Manual
KNX Visualization
Additional explanation

Touch_IT V2

RTC (detailed)

Version: May 2020

arcus-eds

Content

Product Datasheet

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5 RTR

Touch_IT C3 V2 - 3,5“ TFT Colour Touch Display

109 5.1 General Information
109 5.1.1 Structure of this Document
109 5.1.2 How to read this
110 5.1.3 Overview
111 5.1.4 Important
111 5.1.5 Device-Internal Communication to Control the RTC
111 5.1.6 PI-Controller Set Up
5.1.6.1 Adjusting the PI Controller
5.1.6.1 General Basic Rules
112 5.1.7 Setpoint handling
5.1.7.1 Setpoint Adjustment
5.1.7.2 Absolute vs. Relative Setpoint
5.1.7.3 Heating / Cooling Gap
5.1.7.4 Illustrated Examples
114 5.1.8 Room Temperature Controllers
5.1.8.1 Heating vs. Cooling controller
5.1.8.2 One- vs. Two-Stage Controllers
5.1.8.3 Heating / Cooling Switched vs. Gap Controller
5.1.8.4 Controller Output Objects

119 5.2 RTC Parameter
119 5.2.1 1st / 2nd Stage Bandgap (Temp. Controller Heating / Cooling)
119 5.2.2 3-Point Bandgap (Temp. Controller Heating / Cooling)
119 5.2.3 Absolute / Relative Setpoints (Temp. Controller Settings)
5.2.3.1 Relative
5.2.3.2 Absolute
120 5.2.4 Comfort Setpoint Temperature (Absolute) (Temp. Controller Settings)
120 5.2.5 Controller Fan Limit 1 [%] (Controller Page Fan)
121 5.2.6 Controller Fan Limit 2 [%] (Controller Page Fan)
121 5.2.7 Controller Fan Limit 3 [%] (Controller Page Fan)
121 5.2.8 Controller Fan Proportional Part (Controller Page Fan)
122 5.2.9 Controller Proportional Band Style (Temp. Controller Settings)
5.2.9.1 Symmetric to Setpoint
5.2.9.2 Asymmetric to Setpoint
123 5.2.10 Controller Type (Temp. Controller Heating / Cooling)
5.2.10.1 2-Point Controller
5.2.10.2 3-Point Controller
5.2.10.3 PI-Controller
5.2.10.4 PI-Controller with PWM
125 5.2.11 Economy Setpoint Temperature (Absolute) (Temp. Controller Settings)
125 5.2.12 Economy Setpoint Temperature (Heating, Absolute)
(Temp. Controller Settings)
125 5.2.13 Economy Setpoint Temperature Decrease (Temp. Controller Settings)
125 5.2.14 Economy Setpoint Temperature Increase (Temp. Controller Settings)
125 5.2.15 Economy Setpoint Temperature De- / Increase (Temp. Controller Settings)
125 5.2.16 External Temperature Weight [%] (Temp. Controller Settings)

Subject to change

Content

Product Datasheet

A
VISU

5 RTC

Touch_IT C3 V2 - 3,5“ TFT Colour Touch Display

126 5.2.17 Fan Lag-Time [sec] (Controller Page Fan)
126 5.2.18 Fan Lead-Time [sec] (Controller Page Fan)
126 5.2.19 Fan Steadyoutput Stepwidth [%] (Controller Page Fan)
126 5.2.20 Heating / Cooling Bandgap (Temp. Controller Settings)
126 5.2.21 Heating / Cooling Changeover Deadtime (Temp. Controller Settings)
126 5.2.22 Hysteresis (Temp. Controller Heating / Cooling)
126 5.2.23 Integration Time [minutes] (Temp. Controller Heating / Cooling)
127 5.2.24 Minimum / Maximum Gap [%] (Temp. Controller Heating / Cooling)
127 5.2.25 Output Send On Change Off (Temp. Controller Heating / Cooling)
127 5.2.26 Outputs Sending Cycle [minutes] (Temp. Controller Settings)
127 5.2.27 Overwrite Timeout [minutes] (Temp. Controller Settings)
127 5.2.28 Proportional Band (Temp. Controller Heating / Cooling)
128 5.2.29 Protection Setpoint Temperature High
(Absolute) [°C] (Temp. Controller Settings)
128 5.2.30 Protection Setpoint Temperature Low
(Absolute) [°C] (Temp. Controller Settings)
128 5.2.31 PWM Cycletime [seconds] (*10) (Temp. Controller Heating / Cooling)
128 5.2.32 Room Temperature Controller (Main)
128 5.2.33 Setpoint Adjustment Range (Temp. Controller Settings)
129 5.2.34 Stand-by Setpoint Temperature (Absolute) (Temp. Controller Settings)
129 5.2.35 Stand-By Setpoint Temperature
(Heating, Absolute) (Temp. Controller Settings)
129 5.2.36 Stand-by Setpoint Temperature De- / Increase (Temp. Controller Settings)
129 5.2.37 Stand-By Setpoint Temperature Decrease (Temp. Controller Settings)
129 5.2.38 Standby Setpoint Temperature Increase (Temp. Controller Settings)
129 5.2.39 Steady-Output Value (Controller Page Fan)
5.2.39.1 Steps
5.2.39.2 Limits

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5 RTC

This document features three major sections. The first section contains descriptions of rather general characteristics which are related to multiple objects and parameters.

5.1 General Information

5.1.1 Structure of this Document

The different subsections of this first section are called "articles". They appear in the respective parameter and object descriptions and Every parameter and every object includes a functional description.

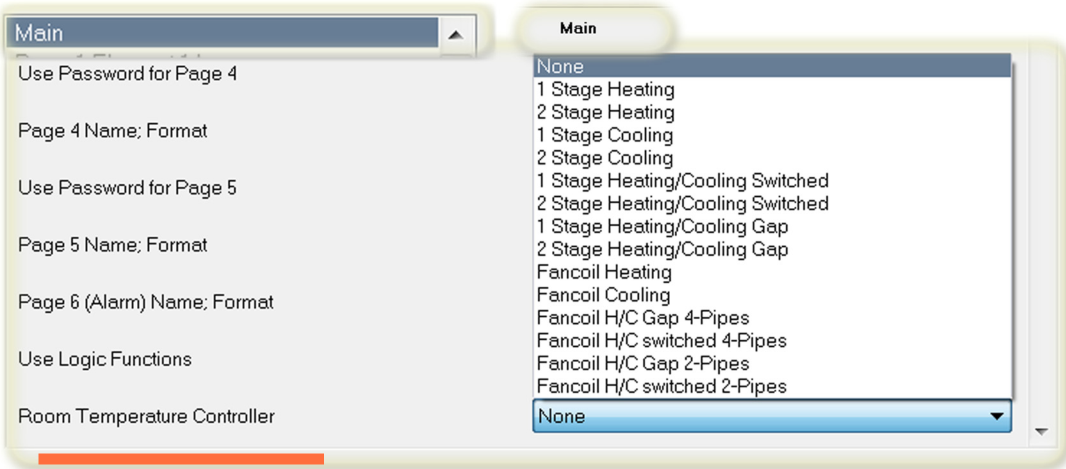
Some of them have examples marked by e.g,

use cases are marked by use

and important notes marked by !.
Also, there are links to other sections with further information corresponding to the respective entry.
In the second section, all parameters are listed and described. In the third section you find a description of all objects related to the Room Temperature Controller. At the end of this document there is an index where all object and parameter names are listed including name and page number.

5.1.2 How to read this

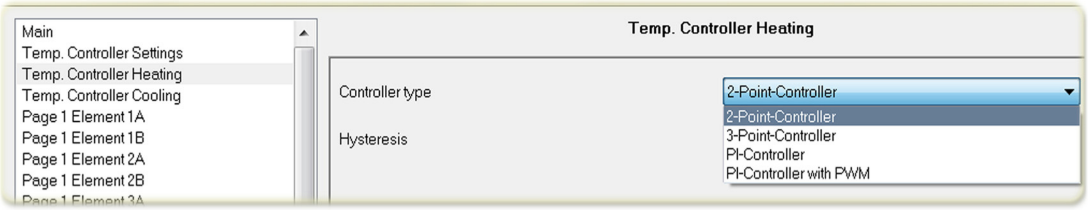
Please use the ETS application.



If there are any ambiguities with a parameter or an object, please look it up in the index at the end and go to the corresponding site with the description. In the section General Information, there is a schematic diagram of the Room Temperature Controller.

If a parameter is referenced in the text, it has the following structure:

Parameter "Controller Type (Temp. Controller Heating / Cooling), Page 123"
The string in the brackets stands for the tab in the ETS parameter of the device (see figure). [4].



The following schematic diagram shows a general overview of the Room Temperature Controller (RTC). It provides an overview, but it doesn't show every detail. For more details, see the list of all parameters and objects including their descriptions. For some special parts, see the following sections.

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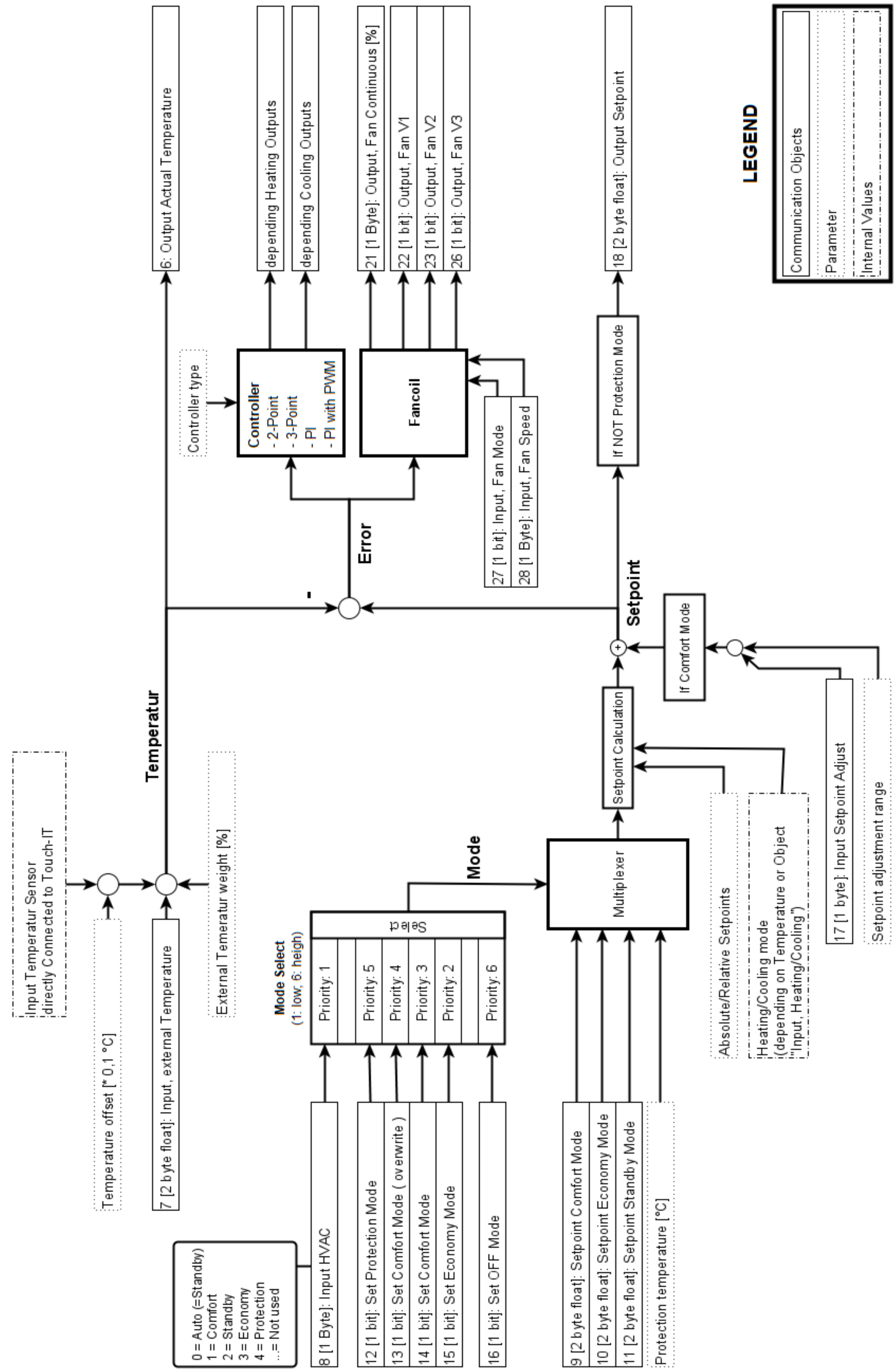
5.1.3 Overview



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5.1.4 Important

- Check the parameter "External Temperature weight [%]" (If no temperature sensor is directly connected to the device, the parameter "External Temperature Weight [%] (Temp. Controller Settings), Page 125 must be 100!).
- Mode selection (comfort, economy, ...) by the different objects is prioritized
- If PI-controller is poorly or wrongly parameterized, there is the danger of continual oscillation
- The controller does not start if there is no temperature input (If both the internal and the external one are used, both must have readings.)
- If the integration time for a PI-Controller is set to 0, it will turn into a simple P-Controller
- There is the possibility to directly control the RTC from the HVAC element types without any object or group address. See "Device-internal communication to control the RTC"

5.1.5 Device-Internal Communication to Control the RTC

Various HVAC element types have the format string INTERN, which allows to directly control the Room Temperature Controller (RTC) without using the object. Only one of the different element types can have the INTERN format. Otherwise, only one element type will be evaluated. This allows to directly define the different setpoints via the element "HVAC setpoint control" without using any group address or object.
For more information see Chapter 2 **Elements**.

5.1.6 PI-Controller Set Up

5.1.6.1 Adjusting the PI Controller

There are different systems for heating and cooling rooms. This is done using water, oil or air in various designs, such as in-floor heating, cooling ceilings, and radiators. The diversity of these combinations and the design of the room, such as the placement of radiators and the types of windows, play an important factor in the correct adjustment of the PI Controller. Therefore, it is not possible to specify a general PI parameter set. This description deals more or less with practical results of properly planned and installed heating units. If a system is improperly installed, it can be either slow, need too long to reach the desired temperature or fluctuate above or below the selected temperature.

Heating Type	**Pre-programmed Value**		**Controlling Type**	**PWM Cycle Type**
	Proportional band	**Integration time**		
Warm Water	5 °C	150 minutes	steady /PWM	15 Min or 2-3 Min if smaller and faster heater
In-Floor Heating	5 °C	240 minutes	PWM	15-20 min
Electric Heating	4 °C	100 minutes	PWM	10-15 min
Heating Ventilation	4 °C	90 minutes	steady	-
Split Unit	4 °C	90 minutes	PWM	10-15 min
Cooling Type				
Cooling Ceiling	5 °C	240 minutes	PWM	15-20 min
Air-Conditioning	4 °C	90 minutes	steady	-
Split unit	4 °C	90 minutes	PWM	10-15 min

- Just a small change in the parameter can result in a noticeable change in the controlling performance.
- The above mentioned values are based on experience and it is suggested to use them in the adjustment of the controlling parameters..

For a more detailed description of the PI controller process, please refer to relevant technical literature.Two other example methods to determine the controller's parameter are the Ziegler-Nichols tuning method and the pole compensation technique. These are only examples and there are more methods. Which method to use always depends on the use case

5.1.6.1 General Basic Rules

Parameter Specifications	**Effect**
Lower Proportional Band	Large fluctuation (perhaps continual fluctuation), quick adjustment to set point
Higher Proportional Band	Little or no fluctuation, but slow adjustment
Short Integration Period	Quick adjustment of controlling modulations (dependent on conditions), danger of continual oscillation
Long Integration Period	Slow adjustment of controlling modulations

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5.1.7 Setpoint handling

The setpoints are predefined in the parameter settings and are changeable via the corresponding objects. As long as the controller is not in the protection mode, the actual setpoint is sent to the object "Output, Setpoint".

The different setpoints are saved if changed manually or over the corresponding objects and stay saved also if the device is reprogrammed via ETS. To reset the setpoints of the parameter on an already RTC-programmed device, it is necessary to program the device with disabled RTC and then reprogram it with the desired settings. Especially if changing the RTC from absolut to relative mode this reset should be done once.

Content

5.1.7.1 Setpoint Adjustment

If the controller is in comfort mode, it is possible to temporarily adjust the setpoint within the range determined by the parameter "Setpoint Adjustment Range (Temp. Controller Settings), Page 128" to the time set in the parameter "Overwrite Timeout [minutes] (Temp. Controller Settings), Page 127" by the object "Input, Setpoint Adjust".

5.1.7.2 Absolute vs. Relative Setpoint

It is possible to set the calculation of the setpoints relative to the comfort setpoint or absolute in °C. This is selectable using the parameter "Absolute / Relative Setpoints (Temp. Controller Settings), Page 119" which determines how the values of the parameter and the object-related setpoint are interpreted. The setpoints for the cooling part are calculated internally by mirroring the set values at the comfort setpoint.

e.g. Setpoint is absolute and a heating/cooling controller type is installed.
Comfort setpoint is set to 20 °C and the economy setpoint for heating is set to 15 °C. In this case, the setpoint for economy cooling will be calculated to 25 °C (20 °C + (20 °C - 15 °C)).

e.g. Setpoint is relative and a heating/cooling controller type is installed. Comfort setpoint is set to 20 °C and the relative economy setpoint for heating is set to 2 °C. In this case, the setpoint for economy cooling is calculated to 22 °C (20 °C + 2 °C) and for heating it is calculated to 18 °C (20 °C - 2 °C).

5.1.7.3 Heating / Cooling Gap

If controller types with a gap are used, all setpoints are pushed apart relative to the comfort setpoint by the set value at the parameter "Heating / Cooling Bandgap (Temp. Controller Settings), Page 126" (the spacing between the comfort setpoints of heating and cooling corresponds to this value), but the output value at the object "Output, Setpoint" is not affected by the gap value. This means that the setpoint calculation with the gap is carried out only internally and will not be sent.

e.g. Setpoint is relative and a controller type with a gap is selected. The comfort setpoint is 20 °C, the relative setpoint for Stand-By is 5 °C, and the gap is set to 2 °C (setpoint adjust is not used!). In comfort mode, the output at the object "Output, Setpoint" is always 20 °C, no matter if heating or cooling. In economy mode, the output corresponds with the actual state (heating or cooling), i.e. 15 °C or 25 °C.
Internally, in heating state the controller uses 19 °C as setpoint for comfort mode and 14 °C as setpoint for stand-by mode. In cooling state it uses 21 °C as setpoint for comfort mode and 26 °C for stand-by mode.

5.1.7.4 Illustrated Examples

In the following, there are some illustrated examples for different setpoints.

Simple Heating Controller Type with Absolute Setpoints

A simple Heating controller, with absolute setpoints and without setpoint adjust. As one sees the setpoints are used as they are by the controller corresponding to the Mode. The values are also sent without changes to the Object "Output, Setpoint".

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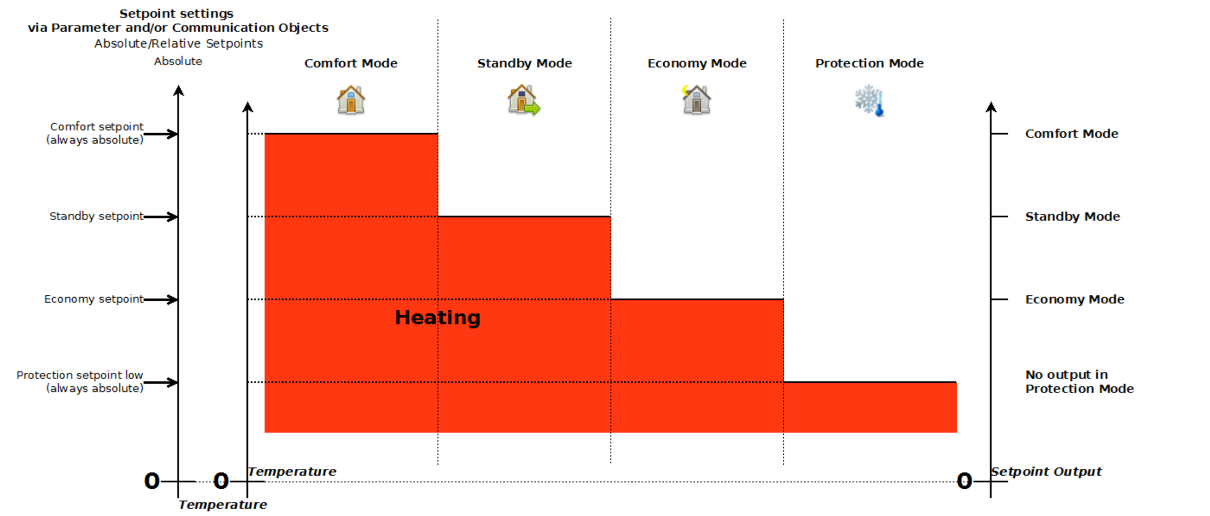
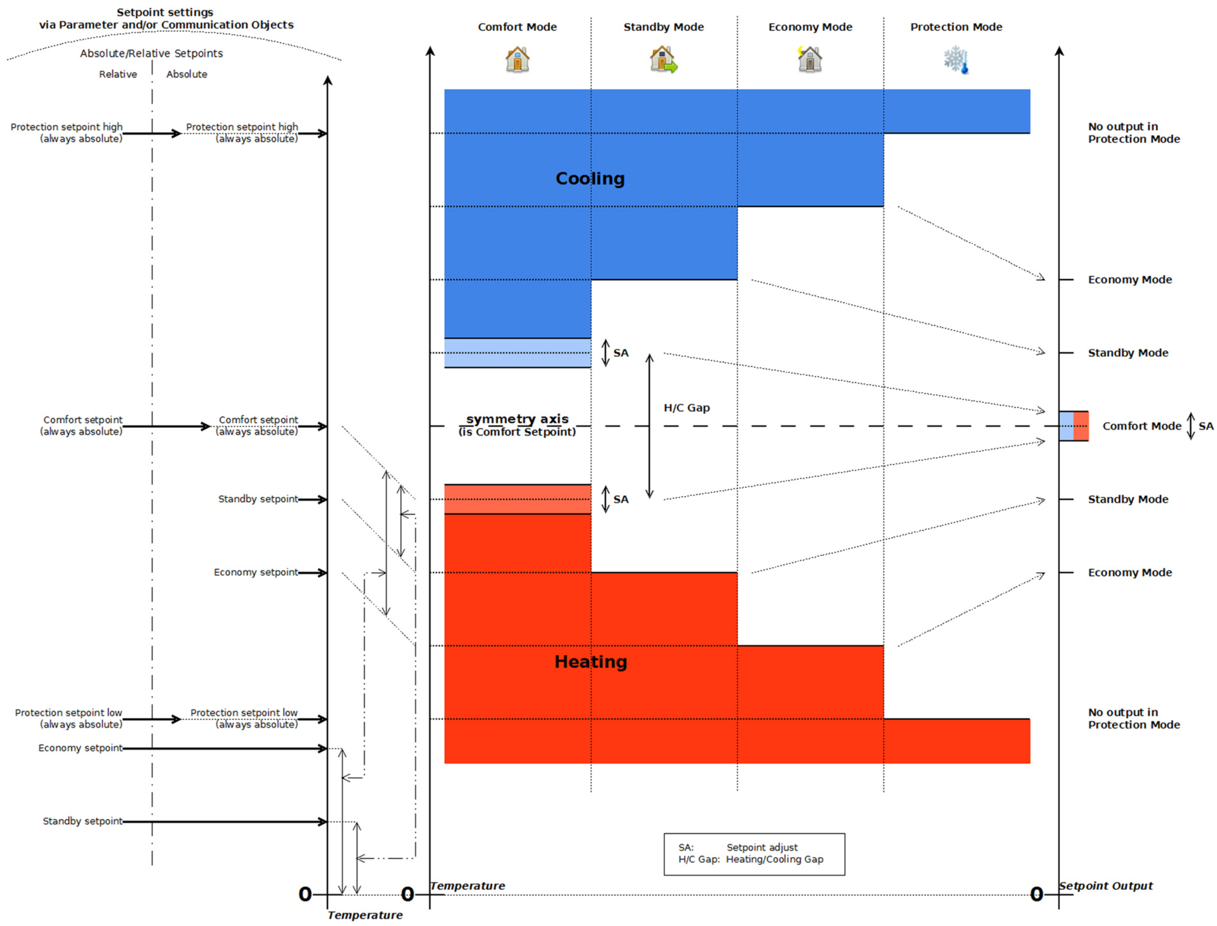


Heating / Cooling Switched Controller Type with Relative Setpoints

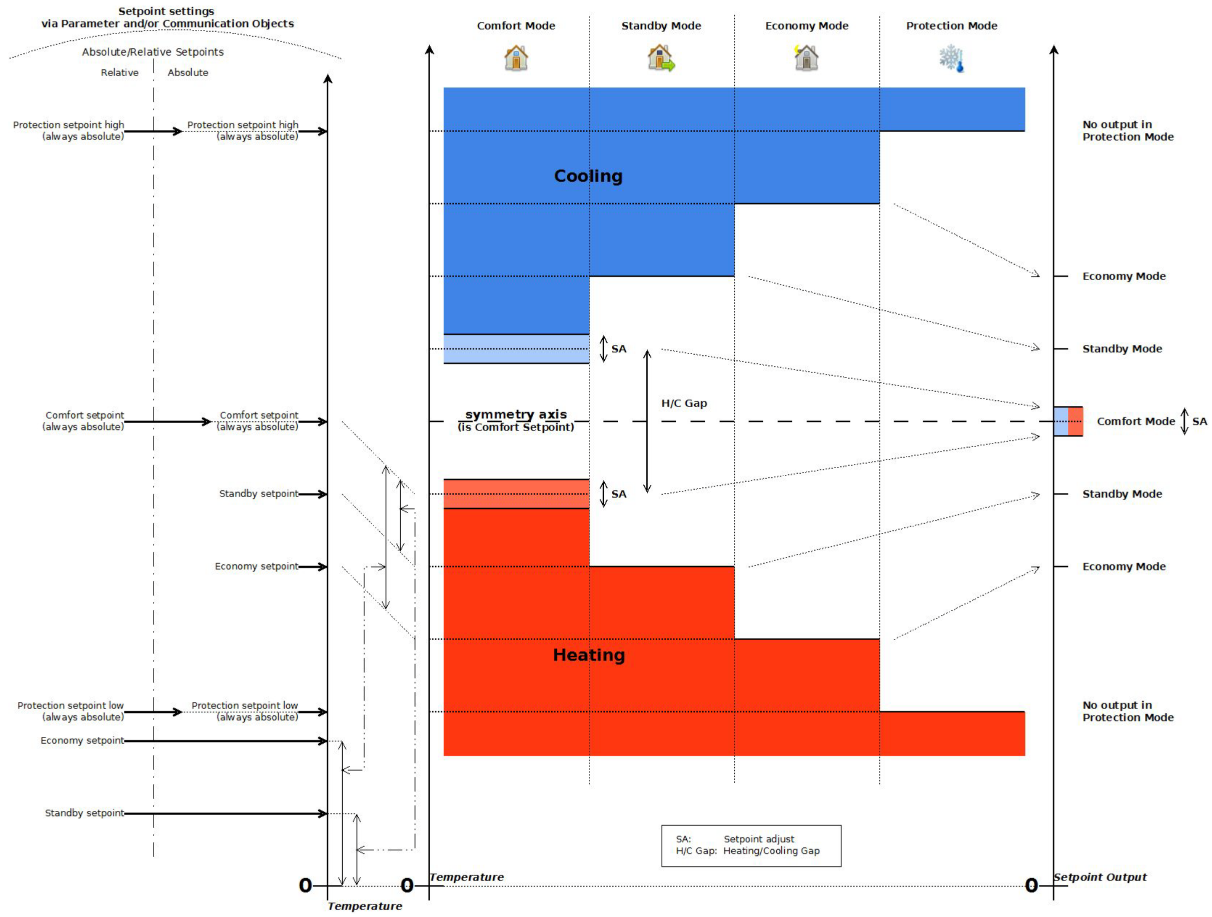
A switched heating / cooling controller with relative setpoints and without setpoint adjustment. As is shown, the set setpoints for economy and stand-by mode are relative to the comfort setpoint. The comfort setpoint, as well as both protection setpoints are always set absolute. The setpoints for cooling mode are calculated by mirroring the setpoints at the comfort setpoint. If the controller is in protection mode, there is no output of the setpoint on the object "Output, Setpoint".



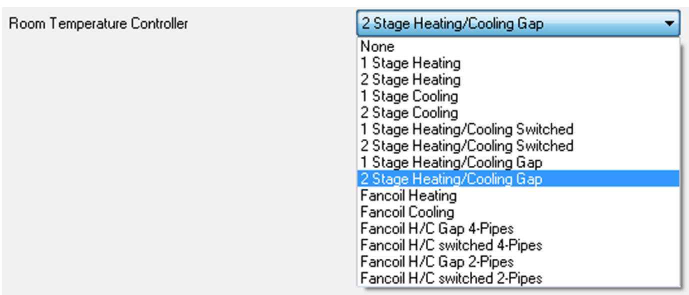
Heating / Cooling with Gap Controller Type, with Relative and Absolute Setpoints and Setpoint Adjustment

This figure shows an overview of a heating / cooling controller type with a heating/cooling gap and setpoint adjustment, as well as the setpoint input interpretation for absolute and relative setpoints and the output of these at the object „Output, Setpoint".

As is shown, the gap causes all setpoints to be pushed apart relative to the comfort setpoint, but the output is still as if there were no gap. The setpoint adjustment is only available in comfort mode and is being output at the object. All relative and absolute setpoints for economy and stand-by are only set for heating. Subsequently, the setpoints for the cooling part are calculated by mirroring the values at the comfort setpoint.



5.1.8 Room Temperature Controllers



There are different selectable controller types with different functionalities. In the following, their different properties will be described. In most cases, a simple 1-stage heating should be sufficient.

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5.1.8.1 Heating vs. Cooling controller

Heating
IIf a heating controller is used or the controller is in heating state (heating / cooling controller), and the actual temperature falls below the current setpoint (corresponding to the actual mode, e.g. stand-by), the controller, if enabled, starts heating, according to the used controller type (e.g. PI-Controllers, selectable in the parameters).

Cooling
Cooling mode works vice versa to the heating mode, so if the temperature rises over the current setpoint, the controller starts cooling.

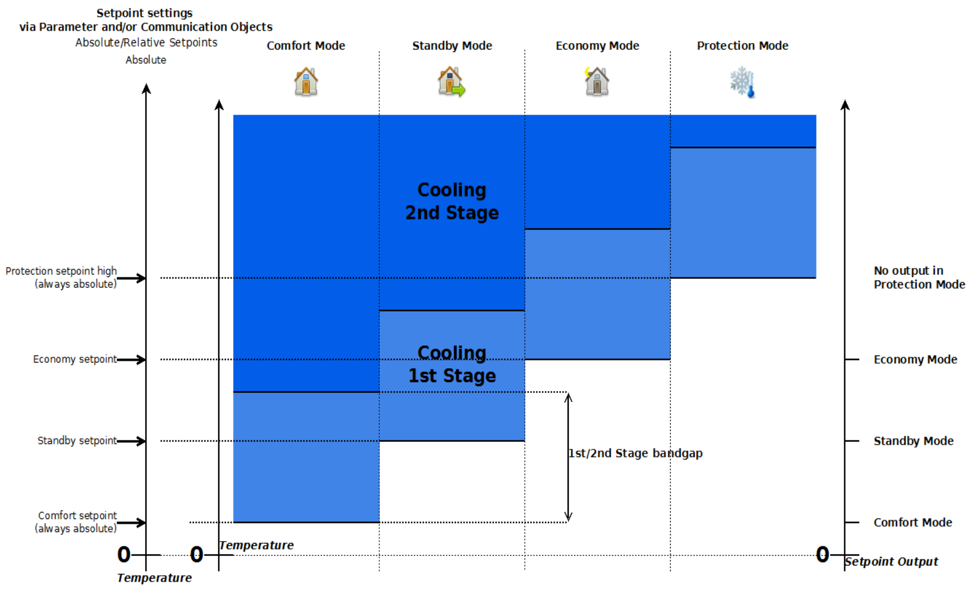
Content

5.1.8.2 One- vs. Two-Stage Controllers

One Stage
One-Stage controllers have only one controller that allows to control the current setpoint.

Two-stage
Two-stage controllers have two controllers, each separately configurable. The first stage controller controls on the current setpoint (depending on mode, setpoint adjustment and heating/cooling gap), the second stage controls the actual setpoint plus / minus the parameter "1st / 2nd Stage Bandgap (Temp. Controller Heating / Cooling), Page 119".

e.g. Comparison: see figure. 2-stage cooling controller in comfort mode, with comfort setpoint at 20 °C, no setpoint adjustment, no heating/cooling gap and parameter "1st / 2nd Stage Bandgap" is 2 °C. If the temperature exceeds 20 °C, the first stage starts to work and tries to reduce the temperature to 20 °C. If the temperature still rises and then exceeds 22 °C (20 °C + 2 °C), the second stage starts working and tries to keep the temperature below 22 °C.



use If there are solar panels used for heating and for cold days and there is also an electrical heater, the solar heater can be connected to the 1st Stage and the electrical one to the 2nd Stage.
Now if the solar heater doesn‘t provide sufficient power, the electrical heater will switch on.

5.1.8.3 Heating / Cooling Switched vs. Gap Controller

Switched
If a switched controller type is selected, the heating or cooling mode needs to be set by the object "Input, Heating / Cooling". So if the controller is in heating mode and the exceeds the comfort setpoint, the controller does not switch automatically into the cooling mode. This must be done by the object.

use Normally the switch signal is calculated from the long term mean value of the outdoor temperature.

Gap
The gap controller types have a gap between heating and cooling mode. If the temperature is within this gap, both controllers are inactive.

e.g. Heating/cooling controller with gap in comfort mode, with setpoint set to 20 °C and heating / cooling gap set to 4 °C. If the temperature is below 18 °C (20 °C - 4 °C / 2), the controller is heating. If the temperature is higher than 18 °C but below 22 °C, the controller is neither heating nor cooling. If the temperature is above 22 °C, the controller is cooling.

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Fancoil

The fancoil controller types allow the control of fan coil units. It is possible to control 2 and 4 pipe units. It allows to control the fan speed via steady output or via three 1-bit objects for three different speeds. The fan can also be controlled by two objects, which allows one to change the fan speed manually for a limited time (Objects "Input, Fan Mode" and "Input, Fan Speed").
Furthermore, there is the possibility to set a Lead and Lag Time (via parameter "Fan Lead-Time [sec] (Controller Page Fan), Page 126" and "Fan Lag-Time [sec] (Controller Page Fan), Page 126") which allows to set a time before the fan starts and how long the fan runs afterwards, even if according to the calculation the fan should already be turned on or off. This makes it possible to e.g. use the remaining heat in the radiator after the controller is shut offf.

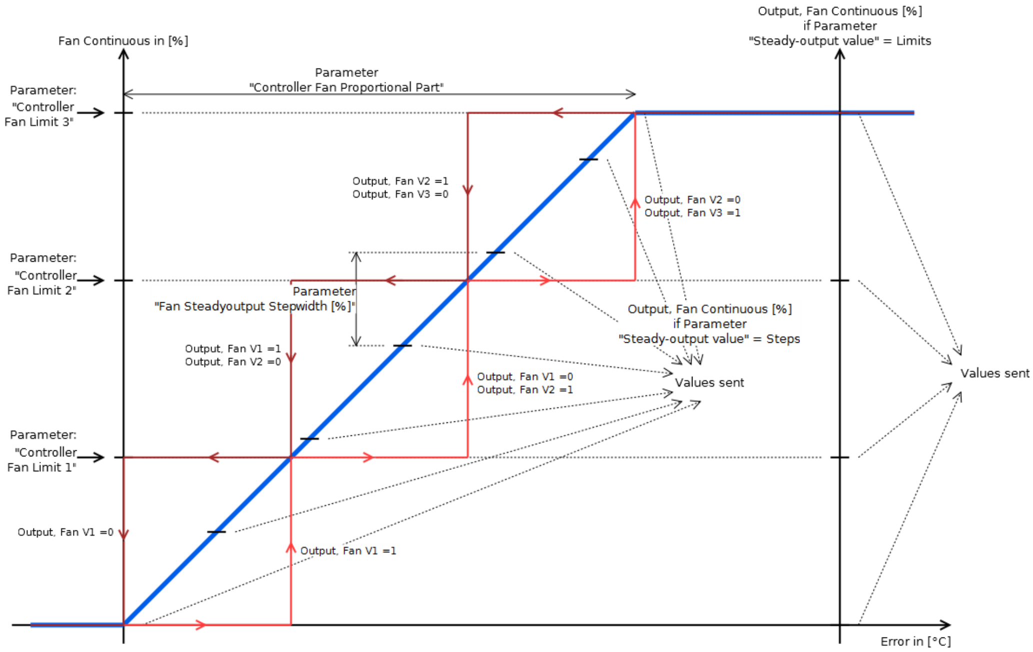
General

Fan output type can be choosen to be scale 0..100% or stage 0 .. 3 on the „Fan"-page
The fan coil controller sets the control-value depending on the actual temperature and the Setpoint as follows: [5]:

$$\text{Fan Continuous}[\%] = \frac{(\text{setpoint} - \text{Temperature})}{\text{Controller Fan Proportional Part}}$$

[For the parameter description see "Controller Fan Proportional Part (Controller Page Fan), Page 121".]

The fan's continuous signal will then be output at the object "Output, Fan Continuous [%]" in a discretized form, as set by the parameter "Steady-Output Stepwidth [%]", the "Controller Fan Limit 1 [%] (Controller Page Fan), Page 120" and, if available, "Fan Steadyoutput Stepwidth [%] (Controller Page Fan), Page 126", as shown in the following figure..



Manual Fan Controll

It is possible to manually control the fan (1-byte Object "Output, Fan Continuous [%]" and the 1-bit Objects "Output, Fan VX"). The objects "Input, Fan Mode" and "Input, Fan Speed" make it possible to set the fan speed for the amount of time set by the parameter "Overwrite Timeout [minutes] (Temp. Controller Settings), Page 127" after which it returns to the actual value given by the controller. That can e.g. be used to switch off the fan manually.

It enables setting the fan speed to zero or one of the three defined limits (parameter "Controller Fan Limit 1 [%] (Controller Page Fan), Page 120]") by setting the object "Input, Fan Speed" to a value between 0 and 3 (see Table).

It is possible to set the fan speed to the actual value selected by the object „Input, Fan Speed" by setting the Object „Input, Fan Mode" to 1. If this object is set to 0, the Fan speed returns to the given controller value. When started, the fan runs for the time set in the parameter „Overwrite Timeout [minutes] (Temp. Controller Settings), Page 127" before it returns to the given value from the controller.
If the object value of "Input, Fan Speed" is changed, the fan automatically starts (only if value is changed) for the set amount of time..

Value „Input, Fan Speed"	**Object „Output, Fan Continuous [%]"**	**Object „Output, Fan ...**		
		V1	**V2**	**V3**
0	0 %	0	0	0

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1	Limit 1	1	0	0
2	Limit 2	0	1	0
3	Limit 3	0	0	1

Content

2 vs. 4-Pipes Fancoil

2 Pipes
2-Pipe Fancoils only have one circuit for both heating and cooling. So there is one valve that controls the flow of the hot / cold media and one that switches between heating and cooling. This controller provides the objects corresponding to the selected type (e.g. PI-Controller) necessary to control a valve for the flow. The object "Output, Heating / Cooling" provides the information whether it is in heating or cooling mode.

4 Pipes
4-Pipe Fancoils have 2 circuits, one for the heating and one for the cooling media. So the Provides two seperate controllers for heating and cooling. This controller provides the objects corresponding to the selected types (e.g. PI-Controller) necessary to control 2 valves for the flow, one for heating, one for cooling. The Object "Output, Heating / Cooling" provides the information whether it is in heating or cooling mode.

Switched vs. gap Fancoil Controller
If a switched room controller type is selected, it is necessary to switch between heating and cooling mode by changing the object "Input, Heating/Cooling". If a gap is selected, a temperature difference needs to be defined (parameter "Heating / Cooling Bandgap (Temp. Controller Settings), Page 126"), so that in the gap around the comfort setpoint all controllers are inactive.

If a fancoil is used for heating and cooling (especially if a 2-Pipe fancoil is used), and if the parameters are set accordingly, there is the possibility that e.g. the heating valve opens immediately after the cooling valve is closed, so that the hot heating fluid floods the cold system, which may be unwanted. To prevent this, use the parameter
„Heating / Cooling Changeover Deadtime (Temp. Controller Settings), Page 126“.

5.1.8.4 Controller Output Objects
The prefixes such as:

- -Output, Heating/Cooling,
- -Output, Cooling 1st Stage,
- -Output, Cooling 2nd Stage,
- -Output, Cooling,
- -Output, Heating 1st Stage,
- -Output, Heating 2nd Stage,
- -Output, Heating,

correspond to the available controllers, which depend on the selected room temperature controller (Parameter "RTC Parameter, Page 119“).

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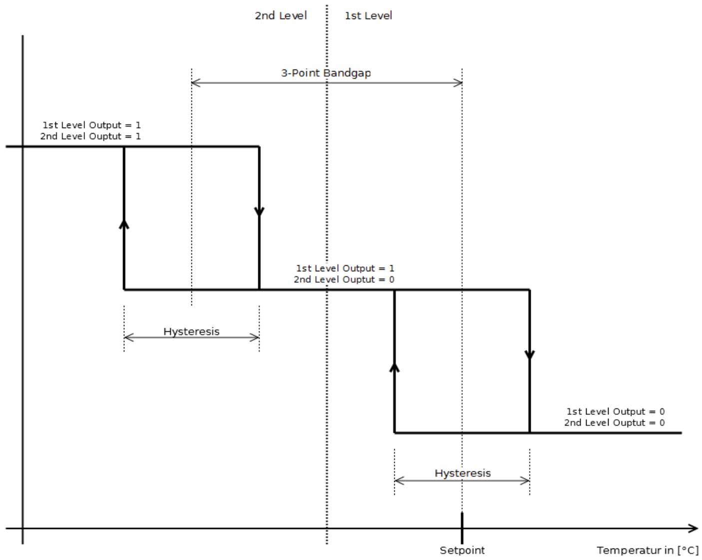
1st Level Switch

This one comes with the 3-point controller and is one of the two 1-bit outputs of this controller. The following figure shows the output values for a simple 3-point heating controller.



2nd Level Switch

See 1st level switch

PWM Output

This one comes with the PI-Controller with PWM. It is a 1-bit object with an PWM signal, its duty cycle is controlled corresponding to the PI-Controller output.

Steady Output

This one comes with the PI-Controller. It is a 1-byte object holding the control variable of the PI-Controller.

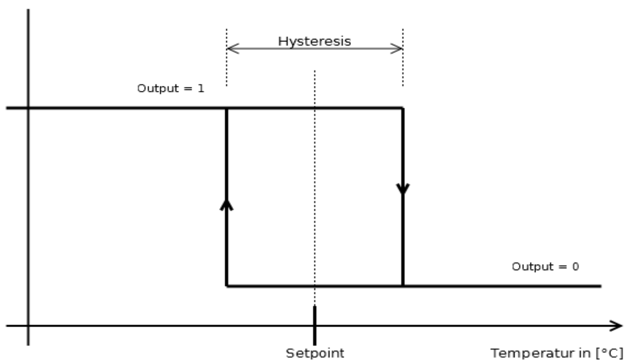
Allows to control a steady valve with a PI-Controller.

Steady Output Non-Zero

This one comes with the PI-Controller. It is a 1-bit object which only determines if the steady output is not zero.
!USE Can be used to indicate that the heater/cooler is active.

Switch

This one comes with the 2-point controller. It is a 1-bit value and outputs a simple switching signal, corresponding to the figure that shows the output values for a simple 2-point heating controller.



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5.2 RTC Parameter

5.2.1 1st / 2nd Stage Bandgap (Temp. Controller Heating / Cooling)

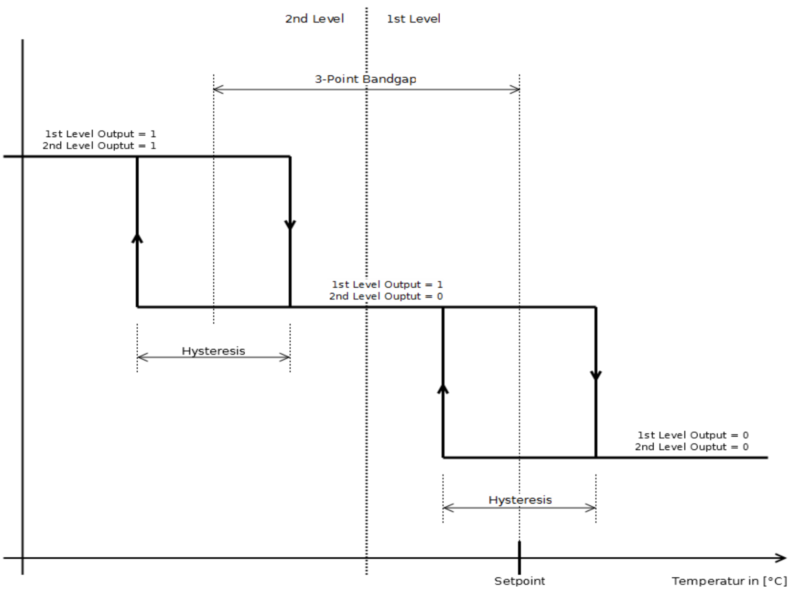
See article "Heating vs. Cooling controller, Page 115".
The gap in °C between the first and the second controller stage.

e.g A two-stage heating controller is selected, the actual setpoint to be regulated is 20 °C and the parameter "1st / 2nd Stage Bandgap" is set to 5 °C. The temperature falls below 20 °C. Now the first controller tries to heat. If the temperature should fall below 15 °C, the second controller will also start to heat.

use If e.g. there are solar panels installed for heating, this heat source can be connected to the first stage. Only if the temperature keeps on falling, the electrical heater is activated via the second stage.

5.2.2 3-Point Bandgap (Temp. Controller Heating / Cooling)

See also section „3-Point Controller, Page 123“.
This sets the bandgap between the two 2-point controllers of the 3-point controller.
See figure.



5.2.3 Absolute / Relative Setpoints (Temp. Controller Settings)

This affects all parameters and objects that have an effect upon the different setpoints (Comfort setpoint is not affected because it is always absolute).
See also article "Setpoint handling, Page 112".

5.2.3.1 Relative

The settings for economy and stand-by setpoints are interpreted relative to the comfort setpoint. To get[1] the setpoint in cooling mode, the relative economy and stand-by setpoints are added to the comfort setpoint. Vice versa, in heating mode they are subtracted.

5.2.3.2 Absolute

The settings for economy and stand-by setpoints are interpreted as absolute values. If a controller with heating and cooling functionality is selected, the economy and stand-by setpoints are set for the heating part. For the cooling controllers, the setpoints are mirrored at the comfort setpoint.

e.g Controller with heating and cooling and absolute setpoints. Comfort setpoint is 20 °C, economy setpoint is 15 °C, so that in heating mode the economy setpoint is 15 °C and in cooling it is 25 °C (20 °C + (20 °C - 15 °C)).

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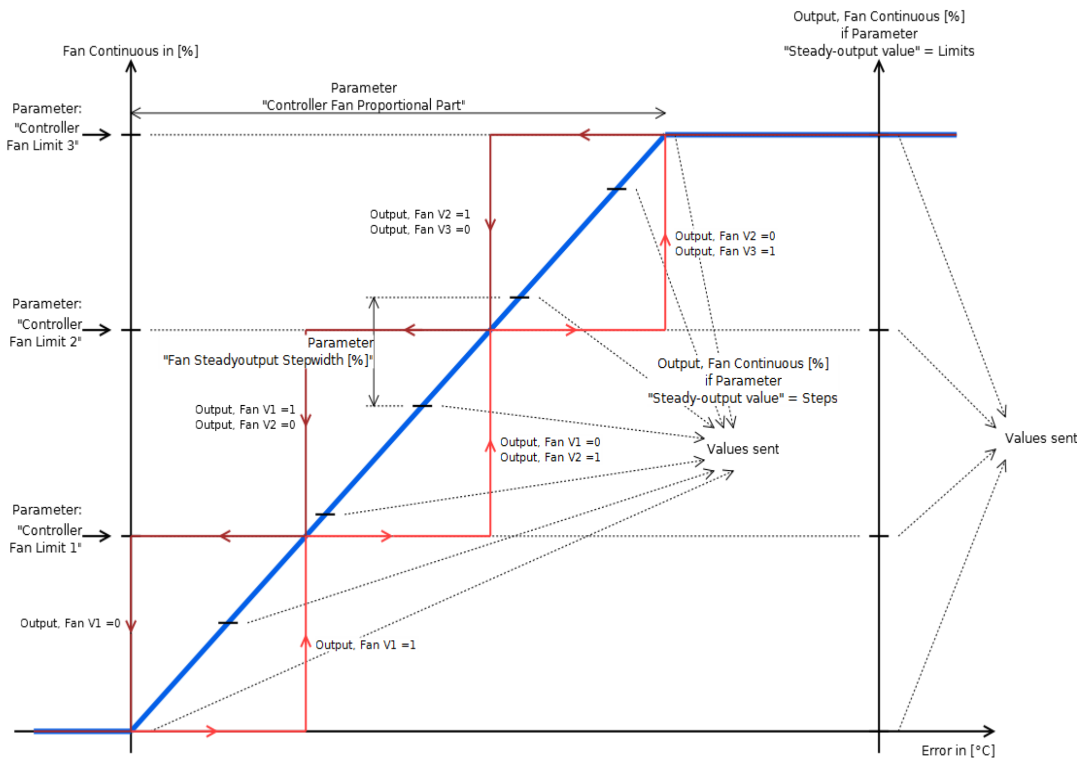
5.2.4 Comfort Setpoint Temperature (Absolute) (Temp. Controller Settings)

See also article "Setpoint handling, Page 112".
The comfort setpoint is always set as an absolute temperature. It is used as mirror point for the economy and stand-by setpoints.

5.2.5 Controller Fan Limit 1 [%] (Controller Page Fan)

See also article "Fancoil, Page 116".



This is used as an input for the calculation of the "Output, Fan VX" 1-bit objects, with the internal steady value of the object "Output, Fan Continuous [%]" as reference value. This is formed according to the error (Setpoint - Temperature) and in dependency of the parameter "Controller Fan Proportional Part (Controller Page Fan), Page 121". The formula for the steady value is {Error * (100% / parameter "Controller Fan Proportional Part")}.

At any time, only one object "Output, Fan VX" can be active. It is not possible that two or more are active at the same time.

If the continuous value exceeds[2] a limit, the corresponding object "Output, Fan VX" is set to 1 if the continuous value falls below the limit the output object remains 1 until the continuous value falls below the next smaller limit or 0.

e.g. Parameter "Controller Fan Limit 1 [%]" is 30%. The steady value is 0, and so is the object "Output, Fan V1". If the steady value exceeds the 30 % threshold, the object is set to 1. If the steady value then falls below the 30 % threshold, the Fan V1 output remains at 1 until the value falls below 0.

If the parameter "Steady-output value" (Controller Page Fan) is set to limits, the "Controller Fan Limits X [%]" limits are also used as discretization steps for the object "Output, Fan Contiuous [%]". See parameter "Steady-Output Value (Controller Page Fan), Page 129".

These limits are also used for the objects "Input, Fan Mode [217], Page 136" and "Input, Fan Speed [218], Page 137".

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5.2.6 Controller Fan Limit 2 [%] (Controller Page Fan)

See Parameter "Controller Fan Limit 1 [%] (Controller Page Fan), Page 120".

5.2.7 Controller Fan Limit 3 [%] (Controller Page Fan)

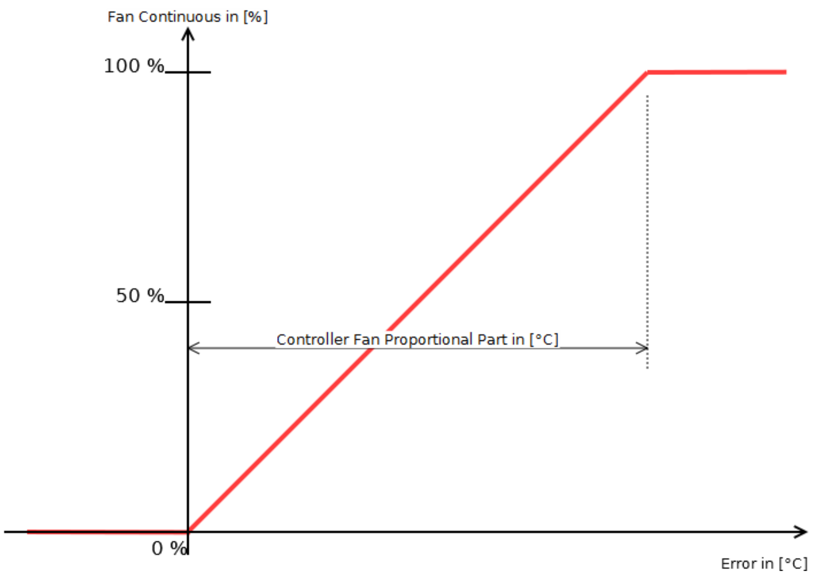
See Parameter "Controller Fan Limit 1 [%] (Controller Page Fan), Page 120".

5.2.8 Controller Fan Proportional Part (Controller Page Fan)

See also article "Fancoil, Page 116".

This sets the proportional part for the calculation of the object "Output, Fan Continuous [%]" (see equation).
Together with the parameters "Controller Fan Limit X [%]", it serves as an input for the calculation for the output values of the objects "Output, Fan VX".

$$\text{Fan Continuous} = \text{Controller Fan Proportional Part} \cdot (\text{setpoint} - \text{Temperature})$$



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5.2.9 Controller Proportional Band Style (Temp. Controller Settings)

Affects all PI-controllers and PI-controllers with PWM. This setting describes how the "Proportional Part" of the PI-controller is interpreted (see figure , Page 122).

Fancoil is not affected.

5.2.9.1 Symmetric to Setpoint

Use this if you only have a P-Controller (I=0)
This controller can be used with advantage in proper designed systems which preregulate the inlet temperature. Then this controller has better response times and lead to less distortion when changing the setpoints. It has disadvantages when using heating+cooling designs, because the bands may overlap.)

At an error of 0, the control variable is 50 %, and within the PB, the control variable is linear to the error and else 0 % or 100 %.
Equation for controller variable:

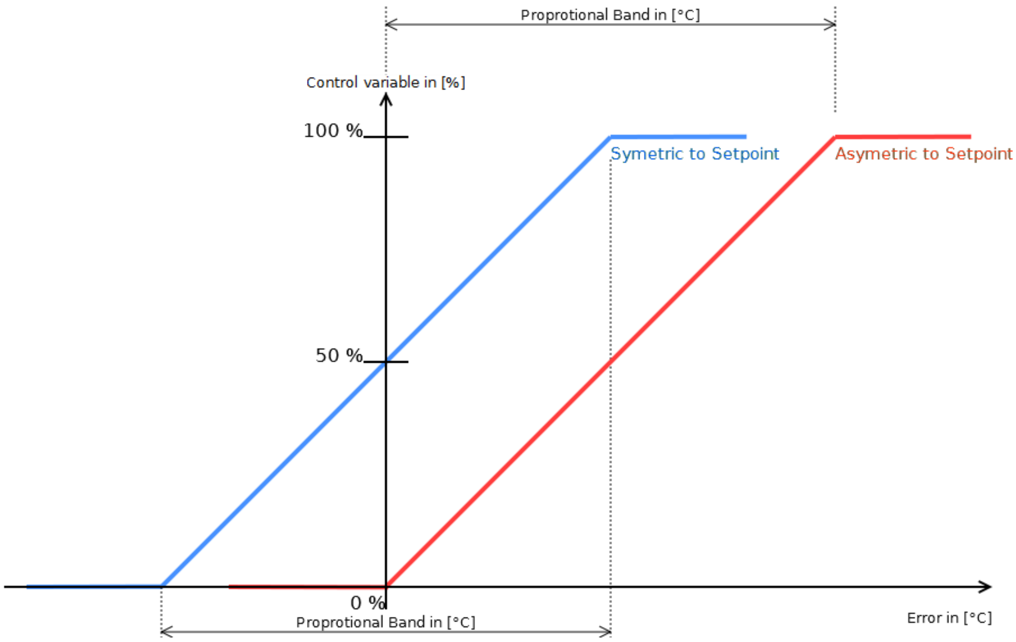
$$\text{Control variable} = K_p \cdot Error(t) + K_i \cdot \int_0^t Error(\tau)d\tau + 50\%$$

(for Kp and Ki see parameter „Controller Type (Temp. Controller Heating / Cooling), Page 123“)

5.2.9.2 Asymmetric to Setpoint

Use this if in doubt.
If the error is 0, the control variable is also 0%, and if the error equals the parameter "Proportional Band", the control variable is 100%. Between these two points, it increases linearly.
Equation for controller variable:

$$\text{Control variable} = K_p \cdot Error(t) + K_i \cdot \int_0^t Error(\tau)d\tau$$



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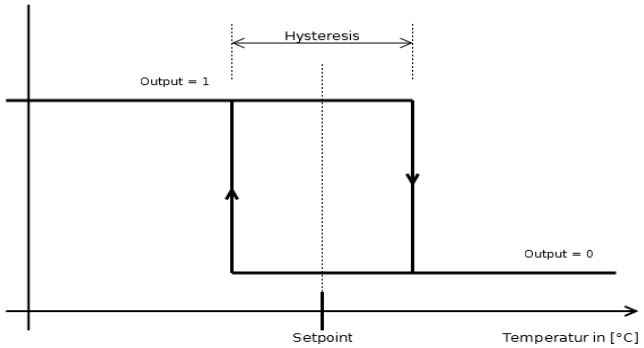
5.2.10 Controller Type (Temp. Controller Heating / Cooling)

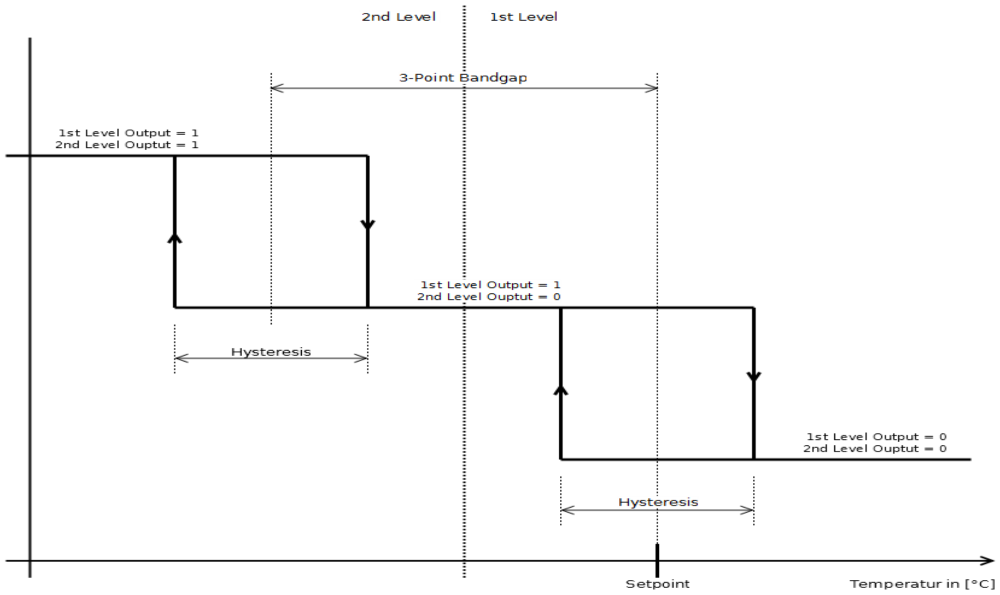
See also article "Controller Output Objects, Page 117".

5.2.10.1 2-Point Controller



The figure shows a 2-point-controller heating. The hysteresis is set by the parameter "Hysteresis" (Temp. Controller Heating / Cooling) and the setpoint is at half the hysteresis value. For cooling mode, the figure can be viewed mirror-inverted at the setpoint.

5.2.10.2 3-Point Controller



The figure shows a simple 3-point-controller heating. The setpoint in the 1st level is at half the hysteresis value. The hysteresis for both levels is the same and set by the parameter "Hysteresis" (Temp. Controller Heating / Cooling). The gap between the two levels is set by the 3-point bandgap. For cooling mode, the figure can be viewed mirror-inverted at the setpoint.

There are two 1-bit objects "... 1st Level Switch" and "... 2nd Level Switch". Both outputs correspond to the two levels in the figure.

5.2.10.3 PI-Controller

Affected by the parameter "Controller Proportional Band Style (Temp. Controller Settings), Page 122". The following description refers to the setting "Asymmetric to Setpoint".

For a more complete overview of how to set up a PI-controller see the article "PI-Controller Set Up, Page 111".

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The equation for the control variable, which is a 1-byte object [0..100%], is shown in the box below. For the variable „proportional band“ see parameter "Proportional Band (Temp. Controller Heating / Cooling), Page 127“, for the variable „Integration Time“ see parameter "Integration Time [minutes] (Temp. Controller Heating / Cooling), Page 126".
The error variable is setpoint minus temperature.

$$\text{Control variable} = K_p \cdot Error(t) + K_i \cdot \int_0^t Error(\tau)d\tau$$

$$K_p = \frac{100}{\text{Proportional band}}$$

$$K_i = \frac{100}{\text{Proportional band} \cdot \text{Integration time} \cdot 60}$$

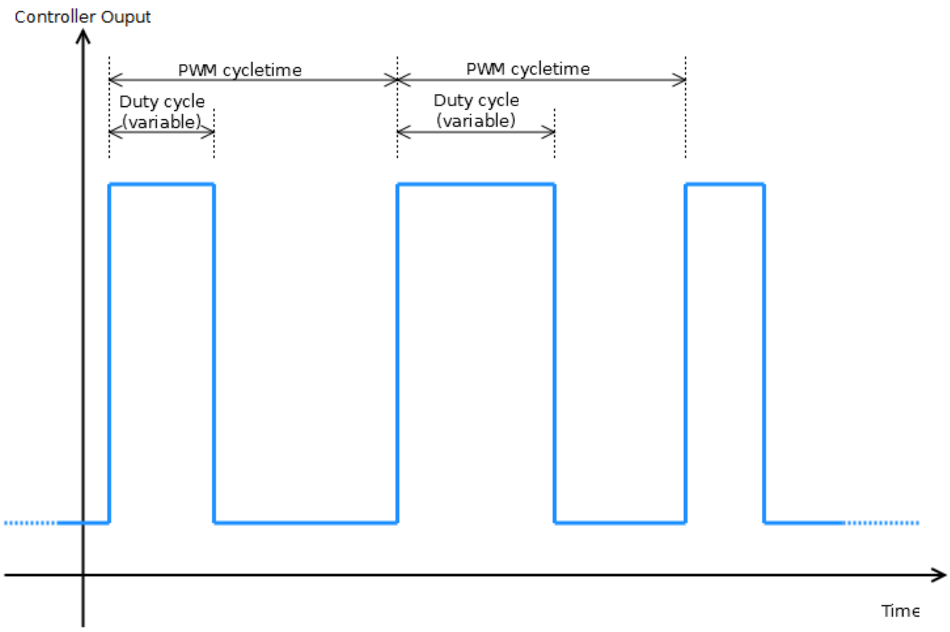
There is also a 1-bit object „... Steady Output non-zero“ output.

5.2.10.4 PI-Controller with PWM

Affected by the parameter "Controller Proportional Band Style (Temp. Controller Settings), Page 122“.

The internal function is the same here as in the PI-controller above. The parameter "PWM Cycletime [seconds] (*10) (Temp. Controller Heating / Cooling), Page 128“ sets the time for the cycle and for the duty cycle according to the control variable (see Picture).

There is a steady 1-byte and a 1-bit PWM output.



5.2.11 Economy Setpoint Temperature (Absolute) (Temp. Controller Settings)

See also article „Setpoint handling, Page 112“.
The economy setpoint for a heating or cooling controller is set as absolute temperature value.

5.2.12 Economy Setpoint Temperature (Heating, Absolute) (Temp. Controller Settings)

See also article „Setpoint handling, Page 112“.

The economy setpoint for a combined heating/cooling controller is set as absolute temperature value for the heating controller part. For the economy setpoint of the cooling controller part, the value set here is mirrored at the comfort setpoint.

(calculation: EconomySetpointCooling = ComfortSetpoint + (ComfortSetpoint - EconomySetpoint)).

5.2.13 Economy Setpoint Temperature Decrease (Temp. Controller Settings)

See also articel „Setpoint handling, Page 112“.
Economy setpoint for an Heating Controller, set as temperature difference to the Comfort Setpoint (relative).

5.2.14 Economy Setpoint Temperature Increase (Temp. Controller Settings)

See also article „Setpoint handling, Page 112“.

The economy setpoint for a cooling controller is set as temperature difference to the comfort setpoint (relative).

5.2.15 Economy Setpoint Temperature De- / Increase (Temp. Controller Settings)

See also article „Setpoint handling, Page 112“.

The economy setpoint for a heating / cooling controller is set as temperature difference to the comfort setpoint (relative).

5.2.16 External Temperature Weight [%] (Temp. Controller Settings)

Defines the weight of the external temperature (object "Input, Actual Temperature") in relation to the temperature measured by the sensor that is directly connected to the device.

The temperature. For the calculation see equation..

$$\text{Temperature} = \begin{array}{l} \text{ExternalTemperature [°C]} \cdot \text{ExternalTemperature weight [\%]} \quad + \\ \text{InternalTemperature [°C]} \cdot (100\ \% - \text{ExternalTemperature weight [\%]}) \end{array}$$

The calculated temperature is displayed at the object "Output, actual Temperature" and is used as a reference for all operations of all controllers and is the displayed actual temperature if used.

e.g. No sensor directly connected to the device, only the temperature from the object "Input, External Temperature" shall be used. Set the parameter "External Temperature weight" to 100. With this setting, the external temperature will be used and the other temperature input will be ignored.

e.g. The parameter "External Temperature weight" is set to 50, the external temperature reading is 21 °C and the internal is 22 °C. With this setting, the internal temperature will be calculated to 21.5 °C and also sent to the object "Output, Actual Temperature".

! If no sensor is directly connected to the device, the external temperature weight must be 100%.

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5.2.17 Fan Lag-Time [sec] (Controller Page Fan)

See also article "Fancoil, Page 116".

The timer starts after the internal Continuous Fan Value[3] returns to zero. Until the time set with this parameter is elapsed, the object "Output, Fan V1" remains on 1 and the object "Output, Fan continuous [%]" remains on the value set at parameter "Controller Fan Limit 1 [%]" (Controller Page Fan), although both should already be zero.

use If the valve for the heating/cooling fluid is closed, there is still some fluid left in the radiator. With this setting it is possible to use this rest more efficiently.

5.2.18 Fan Lead-Time [sec] (Controller Page Fan)

The timer starts after the Continuous Fan Value[4] becomes other than zero. The objects "Output, Fan VX" and "Output, Fan Continuous [%]" remain on 0 until the time has elapsed, although both should already have values.

use When the valve for the heating/cooling fluid is opened, it takes some time until the fluid arrives at the radiator. With this setting it is possible to save the energy for the fan in that time

5.2.19 Fan Steadyoutput Stepwidth [%] (Controller Page Fan)

Defines how big the change of the object "Output, Fan Continues [%]" has to be before it is sent to the bus.

5.2.20 Heating / Cooling Bandgap (Temp. Controller Settings)

More also article "Setpoint handling, Page 112".

Defines the gap between heating and cooling mode in °C.

e.g. If the temperature rises above the comfort setpoint minus heating / cooling gap, half the heating controller will be switched off. If the temperature then rises above the comfort setpoint plus heating / cooling gap, half the cooling controller will be switched on, using comfort setpoint plus heating / cooling gap half as setpoint to regulate upon. In the area between these two points, both controllers are inactive.

5.2.21 Heating / Cooling Changeover Deadtime (Temp. Controller Settings)

Time until the switch between heating and cooling controller occurs.

e.g. After the temperature has risen above the comfort setpoint, the heating controller will be switched off, and the timer starts. When the timer has elapsed, the cooling controller starts if the temperature is still above the comfort setpoint.

use Can prevent fluctuations of fast switching between heating and cooling mode.

5.2.22 Hysteresis (Temp. Controller Heating / Cooling)

See also parameter "Controller Type (Temp. Controller Heating / Cooling), Page 123".
Defines the hysteresis in °C for the 2-point and the 3-point controller.

5.2.23 Integration Time [minutes] (Temp. Controller Heating / Cooling)

See also parameter "Controller Type (Temp. Controller Heating / Cooling), Page 123" and article "PI-Controller Set Up, Page 111".
Defines the integration time for the PI and PI-controller with PWM.

! If this value is set to 0, the PI-controller becomes an simple P-controller.

! There is always the possibility that a PI-controller oscillates if the wrong or poor parameters are used.

In general, a shorter integration time means a quicker adjustment to the setpoint but a higher risk of continual oscillation. Vice versa, a longer integration time means a slower adjustment to the setpoint but an lower risk of continual oscillation.

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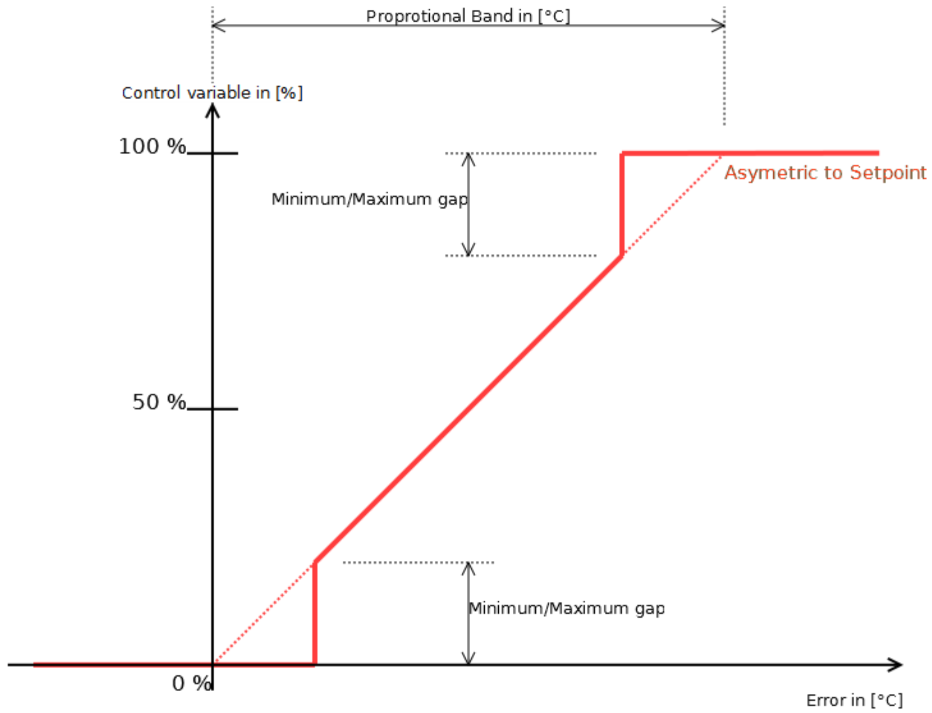
5.2.24 Minimum / Maximum Gap [%] (Temp. Controller Heating / Cooling)

If the control variable rises above (100% - Minimum/maximum gap) or below the minimum / maximum gap, the control variable is directly set to 100% or 0%, see figure.

Some steady valves have problems in there marginal areas. With this, it is possible to "jump" over these areas.



5.2.25 Output Send On Change Off (Temp. Controller Heating / Cooling)

This affects the corresponding Steady PI-Controller Outputs and determines after which change the value is sent again.

5.2.26 Outputs Sending Cycle [minutes] (Temp. Controller Settings)

This affects the output of the object "Output, actual Temperature" and determines, in which time interval the temperature is sent. If 0, the value will not be sent cyclically.

5.2.27 Overwrite Timeout [minutes] (Temp. Controller Settings)

This determines how long it takes to return to the last mode before the object "Input, Set Comfort Mode (overwrite)" was used and how long it takes to return to the default comfort setpoint after a setpoint adjustment via object "Input, Setpoint Adjust" was carried out. This timeout is also used for the fancoil object "Input, Fan Mode" and "Input, Fan Speed". See the object descriptions for further information.

e.g. If the controller is in stand-by mode and the comfort overwrite mode is activated via the object "Input, Set Comfort Mode (overwrite)", the controller changes into comfort mode and starts to regulate the corresponding comfort setpoint. The timer with the set timeout starts. If the mode is not changed otherwise (e.g. by higher prioritized mode selectors like object "Input, Set Protection Mode") and the timer elapses, the controller returns to stand-by mode.

5.2.28 Proportional Band (Temp. Controller Heating / Cooling)

See also parameter "Controller Type (Temp. Controller Heating / Cooling), Page 123" and article "PI-Controller Set Up, Page 111".
Defines the proportional band for the PI and PI-controller with PWM.

There is always the possibility that a PI-controller oscillates if the wrong or poor parameters are used.

In general, a smaller proportional band means an quicker adjustment to the setpoint, but more fluctuations. Vice versa, a bigger proportional band means a slower adjustment to the setpoint and smaller or no fluctuations.

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5.2.29 Protection Setpoint Temperature High (Absolute) [°C] (Temp. Controller Settings)

See also article "Setpoint handling, Page 112".

Protection setpoint for cooling controller. This one is always set absolute in °C. If the controller is in protection mode, there is no setpoint output on the object "Output, Setpoint".

5.2.30 Protection Setpoint Temperature Low (Absolute) [°C] (Temp. Controller Settings)

See also article "Setpoint handling, Page 112".

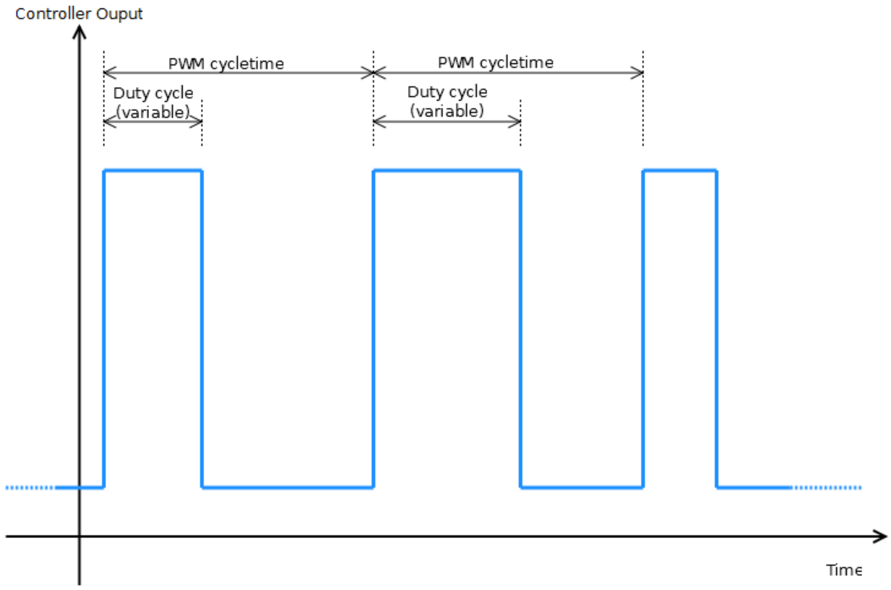
Protection setpoint for heating controller. This one is always set absolute in °C. If the controller is in protection mode, there is no setpoint output on the object "Output, Setpoint".

5.2.31 PWM Cycletime [seconds] (*10) (Temp. Controller Heating / Cooling)

See also parameter "Controller Type (Temp. Controller Heating / Cooling), Page 123" and article "PI-Controller Set Up, Page 111".

A low PWM cycle time also means more switching cycles for the valves or relays. Not all are designed for that.

Defines how long one PWM cycle takes. See figure.
In general, a shorter cycle time means a faster response and less temperature fluctuation but also more stress for the valve or relay. Vice versa, a longer cycle time means a slower response and more temperature fluctuations, but also less stress for the valve or relay. This strongly depends on the used heating and/or cooling system.
.



5.2.32 Room Temperature Controller (Main)

Determines the general used controller structure, e.g. how many unique controllers there are, if fancoil is available, if it is a one- or two-stage controller, heating and/or cooling, etc. The major differences of the available entrys are described in the article "Room Temperature Controllers, Page 114".

5.2.33 Setpoint Adjustment Range (Temp. Controller Settings)

The comfort setpoint can be adjusted temporally in the range set by this parameter. The setpoint changes at least for the time set in parameter "Overwrite Timeout [minutes] (Temp. Controller Settings), Page 127" or until the mode is changed otherwise (e.g. to stand-by).

The object "Input, Setpoint Adjust" is a 1-byte object which is interpreted according to the set range as follows:

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Selection "+0 °C .. +3 °C" and "+0 °C .. +5 °C"
as 1 byte unsigned in which 0 corresponds to +0 °C and 255 to +3 °C or +5 °C.

Selection "-3 °C .. +3 °C" and "-5 °C .. +5 °C"
as 1 byte signed in which 0 corresponds to +0 °C, 127 to +3 °C or +5 °C and -128 to -3 °C or -5 °C.

Selection "-3 °C .. +0 °C" and "-5 °C .. +0 °C"
as 1 byte unsigned in which 0 corresponds to +0 °C and 255 to -3 °C or -5 °C.

5.2.34 Stand-by Setpoint Temperature (Absolute) (Temp. Controller Settings)

See also article "Setpoint handling, Page 112".

Stand-by setpoint for a heating or cooling controller, set as absolute temperature value.

5.2.35 Stand-By Setpoint Temperature (Heating, Absolute) (Temp. Controller Settings)

See also article "Setpoint handling, Page 112".

Stand-by setpoint for a combined heating/cooling controller, set as absolute temperature value for the heating controller part. For the stand-by setpoint of the cooling controller part, the value set here is mirrored at the comfort setpoint .
(calculation: Stand-bySetpointCooling = ComfortSetpoint + (ComfortSetpoint - Stand-bySetpoint)).

5.2.36 Stand-by Setpoint Temperature De- / Increase (Temp. Controller Settings)

See also article "Setpoint handling, Page 112".
Economy setpoint for a heating/cooling controller, set as temperature difference to the comfort setpoint (relative).

5.2.37 Stand-By Setpoint Temperature Decrease (Temp. Controller Settings)

See also article "Setpoint handling, Page 112".

Stand-by setpoint for heating controller, set as temperature difference to the comfort setpoint (relative).

5.2.38 Standby Setpoint Temperature Increase (Temp. Controller Settings)

See also article "Setpoint handling, Page 112".

Stand-by setpoint for cooling controller, set as temperature difference to the comfort setpoint (relative).

5.2.39 Steady-Output Value (Controller Page Fan)

Determines in which intervals the output on the object "Output, Fan Continuous [%]" is sent. See figure below.

5.2.39.1 Steps

If this is selected, the parameter option "Fan Steadyoutput Stepwidth [%]" (Controller Page Fan) is enabled. Now this new parameter allows to set a stepwidth, which defines how much the object "Output, Fan Continuous [%]" has to change until it is sent again.

5.2.39.2 Limits

The output is only sent if the value passes the corresponding limit of the limits set by the parameters "Controller Fan Limit X [%]" (Controller Page Fan).

e.g. Fan limit 1 is 25 %. If the value exceeds this limit, the value 25 % is sent to the object "Output, Fan Continuous [%]". If the value falls below this limit, it remains to be 25 %. If the value reaches 0% (in other cases the next lower limit), the object is updated to 0%.

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