Technical Support
Bulletin Nr. 20 –Special AC Functions

Summary

Introduction

This bulletin describes the special control functions incorporated in certain air conditioning controllers to supplement conventional control functions.
The bulletin describes the potential applications of each function and lists the controllers it is available in.

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Hot Start Control

Description

Hot Start Control allows the internal fan to start only when the heat exchanger is hot enough, thus avoiding unpleasant draughts of cold air.

Controllers providing this function

ERT200, ECH200, Energy ST500

Enabling and activation of Hot Start Control

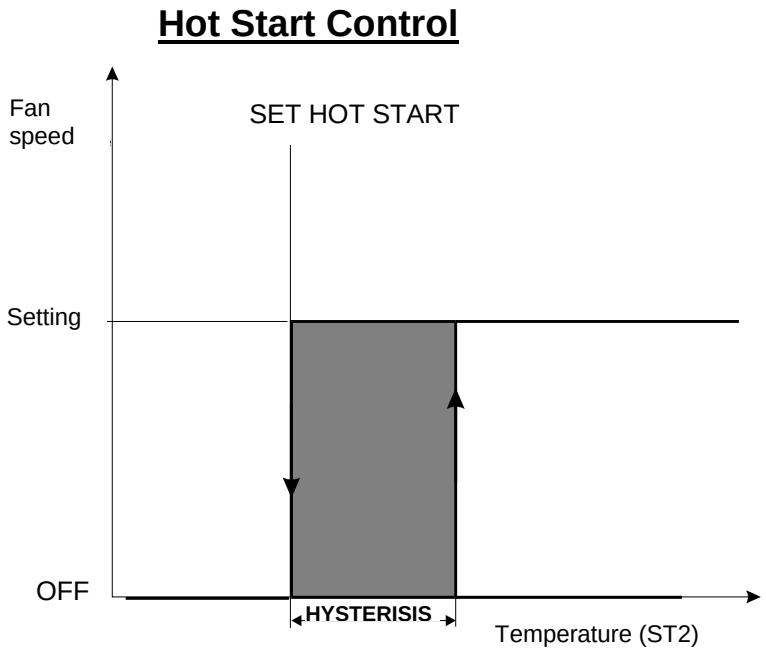
Hot Start Control is enabled and activated if the following conditions are satisfied.

- The internal fan is enabled.
- The temperature sensor is configured as NTC water/air output sensor.
- The controller is in heating mode.

Hot Start setpoint and hysteresis are controlled by the following parameters:
HOT START setpoint
HOT START hysteresis

Functioning

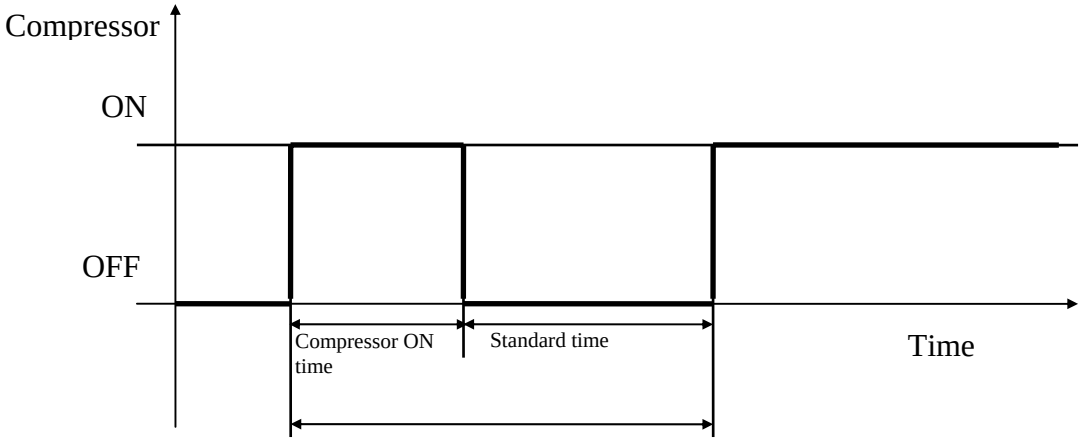
The following diagram illustrates the functioning of Hot Start Control.



Adaptive Control

Description

Many chillers incorporate water accumulators. These provide the thermal inertia required to avoid frequent compressor starts and stops during periods in which there is little call for cooling from the conditioned rooms. For example, if a chiller is dimensioned to serve 10 fan coils but only one is switched on in cooling mode, the compressor would only remain on for a very brief time. Because safety times have to be respected, however, water temperature would soon rise well above the switching point determined by hysteresis. The presence of water accumulators increases thermal capacity and provides the inertia needed to extend compressor functioning times. Water accumulators nevertheless represent a significant cost and also increase the size of the equipment.
Adaptive Control modifies setpoint and hysteresis values in order to extend compressor run time and limit the need for water accumulators.



Controllers providing this function

ECH200BD, ECH200BP, ECH400SRD, Energy ST500

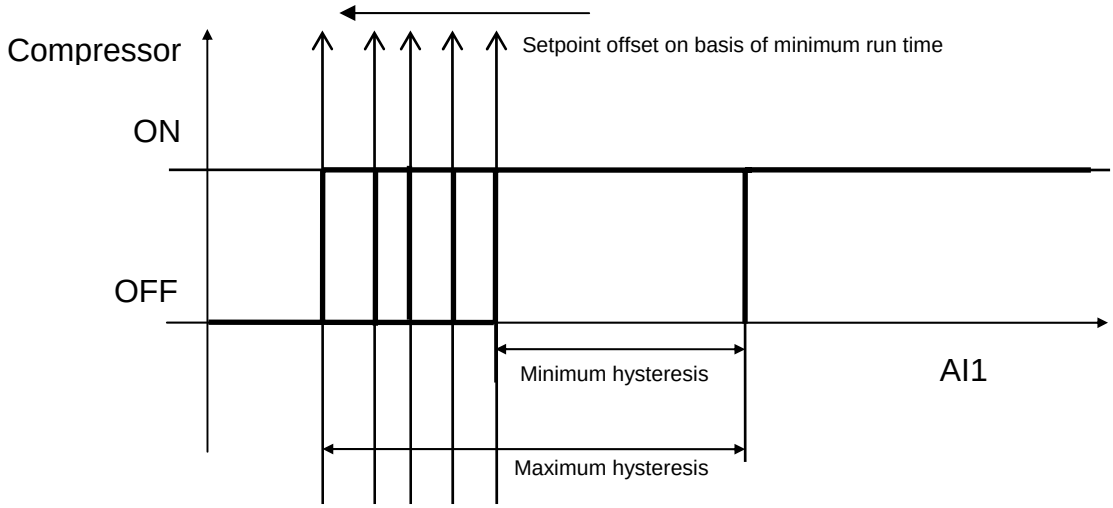
Enabling and activation of Adaptive Control

Adaptive Control is enabled and activated by setting the relevant parameter accordingly.

Functioning

Adaptive Control analyses the compressor's effective run time and compares it with the minimum run time setting. If effective run time is below minimum run time in cooling mode, every time the compressor switches off at the setpoint or at hysteresis (or both), an offset value is subtracted or added accordingly. In heating mode this offset increments both hysteresis and setpoint. The offset value is determined by summing a fixed value and a value proportional to the difference between minimum run time and effective run time.
The following diagram illustrates an example, valid for the ECH200 controller, of how setpoint and hysteresis are changed in cooling mode with an effective compressor run time shorter than minimum run time.
The function is disabled (i.e. offsets are disabled) if water output temperature (AI2) reaches the maximum limit in heat mode (Pa C09) or minimum limit in cooling mode (Pa C10). If this happens the compressors are switched off just as if AI1 had reached setpoint.

If compressor run time is greater than parameter P C12, the setpoint and hysteresis are decremented by the same fixed value Pa C11. Functioning is cyclical, and is repeated after the compressor has been running for a further Pa C12 seconds. The cycle is interrupted when the setpoint and hysteresis both return to their initial values.



The following is a description of the parameters governing Adaptive Control.

- Function enabling
- Setpoint AI2 for disabling the function in cooling mode (expressed in degrees)
- Setpoint AI2 for disabling the function in heating mode (expressed in degrees)
- Setpoint differential: this value is subtracted from the cooling setpoint and added to the heating setpoint; it is added to both the cooling and heating hysteresis.
- Offset reset time: whenever compressor run time reaches this value, Pa C11 is added to the cooling setpoint and subtracted from the heating setpoint and hysteresis. The count restarts from zero with every reset.
- Proportional constant: this value is used to multiply the difference between minimum run time and effective run time.

Defrost Start Temperature Compensation Control

Description

In particularly dry and cold climates, defrost start temperature may not coincide with the actual temperature at which the outdoor unit can freeze. Defrost Start Temperature Compensation Control provides linear compensation for defrost start temperature/pressure by adding negative or positive values on the basis of outdoor temperature.

Controllers providing this function

ECH200BD, ECH200BDK, ECH200BDT, ECH200BP, ECH400S, ECH400SR, Energy ST500

Enabling and activation of Defrost Start Temperature Compensation Control

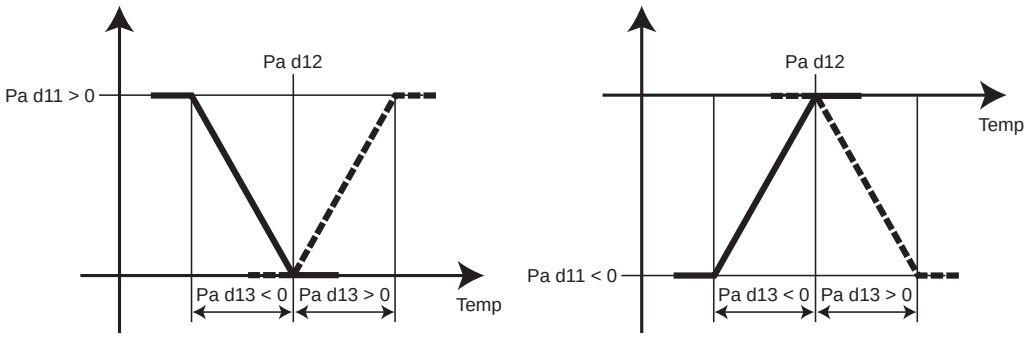
Example for ECH: Defrost Start Temperature Compensation Control is enabled and activated by setting Pa d12=1 and by configuring sensor AI4 as outdoor sensor (Pa H08=3).

Functioning

The following is a description of the parameters governing Defrost Start Temperature Compensation Control.

- Defrost temperature/pressure compensation offset.
- Defrost temperature/pressure compensation setpoint.
- Defrost temperature/pressure compensation differential.

The following two diagrams illustrate how the defrost setpoint is offset on the basis of outdoor temperature when this is above and below 0.



Anti-Sticking Control (periodical operation of water pump)

Description

Anti-Sticking Control allows you to force the water pump on if it has been idle for a set time (determined by a parameter setting) and keep it running for another set time (also determined by a parameter setting).

Controllers providing this function

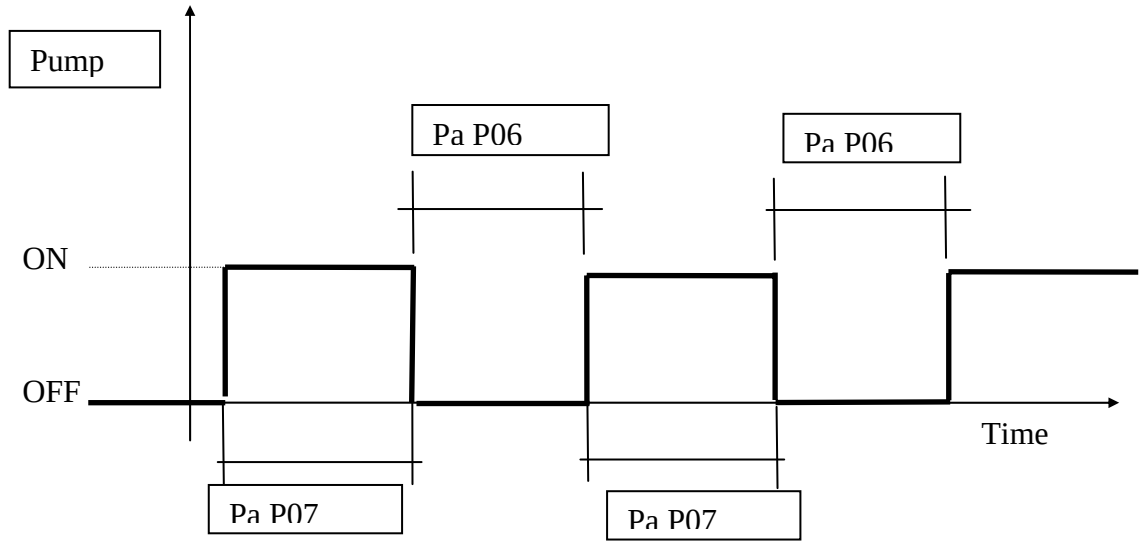
ECH200BDT, Energy ST500

Enabling and activation of Anti-Sticking Control

Example for ECH 200: To enable Anti-Sticking control simply set parameters P06 (pump idle time expressed in hours) and P07 (pump Anti-sticking run time). The function is disabled by setting both these parameters to 0.

Functioning

The following diagram illustrates the functioning of Anti-Sticking Control.



Water Free Cooling Control

Description

Water Free Cooling makes use, whenever possible, of outdoor air to lower the temperature of the conditioned circuit.

Cooling action is obtained by channelling water returning from the circuit through a finned cooling unit, (the free cooling unit) before it enters the evaporator heat exchanger.

When free cooling is active, the compressors are not disabled but continue to follow the same rules and same on/off setpoint.

While free cooling remains active, water temperature is controlled not only by the compressors, if needed, but also by modulating the fans controlling air flow through the free cooling unit. These may be the same fans used to control condensation, (internal free cooling Pa L01=3), or fans dedicated to this purpose, (external free cooling Pa L01=2).

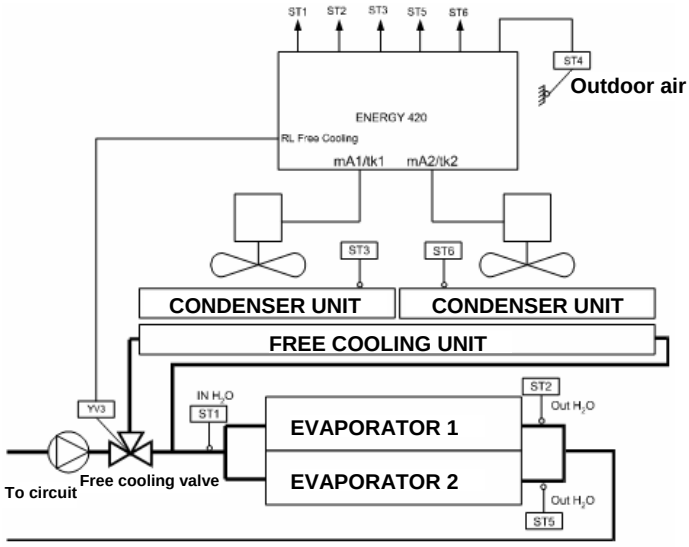
The following is a brief description of the positioning of the free cooling unit for internal and external free cooling.

INTERNAL Free Cooling The free cooling unit is installed on top of the condensation units, and the fans that provide the air flow for cooling the water are the same fans that regulate compressor condensation pressure.

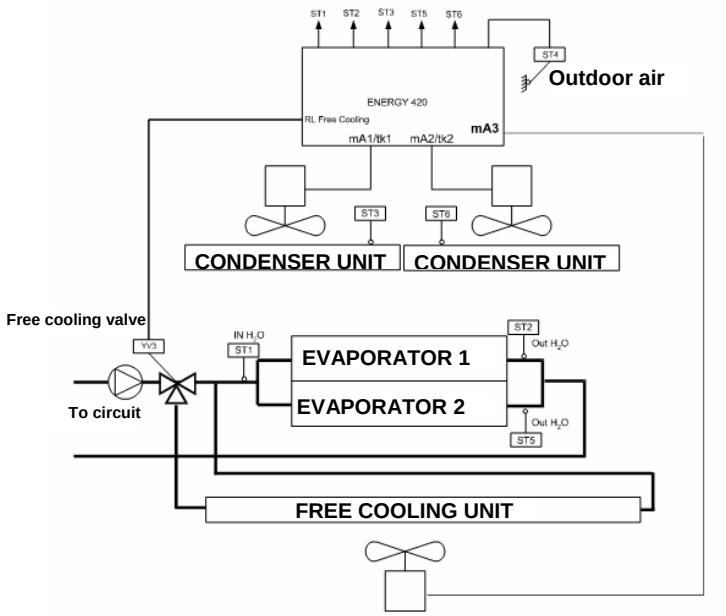
EXTERNAL Free Cooling The free cooling unit is installed separately, away from the condensation units, and incorporates its own independent fan.

The following diagrams illustrate two systems, with internal and external free cooling unit.

Example of system with internal unit:



Example of system with external unit:



EXTERNAL free cooling units are located separately from the condensing units, and have their own independent fans.

Controllers providing this function
ECH400F, XT

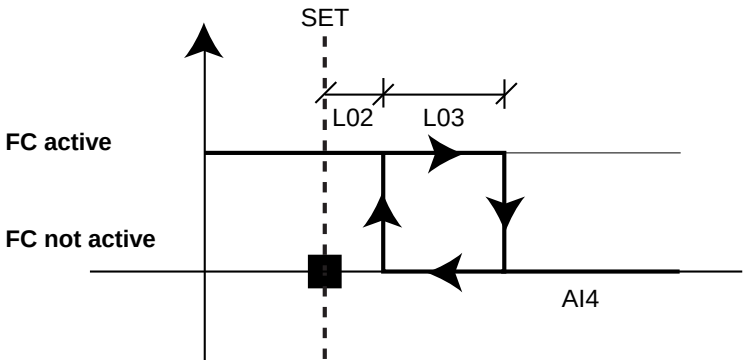
Enabling and activation of Free Cooling control
Example for ECH: Free Cooling Control is activated by parameter L01 (Pa L01=1), and starts and stops only under the following conditions:

Free cooling starts if:

- Outdoor temperature (AI4) is below the value determined by:
  AI4 ≤ Current setpoint + L02 (Pa L02 Free Cooling inlet differential)
- The digital input that enables free cooling is NOT ACTIVE.
- The lower of the evaporator output water temperatures is above the anti-frost pre-alarm threshold value (Pa L04 anti-frost pre-threshold) plus 1°C.

Free cooling stops when:

- Outdoor temperature (AI4) is above the value determined by:
  AI4 > (Current setpoint +L02) + L03 (Pa L03 Free Cooling output hysteresis)
- The digital input that enables free cooling is ACTIVE.
- The lower of the evaporator output water temperatures is below the anti-frost pre-alarm threshold value (L04). (Valid only if compressors are already stopped).



Functioning

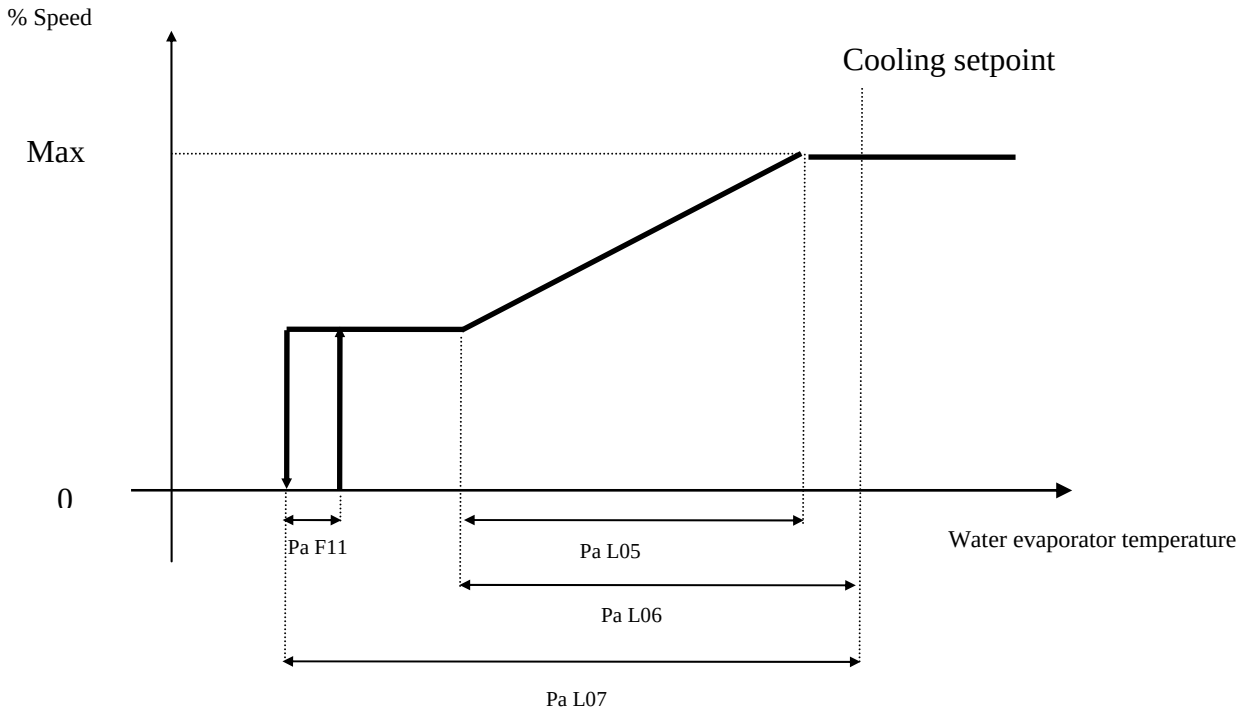
Free cooling works by deviating the flow of water returning from the user circuit through the free cooling unit before it enters the evaporator heat exchanger. Free cooling is only activated if outdoor air temperature is below a certain value (dynamically linked to the system's cooling setpoint). This means that water leaving the free cooling unit will already have been cooled. The extent of this cooling will depend on outdoor temperature, and on the air flow rate provided by the fans. Free cooled water then enters the evaporator heat exchanger, where its temperature is measured by sensor AI1. The compressors are switched on or off on the basis of this temperature, just as in normal operation without free cooling.

Water temperature during free cooling is regulated by varying the rate of air flow. Air flow is controlled on the basis of evaporator inlet temperature.

FREE COOLING FANS

The following graph shows the curve for the proportional fan control outputs. (The graph shows the behaviour of the temperature controller when free cooling is active).

For simplicity's sake we assume in this example that the unit has just two steps).



The fans are stopped when evaporator inlet water temperature (AI1) is below the value determined by: Current setpoint + L07 (free cooling cut-off temperature differential). They start up again when evaporator inlet water temperature rises to the free cooling minimum value (AI1> Cooling setpoint + L07 + F11).

Economiser Control

Description

Example for ECH: Economiser Control uses the controller's 0-10V dc analog output or relay output (Pa H35-H40 or N06-N010 = 15) to control the gate valve.
Economiser Control permits room temperature to be controlled by free cooling or free heating using outdoor air entering the rooms through the gate valve. Gate valve control is proportional.
Temperature and enthalpia based free cooling/heating functions are described below.

Controllers providing this function

ERT400, ERT200 (the latter model only provides temperature based free cooling/heating)

Temperature based free cooling and free heating

Enabling and activation of temperature Free Cooling/Heating Control

The function is enabled if:

- Free-cooling is enabled (Pa L01=1)
- Sensor AI1 is configured as analog control input (Pa H11)
- Sensor AI4 is configured as analog input for outdoor temperature (Pa H14 = 1)
- Outdoor temperature is above Pa L08 + Pa L09

Functioning

If outdoor temperature is near the free cooling/heating setpoint, and outdoor temperature and the free cooling/heating setpoint are both higher or both lower than the system temperature setpoint, the gate valve must be completely open. This will help indoor temperature reach the free cooling/heating setpoint more rapidly. If on the other hand outdoor temperature is far off the free cooling/heating setpoint, the gate valve is modulated in order to bring indoor temperature closer to the system temperature setpoint.
If outdoor temperature (AI4) falls below the value set in Pa L08, Economiser Control is deactivated and the gate valve is set to minimum aperture Pa L07. When outdoor temperature rises above Pa L08 + Pa L09, the function is re-enabled and the controller again assumes control over the gate valve.

Care must be taken to distinguish between free cooling mode and free heating mode. Let us examine two possible scenarios.

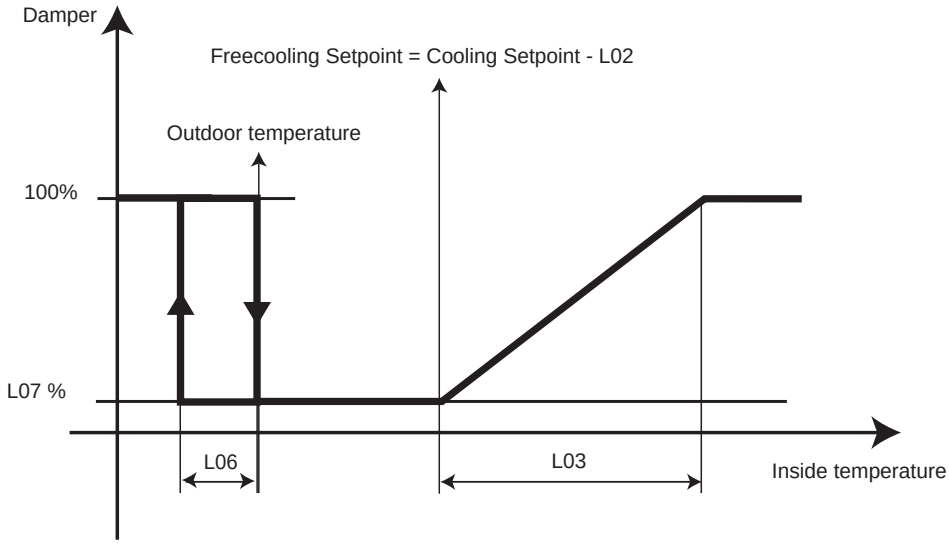
Cooling mode

The following cases illustrate free cooling mode.

Outdoor temperature is below the cooling setpoint.

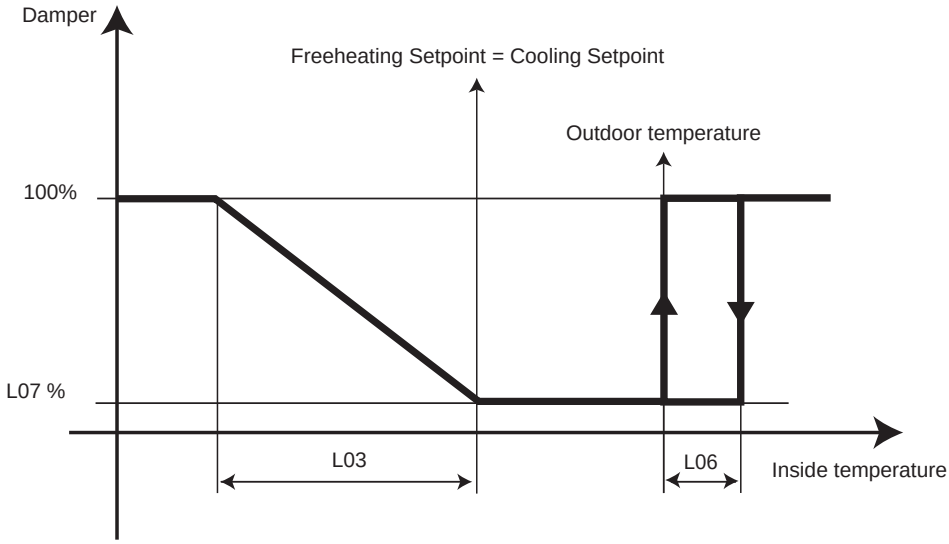
If the free cooling setpoint coincides with the cooling setpoint, as soon as the compressors are switched off the gate valve closes, making it impossible to save energy through the use of cooler outdoor air. The free cooling setpoint is calculated by subtracting the value set in parameter Pa L02 (cooling mode free cooling offset) from the cooling setpoint. The gate valve is set at its minimum aperture at the free cooling set point. If indoor temperature falls below the free cooling setpoint and below outdoor temperature, the gate valve is

opened fully to warm the indoor rooms and bring indoor temperature up to the system setpoint.



Outdoor temperature is above the cooling setpoint.

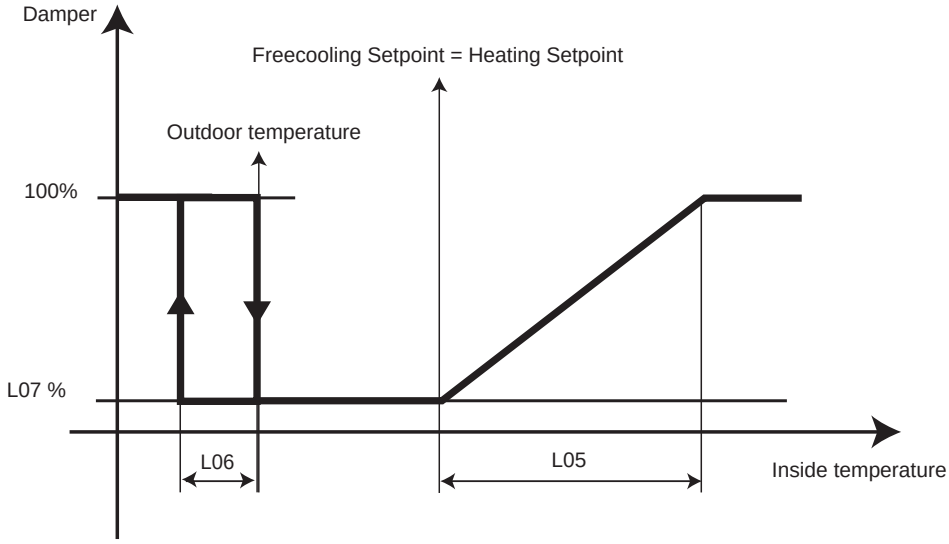
In this case outdoor temperature cannot be used to cool the indoor rooms unless indoor temperature rises above outdoor temperature (in which case the gate valve is fully opened). Outdoor air can instead be used to warm the rooms if indoor temperature is below the setpoint. In this case the free heating setpoint coincides with the cooling setpoint.



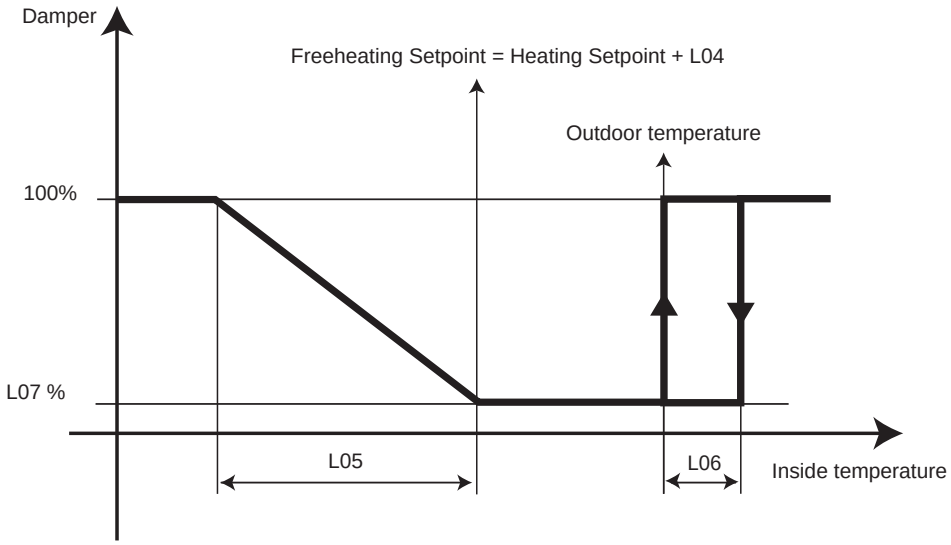
Heating mode

The same considerations apply in heating mode as in cooling mode, with the difference that the logic for calculating the free heating setpoint is reversed.

Outdoor temperature is below the heating setpoint.
In this case outdoor temperature cannot be used to heat the rooms unless indoor temperature drops below outdoor temperature (in which case the gate valve is fully opened). Outdoor air can be used instead to cool the rooms if indoor temperature is above the setpoint. In this case the free cooling setpoint coincides with the heating setpoint.



Outdoor temperature is above the heating setpoint.
If the free heating setpoint coincides with the heating setpoint, as soon as the compressors are switched off the gate valve closes, making it impossible to save energy through the use of warmer outdoor air. The free heating setpoint is calculated by adding the value set in parameter Pa F28 (heating mode free cooling offset) to the cooling setpoint. The gate valve is set to its minimum aperture at the free heating setpoint. If indoor temperature rises above the free heating setpoint and above outdoor temperature, the gate valve is opened fully to cool the indoor rooms and bring indoor temperature to the system temperature setpoint.



Enthalpia based free cooling and free heating

Enabling and activation of enthalpia based Free Cooling/Heating Control
This function is enabled by setting the following parameters:

- Pa L01: free cooling enabling
- Set the outdoor air temperature sensor
- Pa H14=1 Sensor AI4 present
- Set the outdoor humidity sensor
- Pa H13 = 3, sensor AI3 configured as 4-20mA outdoor humidity input
- If AI3 is not configured as humidity input you can set parameter N12 instead
- Pa N12 = 1, sensor AI8 configured as 4-20mA outdoor humidity input
- Set the indoor humidity sensor
- Pa H16 = 3, sensor AI6 configured as 4-20mA recirculated air humidity input
- If AI6 is not configured as humidity input you can set parameter N11 instead.
- Pa N11 = 1, sensor AI7 configured as 4-20mA recirculated air humidity input

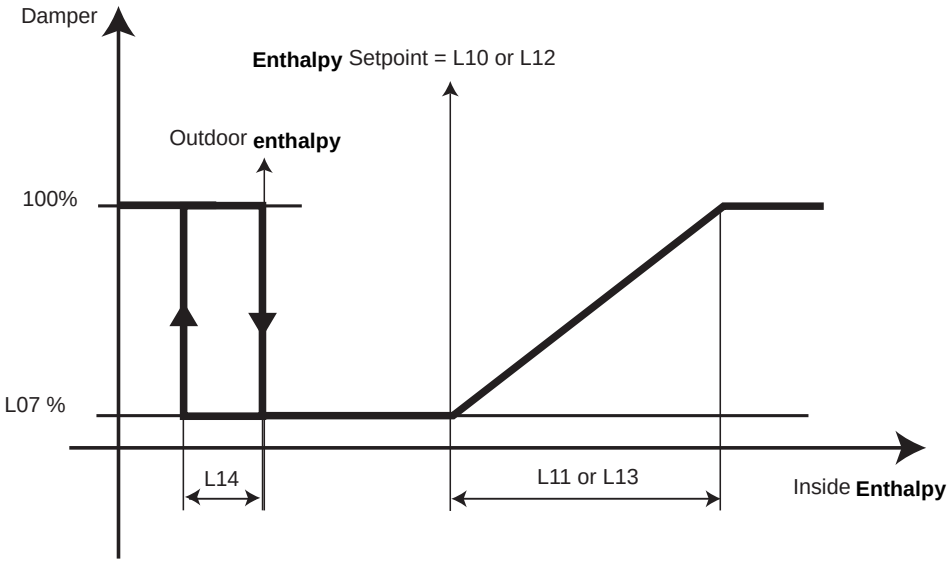
Dummy humidity sensor
If no sensor is configured as outdoor humidity sensor, and parameter L15 is set to a value other than 0, this value will be used as the outdoor humidity value for the purposes of enthalpia calculations.

Automatic free cooling recognition
If sensor AI4 is present and free cooling is enabled, the free cooling function provides temperature based free cooling. If the 2 humidity sensors are also present, the function provides enthalpia based free cooling instead. If a dummy humidity setting other than 0 is made (in Pa L15), an outdoor humidity sensor is assumed to be present even if no physical sensor is installed.

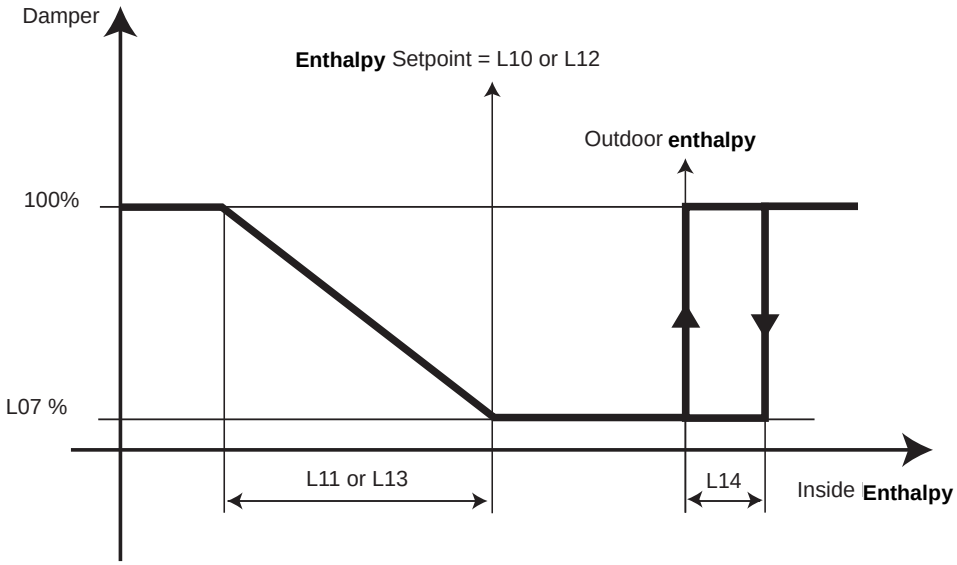
Functioning

Enthalpia is a thermodynamic quantity that takes account of humidity as well as air temperature. In simple terms it can be considered as the heat to be subtracted or added to air in order to pass from one set of humidity and temperature values to another set of humidity and temperature values.
Let us examine the following scenarios for the enthalpia setpoint.

Outdoor enthalpia is below the enthalpia setpoint.
The enthalpia setpoint is set in parameter L10 (cooling mode enthalpia). The gate valve is set to its minimum aperture at the setpoint. If indoor enthalpia falls below the enthalpia setpoint and below the outdoor enthalpia value, the gate valve is opened fully to bring indoor enthalpia to the setpoint.



Outdoor enthalpia is above the enthalpia setpoint.
In this case outdoor enthalpia cannot be used to reduce indoor enthalpia unless indoor enthalpia rises above outdoor enthalpia (in which case the gate valve is fully opened). Outdoor air can be used instead to increase indoor enthalpia if it is below the setpoint.


Damper
Enthalpy Setpoint = L10 or L12
Outdoor enthalpy
100%
L07 %
L11 or L13
L14
Inside Enthalpy

Antifrost Control with Water Pump and Heat Pump

Description

Antifrost Control with Water Pump and Heat Pump is a special function that uses the water pump and heat pump to provide anti-frost protection.

Controllers providing this function

ECH400 Special

Enabling and activation of Antifrost Control with Water Pump and Heat Pump (Tsinghua function)

Antifrost Control with Water Pump and Heat Pump is activated by setting parameter A23=1.

Functioning

Antifrost Control with Water Pump and Heat Pump works in two ways according to the temperature read by sensor ST1.

- **The temperature read by ST1< Pa 20 (water pump on setpoint)**
  The water pump is switched on (if off). This occurs in all functioning modes (cooling, heating, stand-by, off) and does not alter display status.

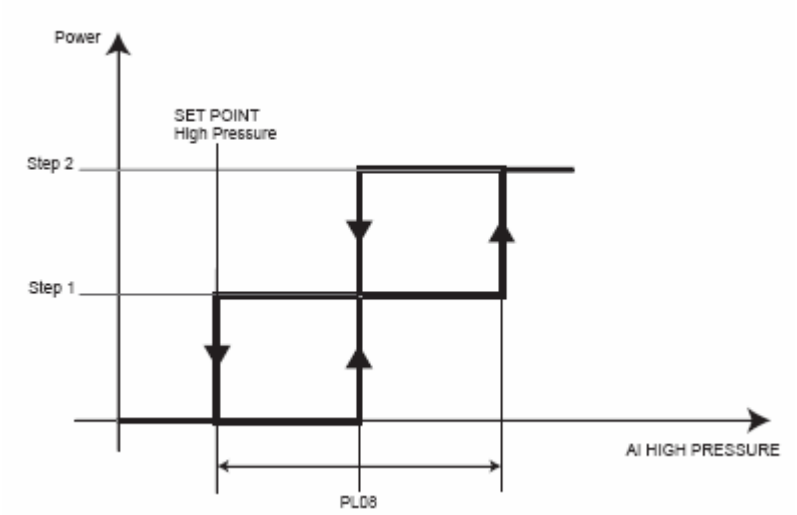
- **The temperature read by ST1< Pa 21 (heating mode on setpoint)**
  The heat pump is temporarily switched on (if off). This occurs in all functioning modes (cooling, stand-by, off) and alters the display status (heating mode is displayed). When this function is active it is not possible to change functioning mode either from the keypad or by means of a digital input.

The controller returns to normal functioning if temperature **ST1> Pa A22** (function off setpoint).

Anti-Sticking Control (periodical switching on of water pump)

Description

In the controllers in which it is implemented, Anti-Sticking Control reduces the power (i.e. the number of active steps), either by means of a digital input, or at a set threshold (e.g. a pressure value). This avoids the inconvenience of system safety devices tripping.



Sensor Upstream/Downstream from Valve Control

Description

Sensor Upstream/Downstream from Valve Control is implemented on two tube fan coil controllers with a valve thermostat, and allows the valves and fans to be controlled on the basis of water sensor position.

Controllers providing this function

FAN COIL BASICOM, FAN COIL PLUS

Functioning

Sensor Upstream/Downstream from Valve Control works differently depending on the position of the water temperature sensor. We can distinguish two situations.

- Water sensor fitted downstream from valve (Pa P50=0)
  The Hot Start and Too Cool functions stop the fan operating but not the valve.

- Water sensor fitted upstream from valve (Pa P50=1)
  The Hot Start and Too Cool functions stop the valve operating but not the fan.

N.B.
On 2 and 4 tube systems with a fan thermostat, the meaning of parameter **P50** is irrelevant (see the controller's user manual for details of functioning).

DISCLAIMER