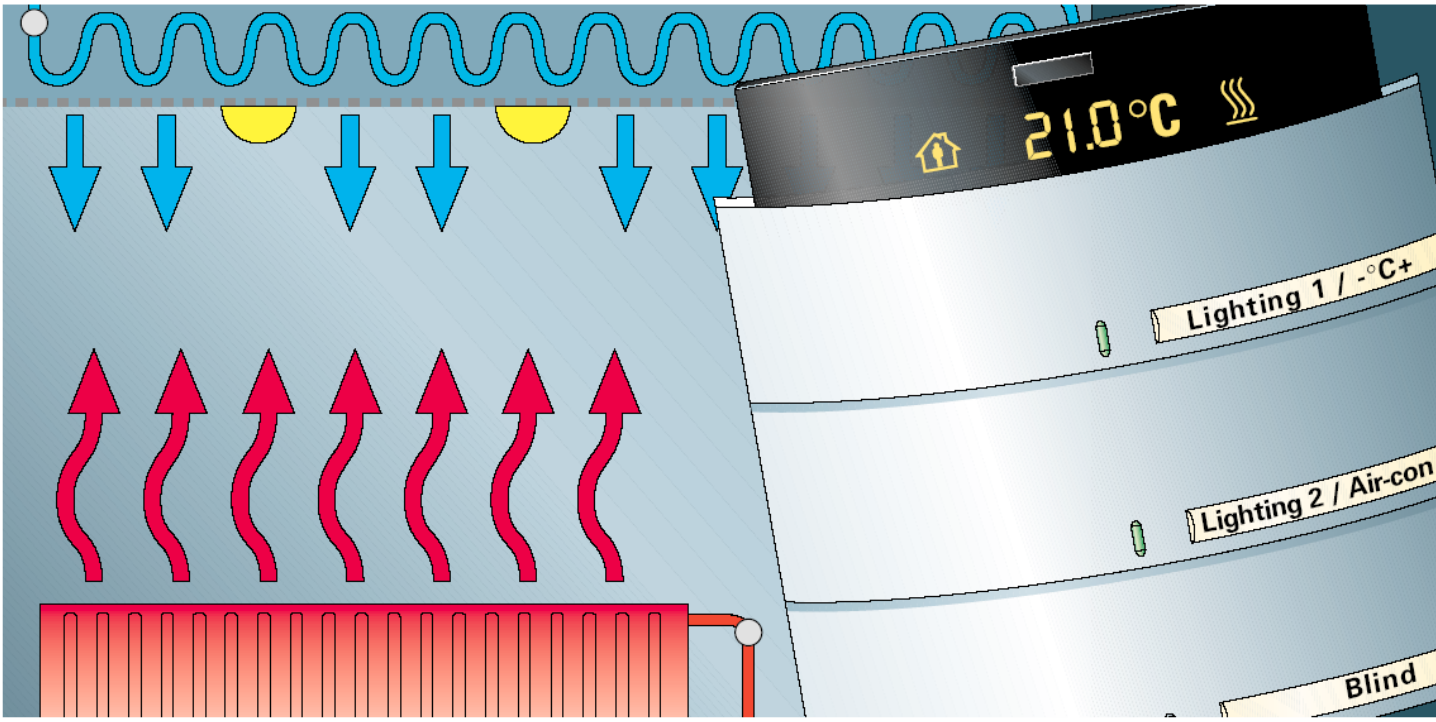
ABB i-bus® EIB / KNX



Heating, Air-conditioning and Ventilation Control with EIB.

Contents

Introduction

The right room temperature contributes decisively towards our feeling of well-being in all situations. Needs differ greatly in this respect, depending on where one lives and how one personally reacts to temperatures. While room temperatures of 16°C to 18°C suffice for the kitchen and bedroom, we like to have a cosy temperature of 21°C in the living room and, perhaps, even 22°C in the bathroom.

A feeling of well-being, both in private life and in the work environment, is extremely important for us as human beings. Consequently, thermal comfort is also very important as far as the health and well-being of people is concerned, because they spend 95% of their time in buildings.

But the need for comfort and cosiness does not cease when we leave our own "four walls". All the other indoor areas where we spend time (shopping centres, restaurants, sports centres, offices, ...), as different as they are from one another, should also have an appropriate temperature.

A person feels uncomfortable when the body's temperature-regulating system (the skin) is subject to stress, e.g., as a result of too low or too high air and wall temperatures, strong air movements, too low or too high humidity and to light or too heavy clothing. In these cases, concentrations of heat, or heat losses occur in the body. A person feels comfortable when the air temperature, air movement, humidity and wall temperatures are in a balanced ratio to their activity and clothing. Comfortableness and well-being are also favourably influenced by the cleanliness of the air and a low noise level in the room.

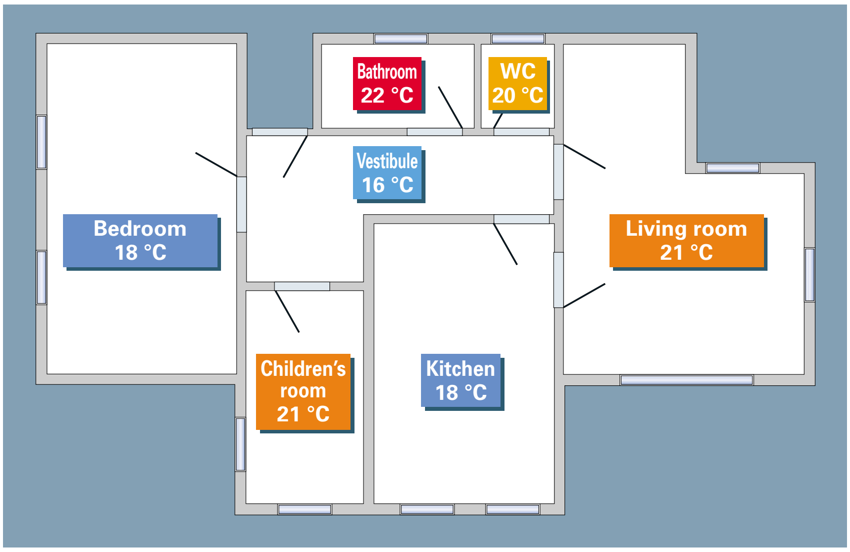
With an increasing demand for comfort and a reduction in energy consumption, environmental consciousness becomes more and more a part of our lives. In private households in Germany, approx. 70% of the energy consumed is for heating and hot water. Calculated on the basis of the energy consumption in the country as a whole, 30% of the total energy is consumed for heating and hot water alone. The objective when planning any heating/air-conditioning system is to achieve the desired level of comfort and cosiness while saving as much energy as possible. This is of benefit to the environment, our purse and our well-being.

In the following, it will be shown how an individual room temperature control system can be planned and installed without difficulty.

Individual Room Temperature Control

Apart from a central inlet temperature control, heating systems must have devices for controlling the temperature in individual rooms. In this context, the control task "requirement-oriented temperature" becomes increasingly important as far as our feeling of well-being is concerned. Individual room thermostats fufil this prerequisite. They ensure that each individual room has the desired and requirement-oriented temperature. The different degrees of heat required in a room are set (time and/or requirement-dependent) via the room thermostat and the desired temperature constantly maintained.

The objective is to accelerate the incorporation of heating systems in the automatic building services control system. This creates further potential for saving energy and results in much greater comfort. An additional 6% of energy can be saved by lowering the room temperature by as little as 1°C.



Advantage

The advantages of individual room temperatures control are obvious:

- Additional saving in energy
- Greater comfort
- Individual customer requirements can be fulfilled
- Improved productivity
- Increased motivation
- Longer time spent in the rooms

Heating and Air-conditioning Systems

In the majority of cases, the heating and air-conditioning systems have already been installed, or they are specified by a heating, air-conditioning and ventilation planner (for commercial/public buildings).

With the Busch Installationsbus® EIB and the Busch Powernet® EIB (both referred to as EIB System in the following), you can control all conventional heating and air-conditioning systems available on the market.

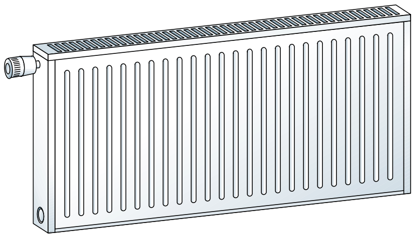
Heating Systems

Radiator

Radiators are the most widely used type of heating system. The water is heated to a specific temperature in a central boiler (inlet temperature between 35°C and 70°C). The heated water is conveyed, via a system of pipelines, to the radiators, which convey heat into the room as a result of air convection.

The radiator is a system which reacts relatively quickly and is used both in residential and commercial/public buildings.

In the case of radiators, differentiation is made between systems with a normal inlet temperature (45 – 70°C) and those with a lower inlet temperature (30 – 45°C), normal inlet temperatures being required for small radiators. In the last few years, large-format radiators have also been being used in individual cases. In such cases, the boiler need only supply the radiator with water with a low inlet temperature.



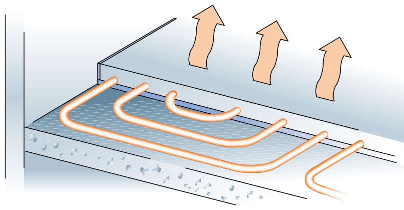
Underfloor/Wall Heating

Water flows through a system of pipes installed in the floor. As in the case of radiators, the water is heated to 30 – 45°C in a boiler.

As a rule, the inlet temperature is adjusted to the outdoor temperature. That is, when the outdoor temperature is low, a higher inlet temperature is selected. Adjustment is made directly at the boiler, to which an outdoor sensor is connected.

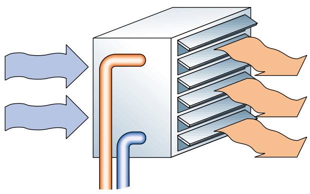
In the case of some underfloor heating systems, the degree to which the temperature can be lowered overnight is restricted. That is, the temperature cannot be lowered beyond a specific value (e.g., 4 – 6 K) for the nighttime mode. You can obtain further information on this from the heating engineer responsible for servicing the system.

In principle, wall heating systems operate in the same way as underfloor heating systems and, therefore, will not be dealt with separately here.



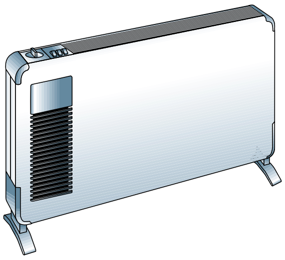
Hot-water Fan Heater

With this type of hot-water heating system, the heating coil is heated by the hot water flowing through this. The fans blow the air through the heating coil and into the room.



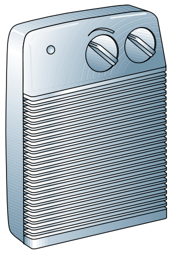
Electric Convector Heater

With an electric convector heater, a fluid (e.g., oil) is heated by by means of heating rods. The heater conveys heat into the room, similarly to the radiator, as a result of air convection.



Electric Fan Heater

Similarly to a hand-held hair dryer, air is blown into the room viaheating coils. As a result, the room is heated. The system reacts very quickly, since no additional heat-carrier (e.g., water or oil) need be heated up.

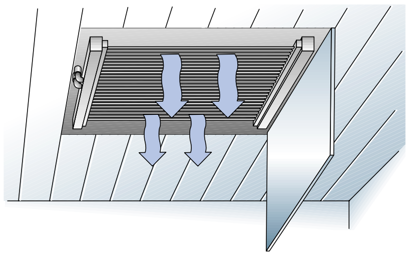


Air-conditioning Systems

Air-conditioning systems are being used more and more frequently, even in our part of the world. In the meantime, they are being installed in many commercial/public buildings, because the productivity of the personnel increases distinctly as a result.

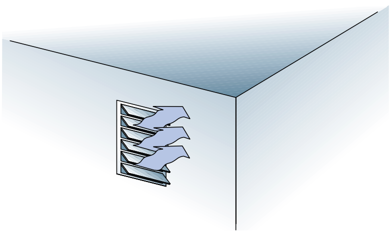
Chilled Beams

In principle, chilled beams function in the same way as an underfloor heating system. Cold water is conveyed through the cooling pipes installed in the ceiling and cools the ceiling. The cold air at ceiling level slowly moves downwards and cools the room uniformly. This system is chiefly used in commercial/public buildings.



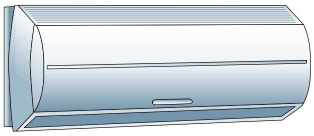
Fan Cooling

In the case of fan cooling, the air sucked in at a central point is cooled (to approx. 15 - 20°C) and distributed throughout the building via a system of air pipes. There is an inlet and outlet air vent in each room. The required amount of cool air is controlled via a positioner and a damper.



Heat Exchanger

In this case, air is cooled via a cooling compressor and distributed over the room via a fan. These units are also offered as mobile versions, which can be flexibly installed at different locations.

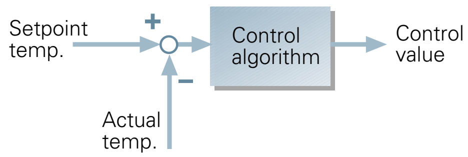


The Control System

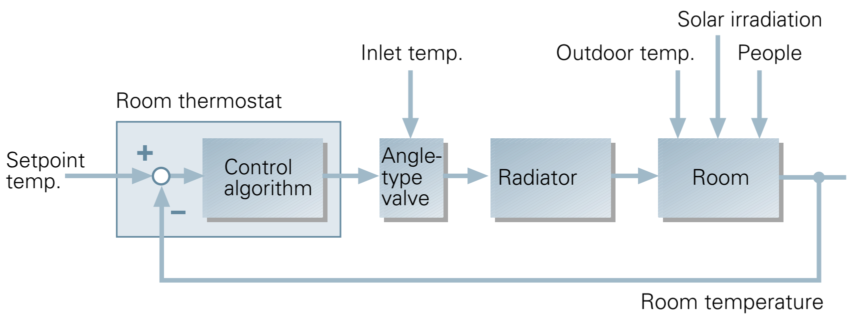
A room thermostat measures the actual temperature and compares this with the preselected setpoint temperature.

The control value is calculated (e.g., in percent, or ON/OFF switching commands) by means of the set control algorithm on the basis of the difference between the actual and setpoint temperature.

The control value defines the thermal or cooling output with which the system is to be supplied.



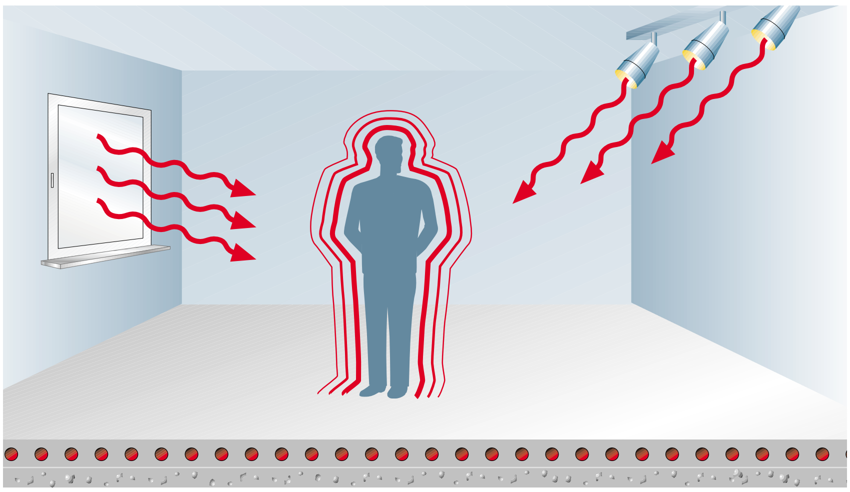
The control system of a heating unit comprises the room thermostat, the positioner (if applicable, a switch actuator), the radiator, and the room in which the temperature is to be controlled



Many factors influence the control system, such as:

- **the inlet temperature**
- **the outdoor temperature**
- **under certain circumstances, solar irradiation**
- **people**
- **electrical consumers**

Based on the difference between the actual and setpoint temperature, the control system recognizes influences, readjusts the control value and compensates for the influences.



Example
Several people enter a recreation room simultaneously. The room temperature rises. The control system recognizes that the actual temperature (room temperature) is rising. This results in a reduction of the control value of the control system. Consequently, the thermal output of the radiator is reduced. The room temperature returns to the preset value.

Different Types of Control System

2-point Control System

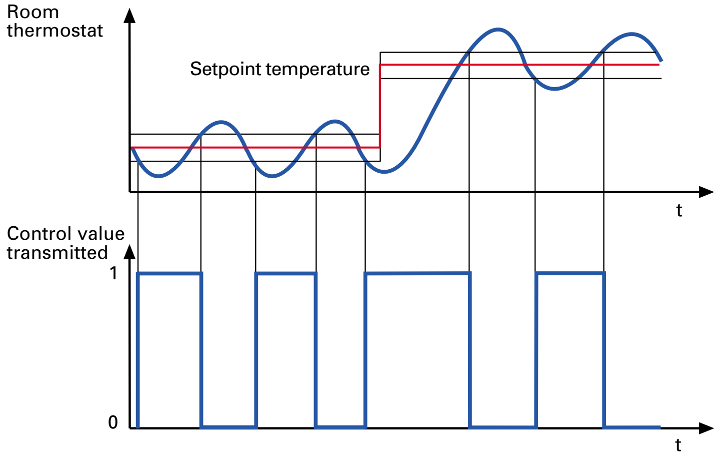
Heating or air-conditioning systems can be controlled by means of different types of controller, which will be described in the following chapter.

The 2-point controller is the simplest type of control. In this case, a control value is not calculated. The controller switches the system on when the room temperature has dropped below a specific temperature and off again as soon as a specific value has been exceeded. When the hysteresis is exceeded, the heating is switched off and when the hysteresis is fallen short of, the heating is switched on.

Example
Setpoint 20°C, hysteresis 1 K. The heating is switched on at 19°C and off at 21°C.

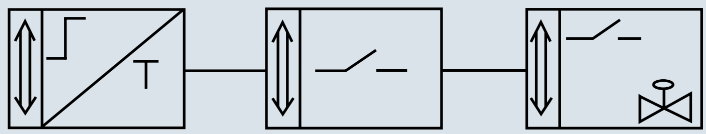
On the one hand, there is the advantage of a simple control and on the other, the disadvantage of a constantly fluctuating room temperature.

Overswing of the temperature occurs because the positioner takes approx. 3 minutes to close completely. In addition, the radiator also continues to radiate stored heat into the room after the flow of water has been cut off. There is a similar system delay when the heating is switched on. Slow-reaction heating or cooling systems cannot be controlled via a 2-point controller, because very wide overswing would occur and result in considerably less comfort.



In the case of the PWM and the 2-point control system, the room thermostat triggers a switch actuator. The switch actuator opens or closes the positioner. This combination is more favourable in terms of cost than the continuous-action positioner.

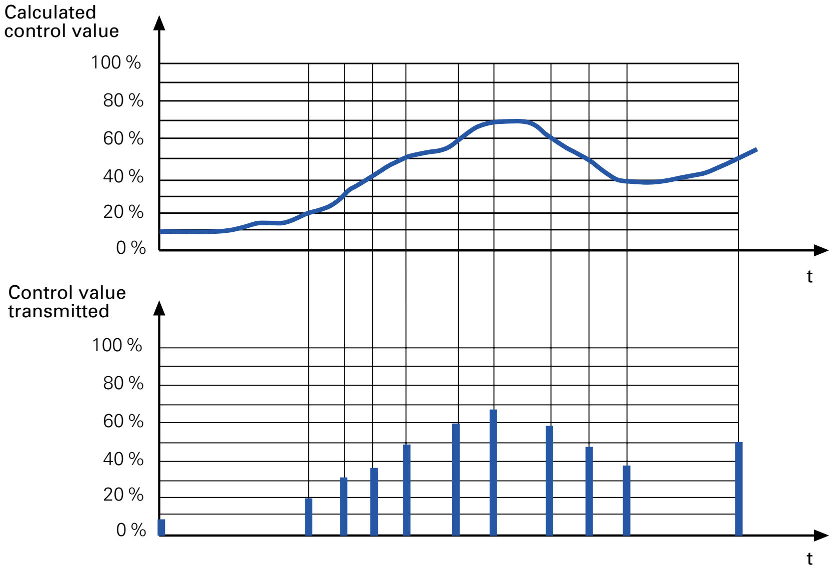
In fact, if there are several radiators in a room, this combination is far cheaper than the continuous controller, because several thermoelectric positioners can be controlled via a single positioner channel.



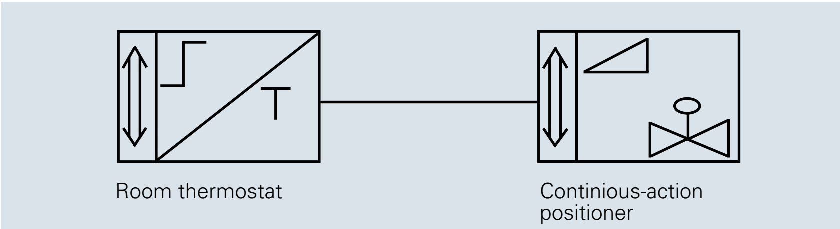
Continuous PI Control*

The continuous controller transmits the control value to the bus in the form of a 1-byte value (0...255). In order to reduce the bus load, the control value is only transmitted if it has changed by a previously defined percentage.

The upper diagram shows, by way of example, a calculated control value. The control value is only transmitted if it has changed by 10% (1, 2, or 5% are also parameterizable). The lower diagram shows at which point in time the control value is transmitted to the bus.



The room temperature is constantly maintained by the control algorithm. The control value transmitted acts on a continuous-action positioner, which is mounted on an angle-type valve. This doses the quantity of heat through the radiator (0 to 100%).



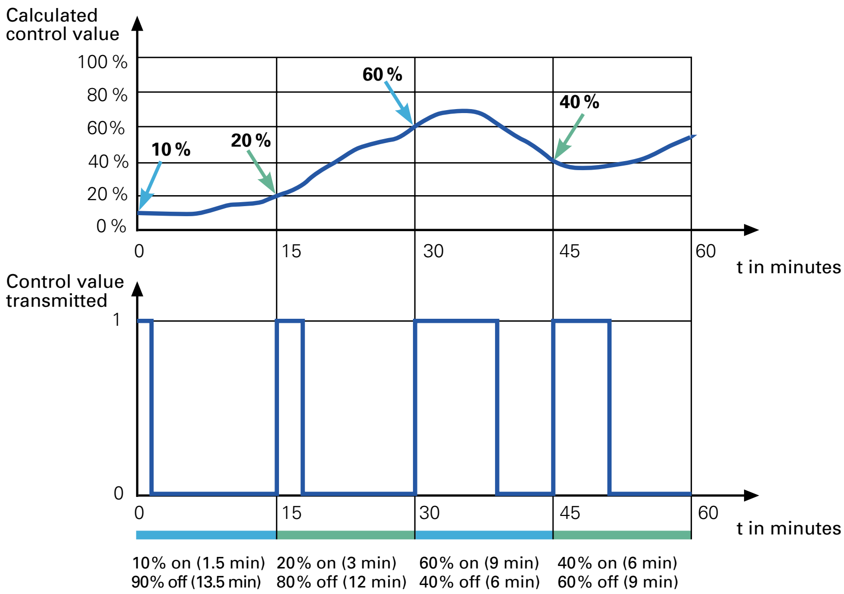
* PI control is a control engineering term which describes a controller with a proportional and an integral component.

Discontinuous PI Control (PWM control)

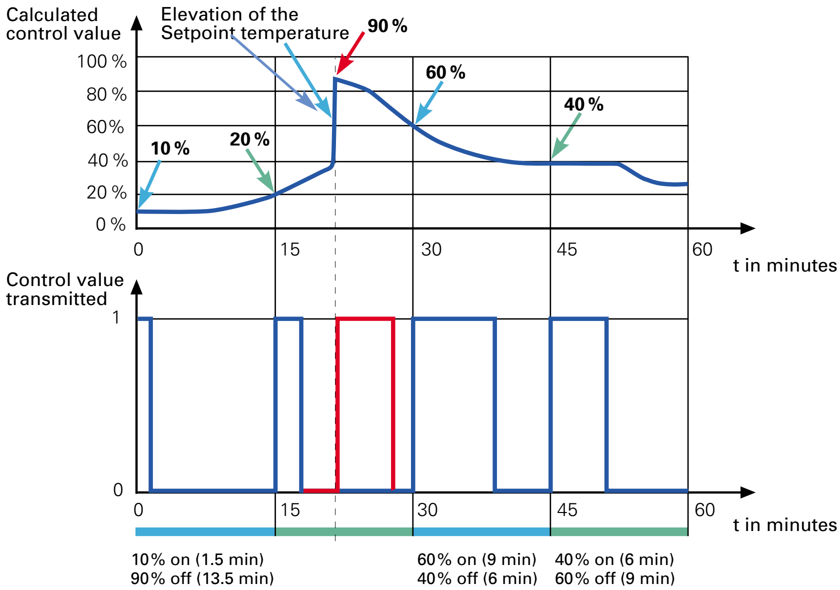
In the case of PWM control (pulse-width modulation), the values (0...100%) calculated on the basis of the control algorithm are converted into a PWM. This is always based on a constant cycle time. If the controller calculates a control value of 20%, then, if the "cycle time of the discontinuous control value" is 15 minutes, a logical "1" for 3 minutes (20% of 15 minutes) and, subsequently, a "0" for 12 minutes, is transmitted. After expiry of the cycle time, the actual control value of the controller is again converted into a new PWM.

The upper diagram shows, by way of example, a calculated control value. The lower diagram shows the control value converted into a PWM. These ON/OFF telegrams are transmitted to the bus and operate a switch actuator, which acts on a thermoelectric positioner.

The room temperature is also constantly maintained via the control algorithm. Averaged out over the time, the behaviour of the control system is the same as with a continuous controller.
Since heating systems react relatively slowly, in almost all cases, a PWM control suffices. Even a radiator, which is considered to be a system which reacts relatively quickly, has time constants of more than 30 minutes and can, thus, be controlled via a PWM control without any loss in comfort.



If one changes the setpoint temperature, the control value is recalculated and operation in the cycle which has begun continues in accordance with the new control alue.



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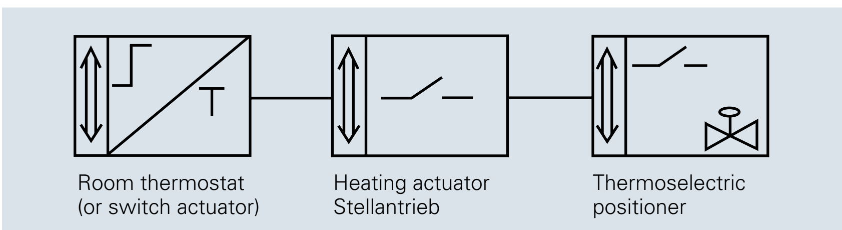
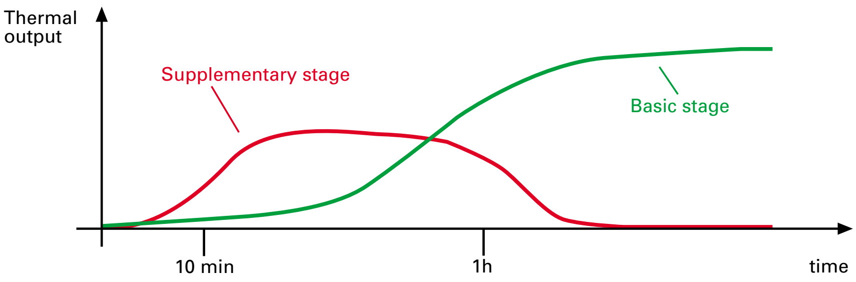


2-step Heating System

The 2-step heating system is very often used in conjunction with an underfloor heating system. Underfloor heating is a system which reacts very slowly. Heating-up of the room takes a correspondingly long time (in some cases, up to several hours).
In order to shorten the heating-up phase, a supplementary, quick-reaction heating system e.g., a radiator system) is used.

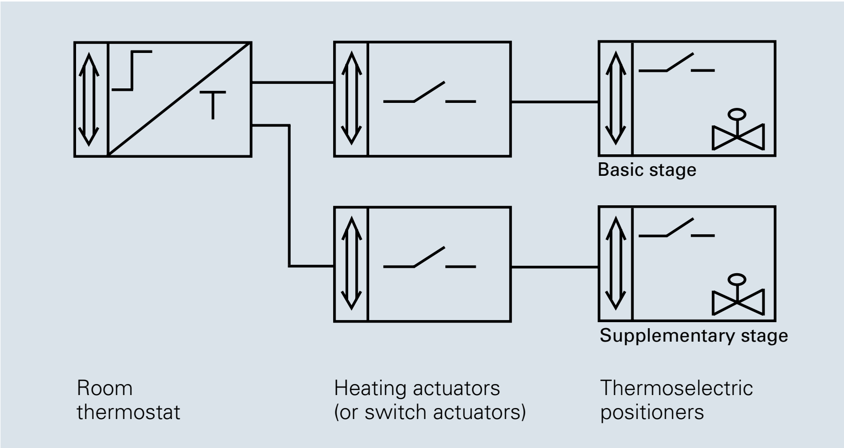
Immediately the setpoint temperature is increased considerably, the supplementary stage (quick-reaction heating system) switches on, together with the basic stage (e.g., underfloor heating system). The room is then essentially heated-up via the supplementary stage, since this reacts more quickly and, thus, the thermal output is available more quickly.

When the room has been heated up to a specific temperature (e.g., setpoint temperature – 1K, parameterizable), the supplementary stage is switched off. In the meantime, the basic stage can supply the room with the required thermal output and then takes over complete control.



Thermal behaviour as soon as the basic and supplementary stages are simultaneously switched on, e.g., if the heating system in activated in the morning.

The basic stage is parameterized in the normal way (e.g., in the case of underfloor heating: PWM with 30 minutes cycle time). A 2-point control is quite sufficient as far as additional heating is concerned, since this is not used to control the system, but only for the heating-up phase.



Which control system for what heating or air-conditioning system?

Recommendations for controlling the different heating and air-conditioning systems will be given in the following.

The recommendations are also summarized in tabular form in the Appendix.

Radiator

- **With a low inlet temperature (30 - 45°C):** PWM or 2-point control
- PWM control
  Set the cycle time of the switching control value to 15 minutes
- 2-point control
  Set hysteresis to 0.3K - 1K
- **With a normal inlet temperature (45 - 70°:** PWM control

Underfloor/Wall Heating

This system reacts very slowly, therefore, a PWM control with a cycle time of 20 - 30 minutes is appro-priate.

Hot water Fan Heaters

In this case, the hot-water circuit is controlled. A continuous control is ideal. As a result, the temperature of the air stream remains relatively constant.

- Continuous PI control
  Set change for automatic transmission to 5%.
- Alternatively, the 2-point control can be used here as soon as the fan is controlled together with the hot-water circuit

Electric Heaters

- Electric convector heater
  PWM control
  Cycle time 15 minutes
- Electric fan heater
  2-point control
  Hysteresis 0.5K - 1.5K

Chilled Beams

- PWM control
  Cycle time 15 minutes

Fan Cooling

- Continuous PI control
  Change for automatic transmission: 5%
- An alternative here is the 2-point control. However, this results in a loss of comfort, because the cool air stream is switched on and off.

Heat Exchanger

- 2-point control
  Hysteresis 0.5K - 1.5K

Planning/Parameterizing

In our Busch Installationsbus® EIB and Busch Powernet® EIB range of products, three room thermostats are available which can be used for both systems.

Room Thermostat 6134-102

On the one hand, there is the 6134-102 in the *alpha nea*® design

Room Thermostat 6326-101

On the other hand, with the 6326-101, a second room thermostat is available in the Busch triton® design. Apart from the room thermostat function, with the three rocker switches, it can also be used to switch/dim lights, as well as to operate blinds and ventilation systems.

Room Thermostat 6327*

As the third, the Busch triton® 5-gang with room thermostat rounds off the range. It is an extended version of the 6326-101 and has the same room thermostat functions. The 6327 has too more rockers than the 6326-101, which can be freely assigned, or assigned to 4 lighting scenes. All rocker functions can also be infrared-controlled.

***Available as from Jan. 2001**

Thermoelectric Positioners 6164/10 and 6164/11

The thermoelectric positioners 6164/10 (230 V) and 6164/11 (24 V) are used, together with the heating actuator 6164 U, or a switch actuator, to control heating systems and cooled ceilings. The positioners have a function indicator, which indicates the state of the positioner (open or closed). This ensures clear functional definition.

By means of an adaptation check, it can immediately be seen whether the positioner is seated correctly on the valve adaptor. Four valve adaptors are available to enable adaptation to the angle-type valves of the different manufacturers.

Heating Actuator 6164 U

The heating actuator is used to control thermoelectric positioners which control heating systems or cooled ceilings. This control takes place noiselessly via an electronic output terminal. In addition to this electronic output terminal, two input terminals are available for floating contacts. For example, window contacts can be connected in order to save energy when windows are open.

In the case of a Busch Powernet® EIB application, the heating actuator can be replaced by a switch actuator.
If window contacts are intended, a Busch Powernet® EIB binary input terminal can be used for connecting.

TP Controller EIB 6100
Controller 6910

For each of the transmission mediums, the Busch Powernet® EIB and Busch Installationsbus® EIB, a time controller is available. With up to 100 time programs, this is ideal for controlling the temperature in individual rooms.

In addition, the two devices provide information information on the statuses in the building.
The vacation mode, or presence simulation, makes it appear that building is occupied, even when noone is there.

Teleswitch REG 6986/10*
6186 /10

A link between the telephone network and the EIB installation is available for each of the transmission mediums. With this, it is possible to switch, e.g., the heating, or sauna, on and off simply when one is out and about. It is also possible to query the different statuses in a building via the telephone.

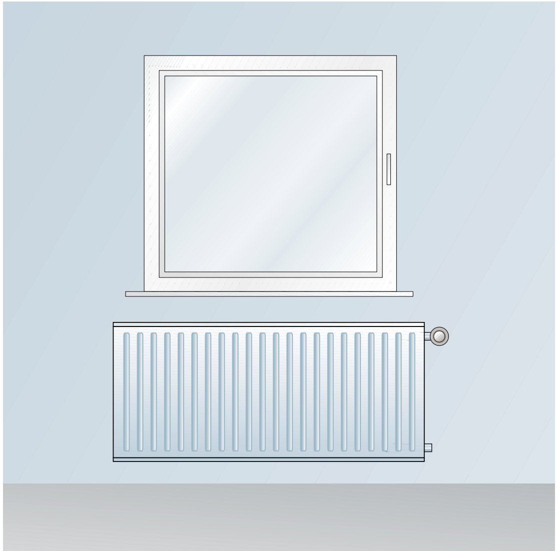
***Start-up with the controller/PowerProject is in preparation**

Project Planning

The functionality and scope of an EIB unit must be defined and planned in the initial phase. In this context, it is important that the requirements of the end consumer/building sponsor be determined. In the initial discussion with the customer, the different applications possible should be explained, in order to be able to plan an optimum installation in accordance with his/her present, as well as future, requirements. In principle, project planning is simply the translation of the planned installation into reality. In this context, the capacity of the spatial arrangements, the type of device and the functions are defined.

Installation Site of the Radiator

In order to achieve uniform heat distribution in the room, the radiator should be installed at the coldest point. This is usually under the window. The radiator should be at least as wide as the window.

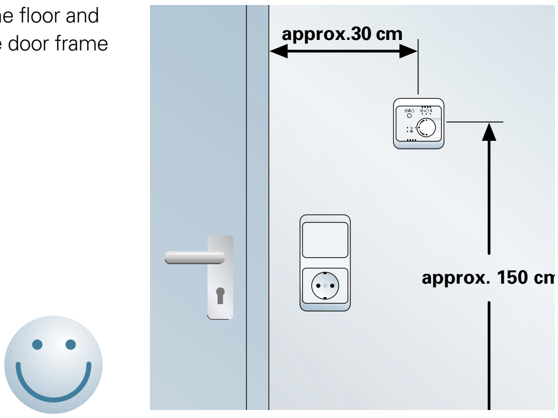


Note
All pipes in the system are to be properly and adequately insulated. In well-insulated buildings, inadequately insulated pipes alone can heat the rooms (when the angle-type valve is closed). Control is then no longer possible.

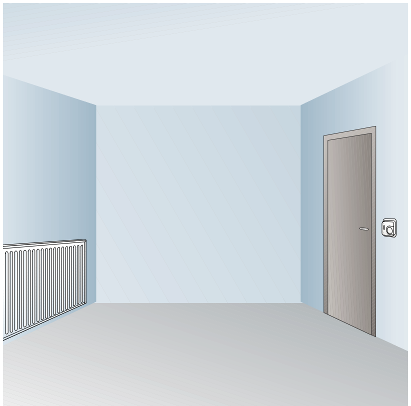
Attention
When a room thermostat is used, there must be no other uncontrolled heating systems in the room.

Installation Site of the Room Thermostat

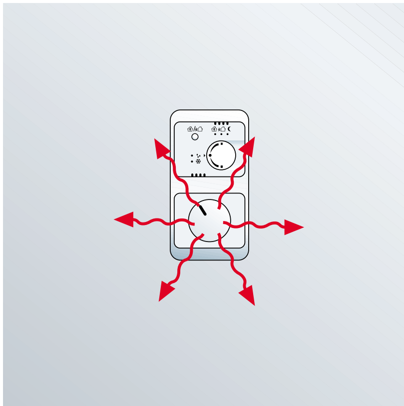
150 cm from the floor and 30 cm from the door frame



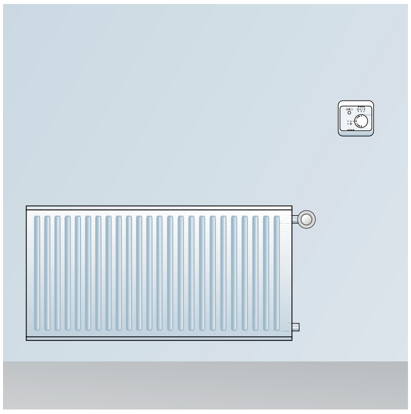
Normal switch position



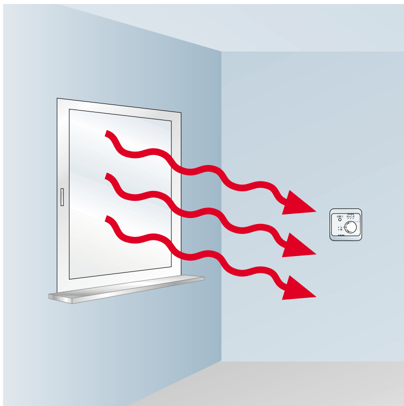
Room thermostat
(RT) opposite the
radiator



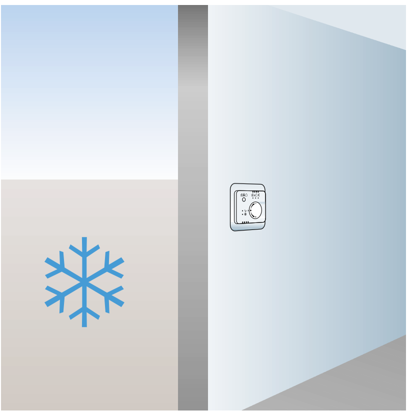
Near electrical
consumers
(heat radiation)



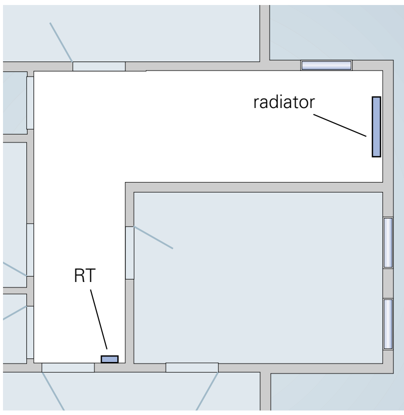
On the same
wall as the
radiator



Solar irradiation



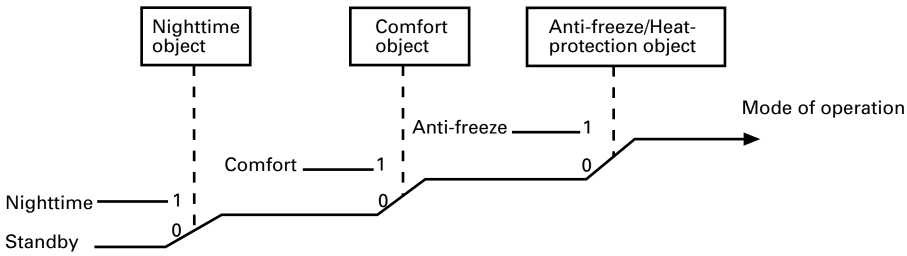
On an
exterior wall



Room thermostat
a wide distance
from the radiator

Modes of Operation of a Room Thermostat

The room thermostats have 4 modes of operation which differentiate, in each case, between 4 temperature levels in the heating or cooling mode.
In the comfort mode, the highest temperature level (e.g., 22°C) is selected when heating, and the lowest cooling level (e.g., 24°C) when cooling.
In standby mode, the setpoint temperature for the heating is slightly lowered (e.g., to 20°C). If the controller is in cooling mode, the setpoint temperature is increased accordingly (e.g., to 26°C). This mode of operation is intended for short periods of absence. The room can then be heated up (or cooled down) more quickly as required.
In the nighttime mode, the temperature is lowered further when heating (or increased when cooling).
In the anti-freeze/heat-protection mode, the setpoint temperature is lowered, e.g., to 7°C, if a window is opened. It is not recommendable for the heating to be switched off completely, because otherwise, the piping system of the heating could freeze.
As far as the room thermostats are concerned, anti-freezing mode takes the highest priority, i.e., when the anti-freeze mode is active, a switchover cannot be made to another mode of operation. The anti-freeze mode must first be deactivated (e.g., the window(s) must be closed again).
The comfort mode has the next highest priority to the anti-freezing mode, then comes the nighttime mode. If none of the abovementioned modes of operation is selected, the room thermostat is in standby mode.



Simplified illustration of the modes of operation

	Object		
Betriebsart	Anti-freeze	Comfort	Nighttime
Anti-freeze/Heat-protection		1	X X
Comfort	0	1	X
Nighttime	0	0	1
Standby	0	0	0

Table of priorities: X = status has no influence

If the controller is in standby or comfort mode, one can switch over between these modes of operation via the local pushbutton of the controller.
In nighttime mode, one can switch over to comfort mode for a set time (parameterizable) via the local pushbutton. This process is called comfort extension or party time.
In the case of the room thermostat 6134-102, there is an additional mode of operation: "dew-point mode". In this mode of operation, the room thermostat can be completely switched off. The dew-point mode has the highest priority.

Switchover to Comfort/Standby Mode via a Central Command/Timer

If the comfort object is set to "1", the comfort mode is activated; if it is set to "0", the standby mode or the nighttime mode (if the nighttime object = 1) is activated.

Switchover to Nighttime Mode via a Central Command/Timer

In order to changeover from the standby mode into the nighttime mode, the nighttime object must be set to "1".

If a switchover from the comfort mode to the nighttime mode is made, the comfort object must be set to "0" and the nighttime object to "1".

This switchover can be made by means of a scene application of the timer, or by transmitting two group addresses one after the other.

Window Contacts

Window contacts are used to allow additional energy to be saved. If, in addition to the room thermostat, window contacts are installed, the heating system switches to anti-freeze mode ("1" on the anti-freeze/heat-protection object).

The room thermostat automatically switches to a set-point temperature of, e.g., 7°C. The heating system should not be completely switched off, because it could freeze in winter.

Presence Detector

A presence detector monitors the presence of people in a room. If someone is in the room, a logical "1", for example, is transmitted. If no-one is in the room, this is registered with "0".

If the presence detector is connected to the comfort object, the room is only heated up to comfort temperature when in use and to standby in the absence of people (or nighttime, if the nighttime object = "1"). As a result, considerable energy is saved.

Note
A presence detector is not practical in conjunction with an underfloor heating system, because the underfloor heating system is too slow-acting.

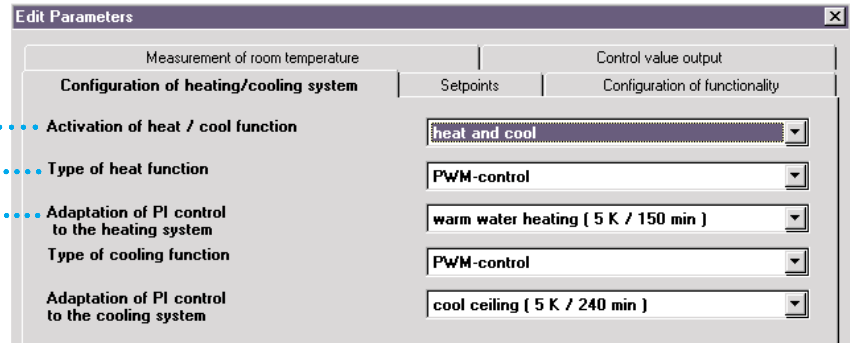
Folder "Configuration of Heating/Cooling System"**

By means of the parameter "Activation of heat/cool function", one defines whether a heating or a cooling system, or both, are to be controlled.

The parameter "Type of heat/cool function" selects the different types of controller for the heating or cooling function.

With the parameter "Adaptation of PI control to the heating/cooling system", one can set the control parameters for continuous and for PWM control.

In the case of 2-point control, the hysteresis must be entered here.

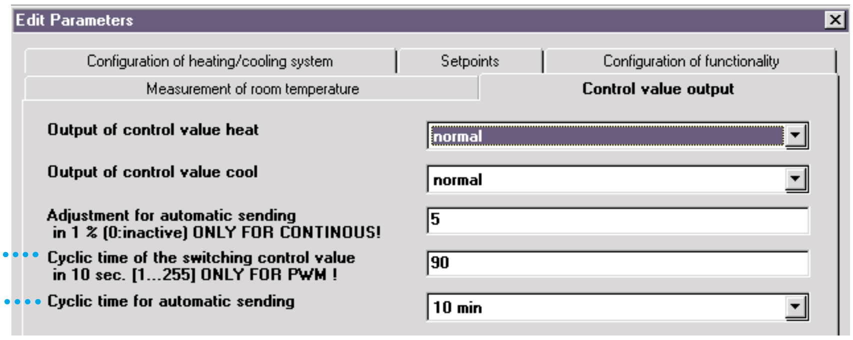


The preset standard parameters for the different heating/cooling systems achieve very good control results for almost all constellations and need not, therefore, be changed.

Folder "Output of Control Value"

In the folder "Output of control value", the cycle time of the discontinuous control value for a PWM control can be set (e.g., 15 minutes = 900 seconds = set > parameter to "90"). With continuous control, the parameter "Adjustment for automatic sending" must be parameterized (5% is adequate here).

With the parameter "Cyclic time for automatic sending", whether the control value (applicable for each control) is to be additionally transmitted, e.g., every 10 minutes, is defined. It is recommendable to always activate automatic transmission. If the control value has not been allocated a value (e.g., during start-up), the room could continuously heat up, or cool down.

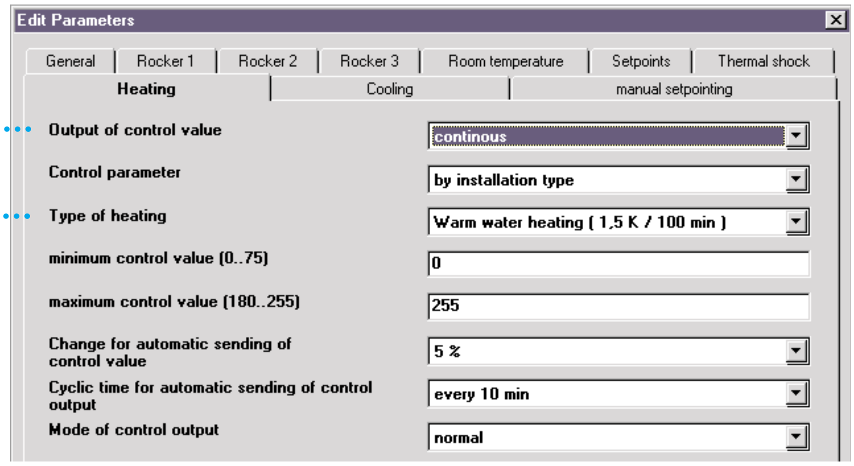


* When parameterizing is effected via the Controller/PowerProject, only heating with the PWM control and 2-step heating is available.

** A folder contains a functional grouping of parameters within an application.

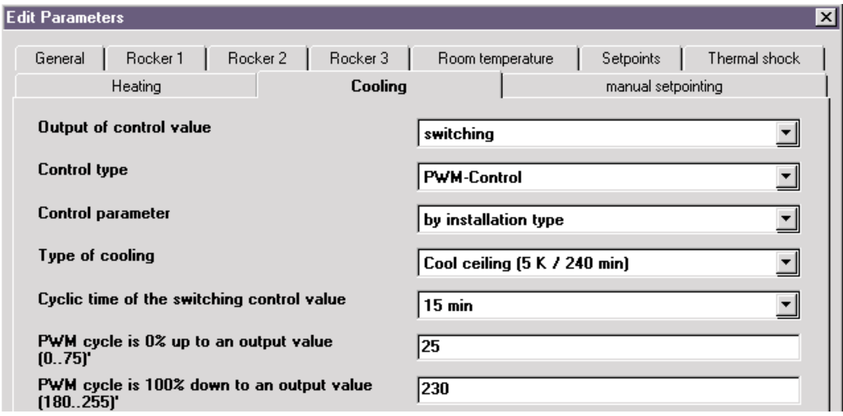
Folder "Heating"

With the parameters "Output of control value" and "Type of heating", the different types of heating can be addressed (continuous or discontinuous). By means of a switching controller, a choice can be made between 2-point and PWM control.
Otherwise, the procedure in this case can be analogous to that in the case of the 6134-102.



Folder "Cooling"

If the room temperature is used for cooling, the settings can be analogous to those for heating.



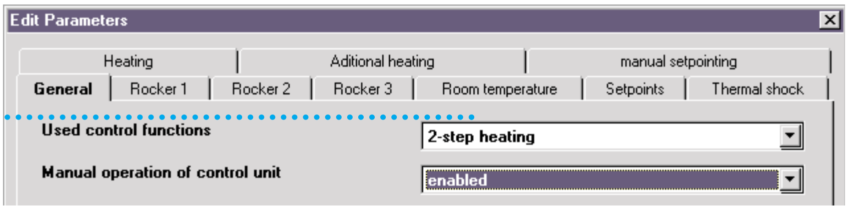
* When parameterizing is effected via the Controller/PowerProject, only heating with the PWM control and 2-step heating is available.

2-step Heating

In the following chapter, the settings for 2-step heating will be explained on the basis of the Busch triton® 6326-101.

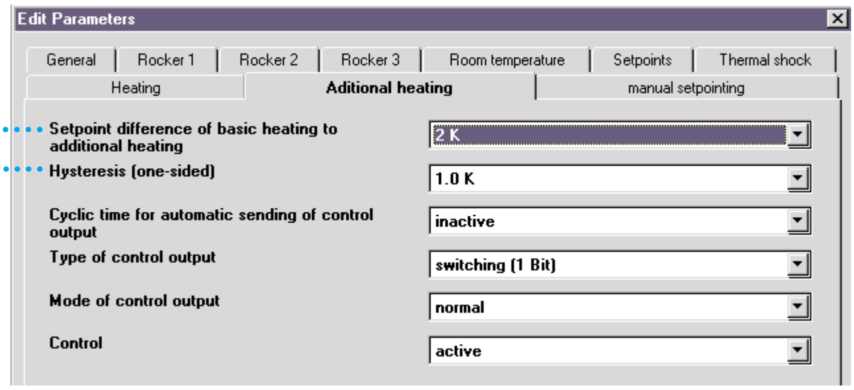
Folder "General"

2-step heating is selected in the folder "General".
The cooling function is now replaced by the 2nd step (additional step). As a result, the setpoints of the cooling function are also dispensed with.



Folder "Additional Heating"

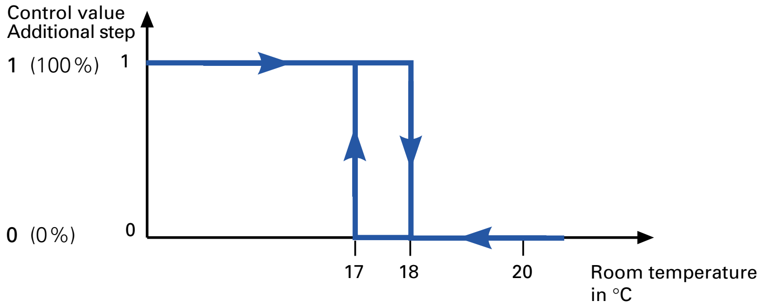
The parameter "Setpoint difference of basic step to additional step" is used to define at which temperature difference below the setpoint temperature the additional step is to be switched off.
A 2-point control is quite sufficient for the additional heating, since this is only switched on and off in the heating-up phase.



Example
Setpoint temperature 20°C
Setpoint difference of basic step to additional step: 2 K
Hysteresis (one-sided) of the additional step: 1 K

The additional heating remains switched on as long as the room temperature is lower than the "setpoint temperature" minus the "setpoint difference of basic step to additional step": 20°C - 2 K = 18°C.

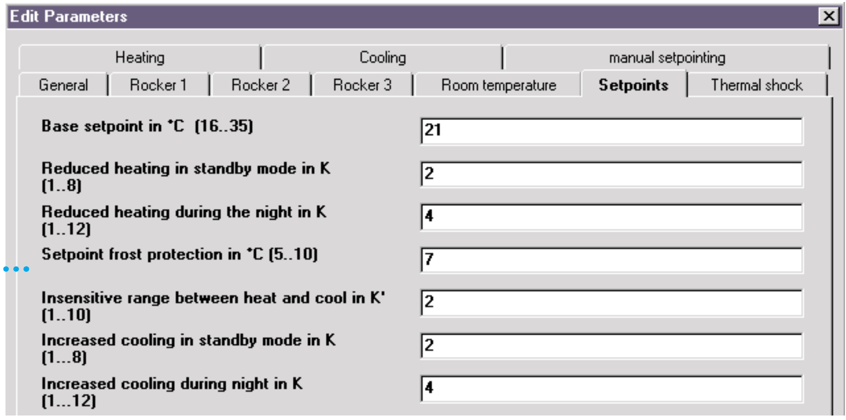
After this threshold has been passed, the additional heating is switched off. The additional heating is only switched on again when the room temperature is lower than the "setpoint temperature" minus the "setpoint difference of basic step to additional step" minus "hysteresis": 20°C - 2 K - 1 K = 17°C.



Setpoints

In this folder, the setpoints of the different modes of operation, which are selected from the bus via the appropriate object, can be set.

Switchover to comfort/standby can also be effected via the local pushbutton.



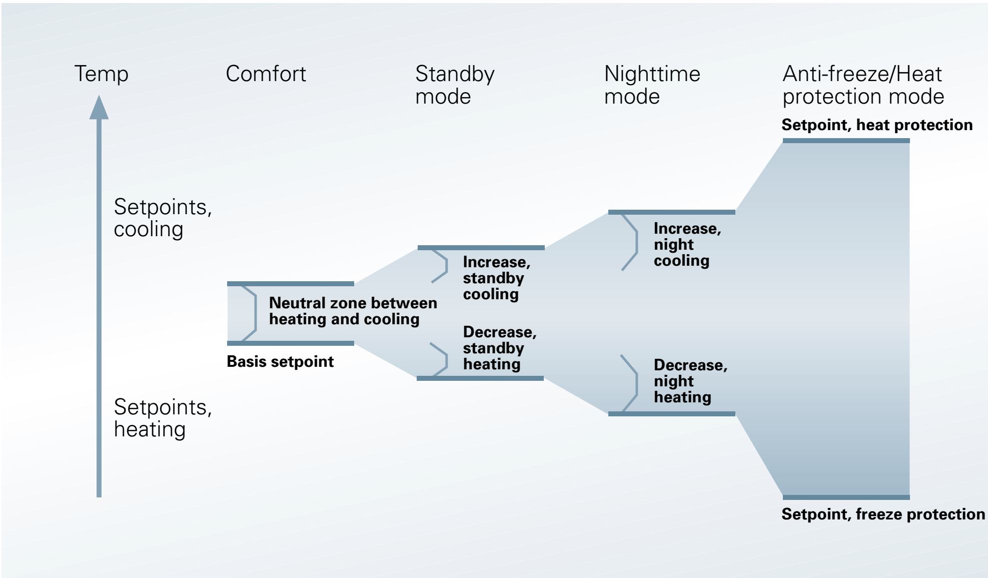
Parameter "Setpoints"

The basic setpoint is the comfort setpoint of the heating mode. The comfort setpoint for cooling is the basic setpoint plus the "neutral zone between heating and cooling". When an air-conditioning unit is used, the neutral zone between heating and cooling should be set higher than 1 K. The comfort setpoint should be parameterized in such a way that the end consumer feels comfortable when carrying out normal activities in the room.

If one switches into standby, the setpoint is lowered (by, e.g., 2 K) when heating and raised when cooling. The room can then be heated up, or cooled down to the comfort temperatures relatively quickly.

In nighttime mode, the setpoint is yet again lowered when heating (by, e.g., 4 K) and raised when cooling. In nighttime mode, it is possible to switchover to comfort mode for the set time if the room temperature becomes unpleasant for the end consumer. This process is called "comfort extension (party time)" and the controller switches back to the nighttime mode after expiry of the set time.

For anti-freeze and heat-protection mode, the setpoints are always stated absolutely (e.g., 7°C). The anti-freeze mode has the highest priority (see chapter "Switchover of the modes of operation").



The manual setpoint specified (in the standby and comfort modes of operation) is added to the setpoint temperature determined on the basis of the mode of operation. The result of this is then the setpoint temperature.

Setpoints

Example

Basic setpoint for heating	: 21 °C
Decrease, standby heating	: 2 K
Decrease, nighttime heating	: 4 K
Neutral zone	: 3 K
Increase, standby cooling	: 2 K
Increase, nighttime cooling	: 4 K

Comfort value, heating	= 21 °C
Standby heating	= 19 °C (21°C - 2K)
Nighttime heating	= 17 °C (21°C - 4K)
Comfort value, heating	= 24 °C (21°C + 3K)
Standby cooling	= 26 °C (21°C + 3K + 2K)
Nighttime mode, cooling	= 28 °C (21°C + 3K + 4K)

In this example, the manual setpoint specified is "0". Otherwise, in the standby and comfort modes of operation, this is added on.

6134-102 Folder "Setpoints"

In commercial/public buildings, it is recommendable to limit, or even block, local adjustment of the setpoint.

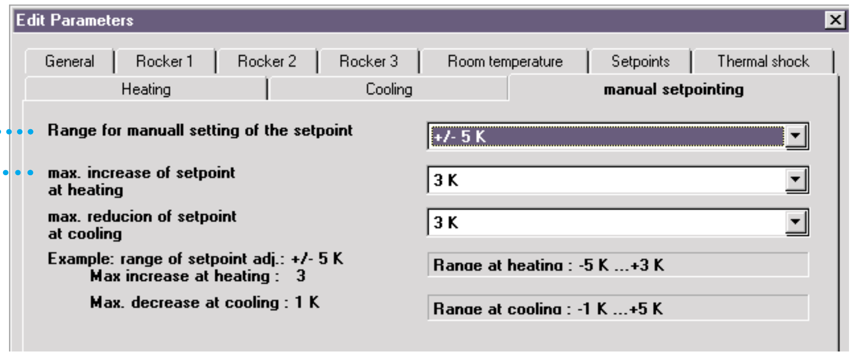
In the folder "Setpoints", the setpoint range of the adjustment button on the room thermostat can be limited by means of this parameter. 3 corresponds to ± 3K, 0 means a complete blockage of local adjustment.

6326-101 Folder "Manual Setpointing"

In the folder "Manual Setpointing", the increases/decreases of the room thermostat, which are unfavourable in terms of energy, can be limited.

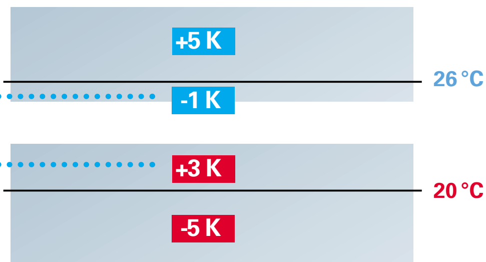
When heating, an increase is unfavourable in terms of energy. An increase of 1 K results in approx. 6% more energy costs (heating costs).

The reverse is the case when cooling. Here, a decrease results in higher energy costs (cooling costs).



Example

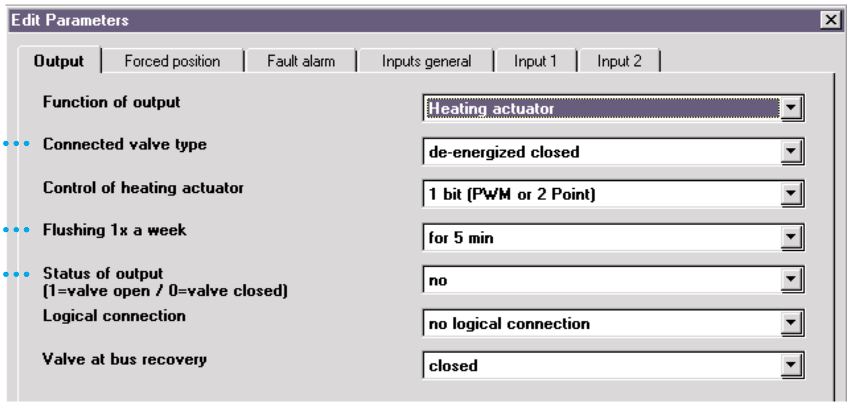
Range for manual setpointing = ± 5K
Maximum decrease in the setpoint when cooling = 1 K
Maximum increase in the setpoint when heating = 3 K



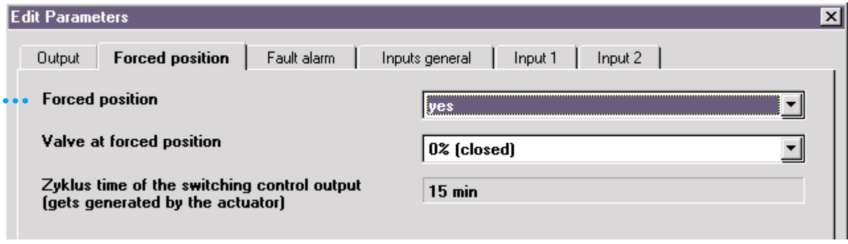
Heating Actuator

Here, the type of valve connected is selected, e.g., de-energized when closed, in the case of the thermoelectric positioner 6164/10-

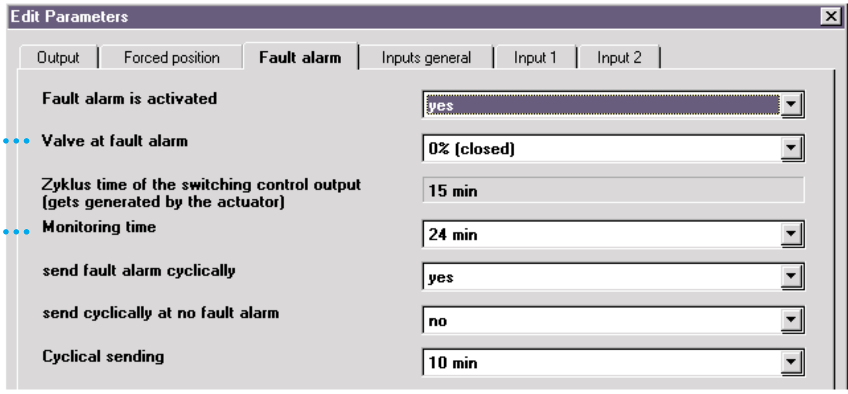
If the output of the heating actuator does not change for more than a week, the valve can be opened for a certain period. This function prevents corrosion of the angle-type valve and, thus, saves repair costs.
With a status object, whether heating or cooling is required can be displayed.



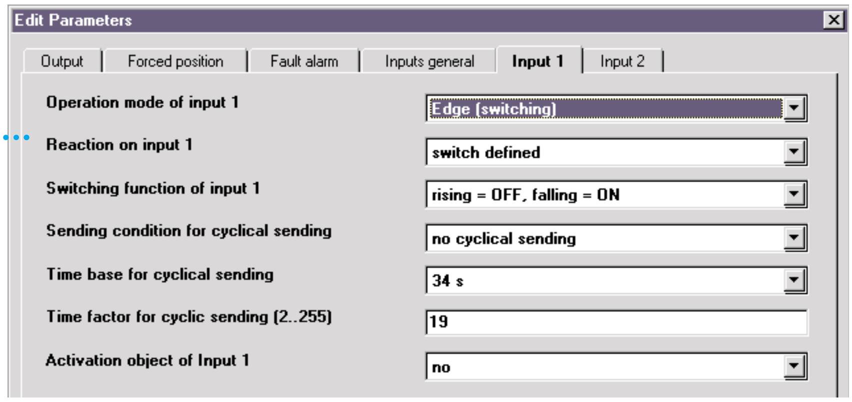
Via 3 OR logic objects, the heating actuator can be put into a specific controlled position as soon at least one of the objects has the value "1".



When the heating actuator has not received a control value within a certain period of time (monitoring time), it can be put into a specific position (valve in the case of a fault). In addition, it is possible to transmit a fault message, e.g., for visualisation or display, via a separate object.
A longer monitoring time than the "cyclic time for automatic sending of control output" must be selected on the room thermostat.



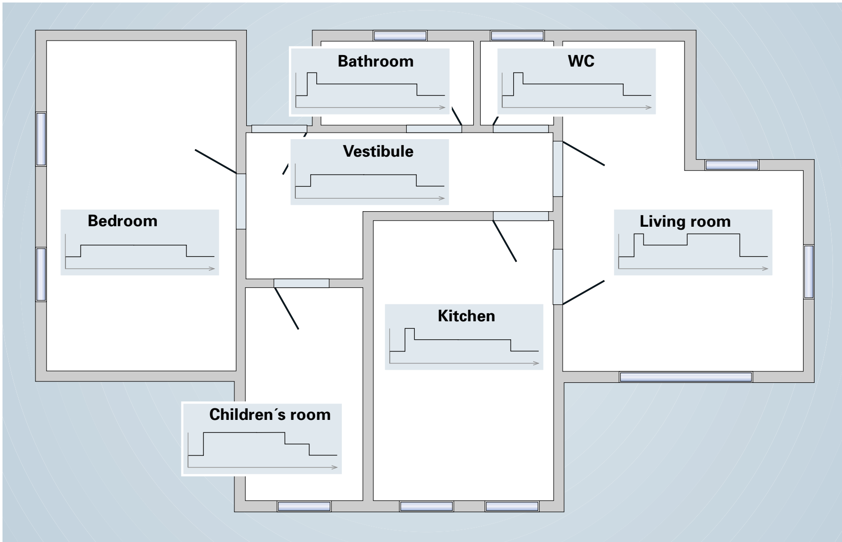
The heating actuator has 2 input terminals for floating contacts. Here, e.g., a window contact can be connected in order to switch the room thermostat into anti-freeze mode and, thus, to save energy, when the window is open.
The second input terminal can be used, in addition, to connect a conventional pushbutton, or switch, in order, e.g., to switch/dim the lighting.



Individual Modes of Operation for the Individual Rooms

With the controller or the TP controller, individual temperature control in the individual rooms is possible.
100 time programs are at disposal for this.

In addition, all statuses of the rooms (room temperature, light ON/OFF ....) can be displayed.

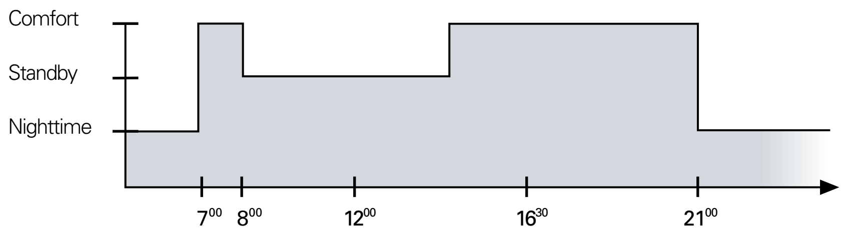


Note

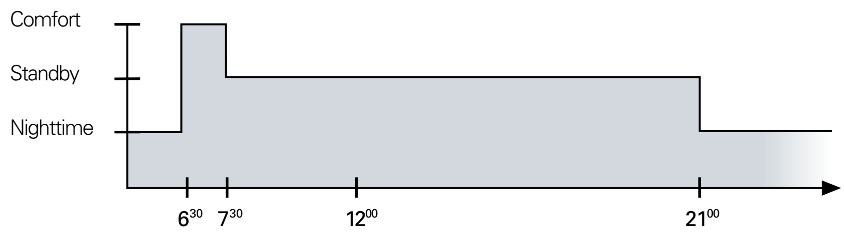
In the case of an underfloor heating system two temperature levels usually suffice (comfort and standby). As the underfloor heating system reacts very slowly, this should be taken into consideration in the time profiles. That is, if the living room should be warm about 7.00 a.m., the mode of operation must be changed correspondingly earlier (e.g., at 6 a.m.).

In the following, some profiles of modes of operation are shown by way of example. The profiles can be individually adapted to the end consumer's requirements.

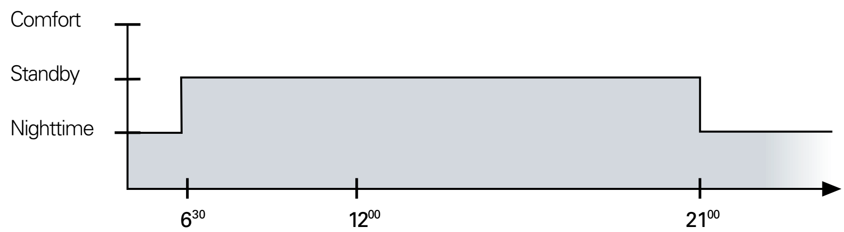
Living room



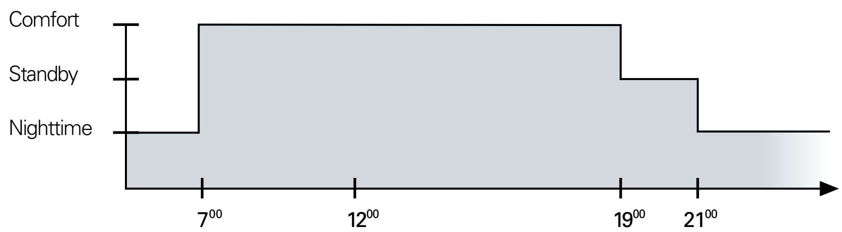
Kitchen, bathroom, WC



Bedroom, vestibule



Children's room



EIB in Large Commercial/Public Buildings

Connection of the EIB to a high-level system

In large commercial/public buildings, a so-called Management, or Command Level is sometimes used. This Command Level controls and visualises all processes in the building and, if appropriate, connects different bus systems with each other.

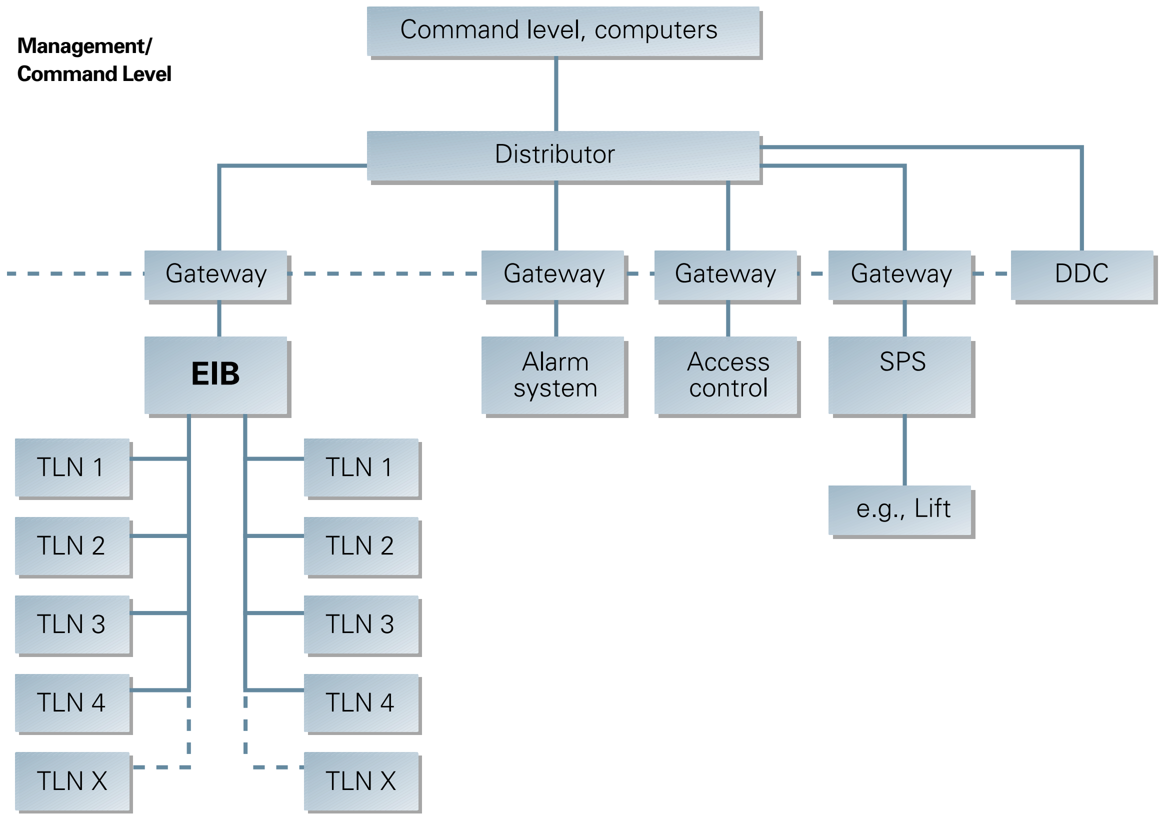
Apart from the EIB, DDC (Direct Digital Control) systems, special security systems, lift control and access control systems, can, for example, also be used. These systems are then connected to the Management, or Command Level, via gateways (connecting elements between the different bus systems).

The Management System then specifies, e.g., the basic setpoint temperature for the room thermostat. This information is then converted by the gateway into an EIB telegram.

For the boiler system (e.g., DDC-controlled), it can, e.g., be important to receive information from the individual room regarding the actual, or setpoint temperatures, or the control values.

As a rule, the gateways are placed at disposal and planned by the those installing the Command or Management Level, so that merely the information flow via the gateway need be agreed on.

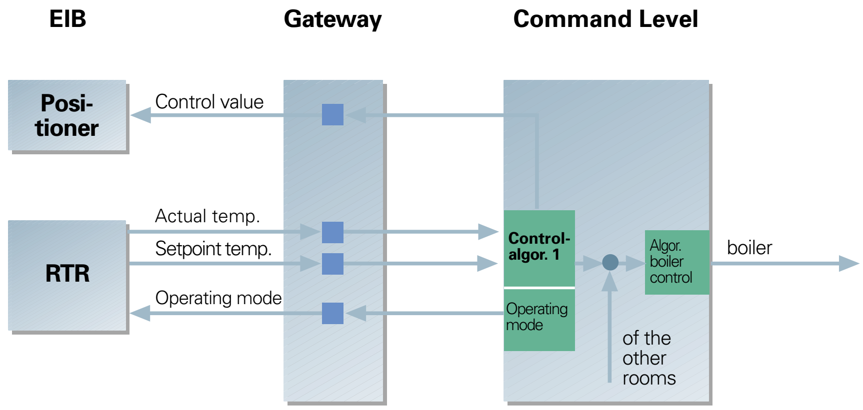
Due to its wide use, connection of the EIB is unproblematical.



TLN = Participant in a bus line

Previous DDC Connection

Example for a room

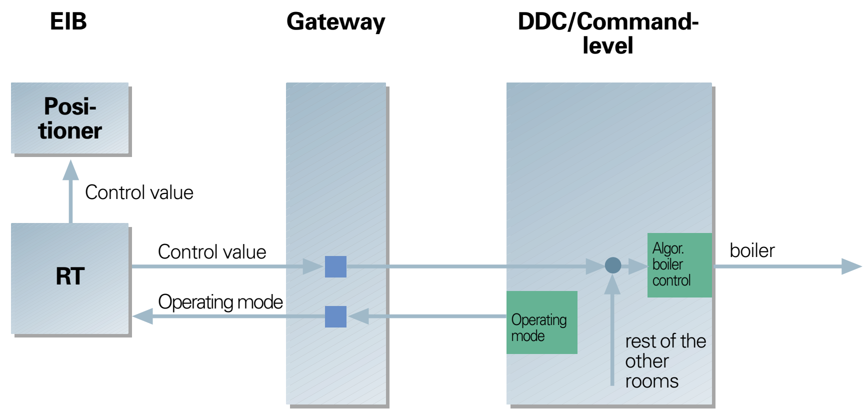


- Actual temperature and setpoint temperature are scanned cyclically
- From this, the DDC calculates the control value

➡ High bus load
➡ High arithmetic capacity of the DDC

DDC Connection Now

Example for a room



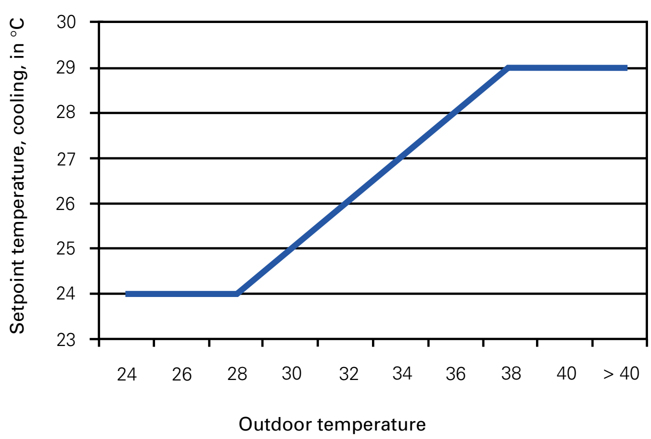
- The control value from each room is needed to calculate the boiler control
- The mode of operation of the room thermostat is specified centrally for the whole house (group address)

➡ Low bus load (control value is in any case, transmitted to the bus)
➡ Low arithmetic capacity of the DDC

Summer Compensation

In order to save energy costs in the summer months, the room temperature can be increased by the Management or Command Level as a function of the outdoor temperature (from approx. 30°C upwards). Furthermore, people will not be subject to wide temperature fluctuations when they enter or leave the building.

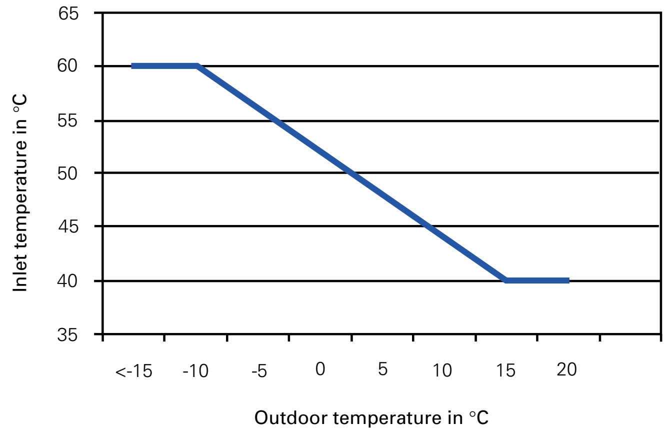
The following graph shows, by way of example, an increase in the setpoint temperature (cooling) as a function of the outdoor temperature. This correction is effected via the object of the basic setpoint temperature. The Command Level transmits the correct value to all room thermostats via the gateway, by means of a group address.



Requirement-oriented Control of the Inlet Temperature

Some boiler controls for heating systems in the residential sphere are already equippped with an inlet temperature control. In these cases, the inlet temperature is adjusted to the outdoor temperature. This prevents unnecessary heat loss of the boiler and the piping system in the case of relatively high outdoor temperatures (> 8°C). With these outdoor temperatures, the boiler of the heating system need not be operated with high inlet temperatures.

The following graph shows such an adjustment by way of example.
Even this adjustment saves energy. However, it has the disadvantage that it does not take into account the actual heat requirement, for, during the night, the temperature in the rooms is lowered a great deal, so that a high inlet temperature is no longer necessary.



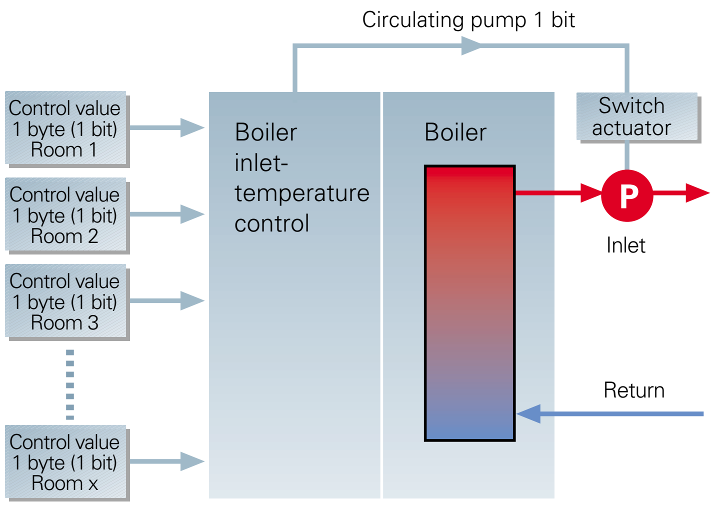
For quite a long time now, modern boiler controls (DDC's) for large commercial/public buildings have taken this fact into consideration.

In the last few years, similar boiler controls for the residential sphere, with connections to the EIB have been being offered by the leading boiler manufacturers (e.g., Viessmann, Buderus and Junkers).

In principal, these controls are configured as follows. The optimum inlet temperature for the heating systems is calculated on the basis of the control values of the different rooms (up to approx. 30) and continuously adjusted to the current heat requirements.

In addition, the circulating pump is only switched on when there is a heat requirement.

In conjunction with individual room temperature control, this system offers a maximum saving in energy as far as heating systems in the residential sphere are concerned.



Examples

Individual room control systems meet the demand for optimum comfort with a minimum of energy consumption. The following examples are given to describe the comfort levels possible.

Residential building

We are prepared to do a lot for our well-being. At the same time, Residential building we, naturally, do not want to "send our money up in smoke".
A heating system with individual room temperature control is a step in the right direction. It is even better if, apart from the individual room temperature control system, window contacts are installed. These ensure that, when a window is opened, the heating system automatically switches over to anti-freeze mode. No matter how long the ventilation procedure (window) lasts, the heating system only heats with the intensity necessary to prevent the pipes from freezing (e.g., 7°C). Comfort is increased even more by using an additional timer. Once programmed, each room is automatically heated to our desired temperature. Even the settings during a vacation and other periods of absence can be taken into account.

Offices and doctors' surgeries, sports centres, and public buildings

In commercial/public buildings such as offices and administrative buildings, administrative buildings, doctors' surgeries, department stores and sports centres, a heating department stores, system with individual room temperature control results in distinctother commercial/savings and far greater comfort. In addition, the right room temperature increases the productivity of the personnel.

Here too, the use of a system with window contacts is of advantage to minimize energy consumption. Since the people who spend time in these rooms are not usually responsible for the costs, attention is seldom paid to the effect of an open window.
The additional use of a timer ensures that the rooms are only heated to the full degree at the set times. In other words, no unnecessary energy is consumed at night, at weekends, or in accordance with the requirement profile.

The supplementary use of a presence detector in commercial/public buildings would be a further step towards more comfort. Apart from the advantages described, this system would also take into account all unforeseeable times where rooms are unoccupied. This means that, in cases of illness, when sports events are cancelled, or similar situations, the heating system is not heated up to the maximum room temperature. As a result, further energy is saved.

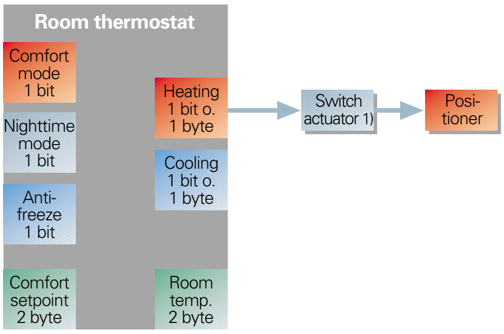
Equipment Levels

In the following, a few examples are given of the levels of equipment (comfort levels) for offices and living areas.

1. Basic Level

The basic equipment (per room) comprises a room thermostat and a switch actuator, which controls a thermoelectric positioner.

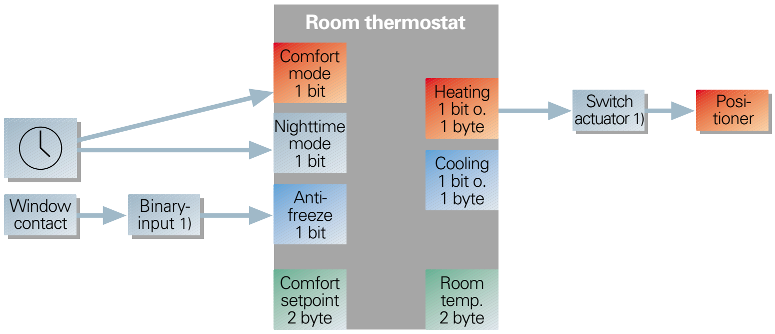
Switchover between the standby and comfort modes of operation can be manually effected via the local control. The comfort temperature can also be changed via the local control.



2. Upgraded Level

In addition to the basic equipment, a window contact is connected to the room thermostat via a binary input terminal. As soon as a window in the room is opened, the room thermostat switches to anti-freeze mode.

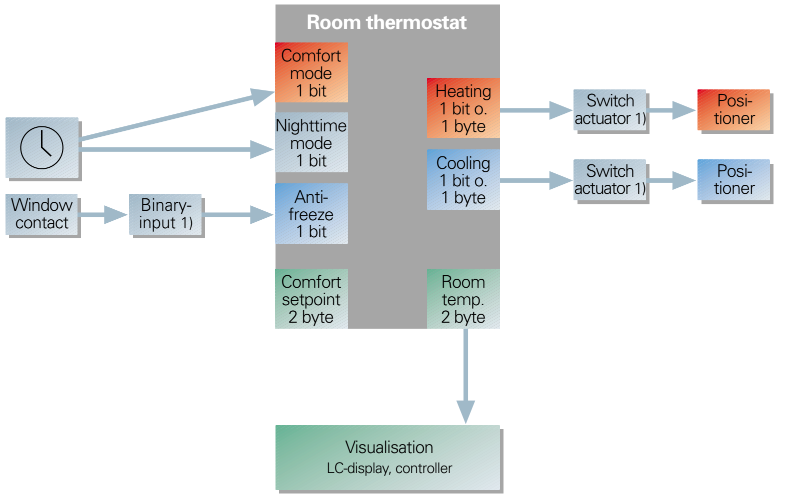
Furthermore, a central timer can switch all room thermostats to a specific mode of operation. For example, in the evening, to nighttime mode, in the morning, or in the afternoon, to comfort mode, and during the day, to standby mode.



1) The heating actuator 6164 U has an integrated binary input terminal for the connection of window contacts

3. Comfort Level

To achieve the comfort level, an air-conditioning system is added, as well as visualisation of the actual room temperature.

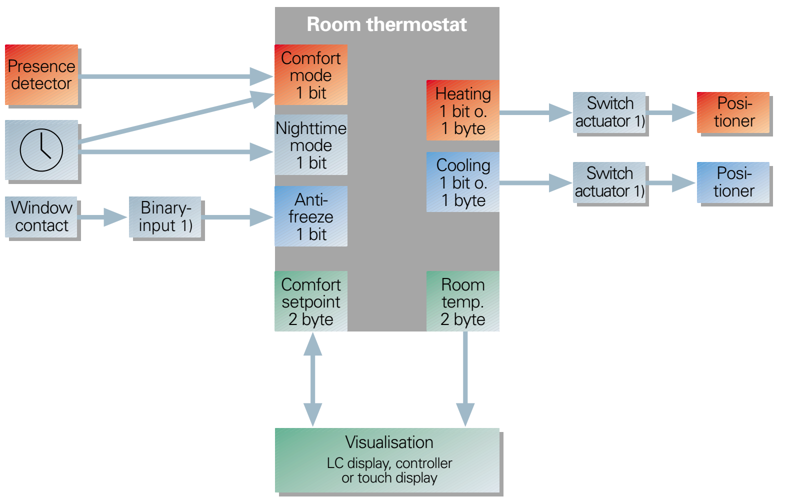


4. Exclusive Level

In addition to the equipment to achieve the comfort level, in this case, a presence detector switches the room thermostat to comfort mode when no persons are in the room.

If underfloor heating is used, the presence detector is not recommendable, since the underfloor heating reacts very slowly. When a room is entered, it would take a long time before this is heated up to comfort temperature.

In addition, with this level of equipment, the comfort temperature can be changed. This is practical, e.g., in summer, so that the difference between the outdoor temperature and the room temperature is not too great (summer compensation).



Heating and Air-conditioning Systems (Advantages/Disadvantages)

Heating Systems	Advantages	Disadvantages
Radiator	- A system which reacts relatively quickly - Most widely used - Less heat loss at low inlet temperatures	- Ambient air may be dry
Underfloor Heating	- No visible radiator - Low convection - Dries the air only slightly	- A system which reacts very slowly - The room may become overheated as a result of solar irradiation
Hot-water Fan Heater	- A system which reacts relatively quickly	- Usually only for industrial workshops - Dry ambient air
Electric Fan Heater	- A system which reacts very quickly	- High energy consumption
Electric Convector Heater	- Noiseless	- High energy consumption

Air-conditioning Systems	Advantages	Disadvantages
Chilled beams	- Uniform cooling - Non-visible	- Usually only viable for commercial/public buildings
Fan cooling	- A system which reacts relatively quickly - No visible cooling unit	- Usually only viable for commercial/public buildings
Heat exchanger	- A system which reacts relatively quickly - Mobile units can be used very flexibly - Retrofitting possible	- Visible

Heating and Air-conditioning Systems

Heating Systems	Positioner	Regelungsart	Zykluszeit (bei PWM)	Hysterese (bei 2-Punkt)
Radiator Inlet temperature 45°C - 70°C	Thermoelectric	PWM	15 min.	–
Radiator Inlet temperature <45°C	Thermoelectric	2-point PWM	– 15 min.	0,3K–1K –
Underfloor/Wall Heating	Thermoelectric	PWM	20–30 min.	–
Hot-water Fan Heater	Continuous-action	Continuous	–	–
Electric Fan Heater	Switch actuator	2-point	–	0,5–1,5K
Electric Convector Heater	Switch actuator	PWM 2-point	10–15 min. –	– 0,3K–1K

Air-conditioning Systems	Positioner	Regelungsart	Zykluszeit	Hysterese
Chilled Beams	Thermoelectric	PWM	15–20 min.	–
Fan Cooling	Continuous-action	Continuous	–	–
Heat Exchanger	Switch actuator	2-point	–	0,5K–1,5K

Advantages and Disadvantages of Continuous-action and Thermoelectric Positioners

Positioner	Advantages	Disadvantages
Continuous-action	- Connection only via the bus	- Only one valve controllable in each case - High current load of the bus line - High costs - No status display - Not available for Powernet
Thermoelectric	- Status display - Low costs - Bus is not subject to high load - More valves per actuator channel - Noiseless in conjunction with heating actuator 6164 U	- Additional voltage supply necessary

Tips and Tricks

Useful tips regarding parameterizing and start-up are given in abbreviated form in the following.

Preventing local operation of the room thermostat

6134-102
In the case of commercial/ public buildings (schools, department stores, government institutions, etc.), it is recommendable to change "Reaction to pushbutton action" to "Pushbutton without function" in the folder "Configuration of Functionality", in order to prevent unauthorized access.
Enter a "0" under "Scaling of setpoint adjustment button" in the folder "Setpoints". This prevents the adjustment button on the room thermostat from functioning".

6326-101
In the folder "General", set the parameter "Manual operation of control unit" to "disabled". This prevents local operation of the room thermostat.

Changing the setpoints of the room thermostat

6134-102
The setpoints of the 6134-102 can be changed locally via the adjustment button of the room thermostat within the range ±0...10K in the comfort and standby modes of operation only.

6326-101
If a change is made to the "room thermostat" mode of operation via the auxiliary button, the setpoint temperature selected and the mode of operation of the room thermostat appear in the display. The setpoint temperature can be changed via the upper rocker ("+/-").

"Cleaner Defect"

This defect could occur:
Prior to a vacation, switchover is made to anti-freeze mode (anti-freeze object = 1) either manually or via a timer (or, in the case of Powernet, via the controller).
During the vacation, the cleaner airs the room (window open). The reed contacts act on the anti-freeze object (once again on "1"). After the room has been aired, the window is closed again (anti-freeze object on "0"). The controller switches to comfort or standby, depending on the state of the comfort object, and the heating system heats up the house.

Remedy
- During the vacation, cyclically transmit a "1" to the anti-freeze object via a timer.

Comfort/Standby switchover

In order to switch from the comfort mode of operation to the nighttime mode, the comfort object must be set to "0" and the nighttime object to "1". The sequence is unimportant.
This switchover can be effected as follows:
- Timer: scene application
- *alpha nea*® touch sensor: Via the application "flexible allocation", send a telegram by pressing and releasing the rocker.
- Logic module: As the objects always have opposite values – in nighttime mode, the nighttime object is "1" and the comfort object "0", and vice versa – a negati on gate can also be used.
- Send two telegrams in quick succession via the controller or the TP controller.

Comfort/Standby/Nightime switchover in large commercial/public buildings

When the mode of operation is changed, the control value and the setpoint temperature (if parameterized) are transmitted by the room thermostat.
If these group addresses are required centrally (e.g., visualisation, gateway to command level), a very high telegram load can result in large commercial/public` buildings.
Therefore, only 10 room thermostats should be switched over at once.

Start-up

Prior to putting the room thermostat in operation, remove the positioner from the angle-type valvfe. The angle-type valve is then open. The room should now heat up, after a certain time (1 hour to 3 hours, depending on the type of heating), to a temperature which is distinctly higher than 10°C. If this is not the case, the heating installation is defective.

Fault Analysis

If the heating system does not function as desired after start-up, the following procedures can be followed to locate the fault.

If the room remains cold, then proceed as follows

1 Check whether
- the positioner is properly mounted,
- electrical connection has been effected correctly
- the parameterizing is cor rect
- the room thermostat is in comfort mode

2 Start recording telegrams and increase the setpoint temperature so that is is approx. 4K higher than the actual room tempera ture.

3 The room thermostat must now transmit "1" (with 2-point and PWM control) or a control value >50% in the case of con tinuous control.

4 Check whether the switch actuator has switched (measure volta ge) and the thermo- electric positioner is open.

5 If the positioner is open and the room is still not warm, then the heating installation is defective.

is overheated, the following should be checked

1 Check whether
- the positioner is properly mounted (this is the most frequent cause)
- electrical connection has been effected correctly
- the parameterizing is cor rect
- the room temperature (actual temperature) corresponds to the setpoint temperature.

2 If the room temperature is considerably higher (>3K) than the setpoint, **check whether the switch actuator is switched off** (measure voltage, record tele- grams).

3 If the positioner is closed and the radiator is cold, there could be other heat sources in the room.