



Zennio Thermostat

Simple/Advanced Thermostatic Control Module

User Manual Version: [2.0]_a

www.zennio.com

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DOCUMENT UPDATES

Version	Changes	Page(s)
[2.0]_a	Changes in the application program: <ul style="list-style-type: none">• DPTs update.	-
[1.0]_a	Changes in the application program: <ul style="list-style-type: none">• Two control systems available for each mode.• Added change of absolute setpoints by step.	-

1 INTRODUCTION

1.1 ZENNIO THERMOSTAT

A variety of Zennio devices feature a module for performing a thermostatic control of the room by monitoring a set of indicators. Depending on the configuration and the setpoint (or target) temperature, different **commands addressed to the interfaces that interact with the climate system will be transmitted over the KNX bus**, so that the temperature setpoint can be achieved.

The thermostatic control function does not require connecting inputs or outputs to the device as all the communication takes place through the KNX bus.

This user manual refers specifically to the **Zennio thermostat** function.

Important: *to confirm whether a particular device or application program incorporates the thermostat function, and whether it is the Zennio thermostat, the Hospitality thermostat, the Building thermostat or the Home thermostat, please refer to the **device user manual**, as there may be significant differences between the thermostat function of each Zennio device. Moreover, to access the proper thermostat user manual, it is always recommended to make use of the specific download links provided at the Zennio website (www.zennio.com) within the section of the specific device being parameterised.*

2 CONFIGURATION

2.1 TEMPERATURE

Prior to describing the thermostatic control procedure, it is important to clarify the following basic concepts:

- **Setpoint temperature:** this is the target temperature to be reached in the room, according to the user requirements. Although initially set by parameter, the setpoint temperature may vary at the user's request, depending on their needs each time.
- **Reference temperature:** this is the actual ambient temperature registered in the room at a certain time, and is typically provided by an external KNX device with temperature measurement capabilities.

It is also possible to combine two different reference temperatures obtained from separate sources (one of which can be the internal temperature probe of some Zennio devices). Such combination, the result of which will be referred as **effective temperature**, can be done in different proportions:

Proportion	Source 1	Source 2
1	75%	25%
2	50%	50%
3	25%	75%

Table 1. Combining Reference Temperatures.

Of course, it is necessary to group under the same address the objects provided for the reception of the reference temperatures and the corresponding objects from the devices that will measure them (or with the object of the **internal probe** of the device itself, if required).

The Zennio thermostat can take care, if configured, of **automatically switching between the two main operation modes (Cooling and Heating)** by comparing the setpoint and the reference temperatures. This is detailed in later sections of this document.

2.2 OPERATION MODES

To begin with, the integrator should configure which of the two main climate working modes (Cooling, Heating or Both) will be available, so that the thermostat can manage (by sending the corresponding orders to the bus) situations of hot weather, cool weather, or both, respectively.

If both modes are available, it will be possible to parameterise a periodical sending of the two control variables, and not only of that of the current mode (the other variable will be obviously zero).

Moreover, provided that both modes have been enabled, **switching** between them can be done automatically, or depending on the state of a certain binary communication object.

2.2.1 MANUAL MODE SWITCH

The manual mode switch takes place upon the reception of a specific binary object, so that the value “0” will trigger the **Cooling** operation mode, while one “1” will trigger **the Heating operation mode**. Whenever the operation mode switches, the thermostat will confirm it by sending the proper status objects.

2.2.2 AUTOMATIC MODE SWITCH

Under the automatic mode switch, the thermostat itself will assume the decision of which of the two operation modes is the proper one every time, notifying the bus (through the corresponding status objects) about mode changeovers.

For this automatic switch, the thermostat compares **the external reference temperature** with the setpoints of the current and inverse working modes:

- Under Heating, **it will switch to Cooling** if the reference is equal than the setpoint of the Cooling mode.
- Under Cooling, **it will switch to Heating** if the reference is equal than the setpoint of the Heating mode.

The following figure illustrates this algorithm.

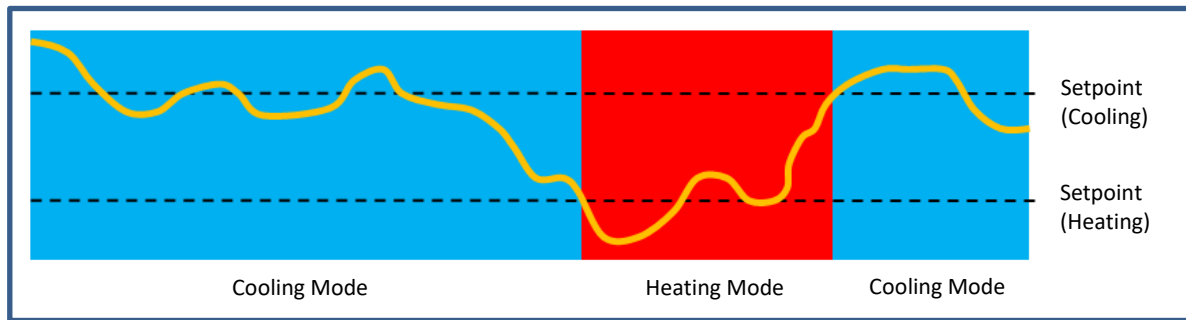


Figure 1. Automatic Mode Switch.

Note: for a proper behaviour of the automatic switch function, the setpoint of the Cooling mode is required to be higher than that of the Heating mode.

Nevertheless, the Zennio thermostat does not only work according to the operation mode (cool / heat). It also incorporates a set of **special modes**, each of which defining a particular actuation band with its own setpoint temperatures for Cooling and for Heating, as explained in section 2.5.

Thus, the aforementioned automatic mode switch takes into account the current special mode. Moreover, in the particular case of being “Comfort” the current special mode and of working with **basic setpoints** (2.5.1) or **relative setpoints** (2.5.1), it will be possible to apply a certain dead band around the setpoint temperatures, so that:

- Being in Comfort, **the thermostat will switch to Cooling** when the reference is matched to than the Comfort setpoint for Cooling plus the **upper band**.
- Being in Comfort, **the thermostat will switch to Heating** when the reference is matched to the Comfort setpoint for Heating minus the **lower band**.

Making use of these dead bands makes sense especially when the same setpoint configuration is set for both Heating and Cooling (in the Comfort mode).

2.3 CONTROL METHODS

Room thermostatic control consists in sending the proper orders to the climate system, so the room ambient temperature reaches a certain setpoint and then remains stable around that value.

Different algorithms are possible to perform such temperature control. The Zennio thermostat lets the integrator select one of the following two:

- **Two-Point Hysteresis Control.**
- **Proportional-Integral (PI) Control.**

2.3.1 TWO-POINT HYSTERESIS CONTROL

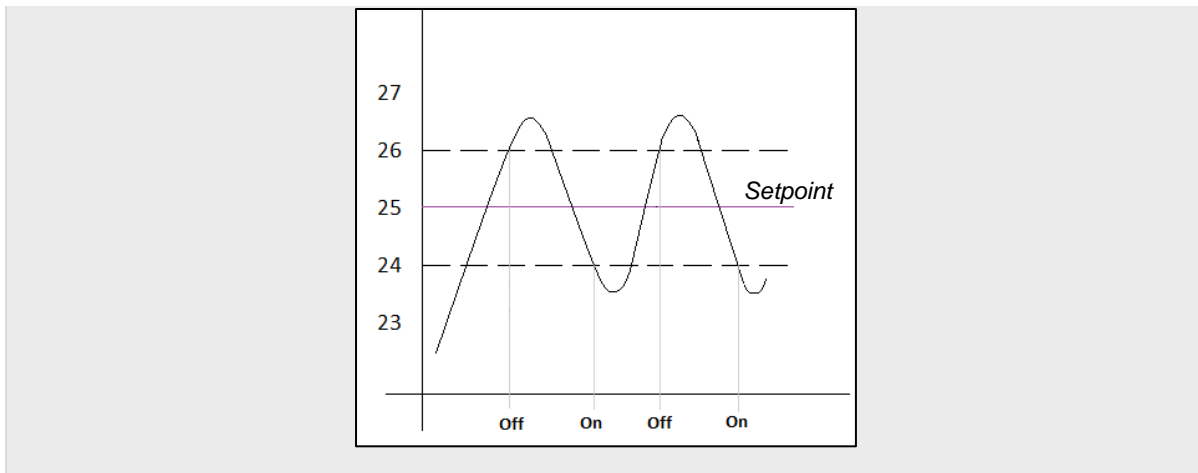
Similar to the climate control performed by conventional thermostats, the basis of this algorithm consists in **commuting the control signal** between “on” and “off” depending on whether the reference temperature has reached the setpoint or not.

Indeed, apart from the **setpoint temperature**, two **values of hysteresis** (lower and upper) are required in order to define a hysteresis or margin around the setpoint, therefore preventing a continuous commutation between the two modes.

Example: *Two-Point Hysteresis.*

Let the initial setpoint be 25°C, with an upper and lower hysteresis of 1°C for the Heating mode. Supposing an ambient temperature of 19°C, the system will start heating the room. Once the temperature is 25°C, it will continue heating until it becomes 26°C, which is the upper limit of the hysteresis band. The climate system will then shut down, and will remain off until the ambient temperature is lower than 24°C (not 25°C), after which it will turn on again.

This algorithm throws a very particular temperature graph:



The main disadvantage of this algorithm, when compared to other advanced systems, is the permanent fluctuation around the setpoint temperature, which has a direct impact on the power consumption and on the comfort:

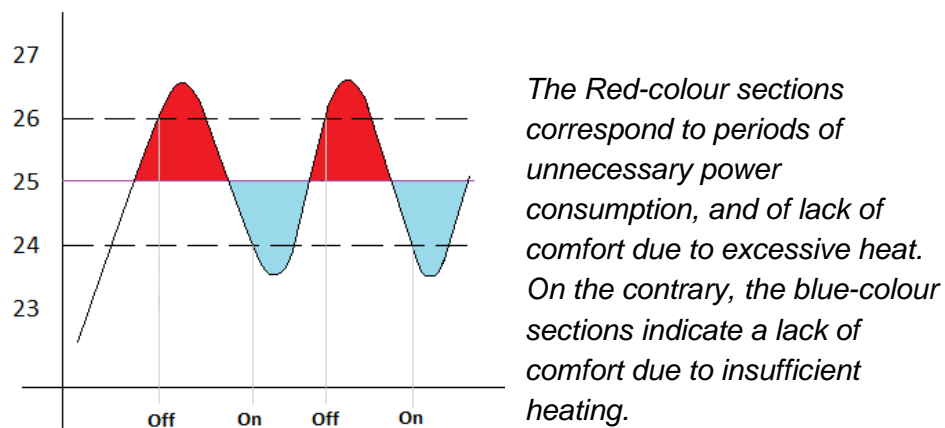


Figure 2. Lack of Comfort.

The two-point hysteresis control will be restarted when any of the following occurs:

- The current operation mode (Cooling/Heating) changes.
- The current special mode changes.
- The thermostat is switched on.
- The device is restarted.
- The setpoint temperature changes.

2.3.2 PROPORTIONAL-INTEGRAL (PI) CONTROL

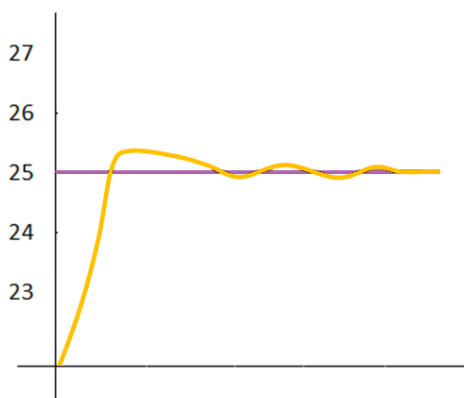


Figure 3. Proportional-Integral Control.

It is a lineal control algorithm based not only on the difference between the setpoint and the reference, but also on the history of the system. In addition, the control signals sent are not strict open/close orders, but intermediate orders. This reduces the temperature oscillation and the non-comfort sections of the previous algorithm, making the ambient temperature become progressively stable around the setpoint.

This algorithm requires configuring three main parameters:

- **Proportional Constant (K):** expressed in terms of degrees, estimates an error value proportional to the difference between the setpoint and the reference temperature.
- **Integral Time (T):** expressed in minutes, this constant depends on the thermal inertia of the climate system, and makes it possible to adjust the error of approximation depending on the elapsed time.
- **PI Cycle Time:** expressed in minutes or seconds, this cycle time is taken into account for setting the temperature sampling frequency and therefore the update frequency of the control signal being sent.

Although the Zennio devices let expert users manually set custom values for the above parameters, generally it is preferable to make use of one of the pre-set options, which should fit the most common climate situations (see *ANNEX: Pre-set Values for the PI Control*).

Regarding the control signals of the PI mode, they can be expressed in two forms:

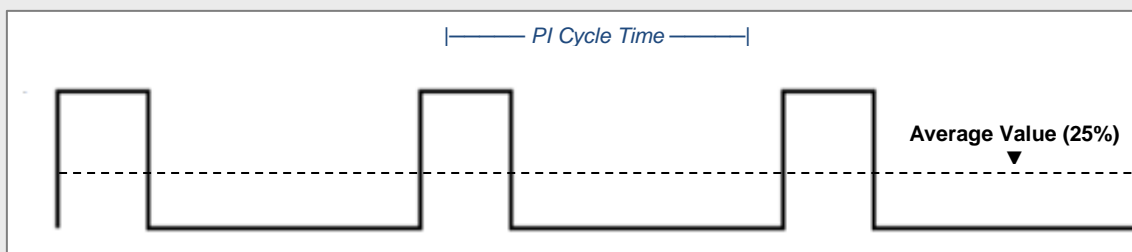
- **Continuous PI:** the control variable will throw **percentage values**, thus indicating *how much* the valve of the climate system should open. For instance, a value of 50% will indicate that the gate must remain half open. Of course, this method only applies to advanced systems, where the valves permit intermediate positioning.
- **PWM (Pulse Width Modulation):** the control variable will be in this case **binary**, being therefore possible to control “on/off” valves, i.e., valves not permitting intermediate positions. Partial opening of the valve (for example: at 50%) is therefore emulated by successively opening/closing it (entirely) for similar time portions.

To prevent repeatedly opening and closing the gate relays, it is possible to define a **minimum PWM signal commutation time**. In addition, it is possible to specify what to do in case a **PWM time lower than the minimum time** is required: commuting the control signal (applying the minimum time) or ignoring the commutation.

Note: for a proper behaviour of this kind of control, it is necessary that the PI cycle time is at least twice the minimum PWM commutation time.

Example: PI control with PWM.

Let a “continuous PI” thermostat control system determines a control variable of 25%, which will be interpreted by intermediate-positioning valves as an order to open to 25%. The equivalent PWM variable for that would be a binary signal that remains at high level (value “1”) for 25% of the configured PI cycle time, and at low level (value “0”) during the remaining 75% of the cycle time. Therefore, an on/off valve will stay entirely open 25% of the time, and entirely closed 75% of the time.



On the other hand, under situations of control signal saturation, during which the variable becomes 100% due to drastic differences between the setpoint and the

reference temperature, a significant integral error will accumulate as the time passes, so once the setpoint is reached, the system will still send a positive signal because of the influence of the system history in the PI algorithm. This will cause an excessive heat/cool supply, which will take some time to be compensated. To prevent these situations, the advanced configuration of the Zennio thermostat offers an option to **reset the accumulated error** as soon as the setpoint is reached after a saturation of the signal.

The following figures show the effect on the ambient temperature depending on whether the reset of the accumulated integral error is enabled or not.

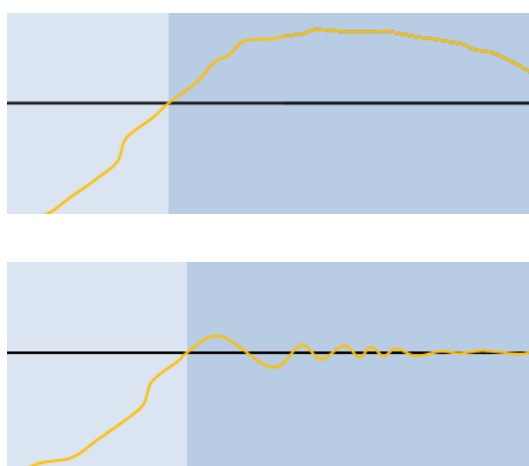


Figure 4. Effect of Resetting the Accumulated Integral Error after Signal Saturation.

2.3.3 CONTROL UNDER THE PROTECTION MODE

With independence of the parameterised control type (two-point hysteresis or PI), under the **Protection special mode** a variant of the two-point control algorithm will always be applied, with the following hysteresis values:

- Lower hysteresis of 0°C and **upper hysteresis of 1°C** for the **Heating** mode.
- **Lower hysteresis of 1°C** and upper hysteresis of 0°C for the **Cooling** mode.

The **outputs** will behave on/off: if a two-point control was configured, the output variable will take the values 0 and 1, while in the PI control it will still consist in 0s and 1s, but sent periodically.

Example: *Control under the Protection mode.*

Suppose setpoint temperatures in the Building Protection mode of 7°C and 35°C for Heating and Cooling, respectively, and a PI control with a percentage signal-type.

- **Case 1:** *when working in the Heating mode, a control order of 100% will be sent as soon as the reference temperature reaches 7°C, and of 0% as soon as it is greater than 8°C.*
- **Case 2:** *when working in the Cooling mode, a control order of 100% will be sent as soon as the reference temperature reaches 35°C, and of 0% as soon as it is lower than 34%.*

2.4 ADDITIONAL COOLING / HEATING

The Zennio thermostat is capable of **controlling two heat/cool sources** (air-conditioning devices, heat pumps, etc.) at the same time. One of the sources acts as the **main system** and the other as the **additional system**, being possible to choose at any time which one of them acts as the main one. This way, it is possible to perform an even more effective thermostatic control by combining multiple climate systems for the same purpose, which will report a higher comfort level.

As an example of this function, think of a room where the primary climate system is a radiant floor system (which is known to have a high thermal inertia and a moderately slow response after setpoint changes) and a split air conditioner working as a support system, being the latter capable of a more agile response when significant setpoint changes occur.

The additional system has the same configuration possibilities as the main system, being possible to choose between a 2-Point Control and a PI Control. To configure the additional heat/cool function, it is necessary to define an **Activation Band** and a **Deactivation Hysteresis**. Once these values have been defined, the behaviour is as follows:

- **Cooling Mode:** as soon as the reference temperature is **greater or equal** than T_1 (being T_1 the sum of the setpoint temperature plus the Additional Cool band), the additional cool system will be activated. Then, it will switch off once

the reference temperature is **lower or equal** than T_2 (being T_2 the subtraction of T_1 minus the deactivation hysteresis).

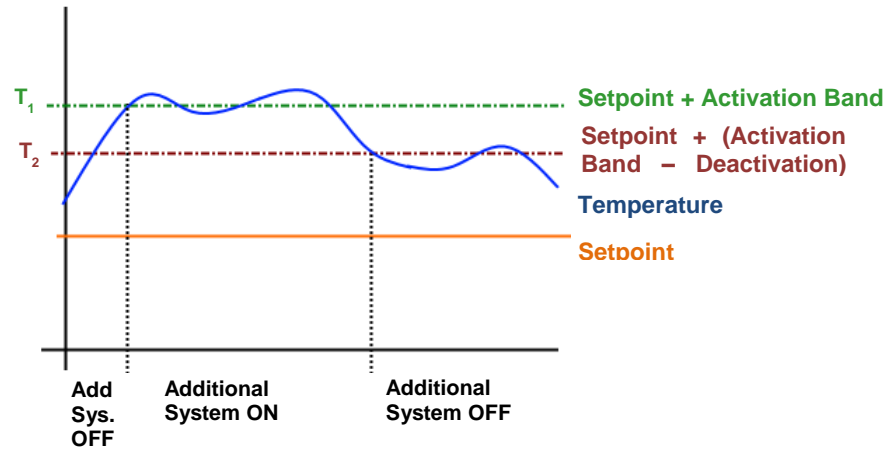


Figure 5. Switching the additional system on and off in cooling mode.

Example: Additional Cooling with 2-Point Control.

Suppose a setpoint temperature of 23°C, an Activation Cool band of 2.5°C and a Hysteresis of 1.5°C. When the reference temperature is 25.5°C or higher, the additional cooling system is switched on and it will be switched off when the reference temperature is 24°C or lower.

- **Heating Mode:** the operation is equivalent to the one described for the cold mode. As soon as the reference temperature is **lower or equal** than T_3 (being T_3 the subtraction of the setpoint temperature minus the Additional Heat band), the additional heat system will come into operation to provide a more effective heating. Then, it will switch off once the reference temperature is **greater or equal** than T_4 (being T_4 the sum of T_3 plus the deactivation hysteresis).

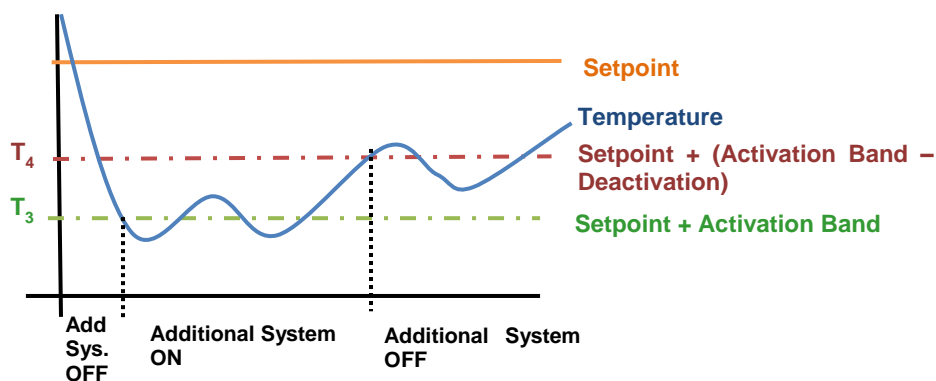


Figure 6. Switching the additional system on and off in heating mode.

Example: *Additional Heating with PI Control.*

Suppose a setpoint of 23°C, an Activation Heat band of 2.5°C and a Hysteresis of 1.5°C. When the reference temperature is 20.5°C or lower, the additional heating system will be switched on sending the corresponding control signal. This system will be switched off when the reference temperature is 22°C or higher.

Note: *in case use Two-Point Hysteresis Control as additional system, the Hysteresis will not be taken into account, with priority given to the activation and deactivation band.*

2.5 SPECIAL MODES

With Independence of the main operation mode (Cooling/Heating), the Zennio thermostat must stay at a certain *special mode* every time. Depending on the configuration, up to four special modes are available: **Comfort**, **Standby**, **Economy** and **Protection** (also known as Building Protection). Each of these modes has its own pair of setpoint temperatures (one for Cooling and one for Heating), pre-set by parameter but changeable in runtime. So, when the user requirements change, it is possible to adjust the climate system by simply triggering the special mode that best matches them.

- **Comfort Mode:** this mode is intended to perform usual climate control, i.e., while there are people present in the room. Therefore, the setpoint values under this special mode should guarantee their comfort.
- **Standby Mode:** this mode is intended for short periods during which the room remains empty. For example, think of the staff of a company leaving the office due to a meeting in an adjacent one, after which they will come back. In such case, it is possible to slightly relax the setpoint values to reduce consumption.
- **Economy Mode:** this one is intended for longer periods with no presence in the room. For example, when the day ends and the occupants of the room leave it till the next morning. Under these circumstances, a relaxed enough setpoint would rather reduce the power consumption.
- **Protection Mode:** this mode is typically reserved for abnormal situations where external factors are conditioning the room climate control: repair works, a broken window or any circumstance because of which the room is going to stay empty for a long time. In such case, a considerably low (Heating mode) or considerably high (Cooling mode) setpoint can be established so that the climate system remains normally off, unless extreme temperature values are actually reached.

Note: *it is not possible to modify the temperature setpoint for this mode in runtime.*

Note that the thermostat **will necessarily stay at one of the above special modes every time**. When switching from one mode to another, the setpoint temperature will automatically change to that of the selected mode.

Although the integrator is free to configure any desired setpoint for each special mode, assuring an **efficient configuration** is encouraged. To begin with, it is important to ensure the Standby setpoints fall down between the Comfort and Economy setpoints.

The current setpoint is subject to **be changed anytime** by the user, although it will be possible to reset them to the initial value (i.e., the one set by parameter) by means of a specific communication object. Note, on the other hand, that whenever a new setpoint value is set in runtime, the thermostat may automatically switch to the special mode that best fits the new value.

Example: *Special Modes. Suppose the following configuration:*

• **Cooling Mode.**

- *Comfort Setpoint: 23°C.*
- *Standby Setpoint: +3°C with respect to the Comfort setpoint.*
- *Economy Setpoint: +5°C with respect to the Comfort setpoint.*

• **Heating Mode.**

- *Comfort Setpoint: 21°C.*
- *Standby Setpoint: -3°C with respect to the Comfort setpoint.*
- *Economy Setpoint: -5°C with respect to the Comfort setpoint.*

*Being under the Heating mode and the Comfort special mode, a new setpoint of 18°C is manually set (via communication object). **The thermostat will then switch automatically to the Standby mode.** After that, if the setpoint gets changed to 16°C, the Economy special mode will be triggered automatically. Finally, if an order to activate the Comfort mode arrives (via object) then the setpoint will change to 21°C. The behaviour would be analogous in case of progressively increasing the setpoint temperature.*

Depending on the reference temperature, the thermostat may commute from Heating to Cooling at some point during the above sequence. In such case, and depending on the parameterised setpoints for the special modes under the Cooling mode, the actual behaviour may differ slightly.

The configuration and the control of the setpoints and the special modes can be done

in two ways: **basic** and **advanced**. A specific parameter is provided to configure the Zennio thermostat as either of them.

2.5.1 SETPOINTS (BASIC CONFIGURATION)

In case of configuring the thermostat type as **basic**, defining the setpoints of the special modes will be much easier than in the **advanced** type:

- Only the **Comfort and Protection** special modes will be available, and there will be no specific objects for manually switching between them.
- The thermostat will automatically **switch between one special mode and the other** (Comfort, Protection) depending on the active setpoint, although the **window status object** (see section 2.6) will also permit switching from one mode to the other.
- Under **Comfort**, the same setpoint will apply to Heating and to Cooling. This setpoint is initially set in parameters and will be referred to with the name of **initial setpoint**.
- The Comfort setpoint temperature will be modifiable in runtime through an **object**.
- Under **Protection**, the setpoints will be 7°C and 35°C, respectively for Heating and Cooling.
- In case of having activated the **automatic commutation between the Cooling and Heating modes**, it will be as well necessary to define a *dead band* around the setpoint (see 2.2.2).

2.5.2 SETPOINTS (ADVANCED CONFIGURATION)

All special modes mentioned in section 2.5 will be available for the advanced type. Switching between them will be possible through **four binary objects** (one per special mode), or through a **one-byte object**. The former four and the latter work independently: a mode switch order through the one-byte object will be executed unconditionally, no matter which the state of the one-bit objects is. Nevertheless, they will be updated so that only the one corresponding to the new mode has the value "1".

For their part, the binary objects can behave in two ways:

- **Trigger:** activating a special mode will require sending one “1” through the object corresponding to that mode. Sending one “0” will have no effect.
- **Switch:** activating a special mode will require sending one “1” through the object corresponding to that mode, provided that there are no other mode objects with a higher priority and with that value at the same time (therefore, the value “0” necessarily deactivates a mode). The priority is set to the following order: **Protection > Comfort > Standby > Economy**.

Additionally, the integrator can make use of a specific parameter to set which special mode should remain active in case all the aforementioned one-bit objects are found to have the value “0”.

Regarding the configuration and the control of the temperature setpoints, two alternatives are available in the advanced thermostat: **absolute setpoints** and **relative setpoints**.

2.5.2.1 ABSOLUTE SETPOINTS

This method permits a **direct control** of the value of the desired temperature, in absolute terms. The value will be associated to a two-byte communication object, through which the desired setpoints will be received. The setpoint can also be changed using a 1-bit communication object that increase or decrease the setpoint by a value set by parameters. In case the setpoint received differs from the previous one, **the new setpoint value will be returned through the status object** (unless the current special mode is Protection).

In this method, parameterising the setpoints consists in the following:

- The setpoints for **Comfort** (both the one for Heating and the one for Cooling) are defined in absolute terms (e.g., 21°C and 23°C).
- The setpoints for **Standby** and **Economy** (both for Heating and for Cooling) will be defined (in tenths of a degree) as a difference (or offset) with respect to the one defined for Comfort. For example: 25 (i.e., 2.5°C).
- The setpoint for **Protection** (both the one for Heating and the one for Cooling) will be defined in absolute terms (e.g., 40°C).

The following diagram illustrates this:

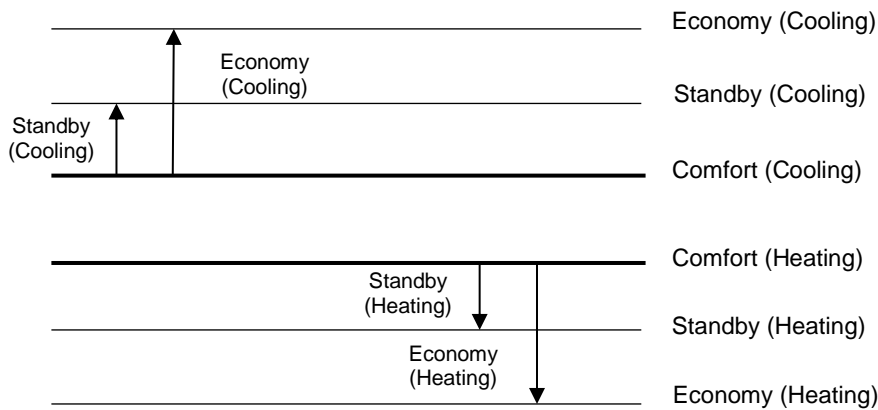


Figure 7. Absolute Setpoints.

On another hand, it is possible to set (“**Permanently apply change to special mode setpoint**”) whether the setpoint change commands received in runtime through the setpoint communication objects should overwrite or not the initial setpoint (i.e., the one defined in ETS). In other words: whether the setpoint defined in ETS should always apply when entering that particular special mode, or whether the setpoint that was active before leaving that special mode should still be active in case of switching back to it.

The specific cases where the setpoints of the special modes should be stored/overwritten can be configured separately:

- On a special mode changeover.
- On an operation mode (cooling/heating) changeover.
- On a setpoint changeover.

Notes:

- If the **storage of the setpoint on special mode changeovers** has been enabled, the updated setpoint value will only be stored if the new mode gets activated through an explicit order by means of the corresponding objects. Permanent setpoint changes do not apply to automatic mode switching, i.e., due to a value change in the setpoint object.
- In the **Comfort mode**, setpoints lower (if cooling) or higher (if heating) than that defined by parameter will not be stored either. This restriction guarantees that, in the Comfort special mode, the temperature setpoints of the Cooling and Heating modes do not overlap each other, which would distort their meaning and the behaviour of the climate control.

- If the **storage of the setpoint on setpoint changeovers** has been enabled, whenever a setpoint changeover through the absolute setpoint object causes an automatic switchover of the current special mode, the setpoint will be stored prior to switching the mode (thus, it will be stored for the previous mode).
- An object to **restore the setpoints** to their original values is provided, which will also make the currently active setpoint change to that of the currently active special mode.

Example: Absolute Setpoints and Setpoint Storage.

Under similar parameter configuration as in the example of section 2.5, suppose the option to permanently store the setpoint on special mode changeovers enabled.

- **Case 1:** being the thermostat in Comfort (Cooling), the initial setpoint of 23°C gets manually increased by one degree (24°C) and afterwards by three more degrees (27°C, which causes an automatic switch to the Standby mode). After that, an order (via the communication object) is sent to go back to Comfort. In this case, the setpoint value will become 23°C, as switching to the Standby mode was a decision of the thermostat itself, not an external order.
- **Case 2:** being the thermostat in Standby (Cooling), the initial setpoint of 26°C gets lowered to 25°C due to an external order, after which another order to commute to Comfort is received from the bus. The setpoint therefore becomes 23°C. In case a new order to switch back to Standby is received, the setpoint will be 25°C again.
- **Case 3:** being the thermostat under Comfort (Cooling), the initial setpoint of 23°C gets lowered to 22°C due to an external order, after which another order to commute to Economy (Cooling) is received from the bus. The setpoint therefore becomes 28°C. In case a request to switch back to Comfort is received, the setpoint will change to 23°C, as the current mode is Cooling and 22°C is higher than the 23°C defined by parameter. Analogously, in case the current mode is Comfort (Heating), no temperatures higher than 21°C will be stored, either.

Now suppose that only the option to store the setpoint on setpoint changeovers has been enabled:

• **Case 4:** the thermostat is in Standby (Cooling) and the setpoint gets changed to 24°C. A new setpoint of 22°C is afterwards received, so the thermostat automatically changes to Comfort. When a new order to switch back to Standby arrives, the setpoint will change to 24°C again.

2.5.2.2 RELATIVE SETPOINTS

This method, which is intended for systems of more complexity (e.g., where a sole supervisor manages the setpoint of multiple thermostats), permits configuring and controlling the target temperature in **relative terms**, as it will be expressed as an offset with respect to a certain **base reference**.

In runtime, the setpoint may be modified by means of binary commands (each of which will add/subtract the offset by a value set by parameters) or by specifying the absolute value to be added or subtracted. To make it possible, a one-bit object and a two-byte object are provided, as well as another two-byte object for modifying the value of the **base reference** anytime.

The parameterisation in this case consists in:

- Defining a **base reference** for the temperatures (for example, 22°C).
- Defining the setpoint temperatures (for both, Cooling and Heating) of the **Comfort, Standby, Economy** and **Protection** modes as an offset to the above base reference (e.g., +2.5°C).

The following diagram illustrates this:

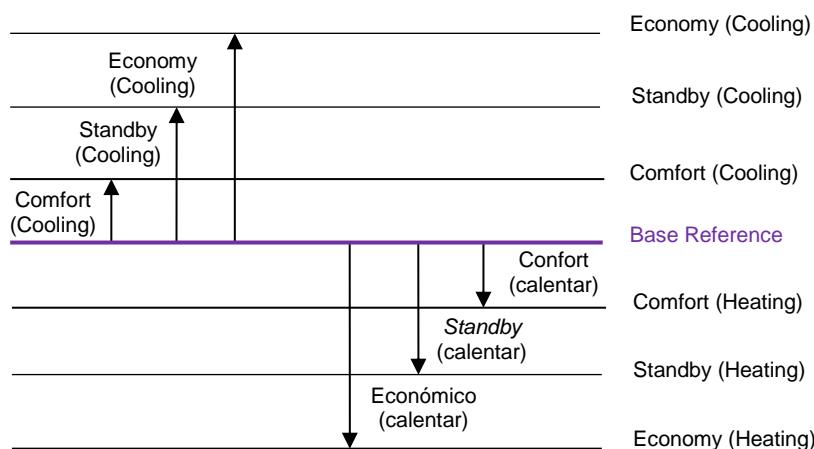


Figure 8. Absolute Setpoints.

To sum up, the current setpoint of the thermostat can be obtained as:

$$\text{Setpoint} = \text{Base Temp.} + \text{Mode Offset (parameter)} + \text{User Offset (object)}$$

Finally, it is possible to parameterise the desired **initial special mode** to be applied after an ETS download. Moreover, another parameter (“**Permanently Apply Change to Basic Setpoint Shift**”) is available to let the integrator select whether after switching to a new special mode, the previously active offset should still apply (being therefore added to the setpoint corresponding to the new mode) or not. Note that the current offset will always remain unchanged on a changeover of the operation mode (Cooling/Heating).

Example: *Relative Setpoints and Offset Storage. Assume the following configuration:*

- **Base Temperature:** 22°C.
- **Cooling Mode.**
 - Offset for Comfort: +1°C.
 - Offset for Standby: +3°C.
 - Offset for Economy: +5°C.
- **Heating Mode.**
 - Offset for Comfort: -1°C.
 - Offset for Standby: -3°C.
 - Offset for Economy: -5°C.
- **Maximum Offset value:** +3°C.
- **Minimum Offset value:** -2°C.

The option to maintain the offset value after mode switches is enabled as well. Then:

- 1) Suppose the thermostat starts up under Standby (Cooling), and therefore with a setpoint of $22^{\circ}\text{C} + 3^{\circ}\text{C} + 0^{\circ}\text{C} = 25^{\circ}\text{C}$ (the value of the offset object is 0°C).
- 2) An “increase” order is received through the binary control object, making the current setpoint change to 25.5°C .
- 3) After that, the 2-byte offset control object receives the value $+4^{\circ}\text{C}$, which would raise the setpoint to 29°C . However, as the maximum offset set by parameter is $+3^{\circ}\text{C}$, the offset is truncated to 3°C , so the setpoint stays at 28°C .

4) An order arrives now to activate the Comfort mode, whose setpoint temperature is 23°C. However, since the offset storage option was activated, those 23°C are added the 3°C of the currently active offset, resulting into 26°C.

In case a new value for the base reference is received from the bus (e.g., 25°C), the accumulated offset will not be reset. For instance, if such order arrives after 4), then the setpoint will become $25^{\circ}\text{C} + 1^{\circ}\text{C} + 3^{\circ}\text{C} = 29^{\circ}\text{C}$.

2.6 COMFORT PROLONGATION AND WINDOW STATUS

There are two more functions available related to the special mode changeover:

- **Comfort Prolongation:** permits switching to the Comfort special mode by writing the value “1” to a specific one-bit object, remaining in that mode for a parameterisable time and then switching back to the previously active special mode.

This function may be particularly useful when combined with a Zennio motion detector so that the Comfort mode can be triggered for a certain time as soon as moving subjects are detected in a room that was being air-conditioned under the Standby or Economy modes.

Notes:

- *The Comfort Prolongation function is not available if the thermostat is configured as **basic**.*
 - *Consecutively receiving the value “1” multiple times during the Comfort Prolongation time will make the count start over.*
 - *The Comfort Prolongation time count is interrupted if an order to change the special mode is received and also if the window status object gets triggered (see below).*
- **Window Status:** shows or hides the “[Tx] Window Status (input)” binary object, which is to be linked to any external sensor that may report anomalous situations (a window being opened, repair works, etc.) that suggest relaxing the thermostatic control temporarily, and thus switching to the Protection mode. Hence, when the value “1” is received through this

object, the thermostat will switch to Protection, and will remain in that mode until the object becomes “0” again, after which it will recover the state that was active prior to the window opening event (taking then into account the mode change orders –if any– that may have been received and ignored while the value was “1”).

Notes:

- *When the Protection mode has been triggered by means of the usual mode change objects, and not through the window object, the thermostat does execute the next mode change order as soon as it arrives, thus leaving the Protection mode.*
- *If the window object gets activated when the current mode is already Protection, deactivating the window object will not make the thermostat leave such mode (unless switch orders had been received in the meanwhile).*
- **Comfort prolongation** *is not available while the window status object has the value “1”. On the contrary, if such object gets triggered during the **comfort prolongation**, the thermostat will switch to Protection; after the object receives back the value “0”, the thermostat will return to the mode that was active prior to the comfort prolongation.*

2.7 SCENE MANAGEMENT

The Zennio thermostat incorporates the possibility of managing up to **5 different scenes**, each of which will make it possible to execute different functions of the thermostat:

- **Switch-on / Switch-off:**

During the **execution** of the scene, it will be possible to send a switch-on or a switch-off order (according to the parameterisation) through the on/off object. In case an order is received to **save** the scene, the parameterised value will be overwritten with the one of the on/off status object at that moment.

Note: *this option is not available in case the thermostat has been configured as “always on”.*

- **Operation Mode (Cooling / Heating):**

During the **execution** of the scene, the mode control object will send the value of the desired operation mode (Cooling / Heating), which should be set in parameters. In case of **saving** the scene, the value parameterised will be overwritten with the one of the mode status object at that moment.

Note: *if the thermostat has been configured for only heating or only cooling, or for an automatic mode change, this option will not be available.*

- **Setpoint:**

In this case, the activation of a **special mode** (or of a custom **setpoint value**) on the **execution** of the scene can be parameterised.

If the second option is selected under a **relative setpoint** control, then the custom value will correspond to the base reference, and therefore the value of the offset will remain unchanged once the scene is executed.

When **saving** the scene, the above value will be overwritten with that of the corresponding status object at that moment.

All these actions can be enabled and configured independently, thus preventing any of them from being executed or saved, if desired.

Example: *Executing and Running Thermostat Scenes.*

The first scene is assigned the number 32, as well as the actions to switch on the thermostat and to activate the Comfort mode, leaving the Heating/Cooling mode as is.

- **Case 1:** *being the thermostat on and in the Cooling and Standby modes, when the order to execute the scene arrives (value "31") it will switch to Comfort.*
- **Case 2:** *being the thermostat off, when the order to execute the scene arrives it will switch on and change to Comfort, remaining in the Heating/Cooling mode it already had before being switched off.*
- **Case 3:** *being the thermostat off and being Heating and Economy the last active modes, the order to save the scene (value "159") arrives. Then, scene number 32 gets updated with the current state of the thermostat (off and under the Economy special mode; note that the Cooling/Heating operation mode is not saved due to the original parameterisation). Afterwards, being the thermostat on and under the Cooling and Comfort modes, if the scene execution order is received it will switch off and activate the Economy special mode (leaving the operation mode in Cooling), according to what it was saved.*

3 ETS PARAMETERISATION

3.1 DEFAULT CONFIGURATION

Depending on the Zennio device, more than one Zennio thermostat may be parameterised, as the figure shows.

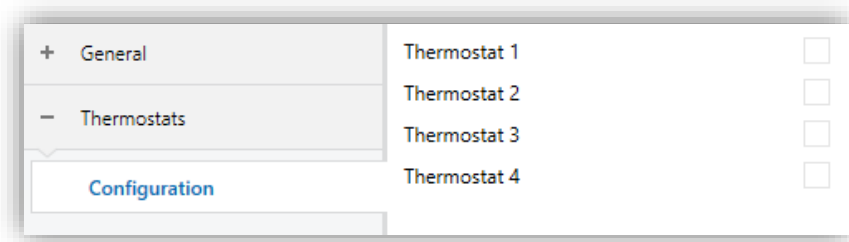


Figure 9. Enabling the Thermostat.

For details on how to enable the available thermostats, please consult the specific user manual of your device.

3.2 THERMOSTAT *n*

Once the thermostat is enabled, the menu on the left will include a set of tabs intended for the configuration of the related parameters.

3.2.1 CONFIGURATION

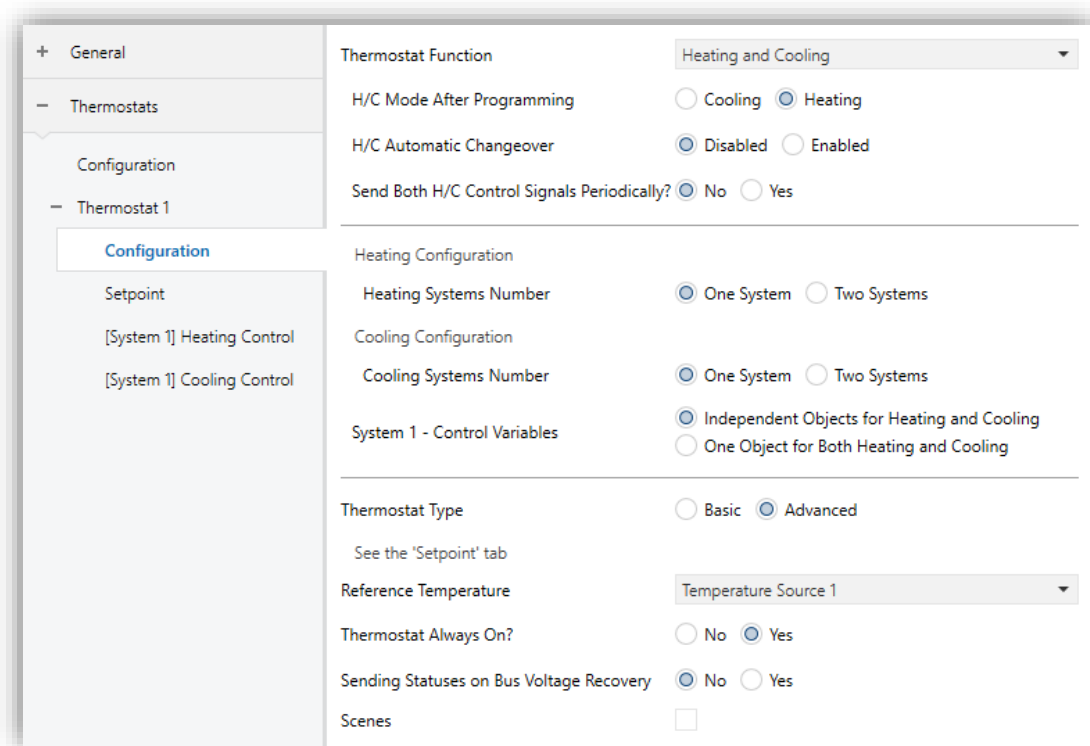


Figure 10. Configuration.

- **Thermostat Function** [[Heating](#) / [Cooling](#) / [Heating and Cooling](#)]: defines the main working modes. Depending on the selection, tabs “[System x] Heating Control” and “[System x] Cooling Control” will show in the tab list on the left. Please refer to sections 3.2.3 and 3.2.4 for details on their parameterisation.

If the option “[Heating and Cooling](#)” has been enabled, additional parameters will be displayed:

- **H/C Mode After Programming** [[Cooling](#) / [Heating](#)]: sets the mode to be activated after an ETS download.

- **H/C Automatic Changerover** [[Disabled](#) / [Enabled](#)]: grants or not the thermostat the responsibility of automatically switching from one mode to the other one (Heating / Cooling) depending on the reference and setpoint temperatures. If not enabled, a communication object named "[Tx] Mode" will be in charge of receiving external mode switch orders ("0" will switch to "Cooling", while "1" will switch to "Heating"). **Enabled or not**, the current mode can always be consulted by reading the value of object "[T] Mode (Status)". "0" will mean Cooling; and "1", Heating.
- **Send Both H/C Control Signals Periodically** [[No](#) / [Yes](#)]: sets whether to send periodically the control variables of both, the Heating and the Cooling modes (and, if enabled, the objects of the additional system; see section 3.2.3 and 3.2.4), or whether to send only the variable of the currently active mode (note that the control variable of the currently inactive mode will be zero). The sending period should be configured for each mode (Heating/Cooling) from its specific parameter tab.
- **Heating Systems Number** [[One System](#) / [Two Systems](#)]: sets whether to use 1 or 2 systems for heating mode. If "[Two Systems](#)" is selected, the following parameters appear:

- **Main System** [[System 1 Heating Control](#) / [System 2 Heating Control](#)]: sets which of the two systems will act as the main for heating mode after ETS download (the unchecked one will act as the additional).

Two new 1-bit objects will also appear. The first one ("[Tx] Main System (Heat)") allows setting the main system for heat mode in runtime. The second one ("[Tx] Enable/Disable Secondary System (Heat)") permits activating/deactivating the additional system.

- **Additional Heating Activation Band** [[-100...-25...-5](#)] [[x 0.1°C](#)]: difference between the setpoint and the current temperature for activation of the additional climate control.
- **Additional Heating Deactivation Hysteresis** [[-20...-5...-1](#)] [[x 0.1°C](#)]: temperature increase relative to the additional heat activation band to deactivate the additional climate control.

Note: *The value corresponding to the hysteresis must be higher than the value of the activation band for the heating mode (see Figure 6 in section 2.4). Otherwise, the additional system may remain on when the main one has been turned off.*

- **Cooling Systems Number** [[One System](#) / [Two Systems](#)]: sets whether to use 1 or 2 systems for cooling mode. If "[Two Systems](#)" is selected, the following parameters appear:

- **Main System** [[/System 1 Cooling Control](#) / [/System 2 Cooling Control](#)]: sets which of the two systems will act as the main for cooling mode after ETS download (the unchecked one will act as the additional).

Two new 1-bit objects will also appear. The first one ("**[Tx] Main System (Cool)**") allows setting the main system for cool mode in runtime. The second one ("**[Tx] Enable/Disable Secondary System (Cool)**") permits activating/deactivating the additional system.

- **Additional Cooling Activation Band** [[5...25...100](#)] [[x 0.1°C](#)]: difference between the current temperature and the setpoint for activation of the additional climate control.
- **Additional Cooling Deactivation Hysteresis** [[1...5...20](#)] [[x 0.1°C](#)]: temperature drop relative to the additional cool activation band to deactivate the additional climate control.

Note: *The value corresponding to the hysteresis must be lower than the value of the activation band for the heating mode (see Figure 5 in section 2.4). Otherwise, the additional system may remain on when the main one has been turned off.*

- **System 1 - Control Variables** [[Independent Objects for Heating and Cooling](#) / [One Object for Both Heating and Cooling](#)]: this parameter only appears if the option "[Heating and cooling](#)" has been selected in **Thermostat Function**. Determines whether System 1 is controlled with a single object for heating and cooling or whether each mode has its own independent objects.
- **System 2 - Control variables** [[Independent Objects for Heating and Cooling](#) / [One Object for Both Heating and Cooling](#)]: this parameter only appears if the "[Heat and Cool](#)" option has been selected in Thermostat Function and

"Two systems" option has been configured in both modes. Determines whether System 2 is controlled with a single object for heating and cooling or whether each mode has its own independent objects.

Notes:

- If the "One Object for Both Heating and Cooling" option is selected, the control method must be the same for both modes.
 - Combining "One Object for Both Heating and Cooling" with **Send Both H/C Control Signals Periodically** will ignore the latter and only send the value of the variable corresponding to the current mode.
- **Thermostat Type** [Basic / Advanced]: sets the desired configuration pattern for the special modes and their respective temperature setpoints (see section 2.5). In the "Advanced" configuration, an additional tab (named "Setpoint"; see section 3.2.2) will show up.

If configured as "Basic" with **H/C Automatic Changeover** between the Cooling and Heating modes active, two parameters will be shown in relation to the comfort **dead band**, which are analogous to those of the advanced thermostat (see section 3.2.2.2). And also, the following parameter:

- **Initial Setpoint** [-20...22...100] [x 1°C]: sets the initial setpoint for the Comfort mode after an ETS download (see 2.5.1).
- **Reference Temperature**: determines the source of the reference temperature. This may be the value of a sole two-byte communication object ("**[Tx] Temperature Source**"), or a combination of two two-byte objects ("**[Tx] Temperature Source 1**" and "**[Tx] Temperature Source 2**") with a configurable proportion. These objects should be themselves linked to those that report the temperature measurement (e.g., the object of the internal temperature probe). See section 2.1.

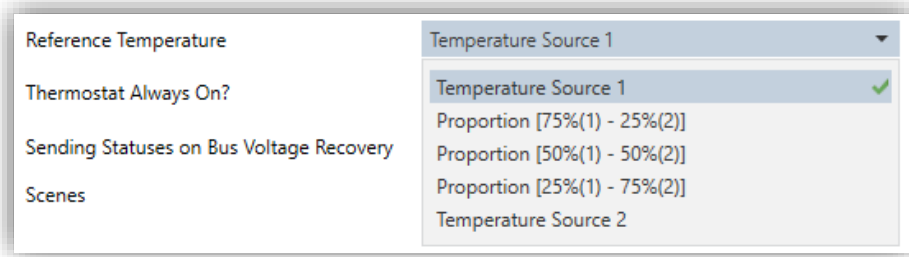


Figure 11. Reference Temperature.

In case of selecting a proportion of the two objects, a two-byte object named “[Tx] Effective Temperature” will be transmitted whenever the value of the temperature resulting from such combination changes.

- **Thermostat Always On?** [No / Yes]: sets whether the thermostat should remain always on or, on the contrary, whether it should be possible to turn it on / off externally.

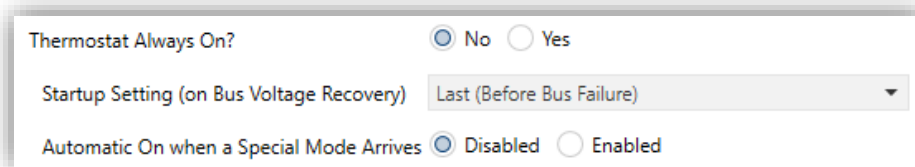


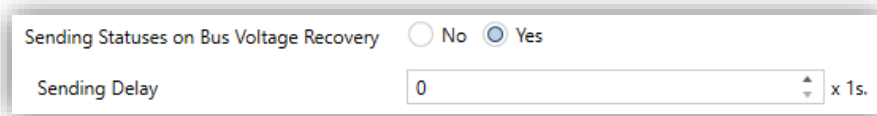
Figure 12. Thermostat Always On.

In case of selecting “No”, two new binary communication objects (“[Tx] On/Off” and “[Tx] On/Off (status)”) will show in ETS, as well as the following parameters:

- **Start-up Setting (on Bus Voltage Recovery)** [Last (Before Bus Failure) / OFF / ON]: sets the start-up state of the thermostat (after a power failure or an ETS download. “Last” will be considered as “Off” on the very first start-up (after a download).
- **Automatic ON when a Special Mode Arrives** [Disabled / Enabled]: enabling this option will make the thermostat automatically switch on (if off) whenever a mode order is received (even if it does not imply a changeover of the special mode, or if the object is not changing the value it already had) through “[Tx] Special Mode” (one byte) or “[Tx] Special Mode: *mode name*” (one bit), as well as when receiving a “1”

through the “[Tx] Window Status (input)” or the “[Tx] Comfort Prolongation” objects.

- **Sending Statuses on Bus Voltage Recovery** [No / Yes]: sets whether the device should send the KNX bus the thermostat state objects after the start-up. Sending their updated value is also possible after a certain **delay** [0...255] [x 1s].



The screenshot shows a configuration window titled "Sending Statuses on Bus Voltage Recovery". It contains two radio buttons: "No" (unselected) and "Yes" (selected). Below the radio buttons is a text input field labeled "Sending Delay" containing the number "0". To the right of the input field is a small upward and downward arrow icon followed by the text "x 1s".

Figure 13. Sending the Status on Bus Voltage Recovery.

Even if a delay time has been set, the following states are sent to the bus immediately after the bus voltage has been restored:

- Setpoint (Status)
 - On/Off (Status)
 - Control Variables
- **Scenes** [disabled/enabled]: enables the Scenes function of the thermostat, and the corresponding specific tab in the menu on the left (see 3.2.5).

3.2.2 SETPOINT

This window is only available if the thermostat type has been set to **Advanced**. It contains the parameters related to the setpoints of the different special modes and to the desired control type (absolute or relative). Reading section 2.5 is highly encouraged for a better understanding of these parameters.

With independence of how this screen is configured, objects “[Tx] Special Mode” and “[Tx] Special Mode (Status)” (one-byte size each) will permit selecting the desired special mode and checking which of them is currently active, respectively, according to the following table.

Value	Mode
1	Comfort
2	Standby
3	Economy
4	Protection

Table 2. Special Modes.

The parameters included in this tab are described next.

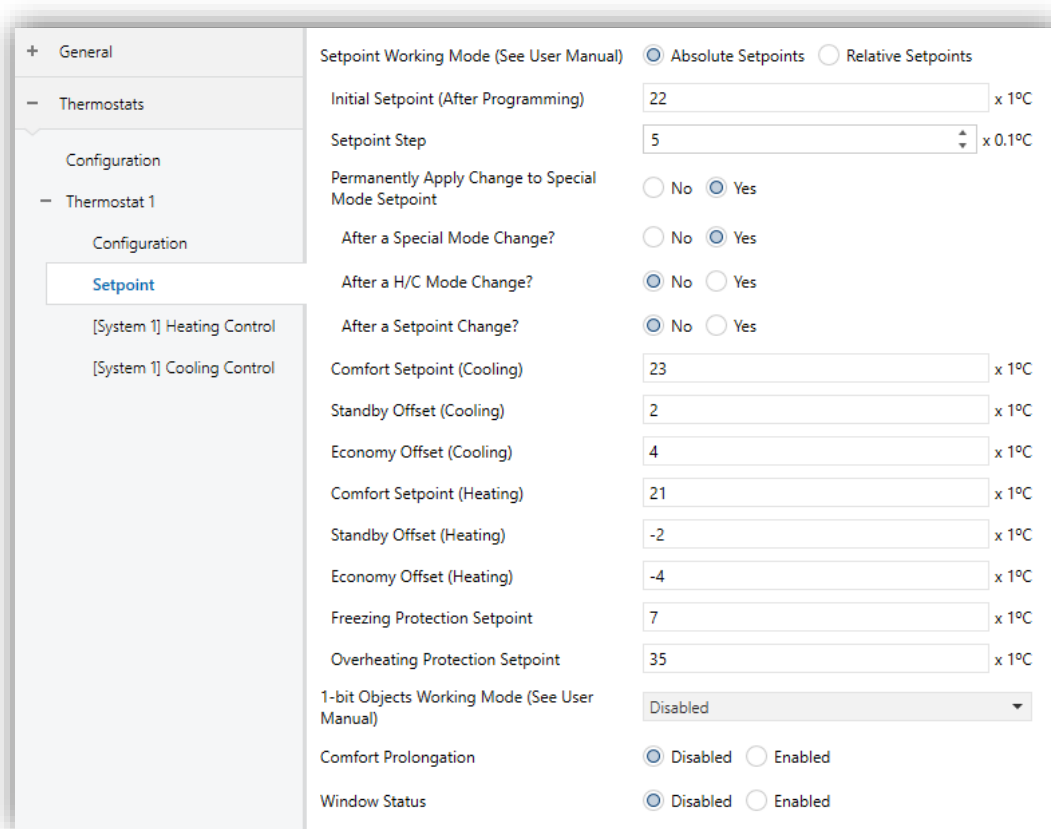


Figure 14. Absolute Setpoints.

Note: the figures shown next contain parameters related to both, the Heating and the Cooling modes. If only one of the two modes have been enabled, ETS will hide the parameters of the other mode

- **Setpoint Working Mode** [[Absolute Setpoints](#) / [Relative Setpoints](#)]: see sections 2.5.2.1 and 2.5.2.2. The specific parameters of one case and another will be detailed in sections 3.2.2.1 and 3.2.2.2, respectively.

- **1-bit Objects Working Mode** [*Trigger / Switch / Disabled*]: enables or disables the special mode selection once-bit objects, and sets the desired response type. These objects are: “[Tx] Special Mode: Comfort”, “[Tx] Special Mode: Standby”, “[Tx] Special Mode: Economy” and “[Tx] Special Mode: Protection”.

In case of opting for “Switch”, an additional parameter will show up (**Default Mode**) for the selection of the special mode to be adopted by the thermostat when all the binary objects have the value “0”. This option should not be confused with the selection of an initial mode for the thermostat, which is determined by the value set for **Initial Setpoint (After Programming)** (3.2.2.2) or for **Initial Mode (After Programming)** (3.2.2.1).

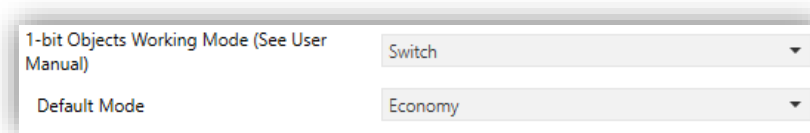


Figure 15. Mode Selection Objects.

In case of selecting “Disabled”, switching the special mode will only be possible through the one-byte “[Tx] Special Mode” object.

- **Comfort Prolongation** [*Disabled / Enabled*]: enables or disables the Comfort Prolongation function (see section 2.6) and shows/hides the “[Tx] Comfort Prolongation” one-bit communication object, which will make the thermostat –on the reception of the value “1”– switch to the Comfort mode, returning to the previous mode once the period defined in **Comfort Prolongation Time** [*[10...30...255] [min] / [1...255] [h]*] ends. Note that receiving the value “1” multiple times will reset the time count successively.

Note: if the value “1” is received through the “[Tx] Window Status (input)” object while the Comfort Prolongation time is counting, the thermostat will trigger the Protection mode until this object acquires the value “0” again, after which the thermostat will in any case consider the Comfort Prolongation time as expired, and will therefore adopt the corresponding special mode.

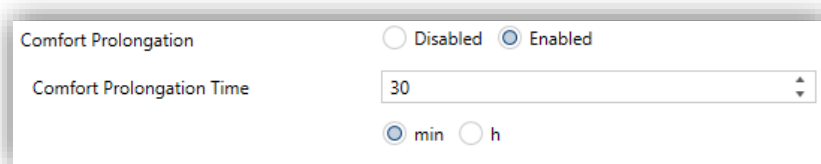


Figure 16. Comfort Prolongation.

- **Window Status** [*Disabled / Enabled*]: enables or disables the “[Tx] Window Status (input)” one-bit object, which will make the thermostat switch to the Protection mode if the value “1” is received through it. See section 2.6.

3.2.2.1 ABSOLUTE SETPOINTS

If **Setpoint Working Mode** is set to “Absolute Setpoints”, some specific parameters are also shown, as in Figure 14.

- **Initial Setpoint (after programming)** [-20...22...100] [x 1°C]: sets the desired setpoint temperature to be adopted by the thermostat initially, i.e., after an ETS download. This value will itself determine the special mode that will be assumed as active when the device starts up.

The value of the setpoint will be modifiable any time through the “[Tx] Setpoint” two-byte object, whose value will as well determine when the thermostat should switch the current mode. Object “[Tx] Setpoint (Status)” can be read to obtain the current setpoint value.

Another one-bit object (“[Tx] Setpoint Reset”) is provided so that when it receives the value “1”, the current setpoint temperature will be reset to its original value, as parameterized in ETS for the currently active special mode.

Note: *for absolute setpoints it is not possible to parameterise the initial special mode, as this will depend on the mode and the initial setpoint.*

- **Setpoint Step** [1...5...100] [x 0.1°C]: sets the increase/decrease in °C that will be applied to the setpoint when the value ‘0’ or ‘1’ is received through the object “[Tx] Setpoint Step”. This increase can have a value between 0.1°C and 10°C.

- **Permanently Apply Change to Special Mode Setpoint** [*No / Yes*]: enables or disables the option to store the current setpoint, as described in section 2.5.2.1. When enabled, three parameters are shown to separately select the vents upon which the setpoint will be stored: **After a Special Mode Change**, **After an H/C Mode Change** and **After a Setpoint Change**.

Permanently Apply Change to Special Mode Setpoint	<input type="radio"/> No	<input checked="" type="radio"/> Yes
After a Special Mode Change?	<input checked="" type="radio"/> No	<input type="radio"/> Yes
After a H/C Mode Change?	<input checked="" type="radio"/> No	<input type="radio"/> Yes
After a Setpoint Change?	<input checked="" type="radio"/> No	<input type="radio"/> Yes

Figure 17. Setpoint Storage.

- **Comfort Setpoint (Cooling) / Comfort Setpoint (Heating)** [*-20...100*] [*x 1°C*]: sets the initial setpoint temperature for the Comfort mode, respectively under Cooling and under Heating.

Important note: *to ensure a proper automatic commutation between the Cooling and Heating modes, the setpoint for Comfort (Cooling) needs to be greater than that for Comfort (Heating), and there must be at least a separation of 2°C between both.*

- **Standby Offset (Cooling) / Standby Offset (Heating)** [*0...10*] [*x 1°C*]: sets the initial setpoint temperature for the Standby mode, respectively under Cooling and under Heating, which is here expressed as a certain increment or decrement with respect to the value set for Comfort.

Example: *Standby Offset.*

Suppose a setpoint temperature that has been configured to have an initial value of 23°C for Comfort (Cooling) and of 21°C for Comfort (Heating). In such case, if a setpoint of 25°C is required for Standby (Cooling) and of 18.5°C for Standby (Heating), it will be necessary to set offset values of 2°C and of -2.5°C, respectively.

- **Economy Offset (Cooling) / Economy Offset (Heating)** [*0...10*] [*x 1°C*]: sets the initial setpoint temperature for the Economy mode, respectively

under Cooling and under Heating. The configuration is analogous to that of the above parameter.

- **Freezing Protection Setpoint** [-10...7...15] [x 1°C]: sets the initial setpoint for the Protection special mode under the Heating mode, between -10°C and 15°C.
- **Overheating Protection Setpoint** [25...35...120] [x 1°C]: sets the initial setpoint for the Protection special mode under the Cooling mode.

The remaining parameters of this window were already explained in section 3.2.2, as the all are common for both, Absolute Setpoints and Relative Setpoints.

3.2.2.2 RELATIVE SETPOINTS

If **Setpoint Working Mode** is set to “Relative Setpoints”, some specific parameters are also shown, as the following figure illustrates.

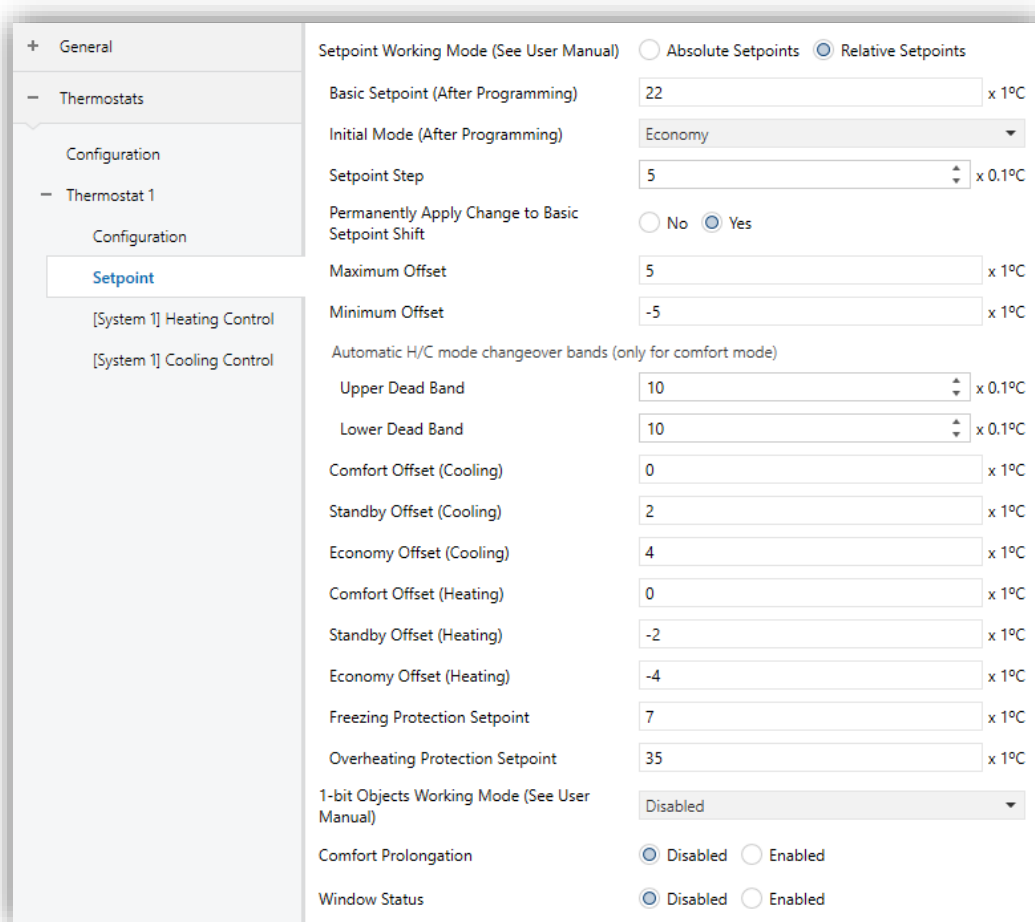


Figure 18. Relative Setpoints.

Through the Relative Setpoints method, the integrator is required to set a base temperature value, and a positive or negative offset for each special mode, which determines its default setpoint temperature.

The base temperature can be modified in runtime through “[Tx] Basic Setpoint” and also be read through “[Tx] Basic Setpoint Status”. It will be also possible to set an additional increment or decrement (user offset) in runtime (see section 2.5.2.2), which leads to:

$$\text{Setpoint} = \text{Base Temp.} + \text{Mode Offset (parameter)} + \text{User Offset (object)}$$

The user offset can be controlled alternatively through the following objects:

- “[Tx] Setpoint Step”, one-bit object that increase/decrease the offset and, at the same time, the setpoint by a value set by parameter.
- “[Tx] Setpoint Offset”, two-byte object that lets the user set the exact value of the desired increment or decrement.
- “[Tx] Offset Restart”, which, on the reception of a “1”, resets the setpoints to the values that were initially defined by parameter, i.e., sets the user offset to “0”.

On the other hand, objects “[Tx] Setpoint Status” and “[Tx] Setpoint Offset Status” make it possible to send the thermostat a read request of the current values of the *total* setpoint and of the user offset, respectively.

This tab offers the following configurable parameters:

- **Basic Setpoint (after programming)** [-20...22...100] [x 1°C]: sets the initial value of the base temperature, which will be considered as a reference for the setpoints of the various special modes (which are parameterised in terms of a certain offset to this base temperature). See section 2.5.2.2 for further details.

As already stated, this base value can be modified later through “[Tx] Basic Setpoint”, and read through “[Tx] Basic Setpoint Status”, two-byte objects both.

- **Initial Mode (After Programming)** [Comfort / Standby / Economy]: sets the special mode that will be initially active in the thermostat.

- **Setpoint Step** [1...5...100] [x 0.1°C]: sets the increase/decrease in °C that will be applied to the setpoint when the value '0' or '1' is received through the object "[Tx] Setpoint Step".
- **Permanently Apply Change to Basic Setpoint Shift** [No / S]: allows enabling or disabling the option to store the user offset when the thermostat leaves the current special mode, so in case the user had altered the setpoint by a certain value "x" with respect to the setpoint of that mode, the target special mode will also shift its own setpoint by "x".
- **Maximum offset** [0...5...20] [x 1°C] / **Minimum offset** [-20...-5...0] [x 1°C]: maximum total increment (i.e., upper limit) permitted for the setpoint with respect to the base temperature. Values 0°C to 20°C (upwards or downwards) can be set. See example "Relative Setpoints and Offset Storage" in section 2.5.2.2.
- **Comfort Offset (Cooling)** [0...10] [x 1°C] / **Comfort Offset (Heating)** [-10...0] [x 1°C]: sets the setpoint temperature corresponding to the Comfort mode, respectively for Cooling and Heating, expressed as an offset (upwards or downwards) with respect to the base temperature.
- **Standby Offset (Cooling)** [0...2...20] [x 1°C] / **Standby Offset (Heating)** [-10...-2...0] [x 1°C]: analogous to the previous parameter, but for the Standby mode.
- **Economy Offset (Cooling)** [0...4...10] [x 1°C] / **Economy Offset (Heating)** [-10...-4...0] [x 1°C]: analogous to the previous parameter, but for the Economy mode.
- **Freezing Protection Setpoint** [-10...7...15] [x 1°C]: sets the initial setpoint for the Protection special mode under the Heating mode.
- **Overheating Protection Setpoint** [25...35...120] [x 1°C]: sets the initial setpoint for the Protection special mode under the Cooling mode.

If **Thermostat Function** (section 3.2.1) was set to "Heating and Cooling" and the **automatic H/C mode changeover** has been enabled, the following two parameters will also show up in the Setpoints tab.

Automatic H/C mode changeover bands (only for comfort mode)		
Upper Dead Band	10	x 0.1°C
Lower Dead Band	10	x 0.1°C

Figure 19. Automatic H/C Mode Changeover Bands.

- **Upper Dead Band / Lower Dead Band** $[0...10...100]$ $[x 0.1°C]$: sets the width of the dead band around the Comfort setpoint, therefore conditioning when the automatic changeover between the Cooling and Heating modes will take place (see section 2.2.2).

The remaining parameters of this window were already explained in section 3.2.2, as the all are common for both, Absolute Setpoints and Relative Setpoints.

3.2.3 [SYSTEM x] HEATING CONTROL

The “[System x] Heating Control” tab offers the integrator the option to set the algorithm and all the parameters involved in the Heating working mode of the thermostat. For a proper configuration it is important to first read the initial sections of this user manual.

+ General	
- Thermostats	
Configuration	
- Thermostat 1	
Configuration	
Setpoint	
[System 1] Heating Control	
Control Method	<input checked="" type="radio"/> 2-Point Control <input type="radio"/> PI Control
Lower Hysteresis	10 x 0.1°C
Upper Hysteresis	10 x 0.1°C
Resending Period (0 = Disabled)	0
	s

Figure 20. Heating.

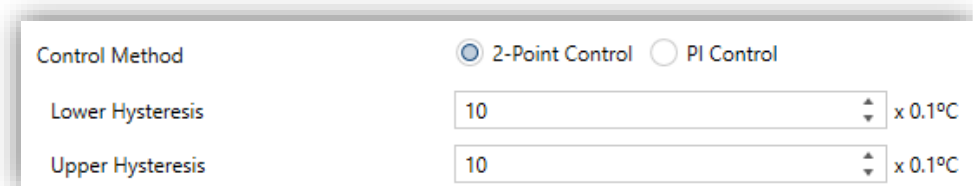
- **Control Method** $[2\text{-Point Control} / PI\text{ Control}]$: selects the control algorithm to be applied. The options are “2-Point Control” (section 3.2.3.1) and “PI Control” (section 3.2.3.2).
- **Resending Period** $[[0...255] [s / min] / [0 / 18] [h]]$: sets every how much time the control variable (i.e., object “[Tx][Sx] Control Variable (Heating)”) will be sent to the bus. A value of “0” disables the sending.

Note: the additional system control variable will only be sent periodically if the additional system is turned on.

If **2 systems** are selected for the heating mode, a tab appears for each system ("[System 1] Heating Control" and "[System 2] Heating Control"). Both tabs are identical and allows to configure how the system will behave if it acts as the **main system**. The activation and deactivation of the secondary system is defined by the activation and hysteresis bands configured in the "Configuration" tab (see section 3.2.1).

3.2.3.1 2-POINT CONTROL

After selecting the "two-point control method" with hysteresis (see section 2.3.1), the following parameters must be configured:



Control Method	<input checked="" type="radio"/> 2-Point Control	<input type="radio"/> PI Control
Lower Hysteresis	10	x 0.1°C
Upper Hysteresis	10	x 0.1°C

Figure 21. Two-Point Hysteresis Control Method.

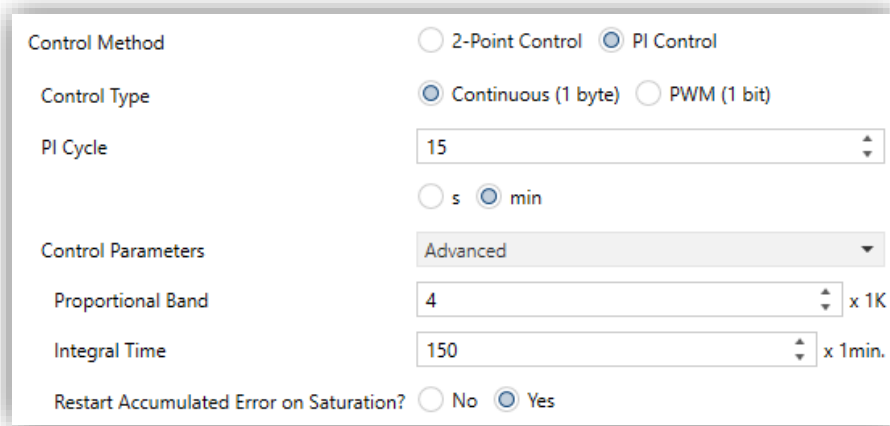
- **Lower Hysteresis** [1...10...200] [x 0. 1C]: defines the value of the lower hysteresis, i.e., the width of the lower margin around the setpoint temperature.
- **Upper Hysteresis** [1...10...200] [x 0. 1C]: sets the value of the upper hysteresis, i.e., the width of the upper margin around the setpoint temperature.

The control variable will be in this case a one-bit object, "**[Tx][Sx] Control Variable (Heat)**", which will throw the value "1" when the thermostat considers that the room needs to be heated, and the value "0" while the climate system can remain off.

This variable will be sent periodically, according to the aforementioned parameter **Resending Period**.

3.2.3.2 PI CONTROL

After selecting the “PI control” method (see section 2.3.2), the following parameters must be configured:



Control Method	<input type="radio"/> 2-Point Control <input checked="" type="radio"/> PI Control
Control Type	<input checked="" type="radio"/> Continuous (1 byte) <input type="radio"/> PWM (1 bit)
PI Cycle	15 <input type="radio"/> s <input checked="" type="radio"/> min
Control Parameters	Advanced
Proportional Band	4 x 1K
Integral Time	150 x 1min.
Restart Accumulated Error on Saturation?	<input type="radio"/> No <input checked="" type="radio"/> Yes

Figure 22. PI Control.

The control variable (“**[Tx][Sx] Control Variable (Heat)**”) in this case may be either a one-byte or a one-bit object, depending on the configuration of the **Control Type** parameter, as explained below.

The configurable parameters are:

- **Control Type** [[Continuous \(1 byte\)](#) / [PWM \(1 bit\)](#)]: sets whether the climate system valve should be controlled through precise positioning or through on/off orders.

In case of choosing “[Continuous \(1byte\)](#)”, the control variable will be a one-byte object and will reflect, as a percentage, the degree of openness required in the valve (100% = entirely open; 0% = entirely closed).

In the second case, “[PWM \(1 bit\)](#)”, this one-byte object will be available together with two new one-bit objects:

- One, with the same name as the above one-byte variable, will alternatively adopt the values “1” and “0” depending on the cycle time (**PI Cycle** [[\[10..255\] \[s\]](#) / [\[1..15..255\] \[min\]](#)]) so that the time proportion between the two states equals the aforementioned degree of openness.

- Another one, named “[Tx] PI State (Heat)” will have the value “1” as long as the value of the PI signal is greater than 0%, and the value “0” while it is exactly 0%.

Moreover, when the control type is set to “PWM (1 bit)”, the following specific parameters need to be configured:

The screenshot shows a configuration window for PWM Control (1 bit). It includes the following elements:

- Control Type:** Two radio buttons are present: "Continuous (1 byte)" (unselected) and "PWM (1 bit)" (selected).
- PWM Minimum Time:** A numeric input field contains the value "10", followed by a unit multiplier "x 1 s".
- If the Switching Time Is Lower than the Minimum:** Two radio buttons are present: "Switch the Control Signal Using the Minimum..." (selected) and "Keep the Control Signal with Its Value" (unselected).

Figure 23. PWM Control (1 bit).

- **PWM Minimum Time** [1...10...60] [x 1s]: minimum time the control signal should stay unchanged, in order to prevent rapid relay commutations.
- **If the switching time is lower than the minimum** [Switch the control signal using the minimum time / Keep the control signal with its value]: sets what to do when the control signal needs to switch its state faster than what the above parameter allows.
- **PI Cycle** [10...255] [s] / [1...15...255] [min]: sets every how much time the required degree of openness of the valve (or, in the case of the PWM modulation, the proportion between the intervals the signal is “1” and “0”) will be re-calculated.
- **Control Parameters** [Warm Water / Floor Heating / Electric Heating / Blow Convector / A/C Split / Advanced]: defines the desired values for the K and T parameters of the PI algorithm. It is highly encouraged to make use of the pre-set values (see *ANNEX: Pre-set Values for the PI Control*) however it is possible to specify custom values (“Advanced”). Selecting the latter brings the following parameters.
 - **Proportional Band** [1...4...15] [x 1K]: defines the value for K (the proportional constant).
 - **Integral Time** [5...150...255] [x 1min]: sets a value for T.

- **Restart Accumulated Error on Saturation** [No / Yes]: activates or deactivates this function during the algorithm application (see section 2.3.2). In case of selecting any of the pre-set values for the control parameters, this option will be implicitly activated.

3.2.4 [SYSTEM x] COOLING CONTROL

The “[System x] Cooling Control” tab offers the integrator the option to set the algorithm and all the parameters involved in the Cooling working mode of the thermostat. For a proper configuration it is important to first read the initial sections of this user manual.

The parameters in this tab and all the communication objects involved are analogous to those of the “[System x] Heating control” (see section 3.2.3), although in this case they refer to the Cooling mode of the thermostat (e.g., the related communication objects include the word “**(Cool)**” in their names, instead of “**(Heat)**”).

Control Method	<input type="radio"/> 2-Point Control <input checked="" type="radio"/> PI Control
Control Type	<input checked="" type="radio"/> Continuous (1 byte) <input type="radio"/> PWM (1 bit)
PI Cycle	15
	<input type="radio"/> s <input checked="" type="radio"/> min
Control Parameters	Advanced
Proportional Band	4 x 1K
Integral Time	150 x 1min.
Restart Accumulated Error on Saturation?	<input type="radio"/> No <input checked="" type="radio"/> Yes
Resending Period (0 = Disabled)	0
	s

Figure 24. Cooling.

If **2 systems** are selected for the cooling mode, a tab appears for each system (“[System 1] Cooling Control” and “[System 2] Cooling Control”). Both tabs are identical and allows to configure how the system will behave if it acts as the **main system**. The activation and deactivation of the secondary system is defined by the activation and hysteresis bands configured in the “Configuration” tab (see section 3.2.1).

On the other hand, the **PI control** is provided in this case with the following pre-set options for the control parameters [Cooling Ceiling / Blow Convector / A/C Split / Advanced] (see ANNEX: Pre-set Values for the PI Control).

3.2.5 SCENES

After enabling **Scenes** in the general “Configuration” (see section 3.2.1), a new tab will be included into the menu on the left.

As shown in Figure 25, from this tab it is possible to independently enable up to five scenes, and to configure what action will be taken over the different attributes of the thermostat.

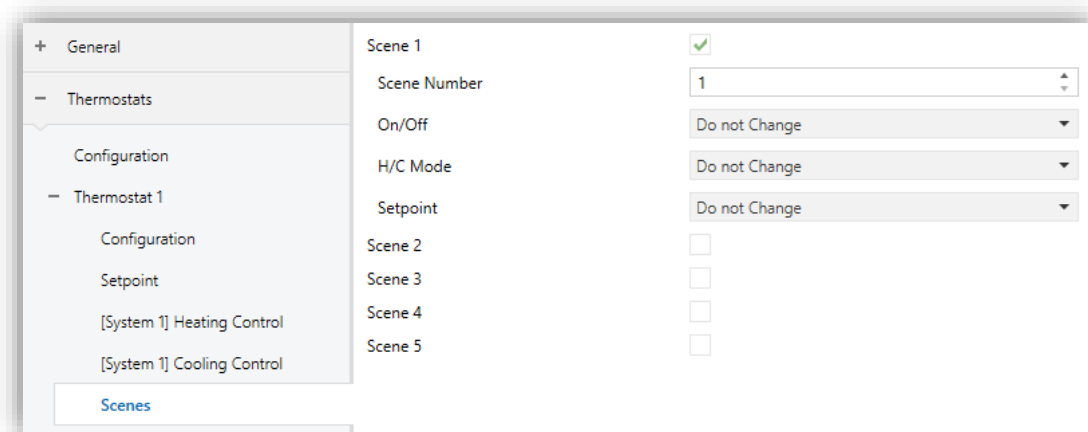


Figure 25. Scenes.

For each of the five scenes, the parameters are:

- **Scene Number** [1...64]: number of the scene the arrival of which (through “[Thermostat] Scene: Input”, decremented by one according to the standard) will trigger the execution of the actions defined below.

Note: the reception of scene-saving commands (values between 128 and 191) is also possible, so that the configuration initially parameterised for the scene can be overwritten with the one the thermostat is executing at a certain time. See section 2.7.

- **On / Off** [Do not change / On / Off]: sets the on/off state the thermostat will adopt upon the execution of the scene. In case the option **Thermostat always ON** (section 3.2.1) has been activated, this parameter will not be available.

Note: if this is set to “Do not Change”, the on/off state of the thermostat will be also ignored when saving the scene. See section 2.7.

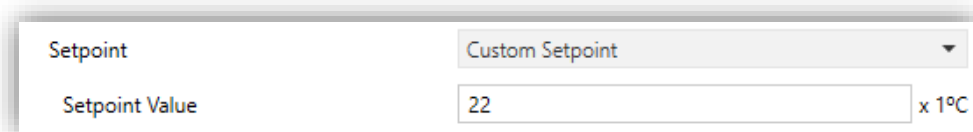
- **H/C Mode** [Do not change / *Cooling* / *Heating*]: sets the general operation mode the thermostat will adopt upon the execution of the scene. In case the option **H/C Automatic changeover** (section 3.2.1) has been activated, this parameter will not be available.

Note: if this is set to “Do not Change”, the general operation mode of the thermostat will be also ignored when saving the scene. See section 2.7.

- **Setpoint** [Do not Change / *Comfort* / *Standby* / *Economy* / *Protection* / Custom Setpoint]: sets a specific setpoint value or a specific special mode the thermostat will adopt upon the execution of the scene. Note that under a **basic** configuration of the thermostat (section 3.2.1) only “Custom Setpoint” and “Don’t Change” will be available.

When setting the option “Custom Setpoint”, **Setpoint Value** will show up:

- In case of having selected the **absolute setpoints** control method (section 3.2.2.1), the available range will be -20°C to 100°C.
- In case of having selected the **relative setpoints** control method (section 3.2.2.2), the available range will remain the same however in this case they will refer to the **base reference**, and not to the setpoint itself.



The image shows a digital thermostat interface. At the top, the word 'Setpoint' is displayed. Below it, a dropdown menu is open, showing 'Custom Setpoint' as the selected option. Underneath the dropdown, there is a text input field labeled 'Setpoint Value' containing the number '22'. To the right of the input field, there is a small icon of a degree symbol followed by 'x 1°C'.

Figure 26. Scene with a Custom Setpoint.

Note: if this is set to “Do not Change”, the current special mode or setpoint of the thermostat will be also ignored when saving the scene. See section 2.7.

ANNEX: PRE-SET VALUES FOR THE PI CONTROL

The tables below show the different profiles for the PI Control that have been pre-set in the Zennio thermostat, together with the corresponding values of K and T.

Profile	K	T (minutes)
Warm Water	5	150
Floor Heating	5	240
Electric Heating	4	100
Blow Convector	4	90
A/C Split	4	90

Table 3. PI Control Profiles for the Heating Mode

Profile	K	T (minutes)
Cooling Ceiling	5	240
Blow Convector	4	90
A/C Split	4	90

Table 4. PI Control Profiles for the Cooling Mode

These values have been obtained empirically, and are therefore optimised for the most common climate control contexts. Making use of them is highly encouraged, leaving the manual configuration of these values for very specific situations and for specialists with experience in advanced climate control.

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