ZENNIO APPLICATIONS

CLIMA I

Thermostat ZENNIO

Edition 1

INDEX

1. INTRODUCTION

The present document, **Thermostat ZENNIO – CLIMA I,** begins a **series** of **specific documentation** about Zennio's products aimed at the **air-conditioning discipline**. This series of documents consists of the following titles:

- **Thermostat ZENNIO – CLIMA I**
- **Split (Quick Guide) – CLIMA II**
- **Zoning KNX – CLIMA III**
- **Fan Coil – CLIMA IV**
- **Fan Coil: thermostatic control over fan – CLIMA V**
- **Radiant floor with additional heating source – CLIMA VI**

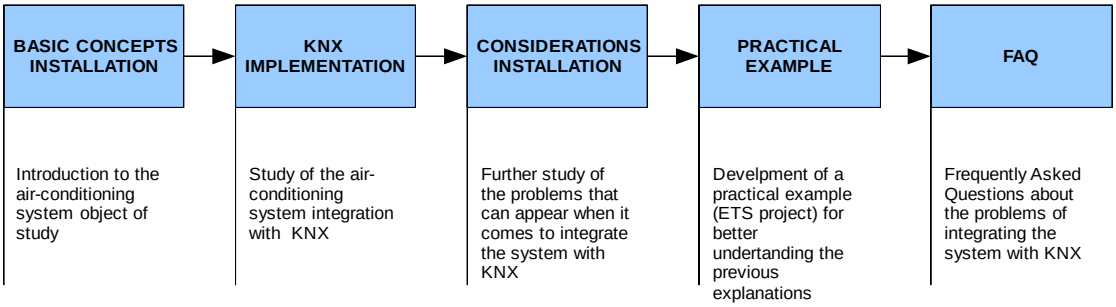
The integration of the air-conditioning in the domotic control is possibly one of the most complicated aspects to carry out. Moreover, there is also very little documentation about it in the standard KNX.

From Zennio, we want to take advantage of both our **experience** with this type of installations and the versatility of our products in this area for presenting this document. The documentation tries to **bring closer the air-conditioning integration** to all integrators.

The **purpose** for these manuals is making the best performance of those Zennio products dedicated to control air-conditioning devices, basing on two fundamental factors:

- **Product Knowledge**
- **Technical aspects of product integration in air-conditioning installations**

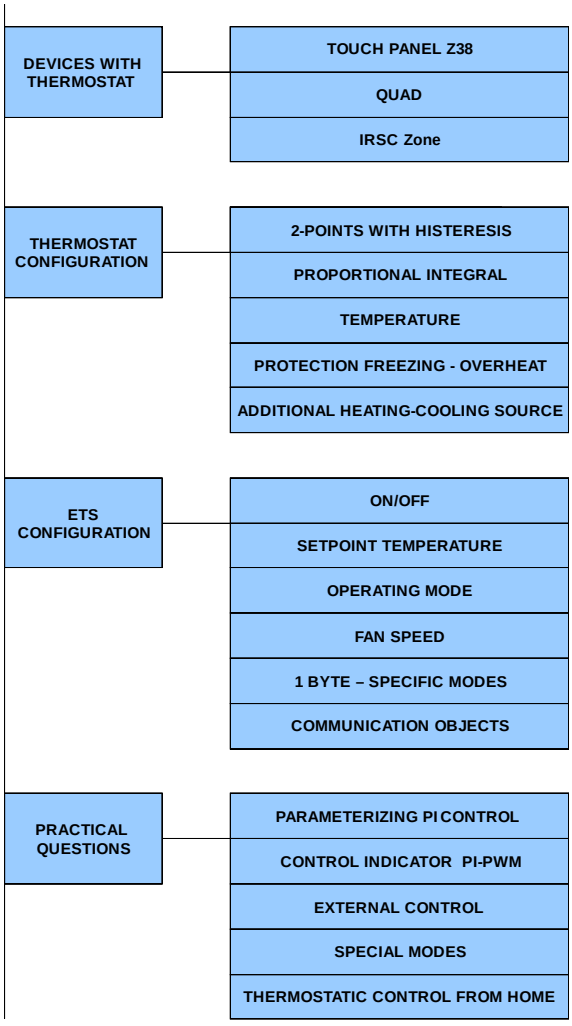
Therefore, this is not only a specific product guide but also a collection of information that facilitates the comprehension of product integration in installations. For that, in the specific air-conditioning guides (manuals CLIMA II, CLIMA III, CLIMA IV, CLIMA V and CLIMA VI), it is followed next document structure:



The document **CLIMA I** is a guide to understand the **thermostats** incorporated in some **Zennio's products**, and it is also useful as a general introduction of Zennio's products integration in installations for controlling the air-conditioning.

This documentation tries to bring up the integrator in the fundamental aspects of **thermostat control**, **basic principle** without which it is not possible to adjust the performance in an air-conditioning installation. And, consequently, the installation cannot be successfully achieved.

The aspects to deal with in this document are the following:



2. DEVICES WITH THERMOSTAT

In Zennio's products family, the thermostat can be found implemented in three of them:

1. Touch panel InZennio Z38

The touch panel InZennio Z38 allows the implementation of up to 4 thermostats in the same panel. In addition, it incorporates a probe that allows measuring the temperature. This means that the touch panel is able to measure the temperature in the room where it is located, and offer the variable as input for the thermostat calculations.

This thermostat allows choosing between two types of thermostatic control that will be explained in the following section: Thermostat Configuration. Control Types.

2. A/D Sensor QUAD

The A/D sensor QUAD incorporates the same thermostat that the touch panel Z38 has incorporated, with one condition, this device can obtain up to 4 different measures of temperature due to the 4 NTC probes that can be connected to its 4 inputs, instead the only measure that the Z38 is able to carry out.

3. IRSC (application program IRSC Zone)

The application program **Zone** (IRSC) only incorporates one thermostatic function of type 2 points with hysteresis, directly applied to the control of the grilles located in a zoning installation. Up to 8 zones can be parameterized so it can be carried out up to 8 thermostatic calculations.

For expanding the information, look up the document **Zoning KNX – Clima III**.

This device does not have temperature measuring function.

3. THERMOSTAT CONFIGURATION

3.1. TYPE OF CONTROL

The thermostatic control can be carried out in two different ways depending on the algorithm used for the calculations of that control.

Zennio's products offer two different control types:

- 2 POINTS WITH HYSTERESIS.
- PROPORTIONAL INTEGRAL (PI).

These types are explained in the following sections:

3.1.1. 2 POINTS WITH HYSTERESIS

The 2-points hysteresis control system is less efficient than other control systems that are more advanced. Nevertheless it may be very interesting for some installations. It is the control implemented in conventional thermostats.

In this control system we have to establish a setpoint temperature, and two hysteresis: lower and upper hysteresis. The purpose of the hysteresis is that the system is not continuously switching around a setpoint temperature in brief time periods.

Example: A setpoint temperature equal to 25 ºC is established (mode "heating").

Both the lower and the upper hysteresis are equal to 1ºC.

The initial room temperature is 19 ºC. When the temperature reaches 25 ºC, the system will go on heating, until the temperature reaches 26 ºC. Once the upper hysteresis is reached, the system is switched off. While the system is off, the temperature begins to decrease, but the system will not be switched on at 25 ºC (setpoint temperature): it will do it when the lower hysteresis is reached. This is when the room temperature is equal to 24 ºC.

In the course of this process, it is obtained a very typical graph similar to the saw teeth. See Figure 3.

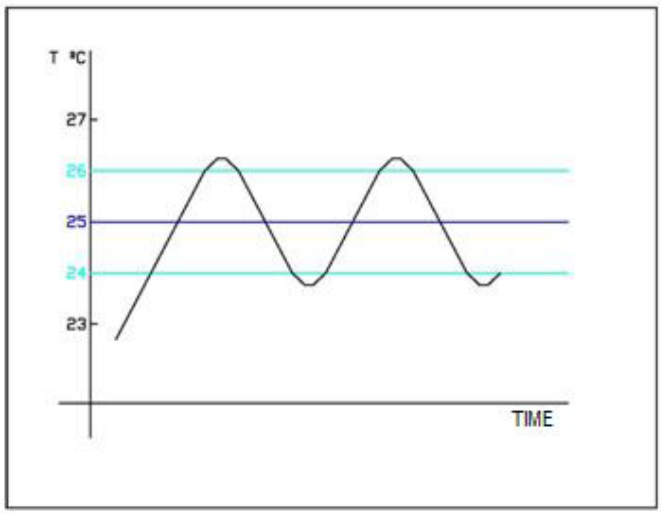


Figure 3.Typical graph of 2 points with hysteresis system

The problem of this control type is the continuous oscillation that has direct influences in the energetic consumption and comfort, as shown in next Figure:

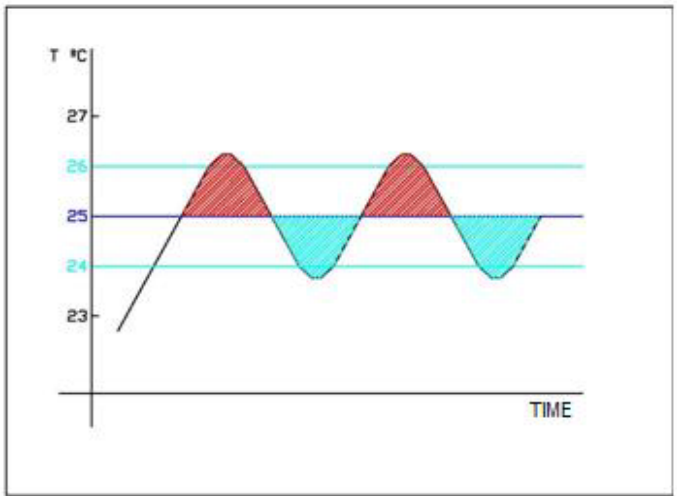


Figure 4.Inefficiency of 2 points with hysteresis control

The red zone indicates an excess in the energetic consumption, because the room temperature is upper than the setpoint temperature.

The blue zone indicates a lack of comfort because the room temperature is lower than the setpoint temperature. Moreover and unlike we could think at first, the blue zone or comfort lack does not compensate the excess energetic consumption of the red zone.

3.1.2. PROPORTIONAL INTEGRAL

Other possibility offered in Zennio's products for carrying out the thermostat function is the selection of the PROPORTIONAL INTEGRAL (PI) control. In short, this control type could be defined in the following way:

PI is a system of integral calculation that depends on two values:

K: Proportional constant, in Kelvin grades (ºK), that allows estimating one error value de error proportional to the difference between the setpoint temperature and the room temperature.

T: Integration time, in minutes (min) that depends on the thermal lag of the air-conditioning system that allows adjusting the approximation error in connection with the passed time.

When configuring this control type, the integrator will have to select from a pull down list, between a series of value pairs K and T. Some of these typical pairs are the following:

System	K	T
Split	4 ºK	90 min
Radiant Floor	5 ºK	240 min
Electric Heating	4 ºK	100 min

It is also given the chance of introducing manually this two parameters, but this is only advised for air-conditioning experts.

Moreover, it is necessary to specify a **time cycle** for carrying out the calculations. The time cycle depends a lot on the thermal lag of the air-conditioning system that is being installed. For air-conditioning systems with low thermal lag, the time cycle has to be higher.

For increasing the knowledge about this topic, it is advised the reading of the **Parameterization of a PI Control in Section 5.**

The PI control system has two variants: PI-Continuous and PI-PWM.

PI – continuous is carried out by means of one variable of 1 byte. This 1-byte variable keeps a percentage that indicates the opening percentage that the valve has to acquire in a certain time cycle. This means that a value of 50% for the PI – Continuous is indicating the valve to open in half.

The inconvenient for this type of control is that the systems need more sophisticated valves than the all – nothing valves, making difficult their control and increasing the installation cost.

For this reason the percentage value is traduced, by means of the Pulse Width Modulation (PWM), for controlling all-nothing valves or status).

Example: Using a control PI – Continuous and a control PI – PWM.
When the value of variable PI-Continuous is equal to 50%, in PWM the variable is "1" during the first time cycle (Ton) and it is "0"during the last half time cycle (Toff).
When the value of PI-Continuous is equal to 50%, the modulation PWM maintains a pulse equal to "1" during ¼ of the time cycle, and a pulse equal to "0" during ¾ of the time-cycle.

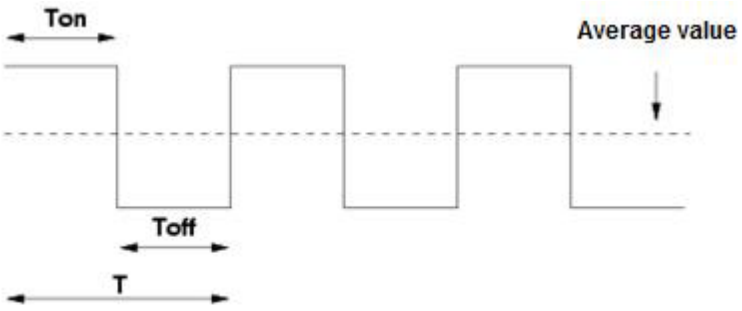


Figure 5.Value of variable PI equal to 50%.

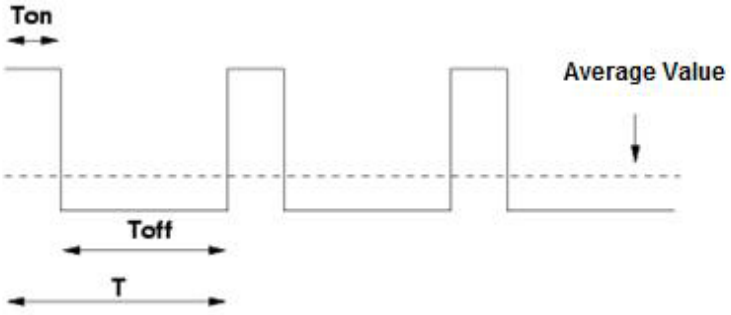


Figure 6.Value of variable PI equal to 25%.

To finish, a typical graph of the temperature evolution under a PI control system is shown (theoretical graph that is not the result of any real simulation):

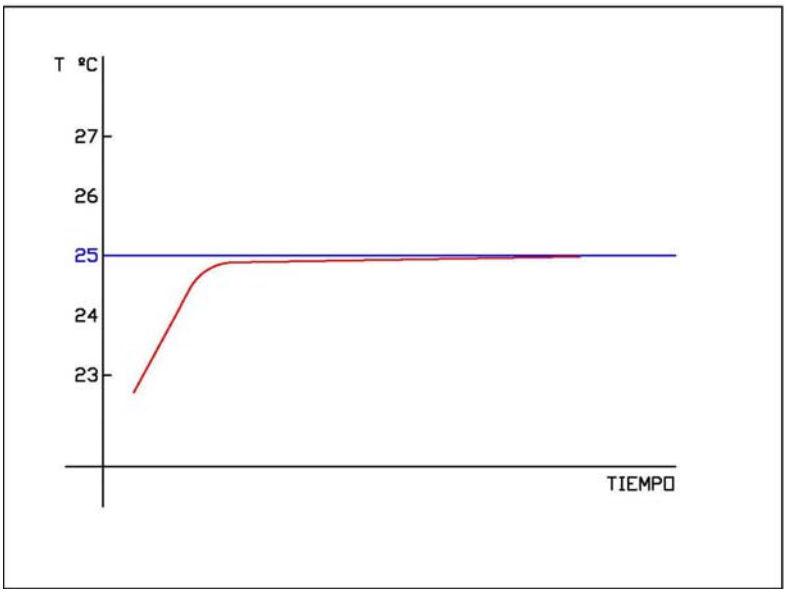


Figure 7.Typical graph of PI system

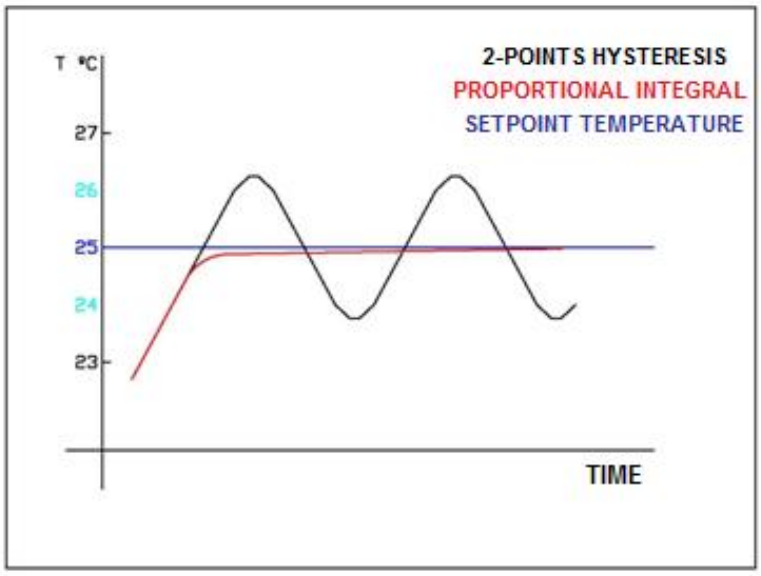


Figure 8.Ideal comparison between control systems

3.1.3. TEMPERATURE

For the thermostatic control it is necessary to indicate two fundamental values to the calculating algorithm:

- **Setpoint temperature:** It is the desired temperature for the room. This temperature is selected by the user by means of devices used as interface between the installation and the user (i.e. with touch panel Z38).

- **Room temperature:** It is the room temperature measured by one device able to do it.

With those input data, the thermostat algorithm carries out the calculations directly depending on its internal parameterization.

Next, it can be found some particularities of different Zennio's products with regard to the temperature measures:

3.1.4. TOUCH PANEL INZENNIO Z38

In order to carry out the thermostat calculation, an external temperature measure can be also used.

The external measure can be mixed with the internal temperature from the Touch Panel in different proportions:

Internal Probe	External Probe
100 %	0 %
75 %	25 %
50 %	50 %
25 %	75 %
0 %	100 %

The object of this option is to use different temperature measures for only one thermostat. This is very interesting, for example, for spacious rooms.

3.1.5. A/D SENSOR QUAD

The A/D sensor QUAD has four analogical inputs where it is possible to connect a temperature probe NTC. In this case, every thermostat is associated to one entry, and it can be carried out a proportional mix (like in Z38) with one external temperature from QUAD.

There is no internal links for using 2 measures from one QUAD in the thermostat of the same QUAD.

3.1.6. IRSC (APPLICATION PROGRAM IRSC ZONE)

The device IRSC does not have any analogical input where connecting a NTC probe for measuring temperature, as in the QUAD. It does not have either any temperature probe directly incorporated in its hardware, as in the touch panel Z38 (it incorporated the probe in its first versions but this option was finally removed).

Therefore, it is not possible to obtain a temperature measure with the device IRSC.

Nevertheless, as it has been mentioned before, it does have thermostat function. For carrying out this function, the application program Zone for IRSC has a 2-byte communication object for every enabled zone (zoning). By means of this object we can communicate the temperature measured by other device (i.e. by a touch panel Z38 or a QUAD), that will be used for the thermostatic calculations.

In this case, different temperature measures cannot be directly mixed for the same thermostat, so it will be used the temperature value introduced in the communication object previously-mentioned.

3.2. COOLING – HEATING PROTECTION: FUNCTIONING (Z38 AND QUAD)

Protection from overheating or freezing is developed in Zennio's thermostat. This protection activates the suitable air-conditioning element to avoid "extreme" temperatures.

The protection, from overheating or freezing, is activated even when the thermostat is switched off. The only way of activating/deactivating that function is through the tool ETS, in the thermostat parameterization.

The limit temperatures from which the protections are activated can be only parameterized with the ETS. There is no possibility of doing it by means of communication objects.

When activating/deactivating the protection an hysteresis equal to 1ºC has been implemented (lower for overheating protection and upper for freezing protection).

Although the protection is activated, there is no signal of it in *Clima* page. The only action is executed over the value of the control system variable, forcing its value in such a way that the air-conditioning system acts in the fastest way:

PROTECTION FROM OVERHEATING:

VARIABLE	SIZE	VALUE
PI – PWM (COOLING)	1 BIT	1
PI – CONTINUOS (COOLING)	1 BYTE	100 %
2 POINTS WITH HYSTERESIS (COOLING)	1 BIT	1

PROTECTION FROM FREEZING:

VARIABLE	SIZE	VALUE
PI – PWM (HEATING)	1 BIT	1
PI – WITHTINUO (HEATING)	1 BYTE	100%
2 POINTS WITH HYSTERESIS (HEATING)	1 BIT	1

Example. Establishing protection from overheating and freezing:

- Upper limit: 35 ºC
- Lower limit: 7 ºC
- Control method: PI - CONTINUOUS

At a given moment the setpoint temperature for the thermostat is equal to 6.9 ºC, so the value of the variable is forced to the value 100%. This happens despite the thermostat is in the status OFF.

Due to the air-conditioning system action, the temperature begins to increase. Once the temperature is higher than 8 ºC (1 ºC of hysteresis), the value of the variable is again modified with value 0%.

3.3. ADDITIONAL COOLING-HEATING SOURCE (Z38 AND QUAD)

Zennio's thermostat incorporates the possibility of using additional heating or cooling sources, in order to control the temperature in the rooms to acclimatize (in case of having more than one air-conditioning system).

By means of the thermostat parameters, it can be defined the temperature band where the additional system begins to work. The parameter called *"Additional heating band"* determines the difference between the maximum temperature of the additional heating band and the setpoint temperature. In case of using an additional cooling source, the "*Additional cooling band*" determines the minimum difference between the minimum temperature of the additional cooling band and the setpoint temperature.

The intervention of the additional system is activated with a dedicated communication object of 1-bit. When the room temperature is in the additional band, the communication object gets the value "1", and returns the value "0" when the temperature is inside the usual working band. There is no hysteresis for this function.

This function is very useful to make the most of installations, because the comfort provided by them is increased, since different air-conditioning systems interact with the same aim.

An example could be the use of one Split as additional heating source in a room where the main air-conditioning system is a radiant floor which has a slower thermal lag than other systems like the split and, it reacts more gradually to setpoint temperature. That is the reason why the Split is a suitable system when great temperature changes are required (for example, an increase of 2 ºC in setpoint temperature).

Example. Using an additional heating system to acclimatize a room:

- Main air-conditioning system: Radiant floor
- Additional heating system: Split
- Additional heating band: 3 ºC
- Room temperature: 22 ºC.

At a given moment, a setpoint temperature equal to 26 ºC is required. Since the difference between the setpoint temperature and the room temperature is higher than 3ºC, the additional heating source (Split) is activated. Once the room temperature exceeds 23 ºC (lower difference than the specified additional heating band), the additional heating source is switched off.

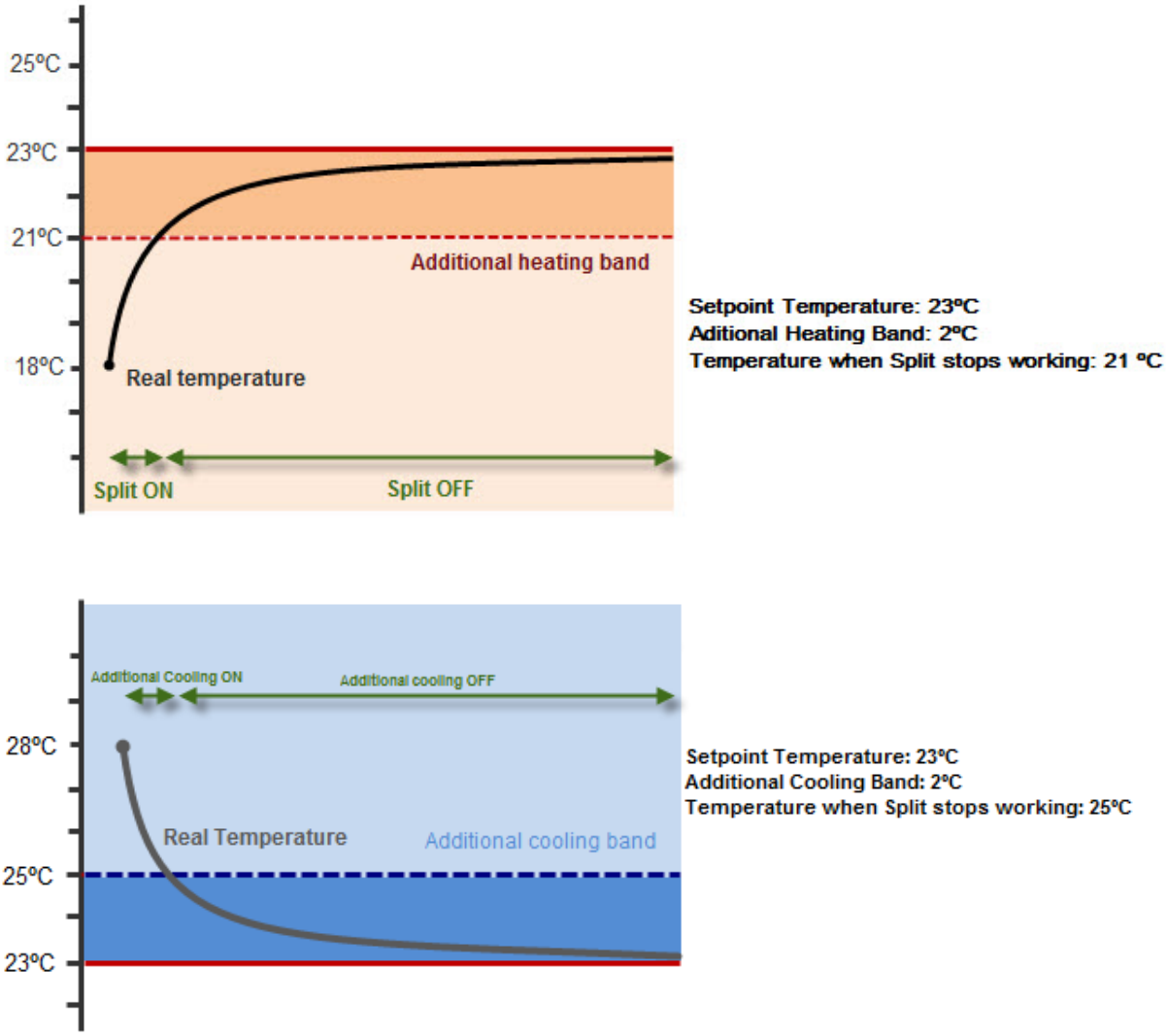


Figure 9.Additional heating and cooling activation.

4. ETS CONFIGURATION

In this section, the thermostat configuration of Touch Panel Z38 and QUAD with the tool ETS is shown. The thermostat configuration of IRSC with the application program Zone is detailed in the manual Zoning KNX – Clima III.

4.1. TOUCH PANEL Z38

For enabling the thermostat in the touch panel Z38 is necessary to enable first one Clima page in Pages. Once it has been done, the thermostat is enabled in the Clima tab as shown in the following figure:

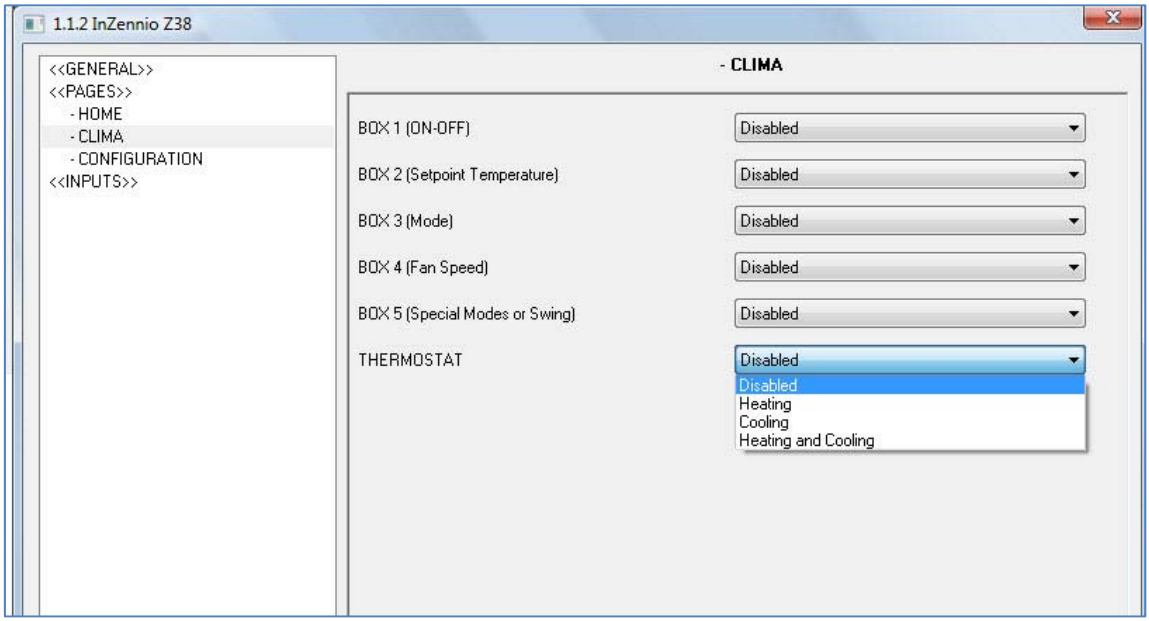


Figure 10.Enabling thermostat in Z38

And we select the type of thermostat according to the application for which is going to be used:

- Only Heating
- Only Cooling
- Heating and Cooling

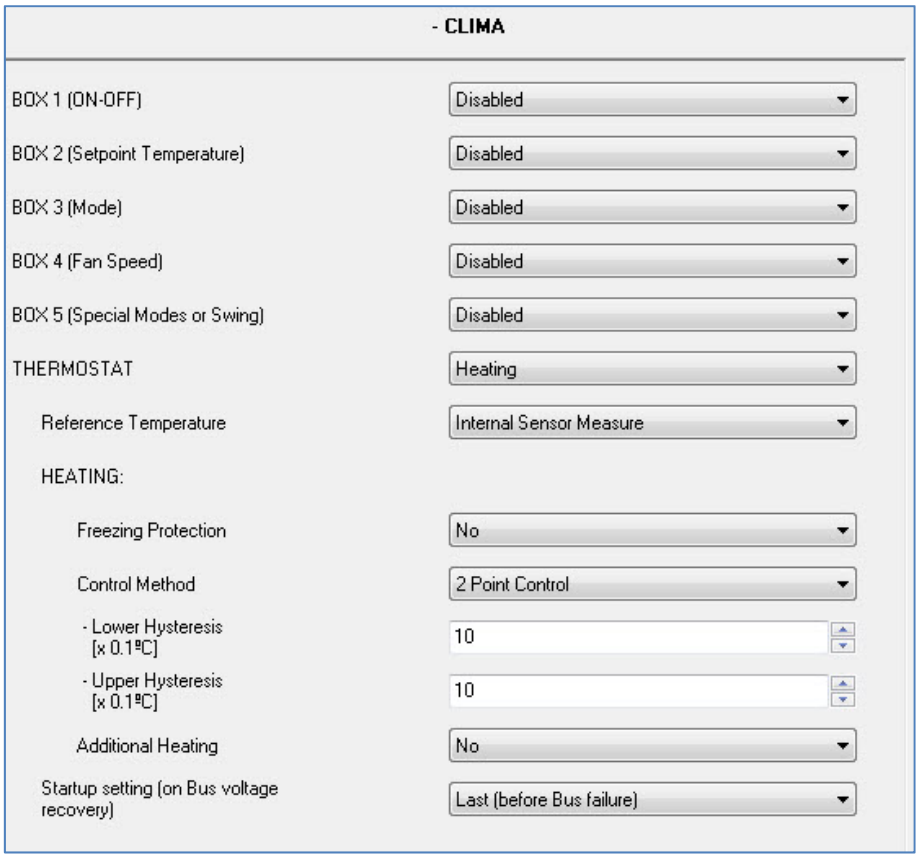


Figure 11 Z38Thermostat: Control 2 Points with Hysteresis

Both for the “Only Heating” an “Only Cooling” types, there are two possible options for configuring the thermostat control:

- **2-Points Hysteresis Control**
  - The upper and lower hysteresis are introduced
- **PI Control**
  - PI PWM or PI-Continuous is introduced.
  - Specify the control parameter according to the application for which the thermostat is going to be used.

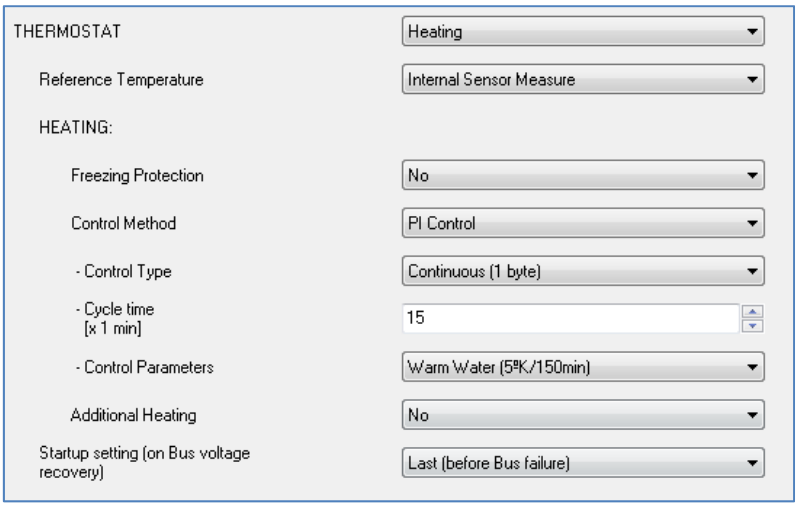


Figure 12 Z38 Thermostat: PI Control

In the following figure the Thermostat configuration zone for “Heating and Cooling” applications is shown:

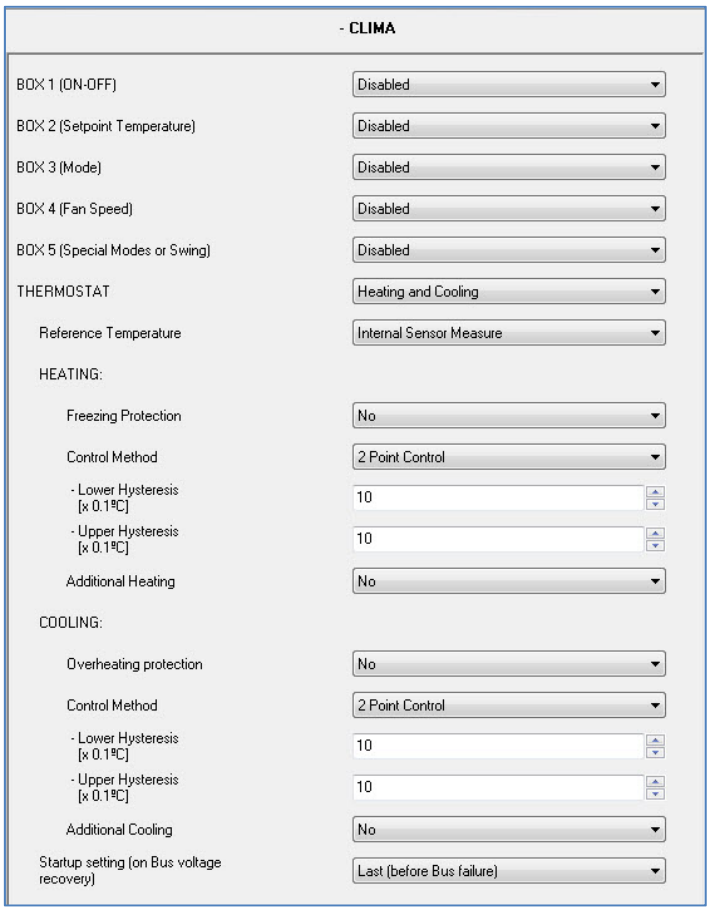


Figure 13.Z38Thermostat: Heating and Cooling

4.2. QUAD

In the device QUAD, the thermostat is enabled in the tab “General” selecting “Temperature Probe and Thermostat” as shown in next figure.

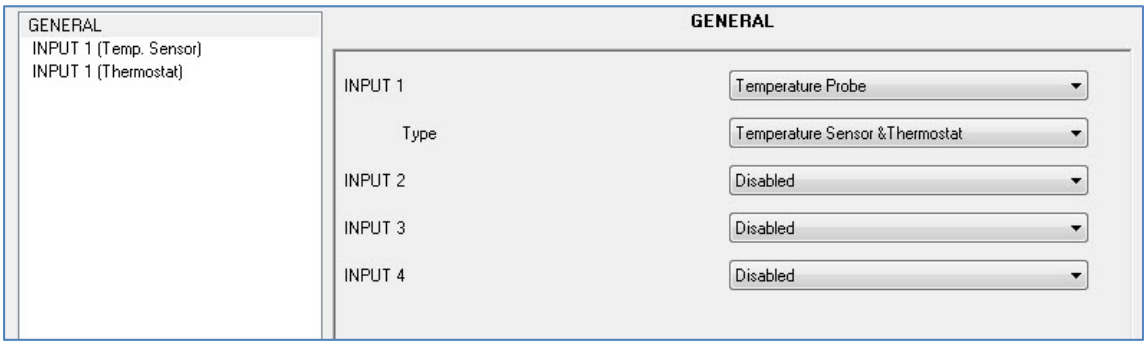


Figure 14.QUAD Thermostat: Enabling Thermostat

We select the type of thermostat according to the application for which is going to be used:

- Only Heating
- Only Cooling
- Heating and Cooling

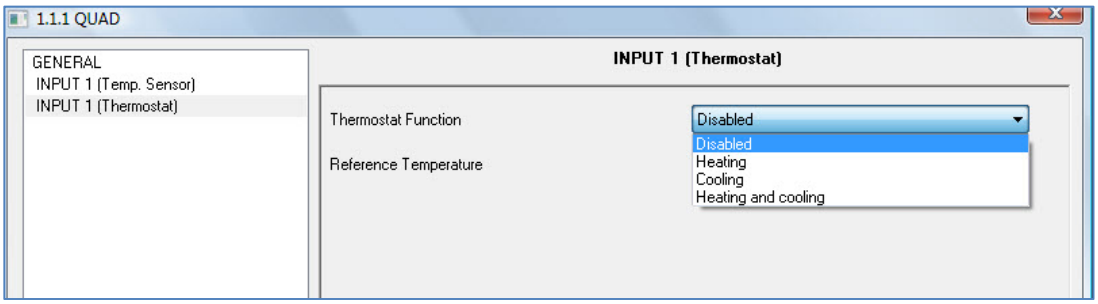


Figure 14.QUAD Thermostat: Thermostat Function

And the option for the desired **reference temperature**:

- Measured by internal sensor
- Measured by external sensor
- Proportion 1 (25 internal, 75% external)
- Proportion 2 (50 internal, 50% external)
- Proportion 3 (75 internal, 25% external)

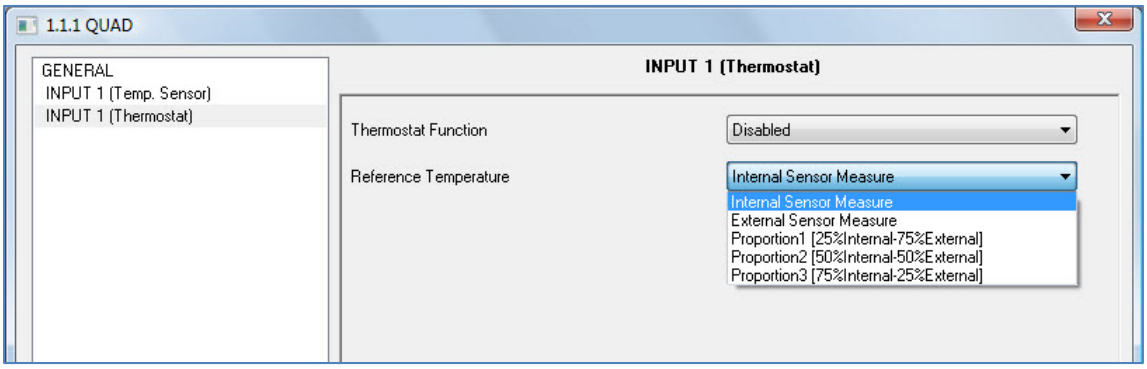


Figure 15. QUAD Thermostat: Reference Temperature

Once the thermostat mode is selected (Heating, Cooling, Heating and Cooling), we have to configure the thermostat control:

- **2-Points with Hysteresis Control**
  - The upper and lower hysteresis are introduced
- **PI Control**
  - PI PWM or PI-Continuous is introduced.
  - Specify the control parameter according to the application for which the thermostat is going to be used.

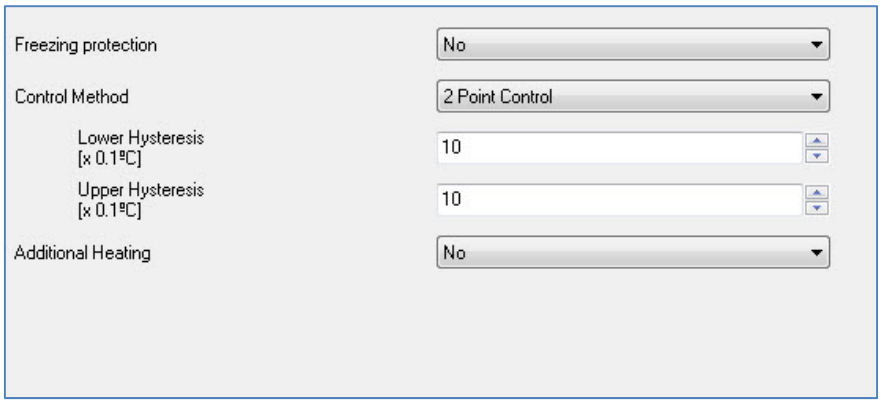


Figure 16.QUAD Thermostat: 2-Points with Hysteresis Control

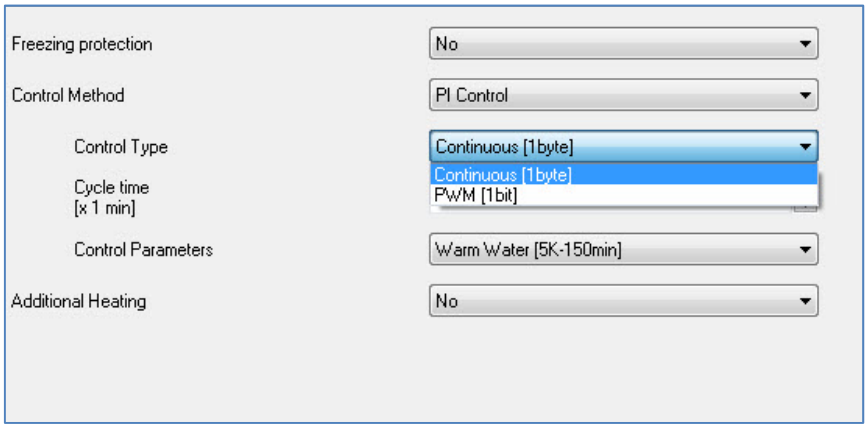


Figure 17.QUAD Thermostat: PI Control

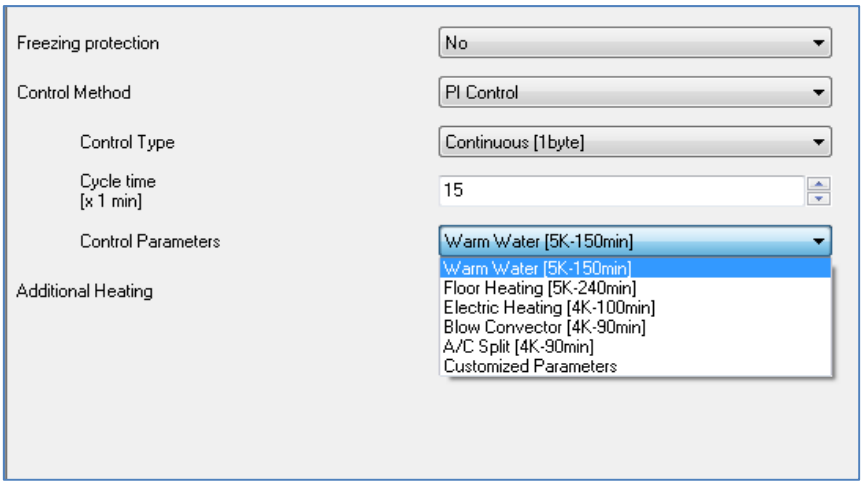


Figure 18. QUAD Thermostat: PI Control Parameters

4.3. IRSC ZONE

The thermostat configuration for the IRSC with the application program Zone is detailed in manual Zoning KNX – Clima III.

5. PRACTICAL QUESTIONS

In this section it can be found a series of notes to take into account for configuring and understanding the thermostat performance in Zennio's devices.

5.1. PARAMETERIZING THE PI CONTROL (Z38 AND QUAD)

When configuring a PI Thermostatic Control there is a control parameter, where specifying the type of air-conditioning system, used for calculating the control variable.

For the parameterization of PI control in the Touch Panel Z38 and the QUAD we can choose among the following air-conditioning systems (see Figure 19 and Figure 20):

- Warm Water [5K – 150min]
- Floor Heating [5K – 240min]
- Electric Heating [4K – 100min]
- Blow Convector [4K – 90min]
- A/C Split [4K – 90min]
- Customized parameters

In case of selecting "customized parameters" we have to introduce:

- ***Proportional Band (ºK):*** error value proportional to the difference between setpoint temperature and room temperature.
- ***Integral Time (minutes)***: it depends on the thermal lag of the air-conditioning system that can adjust the approximation error as time goes by.

For making sure the correct performance of the system it is hardly recommended to choose between the defined options according to the air-conditioning system, since air-conditioning will be the only experts abled to select the suitable configuration in these cases.

It is also specified for the PI control a ***Cycle Time*** in minutes. This cycle of time depends on the inertial lag of the installed system. For air-conditioning systems with slow thermal lags, we will have to indicate a higher cycle of time.

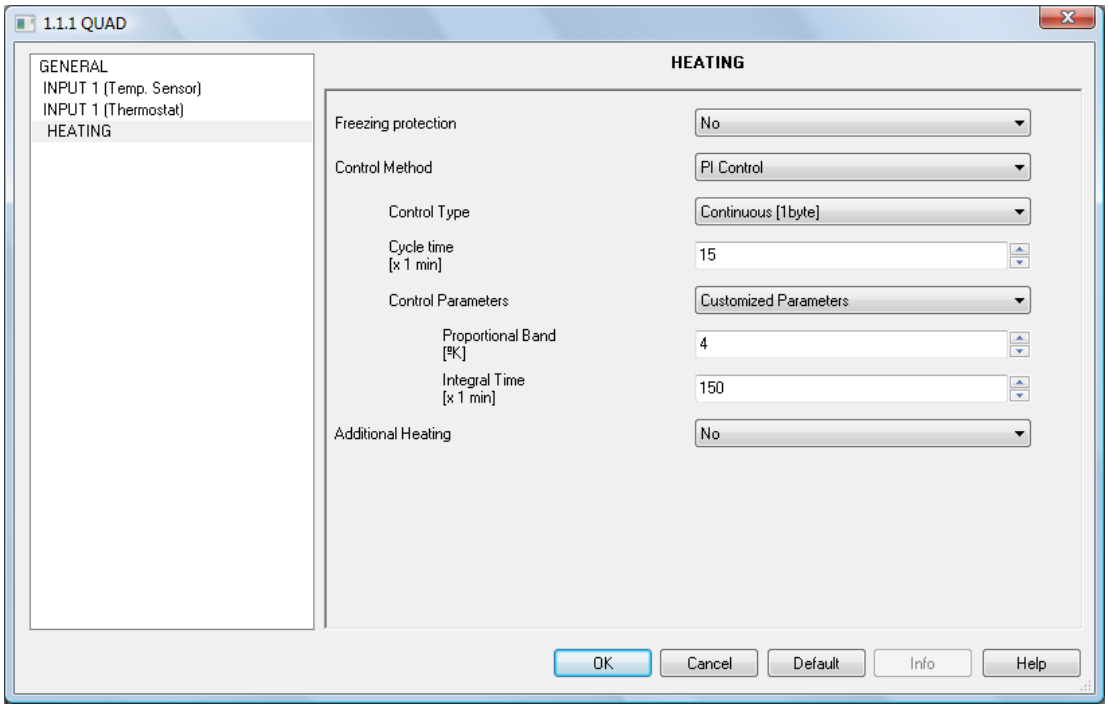


Figure 20. Touch Panel Z38 – Configuring the personalized Control Parameters for PI control

5.2. PI-PWM CONTROL INDICATOR (Z38)

In Touch Pannel Z38, when the thermostatic control PI-PWM is used, there is a value indicator for the control variable. In the specific tab for Clima, in the right upper part of the thermostat status indicator (ON) the symbol * will appear when the variable PI-PWM is equal to “1” and it will not appear when this variable is equal to “0”.

Figure 21.Touch Panel Z38 - Indicator of the control variable PI-PWM

5.3. EXTERNAL CLIMA CONTROL (Z38 AND QUAD)

The clima parameters in QUAD (ON/OFF, setpoint temperature and mode) can be established from external devices, i.e touch panel Z38. The corresponding sending communication objects of Z38 are the following:

- 91: Sending ON/OFF
- 107: Sending Mode
- 111: Sending Temperature

In the same way, the clima parameters for controlling the thermostat in the Z38 can be externally established, with another touch panel (i.e, in the case of a centralized air-conditioning system in all zones of a house). For this external control we will have to link the above-mentioned sending communication objects of the main touch panel, that controls the clima parameters, and the receiving communication objects in the rest of touch panels, that carries out the thermostatic control:

- 115: Receiving ON/OFF
- 131: Receiving Mode
- 135: Receiving Temperature

5.4. SPECIAL MODES (Z38 AND QUAD)

Both the Z38 and the QUAD can be parameterized with special modes (Comfort, Night, etc). With these modes a pre-defined setpoint temperature can be established for the thermostatic control.

When the special modes are established in Z38, a touch panel is used for modifying the setpoint temperatures pre-defined by every mode. In case of using the special modes in the QUAD, it will be necessary one temperature communication object per special mode and Heating/Cooling mode:

- 76: Comfort Temperatura (cooling)
- 77: Comfort Temperature (heating)
- 84: Night Temperature (cooling)
- 85: Night Temperature (heating)
- 92: Stand-by Temperature (cooling)
- 93: Stand-by Temperature (heating)

When the thermostat is ON and a special mode is established, the setpoint temperature is modified. Nevertheless, when the thermostat is OFF and a special mode is established, the thermostat performance will depend on the *Reaction of Clima in OFF when receiving a Special Mode*, according to the selected option among the following:

- It remains OFF and nothing changes
- It remains OFF but setpoint temperature is updated
- Setpoint temperature changes and Clima turns ON

In case of the Touch Panel Z38, this parameter is established in the ETS configuring the BOX 5 of the Clima where the thermostatic control is carried out:

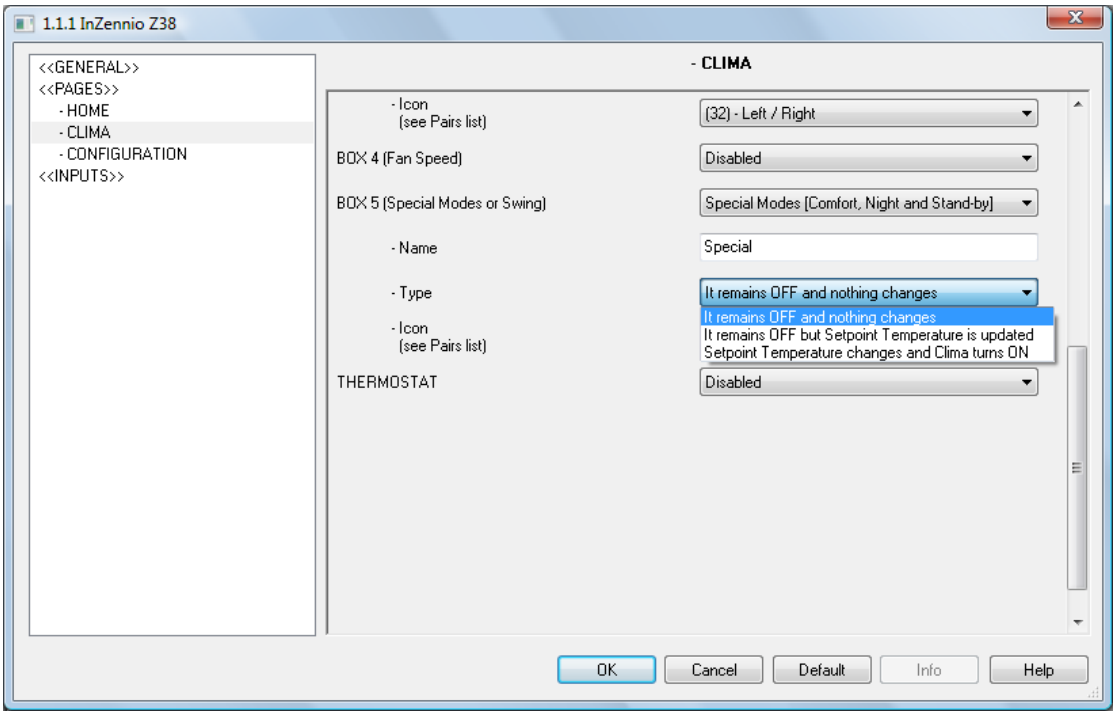


Figure 22. Special Modes in Z38

In the case of QUAD, this parameter is configured in the tab *Input n (thermostat),* where n is the input number:

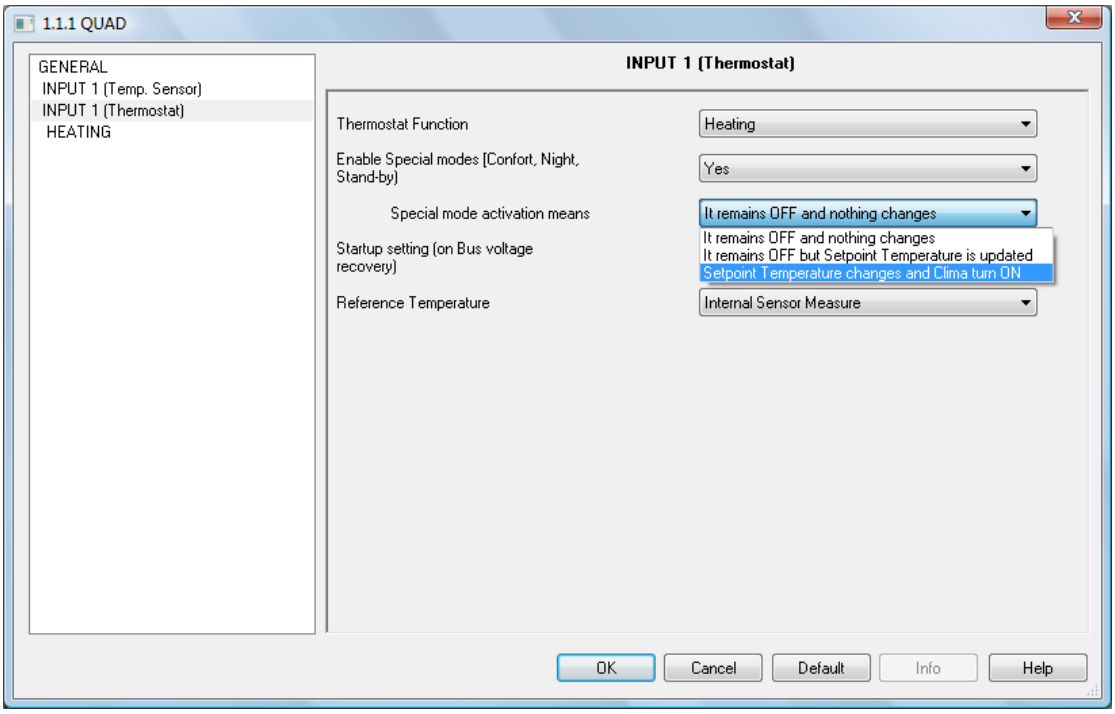


Figure 23. Special Modes in QUAD

5.5. THERMOSTAT CONTROL FROM HOME PAGE

The clima parameters of thermostat (ON/OFF, setpoint temperature or mode) can be modified from the *Home* page of Touch Panel Z38.

For carrying out this type of control from *Home*, first we have to configure the Clima page. Then we have to configure a box specifying that it is for “Clima Control”, the type of control and the *Clima* page to which it is linked.

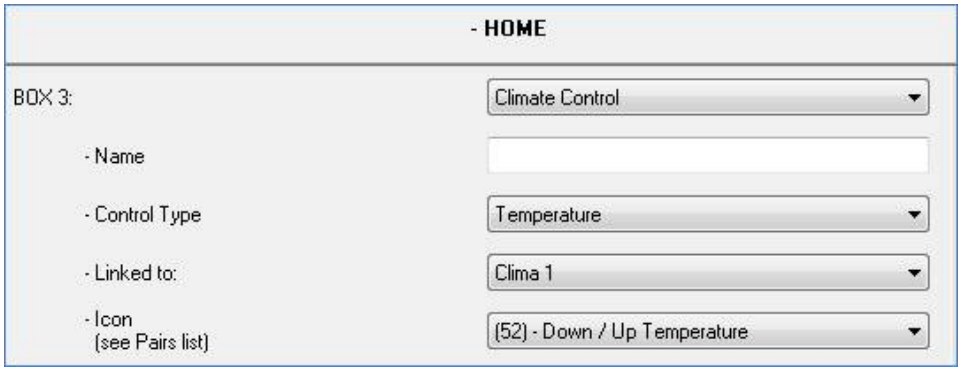


Figure 24.Thermostat Control from Home

It is important to know that this type of control linked to the *Clima* page is not bidirectional. Therefore, changes done from the *Home* page will be shown in the

specific *Clima* page. Howere changes done from the specific *Clima* page will not be shown in the *Home* page.

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