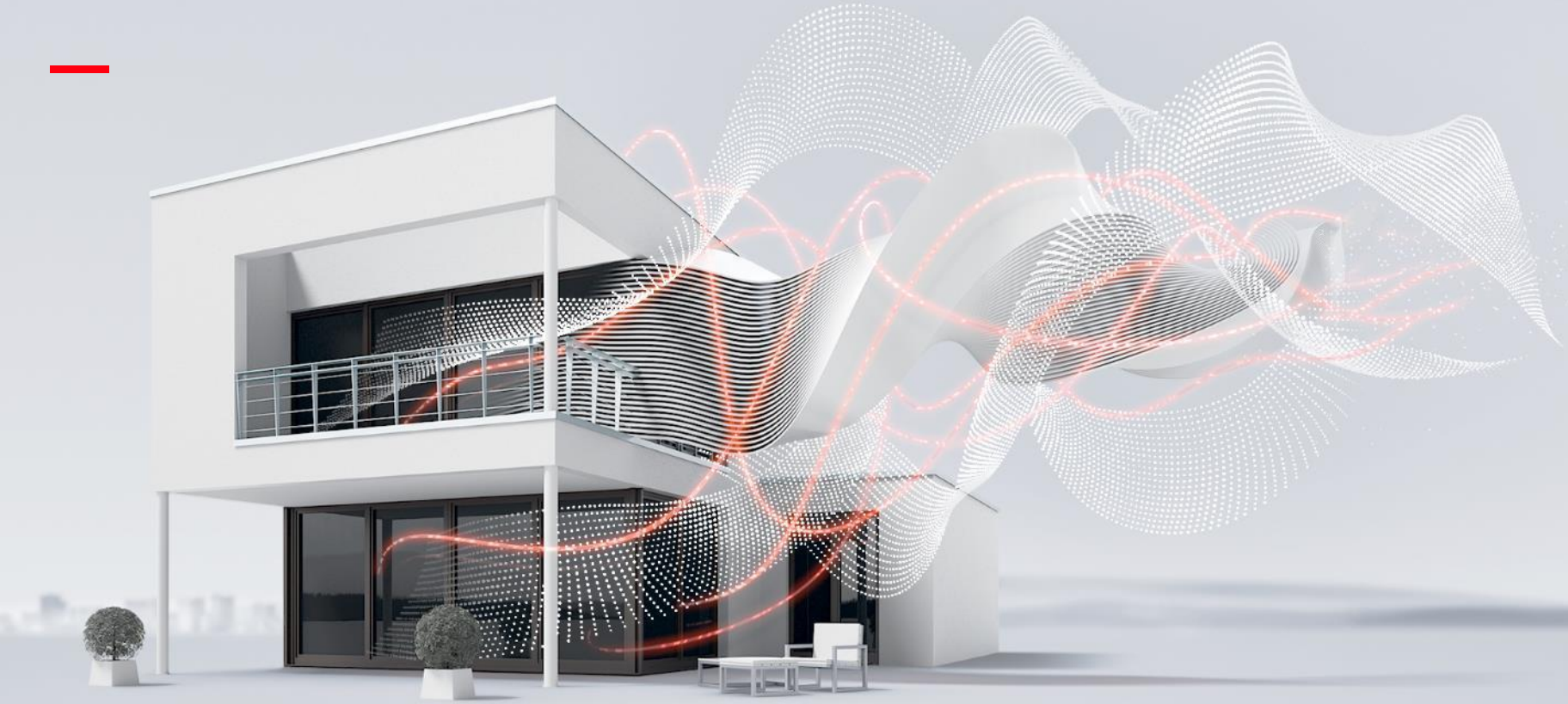

HEIDELBERG, APRIL 2021

ClimaECO – KNX and HVAC - Overview Room Temperature Control 1

Online Learning Session – Competence Center Europe – Smart Buildings

Juergen Schilder, Thorsten Reibel, Marc-Andre Hahn, Michael Rall, Stefan Grosse & Olaf Stutzenberger

 Document ID.: … Rev.: …

Agenda

Overview

Assignment of the controller

Operating modes

Setpoint

Control value types

ABB i-bus® Tool

ClimaECO – KNX and HVAC - Overview Room Temperature Control

Overview

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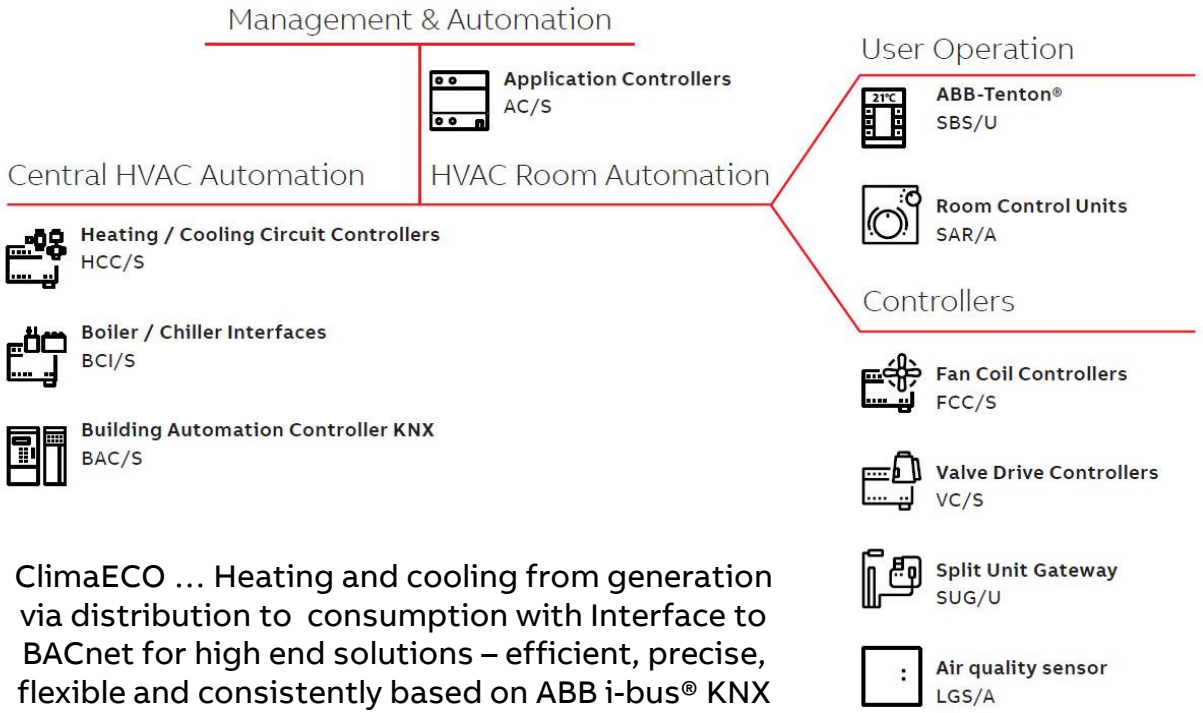
ClimaECO – Intelligent HVAC solutions with ABB i-bus® KNX

- ClimaECO is the holistic heating, ventilation and air-conditioning (HVAC) automation solution based on ABB i-bus® KNX
- A solution that seamlessly integrates room automation, distribution, central HVAC functions, management and automation into one system – a significant step towards increasing energy efficiency and reducing operational costs
- ABB's ClimaECO portfolio includes
  - ClimaECO® Sensors SBx/U and Room Control Units SAx/A
  - Valve Drive Controllers VC/S
  - Fan Coil Controller FCC/S
  - Heating/ Cooling Circuit Controllers HCC/S
  - Boiler/ Chiller Interface BCI/S
  - Application Controllers AC/S with Interface to BACnet
  - Building Automation Controller KNX BAC/S
- Slides & videos of Webinars, Learning Sessions → T&Q Database



ClimaECO … Heating and cooling from generation via distribution to consumption with Interface to BACnet for high end solutions – efficient, precise, flexible and consistently based on ABB i-bus® KNX

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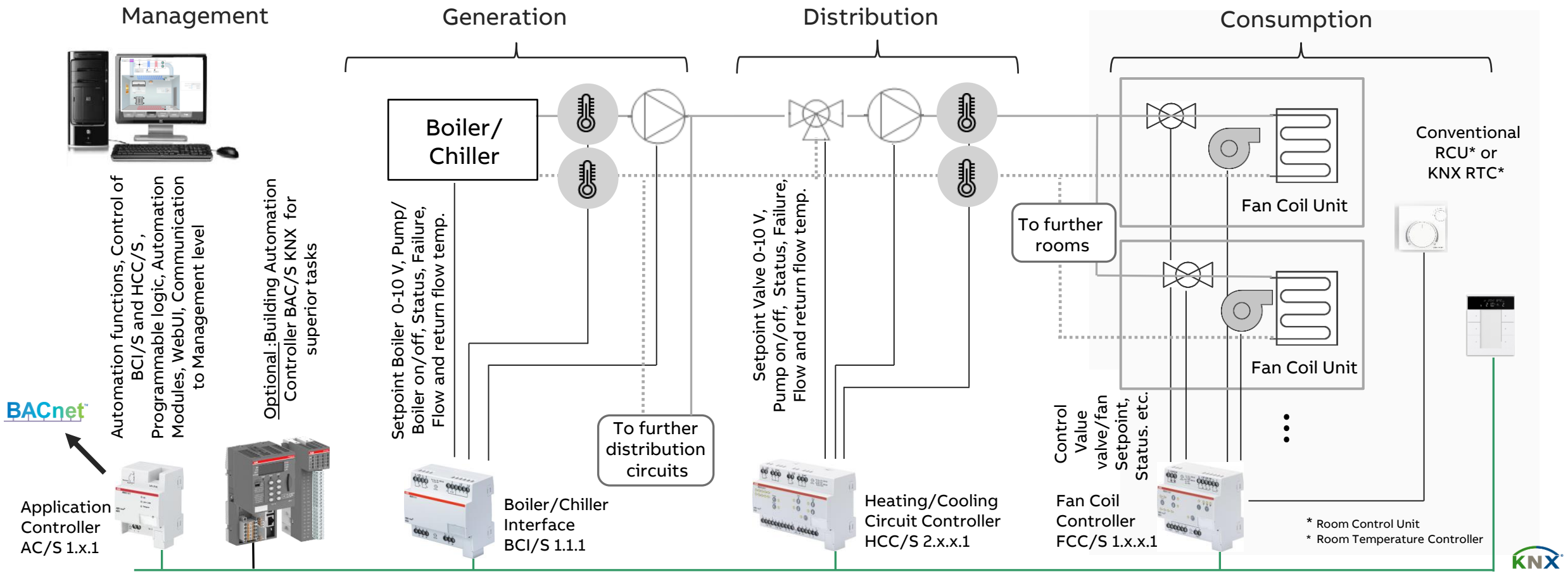

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Overview ABB i-bus® KNX HVAC Range

Room Temperature Controller ... Room Temperature Sensor (Slave)

Fan Coil Controller

Valve Drive Controller

Split Unit Gateway

Building Automation Controller BAC/S KNX

Electronic Switch Actuator

Valve Drive Actuator

Blower Actuator

Electromotor Valve Drive

Application Controller

Boiler/Chiller Interface

Presence Detector

Air Quality Sensor

Analogue Input

Room Master

Heating/Cooling Controller

Room Controller

Electrothermal Valve Drive

Heating Cooling Circuit Controller

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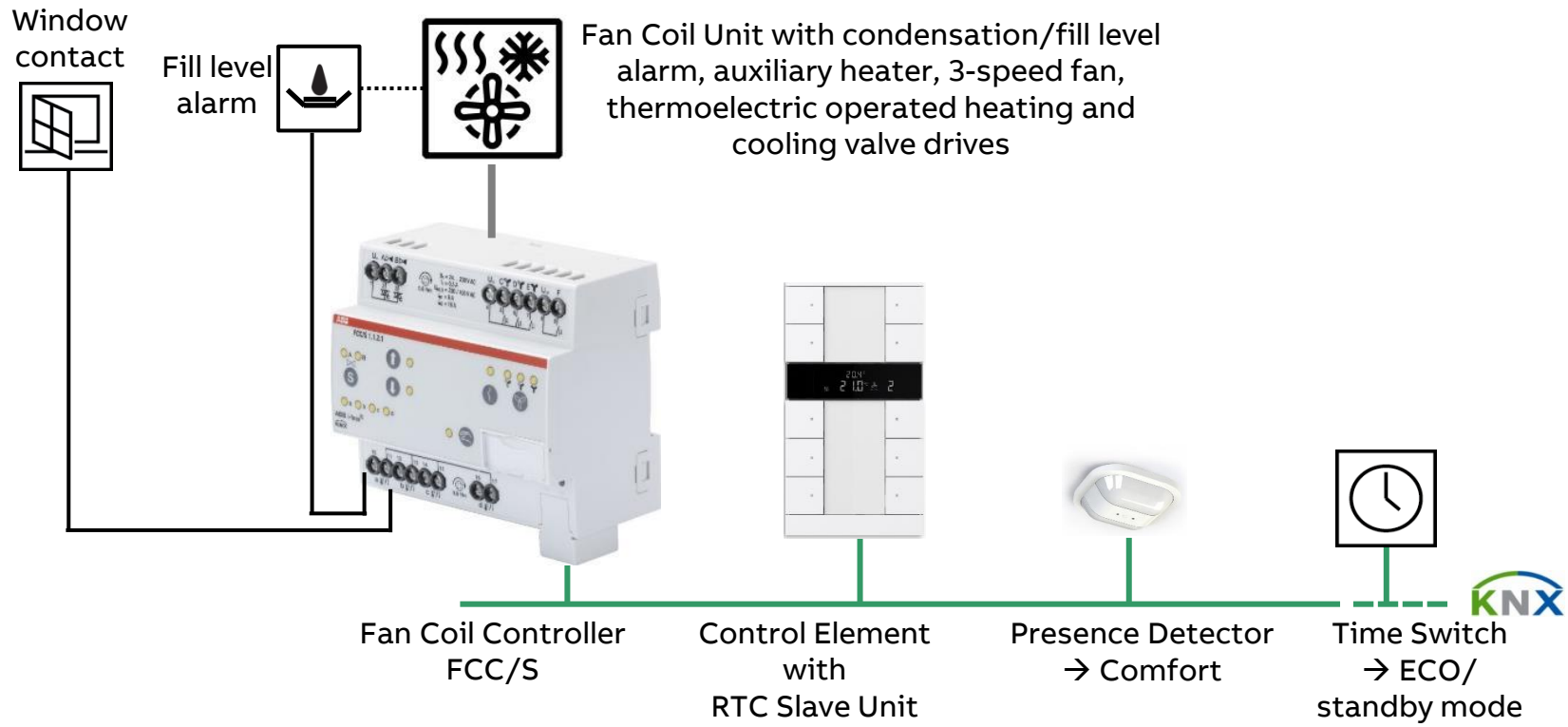
Office solution with Fan Coil Controller FCC/S and Fan Coil Unit



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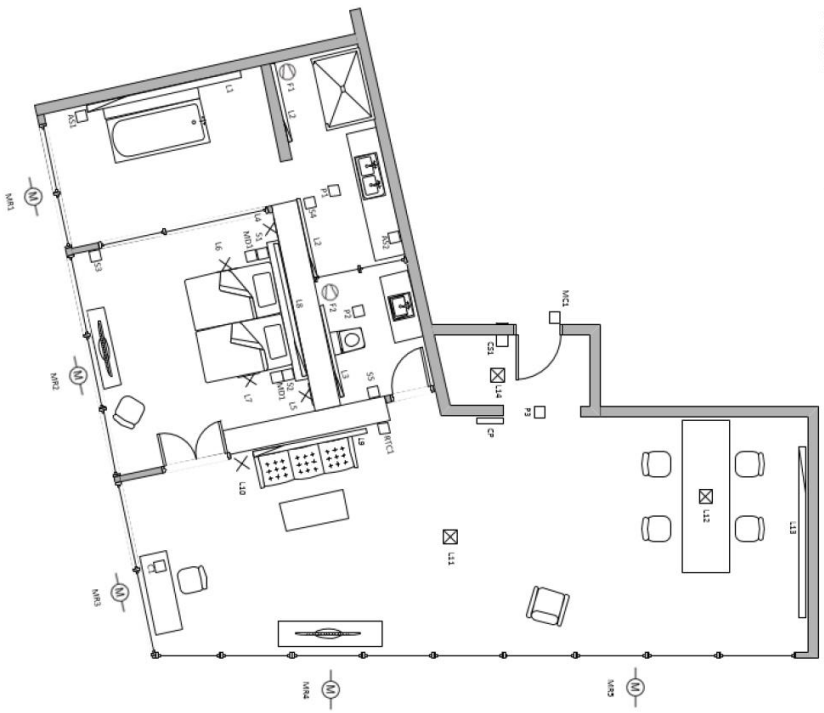
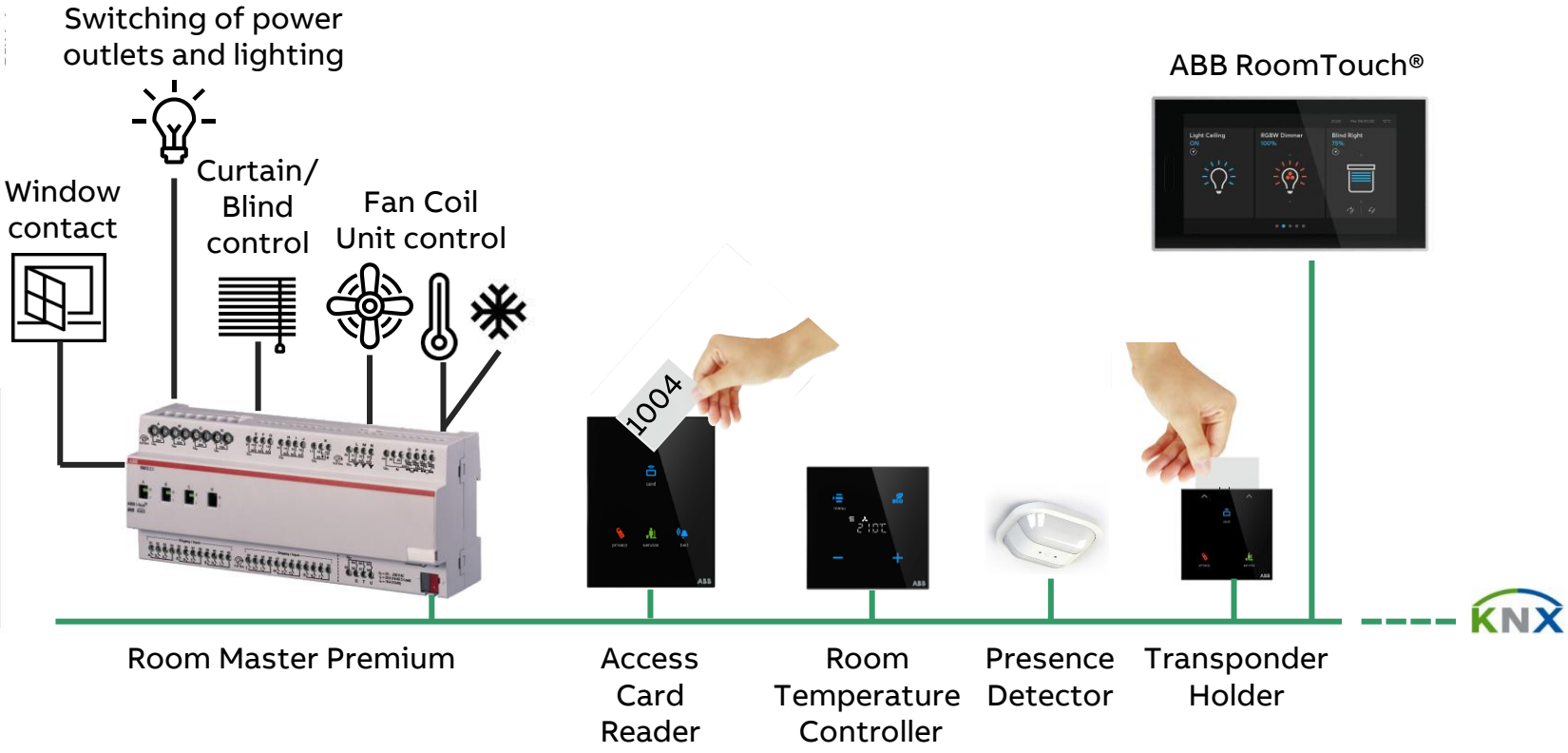
Hotel room solution with Room Master Premium RM/S





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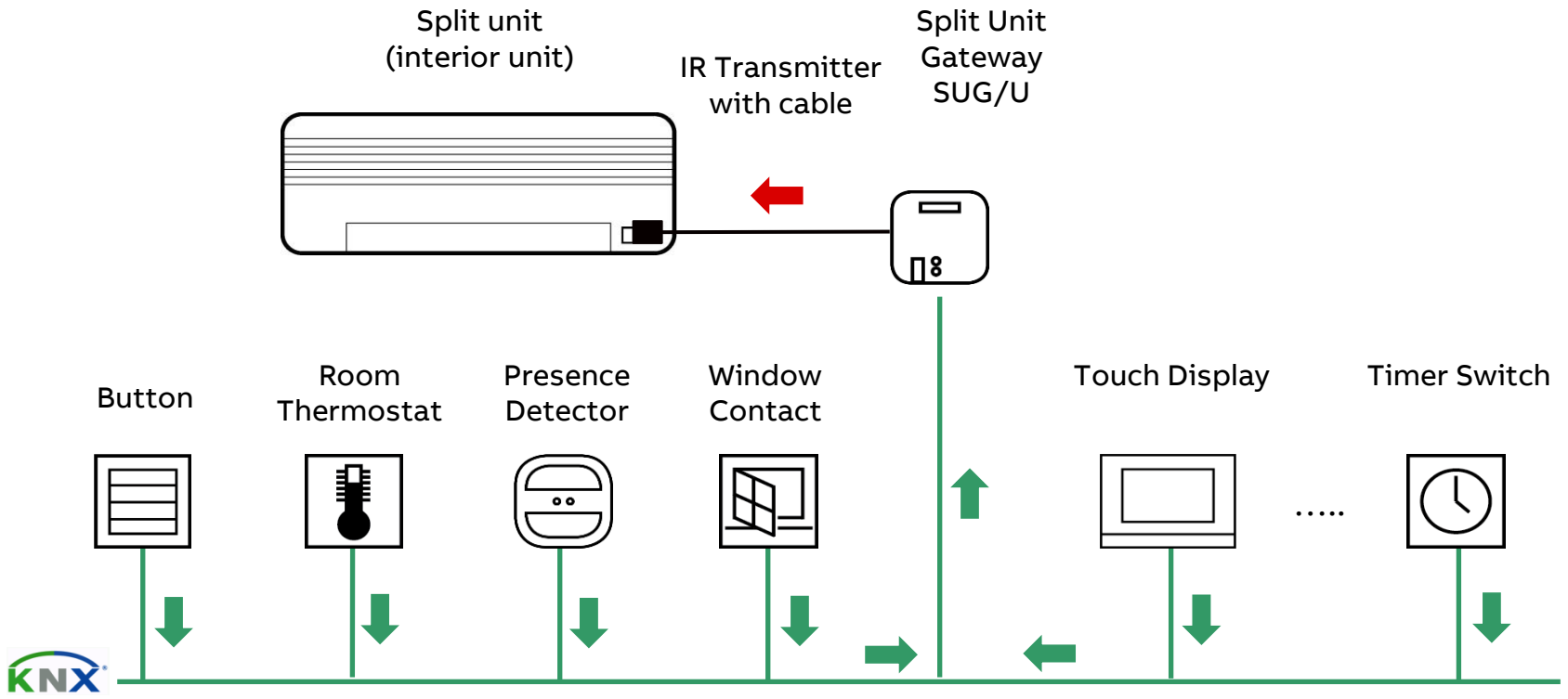
Split Unit Gateway SUG/U – Interface between the KNX system and air-conditioning systems



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Room air quality: CO_2 and humidity sensor with controller and Blower Actuator FCL/S to control a fan

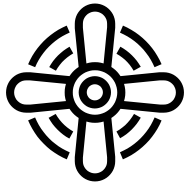
Temperature, humidity, CO_2

Air Quality Sensor LGS/A

RTC, CO_2/Humidity Sensor and Controller with Control Element

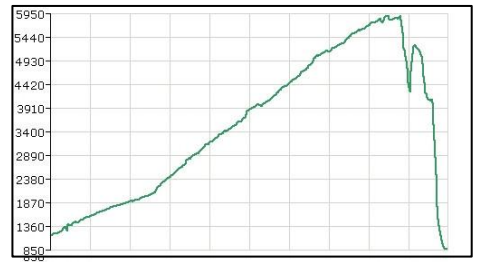
Presence Detector

Direct Operation	Automatic Control
Fan speed Byte	Control value
Fan speed Bit	0 .. 100%
Fan speed up/down	



Blower Actuator FCL/S

ppm CO_2



% Humidity

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Assignment of the controller

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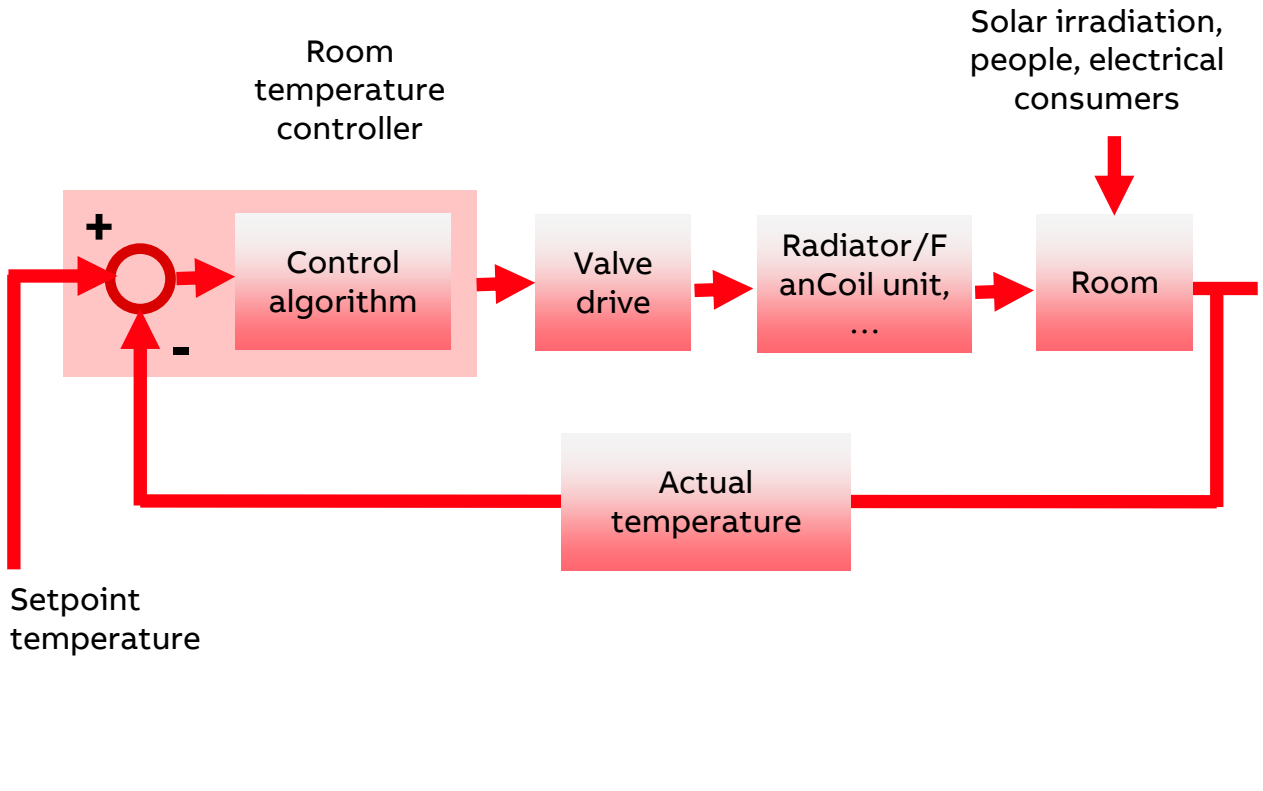
Principle

- A room temperature controller RTC measures the actual temperature and compares this with the preselected setpoint temperature
- The control value is calculated (e.g., 0…100% or ON/OFF) by means of the set control algorithm based on the difference between the actual and setpoint temperature
- The control system of a heating/cooling unit comprises
  - Room temperature controller
  - An actuator that receives the control value and outputs it to a valve drive
  - Valve drive (positioner)
  - The radiator, underfloor/wall heating, hot-water fan heater, chilled beams, fan coil unit, …

  and the room in which the temperature is to be controlled



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Assignment of the controller

Controller in the sensor

– Room temperature controller is parametrized RTC
  - ABB-Tenton®, ABB tacteo®, Busch-triton®, SOLO®, …
  - ABB RoomTouch®, Busch-SmartTouch®, …
  - Busch-Presence Detector Premium, Air Quality Sensor LGS/A, …

– Actuator
  - Valve Drive Controller VC/S and Fan Coil Controller FCC/S are parametrized as ACTUATOR
  - Valve Drive Actuator VAA/S
  - Floor heating Controller VAA/A
  - Electronic Switch Actuator ES/S
  - Room Master RM/S
  - Room Controller RC/A
  - Electromotor Valve Drive ST/K

Calculate and send the control value to …

KNX link
Two-way communication

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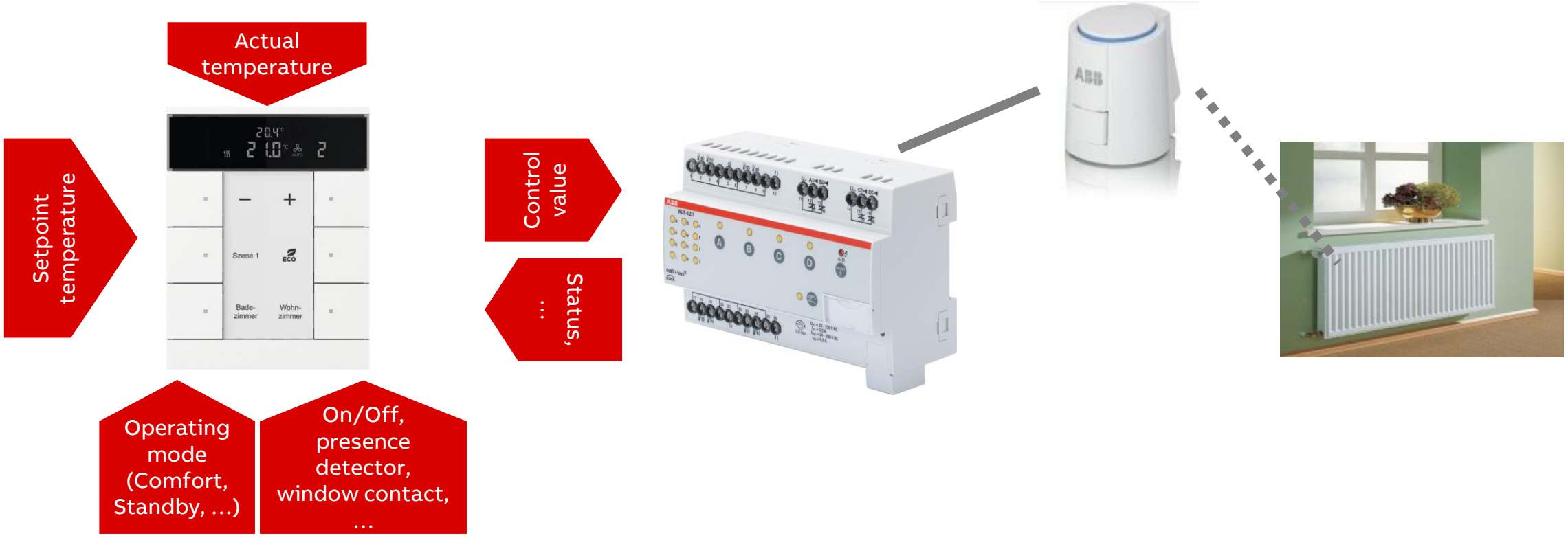
Example: Individual Room Temperature Control – Controller in the sensor



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Assignment of the controller

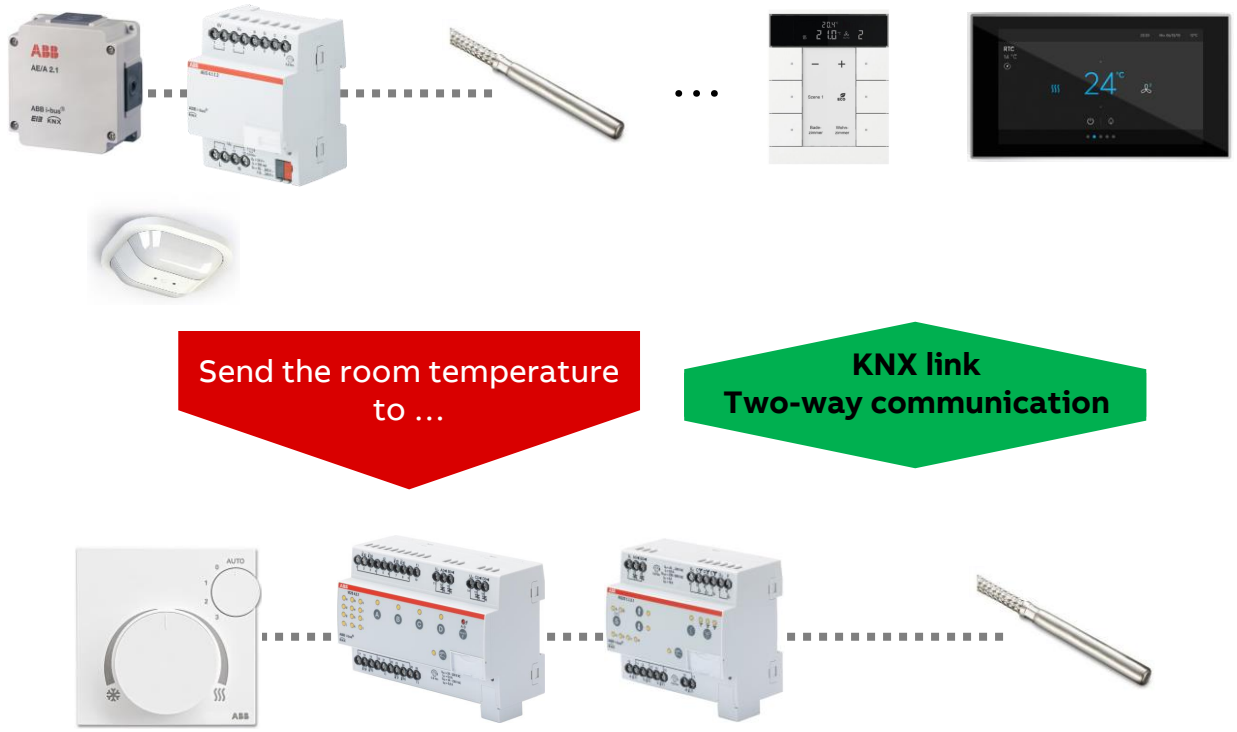
Controller in the actuator

– Room temperature sensor

- ABB-Tenton®, ABB tacteo®, Busch-triton®, SOLO®, ABB RoomTouch®, Busch-SmartTouch®, …
  → are parametrized as a RTC SLAVE (operation, status, …)
- Room Control Unit SAF/A connected to input of Valve Drive Controller VC/S or Fan Coil Controller FCC/S
- Busch-Presence Detector, Air Quality Sensor LGS/A, Temperature sensor (e.g. PT100, PT1000) connected to Analog Input AE/x or to input of Valve Drive Controller VC/S or Fan Coil Controller FCC/S, sends only the room temperature, …

– Actuator

- Valve Drive Controller VC/S and Fan Coil Controller FCC/S are parametrized as CONTROLLER



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Example: Individual Room Temperature Control – Controller in the actuator

Slave 1

Slave X

Actual temperature

Setpoint temperature

Operating mode (Comfort, Standby, ...)

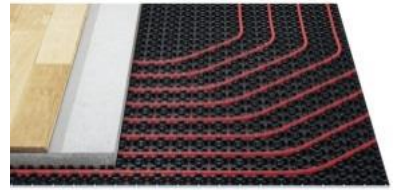
Status, ...

On/Off, presence detector, window contact, ...

Cooling

Heating

Chilled Beams



Underfloor Heating

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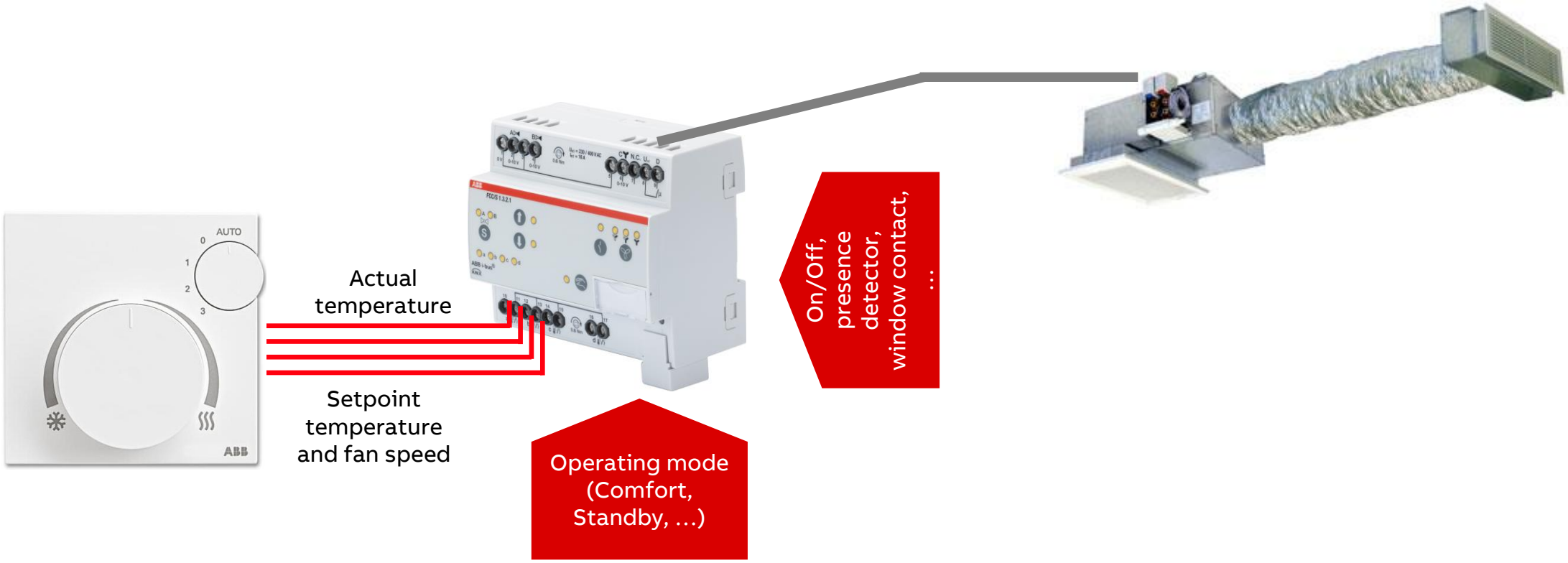
Example: Individual Room Temperature Control – Controller in the actuator



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Operating modes

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Operating modes

- To permit easy adjustment of the set values to meet the requirements for comfort and energy-saving, a room temperature controller supports four operating modes
- The operating modes (HVAC modes) are generally controlled using a time switch, presence detector or window contacts
- ETS Parameter: Operating mode after bus voltage recovery, …
- Operating modes
  - Comfort
  - Standby
  - ECO (night)
  - Frost/heat protection (building protection)
- Switch the operating mode with
  - “1 bit” switching telegrams
  - “1-byte” value telegrams

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Operating modes

Comfort mode (occupied)

– The setpoint is set to a value that enables “normal usage” of the area at a pleasant temperature and is used if there are persons in the room
  - Heating 21°C and cooling 25°C

Standby mode (unoccupied)

– The setpoint is changed slightly. This operating mode is used if the room is not occupied but is expected to be occupied soon. The comfort temperature can be restored quickly when necessary
  - Standby mode “heating”: The ambient temperature is reduced (e.g. during temporary absence) to save heating costs (19°C)
  - Standby mode “cooling”: the ambient temperature is increased (e.g. during temporary absence) to save energy costs (27°C)

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Operating modes

ECO mode (night)

– During the night areas are not used for extended periods (several hours); the setpoint is changed to a value appropriate for the night and the comfort setpoint can be restored relatively quickly in the morning
  - Heating 17°C and cooling 29°C

Frost/Heat Protection mode (building protection)

– The room will not be occupied for several days or a window has been opened and room temperature control is disabled
  - Frost protection mode (with heating): Heating is only on if the ambient temperature has fallen so low that the heating system may be in danger of freezing (7°C)
  - Heat protection mode (with cooling): Cooling is on only if the ambient temperature has risen so far that it is virtually impossible to use the room (35°C)

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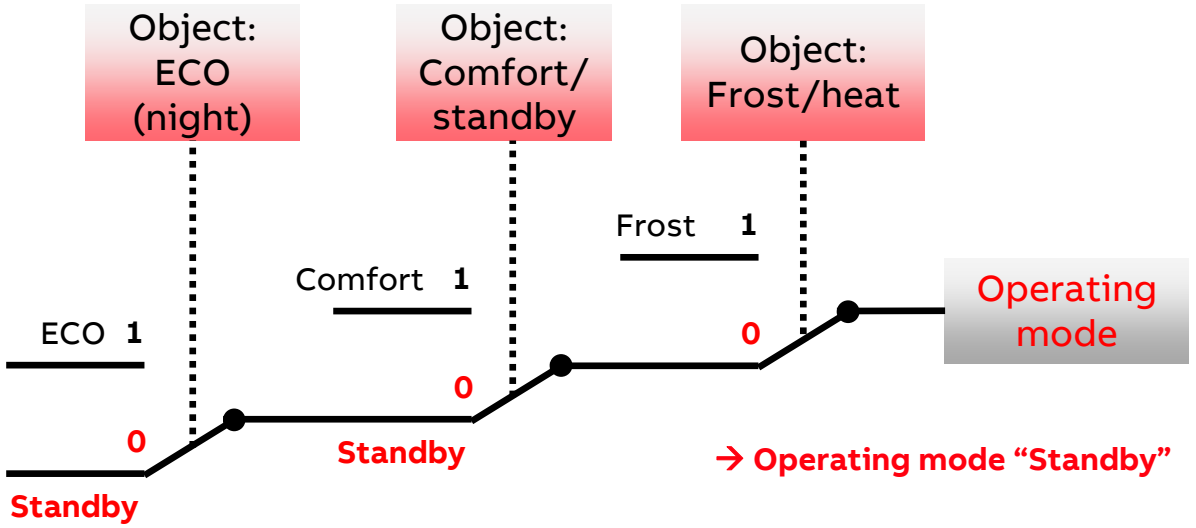
Operating modes

Operating mode switching: Three 1-bit group objects

- Switching principle since the introduction of the KNX
- The switchover takes place with 1-bit group objects
  - Comfort/standby mode
  - ECO mode (night)
  - Frost/heat protection
- The frost/heat protection has the top priority, i.e. in this case switching to a different operating mode is disabled
- Frost/heat protection must be disabled first, e.g. by closing an open window
- Comfort mode has the next higher priority, followed by ECO mode
- If none of the above three operating modes are enabled, the ambient temperature controller is in standby mode



Nu	Group Addre	Name	Object Function	Length
0	17/2/0	Comfort/standby mode	Operational mode	1 bit
1	17/2/1	Night mode	Operational mode	1 bit
2	17/2/2	Frost/heat protection	Operational mode	1 bit

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Operating modes

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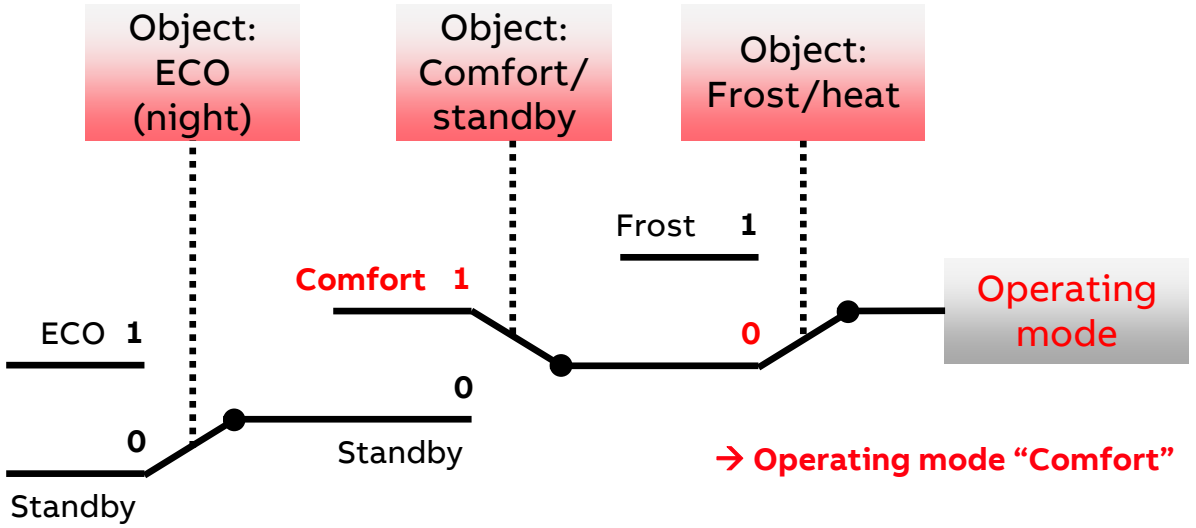

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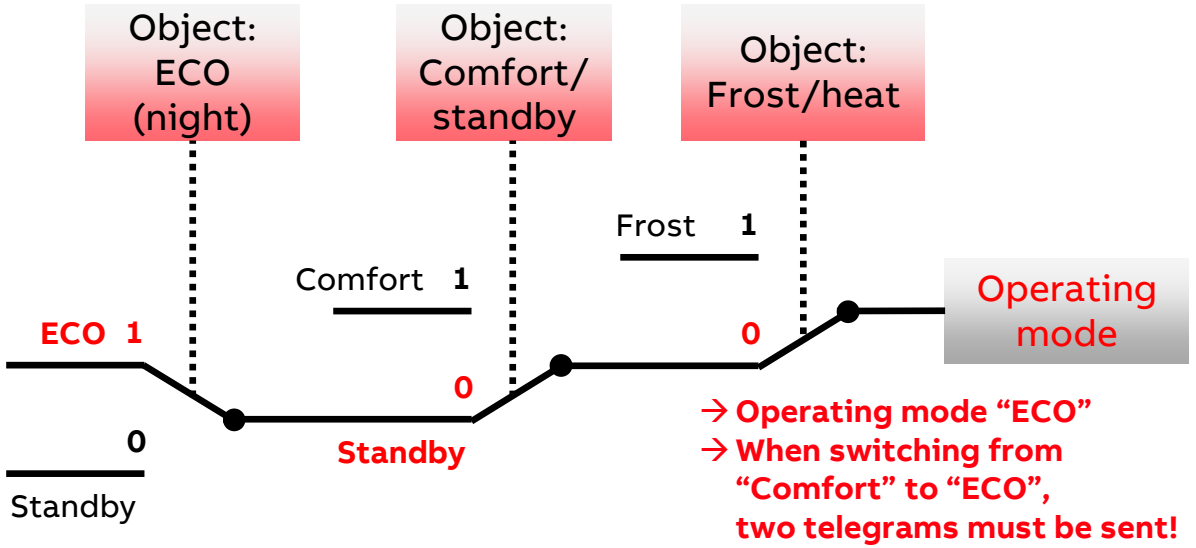

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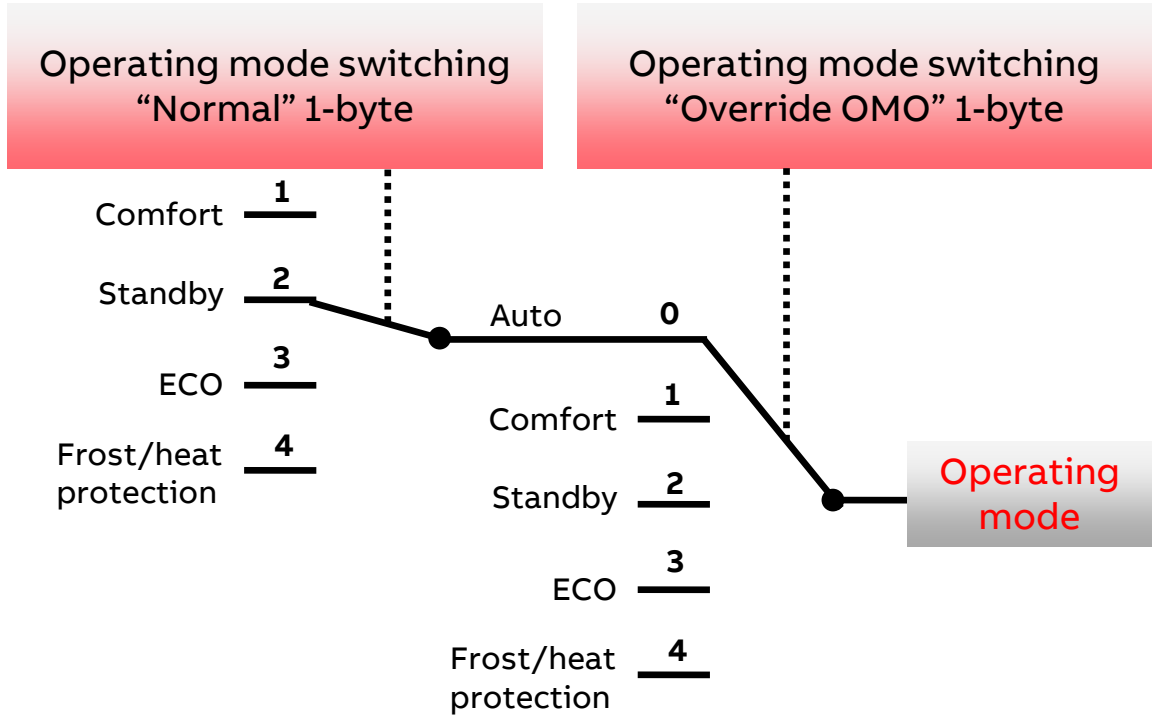
Operating modes

Operating mode switching: Two 1-byte group objects (preferred)

- An object evaluates received telegrams as “Normal“
  - This means, for example, if a comfort telegram is received, the temperature controller switches to comfort mode. If an eco telegram is received, the room temperature controller switches to eco mode. This object is controlled, for example, by time switches, key card reader, presence detectors, …
- The second object “Operating Mode Switching OMO” may overwrite the first temporarily
  - This means, for example, if a frost/heat protection telegram is received, the ambient temperature controller switches to frost or heat protection mode. If the frost or heat protection is reset by the receipt of another telegram, the room temperature controller enables the operating mode on the “normal” object. This object is controlled, for example, by binary inputs that record information from window contacts or via a BMS



Nu	Group Addr	Name	Length	Data Type
28	17/2/11	RTC: Normal operating mode	1 byte	HVAC mode
29	17/2/12	RTC: Override operating mode	1 byte	HVAC mode

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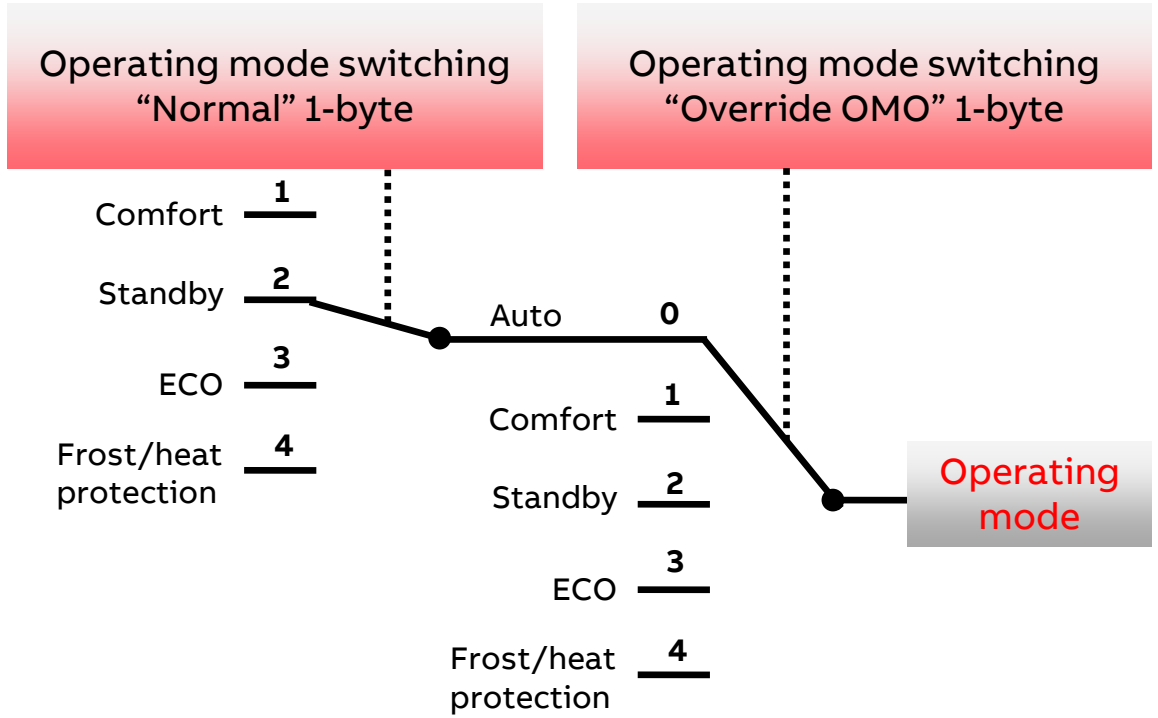
Operating modes

Operating mode switching: Two 1-byte group objects (preferred)

- The following apply to both 1-byte communication objects:
  - 0 = Auto (operating mode switching “OMO” only → override operating mode is inactive)
  - 1 = Comfort
  - 2 = Standby
  - 3 = ECO (night)
  - 4 = Frost/heat protection
  - 5 – 255 = reserved
- Data type
  - 20.102 HVAC mode
  - Range 0…4



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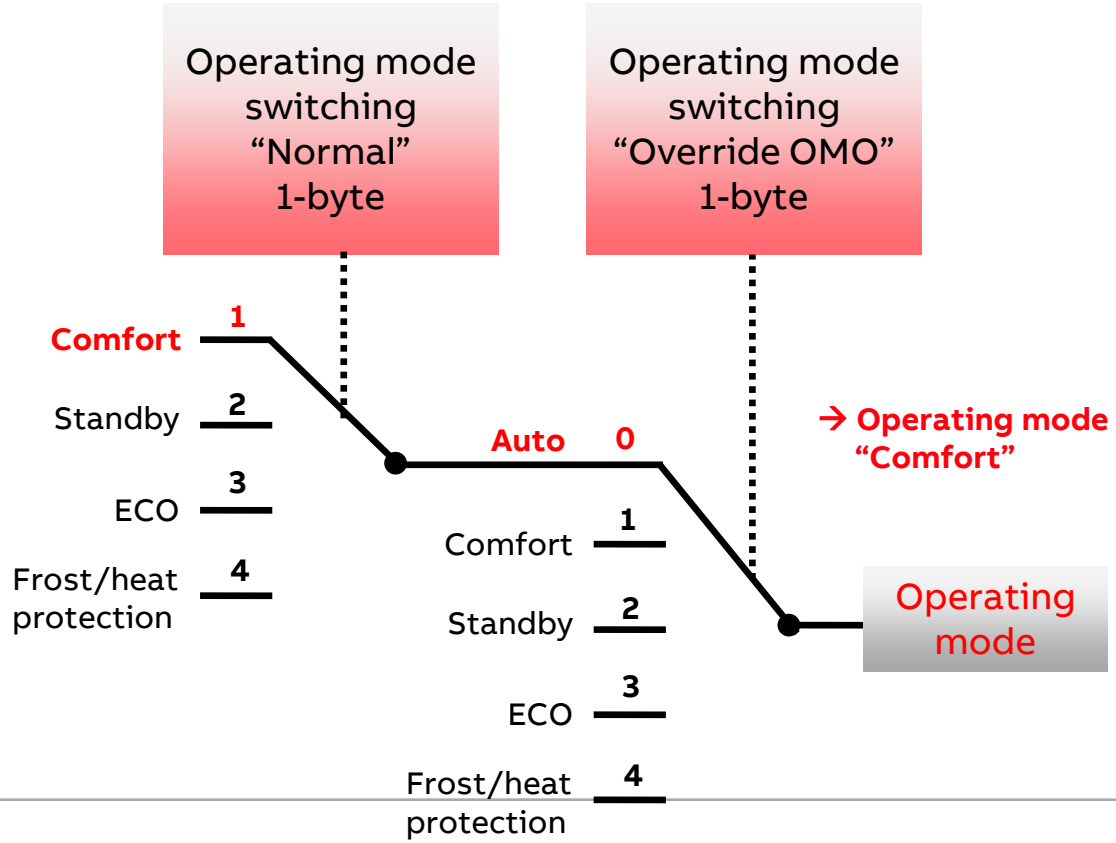
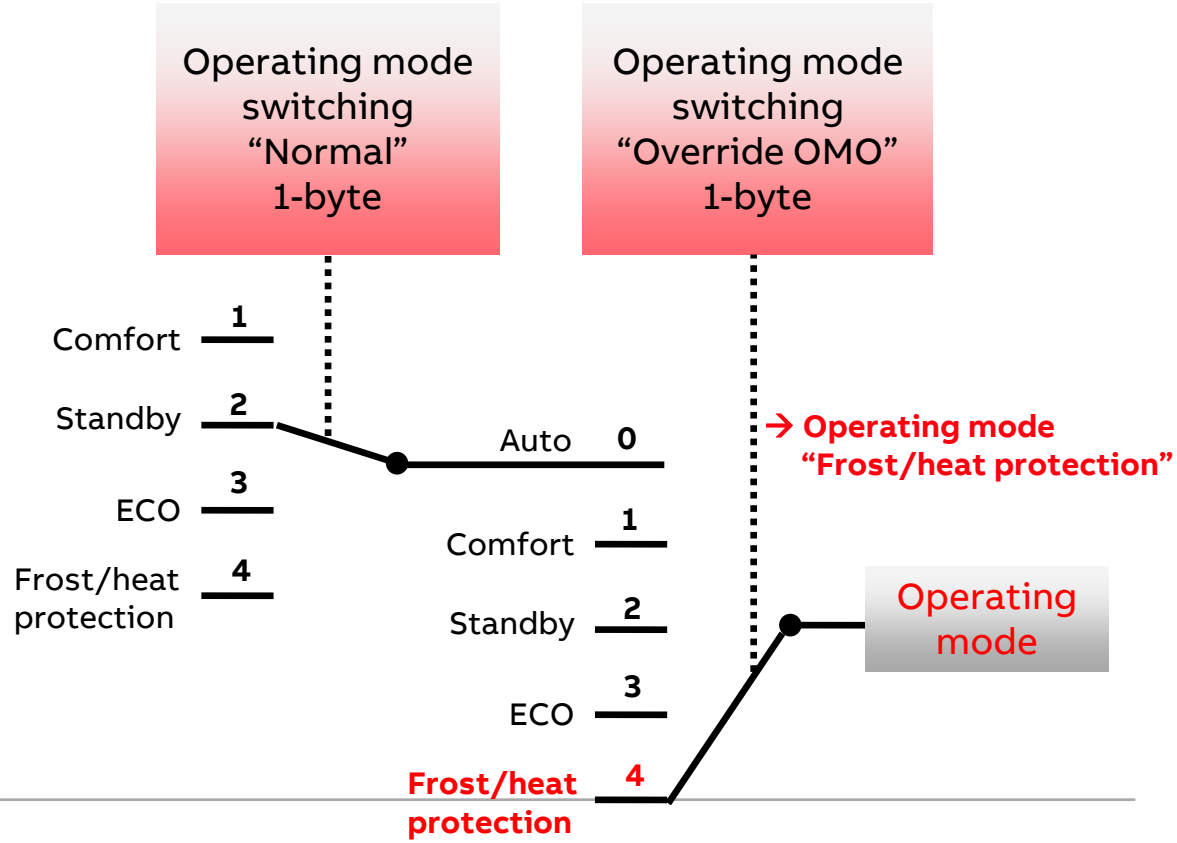
Operating modes





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Operating modes

- Further states can influence the operating mode
- Priorities for determining the operating mode

  Highest priority
  - Operating mode switching “Override OMO”
  - Condensation/fill level alarm (only cooling) → Heat protection
  - Dew point alarm (only cooling) → Heat protection
  - Window contact → Frost/heat protection
  - Control On/Off → Frost/heat protection
  - Presence detector → Comfort
  - Operating mode switching “Normal”

  Lowest priority

Nu	Name	Object Function	Length	Data Type
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19	RTC: Cooling control value	Output	1 bit	switch
21	RTC: Control On/Off	Output	1 bit	switch
22	RTC: Actual temperature	Output	2 bytes	temperature (°C)
25	RTC: Fault actual temperature	Output	1 bit	switch
27	RTC: actual setpoint	Output	2 bytes	temperature (°C)
28	RTC: Normal operating mode	Input/Output	1 byte	HVAC mode
29	RTC: Override operating mode	Input	1 byte	HVAC mode
30	RTC: Window contact	Input	1 bit	switch
31	RTC: Presence detector	Input	1 bit	switch
35	RTC: Switchover heating/cooling	Output	1 bit	cooling/heating
44	RTC: Basic setpoint	Input	2 bytes	temperature (°C)
46	RTC: Dew point alarm	Input	1 bit	switch
47	RTC: Condensation/fill level alarm	Input	1 bit	switch
48	RTC: Outside temperature for summer compen...	Input	2 bytes	temperature (°C)
49	RTC: Summer compensation active	Output	1 bit	switch
61	RTC: Controller status RHCC	Output	2 bytes	RHCC status
62	RTC: Controller status HVAC	Output	1 byte	percentage (0..100%)
73	RTC: Limit temperature basic heating stage	Input	2 bytes	temperature (°C)
85	RTC: Current HVAC operating mode	Output	1 byte	HVAC mode

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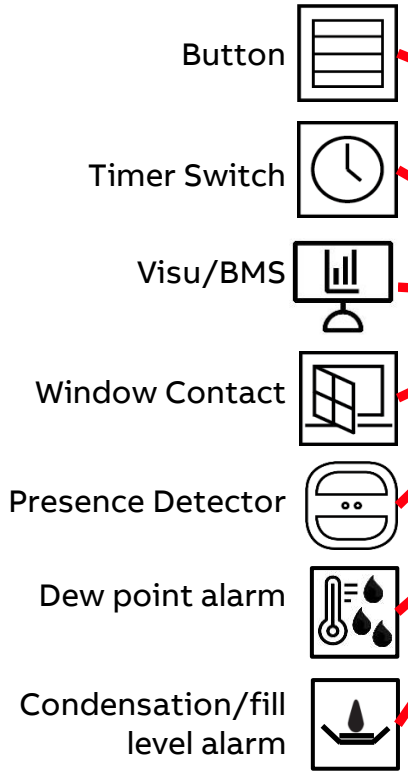
Operating modes



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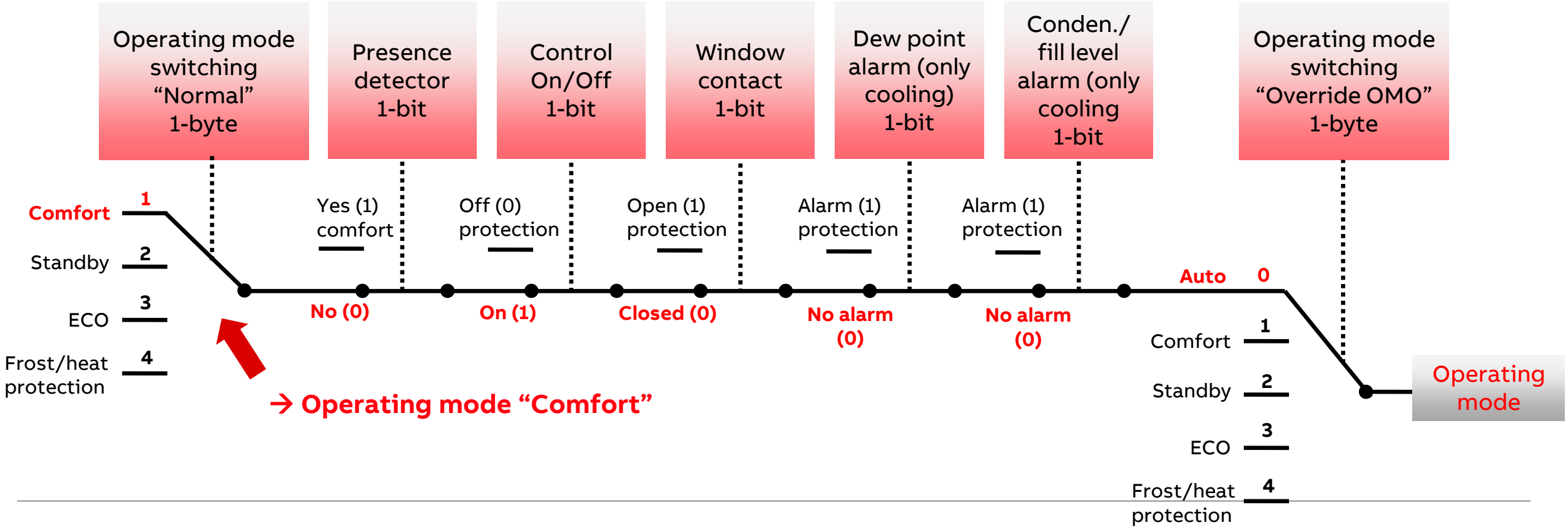
Operating modes



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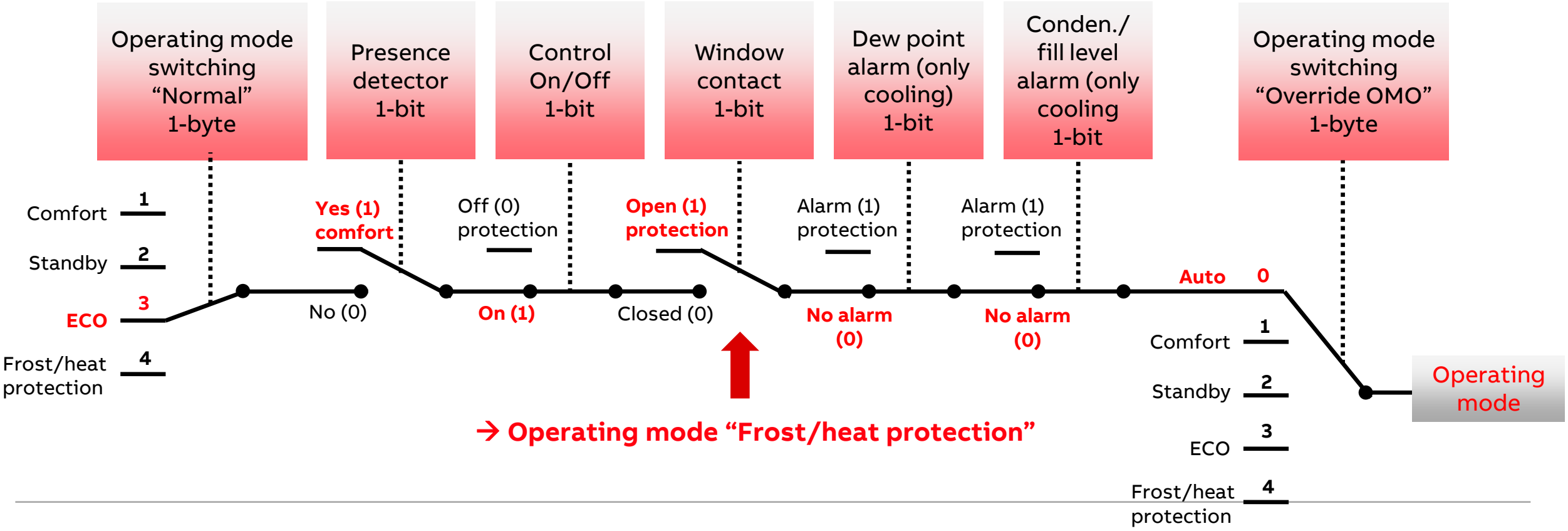
Operating modes



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Operating modes

Status of the current HVAC operating mode

- The RTC uses the group object “Current HVAC operating mode” to send the operating mode after evaluation of all priorities and influences (e.g. window contact, On/Off, presence detector, …)
- The group object indicates the current controller operating mode as a 1-byte value
  - 1 = Comfort
  - 2 = Standby
  - 3 = ECO (night)
  - 4 = Frost/heat protection
- Data type
  - 20.102 HVAC mode
  - Range 1…4

Nu	Group Addr	Name	Object Function	Length	Data Type
85	17/2/13	RTC: Current HVAC operating mode	Output	1 byte	HVAC mode

Status of the current HVAC operating mode

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Setpoint

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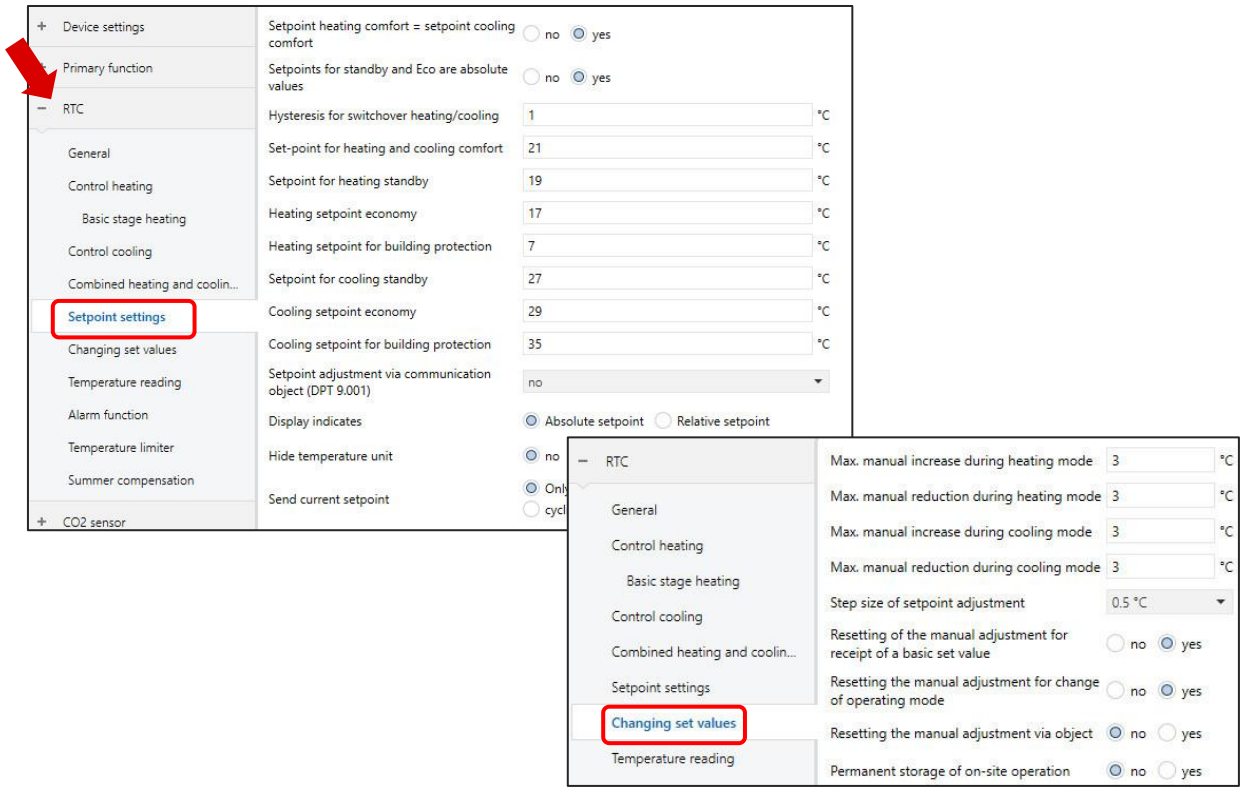
Setpoint

The setpoint is the desired room temperature

- The setpoint can be set for each operating mode
- Depending on the room temperature controller, the setpoint can also be changed via KNX telegram
- Parameter settings
  - One setpoint for heating comfort and one setpoint for cooling comfort
    or
    One common setpoint with hysteresis for switching heating/cooling
  - Relative setpoint
    or
    Absolute setpoint
  - Max. manual increase/reduction and step size of adjustment during heating/cooling mode



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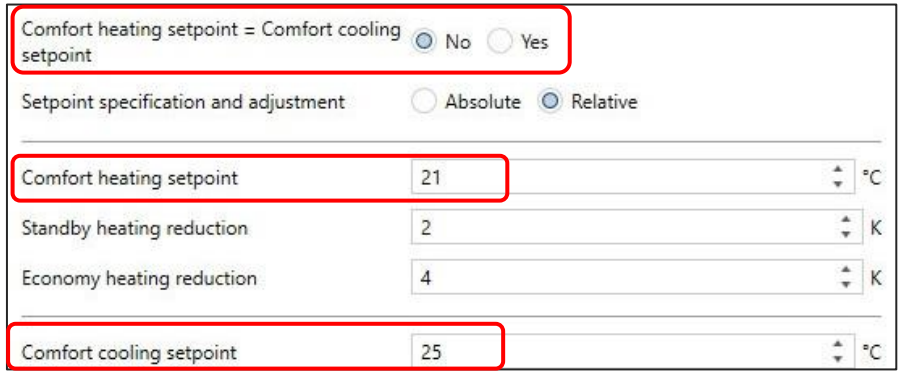
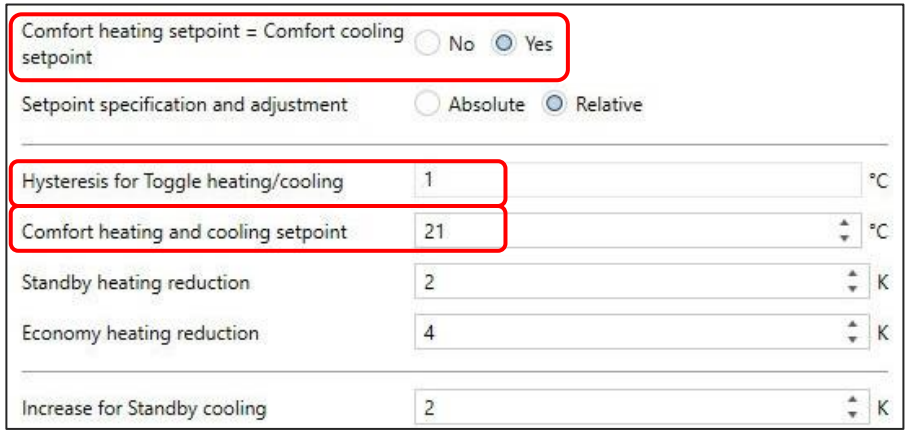
Setpoint

Comfort heating setpoint = Comfort cooling setpoint

– No
  - Two separate comfort setpoints are used for heating (21°C) and cooling (25°C)

– Yes
  - The device has one and the same setpoint for heating and cooling in the comfort mode (21°C)
  - The changeover to heating takes place on dropping below the setpoint minus the hysteresis “1K” → 20°C (21°C - 1K)
  - The changeover to cooling takes place on exceeding the setpoint plus the hysteresis “1K” → 22°C (21°C + 1K)





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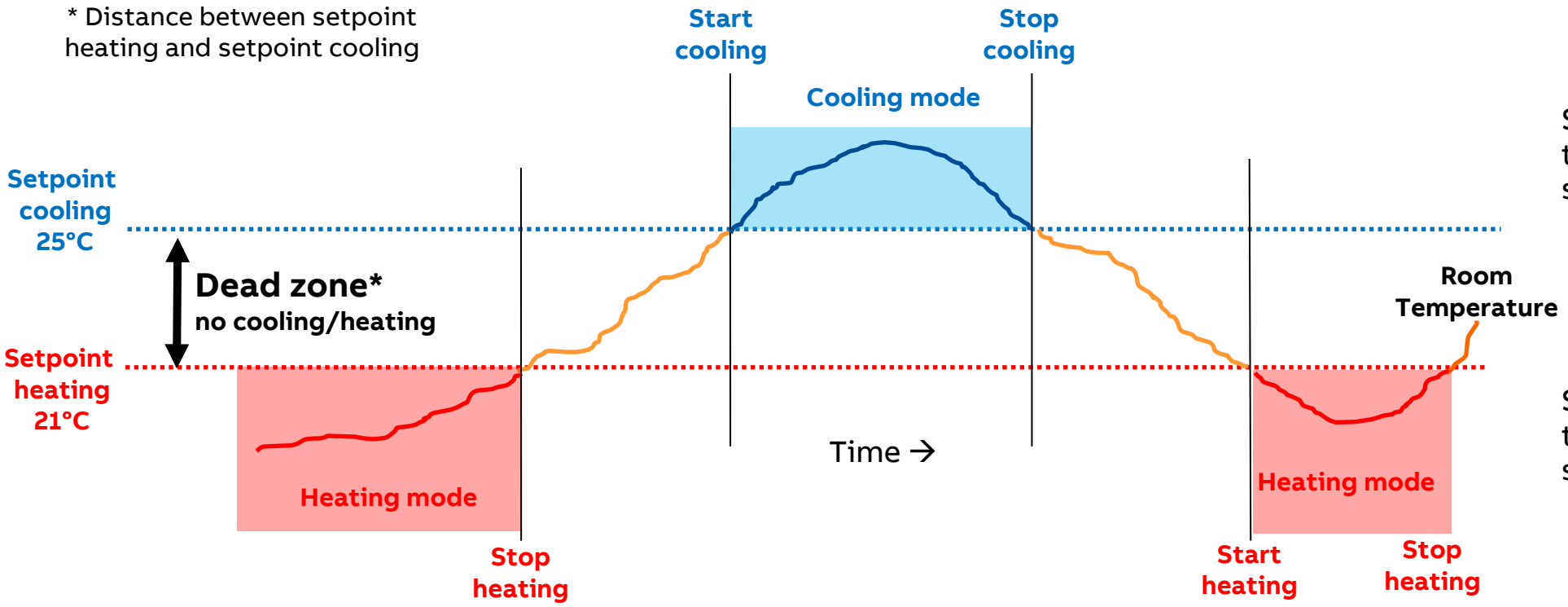
Setpoint: Two separate comfort setpoints are used for heating (21°C) and cooling (25°C)



Switches to cooling mode when the temperature exceeds the setpoint **cooling**

Switches to heating mode when the temperature drops below the setpoint **heating**

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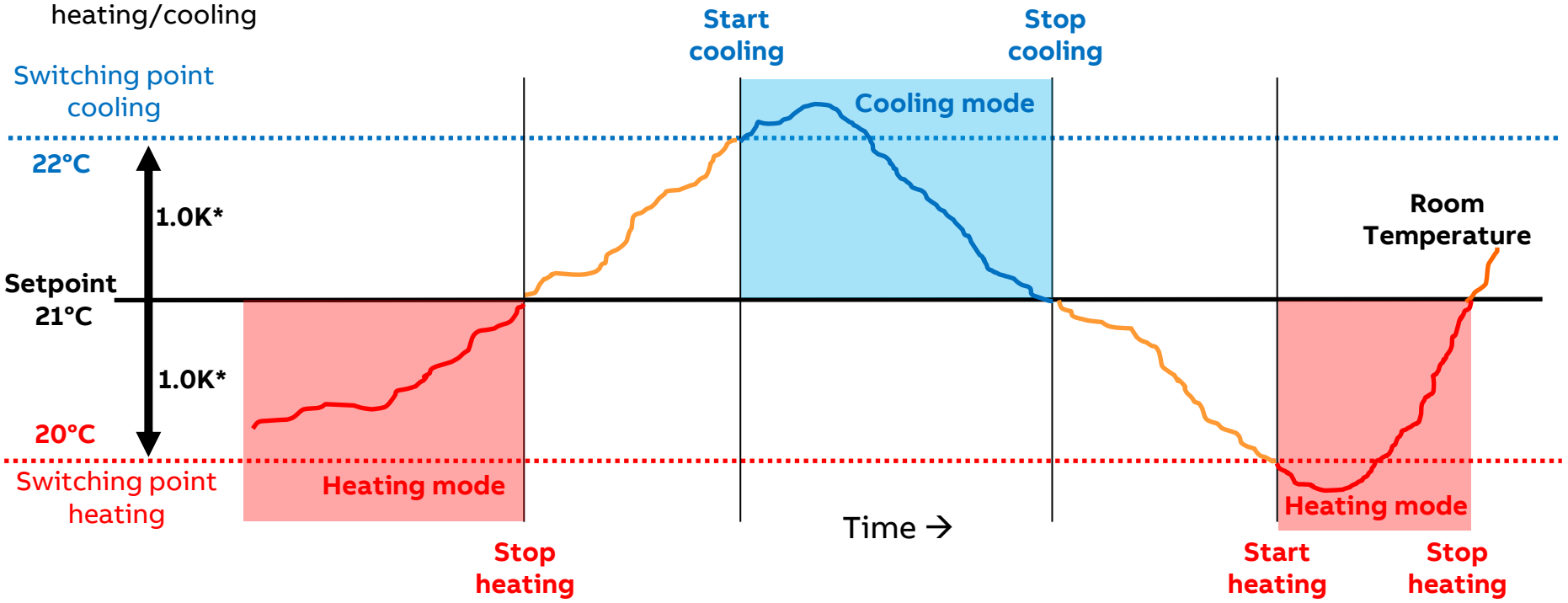
Setpoint: One setpoint (21°C) for heating & cooling and hysteresis (1K)

* Hysteresis for switchover heating/cooling



Switches to cooling mode when the temperature exceeds the **setpoint plus hysteresis**

Switches to heating mode when the temperature drops below the **setpoint minus hysteresis**

Advantage: Easy to understand, like AirCon in a car

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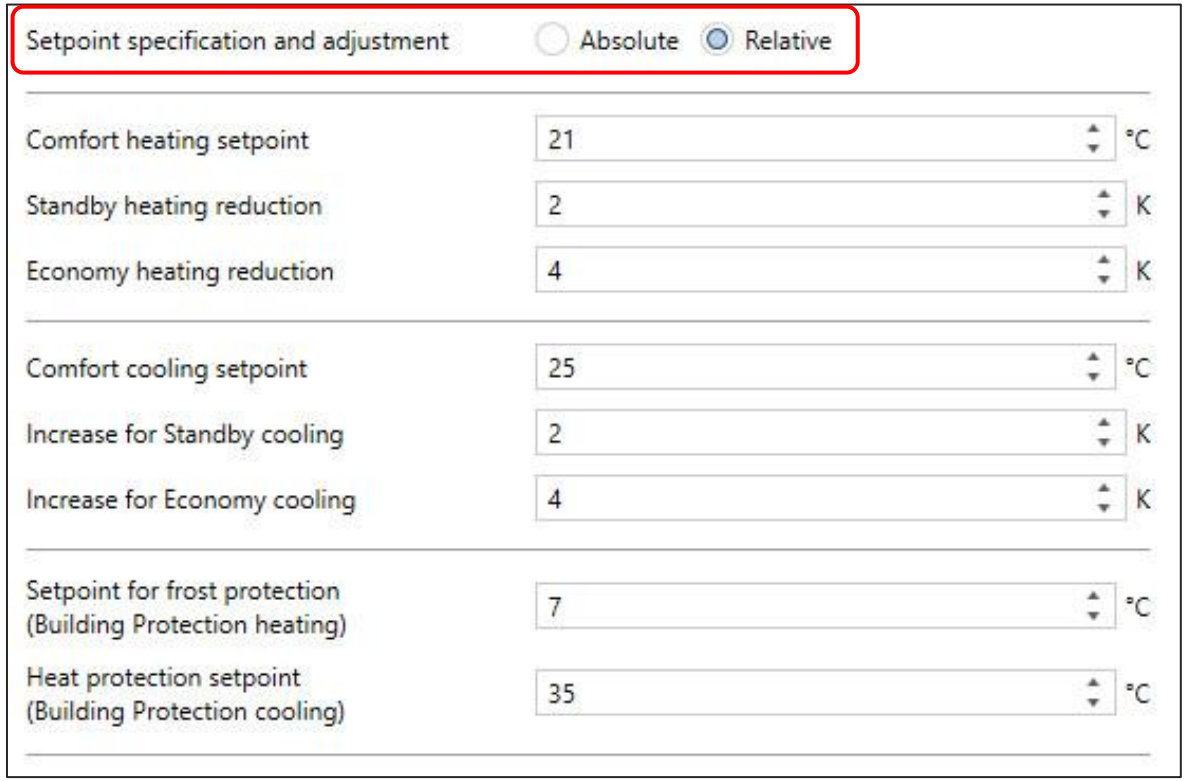
Setpoint

Relative setpoint

- A relative setpoint has a base setpoint “Comfort” and the settings “...reduction/increase” for standby and ECO refer to the base setpoint
- Advantage: If the base setpoint is changed, the setpoints for standby and ECO are automatically shifted with it
- For example:
  - Comfort heating setpoint 21°C (base setpoint heating)
    → Standby heating reduction “2K” → 19°C (21°C - 2K)
    → Economy heating reduction “4K” → 17°C (21°C - 4K)
  - Comfort cooling setpoint 25°C (base setpoint cooling)
    → Standby cooling reduction “2K → 27°C (25°C + 2K)
    → Economy cooling reduction “4K” → 29°C (25°C + 4K)
  - Setpoint for frost protection 7°C
  - Setpoint for heat protection 35°C



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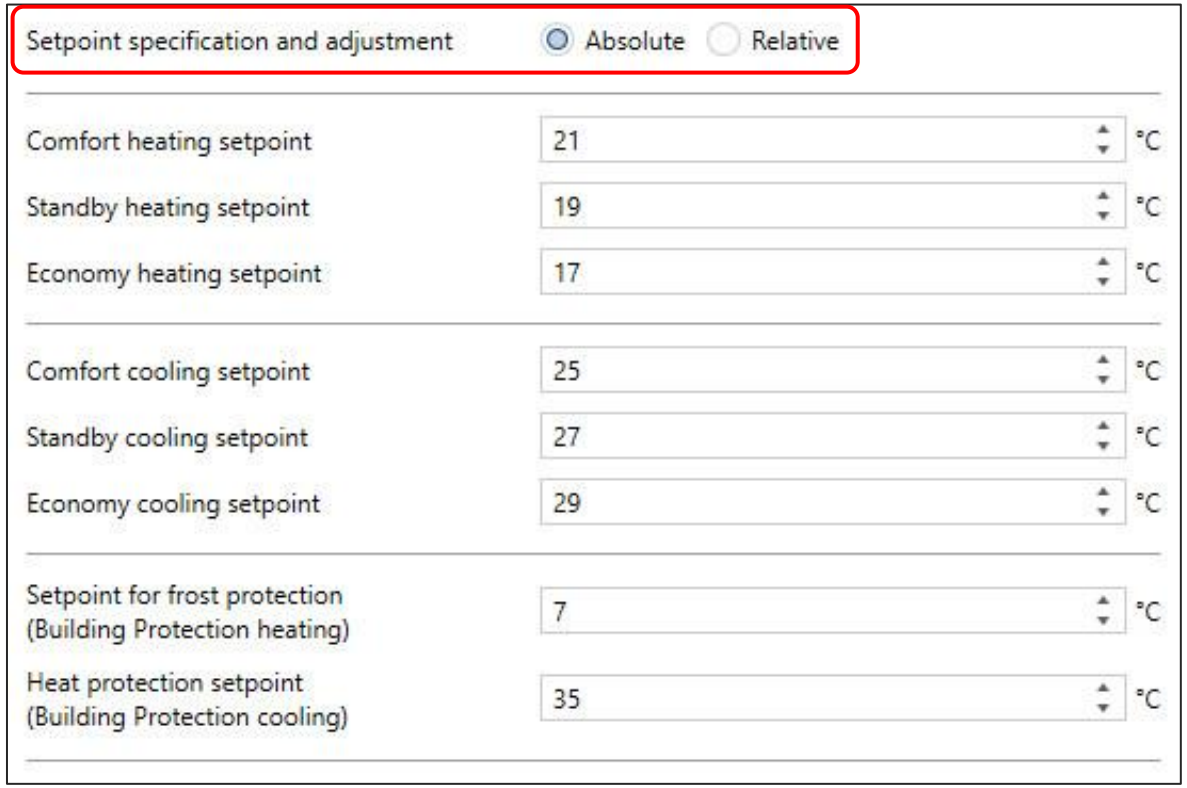
Setpoint

Absolute setpoint

- Absolute setpoints are parameterized for every operating mode
- For example
  - Comfort heating setpoint 21°C
  - Standby heating reduction 19°C
  - Economy heating reduction 17°C
  - Comfort cooling setpoint 25°C
  - Standby cooling reduction 27°C
  - Economy cooling reduction 29°C
  - Setpoint for frost protection 7°C
  - Setpoint for heat protection 35°C



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Control value types

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Control value

- The RTC calculates the control value using an algorithm (e.g. PI) based on the difference between the actual temperature and the setpoint
- The control value is sent to the output of an actuator to control the valve drives
  - Thermoelectric valve drives (TSA/K)
  - Motor valve drives (3-point)
  - Analog valve drives via 0-10 V signal
  - KNX electromotor valve drives (ST/K)
  - …
- Depending on the valve drive, we offer different actuators (Electronic Switch Actuator, Valve Drive Controller/Actuator, Fan Coil Controller, …) with electronic or analog 0…10 V output

Thermoelectric valve drive ABB TSA/K

Motor valve drive 3-point Möhlenhoff

KNX electromotor valve drive ABB ST/K

Electrothermal valve drive Oventrop 0…10 V

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Control value

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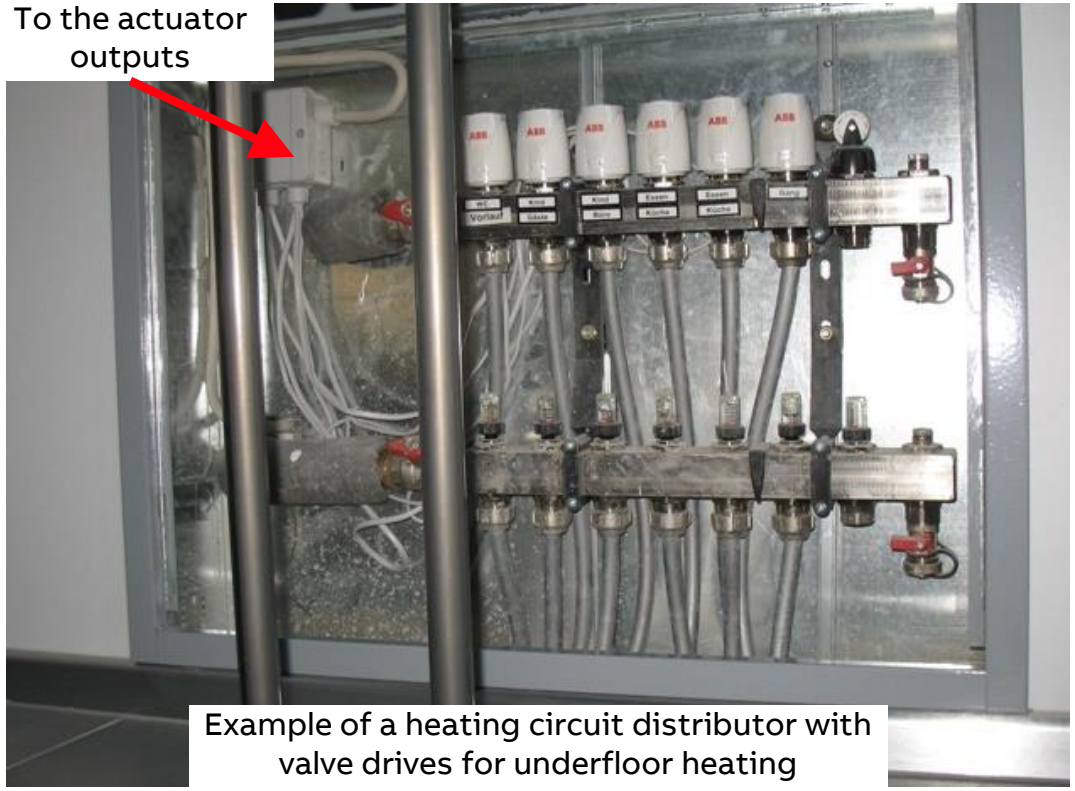

Example of a heating circuit distributor with valve drives for underfloor heating

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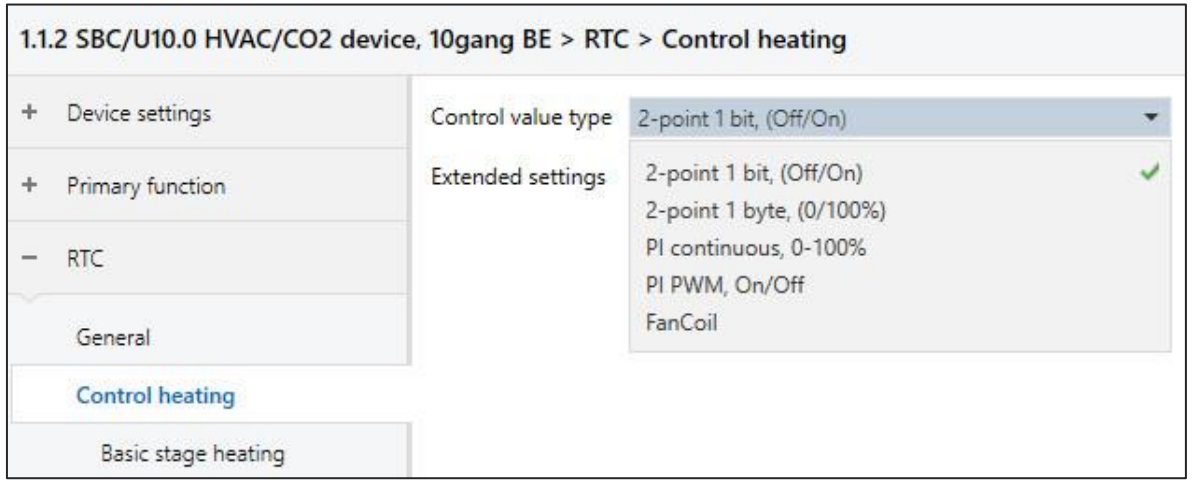
Control value types

– Different control value types are possible depending on the RTC
  - 2-point 1-bit (on/off)
  - 2-point 1-byte (0/100%)
  - PI continuous (0-100%)
  - PI PWM, On/Off
  - FanCoil



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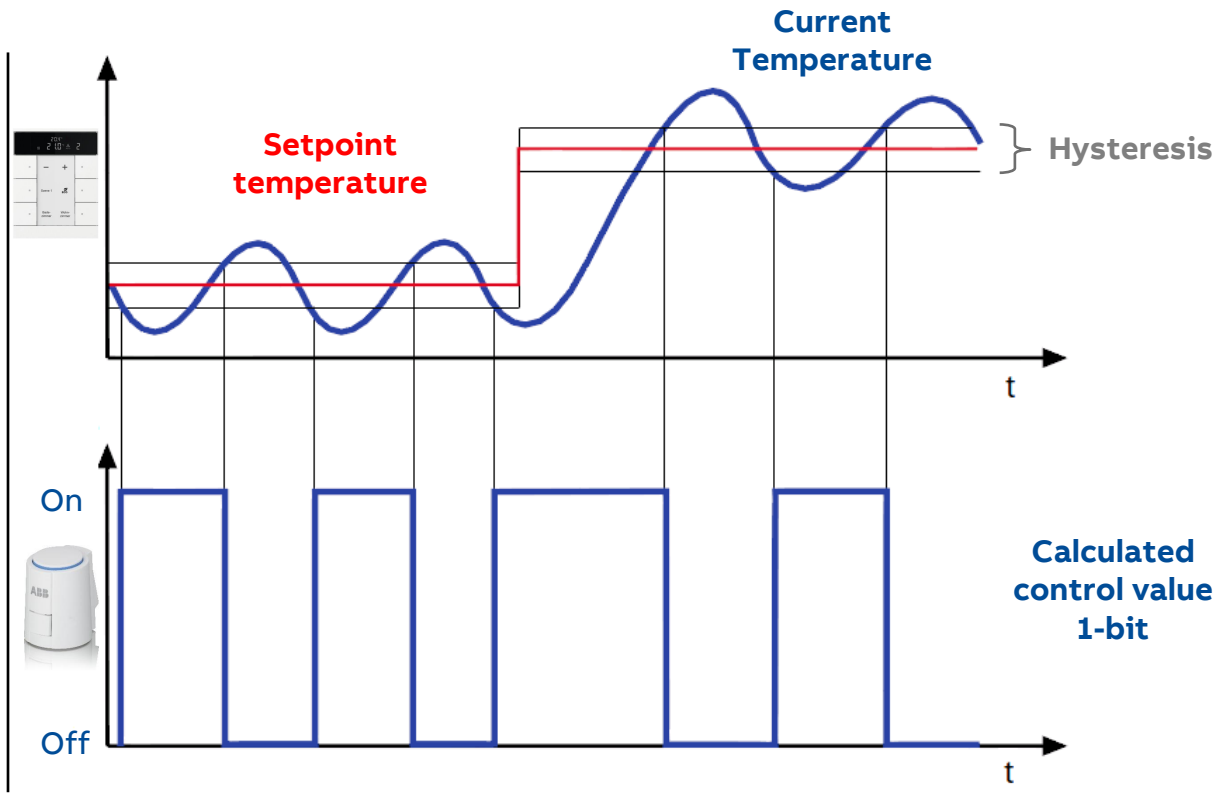
Control value types

2-point controller 1-bit “on/off”

- A 2-point controller possesses two output states (On/Off) that change depending on the actual temperature
  - If the actual temperature is higher than the parametrized setpoint, the associated control value is 0
  - If the actual temperature is less than the parametrized setpoint, the associated control value is 1
- A 2-point controller can quickly compensate for control deviations in case of large changes in the setpoint temperature
- However, it tends to lead to system overshoot (exceeding the setpoint temperature) and an overswing of the temperature
- To avoid overshooting the initial states, 2-point controllers always feature integrated hysteresis (e.g. 1K) that fluctuates around the setpoint



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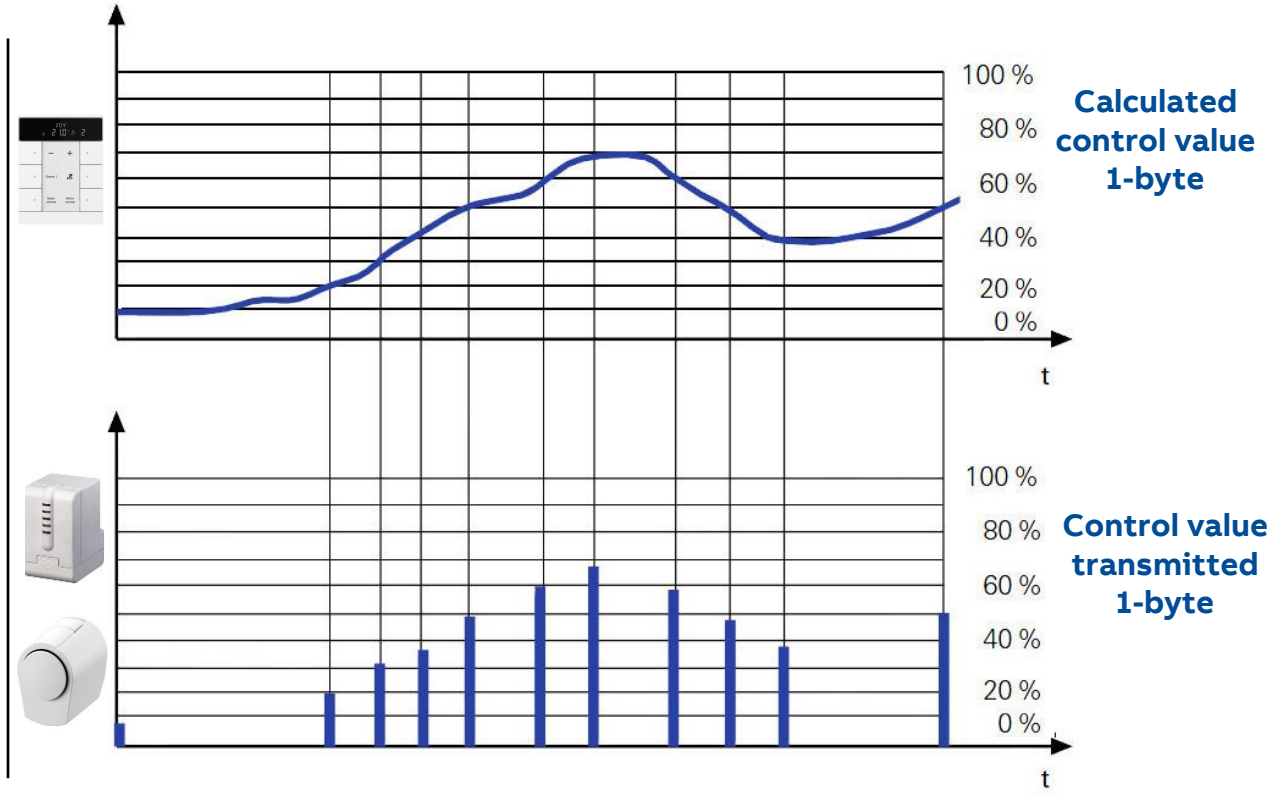
Control value types

PI controller continuous “0-100%”

- The continuous controller calculates the control value in the form of a 1-byte value between 0…100%
- The control value transmitted acts on a continuous-action positioner
  - Electromotor valve drive, e.g. ABB “ST/K”
  - Electrothermal or electromotor 0 - 10 V valve drives
    → ABB Fan Coil Controller FCC/S with 0-10 V valve drive output
- The valve can be fully opened, fully closed and even positioned in every intermediate position
- This doses the quantity of heat or cold
- PI control is a control engineering term which describes a controller with a proportional and an integral component



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Control value types

PI controller with pulse width modulation (PWM) 1-byte

- The PI controller (PWM) basically operates exactly like the PI controller (continuous)
- The calculated 1-byte control value is converted together with the parameterized cycle time from a PWM calculation into a signal for 2-point control (ON-OFF-ON-…)
- The control value is fixed for a timed cycle and recalculated in the duration for valve opening
  - The control value 20% at a cycle time of 15 minutes, for example, will be converted to a valve opening time of three minutes
  - The control value 50% results in a valve opening time of 7.5 minutes
- With pulse width modulation, a relatively accurate setting of the temperature can be achieved without any resulting overshoots and simple electrothermal valve drives can be used

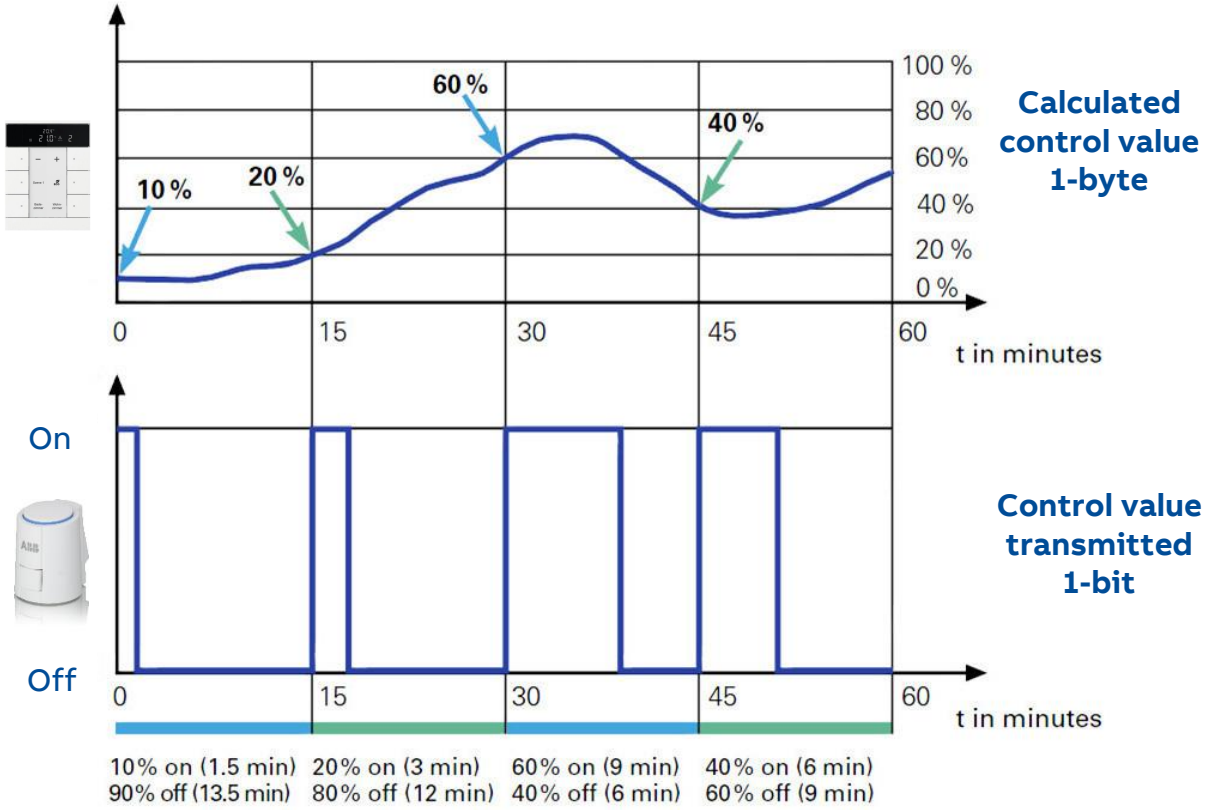

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ABB i-bus® Tool

A professional service tool for KNX system integrators

- It supports system integrators during commissioning and service
- Internal information and states of the device hardware and software applications are now available in a transparent manner
- The i-bus® Tool is optional, i.e. the ABB i-bus® KNX devices must still be commissioned using just the ETS
- An important principle is that no divergences to the ETS project can result through the i-bus® Tool
- KNX devices provide numerous options of parameter settings
- After parametrization and downloading, the behavior of the devices must be checked and tested → use the i-bus Tool !!!

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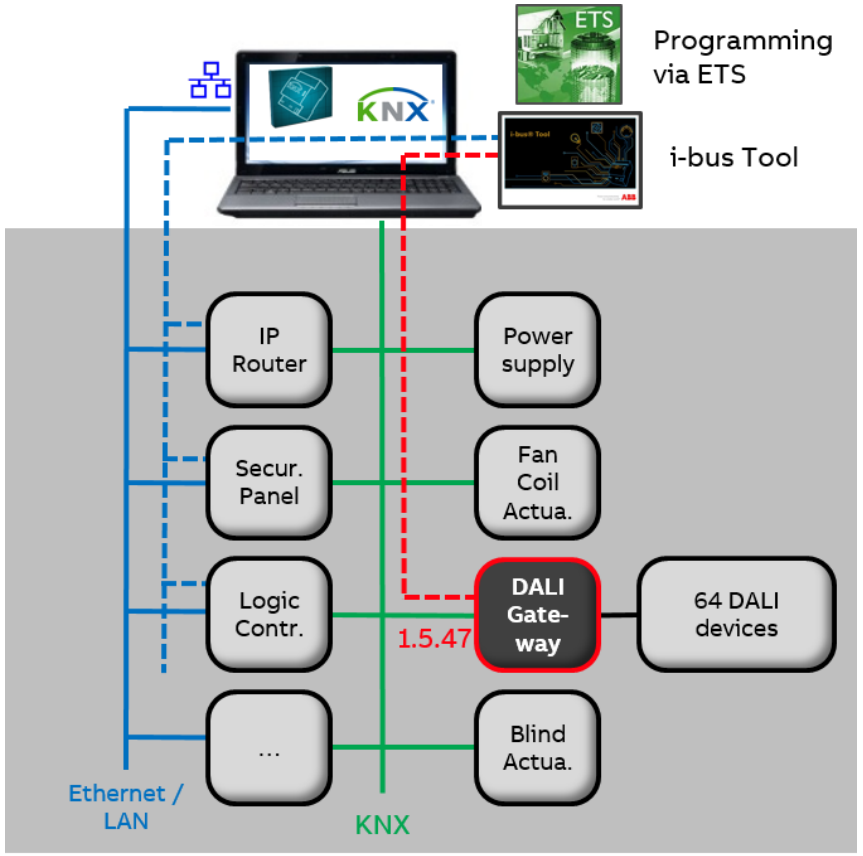

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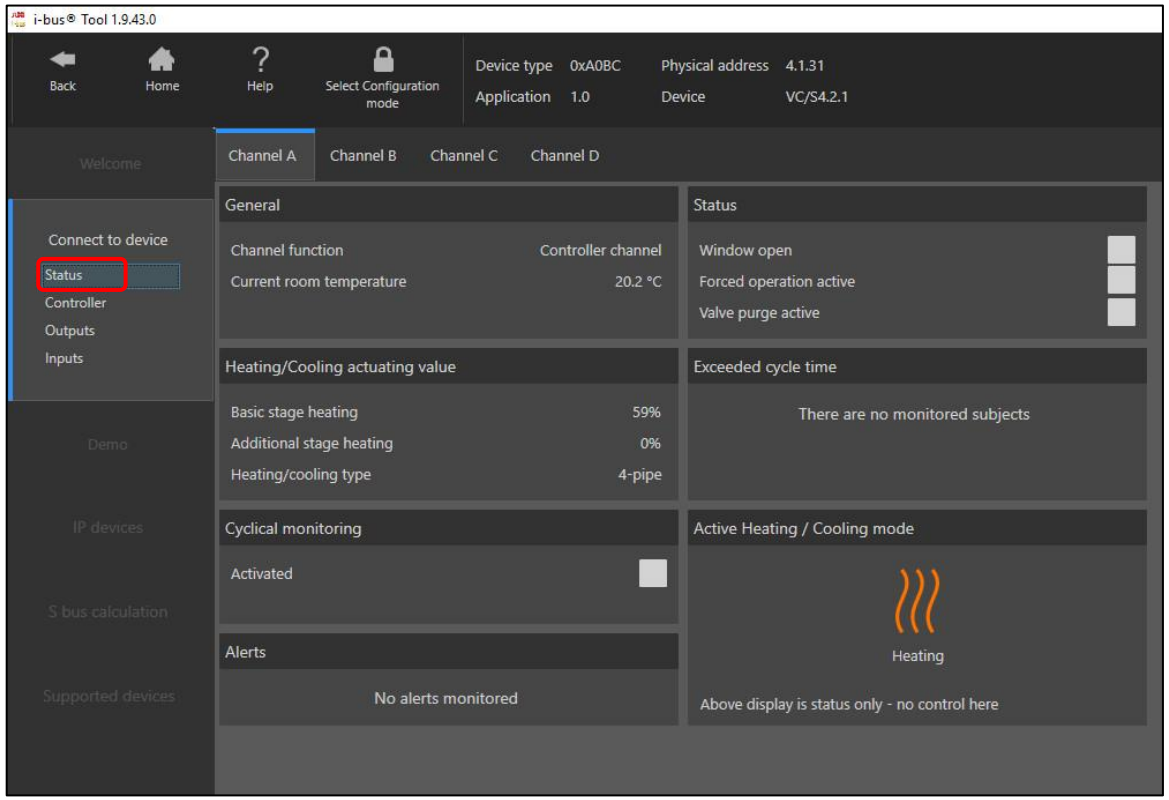
ABB i-bus® Tool – Test and check the ETS parameter settings and the different functions



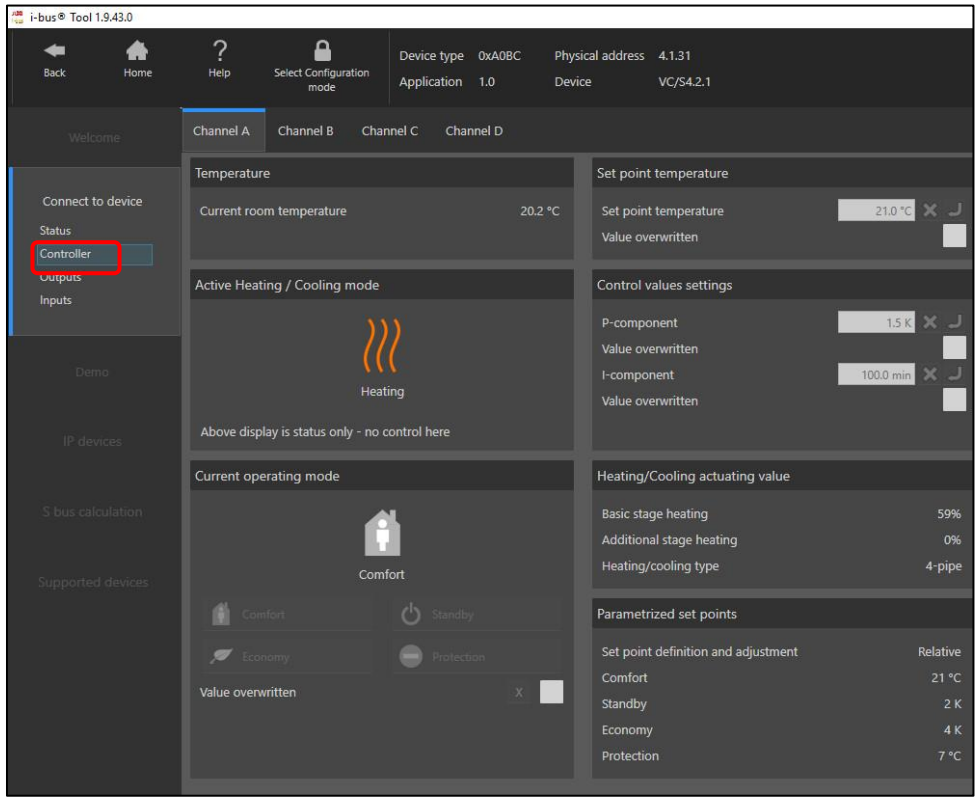


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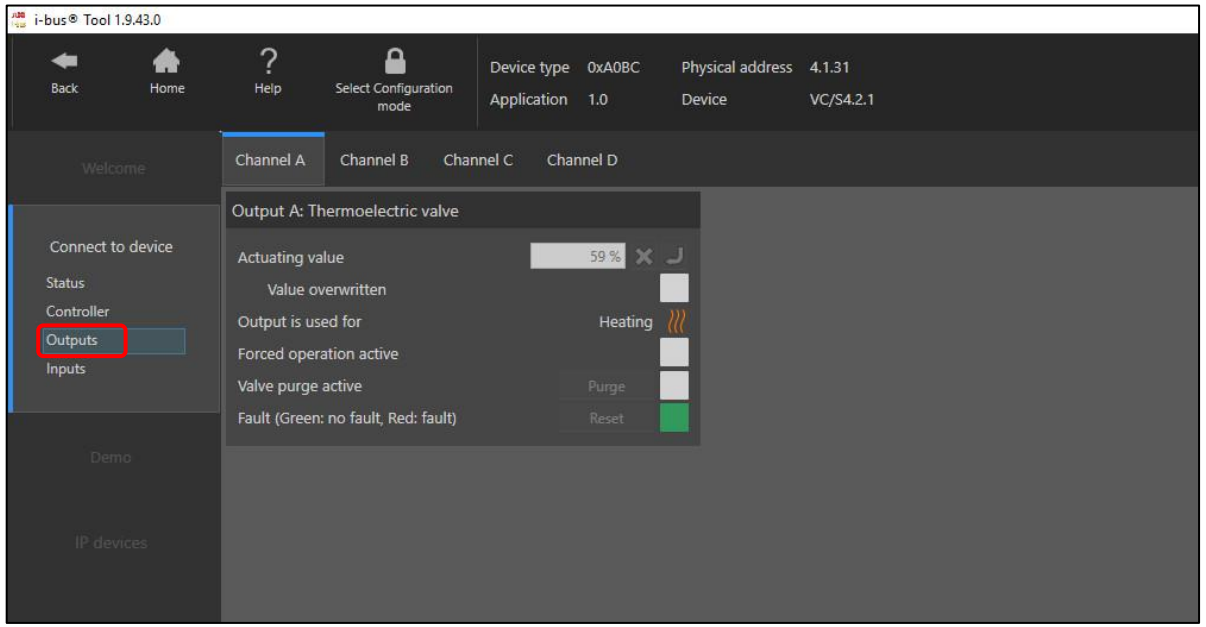
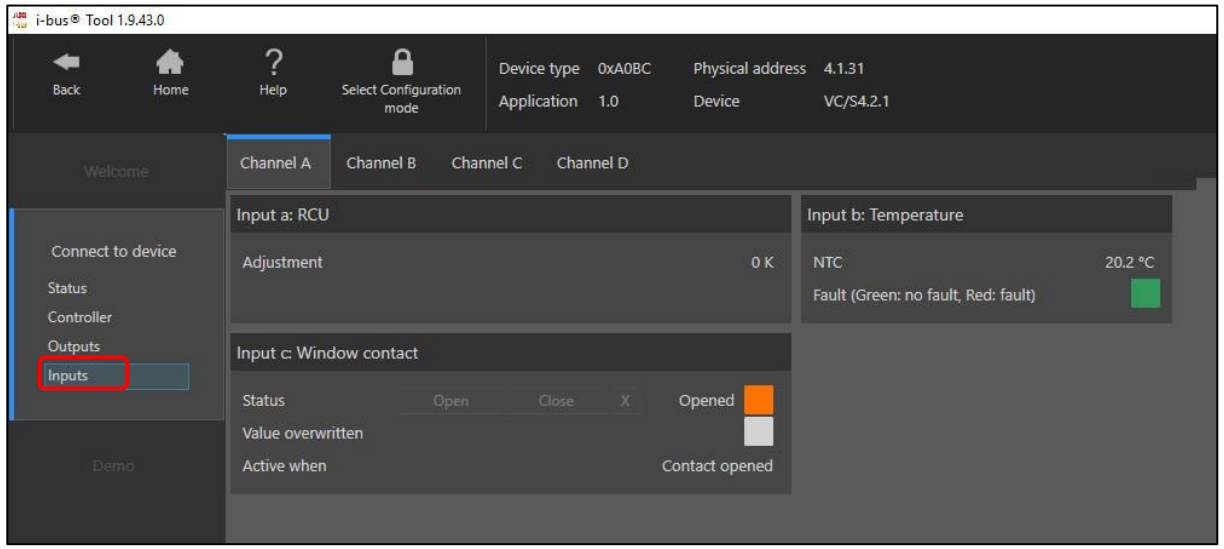
ABB i-bus® Tool – Test and check the ETS parameter settings and the different functions





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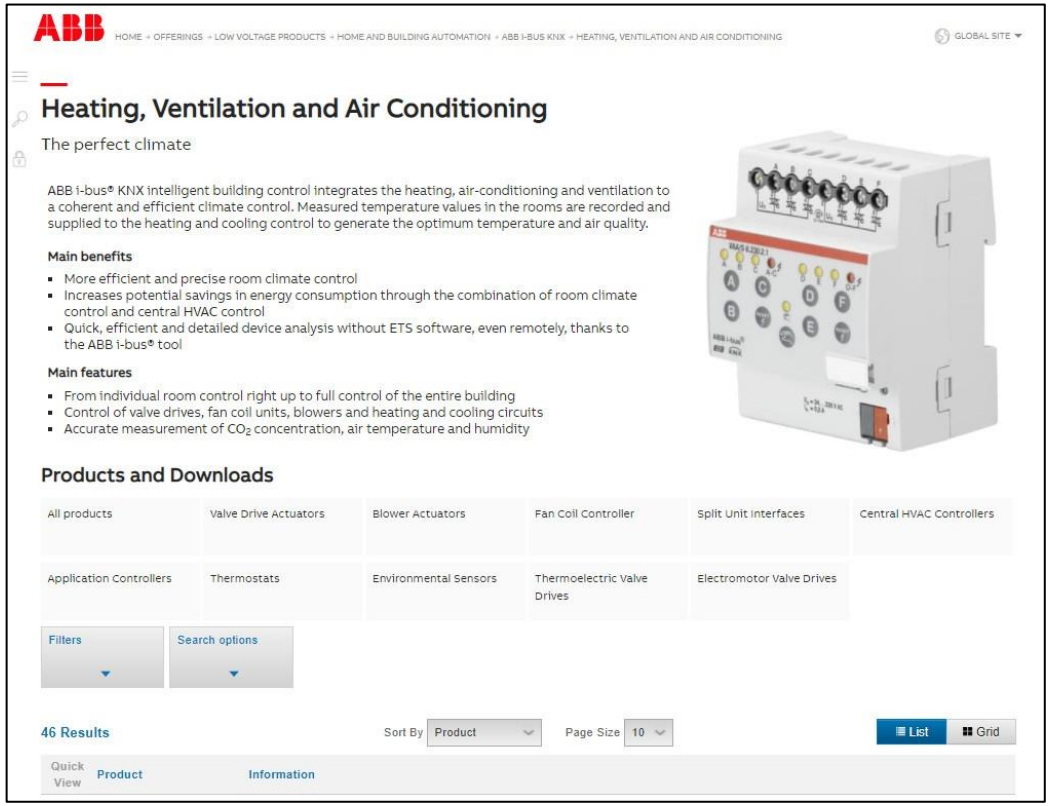
- Specification Text
- …



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Training Material

Training & Qualification Database

– The database contains extensive training content
  - Webinar, Learning Sessions, … slides and videos
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  - https://go.abb/ba-training
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