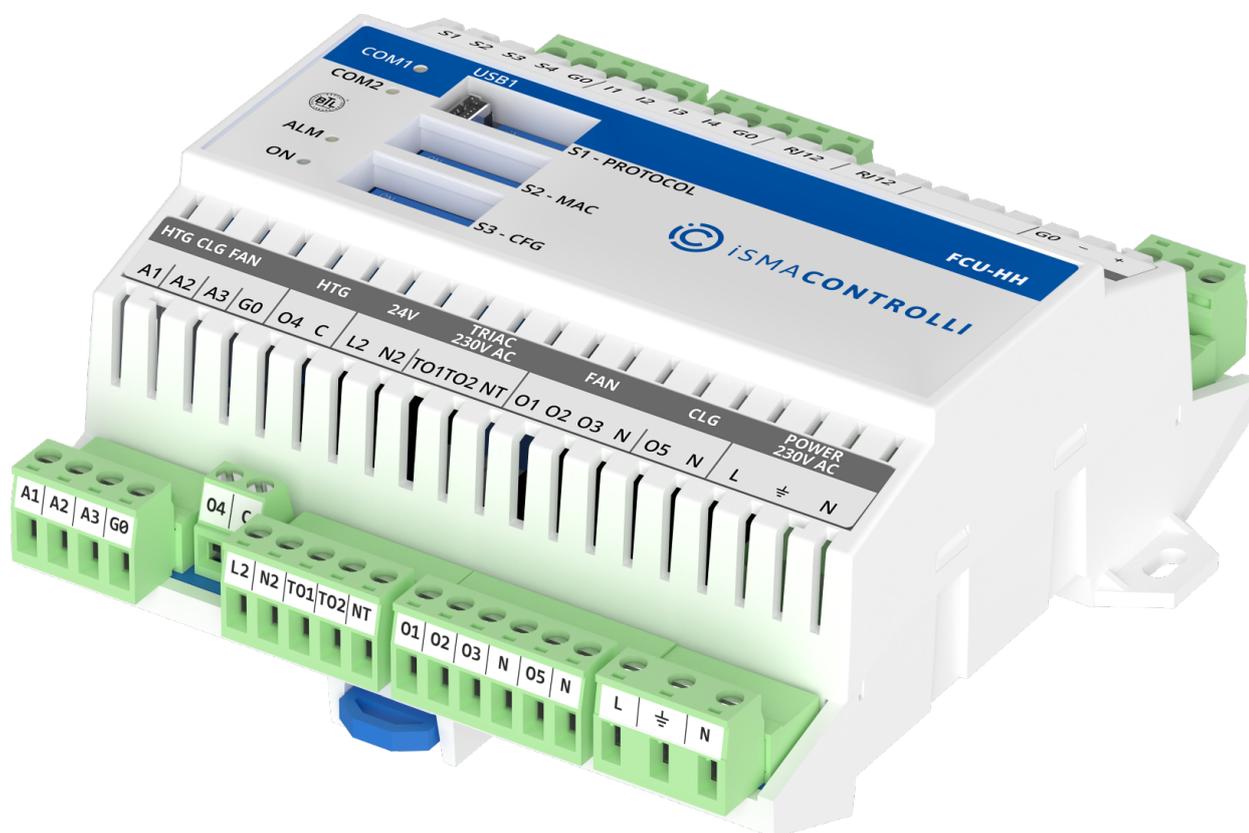


# iSMA-B-FCU

User Manual

## Application



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# 1 Introduction

This user manual outlines basic configurations of the iSMA-B-FCU default application.



Table 1. FCU controllers

## 1.1 Revision History

Rev.	Date	Description
1.0	20 Dec 2016	First edition
1.1	1 Feb 2017	Outputs manual override option added Network parameters list updated
1.2	21 Apr 2017	Information about Simple Panel added Network parameters list updated
1.3	13 Mar 2018	Network parameters list updated Fixed mistake in Modbus and BACnet value of HTG Relays Enable register in Table
1.4	31 Mar 2020	Company data update
1.5	28 Feb 2022	Rebranded Added Touch Point panel references

Table 2. Revision history

## 2 Inputs and Outputs

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

### 2.1 Special Inputs

The iSMA-B-FCU device has four special inputs. In the 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.

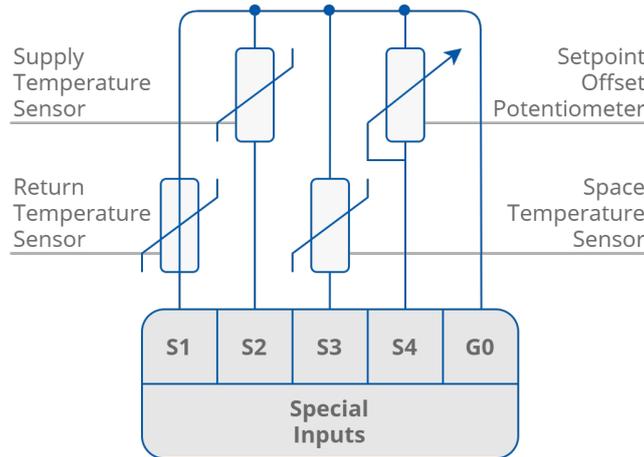


Figure 1. The special inputs connection

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
S1_Return_Temperature	°C	RO	-	113	-	213	-
S2_Supply_Temperature	°C	RO	-	114	-	214	-
S3_Space_Temperature	°C	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 3. Special inputs network parameters

### 2.2 Digital Inputs

The 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 O1st O3 can be inverted, depending on the type of sensors connected to the device.

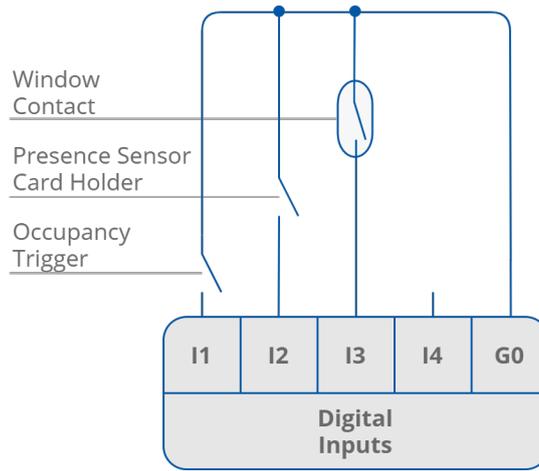


Figure 2. The digital inputs connection

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
I1_Remote_Occupancy_Trigger	-	RO	82	-	1282	-	-
I2_Presence_Sensor_Card_Holder	-	RO	83	-	1283	-	-
I3_Window_Connact	-	RO	84	-	1284	-	-
I1_Remote_Occupancy_Trigger_Invert	-	RW	6	-	1206	-	Off
I2_Presence_Sensor_Card_Holder_Invert	-	RW	7	-	1207	-	Off
I3_Window_Connact_Invert	-	RW	8	-	1208	-	Off

Table 4. Digital inputs network parameters

### 2.3 Triac Outputs

The 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 the PWM. In the PWM mode, the output works in the period when two states are used (low state 0 V and high state 24 V AC or 230 V AC, depending on the hardware version). The periods are defined by the PWM\_Heating\_Period network variable for the TO1 output and PWM\_Cooling\_Period network variable for the TO2 output (both are set to 300 seconds by default). The control signal defines the output of high state in working period (in percentage). Depending on the 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 figures below.

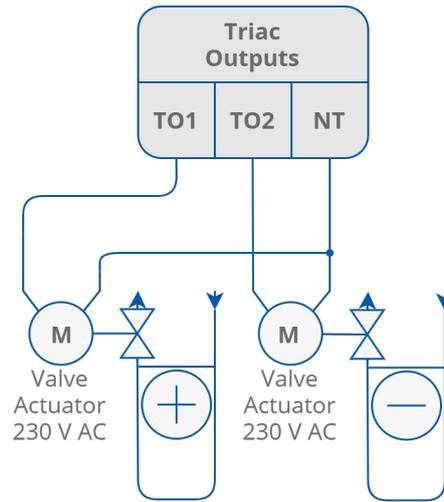


Figure 3. Triac outputs connection

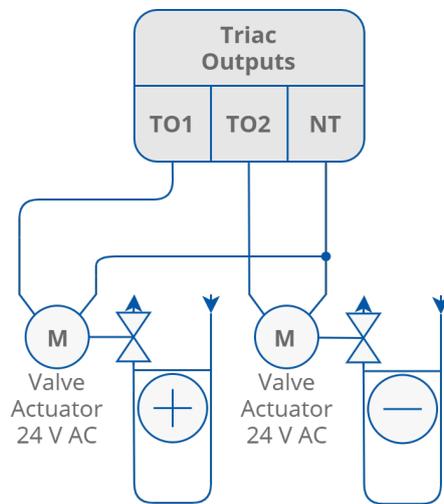


Figure 4. Connection of thermal valve actuators to triac outputs

**Note:** In case of the 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 the 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
Cooling_Valve	%	RO	-	111	-	211	N/A
PWM_Heating_Period	s	RW	-	15	-	115	300
PWM_Cooling_Period	s	RW	-	16	-	116	300

Table 5. Triac output network parameters

## 2.4 Digital Outputs

### 2.4.1 Fan Outputs

The iSMA-B-FCU device is equipped with three relay outputs designed for connecting with the fan. The way of connecting the fan (depending on the number of speeds) is presented in the figure below. These outputs have internal connection to the power supply terminal and are protected by a built-in 6 A fuse. The total load for digital outputs O1st 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 triac outputs are supplied with power by a built-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.

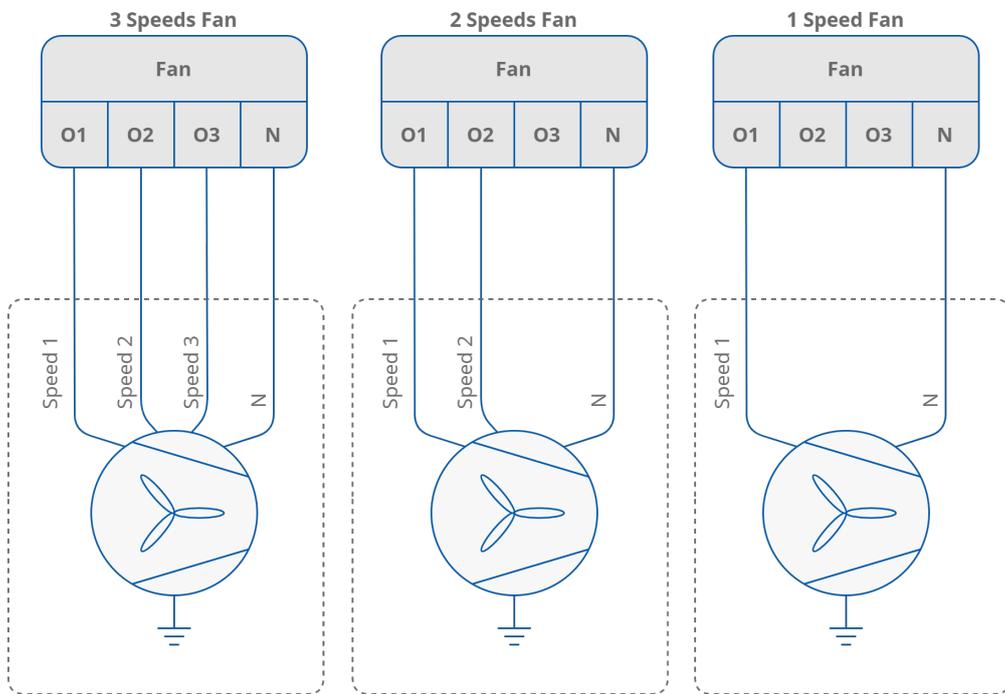


Figure 5. Fan connections

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

Table 6. Fan Type and Fan Value parameters

### 2.4.2 Electrical Heater (HTG)

The iSMA-B-FCU device is equipped with a relay output for connecting the electrical heater. This output can be used for 1<sup>st</sup> or 2<sup>nd</sup> stage heating, depending on the CFG DIP switch configuration. This output is not internally connected to the power supply, therefore 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 the FCU controller power supply.

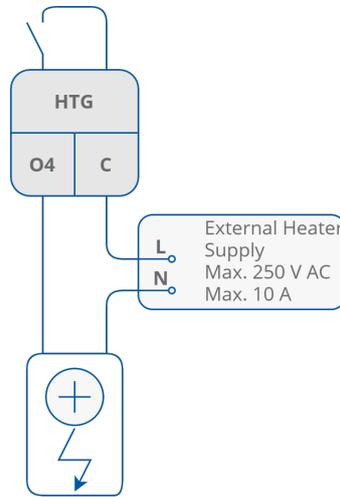


Figure 6. Electrical heater connections

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 7. Network parameters of the O4 HTG digital output

### 2.4.3 Electrical Cooler (CLG)

The iSMA-B-FCU device is equipped with a relay output for connecting the electrical cooler. This output can be used as 1<sup>st</sup> or 2<sup>nd</sup> stage cooling, depending on the CFG DIP switch configuration. The relay output is connected with the power supply internally, therefore it is not necessary to connect an external supply. In the 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, the 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.

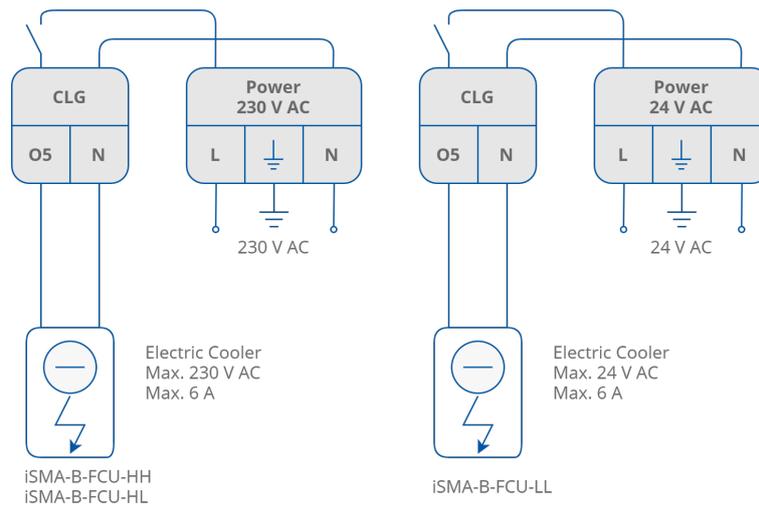


Figure 7. Electrical cooler connection

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 8. Network parameters of the O5 CLG digital output

## 2.5 Analog Outputs

The 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 analog outputs is presented in the figures below.

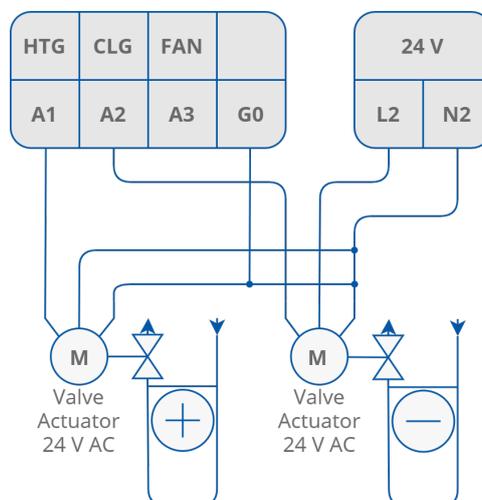


Figure 8. Connection of analog valve actuators

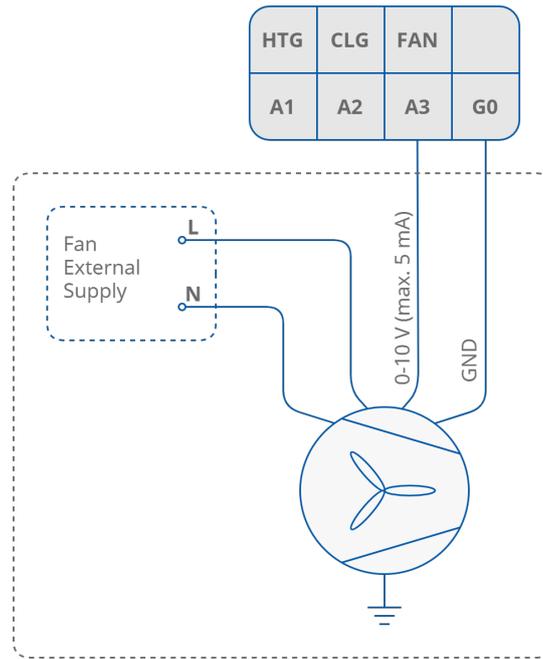


Figure 9. Connection of analog fan control

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

Table 9. Analog outputs status network parameters

## 2.6 Simple Panel Connection

The iSMA-B-SP Simple Panel is a device designed to work with room temperature controllers. The device is fully passive and does not require any power supply. The 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).

The iSMA-B-SP panel internal connection and the connection with the FCU controller are presented in the figures below.

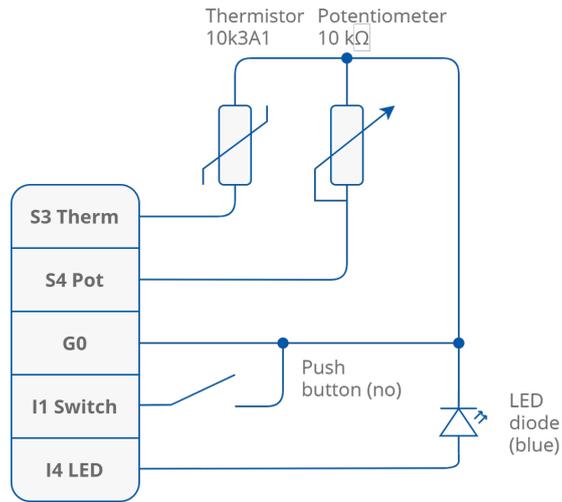


Figure 10. Diagram of internal connections of the simple panel

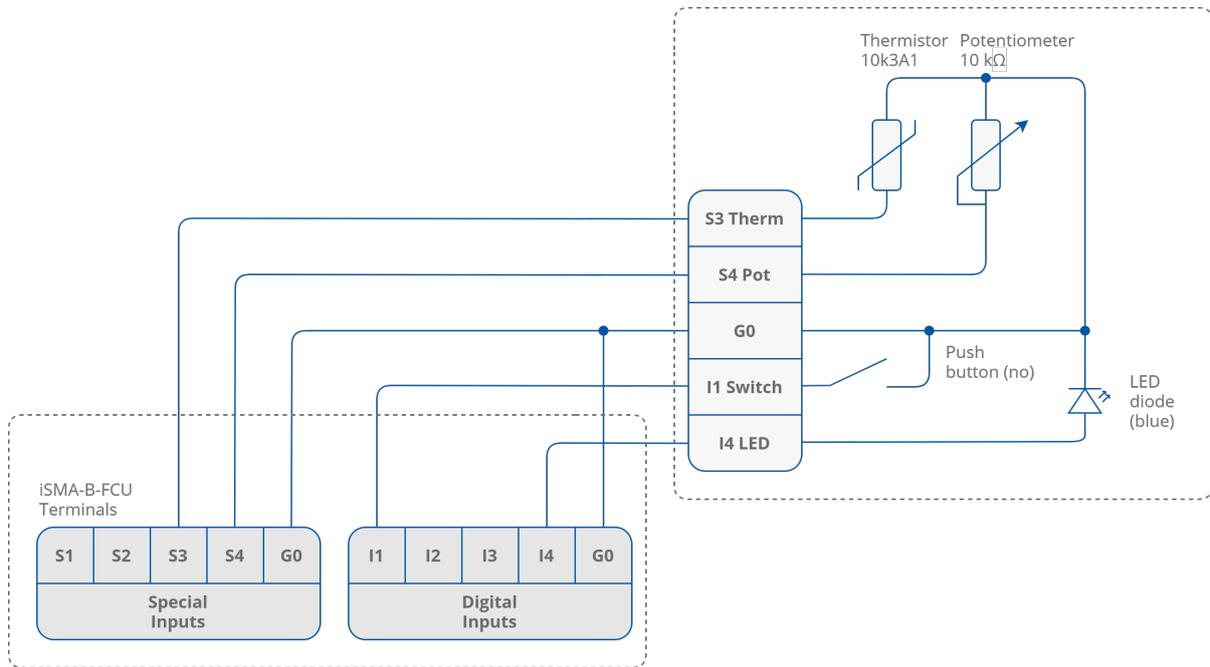


Figure 11. Connection diagram of the iSMA-B-FCU controller

### 3 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 the S3 CFG DIP switch. The FCU application provides the following configurable modes:

- pipe mode;
- 2-stage heating;
- 2-stage cooling;
- heating/cooling control mode;
- CV temperature source;
- fan type.

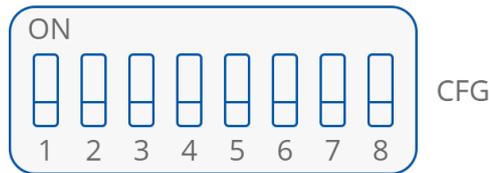


Figure 12. The CFG DIP switch

The status of DIP switch configuration is presented in the 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 2 <sup>nd</sup> Stage	Enable	Disable	Disable	
3	Cooling 2 <sup>nd</sup> 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 0-10 V	3-Speed
		7-Off	8-On	1-Speed	
8		7-On	8-Off	2-Speed	
		7-On	8-On	3-Speed	

Table 10. The CFG DIP switch configuration of particular switches

### 3.1 Switch 1: Fan Coil Unit Pipe Mode System

#### 3.1.1 4-Pipe System

In the 4-pipe system mode, the switch number 1 has to be set to the OFF position as shown in figure below. By default, this mode is ON.

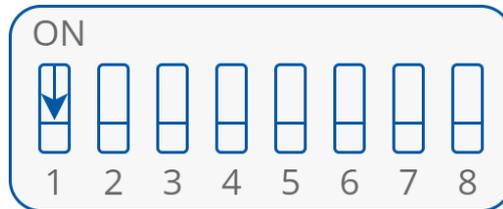


Figure 13. 4-pipe system DIP switch configuration

In this configuration, the fan coil unit is equipped with two separate heating and cooling devices. The electric 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.

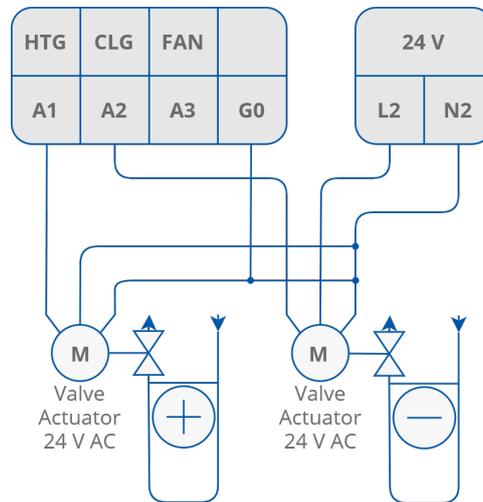


Figure 14. Connection of heater/cooler valve actuators in 4-pipe mode with analog signals 0-10 V DC

The FCU controller can work with thermal valves actuators. For this option, the FCU controller is equipped with 2 built-in triac outputs. The triac outputs can work in digital (open/close) or PWM mode, selected by the CFG DIP switch number 4. Depending on the hardware version, the 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 the FCU controller.

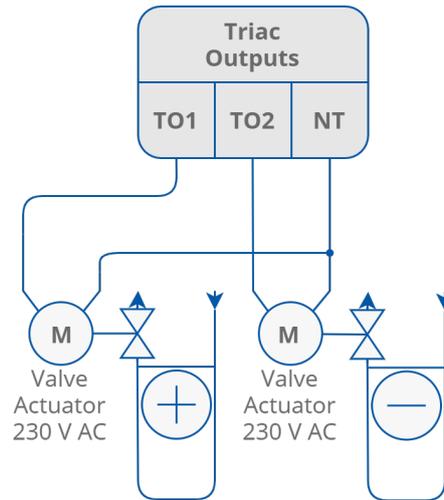


Figure 15. Connection of thermal valve actuator to triac outputs (FCU-HH)

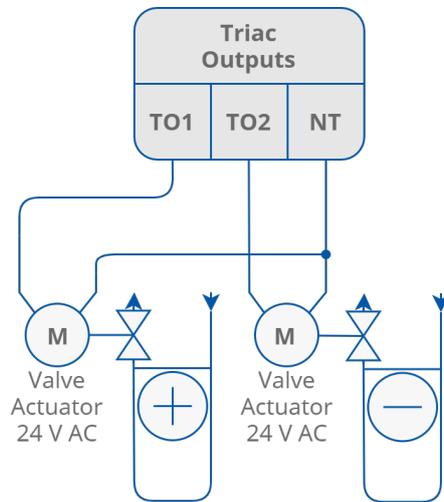


Figure 16. Connection of thermal valve actuator to triac outputs (FCU-HL and FCU-LL)

### 3.1.2 2-Pipe System

In the 2-pipe system mode, the switch number 1 has to be set to the ON position as presented in the figure below. By default, this mode is OFF.

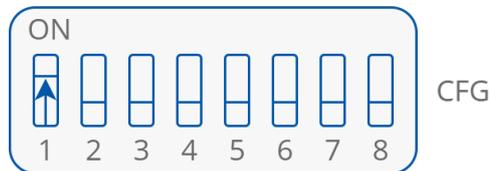


Figure 17. 2-pipe DIP switch configuration

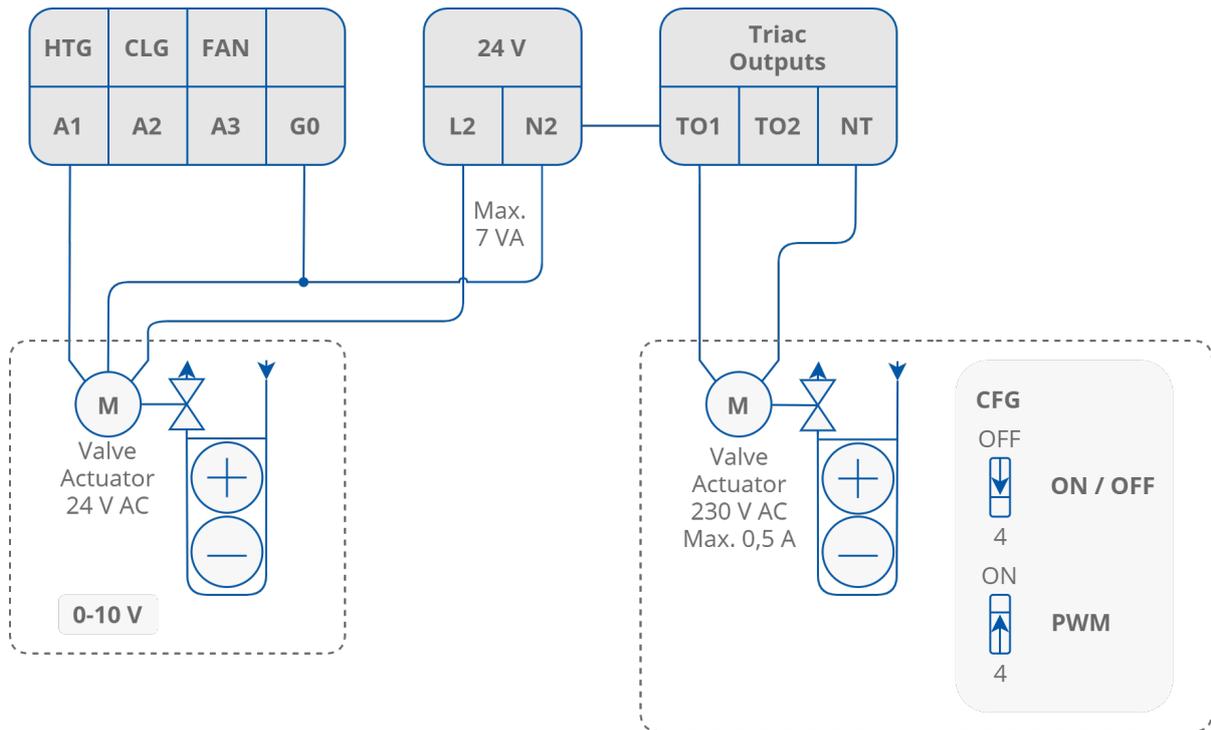


Figure 18. Connection of heating/cooling valve actuators in 2-pipe mode

### 3.2 Switch 2: 1 and 2 Stage Heating

The iSMA-B-FCU device can work with a single heating device (1-stage only) or with two heating devices (basic, 1-stage, and additional, 2-stage). The type of operating stages is chosen by the S3 CFG DIP switch number 2.

#### 3.2.1 1 Stage Heating

For the 1-stage only, depending on the 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 this example, the iSMA-B-FCU-HH version—is presented in the figure below.

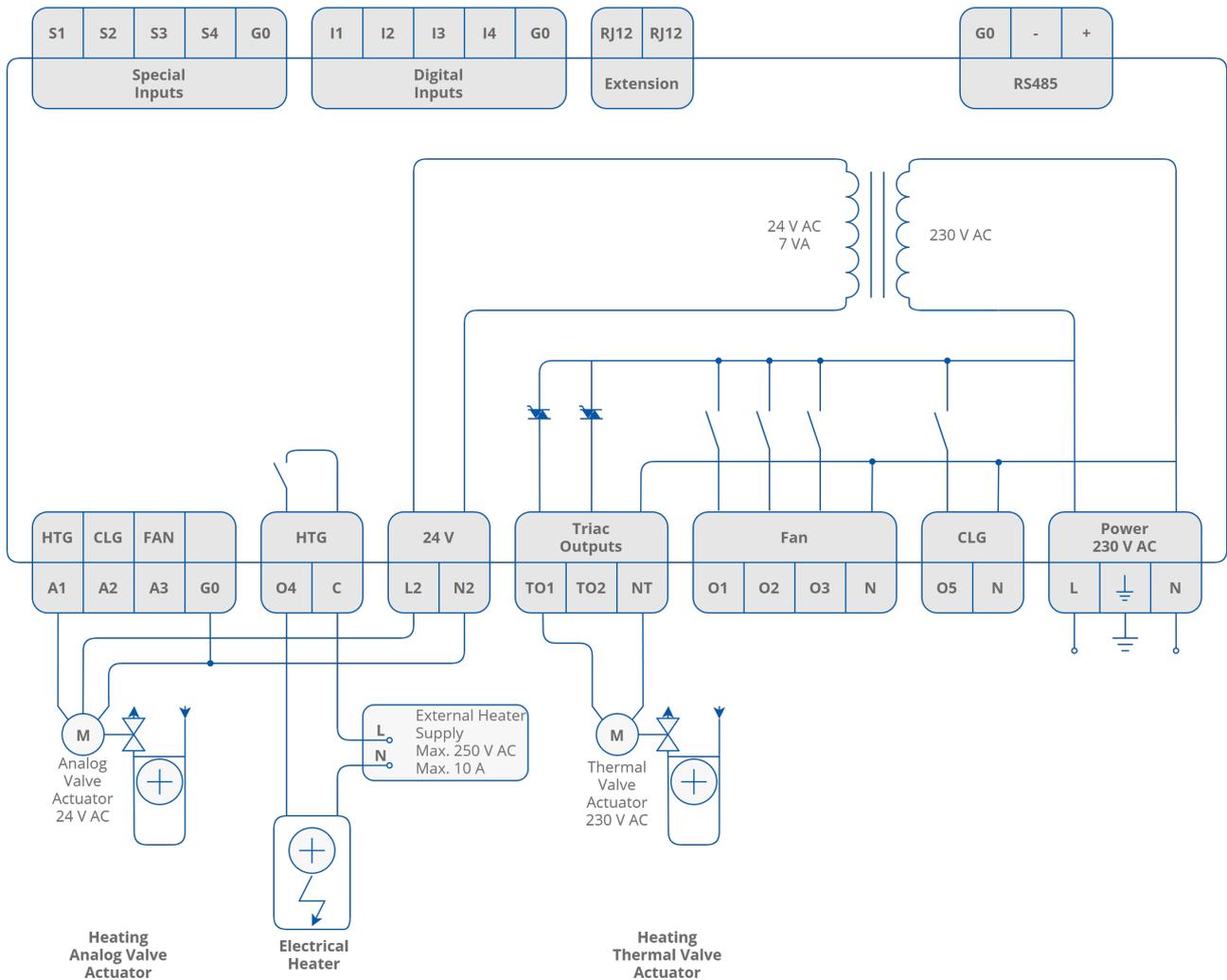


Figure 19. Example connection of FCU-HH heating devices

## Digital Control Mode

In this mode, the control algorithm works as a typical thermostat, based on the Effective Setpoint and Control Value with heating the Diff parameter defined in the Heating\_Binary\_Diff network parameter. The output signal works in 2 states, low and high. In the 1st stage 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.

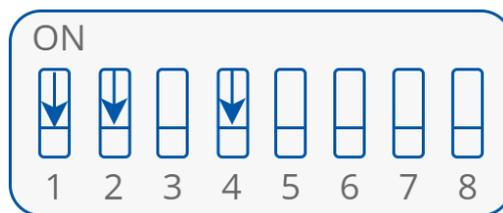


Figure 20. The CFG DIP switch configuration in digital control mode

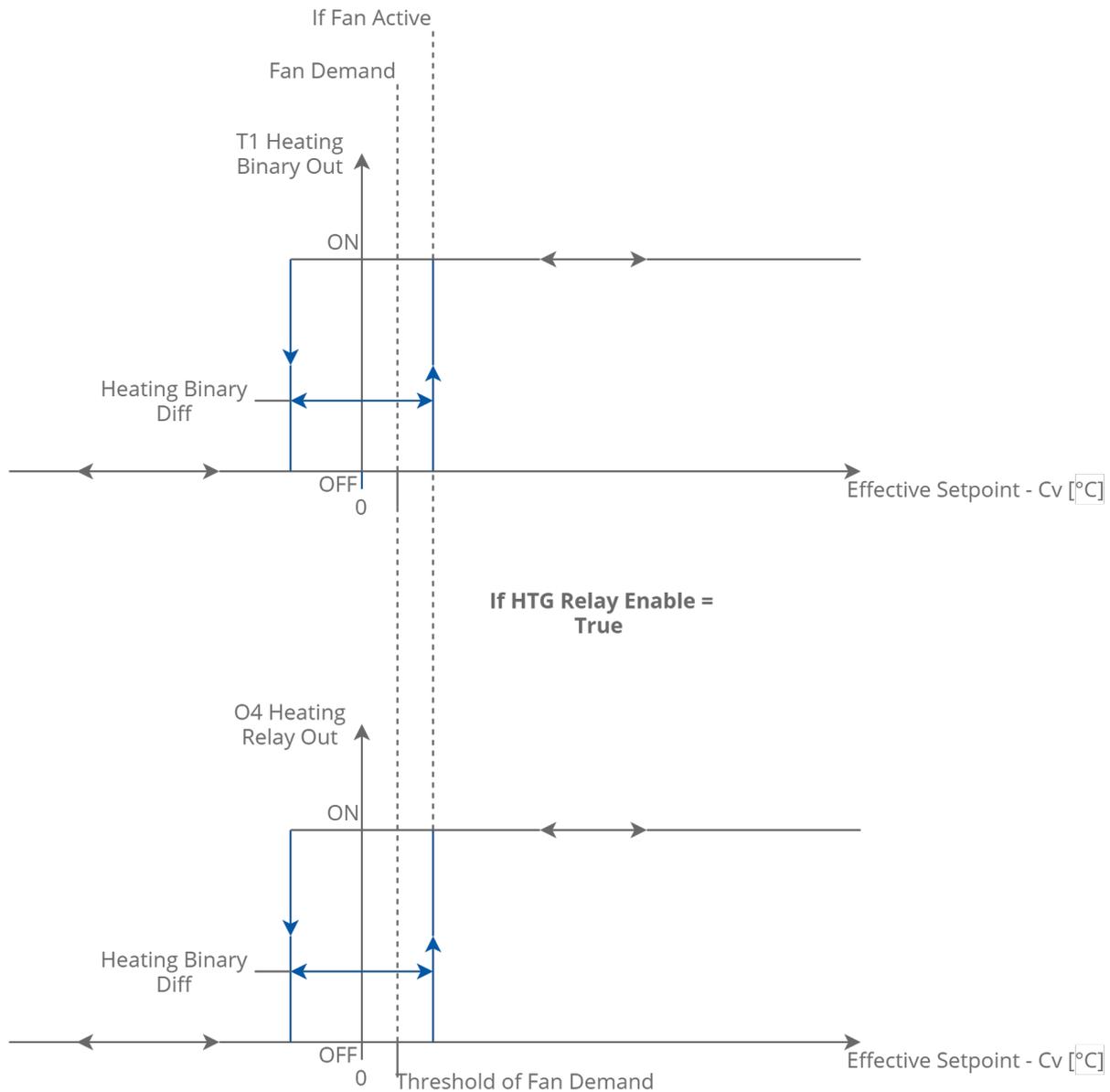


Figure 21. 1 stage heating digital control mode

**Note:** The O4 HTG output relay can be enabled/disabled with the HTG\_Relays\_Enable network parameter, and by default this relay is enabled. If the output is not in use, it is recommended to disable it.

## Analog Control Mode

In this mode, the algorithm is controlled by the PI regulator, which calculates the output value in the range from 0 to 100%, basing on the Effective\_Setpoint and CV (room temperature) values. The PI regulator can be adjusted by Kp and Ti network parameters. In the 1st stage 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 the PI regulator output. If the 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.

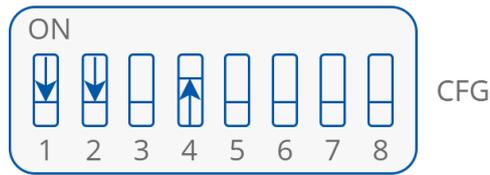


Figure 22. The CFG DIP switch configuration for analog control mode

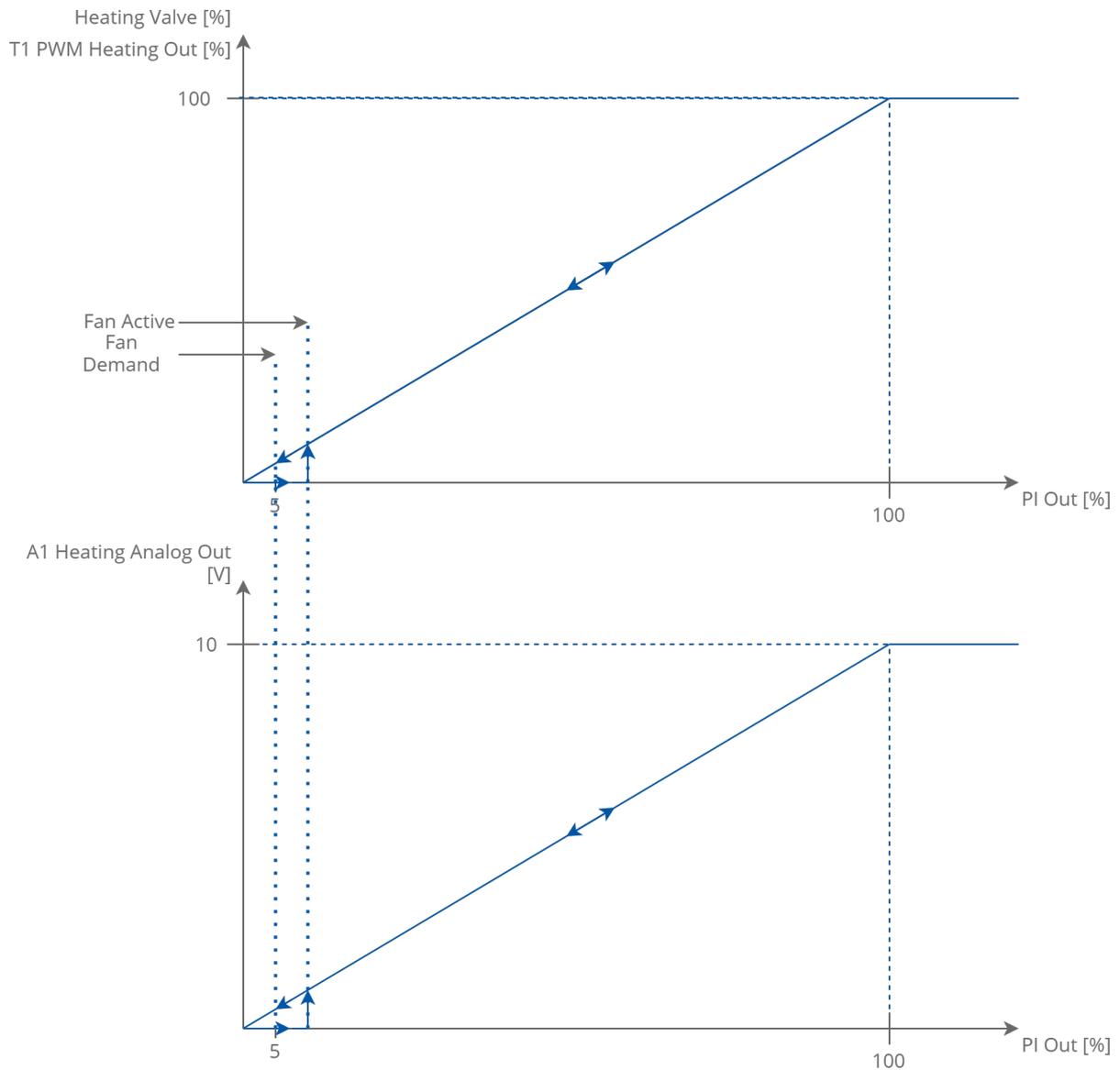


Figure 23. 1 stage heating analog control mode

### 3.2.2 2 Stage Heating

As an additional 2nd stage heating, the default application can operate only with the O4 relay. The 2<sup>nd</sup> stage heating is activated by setting the CFG DIP (switch number 2 in on position).

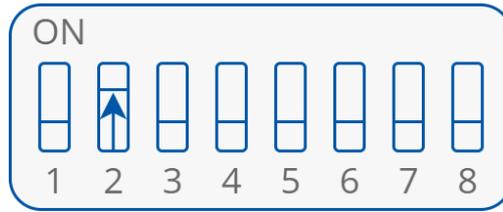


Figure 24. The CFG DIP switch configuration for 2 stage heating

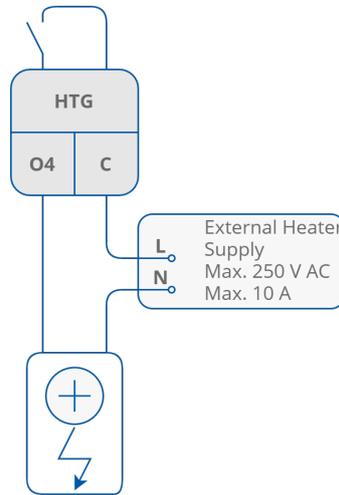


Figure 25. 2nd stage electrical heater connection and heating 2nd stage of heating activated CFG DIP switch configuration

### 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 the Heating\_Binary\_Diff network parameter. 2nd stage thermostat works with shifted Effective Setpoint and Control Value with heating Diff parameters defined in the Second\_Stage\_Diff\_Binary network parameter. 2nd stage setpoint shifting value is defined in the 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 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.

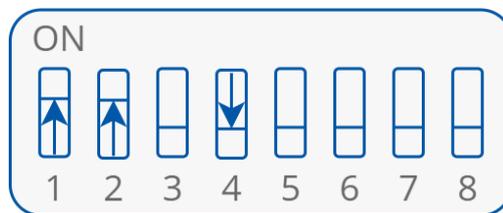


Figure 26. The CFG DIP switch configuration for digital control mode

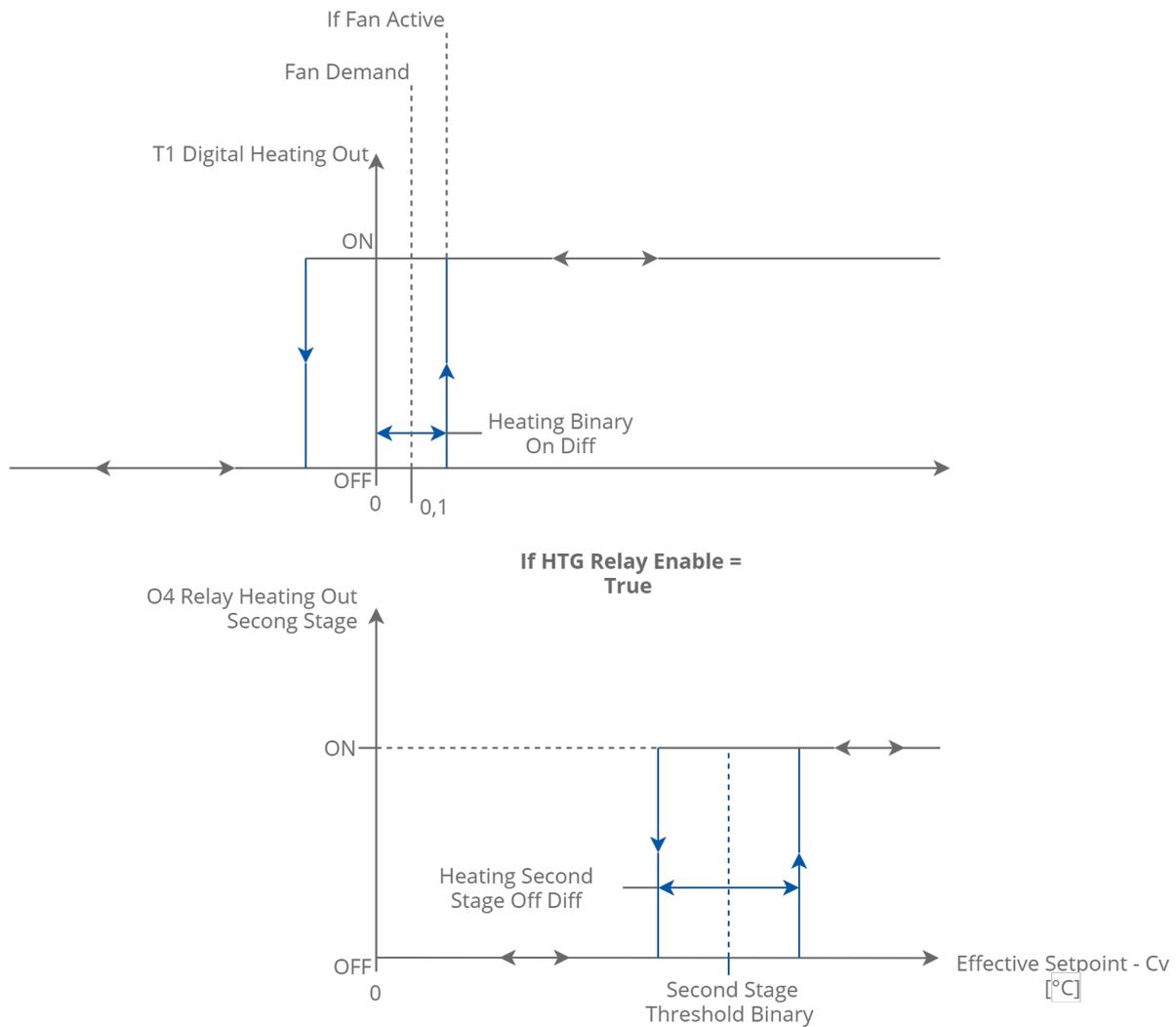


Figure 27. 2 stage heating digital control mode

## Analog Control Mode

In this mode, the algorithm is controlled by the PI regulator, which calculates the output value in the range from 0 to 100%, basing on the Effective\_Setpoint and CV (room temperature) values. The PI regulator can be adjusted by Kp and Ti network parameters. The 1<sup>st</sup> stage analog signal is scaled from 0 to the Second\_Stage\_Threshold\_Analog network parameter value. If the PI regulator output achieves the Second\_Stage\_Threshold\_Analog value, the 1<sup>st</sup> stage analog signal achieves value of 100%. The 2<sup>nd</sup> stage works as a thermostat, basing on the Second\_Stage\_Threshold\_Analog as setpoint, the PI regulator output as Control Value and Diff parameters defined in the Second\_Stage\_Diff\_Analog network parameter. In the 1<sup>st</sup> stage of heating, the user can choose 1 of 2 outputs: A1, analog output or TO1, triac output PWM. The O4 relay output is dedicated to the 2<sup>nd</sup> stage. The A1 analog output value and TO1 PWM signal are proportional to the PI regulator output. If the PI regulator output is equal or higher than 5% of the fan, it activates the fan (Fan Demand). The analog control mode of the 2-stage heating is presented in the charts below.

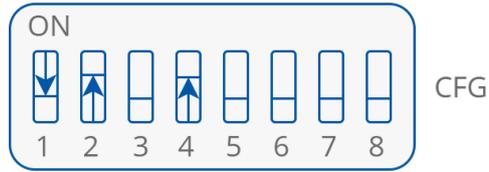


Figure 28. The CFG DIP switch configuration for analog control mode

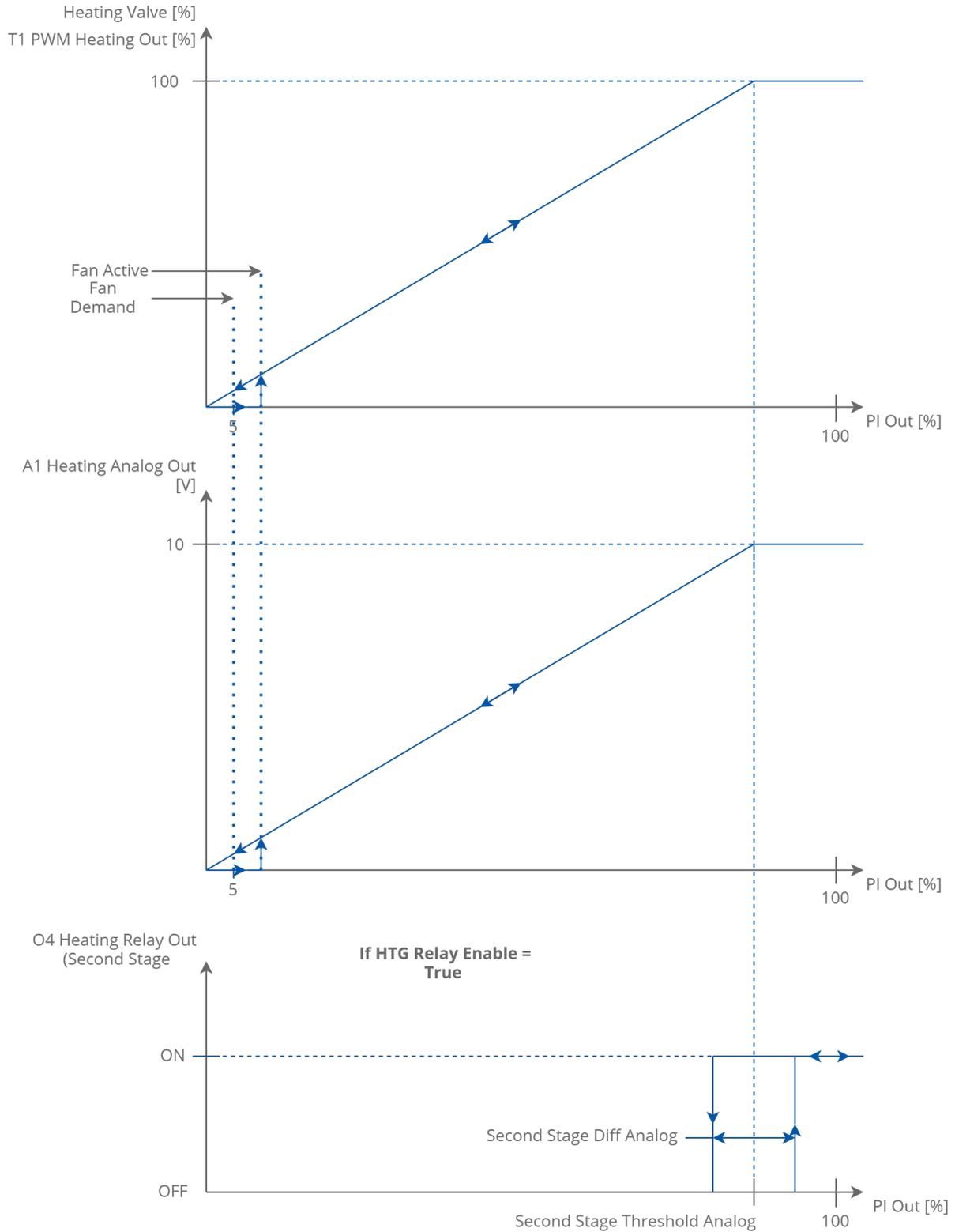


Figure 29. 2-stage heating analog control mode

### 3.3 Switch 3: 1 and 2 Stage Cooling

The iSMA-B-FCU device can work with single cooling device (1<sup>st</sup> stage only) or with two cooling devices (basic, 1<sup>st</sup> stage, and additional, 2<sup>nd</sup> stage). The type of operating stages is chosen with the S3 CFG DIP switch number 3.

#### 3.3.1 1 Stage Cooling

For the 1<sup>st</sup> 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 this example in iSMA-B-FCU-HH, are presented in the figure below.

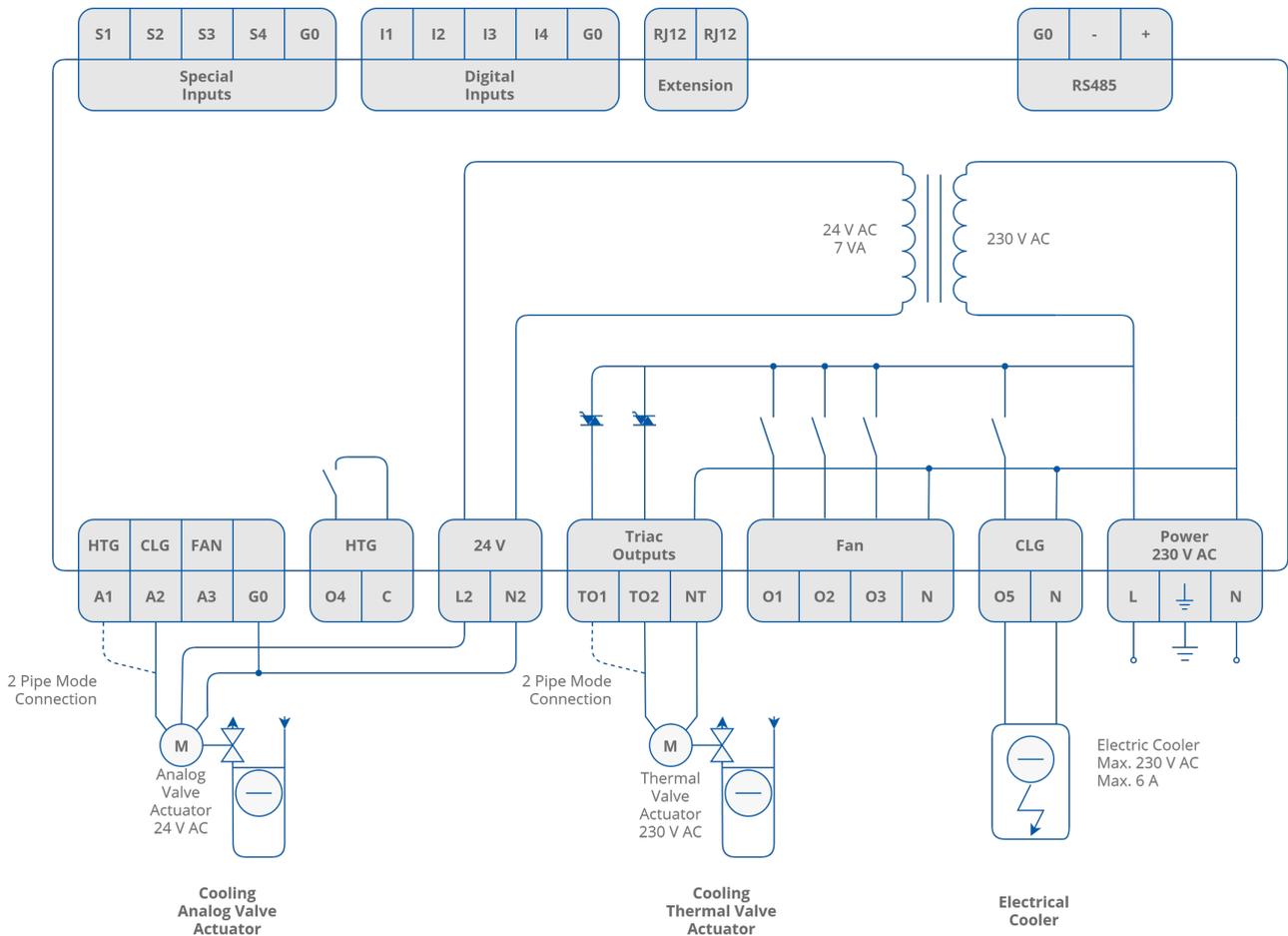


Figure 30. Example connections of FCU-HH cooling devices

**Note:** The O5 CLG output relay can be enabled/disabled with the CLG\_Relays\_Enable network parameter; by default this relay is enabled.

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

## 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 the Cooling\_Binary\_Diff network parameter. The output signal works in 2 states, low and high. In the 1<sup>st</sup> stage 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 the thermostat output also activates the fan. The digital control mode algorithm of cooling is presented in the chart below.

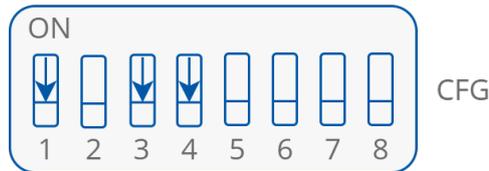


Figure 31. The CFG DIP switch configuration for digital control mode

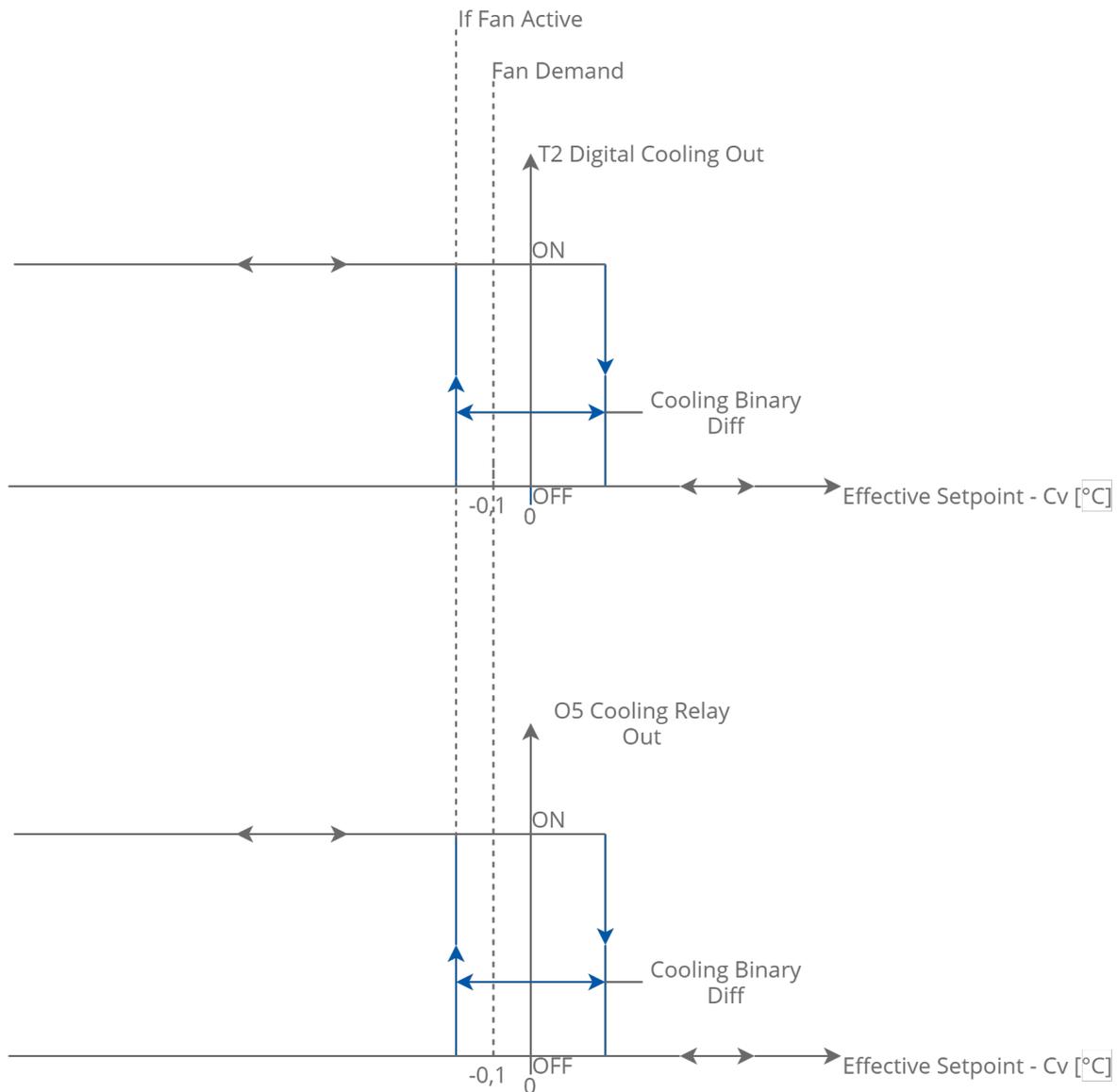


Figure 32. 1 stage cooling digital control mode

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

**Note:** The O5 CLG output relay can be enabled/disabled by the CLG\_Relays\_Enable network parameter; by default this relay is enabled. If the output is not in use, it is recommended to disable it.

### Analog Control Mode

In this mode, the algorithm is controlled with the PI regulator, which calculates the output value in the range from -100% to 0 basing on the Effective\_Setpoint and CV (room temperature) values. The PI regulator can be adjusted with network Kp and Ti parameters network. In the 1<sup>st</sup> stage 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. The O5 relay output is disabled. The analog output value and triac PWM signal are proportional to the PI regulator output. If the PI regulator output is equal or higher than 5, the fan is activated. The analog control mode algorithm of cooling is presented in the charts below.

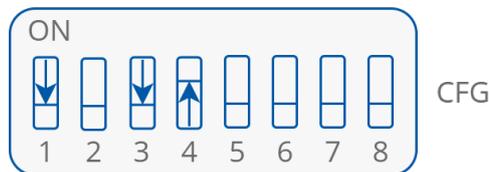


Figure 33. The CFG DIP switch configuration for analog control mode

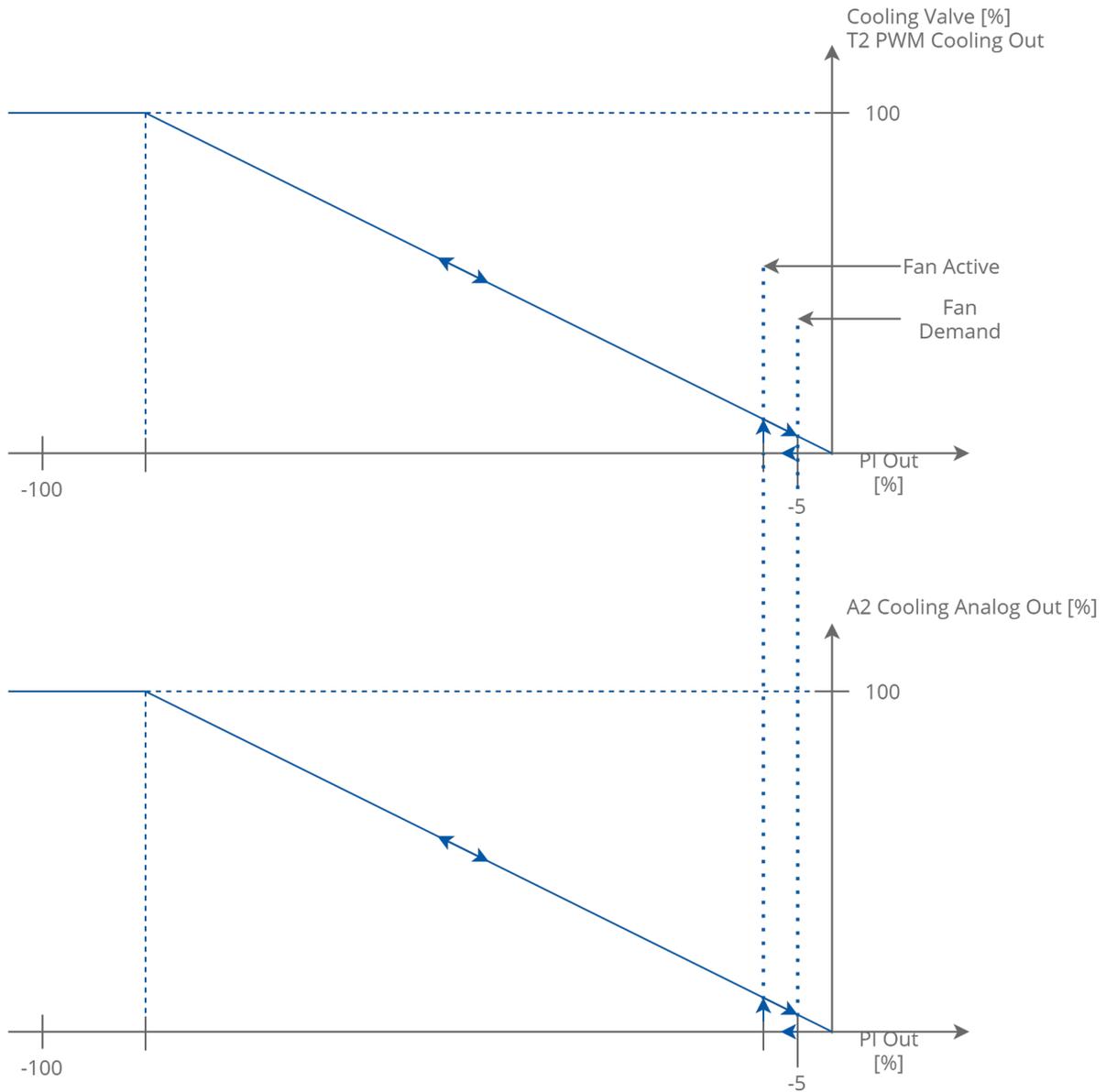


Figure 34. 1 stage cooling analog control mode

### 3.3.2 2 Stage Cooling

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

The connection and the 2<sup>nd</sup> stage activating the CFG DIP switch in high voltage version are presented in the figure below.

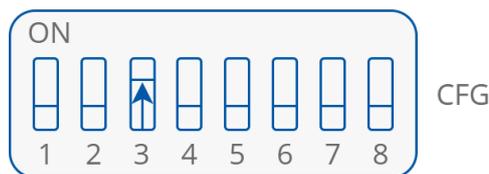


Figure 35. 2 stage cooling DIP switch configuration

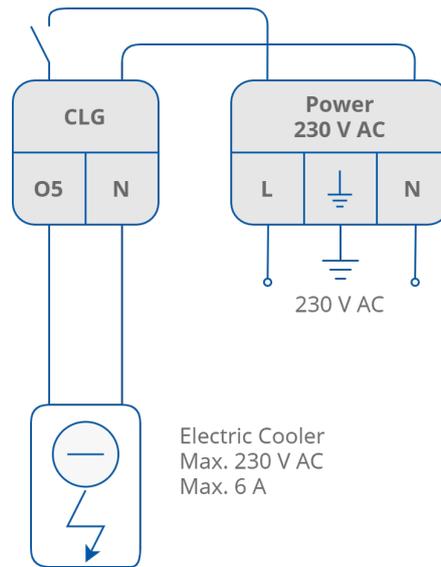


Figure 36. Configuration of the 2nd stage electrical cooler and the 2nd stage of cooling activating CFG DIP switch

**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.

### Digital Control Mode

In this mode, the control algorithm operates with 2 typical thermostats. The 1<sup>st</sup> stage thermostat is based on the Effective Setpoint and Control Value with cooling Diff parameter defined in the Cooling\_Binary\_Diff network variable. The 2<sup>nd</sup> stage thermostat works with shifted Effective Setpoint and Control Value with cooling Diff parameters defined in the Second\_Stage\_Diff\_Binary network parameter. The 2<sup>nd</sup> stage setpoint shifting value is defined in the Second\_Stage\_Threshold\_Binary network variable. The 1<sup>st</sup> stage thermostat output high value also activates the fan. The output signals operate in 2 states, low and high. In the 1<sup>st</sup> stage cooling, the user can only use TO1 triac output, and in the 2<sup>nd</sup> stage only the O5 relay output. A1 and A2 outputs are disabled. The digital control mode algorithm of the 2<sup>nd</sup> stage cooling is presented in the chart below.

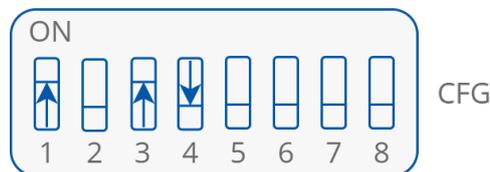


Figure 37. The CFG DIP switch configuration for digital control mode

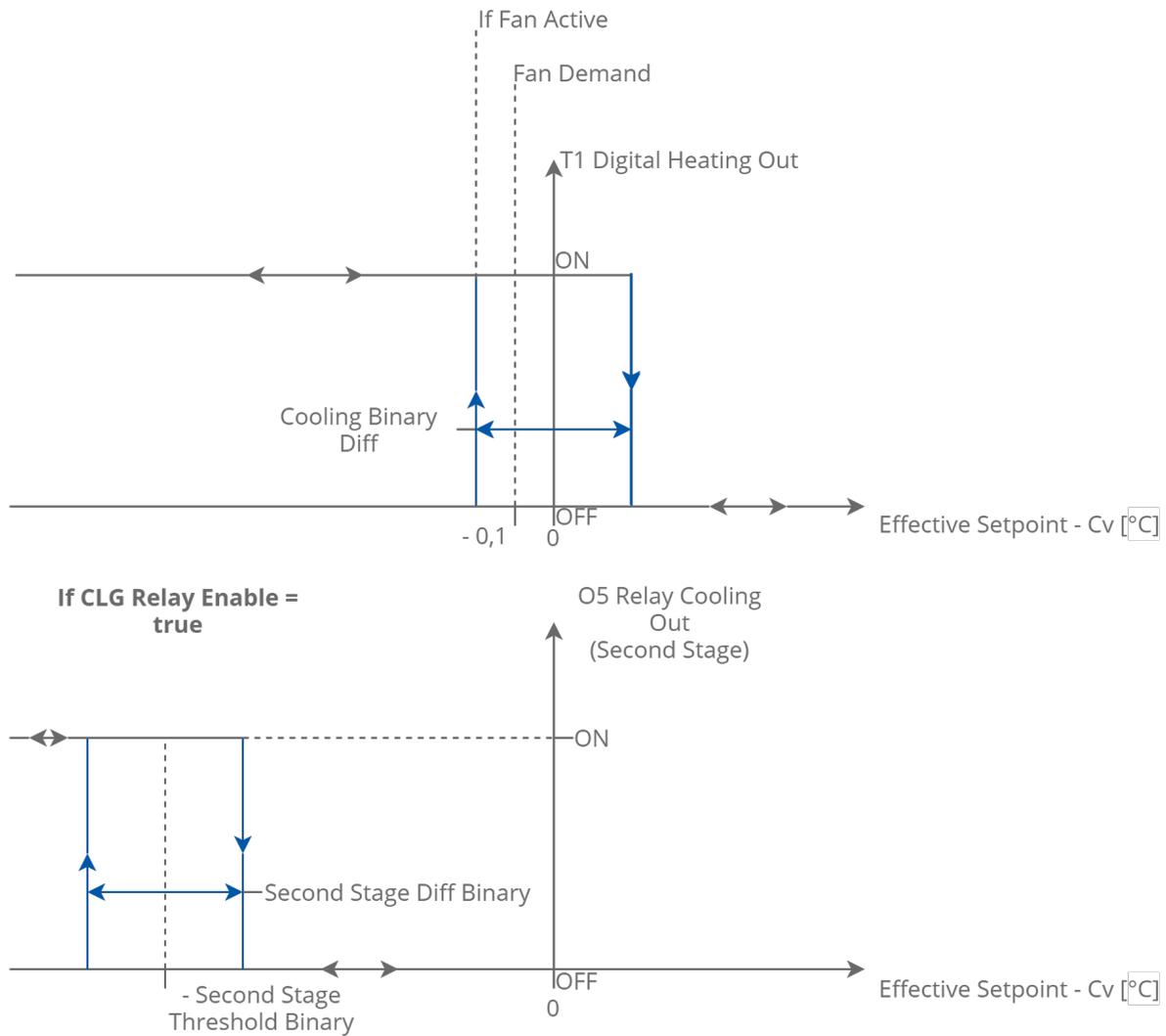


Figure 38. 2 stage cooling digital control mode

## Analog Control Mode

In this mode, the algorithm is controlled by the PI regulator, which calculates the output value in the range from -100% to 0, basing on the Effective\_Setpoint and CV (room temperature) values. The PI regulator can be adjusted by network parameters Kp and Ti. The 1<sup>st</sup> stage analog signal is scaled to Second\_Stage\_Threshold\_Analog network parameter. In the range from 0 to Second\_Stage\_Threshold\_Analog, the analog signal is proportional to PI regulator output in range from 0 to 100%. If the PI regulator output is equal or higher than Second\_Stage\_Threshold\_Analog, the analog signal value is set to 100%. The 2<sup>nd</sup> stage works as a thermostat, basing on the Second\_Stage\_Threshold\_Analog as Setpoint, the PI regulator output as Control Value and Diff parameters defined in the Second\_Stage\_Diff\_Analog network parameter. In the 1<sup>st</sup> stage 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 2<sup>nd</sup> stage. The A2 analog output value and the TO2 PWM signal is proportional to the PI regulator output. If the PI regulator output is equal or higher than 5%, it activates the fan (Fan Demand). The analog control mode of the 2<sup>nd</sup> stage cooling is shown in charts below.

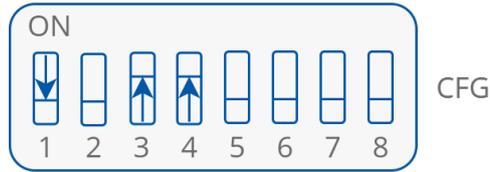


Figure 39. The CFG DIP switch configuration for analog control mode

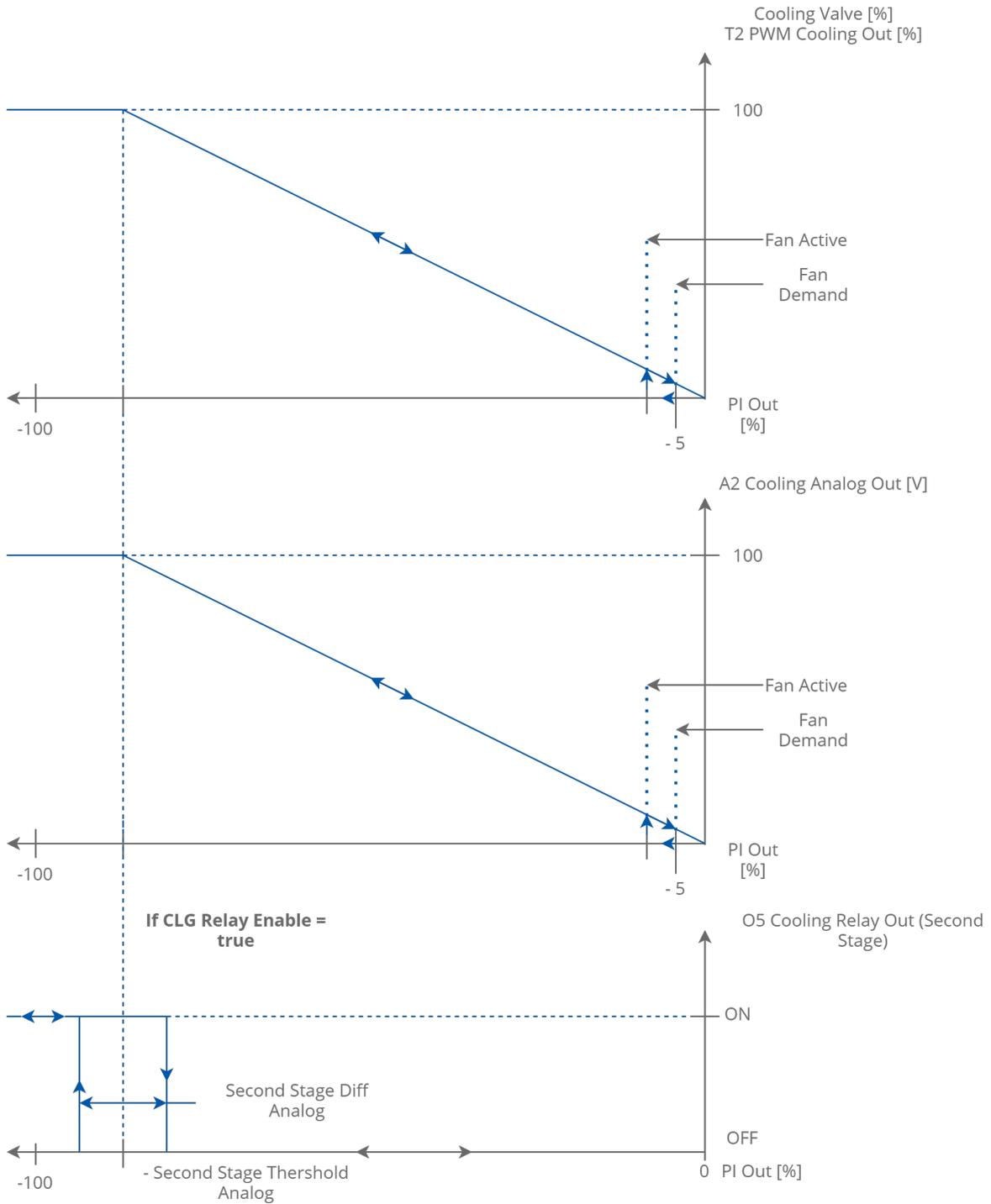


Figure 40. 2 stage cooling analog control mode

### 3.4 Switch 4: Heating/Cooling Control Mode

The FCU application is designed to cooperate with two types of heating/cooling devices (analog or digital). The type of control is selected with the S3 CFG DIP switch number 4, where the off position corresponds to the digital control and on position corresponds to the analog control.

#### 3.4.1 Analog Control Mode

In this mode, the algorithm is controlled by the PI regulator, which calculates the output value in the range from -100% to 100%, basing on the Effective\_Setpoint and CV (room temperature) values. The range from -100% to 0 is for cooling control, and the range from 0 to 100% is for heating control. Basing on this output, the FCU controller controls actuators in binary or analog control. The PI regulator can be adjusted with Kp and Ti network parameters. In order to prevent the algorithm from activating heating and cooling in rapid succession, the Valves\_dead\_band value can be adjusted. It defines temperature deviation from setpoint, if the PI regulator does not activate neither heating or cooling mode.

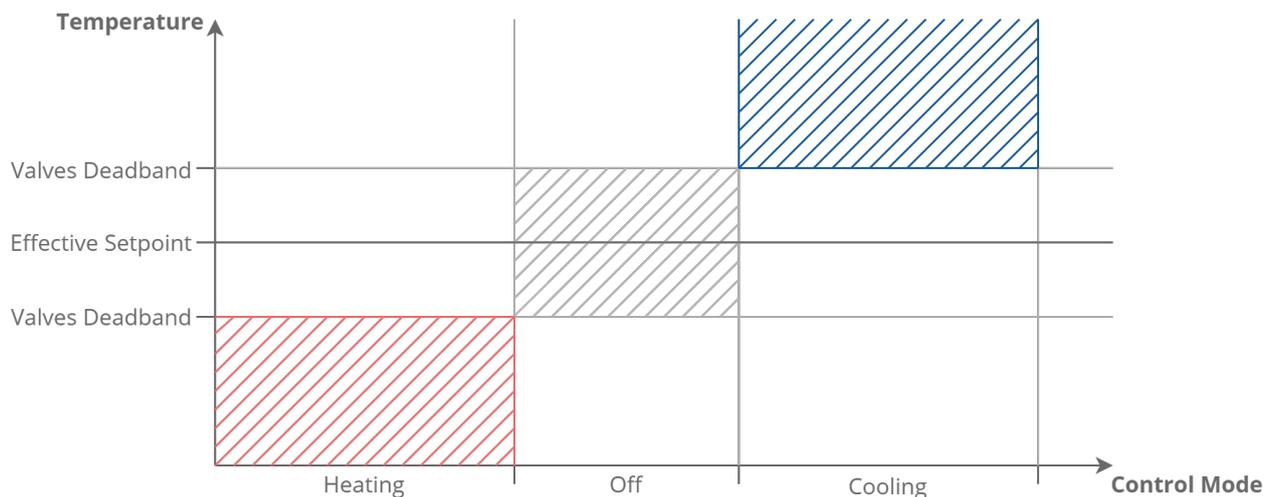


Figure 41. Valve dead band operation chart

#### 3.4.2 Digital Control Mode

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

**Note:** This mode affects also outputs enabled/disabled in the 1<sup>st</sup> stage. In the first stage, outputs O4 and O5 can work only in binary control mode. If the user wants to run the binary control mode without operating these outputs, the outputs can be disabled by setting corresponding to network parameter in false state (O4: HTG\_Relays\_Enable, O5: CLG\_Relays\_Enable).

### 3.5 Switches 5 and 6: CV Temperature Source

The default application can work with 4 different CV temperature sources. The CV temperature source is selected by the S3 CFG DIP switches number 5 and 6. The configuration table is presented below.

No.	Name	On		Off	Default
5	Temperature control value source	5-off	6-off	Room panel (iSMA-B-LP, Touch Point)	Room panel
		5-off	6-on	Room sensor, SI3	
6		5-on	6-off	Air return temperature, SI1	
		5-on	6-on	Network temperature	

Table 11. The CV source selected with the CFG DIP switch configuration

Source description:

- room panel: the temperature is sourced from the iSMA-B-LP/Touch Point room panel connected to the FCU controller by RJ12 socket;
- room sensor: the temperature is sourced from the sensor connected to the S3 special input;
- air return temperature: the temperature is sourced from the sensor connected to the S1 special input—for more information about the Air Return Temp, please see section Return Temperature Sensor Control;
- network temperature: the temperature is sourced from the network variable; this source is dedicated for the slave device in the master-slave working mode.

### 3.6 Switches 7 and 8: Fan Type

The default application is designed to control 1 of 4 different fan types. The fan type is chosen by the S3 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 12. Fan type selected with the CFG DIP switch configuration

Source description:

- room panel: the temperature is sourced from the iSMA-B-LP/Touch Point room panel connected to the FCU controller by RJ12 socket;
- room sensor: the temperature is sourced from the sensor connected to the S3 special input;
- air return temperature: the temperature is sourced from the sensor connected to the S1 special input—for more information about the air return temperature, please see section Return Temperature Sensor Control;
- network temperature: the temperature is sourced from the network variable; this source is dedicated for the slave device in the master-slave working mode.

The connection of supported fan types is shown in figure below.

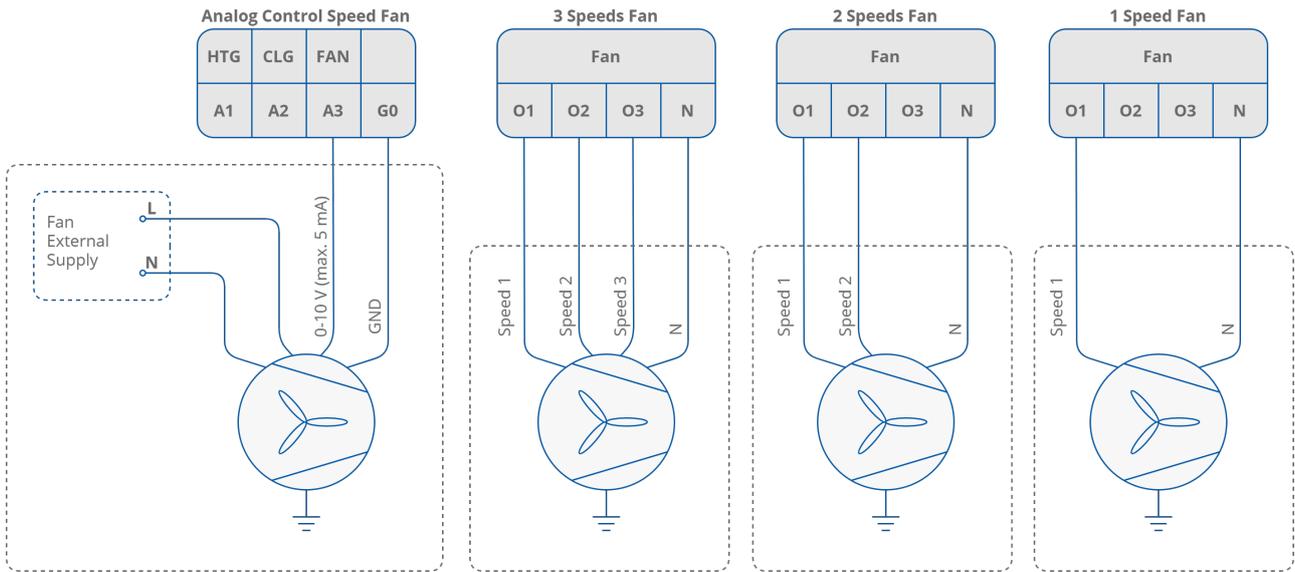


Figure 42. Fan motor connection according to the fan control mode

**Note:** For the digital fan speed control, the FCU application is equipped with a built-in 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

The FCU application has a built-in fan speed control algorithm. The internal variable Fan Control Value is scaled by the difference between CV and Effective Setpoint. The difference is calculated according to linear conversation, where 100% speed is in the Fan\_Scale network parameter. For example: by default, the Fan\_Scale network variable value is set to 3, meaning if the difference between the CV and SP is equal or higher than 3°C, the internal parameter Fan\_Control\_Value is 100% if the difference is half of the Fan\_Scale (in this case 1.5°C), the Fan\_Control\_Value is 50%. The algorithm chart is presented in the figure below.

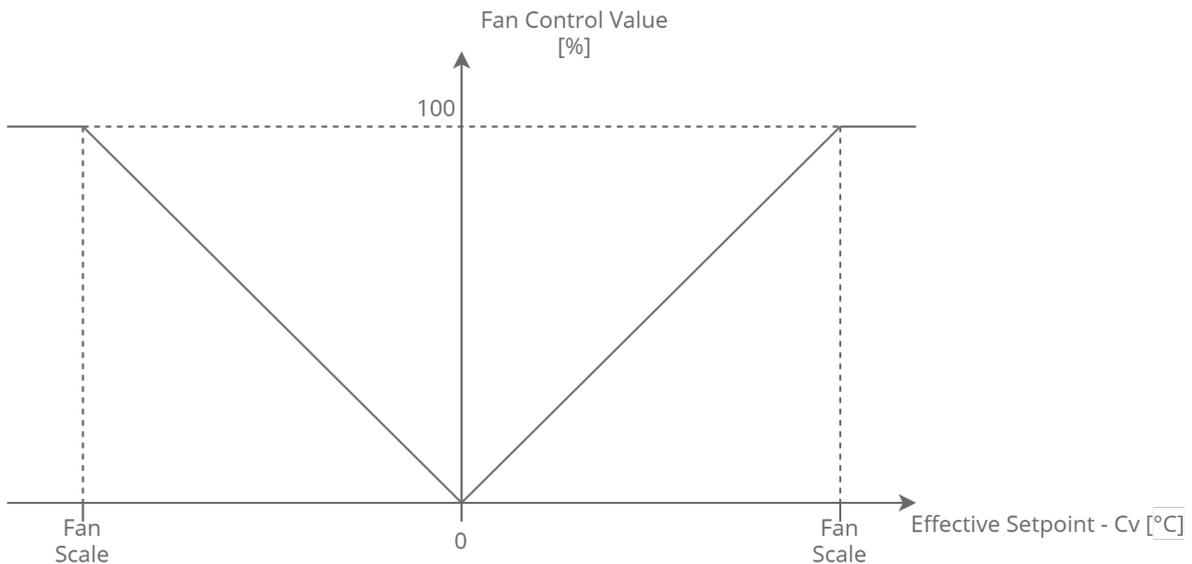


Figure 43. Fan control value conversion chart

The fan can operate in 3 modes: off, manual, auto. These modes can be changed from the room panel, or remotely from the BMS by the Fan\_Mode network variable. The current fan status is shown in the read-only network variable, Fan\_Status. The 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 13. Fan Mode and Fan Status variables descriptions

## Fan Soft Start

This function is designed for analog fan type control supply by motor driver to support fan motor start. If the 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 the fan control signal for the time defined in the Fan Soft Start Time network variable with the value defined in the Fan Soft Start Value network variable. After the Fan Soft Start Time, the control signal switches to the application fan control signal.

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

## Fan Off Delay

The Fan Off Delay function was designed to keep the air flow for defined time after the fan switch off signal. The delay time is defined in the 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 the Fan\_Value network variable (0-100%).

In the default application, the Fan\_Value network variable is calculated according to the internal variable Fan\_Control\_Value and Fan Thresholds network parameters. If the fan starts and the Fan\_Control\_Value is within the range from 0 to Fan\_Speed1\_Threshold, the fan will be switched off. If the Fan\_Control\_Value is equal or higher than the Fan\_Speed1\_Threshold, the fan is switched on and starts working according to the Fan\_Control\_Value or according to the Soft Start algorithm. The fan will be switched off if the Fan\_Value drops below the Fan\_Off\_Threshold.

The fan control algorithm has a built-in function, which keeps fan running with the Fan\_Speed1\_Threshold network variable value, when there is no fan demand. This function works only in the 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 the Fan\_Value network variable, depending on the Fan\_Control\_Value and Fan\_Off\_Threshold, is presented in the figure below.

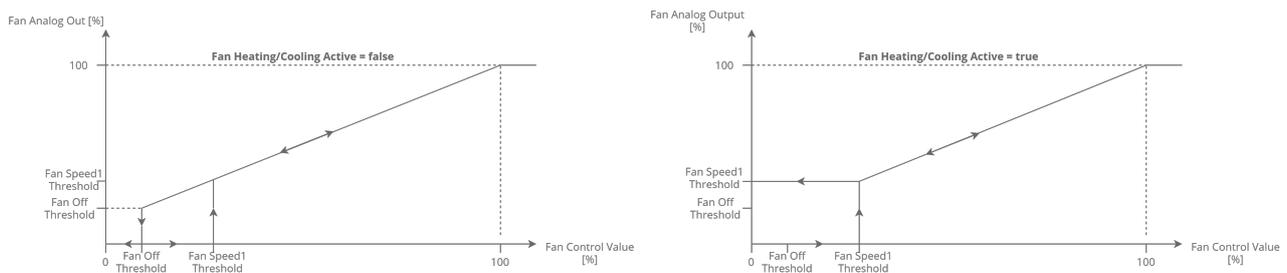


Figure 44. Fan analog type control algorithm

### 3.6.3 Fan 1-Speed Type Control Algorithm

In the 1-speed fan control mechanism, the fan is controlled by O1 digital output only, basing on the Fan\_Value network parameter (0-off; 1-speed 1).

In the default application, the Fan\_Value network variable is calculated according to internal variable Fan\_Control\_Value and Threshold function defined by 2 network parameters:

- Fan Off Threshold, and
- Fan Speed 1 Threshold.

The fan control algorithm has a built-in function, which keeps the fan running with low value if there is no fan demand. This function works only in the 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.

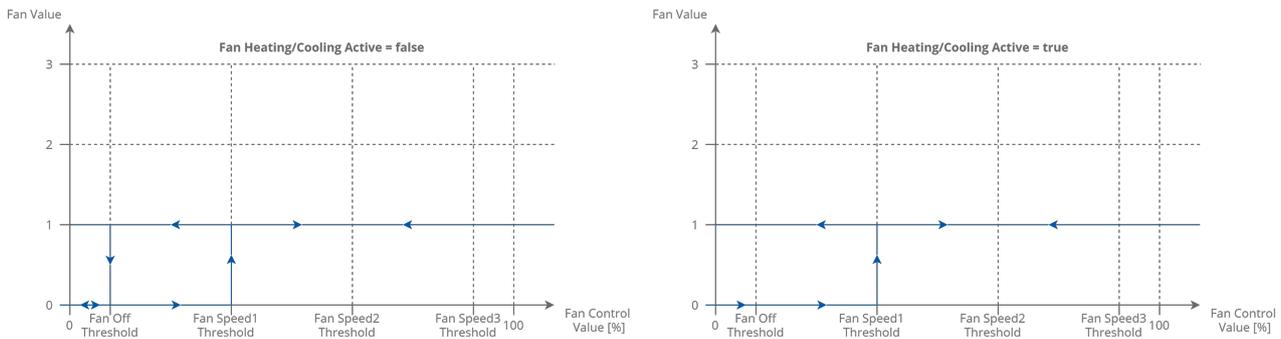


Figure 45. Fan 1-speed type control algorithm

### 3.6.4 Fan 2-Speed Type Control Algorithm

In the 2-speed fan control mechanism, the fan is controlled with digital outputs, O1 and O2, basing on the 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 a built-in function, which keeps the fan running with low value, if there is no fan demand. This function works only in the 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.

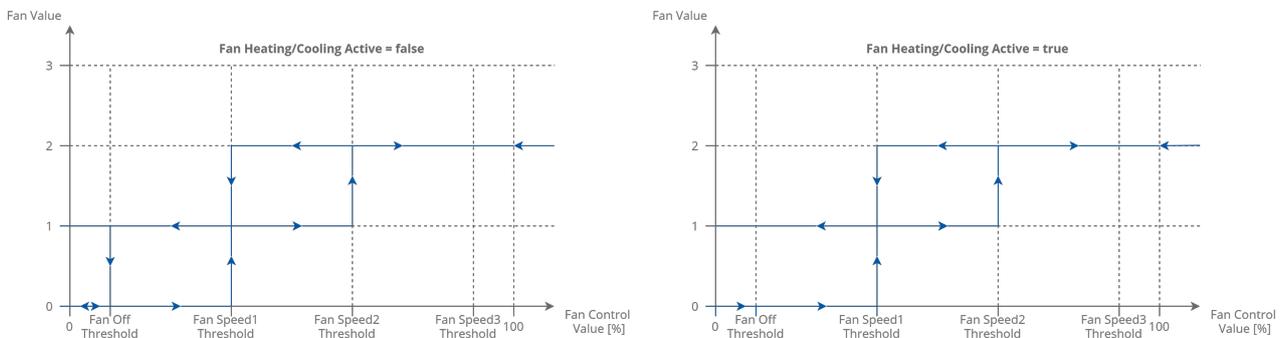


Figure 46. Fan 2-speed type control algorithm

### 3.6.5 Fan 3-Speed Type Control Algorithm

In the 3-speed fan control mechanism, the fan is controlled by O1, O2, and O3 digital outputs, basing on the Fan\_Value network variable (0-off; 1-speed 1; 2-speed 2; 3-speed 3).

In the default application, the 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 a built-in function, which keeps the fan running with low value if there is no fan demand. This function works only in the 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.

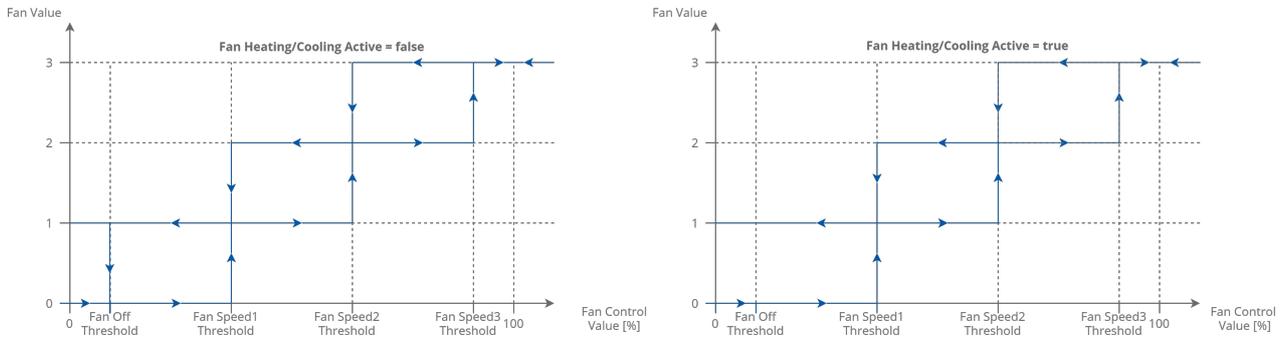


Figure 47. Fan 3-speed type control algorithm

## 4 Control Algorithm

The default application has been designed to service a 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 the default application is designed to control room temperature.

### 4.1 FCU Occupancy Modes

To allow maximum comfort and energy saving as default, the application has 4 operating modes implemented. These modes are used to switch between user temperature if the space is occupied, and energy saving if the 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 the 'Forced Occupied' mode only;
- BMS using the Occupancy Mode network variable for setting any mode. The mode is changed immediately after changing the value of variable. The 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 14. 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.

## 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 the value, which user can add or subtract to the setpoint. The Offset range is limited by the Offset\_Range network variable, by default to 3, therefore the user can add or subtract max. 3 degrees to Setpoint value.

## Occupied Fan Control

In the occupied mode, the fan can operate with auto algorithm (see section [Control algorithm](#)), or with the user manual value. By setting the fan to the Off mode, the user can switch off device.

## Occupied Heating / Cooling FCU Mode Switching

In this mode (if the FCU\_Mode network variable is set to auto), the application can automatically switch between heating and cooling. The switching point is based on the Effective Setpoint and CV with Diff parameters, defined in the Heating\_Cooling\_Switching\_Diff.

### 4.1.2 Unoccupied Mode

#### Unoccupied 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 the 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 - Unoccupied_Offset
0 (Unoccupied)	Cooling	False	Effective_Setpoint = Setpoint + Setpoint_Offset + Unoccupied_Offset
0 (Unoccupied)	Heating	True	Effective_Setpoint = Setpoint - Unoccupied_Offset
0 (Unoccupied)	Cooling	True	Effective_Setpoint = Setpoint + Unoccupied_Offset

Table 15. Effective Setpoint in unoccupied mode calculation table

#### Unoccupied Fan Control

In the unoccupied mode, the fan operates in the Auto Mode, the value of which is calculated by the application. (See section 3.6.1 Fan control algorithm). In this mode, the Fan Manual Modes are disabled, and the user cannot switch off or define fan speed. If the

unoccupied mode changes to occupied, the Fan Mode is switched to previous mode (Auto or user settings).

## Occupied Heating / Cooling FCU Mode Switching

In this mode (if the FCU\_Mode network variable is set in Auto), the application remains in the last running mode (heating or cooling) in the occupied mode. The control algorithm does not change and depends of the 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 if 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.

### 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 16. Effective Setpoint in standby mode calculation table

### Unoccupied Fan Control

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

## Occupied Heating / Cooling FCU Mode Switching

In this mode (if the FCU\_Mode network variable is set in Auto), the application stays in the last running mode (heating or cooling) in the occupied mode. The control algorithm does not change, and it depends on the CFG DIP switch configuration.

### 4.1.4 Forced Occupied

This mode is called by external devices connected to FCU digital inputs or from the room panel. This mode operates for the time defined in network parameters. The Forced Occupied behavior is the same as the occupied mode.

### Switching to Forced Occupancy Mode by Occupancy Button I1

The I1 digital input is dedicated to connect presence button or sensor, which remotely runs the forced occupancy mode. This input is active only in the unoccupied or standby modes (in the occupied mode this input is inactive). If the application detects rising edge on the I1 input, it switches to the forced occupied mode. If the application detects falling edge on the I1 input, it starts counting down the time defined in the Occupancy\_Time\_Remote\_Trigger network variable. During that time, the application is in the 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 the 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.

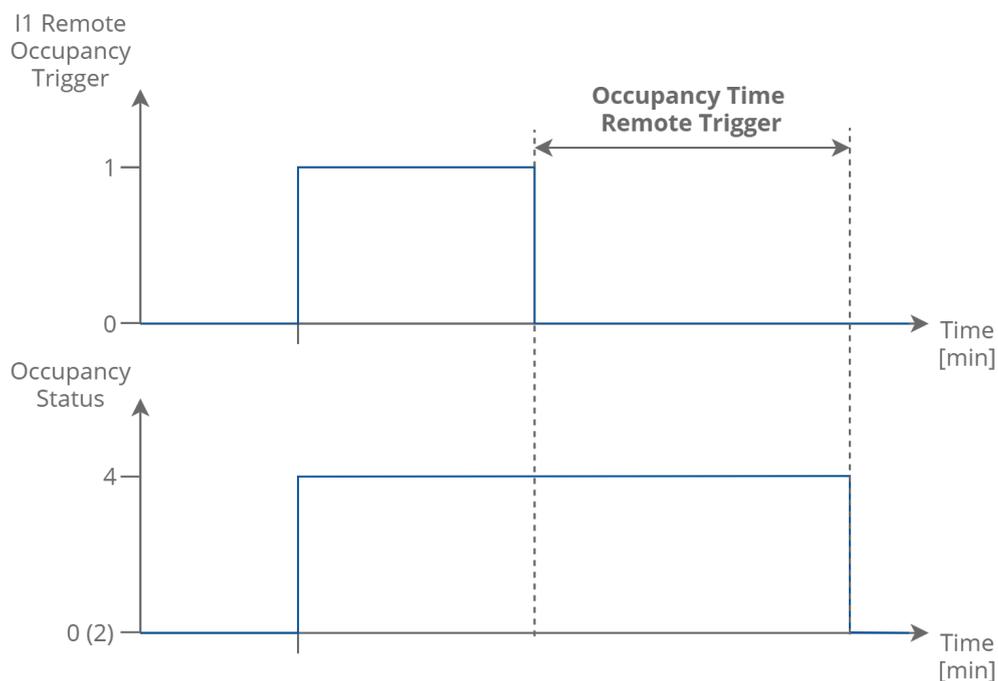


Figure 48. Occupancy trigger time function

### Switching to Forced Occupancy Mode with Digital Input I2

The I2 digital input is dedicated to connect the presence button or card holder, which remotely run forced occupancy mode. This input is active only in the unoccupied or standby modes (in the occupied mode this input is inactive). If the application detects

rising edge on the I2 input, it switches to the forced occupied mode. If the application detects falling edge on the I2 input, it starts counting down the time defined in the Occupancy\_Time\_Presence\_Sensor network variable. During that time, the application is in the 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 the 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.

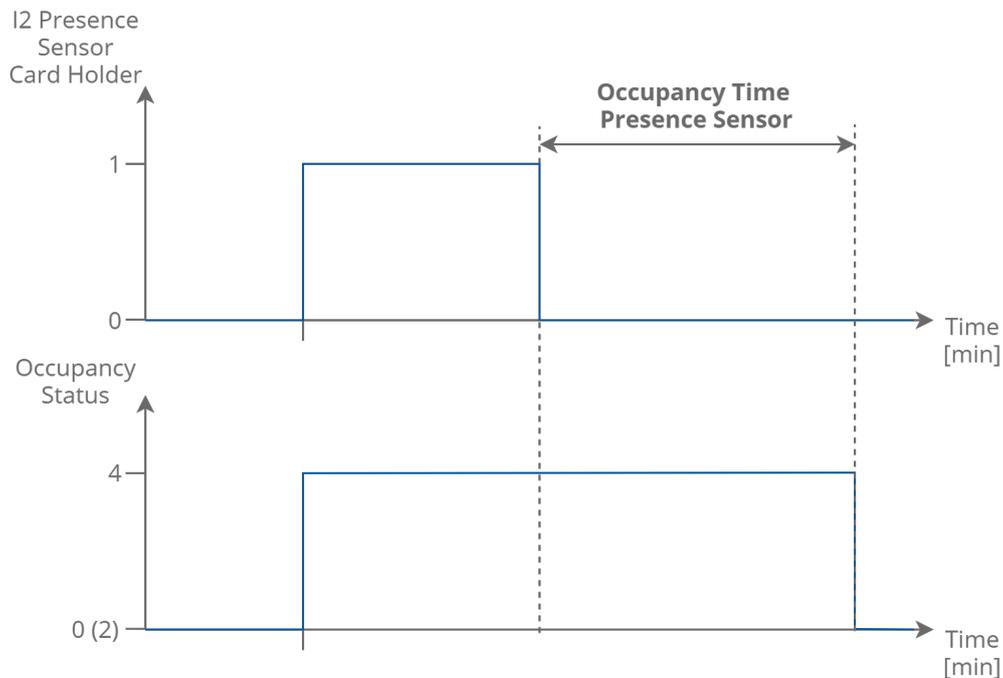


Figure 49. Presence sensor or card holder function time

## Switching to Forced Occupancy by Room Panel (iSMA-B-LP/Touch Point)

The FCU default application is designed to work with the iSMA-B-LP and Touch Point room panels. In the panel menu, user can switch from the unoccupied or standby mode to forced occupied for the time defined in the Occupancy\_Time\_Remote\_Trigger network parameter. The forced occupied mode is shown as a flashing occupied icon. From the room panel, the user can switch off the forced occupied and come back to the previous mode.

## 4.2 FCU Modes

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

- OFF: in this mode, the FCU controller software is off, only the anti-frost procreation can start the FCU controller;
- Auto: in this mode, the FCU controller switches between cooling or heating function based on the measurement temperature and effective setpoint temperature;
- Heating Only: in this mode, the FCU controller can perform only heating function (dedicated for 2-pipe mode or if the cooling medium is not available: winter mode);
- Cooling Only: in this mode, the FCU controller can perform only cooling function (dedicated for 2-pipe mode or if the heating medium is not available: summer mode);

- Fan Only: in this mode, the FCU controller can perform only ventilation, heating and cooling functions are disabled.

For the remote mode control, the default application has the 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 17. FCU mode network variable values description

### 4.2.1 OFF Mode

In this mode, the fan is switched off, all heating and cooling devices are disabled. This mode can be set from BMS (by writing 0 value to the FCU\_Mode network variable). This mode is called if the 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. If the controller comes back to the Occupancy mode, algorithm will calculate in which function it should work.

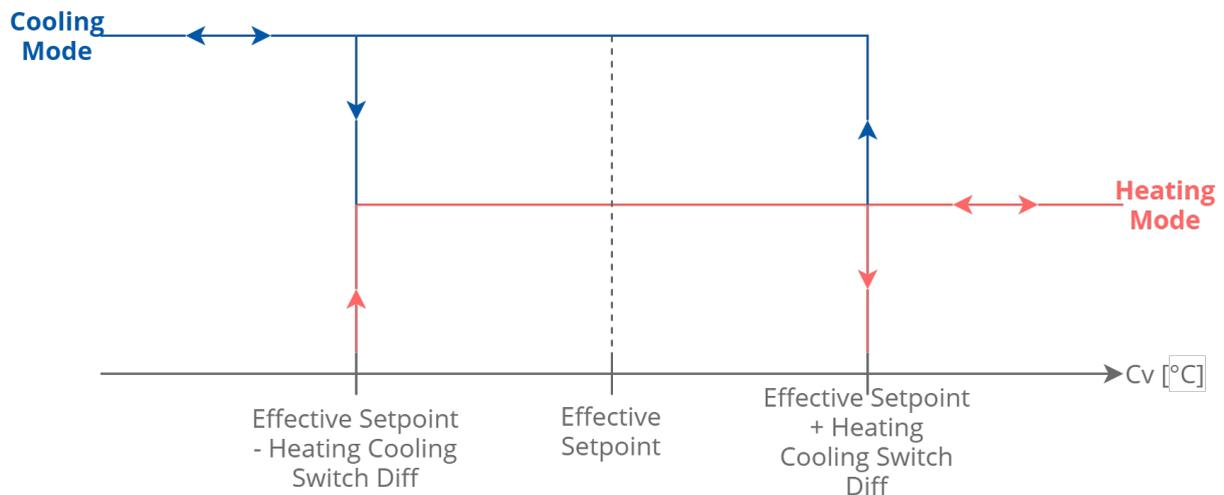


Figure 50. Switching between heating/cooling chart

### 4.2.3 Heating Only Mode

In the Heating Only mode, the application is running only with the heating algorithm. 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 the 2-pipe system during winter mode or the 4-pipe system if the cooling medium is not available.

### 4.2.4 Cooling Only Mode

In the Cooling Only mode, the application runs only with the cooling algorithm. 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 the 2-pipe system during summer mode or the 4-pipe if the heating medium is not available.

### 4.2.5 Fan Only Mode

In the 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 the application algorithm.

## 4.3 Additional Features

### 4.3.1 Open Window (I3)

The I3 digital input is dedicated to connect window contraction, which checks if the window is open or closed. If the input detects the open window status (rising edge on the I3 input), it starts counting down the time defined in the Window\_Status\_Delay network variable (60 seconds by default). After the time elapses, if the window is still open, the application calls the FCU Off mode (for more information, please see section 4.2.1 OFF mode). If the input detects the closed window, the application resets the counter and continues normal operation. If the input detects the closed window before the time elapses, the application also resets the counter and continues normal operation. If the window is open, only the anti-frost protection can start. By changing the 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 temperatures. If the application detects a temperature drop below 6°C, it starts the fan and activates all actuators of the heating valves (including 2<sup>nd</sup> stage, if it is active) with maximum defined value. This action is continued until the room temperature reaches above 8°C. The anti-frost function is always active even if the user switches off the device from BMS or local panel. To prevent unnecessary start after sensor fault, there is a built-in algorithm, which detects a sensor brake. If the temperature value from all available sensors is incorrect (out of the range from -100°C to 100°C), the anti-frost function is disabled.

### 4.3.3 Return Temperature Sensor Control

The default application can control room temperature based on the air return temperature sensor, SI1. To prevent an incorrect temperature value if the fan is off, the CV temperature is taken from the room sensor. The built-in algorithm checks, which sensor is available (from the room panel, SI1 room sensor, or from the network variable if the FCU is working as slave). After the fan start, the algorithm waits for time defined in the Return\_To\_Space\_Time network variable (by default 30 s) to blow the ducts and switch the CV to the SI1air return sensor. To activate this function, the Return\_To\_Space\_Enable network variable must be set to true.

### 4.3.4 Supply Air Temperature Limitation

In order to maintain room conditions comfortable for the user, the supply air can have a temperature limitation. This function is available only if the supply air sensor is connected and works correctly. The supply air temperature can have a high limit defined by the Supply Temperature High Limit slot (default value 40°C), and a low limit defined by the Supply Temperature Low Limit slot (default value 10°C). The range between the Supply Temperature Low Limit and Supply Temperature High Limit values is called a comfort range.

#### Supply Air Temperature limitation in the 1<sup>st</sup> stage, binary control

If the supply air temperature value exceeds the comfort range, the default application disables heating (if the temperature value is above the SupplyTemperatureHighLimit), or cooling (if the temperature value is above the SupplyTemperatureLowLimit). If the supply air temperature value returns to the comfort range, the FCU application resets the delay counter and returns to normal operation.

#### Supply Air Temperature limitation in the 2<sup>nd</sup> stage, binary control

If the supply air temperature value exceeds the comfort range, the default application disables the 2<sup>nd</sup> stage and starts counting 30 seconds delay time. After 1 minute, if the supply air temperature value is still out of the comfort range, the FCU application disables heating (if the temperature value is above the SupplyTemperatureHighLimit) or cooling (if the temperature value is above the SupplyTemperatureLowLimit). If the supply air temperature value returns to the comfort range, the FCU application resets the delay counter, enables the 2<sup>nd</sup> stage, and returns to normal operation.

#### Supply Air Temperature limitation in the 1<sup>st</sup> stage, analog control

In the analog control, if the supply air temperature approaches 1°C to the comfort range limit, the FCU application starts a built-in algorithm, which reduces the air temperature (if the temperature value is close or above the SupplyTemperatureHighLimit) or increase the air temperature (if the temperature value is close or below the SupplyTemperatureLowLimit). If the supply air temperature value returns to the comfort range  $\pm 1^\circ\text{C}$ , the default application resets the delay counter and returns to normal operation.

## Supply Air Temperature limitation in the 2<sup>nd</sup> (with external heater/cooler), analog control

In the analog control, if the supply air temperature approaches 1°C to the comfort range limit, the FCU application disables 2<sup>nd</sup> stage and starts counting 30 seconds delay time. After 1 minute, if the supply air temperature value approaches 1°C to the comfort range limit, the default application starts a built-in algorithm, which reduces the air temperature (if the temperature value is close or above the SupplyTemperatureHighLimit) or increase the air temperature (if the temperature value is close or below the SupplyTemperatureLowLimit). If the supply air temperature value returns to the comfort range  $\pm 1^\circ\text{C}$ , the default applications resets delay counter, enables 2<sup>nd</sup> stage, and returns to normal operation.

### 4.3.5 FCU Test Mode

This mode was implemented to conduct a quick heating/cooling test. In this mode, the FCU application starts the fan and heating or cooling actuators with 100% value. Depending on the FCU\_Test\_Mode network variable value, the test mode activates 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 18. FCU\_Test\_Mode network variable values description

### 4.3.6 FCU Controller Outputs Manual Override

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

## 5 FCU Panel Connection and Configuration

The FCU controller works with three types of dedicated panels:

- iSMA-B-FCU-LP, panel with LCD display;
- iSMA-B-FCU-SP, panel without display, fully passive;
- Touch Point panel.

The default application allows the user to select, which temperature sensor source is chosen to control algorithm.

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

No.	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

Table 19. Sensor selection with the CFG DIP switch

### 5.1 iSMA-B-LP Configuration

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

If the room panel is connected, the user can decide, which temperature sensor to control the algorithm from the panel or from special input. The temperature source is chosen by the CFG DIP switches number 5 and 6, according to the table above. Using the iSMA-B-LP, the user can set and display many FCU controller parameters, such as fan speed, setpoint, offset, occupancy status, etc. If using the iSMA-B-LP device, the configuration and user parameters are synchronized with the BMS, the last change from the BMS or panel is the most current.

### 5.2 iSMA-B-SP Configuration

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

Effective\_Setpoint = Setpoint + Setpoint\_Offset

## 5.3 Touch Point Configuration

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

If the room panel is connected, the user can decide, which temperature sensor to control the algorithm from the panel or from special input. The temperature source is chosen by the CFG DIP switches number 5 and 6, according to the table above. Using the Touch Point panel, the user can set and display many FCU controller parameters, such as fan speed, setpoint, offset, occupancy status, etc. If using the Touch Point device, the configuration and user parameters are synchronized with the BMS, the last change from the BMS or panel is the most current.

## 6 FCU Master-Slave Configuration

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

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

### 6.1 FCU Addressing MAC and ID

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

**Example:** Configuration how to set the FCU controller MAC address 83. Device's manufacture BACnet number is 826.

The MAC address 83 contains the following multiplicity of number 2:  $83 = 1 + 2 + 16 + 64$ . The DIP switch address settings is shown in table below. All addresses of the 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 20. Address 83 DIP switch configuration

In this case the BACnet ID will be: 826 083.

### 6.2 Auto Binding Addressing

The default application allows for automatic calculation of the BACnet Device Id of slave devices in the 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

Master Id	Slave 1 ID	Slave 2 ID	Slave 3 ID	Slave 4 ID	Slave 5 ID
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 21. Master Slave Id - Auto Binding function

The auto-binding function can be disabled (by setting the true value to the 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

If the master device detects that it can communicate with a 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

Network Variable Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value	Direction
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 22. Master-slave sharing parameters

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

- Net\_Temperature: sends the room temperature from the 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: the setpoint for slave devices, based on the master device's setpoint and the Setpoint\_Offset value. This parameter does not include the Unoccupied\_Offset and Standby\_Offset, Effective Setpoint is calculated in the slave device according to the FCU mode;
- Occupancy\_Mode: the occupancy mode for slave devices, based on the master device Occupancy\_Status value;
- Fcu\_Mode: the FCU\_Mode for slave devices, based on the master device's FCU\_Mode value;
- Fan\_Mode: the Fan\_Mode for slave devices, based on the master device's Fan\_Mode value;
- Slave\_Window\_Status: every 1 minute the master device checks the slave device's open window status. If the master device detects that the window is open (their own or one of the devices in group), it runs the open window function (waits the time defined in the Window\_Status\_Delay network variable, and if the window is still open, switches 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	9	-	1209		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

Name	Units	Access	BACnet BV ID	BACnet AV ID	Modbus Coil	Modbus Register	Default Value
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 23. Master device network parameters dedicated to master-slave function

## 6.4 Application Status

In order to give the user possibility to troubleshoot and diagnose application's operation, the App\_status network variable was added. The information is represented as a multistate value available in the Modbus register 99 and the BACnet Device object property 5002. This network variable allows to understand, what is causing a problem if the application is not working, or which fault it has gone into. It also shows transitional states such as yield, restart, and hibernate.

## 7 FCU Network Variables

### 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

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
Occupancy_Mode	N/A	RW	0	100	0	0 – Unoccupied mode, 1 – Occupied mode, 2 – Standby mode
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

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
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	1 <sup>st</sup> stage heating thermostat differential value
Cooling_Binary_Diff	°C	RW	27	127	4	1 <sup>st</sup> stage cooling thermostat differential value
Second_Stage_Threshold_Binary	°C	RW	28	128	2	2 <sup>nd</sup> stage shifting parameter in digital control mode
Second_Stage_Diff_Binary	°C	RW	29	129	6	2 <sup>nd</sup> stage thermostat differential parameter in digital control mode
Second_Stage_Threshold_Analog	%	RW	30	130	80	2 <sup>nd</sup> stage shifting parameter in analog control mode

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
Second_Stage_Diff_Analog	%	RW	31	131	5	2 <sup>nd</sup> 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

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
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 4 – sensor type 20K6A1 NTC 5 – sensor type 2,2K3A1 NTC 6 – sensor type 3K3A1 NTC 7 – sensor type 30K6A1 NTC 8 – sensor type SIE1 NTC 9 – sensor type TAC1 NTC 10 – sensor type SAT1 NTC
S2_Sensor_Type	N/A	RW	44	144	1	
S3_Sensor_Type	N/A	RW	45	145	1	
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

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
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  Note: In Modbus protocol this is 32nd bits register
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	
Slaves_Ping_Frequency	min	RW	64	164	15	Slaves ping frequency value
Effective Setpoint	°C	RO	100	200	N/A	Effective setpoint Value
Occupancy Status	N/A	RO	101	201	0	0 – Unoccupied 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

Name	Units	Access	BACnet ID	Modbus Address	Default Value	Description
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
Cooling_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/ Touch Point Temperature value
LCD Panel Humidity	%	RO	121	221	N/A	Room panel iSMA-B-LP/ Touch Point Humidity value
LCD Panel CO2	ppm	RO	122	222	N/A	Room panel iSMA-B-LP/ Touch Point CO <sub>2</sub> value

Table 24. FCU BACnet AnalogValues and Modbus registers

## 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

Name	Access	BACnet ID	Modbus Address	Default Value	Description
Fan Heating Occupied Active	RW	1	1201	True	Enable/Disable fan running at low speed after no fan demand in heating occupied mode
Fan Cooling Occupied Active	RW	2	1202	False	Enable/Disable fan 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_Trig- ger_Invert	RW	6	1206	False	False – normal, true – invert
I2_Presence_Sensor _Invert	RW	7	1207	False	
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	False – auto, true – manual
Cooling_Valve_Manual_Enable	RW	11	1211	False	
HTG_Relay_Manual_Enable	RW	12	1212	False	
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 LCD panel submenu icons
LCD Temperature Active	RW	16	1216	True	Enable/Disable room panel current temperature display

Name	Access	BACnet ID	Modbus Address	Default Value	Description
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 Visible	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 Visible	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 <sub>2</sub> 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

Name	Access	BACnet ID	Modbus Address	Default Value	Description
Cooling_Second_Stage	RO	81	1281	N/A	Heating in second stage current status
I1_Remote_Occupancy_Trigger	RO	82	1282	N/A	Digital input current status
I2_Presence_Sensor_Card_Holder	RO	83	1283	N/A	
I3_Window_Contact	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	

Table 25. FCU BACnet BinaryValues and Modbus coils