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Application manual

Air quality multisensor and regulator

EK-ES3-TP

Index

Revision	Updating	Author	Date
1.0	First version	G. Schiochet	14/02/2020
1.1	Relative setpoint objects corrected	G. Schiochet	15/06/2019
2.0	Modified product from ES2 to ES3	G. Schiochet	25/05/2022

The latest revision of the application manual is available at www.ekinex.com. For previous revisions, contact the technical support at support@ekinex.com.

Foreword

The present document describes the ekinex® KNX air quality multisensor and regulator, for the measurement of temperature, relative humidity (R.H.) TVOC (Total Volatile Organic Compounds) and CO_2 equivalent concentration, versions EK-ES3-TP….

1 General information

The device described in the present document works as an electronic digital temperature controller for a room or a zone (consisting e.g. in a group of rooms or a whole floor) of a building and is part of the secundary regulation for heating and cooling. The room temperature controller was developed according to the KNX standard for use in systems of control of homes and buildings, and is equipped with 3 integrated sensors: temperature, relative humidity and air quality. In particular, the air quality measurement is done by means of a VOC (Volatile Organic Compound) sensor, with TVOC and CO_2 equivalent output signal.

The Multisensor can also work as a controller for these 3 parameters, that are available for a single zone to be managed. Up to 8 integrated LEDs with lightpipe can be configured, in order to display the operating thresholds for TVOC and CO2 equivalent, the activation of the humidification/dehumidification functionality and the cooling/heating working modes.

The device is equipped with an integrated KNX bus communication module and is designed for wall installation on a flush mounting box. Both the programming button and LED are located in the front of the device below the rocker, as well as the 3 sensors. The device is powered by the KNX bus line and does not require any auxiliary power supply.

1.1 Function

The main function of the device is to control the temperature of the air mass of the room by means of the actual temperature (T_{eff}), measured by the device itself or received by the bus, and of the setpoint temperature (T_{set}) set by the user; comparing the two values and a series of parameters set before the commissioning, the regulation algorithm of the device calculates the control variable value that is converted to a telegram and transmitted on the bus toward KNX actuators (such as binary outputs, fan-coli controllers, valve drives, etc.) able to control the operation of heating and cooling terminal units.

Two decision thresholds are available for the temperature, to control the activation/deactivation of the heating/cooling system. At the same time, two independently configurable thresholds can be managed for the relative humidity, as well as three thresholds for both the TVOC and the CO_2 equivalent parameters.

As soon as the measured values go below or above the thresholds, it is possible to manage a corresponding action; e.g., if the CO_2 equivalent concentration is too high, a message over the bus to the actuators can be sent, in order to activate fans for the air mass circulation in the room. In the same way, if an excessive relative humidity is detected by the sensors, a message over the bus can be sent, to activate the room dehumidification.

As regards the CO_2 equivalent parameter, a configurable alarm with a threshold is foreseen, with an exceeding limit that can be set as percentage. If the building is subjected to sustainability certification according to the LEED protocol (Leadership in Energy and Environmental Design, by the US Green Building Council), the configuration of such alarm function can be useful to get the EQ Credit (Advanced Strategies for indoor air quality), with reference to requirement C (carbon dioxide monitoring).

1.2 Main functional features

The main functions carried out by the device are:

- Temperature, relative humidity and air quality (TVOC and CO_2 equivalent) measuring through the integrated sensors, with possibility of sending the read valued on the bus;

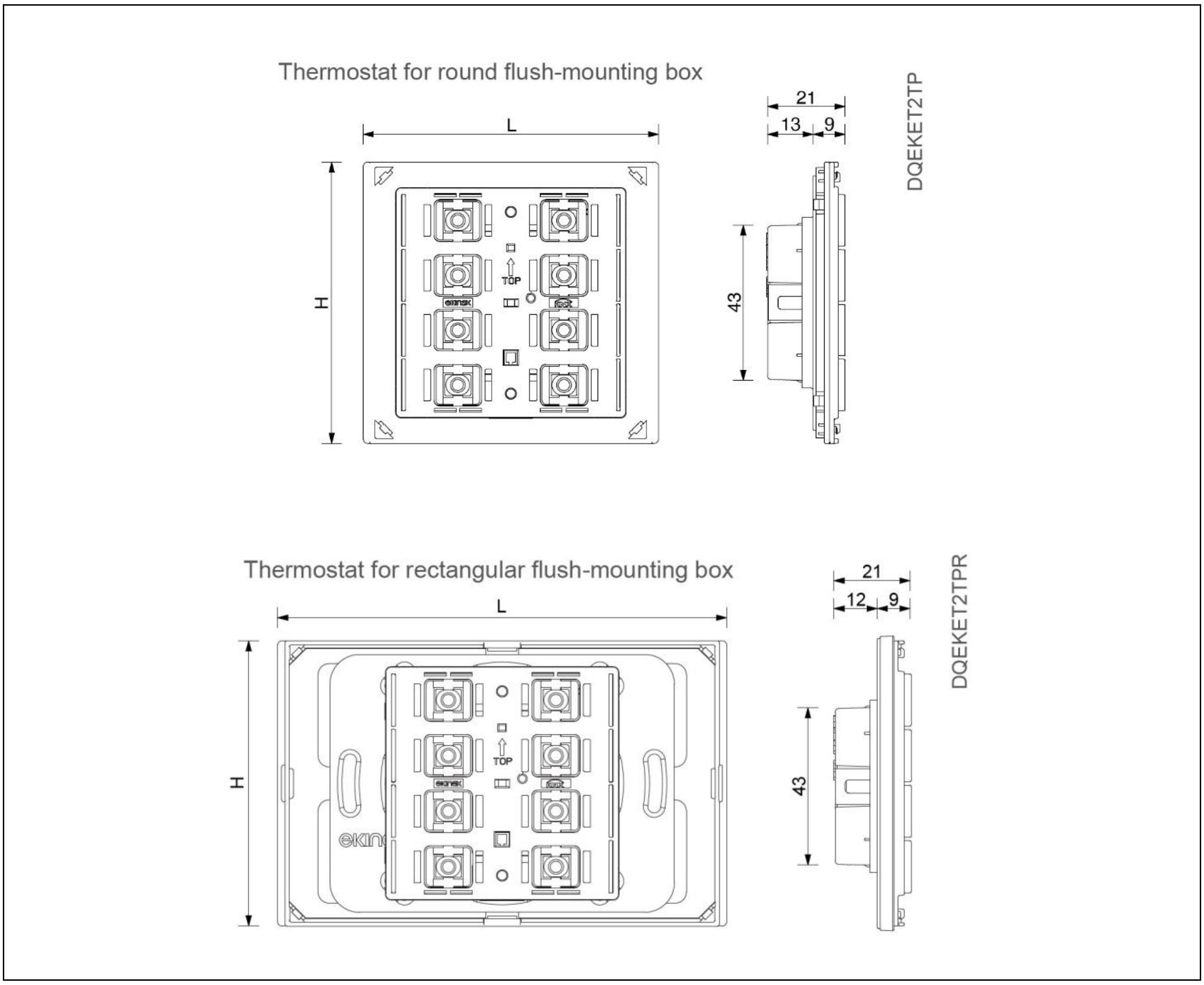
- Two-point (ON/OFF) or proportional (PWM or continuous) room temperature regulation;
- Seasonal modes: heating and cooling with possibility of either local or via bus seasonal changeover;
- Operating modes: comfort, standby, economy and building protection with different setpoint for heating and cooling functions;
- Automatic switching of the operating modes through presence sensor or window contact;
- Weighted average of two temperature values;
- Dew-point temperature computation;
- Temperature regulation (measured and setpoint, as °C), relative humidity (measured and setpoint in percentage), air quality as TVOC concentration, in ppb, and CO_2 equivalent concentration, in ppm, alarms and errors (with alphanumeric coding);
- Relative humidity thresholds setting;
- TVOC and CO_2 equivalent concentration thresholds setting;
- Compatibility with common external sensors, connected to the bus by means of KNX devices, that are able to send either state or value messages over the bus;
- Floor temperature limitation and antincondensation (for radiant panels);
- Delayed start of a fan (“hot-start”) with time-scheduling or depending on the water temperature measured at the coil for thermal exchange;
- Compatibility with KNX actuators for the control of VAV flow regulators;
- Compatibility with KNX actuators for 6-way zone valves management;
- Logic functions (AND, OR, NOT and XOR) availability, in order to implement complex functions in the building automation system.

1.3 Technical data

Feature	Valore
Device	KNX S-mode bus device
Communication	according KNX TP1 standard
Use	dry internal rooms
Environmental conditions	• Operating temperature: - 5 ... + 45°C • Storage temperature: - 25 ... + 55°C • Transport temperature: - 25 ... + 70°C • Relative humidity: 95% not condensating
Power supply	SELV 30 Vdc from bus KNX (auxiliary power supply not necessary)
Current consumption from bus	< 13 mA
Programming elements	1 pushbutton and 1 LED (red) on the front side
Display elements	4 red, 2 blue, 4 white, 2 green, 2 orange and 2 yellow LEDs
Integrated sensors	Temperature, relative humidity and air quality
Installation	On round or square wall-mounting box with distance between fixing holes of 60 mm, or rectangular wall-mounting box with distance between fixing hole of 83.5 mm
Connection	• bus: black/red KNX terminal block
Protection degree	IP20
Dimensions (WxHxD)	81 x 77 x 24 mm

1.4 Design

The device is realised for wall-mounting on either round or square wall box with distance between fixing holes of 60 mm, or rectangular flush-mounting box (3 slots, italian standard) with distance between fixing holes of 83,5 mm.



Picture 1 - Device execution: frontal and lateral view

1.5 Delivery

The delivery includes the screws (2 pairs) and the terminal block for the connection of the KNX bus. The plate, the plastic adapter, the metal support and the frame (if necessary) must be ordered separately. For further information please refer to ekinex® product catalog or visit www.ekinex.com.

1.6 Accessories

The device has to be completed with a square rocker 60 x 60 mm and 1 or 2 places plate, with one 60 x 60 mm window. An ekinex® Form o Flank frame is also required, except for 'NF - No Frame version.

The rocker is available in square modularity, plastic material and three color variations. The square and rectangular frames are available in 2 form solutions (Form and Flank), plastic or aluminium material and several colors and finishes.

The ‘NF – no frame versions are mounted without frame. They show a side profile, that can be ordered in either black or white color. The programming button and LED are located in the front side, below the rocker. The back side of the case hosts the terminal block for KNX bus line.

Code	Mounting	Plate	Rocker
EK-ES3-TP	With frame (Form or Flank series) or without (‘NF – no frame serie)	EK-PQS-…, 1 hole, 60x60 EK-P2G-…, 2 holes, 55x55, 60x60 EK-P2S-…, 2 holes, 60x60	EK-T1Q-…
	With frame (Form or Flank series) or without (‘NF – no frame serie)	EK-PRS-…, 1 hole, 60x60 EK-P2G-…, 2 holes, 55x55, 60x60 EK-P2S-…, 2 holes, 60x60	

Table 1 - Accessories of the device: set of rockers and frames

1.7 Marks and certification

The KNX mark on the ekinex device ensures interoperability with the KNX devices of EKINEX and other manufacturers installed on the same system bus system. The compliance with the applicable European directives is indicated by the presence of the CE mark.

2 Installation

The device has degree of protection IP20, and is therefore suitable for use in dry interior rooms. The installation of the device requires the following steps:

a) fix the metal support with the screws supplied on a wall box with suitable fixing holes. It is recommended to install the device at a height of 150 cm;
b) snap a square frame of the form or flank series, inserting it from the rear of the device;
c) insert the terminal for the bus, previously connected to the bus cable, in its slot on the rear side. Connect the sensors (if foreseen) to the device inputs. At this point it is recommended to carry out the commissioning of the device or at least the download of the physical address;
d) install the device on the metal support through the spring system, tightening then the two screws requires also to tighten the screws included in the delivery. For mounting the device follow also the indication TOP (arrow tip pointing up) on the rear side of the device.

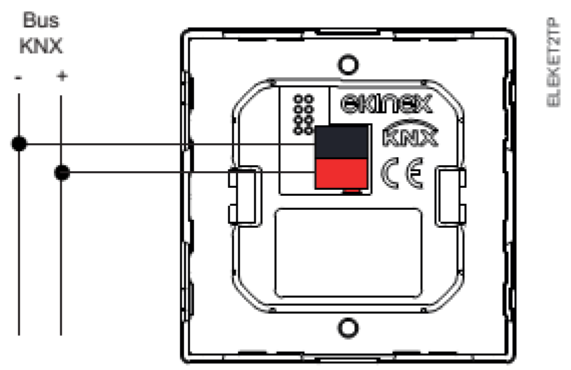
> **i** ***Note on mounting screws***
> *The screws for the metal support must be tightened with a max. torque of 1.0 Nm.*

2.1 Connection

For the operation the device has to be connected to the bus line and addressed, configured and commissioned with ETS (Engineering Tool Software). The connection of the KNX bus line is made with the terminal block (red/black) included in delivery and inserted into the slot of the housing.

Characteristics of the KNX terminal block

- spring clamping of conductors
- 4 seats for conductors for each polarity
- terminal suitable for KNX bus cable with single-wire conductors and diameter between 0.6 and 0.8 mm
- recommended wire stripping approx. 5 mm
- color codification: red = + (positive) bus conductor, black = - (negative) bus conductor



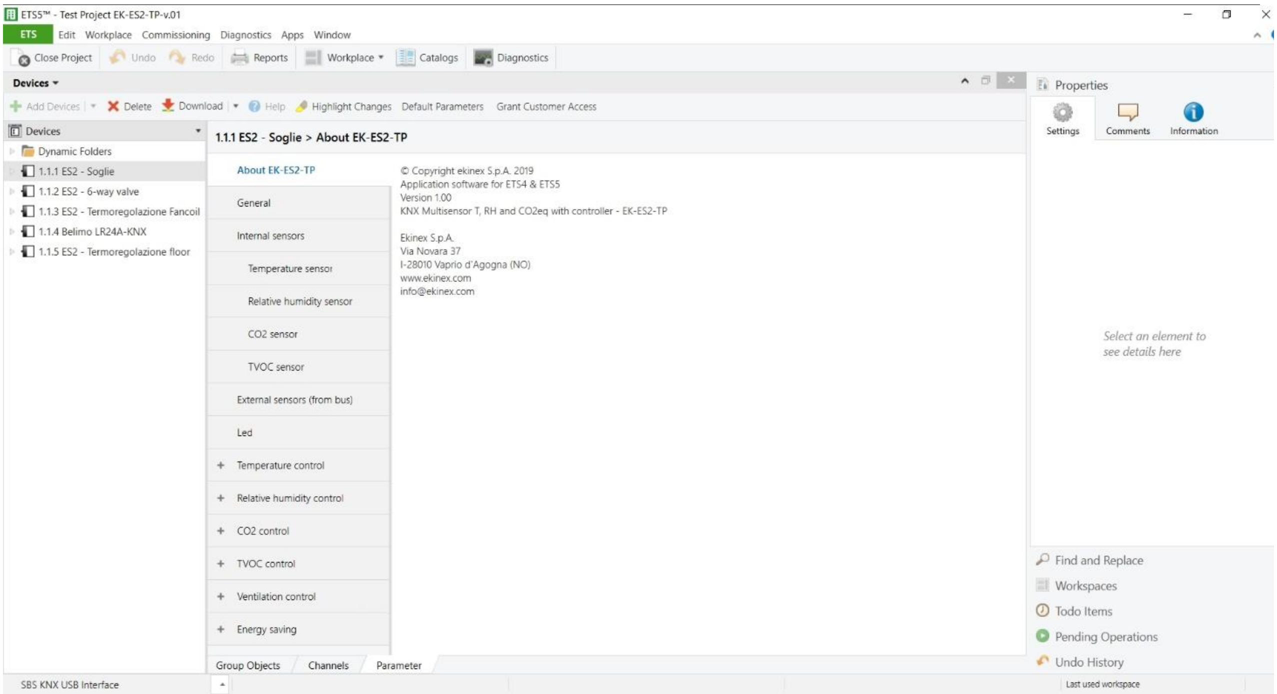
Picture 2 - Connection of the device of the bus line

3 Configuration and commissioning

The configuration and commissioning are carried out with the ETS (Engineering Tool Software) tool and the ekinex® application program provided free of charge by EKINEX; you do not need any additional software or plug-in tool. For further information on ETS see also www.knx.org.

3.1 Configuration

The device functionality is defined by the settings done via software. The configuration requires necessarily ETS4 (or later releases) and the ekinex® APEKES3TP##.knxprod (## = release) application program that can be downloaded from the website www.ekinex.com. The application program allows the configuration of all working parameters for the device. The device-specific application program has to be loaded into ETS or, as alternative, the whole ekinex® product database can be loaded; at this point, all the instances of the selected device type can be added to the project. The configurable parameter details are described in this application manual.



Picture 3 - Application program for ETS APEKES3TP##.knxprod (## = version)

3.1.1 Tree structure of the application program

At its opening, the tree structure of the program includes the following main items:

- About EK-ES2-TP
- General
- Internal sensors
  - Temperature sensor
  - Relative humidity sensor
  - CO2 sensor
  - TVOC sensor
- External sensors (from bus)
- LED
- Temperature control
  - Settings
  - Heating
  - Cooling
  - Ventilation
- Relative humidity control
  - Dehumidification
  - Humidification
  - Calculated psychrometric values
- CO2 control
  - Thresholds
- TVOC control
  - Thresholds
- Ventilation control
- Energy saving
  - Window contacts
  - Presence sensors
  - Card holder
- Logic functions

Other items may appear depending on the choices done for the parameters of the folders.

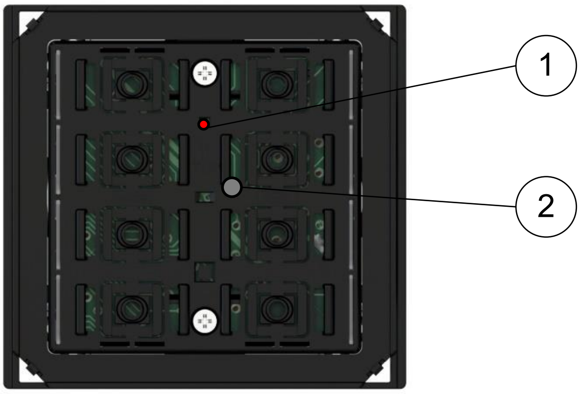
3.1.2 Languages of the application program

The application program is available in four languages: English, Italian, German and French. The language displayed can be changed in ETS choosing "Settings / Presentation language".

3.2 Commissioning

For commissioning purposes, as shown in Picture 4, the device is provided on the front side (in the area usually occupied by the rocker) of the following elements:

- a red LED (1) for indication of the active operating mode (LED on = programming, LED off = normal operation);
- a pushbutton (2) for switching between the normal and programming operating mode.



Picture 4 - Device programming: led (1) and pushbutton (2)

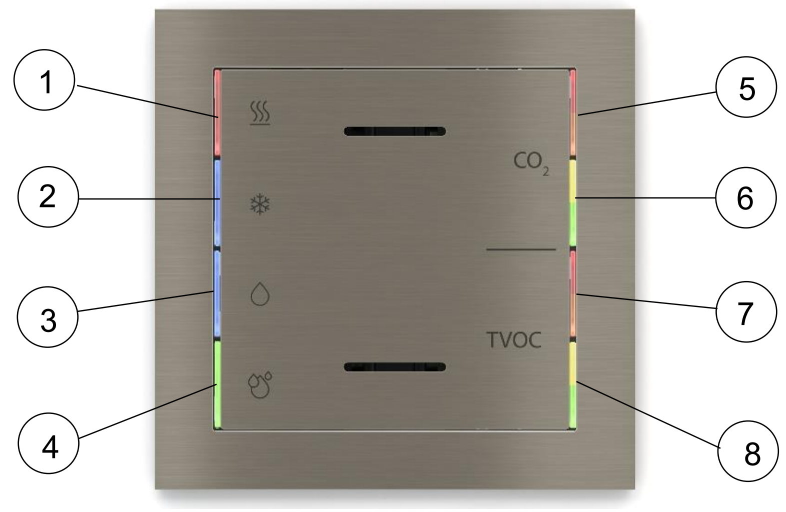
For the device commissioning, the following activities are required:

- make the electrical connections;
- turn on the bus power supply;
- switch the device operation to the programming mode by pressing the programming pushbutton located on the front side of the housing. In this mode of operation, the programming LED is turned on;
- download into the device the physical address and the configuration with the ETS® program.

At the end of the download, the operation of the device automatically returns to normal mode; in this mode the programming LED is turned off. Now the bus device is programmed and ready for use.

4 User interface

The user interface of the room temperature controller includes 8 LED with lightpipes for signalling purposes. They are installed at both sides of the device and aim to show the relative humidity and CO_2 equivalent working thresholds, and the heating/cooling seasonal modes.



Picture 5 - LED indications for heating/cooling, dehumidification/humidification and air quality

With reference to Picture 5, the displayed information are:

- White LED for indication of the heating mode functionality active, red LED if heating is ON (1);
- White LED for indication of the cooling mode functionality active, blue LED if cooling is ON (2);
- Blue LED (3) for indication of the dehumidification functionality ON;
- Green LED (4) for indication of the humidification functionality ON;
- Red flashing LED for indication that the measured CO2 equivalent exceeds threshold 3, orange LED if the concentration is between thresholds 2 and 3 (5);
- Yellow LED for indication that the measured CO2 equivalent is between thresholds 1 and 2, green LED if the concentration is below threshold 1 (6);
- Red flashing LED for indication that the measured TVOC exceeds threshold 3, orange LED if the concentration is between thresholds 2 and 3 (7);
- Yellow LED for indication that the measured TVOC is between thresholds 1 and 2, green LED if the concentration is below threshold 1 (9).

5 Integrated sensors

As already mentioned in the General information chapter, the Multisensor device is equipped with 3 integrated sensors, all located under the plastic half-shell (please refer to Picture 6): temperature, relative humidity (2) and air quality (3). The air quality measurement is done by means of a OVC (Organic Volatile Compound) sensor, providing both TVOC and CO_2 equivalent output signals.

5.1 Temperature sensor

The integrated temperature sensor allows the measure of the room temperature in the range from 0 °C to +40 °C with a resolution of 0.1 °C. To keep into account significant environmental interferences such as the proximity to heatsources, the installation on an outer wall, the chimney effect due to rising warm air through the corrugated tube connected to the wall-mounting box, the measured value can be corrected by means of a offset of ± 5 K or, preferably, can be used a weighted average value between two values of temperature chosen from the following ones: value measured by the integrated sensor, value measured by a temperature sensor connected to one of the inputs of the device, value received via bus from any KNX device (e.g., ekinex pushbuttons).

In Picture 6, the temperature sensor is placed in position (1).

5.2 Relative Humidity sensor

The relative humidity sensor allows to measure the room relative humidity value. This value can be used to manage an advance room thermal regulation and to enlarge the safety working conditions for some cooling terminal systems.

In the next chapters, a detailed explanation on how the relative humidity value can be sent over the bus by using the specific communication object 10 (for 2 bytes) and 11 (for 1 byte) will be shown. The Multisensor device applies a logic for the computation and the sending over the bus of the dew-point temperature psychrometric value, by means of the combined measurements of temperature and relative humidity.

In Picture 6, the relative humidity sensor is placed in position (2).

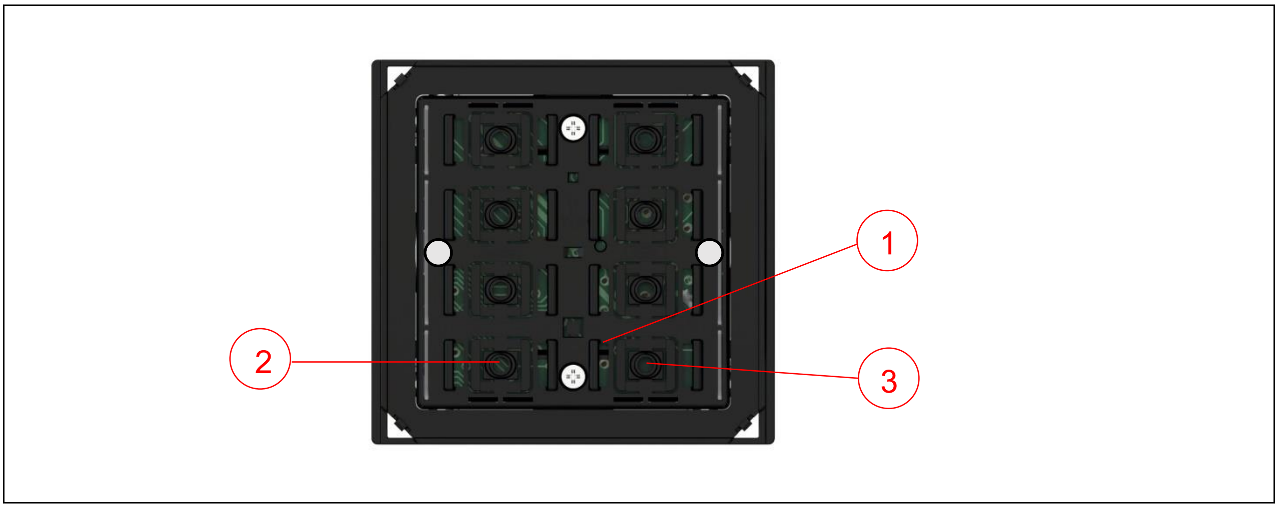
5.3 Air quality sensor

The integrated air quality sensor applies a dynamic correction algorithm and a set of parameters saved in the memory, to provide 2 complementary signals of air quality: the first one is the TVOC (Total Volatile Organic Compound) component, while the second is the CO_2 equivalent.

The output values are included in a range from 0 and 60000 ppb (parts per billion) for the TVOC signal, while the CO_2 equivalent component can fluctuate between 400 and 60000 ppm (parts per million).

The sampling frequence is fixed to 1 Hz for both signal components.

In Picture 6, the air quality sensor is placed in position (3).



Picture 6 - Integrated sensors placement

6 Input variables

The data that the device usesin its control algorithms and /or to be displayed may come from:

- the internal sensors;
- the KNX bus through standard Communication Objects.

The processed data can also be transmitted on the KNX bus as Communication Objects. The classification of the input variables is shown in Table 2.

Data	Coming from	Description
Room temperature	Internal sensor	Analogic value for thermoregulation functions – Object 2 (2 bytes)
Room relative humidity		Analogic value for thermoregulation functions – Object 10 (2 bytes) and Object 11 (1 byte)
TVOC		Analogic value for thermoregulation functions – Object 138 (2 bytes)
CO_2 equivalent		Analogic value for thermoregulation functions – Object 9 (2 bytes)
Room temperature	KNX bus (through communication objects)	Object 20 (2 bytes)
Humidity		Object 21 (2 bytes) and Object 22 (1 byte)
Indoor CO_2 value		Object 139 (2 bytes)
Antistratification temperature		Object 23 (2 bytes)
Outdoor temperature		Object 24 (2 bytes)
Exchange coil temperature		Object 25 (2 bytes)
Floor surface temperature		Object 26 (2 bytes)
Conveying fluid flow temperature		Object 27 (2 bytes)
Presence of condensation		Object 33 (1 bit)
Window state (open/close)		Objects 28 and 29 (1 bit)
Presence of people in the room		Objects 30 and 31 (1 bit)
Card holder state (badge in/out)		Object 32 (1 bit)

Table 2 - Input variables from internal sensors, physical inputs and standard communication objects

The device does not have outputs for direct switching or control of heating / cooling terminals or for status or values signalling. The output variables include exclusively communication objects that are sent on the bus, received and processed by KNX actuators (general-purpose or dedicated to HVAC applications).

7 Application program for ETS

In the following chapters, the list of folders, parameters and communication objects of the application program is reported. Some specific functions of the thermostat are described in more detail in the dedicated paragraphs. The tree structure of the application program as imported into ETS (or by pressing the "Default Parameters" button of ETS) is as follows:

- About EK-ES2-TP
- General
- Internal sensors
  - Temperature sensor
  - Relative humidity sensor
  - CO2 sensor
  - TVOC sensor
- External sensors (from bus)
- LED
- Temperature control
  - Settings
  - Heating
  - Cooling
  - Ventilation
- Relative humidity control
  - Dehumidification
  - Humidification
  - Calculated psychrometric values
- CO2 control
  - Thresholds
- TVOC control
  - Thresholds
- Ventilation control
- Energy saving
  - Window contacts
  - Presence sensors
  - Card holder
- Logic functions

Other folders may appear depending on the choices done for the parameters of the folders represented in the main tree structure.

7.1 About EK-ES3-TP

The folder ***About EK-ES3-TP*** is for information purposes only and does not contain parameters to be set. The information given is:

Application software for ETS4 & ETS5
Version 1.00 (or later)
KNX Multisensor T, RH and CO2eq with controller

EKINEX S.p.A.
Via Novara, 37

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www.ekinex.com
info@ekinex.com

7.2 General

The ***General*** folder includes the following parameters:

- Delay after bus voltage recovery
- Logic functions

The folder has no secondary folders.

7.2.1 Parameter and communication objects tables

Parameter name	***Conditions***	***Values***
Delay after bus voltage recovery		**00:00:04.000 hh:mm:ss:fff** [range 00:00:04.000 … 00:10:55.350]
	Time interval after which the transmission of the telegrams on the bus starts after the power supply is restored. The delay affects both the event-driven transmission and the cyclic transmission of a telegram. Regarding the latter, the counting of the pause interval for retransmission starts at the end of the time of initial delay. *The field has format hh:mm:ss:fff (hours : minutes : seconds .milliseconds): the default value 00:00:04.000 corresponds to 4 seconds.*	
Logic functions		**Disabled** / enabled

Object name	***Conditions***	***Dim.***	***Flags***	***DPT***	***Comm. Obj. No.***
Thermostat – Building protection HVAC mode active		1 bit	CR-T-	[1.011] state	41
Thermostat – Chrono active status		1 bit	CR-T-	[1.011] state	42
Thermostat – Thermal generator lock		1 bit	C-W--	[1.005] alarm	83
Thermostat – Alarm text		14 bytes	CR-T-	[16.000] Character string (ASCII)	85

7.3 Internal sensors

The ***Internal sensors*** folder includes the following parameters:

- Temperature sensor enabling
- Relative Humidity sensor enabling
- CO_2 equivalent sensor enabling
- TVOC sensor enabling

7.3.1 Temperature sensor

The ***Temperature sensor*** folder contains the following parameter:

- Filter type for the internata data computing
- Temperature offset, applied to the measured value
- Minimum change of value to send [K]
- Cyclic sending interval
- Threshold 1
- Threshold 2

7.3.1.1 Parameter and communication objects tables

Parameter name	***Conditions***	***Values***
Temperature sensor		**enabled** disabled
	The temperature sensor is enabled as default.	
Filter type	Temperature sensor = enabled	low **medium** high
	Low = average value every 4 measurements *Medium = average value every 16 measurements* *High = average value every 64 measurements*	
Temperature offset	Temperature sensor = enabled	**0°C** [range -5°C … +5°C]
Minimum change of value to send [K]	Temperature sensor = enabled	**0,5** [range 0 …5]
	If the parameter is set to 0 (zero), no value is sent after a change.	
Cyclic sending interval	Temperature sensor = enabled	**no sending** [other values in the range 30 s … 120 min]
Threshold 1	Temperature sensor = enabled	**not active** below above
Value [°C]	Temperature sensor = enabled, Threshold 1 = below or above	**7** [range 0 … 50]
Threshold value update from bus	Temperature sensor = enabled, Threshold 1 = below or above	**no** / yes
Threshold lock enable	Temperature sensor = enabled, Threshold 1 = below or above	**no** / yes

Parameter name	*Conditions*	*Values*
Behaviour at lock	Temperature sensor = enabled, Threshold 1 = below or above Threshold lock enable = yes	**none** / off / on
Behaviour at bus recovery	Temperature sensor = enabled, Threshold 1 = below or above Threshold lock enable = yes	**previous state** / lock / unlock
Threshold 2	Temperature sensor = enabled	**not active** below above
Value [°C]	Temperature sensor = enabled, Threshold 2 = below or above	**45** [range 0 … 50]
Threshold value update from bus	Temperature sensor = enabled, Threshold 2 = below or above	**no** / yes
Threshold lock enable	Temperature sensor = enabled, Threshold 2 = below or above	**no** / yes
Behaviour at lock	Temperature sensor = enabled, Threshold 1 = below or above Threshold lock enable = yes	**none** / off / on
Behaviour at bus recovery	Temperature sensor = enabled, Threshold 2 = below or above Threshold lock enable = yes	**previous state** / lock / unlock
Hysteresis	Temperature sensor = enabled, Threshold 1 and/or Threshold 2 = below or above	**0,4 K** [other values between 0,2 K and 3 K]
Cyclic sending interval	Temperature sensor = enabled, Threshold 1 and/or Threshold 2 = below or above	**no sending** [other values in the 30 s … 120 min range]

Object name	*Conditions*	*Dim.*	*Flags*	*DPT*	*Comm. Obj. No.*
Temperature value	Temperature sensor = enabled	2 bytes	CR-T-	[9.001] temperature (°C)	2
Temperature threshold 1 - Switch	Temperature sensor = enabled, Threshold 1 = below or above	1 bit	CR-T-	[1.001] switch	3
Temperature threshold 1 - Lock	Temperature sensor = enabled, Threshold 1 = below or above Threshold lock enable = yes	1 bit	C-W--	[1.001] switch	4

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
Temperature threshold 1 – Value (from bus)	Temperature sensor = enabled, Threshold 1 = below or above Threshold value update from bus = yes	2 bytes	C-W--	[9.001] temperature (°C)	5
Temperature threshold 2 - Switch	Temperature sensor = enabled, Threshold 2 = below or above	1 bit	CR-T-	[1.001] switch	6
Temperature threshold 2 - Lock	Temperature sensor = enabled, Threshold 2 = below or above Threshold lock enable = yes	1 bit	C-W--	[1.001] switch	7
Temperature threshold 2 – Value (from bus)	Temperature sensor = enabled, Threshold 2 = below or above Threshold value update from bus = yes	2 bytes	C-W--	[9.001] temperature (°C)	8

Acquisition filter

The acquisition filter calculates an average with a series of measured values before sending on the bus. The parameter can have the following values:

- low = average value every 4 measurements;
- medium = average value every 16 measurements;
- high = average value every 64 measurements.

Correction of the measured temperature

The sampling of the temperature value occurs every 10 seconds, while the display is updated every minute. During the configuration with ETS the opportunity is given to correct the measured temperature value within the offset range of - 5 °C ... + 5 °C (step: 0.1 K).

7.3.2 Relative Humidity sensor

The ***Relative humidity sensor*** folder includes the following parameters:

- Filter type for the internata data computing
- Humidity offset, applied to the measured value
- Minimum change of value to send [%]
- Cyclic sending interval
- Threshold 1
- Threshold 2

7.3.2.1 Parameter and communication objects tables

Parameter name	Conditions	Values
Relative humidity sensor		enabled **disabled**
	The relative humidity sensor is disabled as default.	

Parameter name	***Conditions***	***Values***
Filter type	Relative humidity sensor = enabled	low **medium** high
	Low = average value every 4 measurements *Medium = average value every 16 measurements* *High = average value every 64 measurements*	
Humidity offset	Relative humidity sensor = enabled	**0 %** [range –10 % … +10 %]
Minimum change of value to send [%]	Relative humidity sensor = enabled	**2** [range 0 % … +10 %]
	If the parameter is set to 0 (zero), no value is sent after a change.	
Cyclic sending interval	Relative humidity sensor = enabled	**no sending** [other values in the range 30 s … 120 min]
Threshold 1	Relative humidity sensor = enabled	**not active** below above
Value [%]	Relative humidity sensor = enabled, Threshold 1 = below or above	**65** [range 0 … 100]
Threshold value update from bus	Relative humidity sensor = enabled, Threshold 1 = below or above	**no** / yes
Threshold lock enable	Relative humidity sensor = enabled, Threshold 1 = below or above	**no** / yes
Behaviour at lock	Relative humidity sensor = enabled, Threshold 1 = below or above Threshold lock enable = yes	**none** / off / on
Behaviour at bus recovery	Relative humidity sensor = enabled, Threshold 1 = below or above Threshold lock enable = yes	previous state / lock / **unlock**
Threshold 2	Relative humidity sensor = enabled	**not active** below above
Value [%]	Relative humidity sensor = enabled, Threshold 2 = below or above	**65** [range 0 … 100]
Threshold value update from bus	Relative humidity sensor = enabled, Threshold 2 = below or above	**no** / yes

Parameter name	*Conditions*	*Values*
Threshold lock enable	Relative humidity sensor = enabled, Threshold 2 = below or above	**no** / yes
Behaviour at lock	Relative humidity sensor = enabled, Threshold 1 = below or above Threshold lock enable = yes	**none** / off / on
Behaviour at bus recovery	Relative humidity sensor = enabled, Threshold 2 = below or above Threshold lock enable = yes	previous state / lock / **unlock**
Hysteresis [%]	Relative humidity sensor = enabled, Threshold 1 and/or Threshold 2 = below or above	**3,0 %** [other values between 0,5 % and 4 %]
Cyclic sending interval	Relative humidity sensor = enabled, Threshold 1 and/or Threshold 2 = below or above	**no sending** [other values in the 30 s … 120 min range]

Object name	*Conditions*	*Dim.*	*Flags*	*DPT*	*Comm. Obj. No.*
Humidity value (2 bytes)	Relative humidity sensor = enabled	2 bytes	CR-T-	[9.007] humidity (%)	10
Humidity value (1 byte)	Relative humidity sensor = enabled	1 byte	CR-T-	[5.001] percentage (0…100%)	11
Humidity threshold 1 - Switch	Relative humidity sensor = enabled, Threshold 1 = below or above	1 bit	CR-T-	[1.001] switch	12
Humidity threshold 1 - Lock	Relative humidity sensor = enabled, Threshold 1 = below or above Threshold lock enable = yes	1 bit	C-W--	[1.001] switch	13
Humidity threshold 1 – Value (2 bytes, from bus)	Relative humidity sensor = enabled, Threshold 1 = below or above Threshold value update from bus = yes	2 bytes	C-W--	[9.001] temperature (°C)	14
Humidity threshold 1 – Value (1 byte, from bus)	Relative humidity sensor = enabled, Threshold 1 = below or above Threshold value update from bus = yes	1 byte	C-W--	[5.001] percentage (0…100%)	15

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
Humidity threshold 2 - Switch	Relative humidity sensor = enabled, Threshold 2 = below or above	1 bit	CR-T-	[1.001] switch	16
Humidity threshold 2 - Lock	Relative humidity sensor = enabled, Threshold 2 = below or above Threshold lock enable = yes	1 bit	C-W--	[1.001] switch	17
Humidity threshold 2 – Value (2 bytes, from bus)	Relative humidity sensor = enabled, Threshold 2 = below or above Threshold value update from bus = yes	2 bytes	C-W--	[9.001] temperature (°C)	18
Humidity threshold 2 – Value (1 byte, from bus)	Relative humidity sensor = enabled, Threshold 2 = below or above Threshold value update from bus = yes	1 byte	C-W--	[5.001] percentage (0…100%)	19

Acquisition filter

The acquisition filter computes an average with a series of measured values before sending on the bus. The parameter can have the following values:

- low = average value every 4 measurements;
- medium = average value every 16 measurements;
- high = average value every 64 measurements.

Correction of the measured relative humidity

The sampling of the relative humidity value occurs every 10 seconds, while the display is updated every minute. During the configuration with ETS the opportunity is given to correct the measured relative humidity value within the offset range of – 10 % ... + 10 % (step: 1.0 %).

7.3.3 CO_2 sensor

The ***CO_2 sensor*** folder includes the following parameters:

- Filter type for the internata data computing
- CO_2 offset, applied to the measured value
- Minimum change of value to send [%]
- Cyclic sending interval
- CO_2 control

7.3.3.1 Parameter and communication objects tables

Parameter name	***Conditions***	***Values***
CO_2 sensor		**enabled** disabled
	The CO_2 sensor is enabled as default.	
Filter type	CO_2 sensor = enabled	low **medium** high
	Low = average value every 4 measurements *Medium = average value every 16 measurements* *High = average value every 64 measurements*	
CO_2 offset	CO_2 sensor = enabled	**0 %** [range –10 % … +10 %]
Minimum change of value to send [ppm]	CO_2 sensor = enabled	**0 ppm** [range -400 ppm … +400 ppm]
	If the parameter is set to 0 (zero), no value is sent after a change.	
Cyclic sending interval	CO_2 sensor = enabled	**no sending** [other values in the range 30 s … 120 min]
CO_2 control	CO_2 sensor = enabled	disabled **enabled**
	It enables the "CO_2 control" folder.	

Object name	***Conditions***	***Dim.***	***Flags***	***DPT***	***Comm. Obj. No.***
CO_2 value	CO_2 sensor = enabled	2 bytes	CR-T-	[9.008] parts/million (ppm)	9

Acquisition filter

The acquisition filter computes an average with a series of measured values before sending on the bus. The parameter can have the following values:

- low = average value every 4 measurements;
- medium = average value every 16 measurements;
- high = average value every 64 measurements.

Correction of the measured relative humidity

The sampling of the CO_2 equivalent value occurs every 10 seconds, while the display is updated every minute. During the configuration with ETS the opportunity is given to correct the measured relative humidity value within the offset range of – 400 ppm ... + 400 ppm (step: 50 ppm).

7.3.4 TVOC sensor

The ***TVOC sensor*** folder includes the following parameters:

- Filter type for the internata data computing
- Minimum change of value to send [%]
- Cyclic sending interval
- TVOC control

7.3.4.1 Parameter and communication objects tables

Parameter name	Conditions	Values
TVOC sensor		**enabled** disabled
	The TVOC sensor is enabled as default.	
Filter type	TVOC sensor = enabled	low **medium** high
	Low = average value every 4 measurements *Medium = average value every 16 measurements* *High = average value every 64 measurements*	
Minimum change of value to send [ppm]	TVOC sensor = enabled	**0 ppm** [range -400 ppm … +400 ppm]
	If the parameter is set to 0 (zero), no value is sent after a change.	
Cyclic sending interval	TVOC sensor = enabled	**no sending** [other values in the range 30 s … 120 min]
TVOC control	TVOC sensor = enabled	disabled **enabled**
	It enables the "CO_2 control" folder.	

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
TVOC value	TVOC sensor = enabled	2 bytes	CR-T-	[9.008] parts/million (ppm)	138
	***Note**: DPT is* [9.008] parts/million (ppm), because KNX specifications do not state a corresponding CO in [ppb] unit. Therefore, the value is scaled to the right unit internally.				

Acquisition filter

The acquisition filter computes an average with a series of measured values before sending on the bus. The parameter can have the following values:

- low = average value every 4 measurements;
- medium = average value every 16 measurements;
- high = average value every 64 measurements.

7.4 External sensors (from bus)

As “external sensors” are intended KNX-devices (or conventional sensors interfaced to the bus through KNX devices) which send states or values to the Multisensor controller via the bus. Enabling an external sensor, without connecting the corresponding communication object, generates a permanent alarm on the display and suspends the thermoregulation function.

The folder ***External sensors (from bus)*** includes the following parameters:

- Room temperature
- Relative humidity
- Indoor CO_2
- Antistratification temperature
- Outdoor temperature
- Coil temperature
- Floor surface temperature
- Flow temperature
- Analog sensors timeout
- Anticondensation
- Window contact X (X = 1, 2)
- Presence sensor X (X = 1, 2)
- Card holder contact
- Digital sensors timeout

7.4.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
Room temperature		**disabled** / enabled
	It enables a bus temperature sensor. The measured value can be used to calculate a weighted average value in combination with the temperature sensor integrated into the device or a temperature sensor connected to a device input.	
Cyclic reading interval	Room temperature = enabled	**no reading** [other values in the range 30 s … 120 min]
	If the parameter is set to “no reading”, the corresponding communication object must be updated by the remote device sending data. With any different value, data are updated with a reading request by the room thermostat.	
Relative humidity	Internal sensors ⇒ Relative humidity sensor = disabled	**disabled** / enabled
Humidity CO dimension	Relative humidity = enabled	1 byte (DPT 5.001) **2 bytes (DPT 9.007)**
Cyclic reading interval	Relative humidity = enabled	**no reading** [other values in the range 30 s … 120 min]

Indoor CO_2	Internal sensors ⇒ CO_2 sensor = disabled	**disabled /** enabled
	It enables a CO_2 equivalent bus sensor.	
Cyclic reading interval	Indoor CO_2 = enabled	**no reading** [other values in the range 30 s … 120 min]
Antistratification temperature		**disabled** / enabled
	It enables a temperature bus sensor to carry out the antistratification function.	
Cyclic reading interval	Antistratification temperature = enabled	**no reading** [other values in the range 30 s … 120 min]
Outdoor temperature		**disabled** / enabled
	It enables an outdoor temperature bus sensor.	
Cyclic reading interval	Light sensor = enabled	**no reading** [other values in the range 30 s … 120 min]
Coil temperature		**disabled** / enabled
	It enables a bus sensor for measuring the coil temperature of the conveying fluid for heat exchange. The acquisition of the value allows realizing the hot-start function of a fan.	
Cyclic reading interval	Coil temperature = enabled	**no reading** [other values in the range 30 s … 120 min]
Floor surface temperature		**disabled** / enabled
	It enables a bus sensor for measuring the surface temperature of a floor heating system. The acquisition of the value allows to realize the function of surface temperature limitation.	
Cyclic reading interval	Floor surface temperature = enabled	**no reading** [other values in the range 30 s … 120 min]
Flow temperature		**disabled** / enabled
	It enables a bus sensor for measuring the flow temperature of the conveying fluid. The acquisition of the value allows calculating the dew-point temperature to realize the active anticondensation protection function in surface cooling plants (floor or ceiling).	
Cyclic reading interval	Flow temperature = enabled	**no reading** [other values in the range 30 s … 120 min]
Analog sensors timeout		**00:05:00hh:mm:ss** [range 00:00:00 … 18:12:15]
	The field has format hh:mm:ss (hours : minutes : seconds): the default value 00:05:00 corresponds to a timeout of 5 minutes. The value 00:00:00 means that the timeout of the analogic sensors is disabled.	
Anticondensation		**disabled** / enabled
	It enables a bus sensor for detecting the condensation.	
Signal	Anticondensation = enabled	**not inverted** / inverted

Cyclic reading interval	Anticondensation = enabled	**no reading** [other values in the range 30 s … 120 min]
Window contact 1		**disabled** / enabled
	It enables a bus sensor for detecting the state of opening / closing of a window or a door.	
Signal	Window contact 1= enabled	**not inverted** / inverted
Cyclic reading interval	Window contact 1= enabled	**no reading** [other values in the range 30 s … 120 min]
Window contact 2		**disabled** / enabled
	It enables a bus sensor for detecting the state of opening / closing of a window or a door.	
Signal	Window contact 2= enabled	**not inverted** / inverted
Cyclic reading interval	Window contact 2= enabled	**no reading** [other values in the range 30 s … 120 min]
Presence sensor 1		**disabled** / enabled
	It enables a bus sensor for detecting the presence / absence of people within a room.	
Signal	Presence sensor 1 = enabled	**not inverted** / inverted
Cyclic reading interval	Presence sensor 1 = enabled	**no reading** [other values in the range 30 s … 120 min]
Presence sensor 2		**disabled** / enabled
	It enables a bus sensor for detecting the presence / absence of people within a room.	
Signal	Presence sensor 2= enabled	**not inverted** / inverted
Cyclic reading interval	Presence sensor 2= enabled	**no reading** [other values in the range 30 s … 120 min]
Card holder contact		**disabled** / enabled
	It enables a bus sensor for detecting the presence / absence of people in a hotel room provided with a card holder.	
Signal	Card holder contact = enabled	**not inverted** / inverted
Cyclic reading interval	Card holder contact = enabled	**no reading** [other values in the range 30 s … 120 min]
Digital sensors timeout		**00:05:00hh:mm:ss** [range 00:00:00 … 18:12:15]
	The field has format hh:mm:ss (hours : minutes : seconds): the default value 00:05:00 corresponds to a timeout of 5 minutes. The value 00:00:00 means that the timeout of the digital sensors is disabled.	

Object name	*Conditions*	*Dim.*	*Flags*	*DPT*	*Comm. Obj. No.*
Room temperature (from bus)	enabled	2 bytes	C-WTU	[9.001] temperature (°C)	20
Humidity (2 bytes, from bus)	Relative humidity sensor = enabled, Humidity CO dimension = 2 bytes	2 bytes	C-WTU	[9.007] humidity (%)	21
Humidity (1 byte, from bus)	Relative humidity sensor = enabled, Humidity CO dimension = 1 bytes	1 byte	C-WTU	[5.001] percentage (0..100%)	22
Indoor CO_2 value (from bus)	enabled	2 bytes	C-WTU	[9.001] parts/million (ppm)	139
Antistratification temperature (from bus)	enabled	2 bytes	C-WTU	[9.001] temperature (°C)	23
Outdoor temperature (from bus)	enabled	2 bytes	C-WTU	[9.001] temperature °C	24
Coil temperature (from bus)	enabled	2 bytes	C-WTU	[9.001] temperature (°C)	25
Floor temperature (from bus)	enabled	2 bytes	C-WTU	[9.001] temperature (°C)	26
Flow temperature (from bus)	enabled	2 bytes	C-WTU	[9.001] temperature (°C)	27
Anticondensation (from bus)	enabled	1 bit	C-WTU	[1.001] switch	33
Windows contact sensor 1 (from bus)	enabled	1 bit	C-WTU	[1.019] window/door	28
Windows contact sensor 2 (from bus)	enabled	1 bit	C-WTU	[1.019] window/door	29
Presence sensor 1 (from bus)	enabled	1 bit	C-WTU	[1.018] occupancy	30
Presence sensor 2 (from bus)	enabled	1 bit	C-WTU	[1.018] occupancy	31
Contact of card holder (from bus)	enabled	1 bit	C-WTU	[1.018] occupancy	32

About sensor timeout

The internal control system of the thermostat cyclically monitors the updating status of the values of the external sensors (from bus) and the inputs when the timeout setting expires. In case no updated value has been received, the regulation function is suspended, an alarm is displayed on the display through the symbol and the corresponding alarm code (see also the list of alarms in the Diagnostics paragraph).

7.5 Weighted temperature value

The ***Weighted temperature value*** folder appears only if two sensors for measuring the room temperature are enabled and includes the following parameters:

- Relative weight
- Minimum change of value to send [K]
- Cyclic sending interval

7.5.1 Parameter and communication object tables

Parameter name	*Conditions*	*Values*
Relative weight		100% main sensor 90% / 10% 80% / 20% 70% / 30% 60% / 40% **50% / 50%** 40% / 60% 30% / 70% 20% / 80% 10% / 90% 100% additional sensor (from bus)
Minimum change of value to send [K]		**0,5** [other values in the range 0 … 5 K]
	If the parameter is set to 0 (zero), no value is sent at the change.	
Cyclic sending interval		**no sending** [other values in the range 30 s … 120 min]

Object name	*Conditions*	*Dim.*	*Flags*	*DPT*	*Comm. Obj. No.*
Weighted temperature	Internal sensors ⇒ temperature sensor = enabled External sensors (from bus) ⇒ room temperature = enabled	2 bytes	CR-T-	[9.001] temperature °C	34

About weighted temperature

The device allows the acquisition of the room temperature in two ways:

1) from the temperature sensor integrated in the device;
2) via bus from another KNX device, e.g. from an ekinex pushbutton (External sensors (from bus) ⇒ room temperature = enabled);

To optimize or correct the room temperature regulation in special cases (in large rooms, in presence of strong asymmetry of the temperature distribution, when the installation of the device is in a position not suitable, etc.), the device can then use a weighted average between two temperature values. The weights are assigned by the parameter *Relative weight* that assigns a ratio of the two values.

7.6 LED

The ***LED*** folder allows to set the following parameters:

- LEDs intensity from bus
- LED L1 and L2 (temperature control)
- LED L3 and L4 (humidity control)
- LED L5 and L6 (CO_2 control)
- LED L7 and L8 (TVOC control)
- Technical alarm

7.6.1 Parameters

Parameter name	*Conditions*	*Values*
LEDs intensity from bus		**no** / yes
LEDs intensity	LEDs intensity from bus = no	**50 %** 0% … 100% with step 10 %
	This parameter sets the intensity for ALL the signalling LEDs.	
LED L1 and L2 (temperature control)		disabled / **enabled**
	If disabled, the LEDs are always off.	
LED L3 and L4 (humidity control)		disabled / **enabled**
	If disabled, the LEDs are always off.	
LED L5 and L6 (CO_2 control)		disabled / **enabled**
	If disabled, the LEDs are always off.	
LED L7 and L8 (TVOC control)		disabled / **enabled**
	If disabled, the LEDs are always off.	
Technical alarm		**disabled** / enabled
	It enables the communication object nr. 0 "Technical alarm" that allows to activate an alarm signal via a bus telegram. The flashing led indicates that the alarm condition is active.	

Object name	*Conditions*	*Dim.*	*Flags*	*DPT*	*Comm. Obj. No.*
Technical alarm	Technical alarm = enabled	1 bit	C-W--	[1.005] alarm	0
LEDs intensity percentage	LEDs intensity from bus = yes	1 byte	C-W--	[5.001] percentage (0..100%)	1

7.7 Temperature control

The ***Temperature control*** folder includes the following secondary folders:

- Settings
- Heating
- Cooling
- Ventilation

The ***Cooling*** and ***Ventilation*** secondary folders appear only if in the ***Settings*** folder the parameter "Thermostat function" is set to either the value *both heating and cooling* or *cooling*.

7.7.1 Settings

The ***Settings*** folder includes the following parameters:

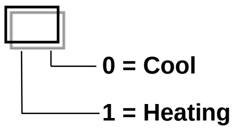
- Setpoint type
- Thermostat function
- Command Communication Object unique or separated (2 or 4-pipes systems)
- Heating – cooling cyclic sending interval
- HVAC mode after download
- Setpoint cyclic sending interval
- End of manual operation
- Disable temperature controller from bus
- Transmission delay after mode change
- Valve protection function

7.7.1.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
Setpoint type		**single** / absolute / relative
Thermostat function		**heating** cooling both heating and cooling
Command Communication Object	Thermostat function = both heating and cooling	**separated** / unique

Parameter name	***Conditions***	***Values***
Control type	Thermostat function = both heating and cooling Command Communication Object = unique	continuous / PWM (pulse width modulation) / **2-points hysteresis** / 6-way valve
	It allows to configure the temperature control type.	
Heating – cooling switch over	Thermostat function = both heating and cooling Control type = 6-way valve	**from bus** / automatic
Heating-cooling cyclic sending interval	Thermostat function = both heating and cooling	**no sending** [other values in the range 30 s … 120 min]
HVAC mode after download	Thermostat function = both heating and cooling	**no change** heating cooling
Setpoint cyclic sending interval		**no sending** [other values in the range 30 s … 120 min]
	The setpoint value that can be sent cyclically is the actual one, depending on the operating mode set manually by the user or automatically by another KNX supervising device with the possibility of time scheduling. The actual setpoint value takes also into account the actual state of the contacts window and presence detection (if the corresponding functions are enabled).	
End of manual operation		**till first telegram from bus** [other values in the range 30 min … 48 h]
Disable temperature controller from bus		**no** / yes
	It defines the possibility to disable the temperature controller function via bus.	
Signal from bus	Disable temperature controller from bus = yes	**not inverted** / inverted
	It defines the logic for the signal that enables or disabled the temperature controller function via bus.	
Transmission delay after mode change		**00:00:04.000** (hh:mm:ss) (range 00:00:00.000 – 00:10:55.350)
Valve protection function		**disabled** / enabled
	It enables the function that activates the drive for the valve control during periods of inactivity of the system.	
Frequency	Valve protection function = enabled	once a day **once a week** once a month
Time interval	Valve protection function = enabled	**10 s** [other values in the range 5 s … 20 min]

Object name	***Conditions***	***Dim.***	***Flags***	***DPT***	***Comm. Obj. No.***
Actual setpoint		2 bytes	CR-T-	[9.001] temperature (°C)	43

Object name	*Conditions*	*Dim.*	*Flags*	*DPT*	*Comm. Obj. No.*
Manual setpoint	Setpoint type = absolute or relative	2 bytes	C-W--	[9.001] temperature (°C)	44
Heating/cooling status out	Always visible	1 bit	CR-T-	[1.100] heating/cooling	35
	The communication object is updated on the bus on event of change internally elaborated by the controller. The object is always available and contains the information about the current conduction mode of the internal temperature controller. **[1.100] DPT Heat/Cool 1 bit** 				
Heating/cooling status in	Thermostat function = both heating and cooling; Heating – cooling switchover = from bus	1 bit	C-W--	[1.100] heating/cooling	36
	The communication object is received by the bus. On switching event, internal controllers of primary and auxiliary stage (if enabled) switch their operating mode.				
HVAC mode in		1 byte	C-W--	[20.102] HVAC mode	37
	The device receives the operating mode (HVAC mode) from a bus device with function of supervisor. The operating mode received through this communication object can be later modified by the user (in this case the room thermostat switches to manual mode).				
HVAC forced mode in		1 byte	C-W--	[20.102] HVAC mode	38
	The communication object allows to receive the operating mode same way as "HVAC mode in" communication object, except the operating mode received through this objct (apart from AUTO command) can no longer be modified by user. The user can modify the operating mode only after "HVAC forced mode in" has sent AUTO command.				
HVAC mode out		1 byte	CR-T-	[20.102] HVAC mode	39
HVAC manual mode		1 byte	CRWTU	[20.102] HVAC mode	40
Chrono active status		1 bit	CR-T-	[1.011] state	42
Manual setpoint status	Setpoint type = absolute or relative	1 bit	CRWTU	[1.011] state	45
Setpoint in	Setpoint type = single	s	CRWTU	[9.001] temperature (°C)	46
Building protection HVAC mode active		1 bit	CR-T-	[1.011] state	41

About heating/cooling terminals

The application functions of the room temperature controller configurable with ETS are particularly suitable for the control through general-purpose or dedicated KNX actuators of the following heating/cooling terminals:

- radiators;
- electric heaters;
- fancoils;
- radiant panels;
- dehumidification units;
- radiant panels + radiators (as auxiliary system);
- radiant panels + fancoils (as auxiliary system);
- radiant panels + dehumidification units.

7.7.1.2 Heating/cooling switchover

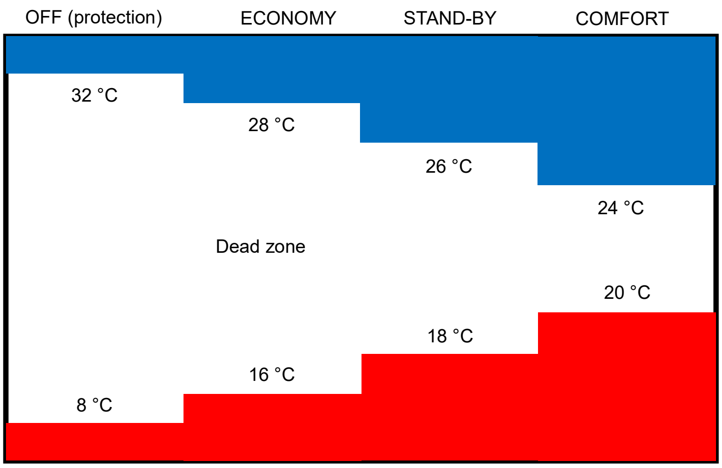
The switchover between the two seasonal modes (heating / cooling) may happens as follows:

1) automatically by the device;
2) from the KNX bus through a dedicated communication object.

Automatic switch-over (mode 1)

The automatic switch-over is suitable for a 4-pipe hydraulic configuration of the heating/cooling installation (used e.g. for fan-coil units or ceiling radianti panels). Also in this case the information can be sent on the bus with the output communication object [DPT 1.100 heat/cool]; the difference from the first mode is that switching is performed automatically on the basis of a comparison between the values of the actual temperature and the setpoint temperature. In this mode, the manual switching by the user is disabled.

The automatic switch-over is realised with the introduction of a neutral zone according to the scheme shown in Picture 7.



Picture 7 - Neutral zone and example of setpoint values correctly distributed

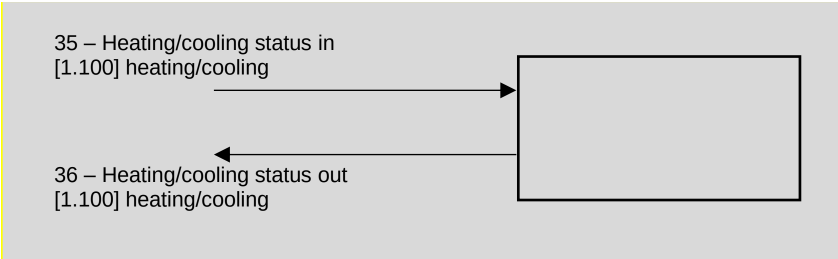
Until the actual (measured) temperature is located below the setpoint value for the heating, the operation is heating; in the same way, if the actual value (measured) is greater than the setpoint value for the cooling, the mode is cooling. If the actual value (measured) temperature is within the dead zone, the previous mode of operation remains active; the switching point of the operation mode for heating / cooling must take place in correspondence with the current setpoint for the active HVAC, in the same way the switching cooling / heating must take place at the setpoint for heating.

Switch-over via KNX bus (mode 3)

The switch-over from the bus requires that the command is received from another KNX device, e.g. another room temperature controller or a Touch&See unit configured to this purpose. The other device works in this way as a “supervisor” device: the switch-over is triggered by the input communication object [DPT 1.100 heat/cool]. In this mode the manual switch-over by an enduser is disabled. Thanks to this mode, the supervising device is able to control the “slave” devices with time-scheduled programs, extending their functionality to that of a chronothermostat (centrally controlled by the supervising device).

The communication objects indicated in the block diagram allows monitoring and modifying the current conduction mode forced on the temperature controller. The object 35 – *Heating/cooling status out* is always available, even when the thermostat function is set on heating or cooling only. When the function is set on *both heating and cooling*, the cyclic sending on bus can be enabled; anyway, the information about the actual conduction mode can be acquired with a reading request to this commiunication object.

The object 36 – *Heating/cooling status in* is exposed only when the function is both heating and cooling and the switching among the different modes is performed by the bus.



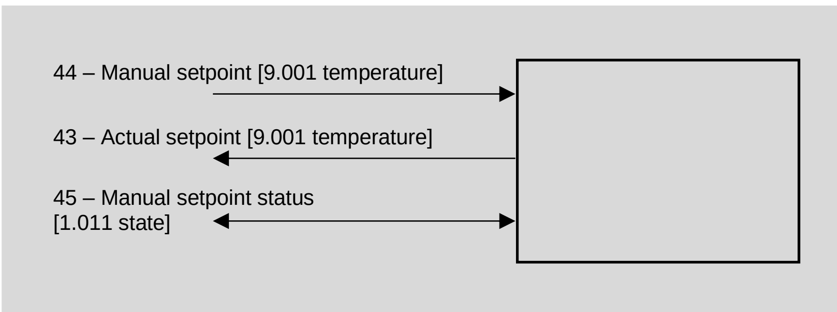
Picture 8

7.7.1.3 Valve protection function

The function is suitable for heating and cooling systems that use water as thermal conveying fluid and are provided with motorized valves for the interception of a zone or of a single room. Long periods of inactivity of the system can lead to the blockage of valves: to prevent this, the room temperature controller may periodically send a command to open / close the valve in the period of inactivity of the system. This possibility is made available in the application program by means of the parameter "Valve protection function", further defined by the frequency and duration of the valve control.

7.7.1.4 Remote Setpoint modification

The communication objects shown in Picture 9 allow to monitor the Setpoint forced modifications performed locally by the user when interacting with the LCD display and the touch buttons of the room thermostat. The communication objects (from now on: C.O.) also allow to perform the same modifications remotely, for example from a supervisor software.

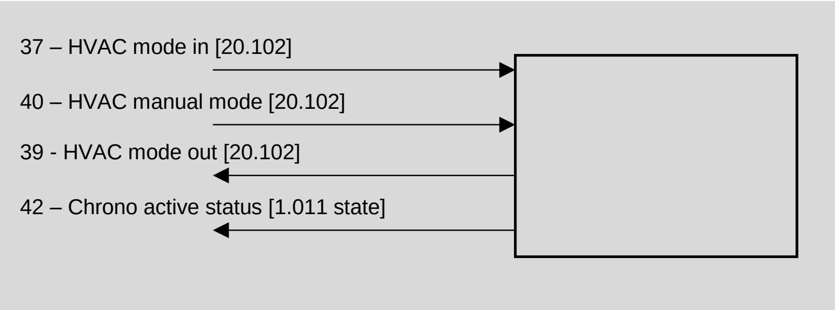


Picture 9

Those objects are about the Setpoint forced modification: alternatively, the supervisor can act directly on the operating mode setpoints (C.O. with index from 46 to 53). The value of the C.O. 43 - *Actual setpoint* represents the current operative setpoint which the control algorithms are based on. The C.O. 45 – *Manual setpoint status* indicates (read request mode) if the forced mode is active. The supervisor can force at any time the actual setpoint by writing a new value directly into the C.O. 44 – *Manual setpoint*. The C.O. 45 – *Manual setpoint status* can also be used in writing to exit the active forced mode.

7.7.1.5 Remote operative mode modification

The communication objects shown in figure allow to monitor the operating mode (comfort, standy, economy and building protection) modifications performed in manual or forced mode, or the operating mode forced by chrono program. The communication objects (from now on: C.O.) also allow to perform the same modifications remotely, for example from a supervisor software.



The C.O. 37 – *HVAC mode in* is associated to the chrono program. The C.O.s 39 – *HVAC mode out* and 42 – *HVAC chrono active status* allow the remote supervisor to discern the operating mode currently active on the room thermostat and also allow to understand if the chrono program is active or if attenuation is handled manually or not. The supervisor can set at any time a manual operating mode through C.O. *40 – HVAC manual mode*; to start the chrono program remotely, the C.O. 40 – *HVAC manual mode* is to be set on value 0 = Automatic.

7.7.2 Heating

The ***Heating*** folder includes the following parameters:

- Temperature setpoint [°C]
- Comfort temp. setpoint [°C]
- Standby temperature setpoint [°C]
- Economy temp. setpoint [°C]
- Standby temperature offset [0,1 K]
- Economy temperature offset [0,1 K]
- Building protection temp. setpoint [°C]
- Heating type
- Control type
- Hysteresis [K]
- Hysteresis position
- Cyclic sending interval
- Proportional band [0,1 K]
- Integral time [min]
- Signal
- PWM cycle time
- Min. change of value to send [%]
- Min. control value [%]
- Max. control value [%]
- Floor temperature limitation
- Temperature limit [°C]
- Hysteresis [K]
- Auxiliary heating
- Communication object
- Disabled from bus
- Offset from setpoint
- Hysteresis [K]
- Cyclic sending interval
- Ventilation for auxiliary heating

7.7.2.1 Parameter and communication object tables

Conditions: *Settings* ⇒ Thermostat function = heating or both heating and cooling.

Parameter name	***Conditions***	***Values***
Temperature setpoint [°C]	Setpoint type = single	**21** [range 10 … 50]
Comfort temp. setpoint [°C]	Setpoint type = absolute or relative	**21** [range 10 … 50]
Standby temp. setpoint [°C]	Setpoint type = absolute	**18** [range 10 … 50]
	For a correct operation of the device the standby temperature setpoint has to be < comfort temperature setpoint.	

Parameter name	*Conditions*	*Values*
Economy temp. setpoint [°C]	Setpoint type = absolute	**16** [range 10 … 50]
	For a correct operation of the device the economy temperature setpoint has to be < standby temperature setpoint.	
Standby temperature offset [0,1 K]	Setpoint type = relative	**-30** [range -80 … -10]
Economy temperature offset [0,1 K]	Setpoint type = relative	**-50** [range -80 … -10]
	For a correct operation of the device the economy temperature offset has to be < standby temperature offset.	
Building protection temp. setpoint [°C]		**7** [range 2 … 10]
Heating type		**radiators** electric fan-coils floor radiant panels ceiling radiant panels
	It defines the terminal used for the thermal exchange in the room. The choice affects the parameters of the PWM control algorithm (Proportional band and Integral time) and the control options.	
Control type		**2 point hysteresis** PWM (pulse width modulation) Continuous 6-way valve
Hysteresis [K]	Control type = 2 point hysteresis	**0,3 K** [other values in the range 0,2 K … 3 K]
Hysteresis position	Heating type = floor radiant panels, ceiling radiant panels, Control type = 2 point hysteresis	**below** / above
	The above hysteresis is suitable in case of special applications requiring mixing group control.	
Cyclic sending interval	Control type = 2 point hysteresis, continuous or 6-way valve	**no sending** [other values in the range 30 s … 120 min]
Proportional band [0,1 K]	Control type = continuous, PWM or 6-way valve	**40** [range 5 … 100]
	The value is in tenths of Kelvin (K) degree. **) The field contains a preset value that depend on the selected heating type (the value can be modified):* • *radiators: 50 (5 K)* • *electric: 40 (4 K)* • *fan-coils: 40 (4 K)* • *floor radiant panels: 50 (5 K)* • *ceiling radiant panels: 50 (5 K)* *The value of the parameter Proportional band represents the max difference between the setpoint temperature and the measured temperature that causes the max control output.*	

Parameter name	Conditions	Values
Integral time [min]	Control type = continuous, PWM or 6-way valve	**90** [other values in the range 0 … 255 min]
	The field contains a preset value that depend on the selected heating type (the value can be modified): • *fan-coils: 90 min* • *floor radiant panels: 240 min* • *ceiling radiant panels: 180 min*	
Signal	Control type = 6-way valve	**not inverted** / inverted
PWM cycle time	Control type = PWM	**15 min** [range 5 … 240 min]
Min. change of value to send [%]	Control type = continuous or 6-way valve	**10** [range 0 … 100]
Min control value [%]	Control type = continuous, PWM or 6-way valve	**15** [range 0 … 30]
Max control value [%]	Control type = continuous, PWM or 6-way valve	**85** [range 70 … 100]
Floor temperature limitation	Heating type = floor radiant panels, External sensors (from bus) ⇒ Floor surface temperature sensor = enabled	**disabled** / enabled
	This parameter enables the floor temperature limitation of a floor radiant panel. It is mandatory to measure the floor surface temperature by enabling the corresponding temperature sensor in "External sensors (from bus)" folder. ***Important!** This function does not replace the overtemperature protection usually installed in hydronic floor systems, realized with the proper safety thermostat.*	
Temperature limit [°C]	Floor temperature limitation = enabled	**29** [range 20 … 40]
	According to EN 1264 a maximum allowed temperature is prescribed for the surface of a floor heating system: • *T(sup) max ≤ 29°C for normal occupancy zones;* • *T(sup) max ≤ 35°C for peripheral areas.* *National standard may limit those temperatures to lower values. As "peripheral areas" are defined bands generally located along the walls of the environment facing the outside of the building, with maximum width of 1 m.*	
Hysteresis [K]	Floor temperature limitation = enabled	**0,3 K** [other values in the range 0,2 K … 3 K]
	Before exiting the alarm status, the device waits until the surface temperature drops below the set threshold by an offset equal to the hysteresis value.	
Auxiliary heating		**disabled** / enabled
Communication object	Auxiliary heating = enabled	unique **separated**
Disabled from bus	Auxiliary heating = enabled	**no** / yes
	It enables the activation and deactivation of the function through a telegram sent on the bus by a supervising device.	
Offset from setpoint	Auxiliary heating = enabled	**0,6 K** [other values in the range 0 …3 K]

Parameter name	Conditions	Values
Hysteresis [K]	Auxiliary heating = enabled	**0,3 K** [other values in the range 0,2 K … 3 K]
Cyclic sending interval	Auxiliary heating = enabled	**no sending** [other values in the range 30 s … 120 min]
Ventilation for auxiliary heating	• Command Communication Object = unique • Heating type = floor radiant panels or ceiling radiant panels OR • Command Communication Object = separated • Heating type = radiators, electric, floor radiant panels or ceiling radiant panels	**disabled** / enabled
	This option allows to match a system with high inertia as the floor radiant panels (hydronic version) with a system with low inertia as the fan-coils.	

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
Setpoint in	Setpoint type = single	2 bytes	CRWTU	[9.001] temperature (°C)	46
Comfort setpoint (heating)	Setpoint type = absolute or relative	2 bytes	CRWTU	[9.001] temperature (°C)	46
Standby setpoint (heating)	Setpoint type = absolute	2 bytes	CRWTU	[9.001] temperature (°C)	48
Offset standby (heating)	Setpoint type = relative	2 bytes	CRWTU	[9.002] temperature difference (K)	48
Economy setpoint (heating)	Setpoint type = absolute	2 bytes	CRWTU	[9.001] temperature (°C)	50
Offset economy (heating)	Setpoint type = relative	2 bytes	CRWTU	[9.002] temperature difference (K)	50
Building protection setpoint (heating)		2 bytes	CRWTU	[9.001] temperature (°C)	52
Heating out command	Command communication object = separated, Control type = 2 points hysteresis or PWM	1 bit	CR-T-	[1.001] switch	56
Heating out command	Command communication object = separated, Control type = continuous	1 byte	CR-T-	[5.001] percentage (0..100%)	56

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
Heating and cooling out command	Command communication object = unique, Control type = 2 points hysteresis or PWM	1 bit	CR-T-	[1.001] switch	56
Heating and cooling out command	Command communication object = unique, Control type = continuous	1 byte	CR-T-	[5.001] percentage (0..100%)	56
Auxiliary heating output command	Command communication object = separated, Auxiliary heating = enabled	1 bit	CR-T-	[1.001] switch	58
Auxiliary heating and cooling output command	Command communication object = unique, Auxiliary heating = enabled	1 bit	CR-T-	[1.001] switch	58
Auxiliary heating disable	Auxiliary heating = enabled, Disabled from bus = yes	1 bit	C-W--	[1.003] enable	60

Note on floor temperature limitation function

The floor heating system (warm water version) provides plastic pipes embedded in the concrete layer or placed directly under the final coating of the floor (light or "dry" system) filled by heated water. The water transfers the heat to the final coating that heats the room by radiation. The standard EN 1264 Floor heating (Part 3: Systems and components - Dimensioning) prescribes a maximum allowed temperature (T_{Smax}) for the surface of the floor that is physiologically correct defined as:

- $T_{Smax} \leq 29°C$ for zones of normal occupancy;
- $T_{Smax} \leq 35°C$ for peripheral zones of the rooms.

National standards may also limit these temperatures at lower values. Peripheral zones are strips generally located along the external walls with a maximum width of 1 m.

The floor heating system (electrically powered version) involves the laying under the floor coating of an electric cable powered by the mains voltage (230 V) or low voltage (for example 12 or 45 V), possibly already prepared in the form of rolls with constant distance between sections of cable. The powered cable releases heat to the overlying coating that heats the room by radiation. The regulation is based on measurement of the temperature of the air mass, but generally requires the monitoring and limiting of the surface temperature by using a NTC-type sensor which is in contact with the floor surface.

The surface temperature limitation may be realized for several purposes:

- physiological compatibility (correct temperature at the height of the legs);
- when the system is used as auxiliary stage for heating. In this case, the heat losses to the exterior of the building are handled by the main heating stage, while the auxiliary stage only works to keep the

floor temperature at a comfortable level (for example in bathrooms of residential buildings, sports centers , spas and thermal baths, etc.);

- protection against damages of the final coating due to an accidental overheating. Note that the warm water radiant panels are usually already equipped with a safety thermostat (with intervention on the hydraulic mixing group), while in the case of electrical power this device is not usable and it is common practice to realize a temperature limitation with a surface temperature sensor connected to the device.

7.7.3 Cooling

The ***Cooling*** folder includes the following parameters:

- Temperature setpoint [°C]
- Comfort temp. setpoint [°C]
- Standby temperature setpoint [°C]
- Economy temp. setpoint [°C]
- Standby temperature offset [0,1 K]
- Economy temperature offset [0,1 K]
- Building protection temp. setpoint [°C]
- Cooling type
- Control type
- Hysteresis [K]
- Hysteresis position
- Cyclic sending interval
- Proportional band [0,1 K]
- Integral time [min]
- PWM cycle time
- Min. change of value to send [%]
- Min. control value [%]
- Max. control value [%]
- Anticondensation with probe
- Active anticondensation
- Flow temperature (project)
- Anticondensation hysteresis range
- Delay for alarm signal
- Auxiliary cooling
- Disabled from bus
- Offset from setpoint
- Hysteresis [K]
- Cyclic sending interval
- Ventilation for auxiliary cooling

7.7.3.1 Parameter and communication object tables

Conditions: *General* ⇒ Thermostat function = cooling or both heating and cooling.

Parameter name	***Conditions***	***Values***
Temperature setpoint [°C]	Setpoint type = single	**23** [range 10 … 50]
Comfort temp. setpoint [°C]	Setpoint type = absolute or relative	**23** [range 10 … 50]
Standby temp. setpoint [°C]	Setpoint type = absolute	**26** [range 10 … 50]
	For a correct operation of the device the standby temperature setpoint has to be > comfort temperature setpoint.	
Economy temp. setpoint [°C]	Setpoint type = absolute	**28** [range 10 … 50]
	For a correct operation of the device the economy temperature setpoint has to be > standby temperature setpoint.	
Standby temperature offset [0,1 K]	Setpoint type = relative	**30** [range 10 … 80]
Economy temperature offset [0,1 K]	Setpoint type = relative	**50** [range 10 … 80]
	For a correct operation of the device the economy temperature offset has to be > standby temperature offset.	
Building protection temp. setpoint [°C]		**36** [range 30 … 50]
Cooling type		**fancoils** floor radiant panels ceiling radiant panels
	If in Settings the parameter Thermostat function = both heating and cooling and Command communication object = unique, the parameter Cooling type is bound to the selection done for Heating.	
Control type	Settings ⇒ Command communication object = separated	**2 points hysteresis** PWM (pulse width modulation) continuous
	If in Settings the parameter Thermostat function = both heating and cooling and Command communication object = unique, the parameter Control type is bound to the selection done for Heating.	
Hysteresis [K]	Control type = 2 point hysteresis	**0,3 K** [other values in the range 0,2 K … 3 K]
Hysteresis position	Heating type = floor radiant panels, ceiling radiant panels, Control type = 2 point hysteresis	**below** / above
	The above hysteresis is suitable in case of special applications requiring mixing group control.	
Cyclic sending interval	Control type = 2 point hysteresis or continuous	**no sending** [other values in the range 30 s … 120 min]

Parameter name	***Conditions***	***Values***
Proportional band [0,1 K]	Control type = continuous, PWM or 6-way valve	**50** [range 5 … 100]
	The value is in tenths of Kelvin (K) degree. **) The field contains a preset value that depend on the selected cooling type (the value can be modified):* • *fancoils: 40 (4 K)* • *floor radiant panels: 50 (5 K)* • *ceiling radiant panels: 50 (5 K)* *The value of the parameter Proportional band represents the max difference between the setpoint temperature and the measured temperature that causes the max control output.*	
Integral time [min]	Control type = continuous, PWM or 6-way valve	**240** [range 0 … 255 min]
	**) The field contains a preset value that depend on the selected cooling type (the value can be modified):* • *fancoils: 90 min* • *floor radiant panels: 240 min* *ceiling radiant panels: 180 min*	
PWM cycle time	Control type = PWM (pulse width modulation)	**15 min** [range 5 … 240 min]
Min. change of value to send [%]	Control type = continuous or 6-way valve	**10** [range 0 … 100]
Min control value [%]	Control type = continuous, PWM or 6-way valve	**15** [range 0 … 30]
Max control value [%]	Control type = continuous, PWM or 6-way valve	**85** [range 70 … 100]
Anticondensation with probe	Cooling type = floor radiant panels or ceiling radiant panels, External sensors (from bus) ⇒ Anticondensation = enabled	**disabled** / enabled
Active anticondensation	Cooling type = floor radiant panels or ceiling radiant panels, Internal sensors ⇒ Relative humidity sensor = enabled, or External sensors (from bus) ⇒ Relative humidity = enabled	**disabled** enabled (project temperature)
	Cooling type = floor radiant panels or ceiling radiant panels, Internal sensors ⇒ Relative humidity sensor = enabled, or External sensors (from bus) ⇒ Relative humidity = enabled External sensors (from bus) ⇒ Flow temperature = enabled	**disabled** enabled (comparison between flow temperature and dew-point)
	If flow temperature is lower than calculated dew point, the operating mode is cooling and the room thermostat is in flow request, then the thermostat will close the valve and send an alarm message over the bus.	
Flow temperature (project)	Anticondensation active = enabled	**19,5 °C** [other values in the range 14 °C … 20 °C]
	Only displayed if the flow temperature from external sensor (from bus) is not enabled.	

Parameter name	***Conditions***	***Values***
Anticondensation hysteresis range	Active anticondensation = enabled (project temperature) External sensors (from bus) ⇒ Flow temperature = enabled	0,2 K / 0,3 K / 0,4 K / **0,5** / 0,6 K 0,8 K / 1 K / 1,5 K / 2 K / 2,5 K / 3 K
	Before exiting the alarm condition, it is expected that the calculated dew-point temperature will drop below the delivery temperature by an offset equal to the hysteresis value.	
Delay for alarm signal	Active anticondensation = enabled (project temperature)	**30 s** [other values in the range 30 s … 120 min]
Auxiliary cooling		**disabled** / enabled
Disabled from bus	Auxiliary cooling = enabled	**no** / yes
	This parameter enables the activation and deactivation of the function through a telegram from a bus device with supervising function.	
Offset from setpoint	Auxiliary cooling = enabled	0,2 K / **0,3 K** / 0,4 K / 0,5 / 0,6 K 0,8 K / 1 K / 1,5 K / 2 K / 2,5 K / 3 K
Hysteresis	Auxiliary cooling = enabled	0,2 K / 0,3 K / 0,4 K / 0,5 / 0,6 K 0,8 K / **1 K** / 1,5 K / 2 K / 2,5 K / 3 K
Cyclic sending interval	Auxiliary cooling = enabled	hh:mm:ss (**00:00:00**)
	00:00:00 means that the cyclic sending is not enabled.	
Ventilation for auxiliary cooling	Cooling type = floor radiant panels or ceiling radiant panels	**disabled** / enabled
	This option allows to combine a high-inertial system as the floor radiant panels to a low-inertial one as the fan-coils.	

Object name	***Conditions***	***Dim.***	***Flags***	***DPT***	***Comm. Obj. No.***
Comfort setpoint (cooling)	Setpoint type = absolute or relative	2 bytes	CRWTU	[9.001] temperature (°C)	47
Standby setpoint (cooling)	Setpoint type = absolute	2 bytes	CRWTU	[9.001] temperature (°C)	49
Offset standby (cooling)	Setpoint type = relative	2 bytes	CRWTU	[9.002] temperature difference (K)	49
Economy setpoint (cooling)	Setpoint type = absolute	2 bytes	CRWTU	[9.001] temperature (°C)	51
Offset economy (cooling)	Setpoint type = relative	2 bytes	CRWTU	[9.002] temperature difference (K)	51
Building protection setpoint (cooling)		2 bytes	CRWTU	[9.001] temperature (°C)	53

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
Cooling out command	Command Communication Object = separated Control type = 2 point hysteresis or PWM	1 bit	CR-T-	[1.001] switch	57
Cooling out command	Command Communication Object = separated Control type = continuous	1 byte	CR-T-	[5.001] percentage (0..100%)	57
Auxiliary cooling output command	Auxiliary cooling = enabled	1 bit	CR-T-	[1.001] switch	59
Auxiliary cooling disable	Auxiliary cooling = enabled, Disabled from bus = yes	1 bit	C-W--	[1.003] enable	61
Anticondensation alarm	Active anticondensation = enabled	1 bit	CR-T-	[1.005] alarm	82

About anticondensation protection function

The purpose of this function is to prevent the condensation on the thermal exchange surfaces of the installation or building when cooling is working. This function is mainly used in systems with thermal exchange consisting in surface terminals such as for the floor and ceiling cooling radiant systems. In this case the hydraulic circuits contain refrigerated water; usually the latent loads (due to the increase of air humidity in the room) are handled by air-conditioning units and the temperature and humidity conditions are far from those that could cause condensation. If this is not done in a satisfactory manner, or in case of stop of the air-conditioning units, it is necessary to provide additional safety measures to prevent or restrict the accidental formation of condensation on cold surfaces.

From a general point of view, the anticondensation protection function can be realized:

- by installing a proper room anticondensation probe; when this is active, the hydraulic circuit closes down. It is a passive protection, because the intervention takes place when condensation has already started;
- by calculating the dew-point temperature and confronting it with the conveying fluid flow temperature. If the critical condition for condensation is approaching, you can intervene by closing down the hydraulic circuit or adjusting the mixing conditions of the conveying fluid. This is an active protection because the goal is to prevent the condensation.

Nr.	Type	Denomination	Description
1a	Passive	Anticondensation protection by probe (via bus)	The thermostat receives the information about condensation via bus from a different KNX device through communication object 33: Anticondensation (from bus) [DPT 1.001 switch].
2a	Active	Anticondensation protection with comparison between flow temperature (constant	Software protection that intervenes by closing down the room cooling circuit when the flow temperature defined in the hydronic project (as set in the corresponding ETS parameter) is lower than dew-point temperature calculated

		projected value, set as parameter on ETS and dew-point temperature (calculated by the thermostat)	by the room thermostat using temperature and relative humidity values. The communication object involved is 57: Cooling out command [DPT 1.001 switch].
2b	Active	Anticondensation protection with comparison between flow temperature (constant projected value, set as parameter on ETS and dew-point temperature (calculated by the thermostat)	Software protection that intervenes by closing down the room cooling circuit when the actual measured flow temperature and received via bus from a different KNX device is lower than dew-point temperature calculated by the room thermostat using temperature and relative humidity values. The communication objects involved are 27 at input: Flow temperature (from bus) [DPT 9.001 temperature °C] and 57: Cooling out command [DPT 1.001 switch].
3	Active	Anticondensation protection with dew-point temperature sending over the bus and adjustment of the flow temperature	Software protection that foresees the sending on the bus of the dew-point temperature calculated by the room thermostat using temperature and relative humidity values to a KNX device capable of controlling the mixing condition of the conveying fluid for the cooling circuit. The regulation is performed by the KNX device receiving the dew-point temperature sent by the thermostat. The communication object involved is 73: Dew-point temperature [DPT 9.001 temperature °C].

Table 3 - Anticondensation protection modes

If an anticondensation sensor is used, it is necessary use a device provided with a potential-free signalling contact. It is possible to connect the signalling contact to an input channel of another KNX device, e.g. a pushbutton interface or a binary input (External sensors (from bus) ⇒ Anticondensation sensor = enabled). In this case the signal of the sensor is transmitted to the room temperature controller through the status of a communication object (case 1b described in Table 3).

If the comparison between dew-point temperature calculated by the thermostat and flow temperature of the conveying fluid is used, there are 3 options:

- if the flow temperature value is not available (case 2a of Table 3), you can insert the value used in the project (parameter Flow temperature (projected));
- if the flow temperature value is available (case 2b of Table 3), you enable the Anticondensation Active parameter for comparison;
- if an bus actuator capable of intervention on the conveying fluid's mixing is available, the thermostat sends on the bus the calculated value of the dew-point temperature; this parameter has to be enabled in the *Relative humidity control ⇒ Calculated psychrometric values* tab.
  The actuator compares this value with the flow temperature and, if necessary, modifies the mixing conditions in order to prevent the risk for condensation formation.

The proper anticondensation protection mode needs to be evaluated during the thermical plant design and depends on many factors such as type of building, continuity of service and desired comfort level, available KNX devices, and so on.

7.7.4 Main and auxiliary ventilation

The ***Ventilation*** folder includes the following parameters:

- Ventilation function
- Control type
- Threshold first speed [0,1 K]
- Threshold second speed [0,1 K]
- Threshold third speed [0,1 K]
- Speed control hysteresis [K]
- Speed proportional band [0,1 K]
- Min. change of value to send [%]
- Manual operation
- Coil temperature usage for fan activation (Hot start)
- Antistratification function
- Disable ventilation from bus
- Signal from bus
- Fan start delay
- Fan stop delay

The conditions for the appearance of the ***Ventilation*** folder are:

Heating ⇒ Heating type = fan-coils or Cooling type = fan-coils

or a combination of the two conditions:

Heating ⇒ Heating type = floor radiant panels or ceiling radiant panels and *Heating* ⇒ Ventilation for auxiliary heating = enabled

Cooling ⇒ Cooling type = floor radiant panels or ceiling radiant panels and *Cooling* ⇒ Ventilation for auxiliary cooling = enabled

This way two types of installations can be controlled: i) fancoil terminals or ii) radiant panels as main stage and fancoil terminals as auxiliary stage.

7.7.4.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
Control type		**1 speed** 2 speeds 3 speeds continuous regulation
Threshold first speed [0,1 K]	Control type ≥ 1 speed	**0** [range 0 … 255]
	The value is represented in tenths of Kelvin degrees. If the parameter Thermostat function = both heating and cooling, the threshold value is valid for both seasonal modes.	
Threshold second speed [0,1 K]	Control type ≥ 2 speeds	**10** [range 0 … 255]
	The value is represented in tenths of Kelvin degrees. If the parameter Thermostat function = both heating and cooling, the threshold value is valid for both seasonal modes. For a correct operation of the ventilation, Threshold second speed > Threshold first speed.	

Parameter name	***Conditions***	***Values***
Threshold third speed [0,1 K]	Control type = 3 speeds	**20** [range 0 … 255]
	The value is represented in tenths of Kelvin degrees. If the parameter Thermostat function = both heating and cooling, the threshold value is valid for both seasonal modes. For a correct operation of the ventilation, Threshold third speed > Threshold second speed.	
Speed control hysteresis	Control type = 1, 2 or 3 speeds	**0,3 K** [other values in the range 0,2 K …3 K]
Speed proportional band [0,1 K]	Control type = continuous regulation	**30** [range 5 … 100]
	The value is represented in tenths of Kelvin degrees. If the parameter Thermostat function = both heating and cooling, the threshold value is valid for both seasonal modes.	
Min. change of value to send [%]	Control type = continuous regulation	**10** [range 2 … 40]
	Please refer to the Control Algorithms chapter for further information about the meaning of this parameter.	
Manual operation		**not depending on the temperature** depending on the temperature
	If the parameter = not depending on the temperature, the fan speed set by the user is not changed even when the temperature setpoint is reached; if the parameter = depending on the temperature, the fan stops when the temperature setpoint is reached.	
Hot start	Thermostat function = both heating and cooling, External sensors (from bus) ⇒ coil temperature = enabled	**no** / yes
	To carry out the function, a sensor for measuring the temperature of the heat exchanger of the fan coil has to be enabled. To this purpose, an external sensor (from bus) can be used.	
Min. temp.to start ventilation [°C]	Hot start = yes	**35** [range 28 …40]
	If enabled, the function is active only in heating mode.	
Antistratification function	External sensors (from bus) ⇒ Antistratification temperature = enabled	**disabled** / enabled
	To carry out the function, at least a sensor for measuring a second temperature value must be enabled at a different height than that of the room temperature controller. To this purpose, an external sensor (from bus) can be used.	
Antistratification temp. differential	Antistratification function = enabled	**2 [K/m]** [other values in the range 0,25 … 4,00 K/m]
	The DIN 1946 recommends a max temperature gradient of 2 K/m for rooms with standard height (between 2,70 and 3 m).	
Hysteresis	Antistratification function = enabled	**0,5 K** [other values in the range 0,2 … 3 K]
Disable ventilation from bus		**no** / yes

Parameter name	***Conditions***	***Values***
Signal from bus	Disable ventilation from bus = yes	**not inverted** inverted
Fan start delay		**0 s** [other values in the range 10 s … 12 min]
	This parameter is also available if the hot-start function is active (through measuring of the conveying fluid temperature at the battery for the thermal exchange). The function is active in both seasonal modes (heating and cooling).	
Fan stop delay		**0 s** [other values in the range 10 s … 12 min]
	The function allows prolonging the operation of the ventilator, dissipating in the room the residual heat or cool present in battery for the thermal exchange. The function is active in both seasonal modes (heating and cooling).	
Cyclic sending interval		**no sending** [other values in the range 30 s … 120 min]

Object name	***Conditions***	***Dim.***	***Flags***	***DPT***	***Comm. Obj. No.***
Fan continuous speed	Control type = continuous regulation	1 byte	CR-T-	[5.001] percentage (0..100%)	62
Fan speed 1	Control type = 1, 2 or 3 speeds	1 bit	CR-T-	[1.001] switch	63
Fan speed 2	Control type = 2 or 3 speeds	1 bit	CR-T-	[1.001] switch	64
Fan speed 3	Control type = 3 speeds	1 bit	CR-T-	[1.001] switch	65
Fan control disable	Disable ventilation from bus = yes	1 bit	C-W--	[1.002] boolean	66
Fan manual speed		1 byte	CRW-U	[5.010] counter pulses (0…255)	68
Fan speed		1 byte	CR-T-	[5.010] counter pulses (0…255)	67
Fan manual active status		1 bit	CRWT-	[1.011] state	70
Fan manual speed percentage		1 byte	CR-T-	[5.001] percentage	69
Fan manual speed off status		1 bit	CR-T-	[1.011] state	71

7.7.4.2 Delayed fan start (“hot-start”)

This function is used in case the fan forces in the room air passing through a heat exchange coil (as in the case of the terminals to the fan-coil). In the heating mode of operation, to avoid possible discomfort caused by the dispatch of cold air in the room, the room temperature controller does not start the fan until the fluid has not reached a sufficiently high temperature. This situation normally occurs at the first start or after long periods of inactivity. The function can be carried out by:

1. a temperature control (through a temperature sensor on the coil exchange battery);
2. a delayed start (function approximated);

In the first case the temperature of the heat conveying fluid is acquired at the exchange battery. The function then has an effective temperature control, but for the execution is necessary that the heat exchange coil is equipped with a sensor of minimum water temperature that acquires the temperature of the heat conveying fluid.

The effectiveness of the function depends on a field measurement of the time actually required to have sufficiently warm air from the terminal.

7.7.4.3 Antistratification function

This function is used in the case of heating systems with thermal exchange of convective type for rooms with height and volume much higher than usual (atriums, fitness facility, commercial buildings, etc.). Because of the natural convection - with warm air rising to the highest altitudes of the room - the phenomenon of air stratification occurs, with energy waste and discomfort for the occupants at the same time. The function opposes to the air stratification, forcing the warm air downwards.

The antistratification function requires:

- rooms of great height;
- availability of ventilation devices able to force the air movement downwards (opposed to the natural convective movement of warm air);
- measuring of the temperature at two heights through the installation of a second temperature sensor at an adequate height in order to measure the actual air stratification (the main room temperature controller is supposed to be installed at 1.5 m).

For rooms with ordinary height (2,70 ÷ 3,00 m) the DIN 1946 standard recommends not to exceed 2 K/m in order to have an adequate comfort; this gradient may be bigger in higher rooms.

7.7.4.4 2-stage configuration with fan-coils as auxiliary stage

The fan-coil units may be used both as a main stage and secondary stage. As main stage they can be combined only to radiators as auxiliary stage. If, however, the main stage is done with (floor or ceiling) radiant panels, the fan-coils can be used as auxiliary stage. In the latter case they work in automatic mode with a configurable offset with respect to the temperature setpoint for the main stage, and then carry out their compensation function while the main stage is brought in temperature with bigger inertia.

The ***Ventilation*** folder, that is unique, configures a main or a auxiliary stage depending on the settings choosed in the ***Heating*** and ***Cooling*** folders. Similarly, the display interface will act on manual / automatic and manual forcing of the only fan-coil.

A particular case occurs when a fan-coil unit works in a season as auxiliary stage and in the other one as main stage. It is for example the case of:

- a radiant panels system that works only for heating and has a fan-coil as auxiliary stage; the same fan-coil works as main stage for cooling;

- a radiator system that has a fan-coil as auxiliary stage for heating; the same fan coil unit functions as main stage for cooling.

In these cases with the configuration adopted, the following steps are necessary:

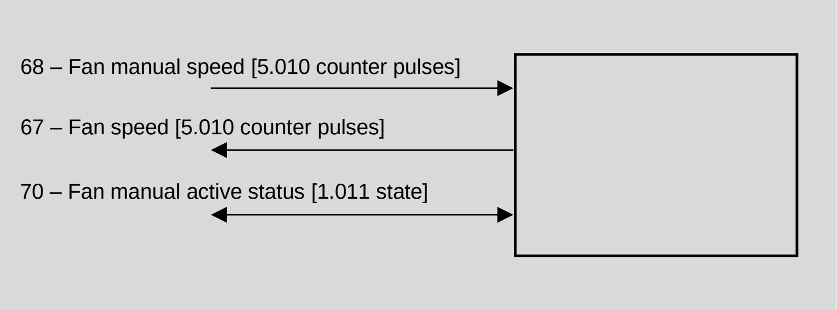
1. Settings ⇒ Thermostat function = both heating and cooling. This configuration enables both folders (heating and cooling)
2. Heating ⇒ Heating type = floor radiant panels or ceiling radiant panels
3. Heating ⇒ Command communication object = separated (if unique is choosen, the parameter Cooling ⇒ Cooling type does not appear)
4. Heating ⇒ Auxiliary heating = enabled
5. Auxiliary heating ⇒ Communication object = separated
6. Heating ⇒ Ventilation for auxiliary heating = enabled
7. Cooling ⇒ Cooling type = fancoils

Important! If the fan-coil system has a 2-pipe hydraulic configuration, the objects Auxiliary heating output command (1 bit) and Cooling out command (1 bit) have to be set in logical OR in the actuator for controlling the fan-coil which in this case is unique.

An alternative solution that avoids the setting of a logic OR can be realized by configuring a main stage for heating and cooling with radiant panels through separate valves and an auxiliary stage for heating and cooling fan coil through combined valves. The offset of the auxialiary stage for cooling is set to the value 0 (zero); this corresponds to a configuration for main stage. The object Cooling out command (1 byte) is not connected so that the radiant panel system works only for heating.

7.7.4.5 Remote fan speed modification

The communication objects shown in figure allow to monitor actiual fan speed forced automatically (A) by the temperature controller or set locally by the user when interacting with the LCD display and the touch buttons of the room thermostat. The communication objects (from now on: C.O.) also allow to perform the same modifications remotely, for example from a supervisor software.



Picture 10

The C.O. *67 – Fan speed* allows to evaluate the actual fan speed; the C.O. 70 – *Fan manual active status* contains the information about automatic (=0, not active) or manual (=1, active) operating mode. By modifying the C.O. 68 – *Fan manual speed*, the fan automatically switches to the setpoint speed; to return to automatic mode (A), the supervisor must exit from manual mode by modifying the C.O. 70 – *Fan manual active status* (=0, not active).

Accepted values for C.O.s 67 and 68 depend on the number of speeds set in ETS.

If *Control Type* parameter in Ventilation folder is = 1, 2 or 3 speeds, C.O.s with DPT [5.010 counter pulses] accept the following values:

- = 0: OFF
- = 1: speed 1
- = 2: speed 2 (if *Control Type* > 1 speed)
- = 3: speed 3 (if *Control Type* > 2 speed)

If *Control Type* parameter in Ventilation folder is = continuous regulation, the values of the C.O.s with DPT [5.010 counter pulses] match the following percentage of the maximum speed:

- = 0: OFF
- = 1: 20%
- = 2: 40%
- = 3: 60%
- = 4: 80%
- = 5: 100%

7.8 Relative humidity control

The ***Relative humidity control*** folder includes the following secondary folders:

- Dehumidification
- Humidification
- Calculated psychrometric values

The secondary folders ***Dehumidification***, ***Humidification*** and ***Calculated psychrometric values*** appear only if a humidity sensor is enabled, either internal or external (from bus). If an external humidity sensor is enabled, the acquisition of relative humidity is made by bus from a KNX R.H. sensor.

The sensor acquires the air humidity value inside the room, which can be used for the following purposes:

- Sending over the bus (for information purpose) through DPT [9.007] percentage (%);
- Use of detected value for dew-point temperature calculations and sending on the bus through corresponding DPTs;
- Use for room ventilation through ventilation start, external intakes opening, window opening through motorized actuators. Control is performed upon thresholds;
- Use for control of thermoigrometric comfort conditions of radiant panel cooling systems equipped with integration of latent heat (starting of dedicated terminals without modification of cooling water flow temperature);
- Use for safety control in radiant panel cooling systems not equipped with integration of latent heat through calculation of critical thermoigrometric conditions (dew point) and corresponding modification of cooling water flow temperature.

7.8.1 Dehumidification

The secondary folder ***Dehumidification***, when the related function is enabled, includes the following parameters:

- Operating modes where dehumidification is active
- Relative humidity setpoint for dehumidification control [%]
- Dehumidification control hysteresis [%]
- Dehumidification secondary to temperature control
- Function of integration of sensible heat
- Disable from bus

7.8.1.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
Dehumidification function	Temperature control ⇒ Settings ⇒ Thermostat function = both heating and cooling	**disabled** cooling heating both cooling and heating
	Temperature control ⇒ Settings ⇒ Thermostat function = heating	**disabled** / heating only
	Temperature control ⇒ Settings ⇒ Thermostat function = heating	**disabled** / cooling only
	Parameter that selects the dehumidification function.	
Humidity setpoint [%]	Dehumidification function ≠ disabled	**55** [range 20 … 80]

Parameter name	***Conditions***	***Values***
Humidity hysteresis	Dehumidification function ≠ disabled	**0,8 %** [other values in the range 0,5 … 4%]
Cyclic sending interval	Dehumidification function ≠ disabled	**no sending** [other values in the range 30 s … 120 min]
Disable dehumidification control from bus	Dehumidification function ≠ disabled	**no** / yes
Signal from bus	Disable dehumidification control from bus = yes	**not inverted** / inverted
Subordinated to temperature control	Temperature control ⇒ Settings ⇒ Thermostat function = cooling or both heating and cooling, Temperature control ⇒ cooling ⇒ cooling type = floor radiant panels or ceiling radiant panels, Relative humidity ⇒ dehumidification ⇒ dehumidification function = cooling only	no / **yes**
Dehumidification start delay	Subordinated to temperature control = no	**00:05:00 hh:mm:ss** [range 00:00:00 … 18:12:15]
	Value 00:00:00 means that the start delay is disabled.	
Integration		**no** / yes
Temperature difference for integration	Integration = yes	**1,5°C** [other values in the range 0,5 °C … 3 °C]
Hysteresis for integration	Integration = yes	**0,5 K** [other values in the range 0,2 K … 3 K]

Object name	***Conditions***	***Dim.***	***Flags***	***DPT***	***Comm. Obj. No.***
Relative humidity setpoint for dehumidification		2 bytes	CRWTU	[9.007] humidity (%)	74
Dehumidification command		1 bit	CR-T-	[1.001] switch	76
Dehumidification water battery command	Temperature control ⇒ Settings ⇒ Thermostat function = both heating and cooling, Temperature control ⇒ cooling ⇒ cooling type = floor radiant panels or ceiling radiant panels,	1 bit	CR-T-	[1.001] switch	77

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
	Relative humidity control ⇒ dehumidification ⇒ dehumidification function = cooling only				
Dehumidification integration control	Temperature control ⇒ Settings ⇒ Thermostat function = both heating and cooling, Temperature control ⇒ cooling ⇒ cooling type = floor radiant panels or ceiling radiant panels, Relative humidity control ⇒ dehumidification ⇒ dehumidification function = cooling only Integration = yes	1 bit	CR-T-	[1.001] switch	78
	This object switches ON if (simultaneously) the relative humidity is greater than the relative humidity setpoint and the room temperature is greater than the setpoint of the parameter Temperature difference for integration.				
Dehumidification control disable	Disable dehumidification control from bus = yes	1 bit	C-W--	[1.002] boolean	79

7.8.2 Humidification

The secondary folder ***Humidification*** includes the following parameters:

- Operating modes where humidification is active
- Relative humidity setpoint for humidification control [%]
- Dehumidification control hysteresis [%]
- Cyclic sending interval
- Disable from bus

7.8.2.1 Parameter and communication object tables

Parameter name	Conditions	Values
Humidification function	Temperature control ⇒ Settings ⇒ Thermostat function = both heating and cooling	**disabled** cooling heating both cooling and heating
	Temperature control ⇒ Settings ⇒ Thermostat function = heating	**disabled** / heating only
	Temperature control ⇒ Settings ⇒ Thermostat function = heating	**disabled** / cooling only
	Parameter that selects the humidification function.	
Humidity setpoint	Humidification function ≠ disabled	**35** [range 20 … 80 %]
Humidity hysteresis [%]	Humidification function ≠ disabled	**0,8 %** [other values in the range 0,5 … 4%]
Cyclic sending interval	Humidification function ≠ disabled	**no sending** [other values in the range 30 s … 120 min]
Disable humidification control from bus	Humidification function ≠ disabled	**no** / yes
Signal from bus	Humidification function ≠ disabled Disable humidification control from bus = yes	**not inverted** / inverted

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
Relative humidity setpoint for humidification	Humidification function ≠ disabled	2 bytes	CRWTU	[9.007] humidity (%)	75
Humidification command	Humidification function ≠ disabled	1 bit	CR-T-	[1.001] switch	80
Humidification control disable	Disable humidification control from bus = yes	1 bit	C-W--	[1.002] boolean	81

7.8.3 Calculated psychrometric values

The secondary folder ***Calculated psychrometric values*** includes the following parameters:

- Dew-point temperature
- Cyclic sending interval
- Min. change of value to send [K]
- Disable from bus

7.8.3.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
Dew-point temperature		**disabled** / enabled
	The dew-point temperature, if sent on the bus, allows to implement an active anticondensation protection with recalibration of the flow conditions of the conveying fluid if each mixing group has its own control device. If the thermostat is installed in an environment where no air conditioning is foreseen (e.g. toilets), it is better to exclude that environment from the control by disabling the dew-point temperature parameter.	
Cyclic sending interval	Dew-point temperature = enabled	**no sending** [other values in the range 30 s … 120 min]
Min. change of value to send [K]	Dew-point temperature = enabled	**0,2 K** / no sending [other values in the range 0,2 … 3 K]

Object name	***Conditions***	***Dim.***	***Flags***	***DPT***	***Comm. Obj. No.***
Dew-point temperature	Dew-point temperature = enabled	2 bytes	CR-T-	[9.001] temperature °C	73

7.9 CO_2 control

The ***CO_2 control*** folder allows to configure the parameters for the air quality functions management.

It includes the following secondary folders:

- Thresholds
- Ventilation

Conditions: Internal sensors ⇒ CO_2 sensor ⇒ CO_2 control = enabled

7.9.1 Thresholds

The secondary folder ***Thresholds*** includes the following parameters:

- Threshold 1, along with the related value [ppm] and hysteresis;
- Threshold 2, along with the related value [ppm] and hysteresis;
- Threshold 3, along with the related value [ppm] and hysteresis;
- CO_2 alarm function, with the related configurable parameters;
- CO_2 ventilation;
- Threshold 1;
- Threshold 2;
- Threshold 3.

7.9.1.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
Threshold 1 – value [ppm]		**500** [range 0 … 10000 ppm]
Threshold 1 – hysteresis		**250** [other values in the 50 … 500 ppm range]
Threshold 2 – value [ppm]		**1500** [range 0 … 10000 ppm]
Threshold 2 – hysteresis		**250** [other values in the 50 … 500 ppm range]
Threshold 3 – value [ppm]		**5000** [range 0 … 10000 ppm]
Threshold 3 – hysteresis		**250** [other values in the 50 … 500 ppm range]

Parameter name	***Conditions***	***Values***
CO_2 alarm function		
Threshold value	CO_2 alarm function = enabled	1000 [range 0 … 10000 ppm]
Max threshold	CO_2 alarm function = enabled	10 [range 0…100%]
Cyclic sending interval	CO_2 alarm function = enabled	**no sending** [other values in the range 30 s … 120 min]
Ventilation		enabled / **disabled**
CO_2 Threshold x - Type		**not active** / below only / above only / below and above
	x = 1, 2, 3	
CO_2 Threshold x – Communication object dimension	Type ≠ not active	**1 bit value** / 1 byte unsigned value / 1 byte percentage
	x = 1, 2, 3	
CO_2 Threshold x – value (below)	Type = below only, below and above Communication object dimension = 1 bit value	**Off** / on
	x = 1, 2, 3	
CO_2 Threshold x – value (above)	Type = above only, below and above Communication object dimension = 1 bit value	**Off** / on
	x = 1, 2, 3	
CO_2 Threshold x – value (below)	Type = below only, below and above Communication object dimension = 1 byte unsigned value	**0** [range 0… 255]
CO_2 Threshold x – value (above)	Type = above only, below and above Communication object dimension = 1 byte unsigned value	**0** [range 0… 255]
CO_2 Threshold x – percentage (below)	Type = below only, below and above Communication object dimension = 1 byte percentage	**0** [range 0… 100 %]
CO_2 Threshold x – percentage (above)	Type = above only, below and above Communication object dimension = 1 byte percentage	**0** [range 0… 100 %]

Parameter name	Conditions	Values
CO_2 Threshold x – cyclic sending interval	Type ≠ not active	**no sending** [other values in the 30 s … 120 min range]
	x = 1, 2, 3	
CO_2 Threshold x – Lock enable	Type ≠ not active	**no** / yes
	x = 1, 2, 3	
CO_2 Threshold x – Behaviour at lock	Lock enable = yes	**none** / send value
	x = 1, 2, 3	
CO_2 Threshold x – Value	Communication object dimension = 1 bit value Lock enable = yes Behaviour at lock = send value	**off** / on
	x = 1, 2, 3	
CO_2 Threshold x – Value	Communication object dimension = 1 byte unsigned value Lock enable = yes Behaviour at lock = send value	**0** [range 0… 255]
	x = 1, 2, 3	
CO_2 Threshold x – percentage	Communication object dimension = 1 byte percentage Lock enable = yes Behaviour at lock = send value	**0** [range 0… 100 %]
	x = 1, 2, 3	
CO_2 Threshold x – Behaviour at bus recovery	Lock enable = yes	**previous state** / unlock / lock
	x = 1, 2, 3	

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
CO_2 threshold x - Switch	Type ≠ not active Communication object dimension = 1 bit value	1 bit	CR-T-	[1.001] switch	86, 88, 90
	x = 1, 2, 3				
CO_2 threshold x - Counter	Type ≠ not active Communication object dimension = 1 byte unsigned value	1 byte	CR-T-	[5.010] counter pulses (0…255)	86, 88, 90
	x = 1, 2, 3				
CO_2 threshold x - Percentage	Type ≠ not active Communication object dimension = 1 byte percentage	1 byte	CR-T-	[5.001] percentage	86, 88, 90
	x = 1, 2, 3				
CO_2 threshold x - Lock	Type ≠ not active Lock enable = yes	1 bit	C-W--	[1.003] enable	87, 89, 91
	x = 1, 2, 3				
CO_2 alarm threshold limit	CO_2 alarm function = enabled	1 bit	CR-T-	[1.005] alarm	149

7.10 TVOC control

The TVOC ***control*** folder allows to configure the parameters for the air quality functions management.

It includes the following secondary folders:

- Thresholds

Condition: Internal sensors ⇒ TVOC sensor ⇒ TVOC control = enabled.

7.10.1 Thresholds

The secondary folder ***Thresholds*** includes the following parameters:

- Threshold 1, along with the related value [ppb] and hysteresis;
- Threshold 2, along with the related value [ppb] and hysteresis;
- Threshold 3, along with the related value [ppb] and hysteresis;
- TVOC ventilation;
- Threshold 1;
- Threshold 2;
- Threshold 3.

7.10.1.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
TVOC Threshold 1 – value [ppb]		**220** [range 0 … 10000 ppb]
TVOC Threshold 1 – hysteresis		**60** [other values in the 20 … 200 ppb range]
TVOC Threshold 2 – value [ppb]		**660** [range 0 … 10000 ppb]
TVOC Threshold 2 – hysteresis		**60** [other values in the 20 … 200 ppb range]
TVOC Threshold 3 – value [ppm]		**2200** [range 0 … 10000 ppb]
TVOC Threshold 3 – hysteresis		**60** [other values in the 20 … 200 ppb range]
Ventilation		enabled / **disabled**
TVOC Threshold x - Type		**not active** / below only / above only / below and above
	x = 1, 2, 3	

Parameter name	***Conditions***	***Values***
TVOC Threshold x – Communication object dimension	Type ≠ not active	**1 bit value** / 1 byte unsigned value / 1 byte percentage
	x = 1, 2, 3	
TVOC Threshold x – value (below)	Type = below only, below and above Communication object dimension = 1 bit value	**Off** / on
	x = 1, 2, 3	
TVOC Threshold x – value (above)	Type = above only, below and above Communication object dimension = 1 bit value	**Off** / on
	x = 1, 2, 3	
TVOC Threshold x – value (below)	Type = below only, below and above Communication object dimension = 1 byte unsigned value	**0** [range 0… 255]
TVOC Threshold x – value (above)	Type = above only, below and above Communication object dimension = 1 byte unsigned value	**0** [range 0… 255]
TVOC Threshold x – percentage (below)	Type = below only, below and above Communication object dimension = 1 byte percentage	**0** [range 0… 100 %]
TVOC Threshold x – percentage (above)	Type = above only, below and above Communication object dimension = 1 byte percentage	**0** [range 0… 100 %]
TVOC Threshold x – cyclic sending interval	Type ≠ not active	**no sending** [other values in the 30 s … 120 min range]
	x = 1, 2, 3	
TVOC Threshold x – Lock enable	Type ≠ not active	**no** / yes
	x = 1, 2, 3	
TVOC Threshold x – Behaviour at lock	Lock enable = yes	**none** / send value
	x = 1, 2, 3	
TVOC Threshold x – Value	Communication object dimension = 1 bit value Lock enable = yes Behaviour at lock = send value	**off** / on
	x = 1, 2, 3	
TVOC Threshold x – Value	Communication object dimension = 1 byte unsigned value Lock enable = yes Behaviour at lock = send value	**0** [range 0… 255]
	x = 1, 2, 3	

Parameter name	*Conditions*	*Values*
TVOC Threshold x – percentage	Communication object dimension = 1 byte percentage Lock enable = yes Behaviour at lock = send value	**0** [range 0… 100 %]
	x = 1, 2, 3	
TVOC Threshold x – Behaviour at bus recovery	Lock enable = yes	**previous state** / unlock / lock
	x = 1, 2, 3	

Object name	*Conditions*	*Dim.*	*Flags*	*DPT*	*Comm. Obj. No.*
TVOC threshold x - Switch	Type ≠ not active Communication object dimension = 1 bit value	1 bit	CR-T-	[1.001] switch	143, 145, 147
	x = 1, 2, 3				
TVOC threshold x - Counter	Type ≠ not active Communication object dimension = 1 byte unsigned value	1 byte	CR-T-	[5.010] counter pulses (0…255)	143, 145, 147
	x = 1, 2, 3				
TVOC threshold x - Percentage	Type ≠ not active Communication object dimension = 1 byte percentage	1 byte	CR-T-	[5.001] percentage	143, 145, 147
	x = 1, 2, 3				
TVOC threshold x - Lock	Type ≠ not active Lock enable = yes	1 bit	C-W--	[1.003] enable	144, 146, 148
	x = 1, 2, 3				

7.11 Ventilation

The secondary folder ***Ventilation control – Settings*** is the same for both CO_2 equivalente and TVOC concentration.

It includes the following parameters:

- Communication object dimension;
- Min. change of value to send [%];
- Cyclic sending interval;
- Value < threshold 1;
- Threshold 1 < value < threshold 2;
- Threshold 2 < value < threshold 3;
- Threshold 3 < value;
- CO_2 - Hysteresis (for continuous speed);
- Min. CO_2 [ppm] value (for continuous speed);
- Max. CO_2 [ppm] value (for continuous speed);
- CO_2 Min. ventilation speed [%] output (for continuous speed);
- CO_2 Max. ventilation speed [%] output (for continuous speed);
- CO_2 ventilation lock;
- Disable ventilation from bus;
- Time scheduled ventilation.

The following condition has to be true:

- Internal sensors ⇒ CO_2 sensor = enabled;
- CO_2 control ⇒ Thresholds ⇒ CO_2 ventilation = enabled.

Or:

- Internal sensors ⇒ TVOC sensor = enabled;
- TVOC control ⇒ TVOC Thresholds ⇒ TVOC ventilation = enabled.

Or both the above conditions.

7.11.1.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
CO_2 ventilation		**disabled** / enabled
TVOC ventilation		**disabled** / enabled
Ventilation – Communication object dimension	CO_2 and/or TVOC ventilation = enabled	4 single bit values / 1 byte unsigned value / **1 byte percentage** / 1 byte percentage (continuous speed)
Cyclic sending interval	CO_2 and/or TVOC ventilation = enabled	**no sending** [other values in the 30 s … 120 min range]

Parameter name	***Conditions***	***Values***
Value < threshold 1 – bit x	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 4 single bit values	**off** / on
	x = 1, 2, 3, 4	
Threshold 1 < Value < threshold 2 – bit x	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 4 single bit values	**off** / on
	x = 1, 2, 3, 4	
Threshold 2 < Value < threshold 3 – bit x	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 4 single bit values	**off** / on
	x = 1, 2, 3, 4	
Threshold 3 < Value – bit x	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 4 single bit values	**off** / on
	x = 1, 2, 3, 4	
Value < threshold 1	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte unsigned value	**0** [range 0… 255]
Threshold 1 < Value < threshold 2	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte unsigned value	**0** [range 0… 255]
Threshold 2 < Value < threshold 3	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte unsigned value	**0** [range 0… 255]
Value > threshold 3	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte unsigned value	**0** [range 0… 255]
Value < threshold 1	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte percentage	**0 %** [range 0… 100 %]
Threshold 1 < Value < threshold 2	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte percentage	**0 %** [range 0… 100 %]

Parameter name	***Conditions***	***Values***
Threshold 2 < Value < threshold 3	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte percentage	**0 %** [range 0… 100 %]
Value > threshold 3	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte percentage	**0 %** [range 0… 100 %]
Min. change of value to send [%]	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**10 %** [range 2… 40 %]
CO_2 - hysteresis	CO_2 ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**150 ppm** (other values in the 50 … 500 ppm range)
Min. CO_2 [ppm]	CO_2 ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**400 ppm** (other values in the 0 … 10000 ppm range)
Max. CO_2 [ppm]	CO_2 ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**5000 ppm** (other values in the 0 … 10000 ppm range)
CO_2 - Min. output [%]	CO_2 ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**0 %** [range 0… 100 %]
CO_2 - Max. output [%]	CO_2 ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**100 %** [range 0… 100 %]
TVOC - hysteresis	TVOC ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**60 ppb** (other values in the 20 … 200 ppb range)
Min. TVOC [ppb]	TVOC ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**250 ppb** (other values in the 0 … 10000 ppb range)
Max. TVOC [ppb]	TVOC ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**400 ppb** (other values in the 0 … 10000 ppb range)

Parameter name	***Conditions***	***Values***
TVOC - Min. output [%]	TVOC ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**0 %** [range 0… 100 %]
TVOC - Max. output [%]	TVOC ventilation = enabled Communication object dimension = 1 byte percentage (continuous speed)	**100 %** [range 0… 100 %]
Ventilation lock	CO_2 and/or TVOC ventilation = enabled	**disabled** / enabled
Behaviour at lock	CO_2 and/or TVOC ventilation = enabled Ventilation lock = enabled	**none** / send value
Behaviour after bus on	CO_2 and/or TVOC ventilation = enabled Ventilation lock = enabled	**previous state** / lock / unlock
Lock value – bit x	CO_2 ventilation = enabled Communication object dimension = 4 single bit values CO_2 ventilation lock = enabled Behaviour at lock = send value	**off** / on
	x = 1, 2, 3, 4	
Lock value	CO_2 ventilation = enabled Communication object dimension = 1 byte unsigned value CO_2 ventilation lock = enabled Behaviour at lock = send value	**0** [range 0… 255]
Lock value	CO_2 and/or TVOC ventilation = enabled Communication object dimension = 1 byte percentage or 1 byte percentage (continuous speed) CO_2 ventilation lock = enabled Behaviour at lock = send value	**0 %** [range 0… 100 %]
Disable ventilation from bus	CO_2 and/or TVOC ventilation = enabled	**no** / yes
Signal from bus	CO_2 and/or TVOC ventilation = enabled Disable ventilation from bus = yes	**not inverted** / inverted
Time scheduled ventilation	Time scheduled ventilation = enabled	**disabled** / enabled
	Please see Note 1.	
Frequency	Time scheduled ventilation = enabled	**30** (other values in the 5 … 60 min range)

Parameter name	*Conditions*	*Values*
Time interval	Time scheduled ventilation = enabled	**2 min** (other values in the 30 s … 5 min range)

Object name	*Conditions*	*Dim.*	*Flags*	*DPT*	*Comm. Obj. No.*
Ventilation bit x - Switch	Ventilation control ⇒ Settings ⇒ Communication object dimension = 1 bit value	1 bit	CR-T-	[1.001] switch	92, 93, 94, 95
	x = 1, 2, 3, 4				
Ventilation - Counter	Ventilation control ⇒ Settings ⇒ Communication object dimension = 1 byte unsigned value	1 byte	CR-T-	[5.010] counter pulses (0…255)	92
Ventilation - Percentage	Ventilation control ⇒ Settings ⇒ Communication object dimension = 1 byte percentage or 1 byte percentage (continuous speed)	1 byte	CR-T-	[5.001] percentage	92
Ventilation - Lock	Ventilation control ⇒ Settings ⇒ Ventilation lock = enabled	1 bit	C-W--	[1.003] enable	96
Ventilation - Disable	Ventilation control ⇒ Settings ⇒ Disable ventilation from bus = yes	1 bit	C-W--	[1.003] enable	97

Note 1: if the ventilation function is enabled for both equivalent CO_2 and TVOC parameters, it will be turned on according to the condition foreseen when the most restrictive threshold is exceeded.

In order to better clarify this behaviour, please consider the following example, where the communication object type is *1 byte percentage*:

- the parameter Value < Threshold 1 is set at 0% (ventilation off);
- the Threshold 1 < Value <Threshold 2 parameter is set at 20%;
- the Threshold 2 < Value <Threshold 3 parameter is set at 50%;
- the parameter Value > Threshold 3 is set to 100% (ventilation at maximum speed);
- the CO_2 control has threshold 1 = 400 ppm, threshold 2 = 1000 ppm, threshold 3 = 1200 ppm;
- the TVOC control has Threshold 1 = 500 ppb, Threshold 2 = 2000 ppb, Threshold 3 = 3000 ppb.

If the multisensor detects a value of 800 ppm for equivalent CO_2 concentration (therefore it lies between Threshold 1 and Threshold 2), while the measured TVOC value is 2500 ppb (that is, between Threshold 2 and Threshold 3), then the ventilation will start at 50%, because the most restrictive condition applies for TVOC with respect to equivalent CO_2 concentration.

Note 2: The *Time scheduled ventilation* function is designed to allow a CO_2 and / or temperature sensor reading the actual value of the data after a configured interval of plant downtime. The purpose is to avoid reading a value deviated by the stagnation of the same air around the sensor. Ventilation is switched on for a few minutes, in order to let the sensor read a new (correct) value.

The parameters are:

- frequency;
- duration.

Example: 30 min, 2 min means that ventilation has been scheduled every 30 minutes for 2 minutes.

7.12 Energy saving

In order to realize energy-saving functions, window contacts (to detect the opening of windows or doors), presence and movement sensors and card holders can be used.

The ***Energy saving*** folder includes the following secondary folders:

- Window contacts
- Presence sensors
- Card holder

The folder is available if the following conditions are satisfied:

- *Internal sensors ⇒ Temperature sensor = enabled, or*
- *External sensors (from bus) ⇒ Room Temperature sensor = enabled.*

7.12.1 Window contacts

The ***Window contacts*** secondary folder appears if at least one sensor dedicated to this function is enabled i.e. if the following condition is verified:

- *External sensors (from bus) ⇒ Windows contact sensor 1 and/or 2 = enabled.*

The ***Window contacts*** folder includes the following parameters:

- Window contacts function
- Wait time to building protection mode

7.12.1.1 Parameter and communication object tables

Parameter name	Conditions	Values
Window contacts function		**disabled** / enabled
	This parameter enables the window contact function.	
Wait time to building protection mode	Window contacts function = enabled	**00:01:00 hh:mm:ss** [range 00:00:00 … 18:12:15]
	Time interval before the automatic switching of the device to the Building protection operating mode	

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
Windows contact sensor 1 (from bus)	Window contacts function = enabled	1 bit	C-WTU	[1.019] window/door	28
Windows contact sensor 2 (from bus)	Window contacts function = enabled	1 bit	C-WTU	[1.019] window/door	29

7.12.2 Presence sensors

The ***Presence sensors*** folder includes the following parameters:

- Presence sensors function
- Presence sensors use
- Thermostat modes
- Absence time to switch HVAC mode

For this function external sensors (from bus) can be used, such as the ekinex EK-SM2-TP movement sensor or the ekinex EK-DX2-TP (X = B, C, D, E) presence sensor. The following condition has to be true:

- *External sensors (from bus) ⇒ Presence sensor 1 and/or Presence sensor 2 = enabled*

7.12.2.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
Presence sensors function		**disabled** / enabled
	Parameter that enables the presence sensor function.	
Presence sensors use	Presence sensor function = enabled	**comfort extension** comfort limitation comfort extension and comfort limitation
Thermostat modes	Presence sensor function = enabled, Presence sensors use = comfort extension and comfort limitation, or comfort limitation	**comfort-standby** comfort-economy
Absence time to switch HVAC mode	Presence sensor function = enabled	**00:01:00 hh:mm:ss** [range 00:00:00 … 18:12:15]
	Time interval before the automatic switching of the operating mode set in the Thermostat modes parameter.	

Object name	***Conditions***	***Dim.***	***Flags***	***DPT***	***Comm. Obj. No.***
Presence sensor 1 (from bus)	Presence sensor function= enabled	1 bit	C-WTU	[1.018] occupancy	30
Presence sensor 2 (from bus)	Presence sensor function = enabled	1 bit	C-WTU	[1.018] occupancy	31

7.12.3 Card holder

The ***Card holder*** secondary folder appears only if the corresponding sensor is enabled, i.e. if the following condition is true:

- *External sensors (from bus) ⇒ Card holder contact = enabled*

The ***Card holder*** folder includes the following parameters:

- Card holder function
- On card insertion switch HVAC mode to
- Activation delay on card insertion
- On card removal switch HVAC mode to
- Activation delay on card removal

7.12.3.1 Parameter and communication object tables

Parameter name	***Conditions***	***Values***
Card holder function		**disabled** / enabled
	Parameter that enables the card holder function.	
On card insertion switch HVAC mode to (*)	Card holder function = enabled	none **comfort** standby economy
	This parameter defines to which operating mode the device should automatically switch, after inserting the card into the holder. *(*) Note: if Setpoint type is set to **single** in the "Temperature control" tab, this parameter is set to "none", since the operating modes are not managed.*	
Activation delay on card insertion	Card holder function = enabled	**00:00:00 hh:mm:ss** [range 00:00:00 … 18:12:15]
	Time interval before the automatic switching to the new operating mode, after inserting the card into the holder.	
On card removal switch HVAC mode to (*)	Card holder function = enabled	none **standby** economy building protection
	This parameter defines to which operating mode the device should automatically switch, after removing the card from the holder. **) Note: if Setpoint type is set to **single** in the "Temperature control" tab, this parameter is set to "**Building protection**", since the operating modes are not managed.*	
Activation delay on card removal	Card holder function = enabled	**00:00:00 hh:mm:ss** [range 00:00:00 … 18:12:15]
	Time interval before the automatic switching to the new operating mode, after removing the card from the holder.	

Object name	***Conditions***	***Dim.***	***Flags***	***DPT***	***Comm. Obj. No.***
Contact of card holder (from bus)	Card holder function = enabled	1 bit	C-WTU	[1.018] occupancy	32

Note on card holder function

The information of card insertion/removal in/from a card holder allows you to directly control the temperature by means of the room thermostat, while sending the object value on the bus allows you to control other room functions with KNX (lighting, electrical loads, feedback status for the hotel reception, etc.) depending on the configuration done with ETS. The value of the setpoint temperature and the switching have to be defined with the hotel responsible in accordance with the target of energy saving and level of service to be offered to the guests.

Conventional (not KNX) card holder

With a conventional card holder the status (card present or absent) of a signal contact is detected through an input of the device configured as *[DI] card holder contact sensor*. This way you can detect only the insertion and extraction of the card, but it cannot be detected e.g. the access of users with different profiles (guests, service staff, maintenance workforce).

KNX card holder

With a KNX card holder you can differentiate the switching to be carried out; this is not resolved by the parameters of the room temperature controller, but through the definition of scenes that are received by the device. Depending on the available device, advanced functions are possible (e.g. different user profiles).

7.13 Logic functions

The EK-ES3-TP KNX Multisensor controller allows to use some useful logic functions (AND, OR, NOT and exclusive OR) in order to implement complex functions in the building automation system.

You can configure:

- 8 channels of logical functions
- 4 inputs for each channel

Each object value, if desired, can be individually inverted by inserting a NOT logic operator.

For each channel, a parameter *Delay after bus voltage recovery* is available: this parameter represents the time interval between the bus voltage recovery and the first reading of the input communication objects for evaluating the logic functions.

i In case of uncorrect connection of the input communication object or electrical trouble on bus resulting in a failed input reading request, the logic output of the corresponding channel can be calculated by setting default input values.

The communicaton object that represents the logic function output is sent on the bus on event basis, i.e. when the status changes; alternatively, a cyclic sending can be set.

7.13.1 Parameter and communication object tables

The following condition has to be true: *General ⇒ Logic functions = enabled*.

Parameter name	***Conditions***	***Values***
Logic function		**disabled** / enabled
Logic operation	Logic function = enabled	**OR** / AND / XOR
	XOR (eXclusive OR)	
Delay after bus voltage recovery	Logic function = enabled	**00:00:04.000 hh:mm:ss.fff** [range 00:00:00.000 … 00:10:55.350]
	Time interval between the bus voltage recovery and the first reading of the input communication objects, for evaluating the logic functions	
Output cyclic sending interval	Logic function = enabled	**no sending** [other value in range 30 s … 120 min]
	No sending means that the output state of the logic function is updated on the bus only on change event. Different values imply cyclic sending on the bus of the output state.	
Output sending	Logic function = enabled	**both values** / only value 0 / only value 1
	It allows to decide the trigger for sending the result of the operation to output.	
Output update	Logic function = enabled	**at value change** / at value or input change
	It identifies the event for the output update.	
Logic object x	Logic function = enabled	**disabled** / enabled
	x = 1, 2, 3, 4	
Logic object x negated	Logic function = enabled Logic object x = enabled	**no** / yes

Parameter name	Conditions	Values
	x = 1, 2, 3, 4 *By denying the logical state of the corresponding input, it is possible to implement complex combinatorial logics. Example: Output=(NOT(Logic object 1) OR Logic object 2)).*	
Logic object x read at startup	Logic function = enabled Logic object x = enabled	**no** / yes
	x = 1, 2, 3, 4	
Logic object x default value	Logic function = enabled Logic object x = enabled	**none** / off / on
	x = 1, 2, 3, 4	

Object name	Conditions	Dim.	Flags	DPT	Comm. Obj. No.
Logic function X – Input 1	Logic function X = enabled Logic object 1 = enabled	1 bit	C-WTU	[1.001] switch	98, 103, 108, 113, 118, 123, 128, 133
	X = 1, …, 8				
Logic function X – Input 2	Logic function X = enabled Logic object 2 = enabled	1 bit	C-WTU	[1.001] switch	99, 104, 109, 114, 119, 124, 129, 134
	X = 1, …, 8				
Logic function X – Input 3	Logic function X = enabled Logic object 3 = enabled	1 bit	C-WTU	[1.001] switch	100, 105, 110, 115, 120, 125, 130, 135
	X = 1, …, 8				
Logic function X – Input 4	Logic function X = enabled Logic object 4 = enabled	1 bit	C-WTU	[1.001] switch	101, 106, 111, 116, 121, 126, 131, 136
	X = 1, …, 8				
Logic function X – Output	Logic function X = enabled At least one logic object enabled	1 bit	CR-T-	[1.001] switch	102, 107, 112, 117, 122, 127, 132, 137
	X = 1, …, 8				

8 List of communication objects

Nr.	Communication object name	Size	Flags	Datapoint type
0	Technical alarm	1 bit	C-W--	[1.005] DPT_Alarm
1	Leds intensity percentage	1 byte	C-W--	[5.001] DPT_Percentage
2	Temperature value	2 bytes	CR-T-	[9.001] DPT_Value_Temp
3	Temperature threshold 1 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
4	Temperature threshold 1 - Lock	2 bytes	C-W--	[1.001] DPT_Switch
5	Temperature threshold 1 - Value (from bus)	2 bytes	C-W--	[9.001] DPT_Value_Temp
6	Temperature threshold 2 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
7	Temperature threshold 2 - Lock	2 bytes	C-W--	[1.001] DPT_Switch
8	Temperature threshold 2 - Value (from bus)	2 s	C-W--	[9.001] DPT_Value_Temp
9	CO2 - Value	2 bytes	CR-T-	[9.008] DPT_Value_AirQuality
10	Humidity value (2 bytes)	2 bytes	CR-T-	[9.007] DPT_Value_Humidity
11	Humidity value (1 byte)	2 bytes	CR-T-	[5.001] DPT_Scaling
12	Humidity threshold 1 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
13	Humidity threshold 1 - Lock	1 bit	C-W--	[1.003] DPT_Enable
14	Humidity threshold 1 - Value (2 bytes, from bus)	2 bytes	C-W--	[9.007] DPT_Value_Humidity
15	Humidity threshold 1 - Value (1 byte, from bus)	1 byte	C-W--	[5.001] DPT_Scaling
16	Humidity threshold 2 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
17	Humidity threshold 2 - Lock	1 bit	C-W--	[1.003] DPT_Enable
18	Humidity threshold 2 - Value (2 bytes, from bus)	2 bytes	C-W--	[9.007] DPT_Value_Humidity
19	Humidity threshold 2 - Value (1 bytes, from bus)	1 byte	C-W--	[5.001] DPT_Scaling
20	Thermostat - Room temperature (from bus)	2 bytes	C-WTU	[9.001] DPT_Value_Temp
21	Thermostat - Humidity (2 bytes, from bus)	2 bytes	C-WTU	[9.007] DPT_Value_Humidity
22	Thermostat - Humidity (1 byte, from bus)	2 bytes	C-WTU	[5.001] DPT_Scaling
23	Thermostat - Antistratification temperature (from bus)	2 bytes	C-WTU	[9.001] DPT_Value_Temp
24	Thermostat - Outdoor temperature (from bus)	2 bytes	C-WTU	[9.001] DPT_Value_Temp
25	Thermostat - Coil temperature (from bus)	2 bytes	C-WTU	[9.001] DPT_Value_Temp
26	Thermostat - Floor temperature (from bus)	2 bytes	C-WTU	[9.001] DPT_Value_Temp
27	Thermostat - Flow temperature (from bus)	2 bytes	C-WTU	[9.001] DPT_Value_Temp
28	Thermostat - Windows contact sensor 1 (from bus)	2 bytes	C-WTU	[1.019] DPT_Window_Door
29	Thermostat - Windows contact sensor 2 (from bus)	2 bytes	C-WTU	[1.019] DPT_Window_Door
30	Thermostat - Presence sensor 1 (from bus)	1 bit	C-WTU	[1.018] DPT_Occupancy
31	Thermostat - Presence sensor 2 (from bus)	1 bit	C-WTU	[1.018] DPT_Occupancy
32	Thermostat - Contact of card holder (from bus)	1 bit	C-WTU	[1.018] DPT_Occupancy
33	Thermostat - Anticondensation (from bus)	1 bit	C-WTU	[1.001] DPT_Switch
34	Thermostat - Weighted temperature	2 bytes	CR-T-	[9.001] DPT_Value_Temp
35	Thermostat - Heating/cooling status out	1 bit	CR-T-	[1.100] DPT_Heat_Cool
36	Thermostat - Heating/cooling status in	1 bit	C-W--	[1.100] DPT_Heat_Cool
37	Thermostat - HVAC mode in	1 byte	C-W--	[20.102] DPT_HVACMode
38	Thermostat - HVAC forced mode in	1 byte	C-W--	[20.102] DPT_HVACMode
39	Thermostat - HVAC mode out	1 byte	CR-T-	[20.102] DPT_HVACMode
40	Thermostat - HVAC manual mode	1 byte	CRWTU	[20.102] DPT_HVACMode

Nr.	Communication object name	Size	Flags	Datapoint type
41	Thermostat - Building protection HVAC mode active	1 bit	CR-T-	[1.011] DPT_State
42	Thermostat - Chrono active status	1 bit	CR-T-	[1.011] DPT_State
43	Thermostat - Actual setpoint	2 bytes	CR-T-	[9.001] DPT_Value_Temp
44	Thermostat - Manual setpoint	2 bytes	C-W--	[9.001] DPT_Value_Temp
45	Thermostat - Manual setpoint status	1 bit	CRWTU	[1.011] DPT_State
46	Thermostat - Setpoint in	2 bytes	CRWTU	[9.001] DPT_Value_Temp
47	Thermostat - Comfort setpoint (cooling)	2 bytes	CRWTU	[9.001] DPT_Value_Temp
48	Thermostat - Standby setpoint (heating)	2 bytes	CRWTU	[9.001] DPT_Value_Temp
48	Thermostat - Offset standby (heating)	2 bytes	CRWTU	[9.002] DPT_Value_Tempd
49	Thermostat - Standby setpoint (cooling)	2 bytes	CRWTU	[9.001] DPT_Value_Temp
49	Thermostat - Offset standby (cooling)	2 bytes	CRWTU	[9.002] DPT_Value_Tempd
50	Thermostat - Economy setpoint (heating)	2 bytes	CRWTU	[9.001] DPT_Value_Temp
50	Thermostat - Offset economy (heating)	2 bytes	CRWTU	[9.002] DPT_Value_Tempd
51	Thermostat - Economy setpoint (cooling)	2 bytes	CRWTU	[9.001] DPT_Value_Temp
51	Thermostat - Offset economy (cooling)	2 bytes	CRWTU	[9.002] DPT_Value_Tempd
52	Thermostat - Building protection setpoint (heating)	2 bytes	CRWTU	[9.001] DPT_Value_Temp
53	Thermostat - Building protection setpoint (cooling)	2 bytes	CRWTU	[9.001] DPT_Value_Temp
54	Thermostat - Disable room temperature controller	1 bit	C-W--	[1.001] DPT_Switch
55	Thermostat - Room temperature controller status	1 bit	CR-T-	[1.003] DPT_Enable
56	Thermostat - Heating and cooling out command	1 bit	CR-T-	[1.001] DPT_Switch
56	Thermostat - Heating and cooling out command	1 byte	CR-T-	[5.001] DPT_Scaling
56	Thermostat - Heating out command	1 bit	CR-T-	[1.001] DPT_Switch
56	Thermostat - Heating out command	1 byte	CR-T-	[5.001] DPT_Scaling
57	Thermostat - Cooling out command	1 bit	CR-T-	[1.001] DPT_Switch
57	Thermostat - Cooling out command	1 byte	CR-T-	[5.001] DPT_Scaling
58	Thermostat - Auxiliary heating output command	1 bit	CR-T-	[1.001] DPT_Switch
58	Thermostat - Auxiliary heating and cooling output command	1 bit	CR-T-	[1.001] DPT_Switch
59	Thermostat - Auxiliary cooling output command	1 bit	CR-T-	[1.001] DPT_Switch
60	Thermostat - Auxiliary heating disable	1 bit	C-W--	[1.003] DPT_Enable
61	Thermostat - Auxiliary cooling disable	1 bit	C-W--	[1.003] DPT_Enable
62	Thermostat - Fan continuous speed	1 bit	CR-T-	[5.001] DPT_Scaling
63	Thermostat - Fan speed 1	1 bit	CR-T-	[1.001] DPT_Switch
64	Thermostat - Fan speed 2	1 bit	CR-T-	[1.001] DPT_Switch
65	Thermostat - Fan speed 3	1 bit	CR-T-	[1.001] DPT_Switch
66	Thermostat - Fan control disable	1 bit	C-W--	[1.002] DPT_Bool
67	Thermostat - Fan speed	1 byte	CR-T-	[5.010] DPT_Value_1_Ucount
68	Thermostat - Fan manual speed	1 byte	CRW-U	[5.010] DPT_Value_1_Ucount
69	Thermostat - Fan manual speed percentage	1 byte	CR-T-	[5.001] DPT_Scaling
70	Thermostat - Fan manual active status	1 bit	CRWT-	[1.011] DPT_State
71	Thermostat - Fan manual speed off status	1 bit	CR-T-	[1.011] DPT_State
72	Thermostat - Room temperature controller alarm	1 bit	CR-T-	[1.005] DPT_Alarm
73	Thermostat - Dew-point temperature	2 bytes	CR-T-	[9.001] DPT_Value_Temp

Nr.	Communication object name	Size	Flags	Datapoint type
74	Thermostat - Relative humidity setpoint for dehumidification	2 bytes	CRWTU	[9.007] DPT_Value_Humidity
75	Thermostat - Relative humidity setpoint for humidification	2 bytes	CRWTU	[9.007] DPT_Value_Humidity
76	Thermostat - Dehumidification command	1 bit	CR-T-	[1.001] DPT_Switch
77	Thermostat - Dehumidification water battery command	1 bit	CR-T-	[1.001] DPT_Switch
78	Thermostat - Dehumidification integration control	1 bit	CR-T-	[1.001] DPT_Switch
79	Thermostat - Dehumidification control disable	1 bit	C-W--	[1.002] DPT_Bool
80	Thermostat - Humidification command	1 bit	CR-T-	[1.001] DPT_Switch
81	Thermostat - Humidification control disable	1 bit	C-W--	[1.002] DPT_Bool
82	Thermostat - Anticondensation alarm	1 bit	CR-T-	[1.005] DPT_Alarm
83	Thermostat - Thermal generator lock	1 bit	C-W--	[1.005] DPT_Alarm
84	Thermostat - HVAC scene number **(not implemented)**	1 byte	C-W--	[17.001] DPT_SceneNumber, [18.001] DPT_SceneControl
85	Thermostat - Alarm text	14 bytes	CR-T-	[16.000] DPT_String_ASCII
86	CO_2 threshold 1 - Percentage	1 byte	CR-T-	[5.001] DPT_Scaling
86	CO_2 threshold 1 - Counter	1 byte	CR-T-	[5.010] DPT_Value_1_Ucount
86	CO_2 threshold 1 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
87	CO_2 threshold 1 - Lock	1 bit	C-W--	[1.003] DPT_Enable
88	CO_2 threshold 2 - Percentage	1 byte	CR-T-	[5.001] DPT_Scaling
88	CO_2 threshold 2 - Counter	1 byte	CR-T-	[5.010] DPT_Value_1_Ucount
88	CO_2 threshold 2 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
89	CO_2 threshold 2 - Lock	1 bit	C-W--	[1.003] DPT_Enable
90	CO_2 threshold 3 - Percentage	1 byte	CR-T-	[5.001] DPT_Scaling
90	CO_2 threshold 3 - Counter	1 byte	CR-T-	[5.010] DPT_Value_1_Ucount
90	CO_2 threshold 3 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
91	CO_2 threshold 3 - Lock	1 bit	C-W--	[1.003] DPT_Enable
92	CO_2 ventilation bit 1 - switch	1 byte	CR-T-	[5.010] DPT_Value_1_Ucount
92	CO_2 ventilation - Counter	1 byte	CR-T-	[5.001] DPT_Scaling
92	CO_2 ventilation - Percentage	1 bit	CR-T-	[1.001] DPT_Switch
93	CO_2 ventilation bit 2 - switch	1 bit	CR-T-	[1.001] DPT_Switch
94	CO_2 ventilation bit 3 - switch	1 bit	CR-T-	[1.001] DPT_Switch
95	CO_2 ventilation bit 4 - switch	1 bit	CR-T-	[1.001] DPT_Switch
96	CO_2 ventilation - Lock	1 bit	C-W--	[1.003] DPT_Enable
97	CO_2 ventilation - Disable	1 bit	C-W--	[1.003] DPT_Enable
98, 103, 108, 113, 118, 123, 128, 133	Logic function x[1] – Input 1	1 bit	C-WTU	[1.001] DPT_Switch
99, 104, 109, 114, 119, 124, 129, 134	Logic function x[1] – Input 1	1 bit	C-WTU	[1.001] DPT_Switch
100, 105, 110, 115, 120, 125, 130, 135	Logic function x[1] – Input 1	1 bit	C-WTU	[1.001] DPT_Switch

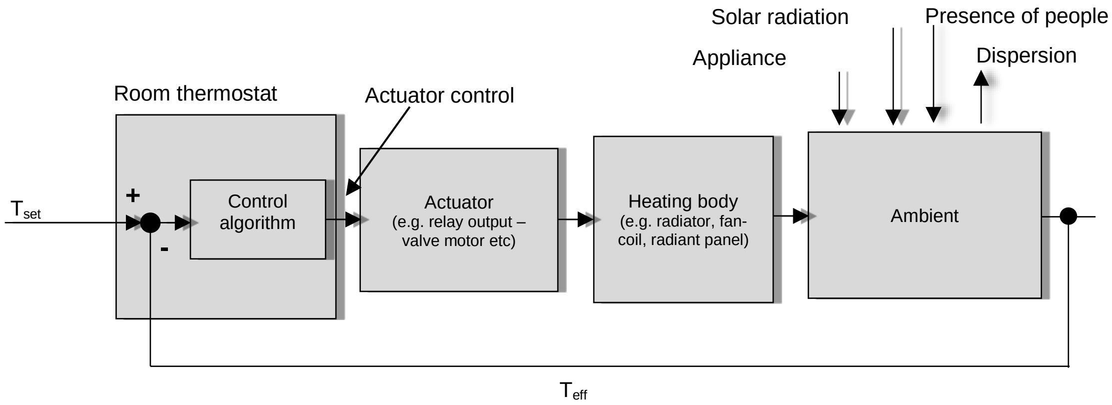
[1] *"x" can span from 1 to 8.*

Nr.	Communication object name	Size	Flags	Datapoint type
101, 106, 111, 116, 121, 126, 131, 136	Logic function x[1] – Input 1	1 bit	C-WTU	[1.001] DPT_Switch
102, 107, 112, 117, 122, 127, 132, 137	Logic function x[1] – Output	1 bit	CR-T-	[1.001] DPT_Switch
138	TVOC value	2 bytes	CR-T-	[9.008] DPT_Value_AirQuality
139	Thermostat – indoor CO_2 value (from bus)	2 bytes	C-WTU	[9.008] DPT_Value_AirQuality
140	Thermostat – Outdoor CO_2 value (from bus) – **not implemented (available for future development)**	2 bytes	C-WTU	[9.008] DPT_Value_AirQuality
141	Flow rate (from bus) – **not implemented (available for future development)**	2 bytes	C-WTU	[9.020] DPT_Value_Volt
142	Insufficient flow rate alarm – **not implemented (available for future development)**	1 bit	CR-T-	[1.005] DPT_Alarm
143	TVOC Threshold 1 - Percentage	1 byte	CR-T-	[5.001] DPT_Scaling
143	TVOC Threshold 1 - Counter	1 byte	CR-T-	[5.010] DPT_Value_1_Ucount
143	TVOC Threshold 1 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
144	TVOC Threshold 1 - Lock	1 bit	C-W--	[1.003] DPT_Enable
145	TVOC Threshold 2 - Percentage	1 byte	CR-T-	[5.001] DPT_Scaling
145	TVOC Threshold 2 - Counter	1 byte	CR-T-	[5.010] DPT_Value_1_Ucount
145	TVOC Threshold 2 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
146	TVOC Threshold 2 - Lock	1 bit	C-W--	[1.003] DPT_Enable
147	TVOC Threshold 3 - Percentage	1 byte	CR-T-	[5.001] DPT_Scaling
147	TVOC Threshold 3 - Counter	1 byte	CR-T-	[5.010] DPT_Value_1_Ucount
147	TVOC Threshold 3 - Switch	1 bit	CR-T-	[1.001] DPT_Switch
148	TVOC Threshold 3 - Lock	1 bit	C-W--	[1.003] DPT_Enable
149	CO_2 threshold alarm	1 bit	CR-T-	[1.005] DPT_Alarm

9 Control algorithms

In figura sono rappresentati i componenti di un generico sistema di controllo per la temperatura ambiente. Il termostato rileva il valore attuale di temperatura della massa d'aria ambiente (T_{eff}) e la confronta con il valore di temperatura desiderato o setpoint (T_{set}).

The components of a common generic control system for ambient temperature are represented in Picture 11. The room thermostat measures the actual temperature of the air mass (T_{eff}) and constantly compares it to the setpoint value (T_{set}).



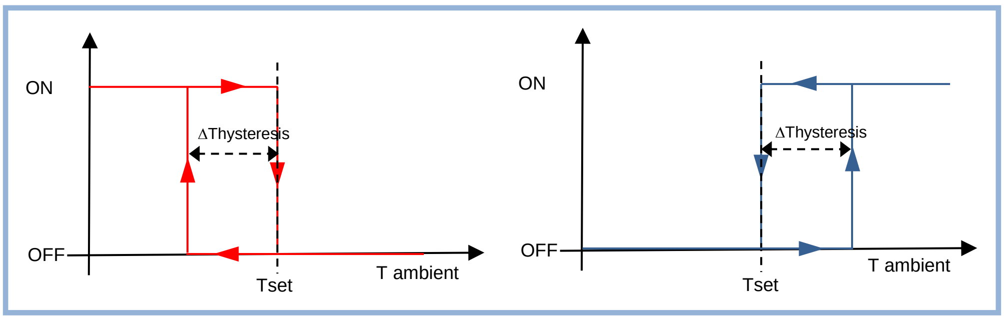
Picture 11 - Generic control system for ambient temperature

The control algorithm, basing on the difference between T_{set} and T_{eff}, processes a command value which can be of analog or On / Off type; the command is represented by a CO that is transmitted via bus, either periodically or event based, to a KNX actuator device.

The output of the actuator device is the driving variable of the control system, which can be e.g. a flow rate of water or air. The control system realized by the room thermostat is of feedback type, namely the algorithm takes into account the effects on the system in order to change the control action on the same entity.

9.1 Two-point control with hysteresis

This control algorithm, which is also known as On / Off, is the most classic and popular. The control provides for the on / off switching of the system following a hysteresis loop, i.e. two threshold levels are considered for the switching instead of a single one (see Picture 12).

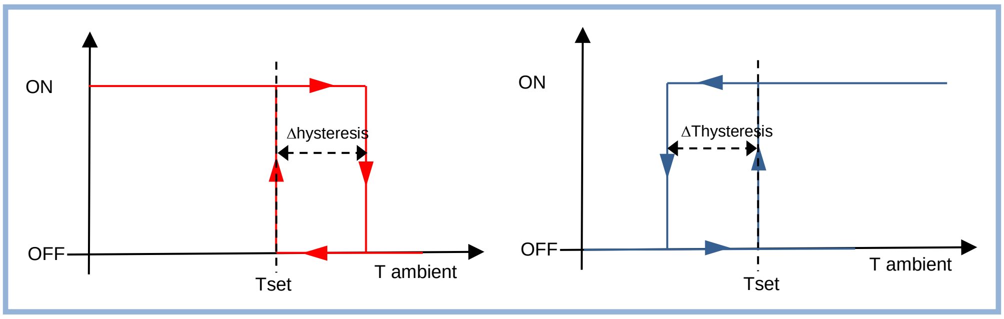


Picture 12 - Two-points control with hysteresi

Heating mode: when the measured temperature is lower than the value of the difference (T_{set} – $\Delta T_{hysteresis}$), whereby $\Delta T_{hysteresis}$ identifies the differential adjustment of the boilers, the device activates the heating system by sending a message or KNX telegram to the actuator that handles the heating system; when the measured temperature reaches the desired temperature (Setpoint), the device disables the heating system by sending another message. In this way, there are two decision thresholds for activation and deactivation of the heating, the first being the level (T_{set} – $\Delta T_{hysteresis}$) below which the device activates the system, whereas the second is the desired temperature above which which the heating system is deactivated.

Cooling mode: When the measured temperature is higher than the value of the difference (T_{set} + $\Delta T_{hysteresis}$), whereby $\Delta T_{hysteresis}$ identifies the differential adjustment of the cooler, the device activates the air conditioning system by sending a message or KNX telegram to the actuator that handles it; when the measured temperature falls below the desired temperature T_{set} the device turns off the air conditioning system by sending another message. In this way, there are two decision thresholds for activation and deactivation of the cooling: the first being the level (T_{set} + $\Delta T_{hysteresis}$) above which the device activates the system, whereas the second is the desired temperature below which which the air conditioning system is deactivated. In the ETS application program, two different parameters are available for the hysteresis value for heating and cooling: the values usually differ depending on the system type and its inertia.

In those applications where floor or ceiling radiant panels are present, it is possible to realize a different 2-point room temperature control. Ths type of control must be paired either to a proper regulation system for flow temperature that takes into account all internal conditions or an optimizer that exploits the thermal capacity of the building to adjust the energy contributions (Picture 13). In this type of control the hysteresis ($\Delta T_{hysteresis}$) o the room temperature high limit (T_{set} + $\Delta T_{hysteresis}$) represent the maximum level of deviation that the user is willing to accept during plant conduction.



Picture 13 - Two-points control with hysteresis and flow temperature

Heating mode – When the measured temperature is lower than the desired temperature T_{set}, the device activates the heating system by sending a message or KNX telegram to the actuator that handles it; when the measured temperature reaches the value (T_{set} + $\Delta T_{hysteresis}$), whereby $\Delta T_{hysteresis}$ identifies the differential adjustment of the boilers the device disables the heating system by sending another message. In this way, there are two decision thresholds for activation and deactivation of the heating, the first being the desired temperature T_{set} below which the device activates the system, whereas the second is the value (T_{set} + $\Delta T_{hysteresis}$), above which which the heating system is deactivated.

Cooling mode – When the measured temperature is higher than the desired temperature T_{set}, the device activates the air conditioning system by sending a message or KNX telegram to the actuator that handles it; when the measured temperature reaches the value (T_{set} - $\Delta T_{hysteresis}$), whereby $\Delta T_{hysteresis}$ identifies the differential adjustment of the air conditioning system, the device disables the air conditioning system by sending another message. In this way, there are two decision thresholds for activation and deactivation of the ai conditioning system: he first being the desired temperature T_{set} above which the device activates the system, whereas the second is the value (T_{set} - $\Delta T_{hysteresis}$) below which which the air conditioning system is deactivated.

In the ETS application program, two different parameters are available for the hysteresis value for heating and cooling: the values usually differ depending on the system type and its inertia.

In the ETS application program, the default 2-point hysteresis control algorithm foresees inferior hysteresis for heating and superior for cooling. If Heating and/or cooling type = floor radiant panels or ceiling radiant panels, it is possible to selet the hysteresis position according to the described second mode, i.e. with superior hysteresis for heating and inferior for cooling.

The desired temperature (T_{set}) is generally different for each one of the 4 operating modes and for heating/cooling modes. The different values are defined for the first time during ETS configuration and can be modified later on. In order to optimize energy saving (for each extra degree of room temperature, outbound dispersions and energy consumption go up 6%), it is possible to take advantage of the multifunctionality of the domotic system, for example with:

- Hour programming with automatic commutation of the operating mode by means of KNX supervisor;
- Automatic commutation of the operating mode according to presence of people in the room;
- Automatic commutation of the opeating mode according to window opening for air refreshment;
- Circuit deativation when desired temperature is reached;
- Flow temperature reduction in case of partial load.

9.2 Continuous Proportional-Integral control

The continuous proportional-integral (PI) controller is described by the following equation:

$$control\ variable(t) = Kp\ \times\ error(t) +\ Ki\ \times \int_0^t error(\tau)d\tau$$

whereby:

$error(t) = (Setpoint - Measured\ temperature)\ in\ heating$

$error(t) = (Measured\ temperature - Setpoint)\ in\ cooling$

$Kp = proportional\ constant$

$Ki = intgral\ constant$

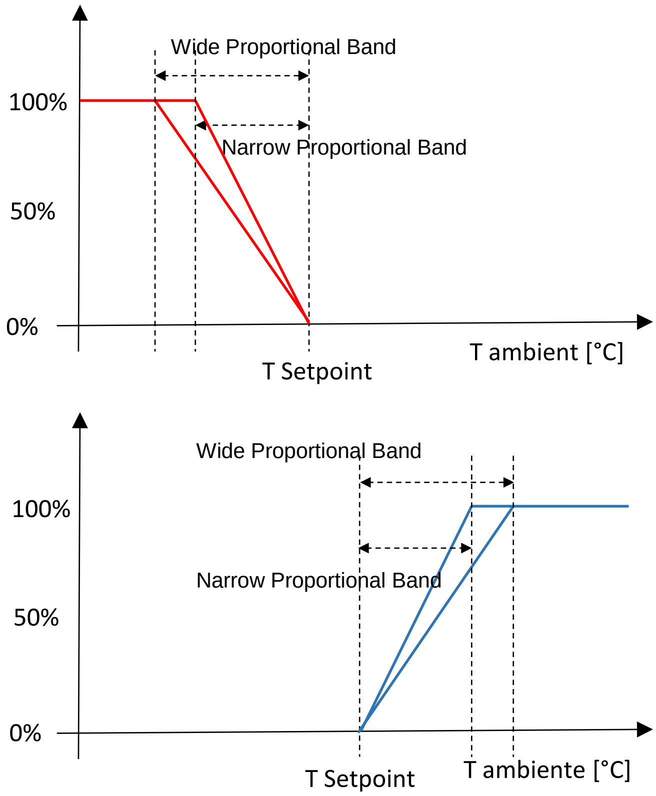
The control variable is composed by 2 numbers, one depending proportionally from the error and one depending from the integral of the error itself.

Practically, some more intuitive values are used:

$$Proportional\ Band\ BP\ [K] = \frac{100}{Kp}$$

$$Integral\ Time\ Ti\ [min] = \frac{Kp}{Ki}$$

The Proportional Band is the error value that determines the maximum span of the control variable at 100%.
For example, a controller with Proportional Band = 5 K regulates at 100% when Setpoint = 20°C and Measured Temperature is ≤ 15 °C in heating mode; in cooling mode, it regulates at 100% when Setpoint = 24°C and Measured Temperature is ≥ 29°C. As shown in Picture 14, a controller with a narrow Proportional Band provides higher control variable values for smaller errors compared to a controller with a wider Proportional Band.



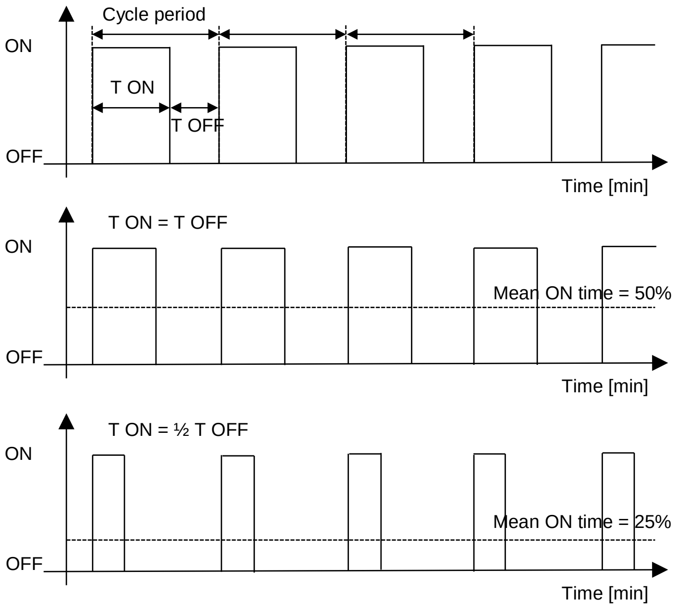
Picture 14 - Continuous Proportional-Integral control

Integral Time is the amount of time necessary to repeat the vaue of the control variable of a purely proportional controller, when error is constant. For example, with a purely proportional controller with Proportional Band = 4 K, if Setpoint = 20°C and Measured Temperature = 18°C, the control variable will be 50%. If Integral Time = 60 minutes, if error remains constant, the control variable will be 100% after 1 hour, i.e. the controller will add to the control variable a contribution equal to the value due to its proportional part.

In heating and air conditioning systems, a purely proportional controller cannot guarantee reaching the Setpoint. An integral action is mandatory in order to reach the Setpoint: for this reason the integral action is also called automatic reset.

9.3 PWM Proportional-Integral control

The proportional-integral PWM (Pulse Width Modulator) controller uses an analog control variable to modulate the duration of the time intervals in which a binary output is in the On or Off state. The controller operates in a periodic manner over a cycle, and in each period it maintains the output to the On value for a time proportional to the value of the control variable. As shown in Picture 15, by varying the ratio between the ON time and the OFF time, the average time of activation of the output varies, and consequently the average intake of heating or cooling power supplied to the environment.



Picture 15 - PWM Proportional-Integral control

This type of controller is well suited for use with On / Off type actuators, such as relays and actuators for zone valves, which are less expensive (both for electrical and mechanical components) than proportional actuators. A distinctive advantage of this type of controller, compared with the raw On / Off controller already described, is that it eliminates the inertia characteristics of the system: it allows significant energy savings, because you avoid unnecessary interventions on the system introduced by the 2-point control with hysteresis and it only provides the power required to compensate for losses in the building.

Every time the user or the supervisor changes the desired temperature setpoint, the cycle time is interrupted, the control output is reprocessed and the PWM restarts with a new cycle: this allows the system to reach its steady state more quickly.

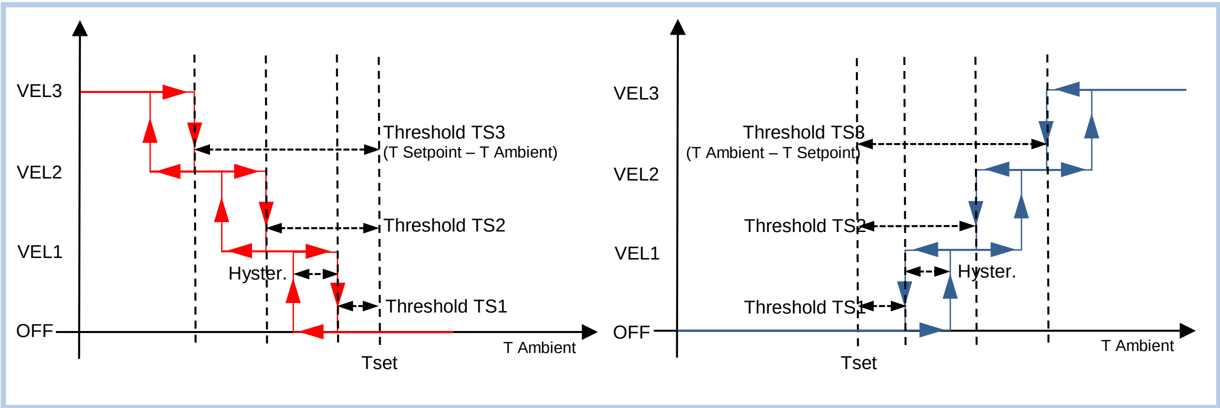
Terminal type	Proportional Band [K]	Integral Time [min]	Cycle Period [min]
Radiators	5	150	15-20
Electrical heaters	4	100	15-20
Fan-coil	4	90	15-20
Floor radiant panels	5	240	15-20

Guidelines for choosing the proper parameters of a PMW Proportional-Integral controller:

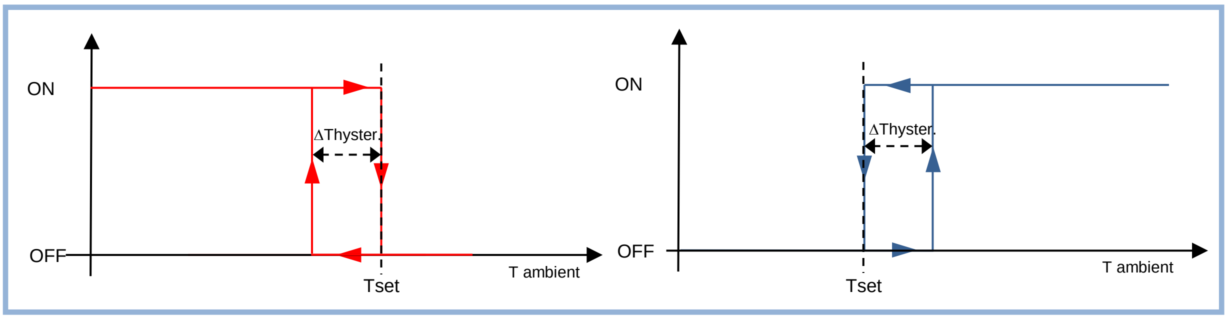
- Cycle time: for low-inertial systems such as heating and air conditioning systems, short cycle times must be chosen (10-15 minutes) to avoid oscillations of the room temperature.
- Narrow proportional band: wide and continuous oscillations of the room temperature, short setpoint settling time.
- Wide proportional band: small or no oscillations of the room temperature, long setpoint settling time.
- Short integral time: short setpoint settling time, continuous oscillations of the room temperature.
- Long integral time: long setpoint settling time, no oscillations of the room temperature.

9.4 Fancoils with On / Off fan speed control

The multi-stage fan control is similar to the 2-point control with hysteresis described in the previous section. The speed of the fan is chosen basing on the difference between the set point (T_{set}) and the actual measured temperature (T_{eff}). The substantial difference from the described 2-points algorithm is that, in this case, there can be up to three stages (depending the number of available fan speeds); a different hysteresis threshold exists for each stage transition. At a given stage, i.e. speed setting, a threshold causes the switching to a higher speed (or none, for the highest stage) while the other causes the switching to a lower speed (or off, for the lowest stage). Usually, but not inherently, a same threshold value will be used for both transitions that lead to each speed from the adjacent ones.



Picture 16



Picture 17

The diagram on the left in Picture 16 refers to the speed control of the fan-coil (with 3-stage operation) in heating mode. Please note that for each speed, two thresholds values are assigned, one for activation and one for deactivation. The thresholds values are specified in the ETS application program, and their effect can be summarized as follows:

- Speed 1 (1st stage) – The speed is activated when the room temperature value is lower than the value (T_{Set} – Threshold TS1 - Hysteresis) and deactivated when the room temperature value reaches the value (T_{Set} – Threshold TS1); the first speed is also deactivated when a higher speed needs to be activated. The default value for Threshold TS1 parameter is 0 K.

- Speed 2 (2nd stage) – The speed is activated when the room temperature value is lower than the value (T_{Set} – Threshold TS2 - Hysteresis) and deactivated when the room temperature value reaches the value (T_{Set} – Threshold TS2); the second speed is also deactivated when speed V3 needs to be activated.
- Speed 3 (3rd stage) – The speed is activated when the room temperature value is lower than the value (T_{Set} – Threshold TS3 - Hysteresis) and deactivated when the room temperature value reaches the value (T_{Set} – Threshold TS3).

The parameter *Speed control hysteresis* in ETS application program represents the hysteresis value which is common to all speed stages and unified for heating and cooling.

As for the intercept valve of the water exchange coil (2-pipe system) or the intercept valve of the water heating coil (4-pipe system), a 2-point hysteresis algorithm can be used in the application program, operating on the same Setpoints. When the room the temperature is lower than the value ($T_{Set} - \Delta T_{hysteresis}$) the device sends the valve activation command; the intercept valve is deactivated when the room temperature reaches the T_{Set} value and simultaneously the fan speed 1 deactivates. In this way, you can avoid the formation of the black "blows" on the wall which are caused by the circulation of water inside the coil without heat exchange.

The diagram on the right in Picture 16 refers to the speed control of the fan-coil (with 3-stage operation) in air conditioning mode. Please note that for each speed, two thresholds values are assigned, one for activation and one for deactivation. The thresholds values are specified in the ETS application program, and their effect can be summarized as follows:

- Speed 1 (1st stage) – The speed is activated when the room temperature value is lower than the value (T_{Set} + Threshold TS1 + Hysteresis) and deactivated when the room temperature value reaches the value (T_{Set} + Threshold TS1); the first speed is also deactivated when a higher speed needs to be activated. The default value for Threshold TS1 parameter is 0 K.
- Speed 2 (2nd stage) – The speed is activated when the room temperature value is lower than the value (T_{Set} + Threshold TS2 + Hysteresis) and deactivated when the room temperature value reaches the value (T_{Set} + Threshold TS2); the second speed is also deactivated when speed V3 needs to be activated.
- Speed 3 (3rd stage) – The speed is activated when the room temperature value is lower than the value (T_{Set} + Threshold TS3 + Hysteresis) and deactivated when the room temperature value reaches the value (T_{Set} + Threshold TS3).

As for the intercept valve of the water exchange coil (2-pipe system) or the intercept valve of the water heating coil (4-pipe system), a 2-point hysteresis algorithm can be used in the application program, operating on the same Setpoints. When the room the temperature is lower than the value ($T_{Set} + \Delta T_{hysteresis}$) the device sends the valve activation command; the intercept valve is deactivated when the room temperature reaches the T_{Set} value and simultaneously the fan speed 1 deactivates.

Both figures refer to a 3-speed fan coil control. For 2-speed and 1-speed case all information in this paragraph apply, with the onyl difference that not all speeds will be controlled.

In fancoils applications, where both heating and cooling modes are active, the activations thresholds are the same on the 2 operating modes.

In order to coordinate the fan action with the intercept valve of the exchange coil, you need to properly choose the right hysteresis values: for instance, by selecting the parameters *Threshold first speed* = 0 K and *Speed control hysteresis* = 0,3 K in *Ventilation* folder, the parameter *Hysteresis* in the *Heating and/or cooling* folder must be 0,3 K in order to guarantee that the valve on the exchange coil will be open when speed 1 is activated.

Another element of flexibility is the possibility to subordinate the fan manual operation to the desired temperature T_{Set}. By selecting in ETS the parameter *Manual operation = not depending on the temperature* in *Ventilation* folder, the ventilation will continue to work at the user defined speed even when the desired temperature is reached. Viceversa, by selecting in ETS the parameter *Manual operation = depending on the temperature*, the manual ventilation will be cut off when the desired temperature is reached.

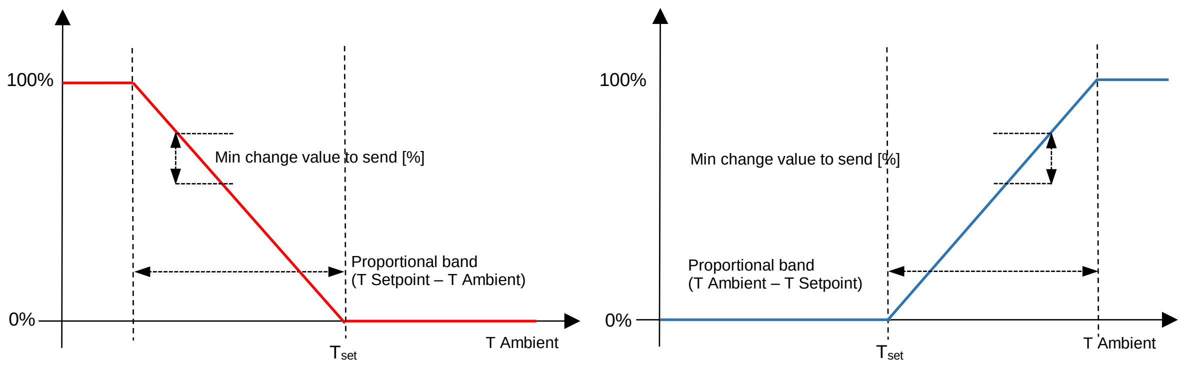
The communication between the controller and the actuator can be realized both with communication objects [1.001] DPT_Switch (63-64-65, Fan speed 1-2-3) or with a single object [5.001] DPT_Scaling (62, Fan continuous speed). The object (62, Fan continuous speed), with ON/OFF fan coil speed control, does not change continuously but gets discrete values according to the hysteresis of the ON/OFF windows, as shown in the following table.

Automatic fan speed	Fan speed communication objects, type [1.001] DPT_Switch			Continuous fan speed communication object, [5.001] DPT_Scaling
	V1	V2	V3	
Control type: 3-speed				
OFF	0	0	0	0 %
1	1	0	0	33,3 %
2	0	1	0	66,7 %
3	0	0	1	100 %
Control type: 2-speed				
OFF	0	0	-	0 %
1	1	0	-	50 %
2	0	1	-	100 %
Control type: 1-speed				
OFF	0	-	-	0 %
1	1	-	-	100 %

During switching, before activating the new speed, the others must be deactivated in order not to damage the fan motor: both binary and continuous communicaton objects are therefore updated to OFF value (0%) before being updated by the internal controller to the next speed.

9.5 Fancoils with fan speed continuous control

This kind of control does not involve independent 1-bit communication objects but only a single 1-byte communication object (DPT 5.001 percentage): this means that it is no longer necessary to deactivate previous speeds before activating the next.



Picture 18 - Fancoils with fan speed continuous control

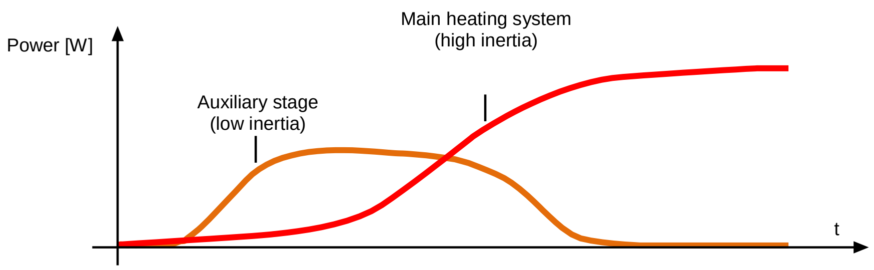
The definiton of hyteresis levels must be directly performed on the fan coil actuator. The application program offers the parameter *Proportional band*, which has the the same value for both heating and cooling: this parameter determines the fan intervention gradient. The parameter *Min. change of value to send [%]* is defined in order to limit the frame exchange on the bus.

i	The 1-byte communication object *Fan continuous speed* (62) changes continuously according to the curve shown in Picture 18. Please refer to the previous paragraph to evaluate differences with the 1-2-3-speed control, where the same communication object has discrete values.

9.6 2-points control with hysteresis for auxiliary heating / cooling system

Some heating / cooling systems show a very large response inertia; this is mostly due to the fact that a relevant part of building mass is involved in the thermal exchange.

In order to improve response time for start-up or ambient temperature transients, auxiliary systems with substantially lower inertia are used in support of the main system whenever the difference between setpoint (T_{set}) and measured temperatures (T_{eff}) becomes significant.



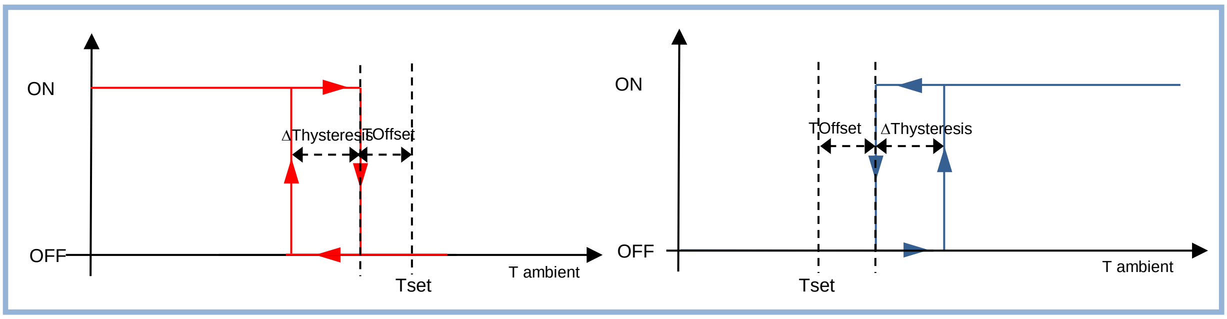
Picture 19 - 2-points control with hysteresis for auxiliary system

The auxiliary – also called “second-tier” – system, in the initial stage, contributes to heat / cool the environment and then stops its action when the difference between T_{set} and T_{eff} is lower and can be addressed by the system with higher inertia.

The control algorithm used for the second-tier system is the 2-points On/Off control with hysteresis.

<u>Heating mode</u>

When the measured temperature (T_{eff}) is lower than the value of the lower threshold ($T_{set} – \Delta T_{Offset} – \Delta T_{hysteresis}$), the device activates the auxiliary heating by sending the relative frame to the proper actuator; when the measured temperature reaches the value ($T_{set} – \Delta T_{Offset}$), the auxiliary heating system is turned off by sending the relative frame to the proper actuator.



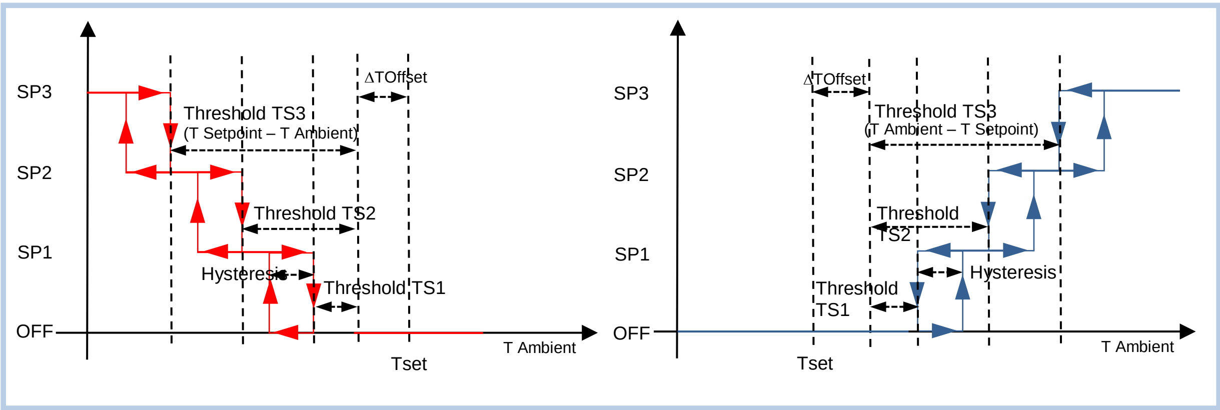
Picture 20

<u>Cooling mode</u>

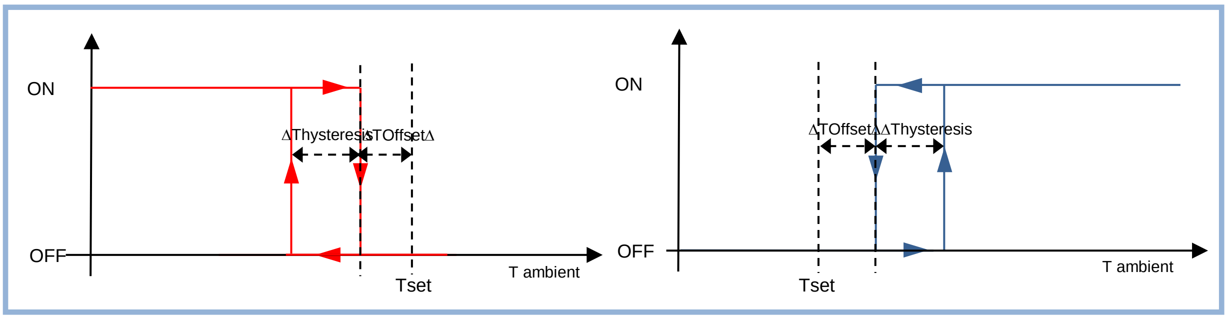
When the measured temperature (T_{eff}) is higher than the value of the lower threshold ($T_{set} + \Delta T_{Offset} + \Delta T_{hysteresis}$), the device activates the auxiliary cooling by sending the relative frame to the proper actuator; when the measured temperature reaches the value ($T_{set} + \Delta T_{Offset}$), the auxiliary cooling system is turned off by sending the relative frame to the proper actuator.

9.7 Auxiliary stage with fan coil

In some heating / cooling system, an auxiliary fan coil system which operates on air volumes is paired with an high inertial system (such as floor radiant panels): EK-ET2-TP Multisensor controller can be easily configured for this kind of application.



Picture 21



Picture 22

As for the configuration of the auxiliary stage, you can apply the same rules already expressed in the ON/OFF and continuous fan coil control paragraph. Particularly relevant here is the auxiliary stage intervention offset, ΔT_{Offset}, which matches the parameter *Setpoint difference* in *Heating and/or cooling* folder. By configuring this parameter (which can be different between heating and cooling if command communication objects are separated) to 0 K, the radiant panel and the fan coil work as two heating and/or cooling devices in parallel. Otherwise, if *Setpoint difference* > 0 K*,* the fan coil intervenes very quickly in the first tuning stages and leaves to the radiant panel the job of reaching the desired temperature.

10 Compatibility with KNX actuators

The Multisensor device offers compatibility with some KNX actuators for VAV flow regulators and 6-way zone valve management.

10.1 Compatibility with VAV flow regulators

Compatibility with VAV (Variable Air Volume) flow regulators, such as the Belimo LM24A-KNX, is aimed at applications for air quality control.

There is also the possibility of interacting with actuators such as Belimo LMV-D3-KNX and NMV-D3-KNX, which also include an integrated pressure sensor, in order to create pressure-independent applications.

From the EK-ES3-TP multisensor point of view, the presence of the pressure sensor has no influence: in fact, the multisensor always sends a value expressed as a percentage (CO 56: Thermostat - Heating and cooling control).

If a pressure sensor is present, the regulation is done by the Belimo actuator, depending on the measured pressure value.

10.2 Compatibility with 6-way zone valve

Compatibility with actuators for 6-way valves management (such as, for example, the Belimo LR24A-KNX) is aimed at applications for climate control.

The use of 6-way valves allows to control the flow of hot or cold heat transfer fluid to be sent to terminals. Typical examples are radiant ceiling systems, cold beams and fan coils used for the air conditioning of non-residential environments, in combination with the 4-way hydraulic distribution pipes, in which cold and hot fluids are simultaneously available.

A single 6-way valve can be used instead of 4 two-way valves without the need to provide interlocking of the servomotors, and guaranteeing no leakage. For the 6-way valve, Belimo has developed the LR24A-KNX servomotor equipped with KNX native communication.

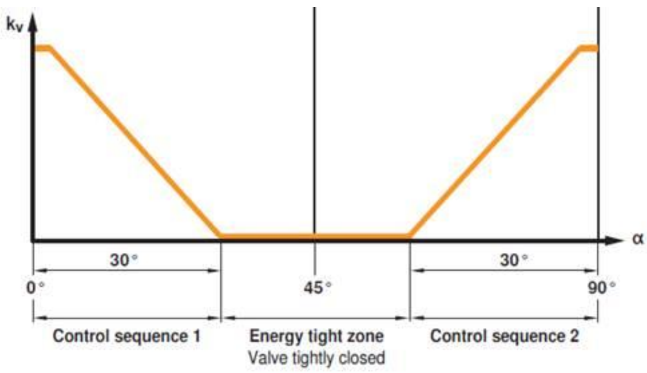
To ensure compatibility with these actuators, a combined heating / cooling sequence must be created in the multisensor using the 1-byte communication object *Setpoint* (Datapoint 5.001_Scaling% [0 ... 100]) made available by the actuator Belimo with Write permission.

The unique control sequence for CO *Setpoint* is as follows:

• object value in range 0 ... 33% → cooling operation;

• object value in range 33 ... 66% → neutral zone (neither cooling nor cooling)

• object value in range 66 ... 100% → heating operation



Picture 23 – Control sequence for 6-way valve

In Picture 23, the angular displacement of the pin (and valve) α is shown on the horizontal axis, while the ordinate indicates the flow rate k_v of the heat transfer fluid.

When the pin is at 45 ° it is exactly in the center of the neutral zone. A movement limited to 15 ° in any direction causes it to remain within the neutral zone. Starting from a movement greater than 60 ° (45 ° + 15 °) the 6-way valve allows the hot fluid flow, while for a movement of less than 30 ° (45 ° - 15 °) the valve allows the cold fluid flow.

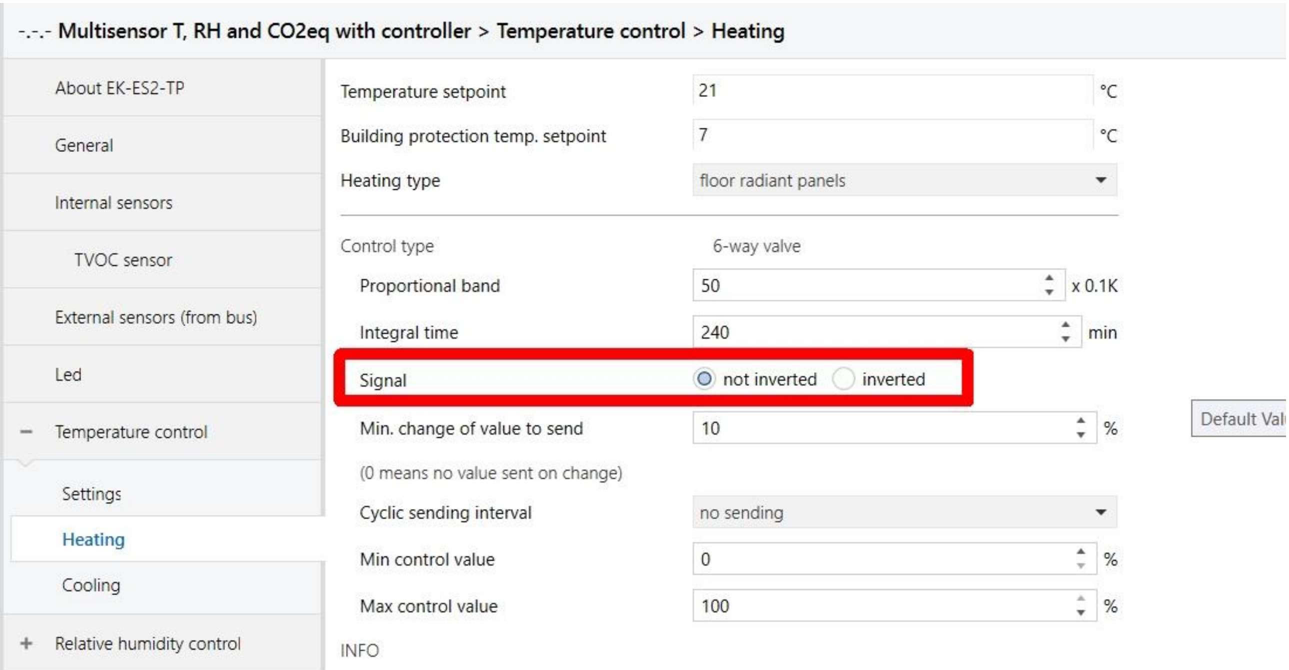
10.2.1 Reversal of the heating / cooling control sequence

If the connection of the hot side and the cold side is reversed during the assembly of the 6-way valve, it is of utmost importance to avoid disassembling the valve or sending it to the manufacturer for the diaphragms adjustment operation.

For this purpose, in the ETS application, a parameter is provided for reversing the heating / cooling cycle. In the *Temperature control ⇒ Heating* section, the following option is available (see Picture 24):

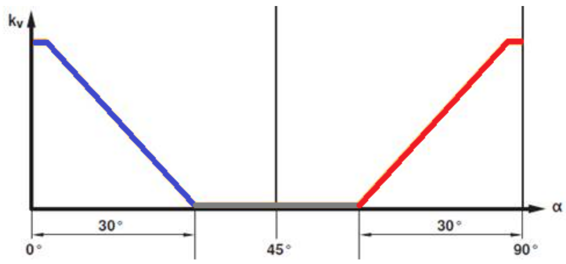
Signal:

- not inverted;
- inverted.

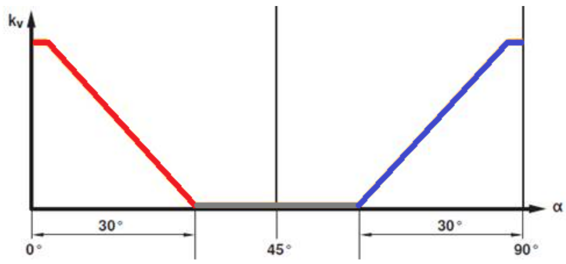


Picture 24 - Parameter for the cycle inversion with a 6-way valve

Picture 25 and Picture 26 show the diagrams of the two sequences of the k_v parameter, depending on the valve assembly (not inverted / inverted) selection.



Picture 25 - Not inverted sequence



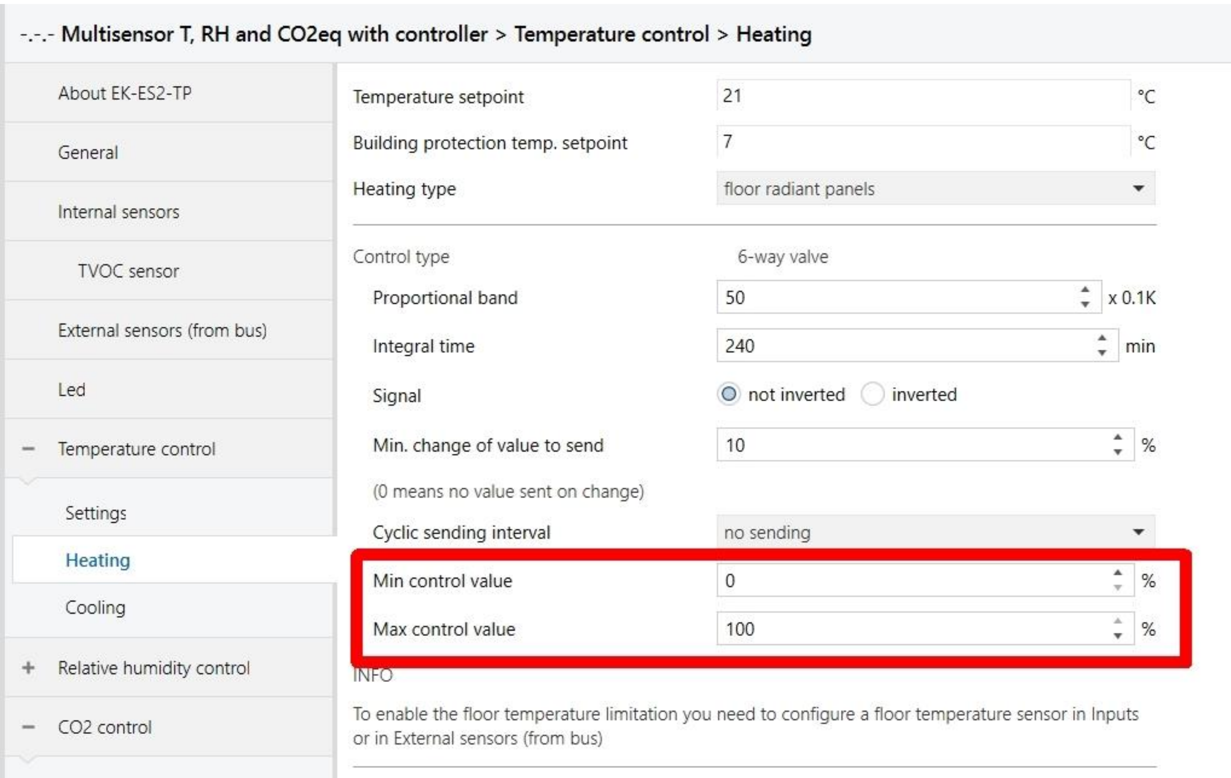
Picture 26 - Inverted sequence

10.2.2 Thermal power limitation

While the same terminals are maintained, the thermal power required in cooling and heating mode is different. Providing excessive power can lead to unwanted fluctuations in the room temperature. Power limitation is generally carried out by means of diaphragms which limit the flow of the heat transfer fluid, therefore by acting on the k_v parameter.

However, in case this is not done, there is still the possibility of setting the following parameters in ETS, as shown in Picture 27:

- *Min. control value %* (default 0)
- *Max. control value %* (default 100)



Picture 27 - Parameters for Min and Max control values setting

These parameters can be set separately for heating and cooling.

11 Diagnostics

Alarm code	Reason
A01	Room controller alarm
A02	Thermal generator lock alarm
A03	Internal temperature sensor alarm
A04	Heating temperature limit alarm
A05	CO_2 threshold limit alarm
Alarm code	**Reason**
E01	Integrated temperature sensor failure
E02	Integrated relative humidity sensor failure
E03	CO: antistratification temperature sensor (from bus) failure
E04	CO: outdoor temperature sensor (from bus) failure
E05	CO: coil temperature sensor (from bus) failure
E06	CO: floor surface temperature sensor (from bus) failure
E07	CO: flow temperature sensor (from bus) failure
W01	CO: integrated temperature sensor timeout
W02	CO: integrated relative humidity sensor timeout
W03	CO: antistratification temperature sensor (from bus) timeout
W04	CO: outdoor temperature sensor (from bus) timeout
W05	CO: coil temperature sensor (from bus) timeout
W06	CO: floor surface temperature sensor (from bus) timeout
W07	CO: flow temperature sensor (from bus) timeout
W09	CO: anticondensation sensor (from bus) timeout
W10	CO: window contact 1 timeout
W11	CO: window contact 2 timeout
W12	CO: presence sensor 1 timeout
W13	CO: presence sensor 2 timeout
W14	CO: card holder contact timeout

Table 4 - Alarm and error codes

12 Warnings

- Installation, electrical connection, configuration and commissioning of the device can only be carried outby qualified personnel in compliance with the applicable technical standards and laws of the respective countries
- Opening the housing of the device causes the immediate end of the warranty period
- In case of tampering, the compliance with the essential requirements of the applicable directives, for which the device has been certified, is no longer guaranteed
- ekinex® KNX defective devices must be returned to the manufacturer at the following address: EKINEX S.p.A. Via Novara 37, I-28010 Vaprio d'Agogna (NO) Italy

13 Other information

- The present Application Manual is addressed to installers, system integrators and project engineers.
- For further information on the product, please contact the ekinex® technical support at the e-mail address: support@ekinex.com or visit the website www.ekinex.com
- Each ekinex® device has a unique serial number on the label. The serial number can be used by either installers or system integrators for documentation purposes and has to be added in each communication addressed to the EKINEX technical support in case of malfunctioning of the device
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