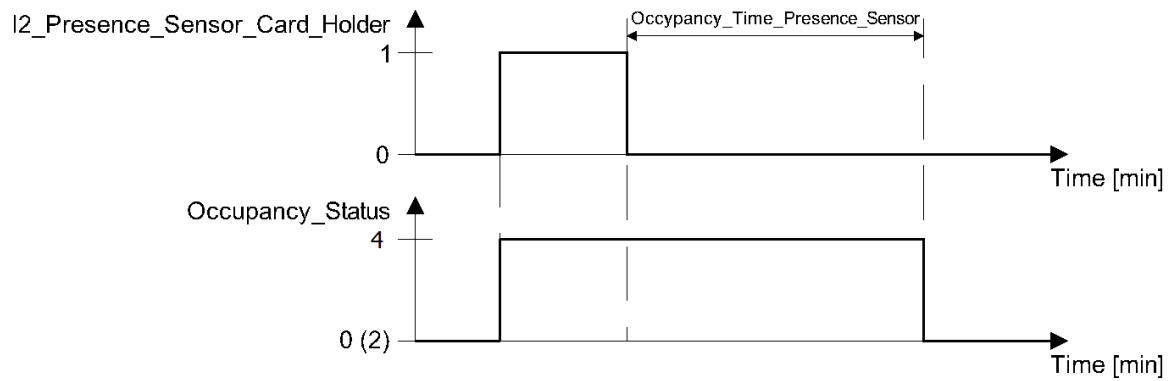
Figure 33 Presence Sensor or Card Holder function time

4.1.4.3 Switching to Forced Occupancy by LCD room panel (iSMA-B-LP)

The FCU default application is designed to work with iSMA-B-LP Room Panel. In this panel menu user can switch from Unoccupied or Standby mode to Forced Occupied for the time defined in "Occupancy_Time_Remote_Trigger" network parameter. The Forced Occupied mode is shown as a flashing occupied icon. From room panel, the user can switch off Forced Occupied and come back to previous mode.

4.2 FCU mode

The FCU mode is a parameter defining how FCU controller is operating. This parameter can have the following states:

- OFF – in this mode, FCU controller is software off, only Anti-Frost procreation can start the FCU controller,
- Auto – in this mode, FCU controller switches between cooling or heating function based on measurement temperature and effective setpoint temperature,
- Heating Only – in this mode, FCU controller can perform only heating function, (dedicated for 2 pipe mode or when cooling medium is not available – winter mode),
- Cooling Only – in this mode, FCU controller can perform only cooling function, (dedicated for 2 pipe mode or when heating medium is not available – summer mode),
- Fan Only – in this mode, FCU controller can perform only ventilation, heating and cooling functions are disabled.

For remote mode control the default application has "FCU_Mode" network variable.

Name	BACnet ID	Modbus address	Value	Function
FCU Mode	0	100	0	Off
			1	Auto
			2	Heating Only
			3	Cooling Only
			4	Fan Only

Table 14 FCU Mode network variable values description

4.2.1 OFF mode

In this mode Fan is switched off, all heating and cooling devices are disabled. This mode can be set from BMS (by writing 0 value to "FCU_Mode" network variable). This mode is called when "Open Window" signal is detected. In this mode the Anti-Frost function is active.

4.2.2 Auto mode

In this mode fan outputs, heating/cooling valves actuators and HTG/CLG relays are active and work with application algorithm. The cooling or heating algorithm is chosen based on current temperature and effective temperature setpoint with switching dead band defined in "Switching_Cooling_Heating_Diff" network variable. Switching between heating/cooling can be done only in Occupancy Mode. In Unoccupied or Standby mode FCU controller remembers and stays in previous function. When controller comes back to Occupancy mode, algorithm will calculate in which function it should work.
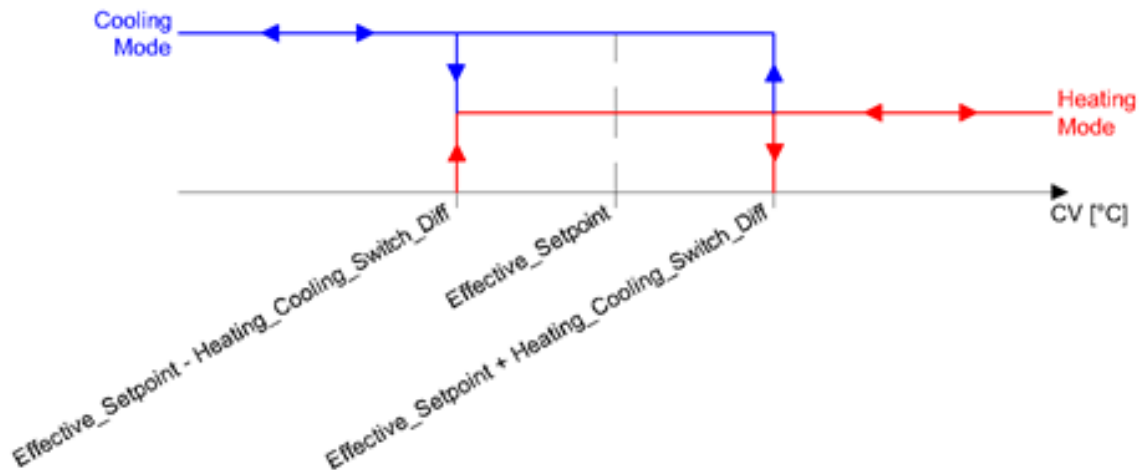
Figure 34 Switching between heating/cooling chart

4.2.3 Heating Only mode

In Heating Only mode, the application is running with heating algorithm only. The fan outputs, heating valve actuator outputs and HTG relay are enabled while the cooling valve actuator outputs and CLG relay are disabled. This mode is dedicated for 2 pipe system during "Winter Mode" or in 4 pipe where cooling medium is not available.

4.2.4 Cooling Only mode

In Cooling Only mode, the application runs with cooling algorithm only. The fan outputs, cooling valve actuator outputs and CLG relay are enabled while the heating valve actuator outputs and HTG relay are disabled. This mode is dedicated for 2 pipe system during "Summer Mode" or in 4 pipe where heating medium is not available.

4.2.5 Fan Only mode

In Fan Only mode, only Fan outputs are enabled while heating and cooling valves actuators outputs and HTG/CLG relays are disabled. The fan is operated with application algorithm.

4.3 Additional features

4.3.1 Open Window DI3

Digital Input I3 is dedicated to connect window contraction which will check if window is open or close. When input detect "Open Window" status (rising edge on I3 input) it will start counting time defined in "Window_Status_Delay" network variable (60 seconds by default). After the time elapses, if the window is still open, the application will call FCU Off Mode (for more information please see section "4.2.1 OFF mode"). When the input detects "Close Window", the application will reset counter and continue normal operation working. If the input detects "Close Window" before the time elapses, the application will also reset counter and continue normal operation working. During "Open Window" only Anti-Frost protection can start. By changing "I3_Window_Contact_Invert" network variable the application can be connected to the devices with normal open NO or normal close NC outputs.

4.3.2 Anti-Frost protection

This function is designed to protect room equipment which can be damaged in low temperature. When application detects temperature drop below 6°C, it will start the fan and activate all the actuators of the heating valves (including 2nd stage, if it is active) with maximum defined value. This action will be continued until room temperature reaches above 8°C. The Anti-Frost function is always active even if user switches off device from BMS or local panel. To prevent unnecessary start after sensor fault there is an in-built algorithm which detects sensor brake. If temperature value from all available sensors is incorrect (out of range -100°C to 100°C), the Anti-Frost function will be disabled.

4.3.3 Sensors breakdown detection

FCU controller has an implemented sensor breakdown detection. The sensor fault status is when temperature value is below -100°C or above 100°C for more than 5 second. If sensor will break down the algorithm will start to search correct value (in correct range and without alarm status). When the value of the sensor returns to correct range, the status is automatically switched to normal state.

Note: In most cases where there is only one sensor, the algorithm will take the network value.

4.3.4 Return Temperature sensor control

The default application can control room temperature based on air return sensor temperature SI1. To prevent incorrect temperature value when the fan is off, the CV temperature is taken from the room sensor. The in-built algorithm checks which sensor is available (from room panel or room sensor SI1 or from network variable when FCU is working as slave). After fan start the algorithm waits time defined in "Return_To_Space_Time" network variable (in default 30 s) to blow the ducts and switch CV to air return sensor SI1. To activate this function, the "Return_To_Space_Enable" network variable must be set to true.

4.3.5 Supply Air temperature limitation

For the comfort of the user of the room, the supply air can have a temperature limitation. This function is available only when supply air sensor is connected to SI2 input. Supply air temperature can have upper limitation defined by SupplyTemperatureHighLimit network variable (default value 40°C) and lower limitation defined by SupplyTemperatureLowLimit network variable (default value 10°C). The range between "SupplyTemperatureLowLimit" and "SupplyTemperatureHighLimit" is called "comfort" range.

Supply Air Temperature limitation in 1st stage - when binary control mode is selected

When Supply Air Temperature value is out of "comfort" range the default application will disable heating (if temperature value is above "SupplyTemperatureHighLimit") or cooling (if temperature value is above "SupplyTemperatureLowLimit"). When the supply air temperature value returns to "comfort" range, the FCU application will reset delay counter and returns to normal operation.

Supply Air Temperature limitation in 2nd stage - when binary control mode is selected

When Supply Air Temperature value is out of "comfort" range, the default application will disable 2nd stage and will start counting 30 seconds delay time. After 1 minute, if supply air temperature value is still out of "comfort" range the FCU application will disable heating (if temperature value is above "SupplyTemperatureHighLimit") or cooling (if temperature value is above "SupplyTemperatureLowLimit"). When the supply air temperature value returns to "comfort" range, the FCU application will reset delay counter, enable 2nd stage and return to normal operation.

Supply Air Temperature limitation in 1st when stage analog control mode is selected

In analog control, when supply air temperature approaches 1°C to the "comfort" range limit, the FCU application will start an in built algorithm which will reduce air temperature (if temperature value is closed or above "SupplyTemperatureHighLimit") or increase air temperature (if temperature value is closed or below "SupplyTemperatureLowLimit"). When the supply air temperature value returns to "comfort" range ±1°C, the default application will reset delay counter and return to normal operation.

Supply Air Temperature limitation in 2nd (with external heater/cooler) – when stage analog control mode is selected

In analog control, when supply air temperature approaches 1°C to the "comfort" range limit, the FCU application will disable 2nd stage and start counting 30 seconds delay time. After 1 minute if supply air temperature value is still approaches 1°C to the "comfort" range limit, the default application will start an inbuilt algorithm which will reduce air temperature (if temperature value is closed or above "SupplyTemperatureHighLimit") or increase air

temperature (if temperature value is closed or below "SupplyTemperatureLowLimit"). When the supply air temperature value returns to "comfort" range ±1°C, the default application will reset delay counter, enable 2nd stage and return to normal operation.

4.3.6 FCU Test Mode

This mode was implemented to conduct a quick heating/cooling test. In this mode the FCU application will start the fan and heating or cooling actuators with 100% value. Depend on "FCU_Test_Mode" network variable value the test mode will active heating or cooling function. Network variable values and corresponding test functions are presented in the table below.

Name	BACnet AV ID	Modbus Register	Default Value	FCU_Test_Mode Value	Fan Value	Heating Value	Cooling Value	Description
FCU_Test_Mode	37	137	0	0	Auto	Auto	Auto	Normal working
				1	100%	100%	0%	Heating test
				2	100%	0%	100%	Cooling test

Table 15 FCU Test_Mode network variable values description

4.3.7 FCU controller outputs manual override

This function allows to override FCU controller outputs control signals by user values. Each control signal has 2 network parameters: first – for output value and second for switch between auto and manual control. The control value depends on output working mode. In analog control mode network parameters are working in range from 0 to 100%. In binary control mode fan is working with range from 0 to 3 and valve actuators outputs (Triacs) are working in range 0 to 1. During manual override fan and valve actuators status network parameters are showing real value. In default all outputs are working in auto mode.

5   FCU Panel connection and configuration

The FCU controller has two types of dedicated panels:

- iSMA-B-FCU-LP – panel with LCD display
- iSMA-B-FCU-SP – panel without display, fully passive

The default application allow user to select which temperature sensor source is chosen to control algorithm.

The sensor is chosen by CFG DIP switches number 5 and 6.

Nr	Name	Switches configuration		Function
5	CV temperature source	5-Off	6-Off	LCD Panel
		5-Off	6-On	Room Sensor SI3
6		5-On	6-Off	Air Return Temp SI1
		5-On	6-On	Slave

5.1 Working with iSMA-B-LP configuration

The room panel is connected to FCU controller's RJ12 socket. This connection provides panel power supply and communication.

When Room Panel is connected, the user can decide which temperature sensor can be chosen to control algorithm from panel or from Special Input. The temperature source is chosen by CFG DIP switches number 5 and 6, according to the table above. Using iSMA-B-LP user can set and display many FCU controller parameters, such as Fan Speed, Setpoint, Offset, Occupancy Status etc. When using iSMA-B-LP device the configuration and user parameters are synchronized with BMS, the last change from BMS or panel is the most current.

5.2 Working with iSMA-B-SimplePanel configuration

Using simple panel, the user can only adjust setpoint offset and force occupation mode. The setpoint offset will be automatically overridden by value from simple panel. For proper operation of the panel, the temperature sensor source must be taken from SI3 input. The sensor is chosen by CFG DIP switches number 5 and 6, in accordance with the table above. When using Simple Panel, the FCU controller should work as an external sensor connected directly to SI3 input (switches number 5 off and 6 on). The temperature Effective setpoint is set by changing Setpoint_Offset value. The Setpoint_Offset cannot be overridden by BMS, from BMS the Effective setpoint can by changed only by Setpoint value. The Effective setpoint pattern is shown below:

Effective_Setpoint = Setpoint + Setpoint_Offset

6 FCU Master-Slave configuration

FCU controller can work in groups where one device is a master and the remaining devices are slaves. This function is useful where there are more than one devices working in a single room. In this case, only Master device can work with room panel and control from BMS. All other devices in the room should follow the master parameters creating the group. In default application the master-slave grouping is activated automatically when master and slaves have been set with the right BACnet Device ID. Single group can contain up to 6 devices, 1 Master and up to 5 slaves.

WARNING! This function is available only in BACnet protocol and it works without a supervisor. In Modbus protocol, master-slave function must be provided by supervisor.

6.1 FCU Addressing MAC and ID

The Controller MAC Address is set using MAC DIP switch. BACnet ID of the device is a combination of device manufacture number and MAC address where first 3 digits contain manufacture number and next 3 digits contain MAC address.

Example: Configuration to how to set the FCU controller MAC address 83. Devices manufacture BACnet number is 826.

The MAC address 83 contains the following multiplicity of number 2: 83 = 1 + 2 + 16 + 64. Address DIP switch settings is shown in table below. All addresses of DIP switch configuration are presented in table at the end of this document.

Address	S1	S2	S3	S4	S5	S6	S7	S8
83	On	On			On		On	

Table 16 Address 83 DIP switch configuration

In this case BACnet ID will be: 826 083.

6.2 Auto binding addressing

The default application allows for automatic calculation of BACnet Device Id of Slave devices in BACnet Master Slave Network, depending on the BACnet Device ID of Master devices. This function is called Auto Binding. The table below presents the values of Master BACnet Device Id and corresponding BACnet Device Id of Slave devices for Auto Binding Function:

Master Id	Slave 1 ID	Slave 2 ID	Slave 3 ID	Slave 4 ID	Slave 5 ID
826101	826001	826002	826003	826004	826005
826102	826006	826007	826008	826009	8260010
826103	826011	826012	826013	826014	826015
826104	826016	826017	826018	826019	826020
826105	826021	826022	826023	826024	826025
826106	826026	826027	826028	826029	826030
826107	826031	826032	826033	826034	826035
826108	826036	826037	826038	826039	826040
826109	826041	826042	826043	826044	826045
826110	826046	826047	826048	826049	826050
826111	826051	826052	826053	826054	826055
826112	826056	826057	826058	826059	826060
826113	826061	826062	826063	826064	826065
826114	826066	826067	826068	826069	826070
826115	826071	826072	826073	826074	826075
826116	826076	826077	826078	826079	826080
826117	826081	826082	826083	826084	826085
826118	826086	826087	826088	826089	826090
826119	826091	826092	826093	826094	826095
826120	826096	826097	826098	826099	826100
Other	0	0	0	0	0

Table 17 Master Slave Id - Auto Binding

Auto Binding function can be disabled (by setting value true to Local Remote Auto Binding network variable). In this case, Id of Slave devices have to be set by the user (in network parameters: Remote Slave 1 Device Id – Remote Slave 5 Device Id).

6.3 Master – Slave sharing parameters

When Master device detects that it can communicate with slave device, it sends/receives the following network parameters:

Network variable name	Units	Access	BACnet BV Id	BACnet AV Id	Modbus Coil	Modbus Register	Default Value	Direction
Net_Temperature	°C	RW	-	6	-	106	21	To Slave
Setpoint	°C	RW	-	1	-	101	21	To Slave
Occupancy_Mode	N/A	RW	-	0	-	100	1	To Slave
Fcu_Mode	N/A	RW	-	4	-	104	1	To Slave
Fan_Mode	N/A	RW	-	3	-	103	0	To Slave
Slave_Window_Status	Bool	RW	69	-	1269	-	true	To Master

Table 18 Master-Slave network parameters sharing

In Auto-binding function the sharing parameters have the following properties:

- Net_Temperature - This parameter sends room temperature from master device to slave devices. The slave devices can work without connected temperature sensor (CGF DIP switches number 5 and 6 in On position),

- Setpoint – Devices group Setpoint, basing on master device Setpoint and Setpoint_Offset value. This parameter does not include Unoccupied_Offset and Standby_Offset, Effective Setpoint is calculated in slave device according to FCU mode,

- Occupancy_Mode – Devices group occupancy mode basing on master device Occupancy_Status value,

- Fcu_Mode - Devices group FCU_Mode basing on master device FCU_Mode value,

- Fan_Mode - Devices group Fan_Mode basing on master device Fan_Mode value,

- Slave_Window_Status – Master device every 1 minute checks slave device "Open Window" status. If the master device detects that "Window is open" (their own or one of the devices in group), it will run "Open Window" function (wait time defined in "Window_Status_Delay" network variable and if window is still open, switch off the whole group).

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
Local_Remote_Auto_Binding	Bool	RW	8	-	1208		False
Remote_Slave1_Device_ID	N/A	RW	-	54	-	154	0
Remote_Slave2_Device_ID	N/A	RW	-	56	-	156	0
Remote_Slave3_Device_ID	N/A	RW	-	58	-	158	0
Remote_Slave4_Device_ID	N/A	RW	-	60	-	160	0
Remote_Slave5_Device_ID	N/A	RW	-	62	-	162	0
Slave1_Active	Bool	RO	96	-	1296	-	N/A
Slave2_Active	Bool	RO	97	-	1297	-	N/A
Slave3_Active	Bool	RO	98	-	1298	-	N/A
Slave4_Active	Bool	RO	99	-	1299	-	N/A
Slave5_Active	Bool	RO	100	-	1300	-	N/A

Table 19 Master device network parameters dedicated for Master – Slave function

6.4 Application status

In order to give user possibility to troubleshoot and diagnose application operation, App_status network variable was added. The information is represented as a multistate value available in Modbus register 99 and BACnet Device Object property 5002. This network variable allows to understand what causing the problem if application isn't working, or in what state of failure it is. It also shows transitional states such as yield, restart and hibernate.

7 FCU network variable

7.1 FCU BACnet AnalogValues and Modbus Registers

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
App_status	N/A	RO	Device Property 5002	99	0	65535 – Initialization, 0 – OK, 1 – Malloc image, 2 – Malloc stack 3 – Malloc static data 4 – Input file not found 5 – Cannot read input file 6 – Bad image magic 7 – Bad image version 8 – Bad image block size 9 – Bad image ref size 10 – Bad image code size 11 – Unknown opcode 12 – Missing native 40 – Invalid args 41 – Cannot initialize application 42 – Cannot open file 43 – Invalid magic 44 – Invalid version 45 – Invalid schema 46 – Unexpected EOF 47 – Invalid kit ID 48 – Invalid type ID 49 – Cannot malloc 50 – Cannot insert 51 – Cannot load link 52 – Invalid application end marker 53 – No platform service 54 – Bad platform service 60 – Invalid comp end marker 61 – Name too long 100 – Null pointer 101 – Stack overflow 102 – Invalid method parameters 253 – Yield 254 – Restart 255 - Hibernate
Occupancy_Mode	N/A	RW	0	100	0	0 – Unoccupied mode, 1 – Occupied mode, 2 – Standby mode

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
Setpoint	°C	RW	1	101	210	User setpoint temperature value
Setpoint_Offset	°C	RW	2	102	0	User setpoint offset temperature value
Fan_Mode	N/A	RW	3	103	0	0 - Off 1 - Speed 1 (Manual) 2 - Speed 2 (Manual) 3 - Speed 3 (Manual) 4 – Auto
FCU_Mode	N/A	RW	4	104	1	0 – OFF 1 – Auto 2 – Heating Only 3 – Cooling Only 4 – Fan Only
Setpoint_Offset_Range	°C	RW	5	105	30	Setpoint Offset ± range
Net_Temperature	°C	RW	6	106	210	Temperature network variable, CV source
Heating_Cooling_Switch_Diff	°C	RW	10	110	10	Differential value switching between cooling/heating mode
Unoccupied_Offset	°C	RW	11	111	20	Offset value in for Unoccupied mode
Standby_Offset	°C	RW	12	112	50	Offset value in for Standby mode
Occupancy_Time_Remote_Trigger	min	RW	13	113	60	Forced Occupied mode time value for Occupancy Button I1 and Room Panel
Occupancy_Time_Presence_Sensor	min	RW	14	114	10	Forced Occupied mode time value for Occupancy Presence Sensor I2
PWM_Heating_Period	s	RW	15	115	300	PWM time period for heating valve actuator
PWM_Cooling_Period	s	RW	16	116	300	PWM time period for cooling valve actuator
Fan_Scale	°C	RW	17	117	30	Fan Scale parameter for Fan control algorithm
Fan_Off_Threshold	%	RW	18	118	5	Fan Off Threshold value
Fan_Speed_1_Threshold	%	RW	19	119	30	Fan Speed 1 Threshold value
Fan_Speed_2_Threshold	%	RW	20	120	60	Fan Speed 2 Threshold value
Fan_Speed_3_Threshold	%	RW	21	121	90	Fan Speed 3 Threshold value
Fan_Off_Delay	s	RW	22	122	5	Fan switch off delay time value
Fan_Soft_Start_Time	s	RW	23	123	20	Time value for "Fan Soft Start" function
Kp	N/A	RW	24	124	100	PI regulator parameter Proportional gain
Ti	min	RW	25	125	10	PI regulator parameter Integral time
Heating_Binary _Diff	°C	RW	26	126	4	1st stage heating thermostat differential value
Cooling_Binary_Diff	°C	RW	27	127	4	1st stage cooling thermostat differential value
Second_Stage_Threshold_Binary	°C	RW	28	128	2	2nd stage shifting parameter in Digital control mode
Second_Stage_Diff Binary	°C	RW	29	129	6	2nd stage thermostat differential parameter in Digital control mode
Second_Stage_Threshold_Analog	%	RW	30	130	80	2nd stage shifting parameter in Analog

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
						control mode
Second_Stage_Diff_Analog	%	RW	31	131	5	2nd stage thermostat differential parameter in Analog control mode
Supply_Temperature_Low_Limit	°C	RW	32	132	100	Supply air temperature limit values used in "Supply Air temperature limitation" function
Supply_Temperature_High_Limit	°C	RW	33	133	400	
Supply_Limits_Time	s	RW	34	134	30	Time value used in "Supply Air temperature limitation" function
Window_Status_Delay	s	RW	35	135	60	Time value for "Open Window" function
Return_To_Space_Time	s	RW	36	136	30	Time value for "Return Temperature sensor control" function
FCU_Test_Mode	N/A	RW	37	137	0	0 - Auto operation 1 - Heating test 2 - Cooling test
Fan_Soft_Start_Value	%	RW	38	138	75	Analog control fan starting value in range from 0% - 100%
Valves_Dead_Band	°C	RW	39	139	0	Valves temperature dead band parameter
Return_Temperature_Offset	°C	RW	40	140	0	Return Temperature sensor correction parameter
Supply_Temperature_Offset	°C	RW	41	141	0	Supply Temperature sensor correction parameter
Space_Temperature_Offset	°C	RW	42	142	0	Space Temperature sensor correction parameter
S1_Sensor_Type	N/A	RW	43	143	1	0 – Voltage Measurement 1 - sensor type 10K3A1 NTC 2 – sensor type 10K4A1 NTC 3 – sensor type 10K NTC
S2_Sensor_Type	N/A	RW	44	144	1	4 – sensor type 20K6A1 NTC 5 – sensor type 2,2K3A1 NTC 6 – sensor type 3K3A1 NTC 7 – sensor type 30K6A1 NTC
S3_Sensor_Type	N/A	RW	45	145	1	8 – sensor type SIE1 NTC 9 – sensor type TAC1 NTC 10 – sensor type SAT1 NTC
Heating_Valve_Manual_Value	%	RW	46	146	0	Heating valve manual value, to active manual override please active Heating_Valve_Manual_Enable
Cooling_Valve_Manual_Value	%	RW	47	147	0	Cooling valve manual value, to active manual override please active Cooling_Valve_Manual_Enable
Fan_Valve_Manual_Value	%	RW	48	148	0	Fan valve manual value, to active manual override please active Fan_Valve_Manual_Enable
LCD_Panel_Temperature_Offset	°C	RW	50	150	0	Room panel temperature sensor correction parameter
LCD_Setpoint_Step	°C	RW	51	151	50	Room panel Setpoint step
LCD_Setpoint_Low_Limit	°C	RW	52	152	180	Room panel Setpoint low limit
LCD Setpoint High Limit	°C	RW	53	153	240	Room panel Setpoint high limit
Remote_Slave1_Device_ID	N/A	RW	54	154	0	BACnet slave device ID number
Remote_Slave2_Device_ID	N/A	RW	56	156	0	
Remote_Slave3_Device_ID	N/A	RW	58	158	0	Note: In Modbus protocol this is 32-bits register
Remote_Slave4_Device_ID	N/A	RW	60	160	0	

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
Remote_Slave5_Device_ID	N/A	RW	62	162	0	
Slaves_Ping_Frequency	min	RW	64	164	15	Salves ping frequency value
Effective Setpoint	°C	RO	100	200	N/A	Effective Setpoint Value
Occupancy Status	N/A	RO	101	201	0	0 – Un occupied mode, 1 – Occupied mode, 2 – Standby mode 3 – Forced Occupied mode.
Fan Status	N/A	RO	102	202	0	0 - Off 1 - Speed 1 (Manual) 2 - Speed 2 (Manual) 3 - Speed 3 (Manual) 4 - Speed 1 (Auto) 5 - Speed 2 (Auto) 6 - Speed 3 (Auto)
Fan Type	N/A	RO	103	203	0	Fan type: 0 - Analog, 1 – Speed 1, 2 – Speed 2, 3 – Speed 3.
Cv	°C	RO	104	204	N/A	Temperature Control Value
Dip_Switch_Configuration	N/A	RO	105	205	N/A	Current CFG DIP switch bits status
App_version	N/A	RO	106	206	2.0	Application version parameter
Heating_Valve	%	RO	110	210	N/A	Heating Analog Output or Triac PWM value
Coolling_Valve	%	RO	111	211	N/A	Cooling Analog Output or Triac PWM value
Fan Value	%	RO	112	212	N/A	Analog type: range 0-100% Binary type: 0 - stop, 1 – Speed 1, 2 – Speed 2, 3 – Speed 3.
S1_Return_Temperature	°C	RO	113	213	N/A	Special Input S1 Temperature Value
S2_Supply_Temperature	°C	RO	114	214	N/A	Special Input S2 Temperature Value
S3_Space_Temperature	°C	RO	115	215	N/A	Special Input S3 Temperature Value
LCD Panel Temperature	°C	RO	120	220	N/A	Room Panel iSMA-B-LP Temperature value
LCD Panel Humidity	%	RO	121	221	N/A	Room Panel iSMA-B-LP Humidity value
LCD Panel CO2	ppm	RO	122	222	N/A	Room Panel iSMA-B-LP CO2 value

7.2 FCU BACnet BinaryValues and Modbus Coils

Name	Access	BACnet ID	Modbus Address	Default Value	Description
Offset In Occupied Only	RW	0	1200	False	Enable/Disable Setpoint Offset parameter calculation in Unoccupied and Standby mode
Fan Heating Occupied Active	RW	1	1201	True	Enable/Disable fun running at low speed after no fan demand in heating occupied mode
Fan Cooling Occupied Active	RW	2	1202	False	Enable/Disable fun running at low speed after no fan demand in cooling occupied mode
Return_To_Space_Enable	RW	3	1203	False	
HTG Relay Enable	RW	4	1204	True	True – Enable, False – Disable O4 relay working
CLG Relay Enable	RW	5	1205	True	True – Enable, False – Disable O5 relay working
I1_Remote_Occ_Trigger_Invert	RW	6	1206	False	
I2_Presence_Sensor_Invert	RW	7	1207	False	False – Normal, True – Invert
I3_Window_Contact_Invert	RW	8	1208	True	
Local_Remote_Auto_Binding	RW	9	1209	False	False – Slave ID from auto binding True - Slave ID from network variable
Heating_Valve_Manual_Enable	RW	10	1210	False	
Cooling_Valve_Manual_Enable	RW	11	1211	False	
HTG_Relay_Manual_Enable	RW	12	1212	False	False – Auto, True – Manual
CLG_Relay_Manual_Enable	RW	13	1213	False	
Fan_Output_Manual_Enable	RW	14	1214	False	
LCD Submenu Icons Hidden	RW	15	1215	True	Show/Hide LCDPanel submenu icons
LCD Temperature Active	RW	16	1216	True	Enable/Disable Room Panel current temperature display
LCD Setpoint Active	RW	17	1217	True	Enable/Disable Room Panel setpoint temperature display
LCD Setpoint Editable	RW	18	1218	True	Enable/Disable room panel setpoint edit
LCD Setpoint Fast Edit Mode	RW	19	1219	False	Enable/Disable display fast setpoint edit in room panel display
LCD Fan Visable	RW	20	1220	True	Enable/Disable display fan icon on room panel display
LCD Fan Editable	RW	21	1221	True	Enable/Disable fan parameters edit on room panel display
LCD Fan Fast Edit Mode	RW	22	1222	False	Enable/Disable display fast fan speed edit in room panel display
LCD Occupancy Visable	RW	23	1223	True	Enable/Disable fan parameters edit on room panel display
LCD Occupancy Editable	RW	24	1224	True	Enable/Disable Occupancy mode change on room panel display
LCD Occupancy Fast Edit Mode	RW	25	1225	False	Enable/Disable run LCD Occupancy Fast Edit Mode on room panel display
LCD Humidity Active	RW	26	1226	True	Enable/Disable Room Panel Humidity value display
LCD CO2 Active	RW	27	1227	True	Enable/Disable Room Panel CO_2 value display
HTG_Relay_Manual_State	RW	28	1228	False	HTG Relay state in Manual override
CLG_Relay_Manual_State	RW	29	1229	False	CLG Relay state in Manual override
Occupied Forced	RO	64	1264	N/A	Forced Occupied mode status
Heating_Second_Stage	RO	80	1280	N/A	Heating in second stage current status
Cooling_Second_Stage	RO	81	1281	N/A	Heating in second stage current status
I1_Remote_Occuapancy_Trigger	RO	82	1282	N/A	
I2_Presence_Sensor_Card_Holder	RO	83	1283	N/A	Digital Input current status
I3_Window_Conntact	RO	84	1284	N/A	

I4_Occupancy_LED	RO	85	1285	N/A	
Slave1_Active	RO	96	1296	N/A	Slave device connection status
Slave2_Active	RO	97	1297	N/A	
Slave3_Active	RO	98	1298	N/A	
Slave4_Active	RO	99	1299	N/A	
Slave5_Active	RO	100	1300	N/A	
Slave1_Window_Status	RO	101	1301	N/A	Window status I3 input read from slave device
Slave2_Window_Status	RO	102	1302	N/A	
Slave3_Window_Status	RO	103	1303	N/A	
Slave4_Window_Status	RO	104	1304	N/A	
Slave5_Window_Status	RO	105	1305	N/A	