



## Operation manual

### Heat pumps with RVS control



Read these instructions carefully before installation, use, or maintenance



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# 1 Introduction

## 1.1 Heat pump's operating principle

Heat pump is a device that heats a building's premises and its domestic water. It consists of a compressor; an expansion valve; an evaporator; and a condenser. Heat pump collects heat from the brine circuit (evaporator circuit) with an evaporator and transfers it to the condenser circuit (output circuit, heating circuit, charging circuit) via a condenser. The brine liquid circulates inside the brine circuit, and inside the condenser circuit, heating water. The brine circuit can be, for example, a thermal well drilled into a rock, a ground circuit dug horizontally into the ground or, for instance, a ventilation system's heat recovery. Two heating circuits are connected to the condenser circuit: the heating circuit responsible for heating the building's premises either directly or through a storage tank, and the service buffer tank's heating circuit.

The evaporator has two sides. One side is connected to the brine circuit and the other is connected to the heat pump's refrigerant circuit. These two sides are separated by a metallic wall. Heat is transferred through the wall, but the brine liquid and the refrigerant running in the refrigerant circuit stay separated. Likewise, the condenser also has two sides. One side is connected to the condenser circuit and the other to the same refrigerant circuit as the evaporator.

The compressor pumps the refrigerant that runs inside the refrigerant circuit, keeping it in motion. It sucks the refrigerant from the evaporator and feeds it to the condenser. Compressor operates on the same principle as an ordinary water pump or a cooling fan used during the summer heat. The water pump and cooling fan increase the pressure by just a tiny amount, and the temperature by a practically imperceptible amount, whereas the compressor increases the refrigerant's pressure and temperature significantly. To illustrate, refrigerant's temperature before the compressor can be  $-1.0\text{ }^{\circ}\text{C}$  with a pressure of 5.6 bar, but after the compressor they have risen to  $70\text{ }^{\circ}\text{C}$  and 20 bar, respectively.

The evaporator turns the refrigerant from liquid into steam. Examples of this seen in the everyday life are water boiling in a kettle, and the evaporation of water as it contacts a hot sauna stove. The difference between water and refrigerant is the evaporation point: for water it is  $100\text{ }^{\circ}\text{C}$ , but for refrigerant it can be for example  $-5\text{ }^{\circ}\text{C}$ . Having a low evaporation temperature enables the collection of heat from the brine circuit into the refrigerant even if the circuit's temperature is only 0 degrees, for example. The heat is therefore transferred from the higher temperature brine (in relation to the refrigerant) to the colder refrigerant. The brine cools down as a result. This cooling down is usually about a few degrees, for example, from 0 degrees to  $-3$  degrees.

Like boiling water, evaporating the refrigerant requires a lot of heat. This is why the brine circuit's temperature and flow rate must be adequate. If the temperature or flow rate are insufficient, the compressor will suck the evaporator's pressure to a level that goes below the low pressure switch's minimum limit, resulting in a compressor halt due to a low pressure alert, or the brine circuit's minimum temperature alert.

The refrigerant condenses from hot vapor into liquid inside the condenser. Examples of this seen in the everyday life are water condensing on a kettle's inner surface when placed on a stove, and the condensation of steam vapor on the skin in a hot sauna. Condensation releases a lot of heat. This process heats the skin surface in a sauna, and the kettle's lid. Correspondingly, the heat released from the refrigerant in the condenser heats the condenser circuit's water. The heat is transferred from the refrigerant to the water because the compressor elevates the refrigerant's temperature level above the temperature of the water coming from the condenser circuit. The refrigerant cools when it releases its heat to the condenser circuit's water. Its pressure does not change substantially in the condenser, however. It remains highly pressurized by the compressor even after the condenser.

The compressor compresses the refrigerant to a pressure that is equivalent to the temperature of the condenser circuit's water. If the water flow is too hot, the pressure exceeds the supply water's temperature or the high pressure switch's maximum limit, which results in a compressor halt due to switch-off temperature or high pressure. This also happens when the flow is insufficient in the condenser circuit, and not enough heat is transferred from the refrigerant to the water.

The lower limit for the refrigerant's temperature is the temperature that the condenser circuit's water enters the condenser with. For example, if the water enters the condenser at 40 °C, the refrigerant can cool down to 40 degrees at maximum. The condenser does not cool below the water's temperature in the condenser. This happens when the refrigerant flows through the expansion valve into the evaporator.

The expansion valve is between the condenser and evaporator. Before entering the expansion valve the refrigerant coming from the condenser is in the high pressure produced by the compressor. The evaporator is located on the other side of the expansion valve, and has low pressure. This is because the compressor keeps sucking the refrigerant out of the evaporator. The liquid refrigerant flowing into the evaporator through the expansion valve expands when it enters the low pressure in the evaporator. Some of the refrigerant will evaporate, cooling down drastically. This natural phenomenon lowers the refrigerant's temperature by dozens of degrees, for example, from 40 degrees down to -5 degrees. The cooling process makes it possible to collect heat from the brine. After expanding, the partly evaporized refrigerant is fully evaporized with the brine's heat, and the vapor is sucked by the compressor.

The refrigerant flows into the evaporator through a small opening in the expansion valve. The flow is regulated by adjusting the size of the opening. The current is kept at a level where the heat collected from the brine is adequate for evaporizing all of the supplied refrigerant, and desuperheating it to a temperature slightly higher than the saturation point. When the refrigerant is saturated, it is in the same state as the steam rising from boiling water would be, barely transformed from liquid into gas, still "damp". If the steam is too damp it may damage the compressor, because the liquid refrigerant in the steam is not compressed inside the compressor (liquids are practically non-compressible). The refrigerant in the upper part of the evaporator is slightly hotter than this "damp" state, entering the compressor "dry". This additional heating is called refrigerant desuperheating. The expansion valve has a sensor that measures the desuperheating in the refrigerant tube running from the top part of the evaporator, and regulates the size of the refrigerant opening based on the data. If the desuperheating is not sufficient, the opening and refrigerant flow are diminished, and the heat from the brine circuit will be able to evaporate the refrigerant better. If the desuperheating is excessive, the opening and refrigerant flow are increased, and the evaporator will be able to evaporate larger quantities of refrigerant. The mechanical expansion valve has an adjustment spindle that can be used to adjust the desuperheating setpoint. In

electrical expansion valves the setpoint is entered into the valve's controller. A suitable amount of desuperheating is usually around 5 °C. Not having enough desuperheating may damage the compressor (damp steam), whereas having too much weakens the heat pump's efficiency (coefficient of performance), because the compressor will have to operate at a higher intensity to reach the same compressed end pressure. The desuperheating is measured by using a refrigeration gauge to check the pressure and temperature. Desuperheating has been configured during the heat pump's manufacturing process. Do not adjust the desuperheating on your own.

The refrigerant has turned into desuperheated steam in the compressor. The amount of desuperheating before the compressor is much larger. This post-compressor desuperheating can be utilized with a separate desuperheating heat exchanger placed before the condenser. This heat exchanger is sometimes also called a desuperheater. With the desuperheater, the high temperature of a hot refrigerant is recovered in a separate water current that is hotter than the condenser flow. The amount of heat extracted with a desuperheater is small compared to using a condenser, but the temperature level is significantly higher.

The refrigerant has become warm liquid after the condenser. The heat of this liquid can be utilized with a subcooler installed after the condenser. The subcooler recovers heat from the liquid refrigerant, usually to a separate water current that is cooler than the condenser flow. It improves the heat pump's efficiency (coefficient of performance).

## 1.2 Overview of the heat pump's automation

The heat pump automation makes use of a controller and a user interface. Extension modules (auxiliary controllers; Siemens AVS75.370) and parallel user interfaces, along with other supplementary devices, can be installed in parallel with the controller (Siemens RVS61.843) and user interface. The extension modules offer additional inputs, outputs, and functions. Several parallel user interfaces can be used to control the automation and measure the room temperature, for fuller control of heating in the space (room unit). Other supplementary devices can be used to establish a remote connection or a Modbus link to the system, for example.

The built-in automation of the heat pump can be used to control the temperature of one DHW storage tank and one heating circuit. The maximum number of heating circuits that may be regulated by a single control valve is three. The controller can be used to control one heating circuit regulated by a control valve and two additional circuits connected directly to the heat pump. Two other regulated heating circuits can be enabled via connection of two or more extension modules in parallel with the controller.

In addition to the heat pump, storage tanks, and heating circuits, the automation can control a solar power system; cooling; and an additional heat source, such as electric heating or an oil boiler. Additional functions of the automation (block diagrams) are enabled by selecting the inputs and outputs required by the feature, such as inputs from temperature sensors and outputs of pumps' and valves' control, as well as by connecting the devices and temperature sensors to the selected inputs and outputs. The automation is equipped with control blocks for dozens of individual connections. The controllers of two or more heat pumps can be connected together. In this way, several heat pumps and other functions connected to the system can be controlled centrally as a discrete entity. The automation's functions are presented in this manual and separate technical manuals. All manuals and instructions can be downloaded from Oilon's website.

The automation setpoints can be changed as normal via the regular display mode shown on the screen. The display mode based on line numbers can be used to make more extensive changes to setpoints. Setpoints can also be changed using an Internet browser via a remote connection device or a separate computer program (Siemens ACS790). The connection via a computer program can be established using a separate connection device plugged into a computer or a remote connection device. Both the computer program and a browser connection provide a direct menu-structure view of the settings. In addition, the computer program automatically presents a piping connection matching the setpoints on the screen and includes setpoints that cannot be changed otherwise. Among other things, the program can be used also to load all settings to the controller, make a backup copy of the settings, export the settings to an Excel file, and save setpoint changes as a function of time. The program and factory settings (parameters) for the automation are available for download on Oilon's website.

The heat pump's automation can be controlled through remote connection via a local area network or the Internet. A regular Internet browser, a smartphone application, or Siemens ACS computer program can be used for administration. Installing the remote connection service via the cloud solution (Siemens Climatix IC) is easy and fast, and does not require network expertise or a fixed IP address. You can include the facility's piping diagram in the remote connection view and link the temperature and setpoint details to it from the automation. The remote access device can also be used to save selected values and present them in graphs automatically, and enable automatic alert messages to selected email addresses.

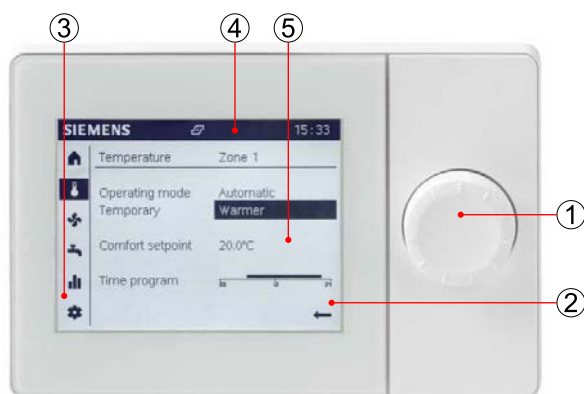
### 1.3 Basic concepts

<b>Buffer tank</b>	Heating circuit's storage tank.
<b>Brine</b>	Liquid that circulates in the brine circuit (evaporator circuit), usually a mixture of water and ethanol.
<b>Brine circuit</b>	The brine circuit is a long loop of pipe embedded in the earth filled with brine, a cold mixture of ethanol and water. The brine circuit extracts heat from the ground.
<b>Brine pump</b>	Pump that circulates brine from the ground source heat pump and into the brine circuit to warm up, from the brine circuit to the evaporator to release heat into the refrigerant, and from the evaporator back to the brine circuit.
<b>Charging circuit</b>	A pipework that heats the heating circuit's storage tank or the service buffer tank.
<b>Coefficient of Performance, COP</b>	Ratio between the electricity used by the heat pump and the heating provided. If a heat pump's COP is 3.5, it will generate 3.5 watts of heating for every watt of electricity.
<b>Compressor</b>	The compressor compresses the evaporated refrigerant to a high pressure, massively increasing the vapor's temperature.
<b>Condenser</b>	Heat exchanger in which the refrigerant releases thermal energy to a heat-transfer fluid (heating water). As it releases its energy, the refrigerant condenses from a gas to a liquid. There are two separate circulations in the evaporator: heating water and the refrigerant that circulates inside the ground source heat pump.
<b>Condenser circuit</b>	A circuit that runs through a heat pump's condenser.
<b>Condenser pump</b>	Pump that circulates heat-transfer fluid (heating water) to the condenser to warm up and from the condenser to the heating circulation.
<b>Condensing</b>	Refrigerant's phase transition from vapor to liquid (cooling and releasing thermal energy). Takes place in the condenser.
<b>Domestic hot water</b>	Hot tap water.
<b>Electric immersion heater</b>	A heating cartridge built into a domestic hot water tank or heating circuit buffer tank. Provides supplementary heating or acts as a backup heater.
<b>Evaporation</b>	Refrigerant's phase transition from liquid to vapor (heating up). Takes place in the evaporator.

<b>Evaporator</b>	Heat exchanger in which refrigerant evaporates. There are two separate circulations in the evaporator: brine that circulates through the brine circuit and the refrigerant that circulates inside the ground source heat pump.
<b>Evaporator circuit</b>	A pipe circuit that runs through a heat pump's evaporator, usually the brine circuit.
<b>Expansion valve</b>	In the expansion valve, the pressure in the liquid refrigerant is reduced. At the same time, its temperature is massively reduced before the evaporator and the start of the next cycle.
<b>Flow</b>	In heating circuits, 'flow' refers to water that has been heated up by the heat pump and fed into the heating circuit. In the brine circuit, 'flow' refers to brine returning from the heat pump to the brine circuit.
<b>Flow temperature</b>	Temperature in a fluid fed into a circuit (water in heating circuits, brine in the brine circuit).
<b>Heating circuit</b>	A circuit that transfers the heat generated by the heat pump to radiators or floor heating pipes. A building can have several heating circuits – one for living areas and another for wet spaces, for example.
<b>Heating curve</b>	A six-point curve that determines the heating provided by the heat pump at different outdoor temperatures.
<b>Heating water</b>	Water heated up by the heat pump and used for heating the domestic hot water tank or a heating circuit buffer tank. If the heat pump is connected directly to a heating circuit (without a buffer tank), heating water is used to heat the heating circuit (as 'flow' water).
<b>In-line heater</b>	An electric heater cartridge built into or connected to a fluid line. In Oilon heat pumps, an in-line heater is often built into the condenser flow pipe to provide supplementary heating or to act as a backup heater.
<b>Outdoor temperature</b>	Outdoor temperature is the primary control variable in space heating; it determines how much heating will the heat pump provide.
<b>Output circuit</b>	The pipework where the heat pump's condenser gives out the produced heat, usually the condenser circuit.
<b>Room optimization</b>	A feature that adjusts the heat pump's operation based on measured room temperature. Heat pump operation is still dependent on outdoor temperature and heating curves.
<b>Subcooling</b>	In a ground source heating system: temperature difference between the condensing temperature of high-pressure refrigerant and the refrigerant's temperature after the condenser. Subcooling takes place in the condenser.
<b>Superheating</b>	Refrigerant being heated to a temperature higher than its boiling point.

## 2 Operation

### 2.1 Heat pump user interface






- Navigate the menus and settings by turning the control knob.
- Select a menu or setting by pushing in the control knob.
- Move to the previous menu by using the arrow or text field at the bottom of the screen.
- 1) Control knob
- 2) Display
- 3) Navigation bar
- 4) Status bar
- 5) Work area

#### Status bar symbols

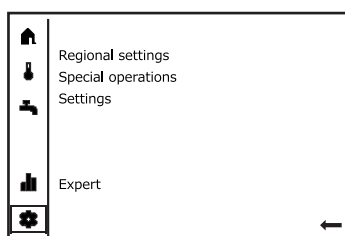
	Active alarm
	Special operations are active (e.g., outdoor temperature simulation or emergency operation), or the maximum number of error notifications permitted by the settings has been reached.
	The heating circuit operating mode has been changed and, as a result, scheduled automatic operation is disabled. This icon is shown if the operating mode is changed from Automatic to another mode, such as Comfort.
	User level No symbol: end-user (no password) 1: commissioning (no password) 2: expert (password: 00017) 3: OEM operation (password 24358)
	The heat pump's compressor is on.
	Event message

#### Navigation bar

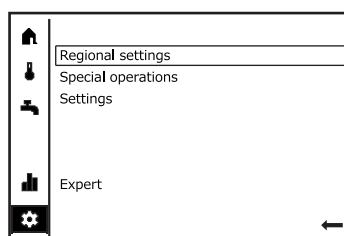
	Start page <ul style="list-style-type: none"> <li>key temperature values</li> <li>switching heating circuits <b>ON</b> (to automatic mode) or <b>OFF</b> (to frost protection mode)</li> </ul>
	Heating circuits <ul style="list-style-type: none"> <li>operating mode</li> <li>room temperature setpoint for <b>Comfort</b> mode</li> <li>time programs</li> </ul>
	Domestic hot water <ul style="list-style-type: none"> <li>switching domestic hot water heating on and off</li> <li>recharging DHW to its setpoint (before the switching limit is reached)</li> <li>Domestic hot water time programs</li> </ul>
	Status information <ul style="list-style-type: none"> <li>temperatures</li> <li>operating modes</li> <li>fault information and resetting the heat pump under fault conditions</li> </ul>

	<b>Settings</b> <ul style="list-style-type: none"> <li>time and language</li> <li>changing the user level</li> <li>resetting the heat pump</li> <li>emergency operation mode</li> <li>basic settings for the heating circuit assigned to the current user interface</li> </ul>
	<b>Diagnostics menu</b> <ul style="list-style-type: none"> <li>testing inputs and outputs</li> <li>bus settings</li> <li>outdoor temperature simulation</li> <li>heat pump status</li> <li>consumer-side heating details</li> <li>error notification history</li> </ul>
	<b>Service menu</b> <ul style="list-style-type: none"> <li>parameter list</li> <li>commissioning menu (incl. assigning heating circuits to the user interface)</li> <li>updating the user interface's operating views (visible if the interface needs to be updated)</li> </ul>

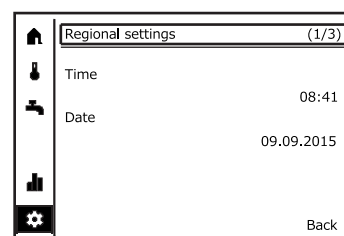
## Using menus



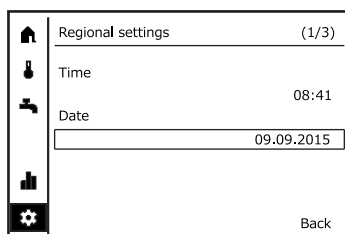
Move the cursor on the left-hand side of the screen to the desired menu icon. Select the menu by pushing in the control knob.



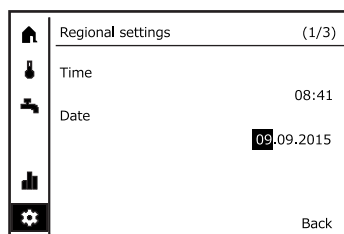
Move to the desired function by turning the control knob. Select the function by pushing in the control knob.



If the menu consists of several pages, the cursor is initially in the status bar.

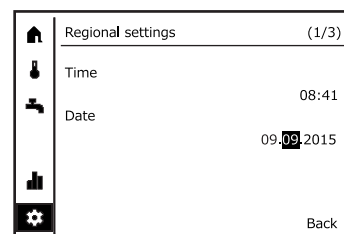


Move to one of the setpoints from the status bar by turning the control knob.



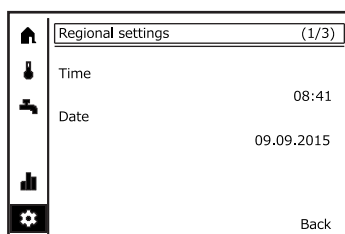
Select the setpoint to be changed by pushing in the knob.

- The setpoint can be changed, when its background turns dark.
- Adjust the setpoint by turning the control knob.

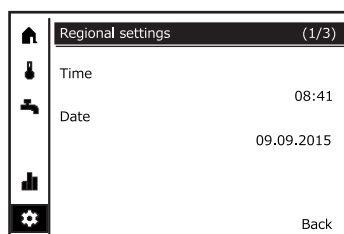


Move to the next number field by pushing in the control knob.

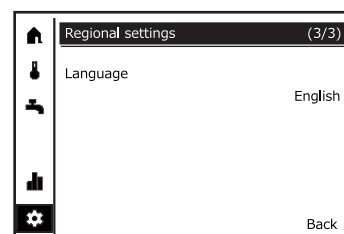
- Proceed like this until you have gone through all the fields.



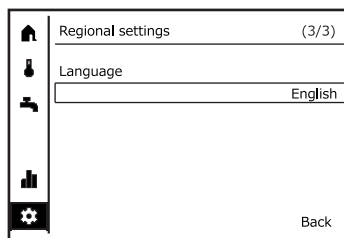
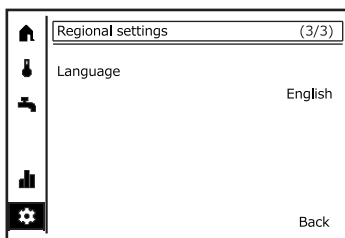
To move from one page to another, move to cursor the status bar



To scroll between the pages, push in the control knob.

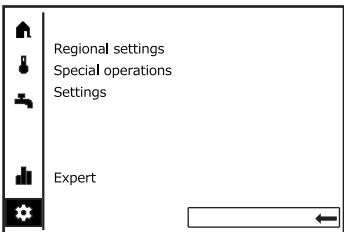
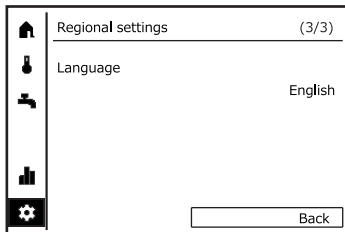


Move from one page to another by turning the knob.



Once you are on the correct page, push in the control knob again.

Move from the status bar to one of the setpoints by turning the control knob.

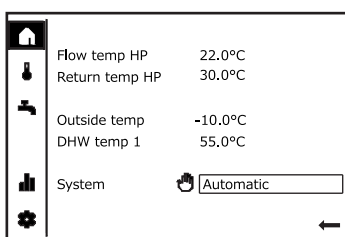


Go back by moving the cursor to the lower right-hand corner and pushing in the control knob.

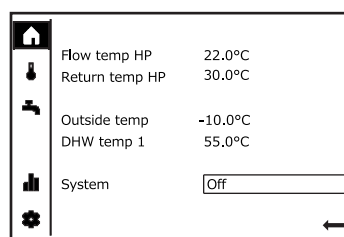
## 2.2 Start page

From the start page, you can switch all heating circuits assigned to the relevant user interface **ON** or **OFF** in one go. When switched **ON**, all heating circuits will operate in automatic mode. When switched **OFF**, all heating circuits will operate in frost protection mode. The start page shows the condenser's flow temperature (sensor B21), the condenser's return temperature (sensor B71), domestic hot water temperature (sensor B3), and the outdoor temperature (sensor B9).

An individual heating circuit's operating mode can be changed separately from the circuit's own settings.



Heating circuits switched **ON** (in automatic mode or in an operating mode selected separately from the settings afterwards).



Heating circuits in frost protection mode.

## 2.3 Heating circuit menu

Three different room temperature setpoints can be assigned to the heating circuits. These setpoints are **Comfort**, **Reduced**, and **Frost protection**. The **Comfort** setpoint can be altered directly from the heating circuit's main menu. The other setpoints can be changed in each heating circuit's advanced settings (through the parameter list).

If the heating circuit is controlled based on a heating curve, changing the room temperature setpoint will correspond to moving the heating curve sideways (parallel displacement). If the heating circuit is controlled based on room temperature measurement instead, changing the room temperature setpoint will directly change the target room temperature value.

Heating circuits should be kept in **Automatic** mode, as this will allow them to be automatically disabled when the heating period ends (summer/winter heating limit). Additionally, time programs are enabled only when the heating circuit is in **Automatic** operating mode.

## Time programs

A time program toggles the heating circuit's operating mode automatically between **Comfort** mode and **Reduced** mode. **Comfort** mode is used during the period specified in the time program. At other times, **Reduced** mode is used. Time programs can be set up for each day of the week separately.

When using factory settings, the heating circuits have **Automatic** mode enabled, and the time program keeps **Comfort** mode on permanently. If a time program is used to switch from **Comfort** mode to **Reduced** mode, **Comfort** mode can be temporarily restored by selecting a temporary operating mode for the heater (from the **Temporary** setting). The heating circuit's operating mode will return to normal the next time the time program changes the mode or the user some other operating mode than **Automatic**.

## Settings

Automatic mode. Heating circuits should be kept in **Automatic** mode.

**Comfort** setpoint for room temperature always on.

When the operating mode is set to **Comfort**, the setpoint for the room temperature in **Comfort** mode can be changed.

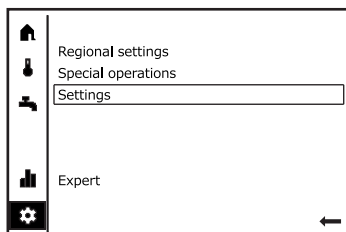
The **Reduced** setpoint for room temperature.

Time programs are enabled in **Automatic** mode only.

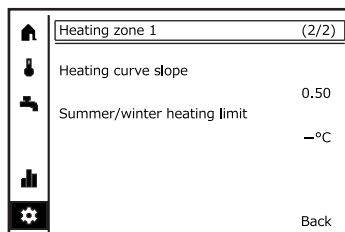
Temporary comfort mode selected for the heating circuit.

## 2.4 Heating curve

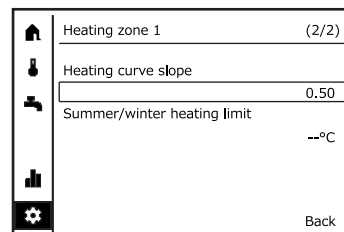
You can adjust the slope of the heating curve in the settings menu. The change applies only to the heating circuit assigned to the relevant user interface. Use the parameter list to change other settings for the particular heating circuit (and the settings of other heating circuits connected to the system).



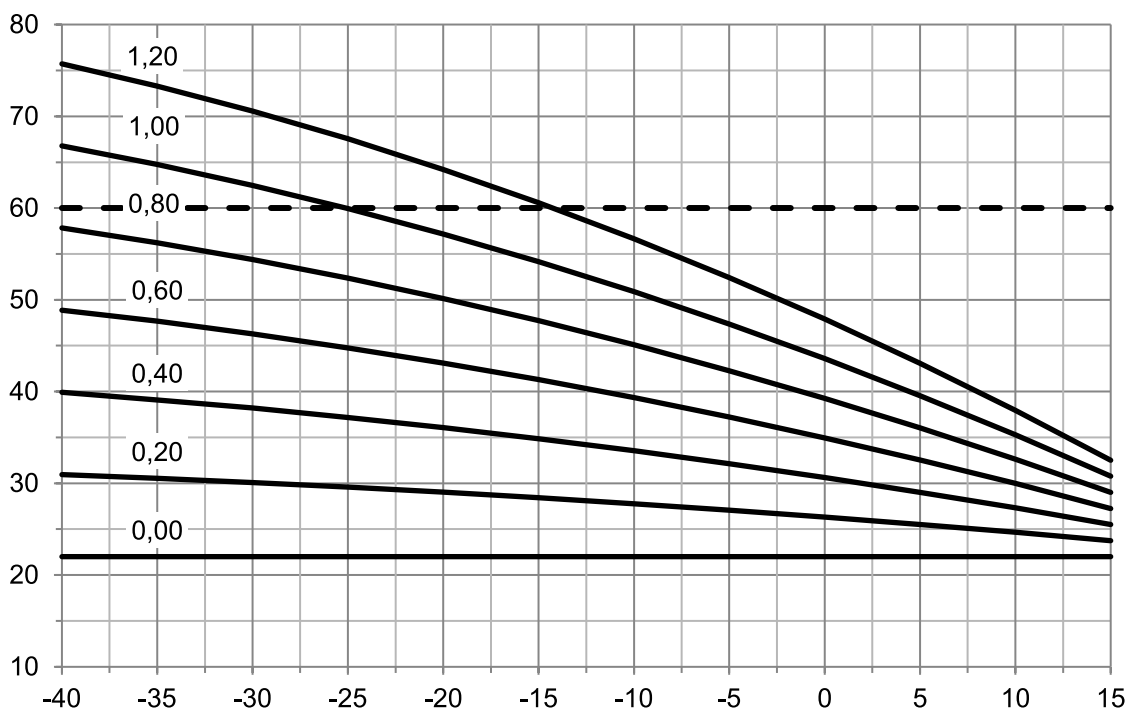
1. Select **Settings**.



2. Move to the correct menu page.



3. Enter the desired heating curve slope.



X-axis: outdoor temperature, °C. Y-axis: heating water temperature, °C.

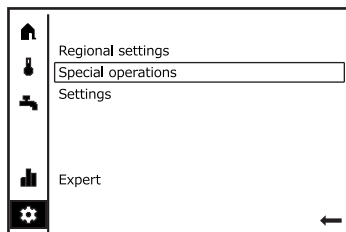
Heating curves when the room temperature setpoint is 22 °C, the heating curve displacement is 0 °C, and the upper and lower limits do not restrict the heating water temperature.

## 2.5 Emergency operation

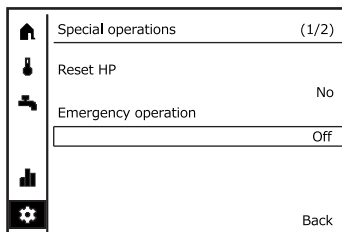
Emergency operation mode switched on through the automation disables the heat pump's compressor. In emergency operation mode, heating is performed only with the electric heater connected to the heat pump automation.

Emergency operation is available only when the heat pump's automation is connected to an electric heater that supports emergency operation. Usually, electric immersion heaters connected to the condenser line are used (section *In-line heater in the condenser line*).

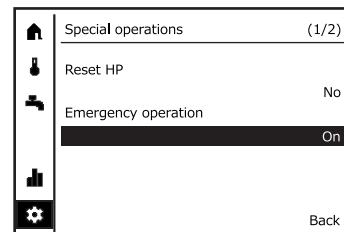
## User interface, integrated to the heat pump



Select **Special operations**.



Select **Emergency operation**.



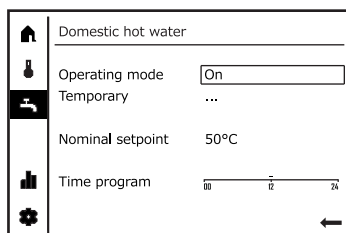
Change the setting to **Yes**.

## All interfaces on the parameter list

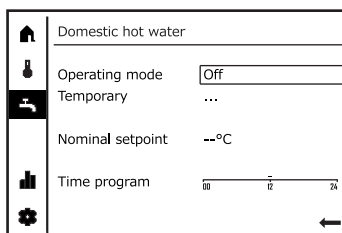
Emergency operation can be switched on from the parameter list (section *Parameter list*), in the menu **Service/special operation** on line 7141.

## 2.6 Domestic hot water menu

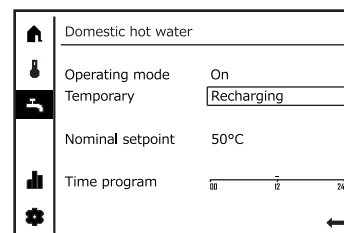
Key domestic hot water settings can be changed in the **Domestic hot water menu**. Other DHW settings can be changed in the domestic hot water and DHW storage tank settings in the parameter list.



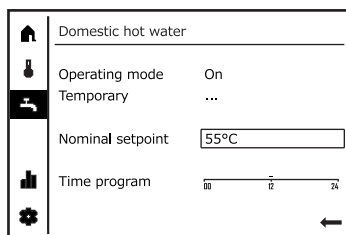
Domestic hot water heating on.



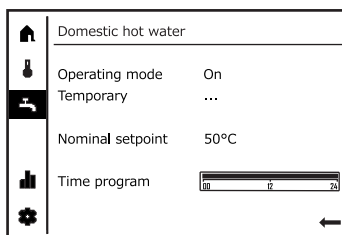
Domestic hot water heating off.



DHW is being heated to its setpoint before the temperature has fallen to the switch-on threshold. The function returns to normal mode once DHW temperature has reached its setpoint.



Changing the DHW temperature setpoint.



DHW time program (time program 4). Activate the time program from line 1620.

## 2.7 Changing the user level

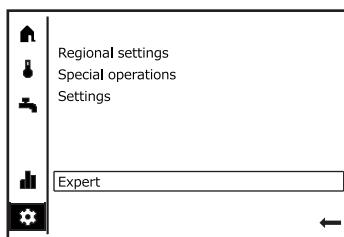
The heat pump automation has four distinct user levels. The user level influences the menu structure and the setpoints displayed in the menus. The user levels are **end user**, **commissioning**, **engineer**, and **OEM**.

The end user view is the default interface view. The **end user** and **commissioning** levels are sufficient for performing most actions.

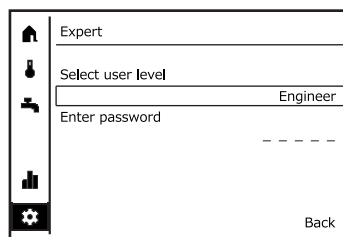
Change the user level from the settings menu (gear icon).

The **commissioning** level does not require a password, but the **engineer** and **OEM** levels are password-protected. The current user level is indicated by a number in the status bar.

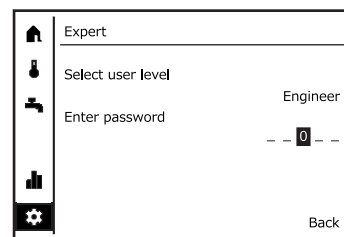
- No number: end user (no password)
- 1: commissioning (no password)
- 2: expert (password 00017)
- 3: OEM level (password 24358)



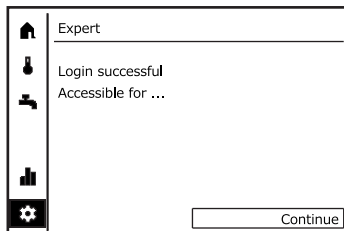
1. Enter the settings menu (gear symbol), and select **Expert**.



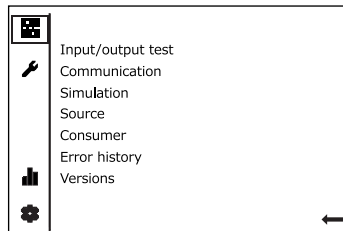
2. Select the user level.



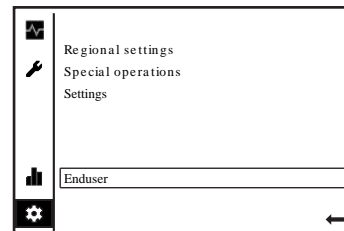
3. Enter the password (if necessary).



4. The interface will inform you that you have logged in.



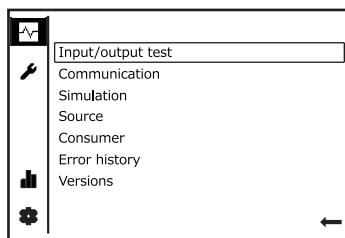
5. The menus applicable to the selected user level are now shown.



Returning to end-user level.

## 2.8 Diagnostics menu

The diagnostics menu can be accessed only at the commissioning user level or above. The sub-menus displayed depend on the user level.



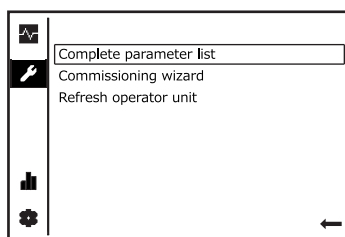
Diagnostics menu.

## 2.9 Service menu

The service menu can be accessed only at the **commissioning** user level or above. The service menu provides access to the **parameter list**. The parameter list allows for a much more in-depth configuration of the automation settings than the basic views.

In addition, the commissioning wizard can be launched again, and the user interface can be updated via the service menu. It is advisable to update the user interface after any changes in connections, such as after adding heating circuits.

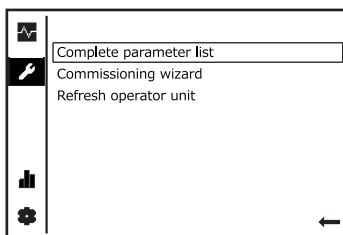
- If there is no need to update the user interface, the service menu does not include an option to start an update.



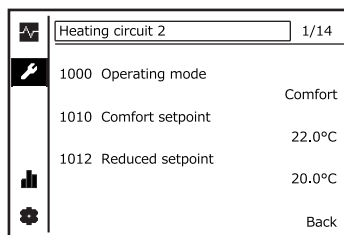
Service menu.

## 2.10 Parameter list

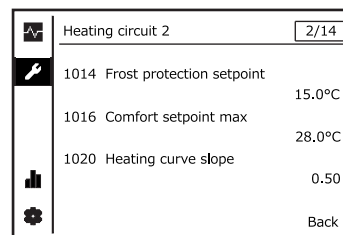
The parameter list can be accessed from the **service** menu. The parameter list can be accessed only at the **commissioning** user level or above. The lines displayed in the parameter list depend on the user level. During first start-up and after changing the user level, it will take some time for the user interface to load the parameter list.



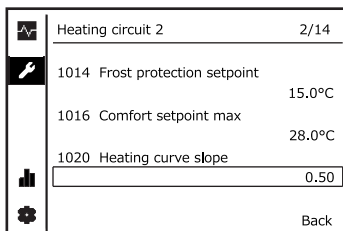
1. Open the parameter list.



2. Select the desired menu from the status bar.

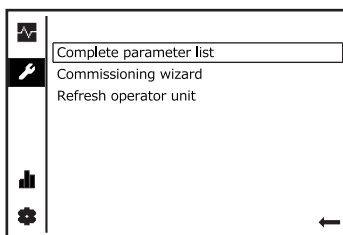


3. Scroll through the pages in the menu and select the relevant one.

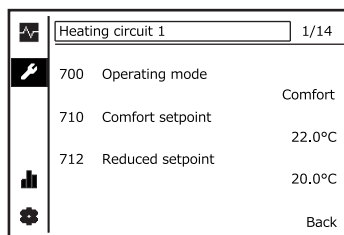


4. Move the cursor to the desired setpoint and edit it.

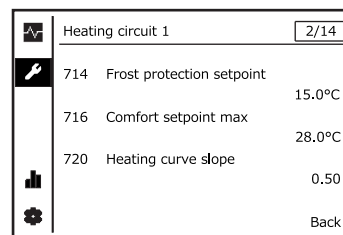
## Advanced settings for heating circuits



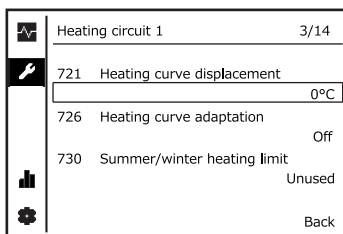
1. Open the parameter list.



2. Select the desired menu from the status bar.



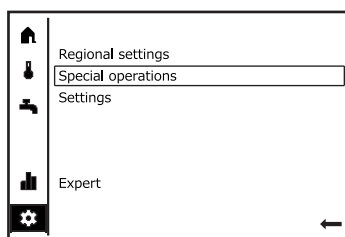
3. Scroll through the pages in the menu and select the relevant one.



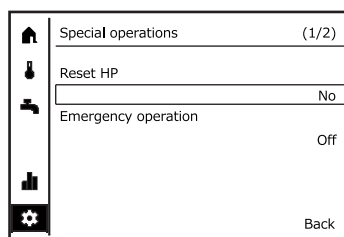
4. Move the cursor to the desired setpoint and edit it.

## 2.11 Resetting the heat pump

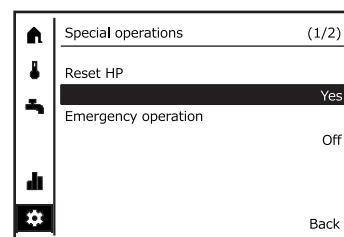
The heat pump can be reset (recovered) from a fault condition from the settings menu. Before the reset, you should investigate the causes of the fault and address the issue.



1. From the settings menu, select **Special operations**.

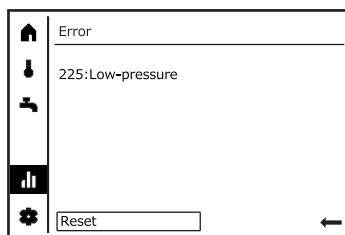


2. Select **Reset HP**.



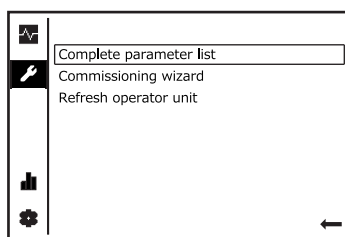
3. Change the setting to **Yes**.

## In case of a fault

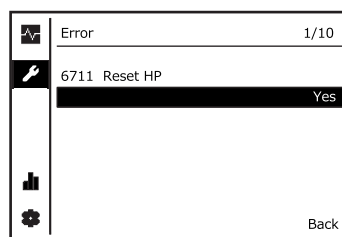


In the diagnostics menu, select **Reset**. Select **Confirm**.

## Through the parameter list



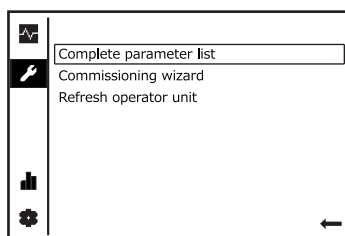
Open the parameter list.



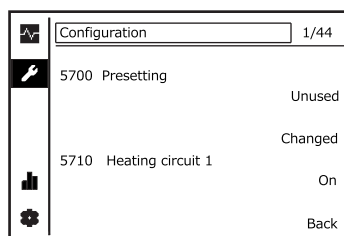
Enter the fault menu and select **Reset HP** on line 6711. Switch the line value to **Yes**.

## 2.12 Switching on heating circuit 2

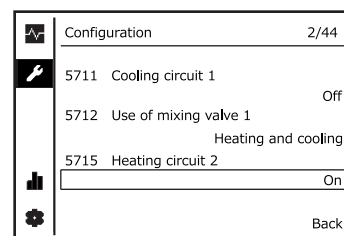
Heating circuit 2 is switched on from the parameter list's (see *Parameter list*) configuration menu on line 5715.



Open the parameter list.



Select the configuration menu from Switch the heating circuit 2 (**On**) the status bar.



Switch the heating circuit 2 (**On**) on line 5715.

## 2.13 Assigning user interfaces to heating circuits

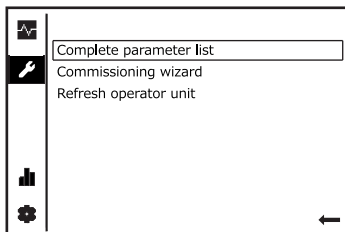


The settings presented here have been configured at the factory in most models.

Assign user interfaces to heating circuits with the commissioning wizard. The wizard starts when the user interface is commissioned for the first time. Alternatively, activate the wizard from the **Service** menu.

User interface settings can be edited later by starting the wizard from the diagnostics menu.

1. To enable access to the diagnostics menu, the user level must be set to “commissioning”, at minimum (section *Heat pump user interface*).
2. In the service menu, select the function Refresh operator unit.
  - This function is displayed only when the user interface needs to be updated.



Select **Commissioning wizard** in the service menu.

### Selecting the intended use of a user interface

Used as (line 40)	Heating circuit assigned to the user interface
Operator unit 1 / Room unit 1	Heating circuit 1 (can be additionally assigned to heating circuits 2 and 3 on line 42)
Operator unit 2 / Room unit 2	Heating circuit 2
Operator unit 3 / Room unit 3	Heating circuit 3

Line 40 is for selecting the user interface sequence number and the assigned heating circuit (zone). The sequence number is the same as the assigned heating circuit's number. The first user interfaces by sequence number (operator unit 1 and room unit 1) are the primary interfaces, which can be used to control heating circuit 1 and all other heating circuits centrally (circuits 2 and 3). Other heating circuits assigned to operator unit 1 are selected on line 42.

The correct sequence number for the operator unit is Operator unit 1. For the primary room unit, select Room unit 1. The system may not have two interfaces of the same type sharing the same sequence number. For example, the system may contain an operator unit 1 and a room unit 1, but not two room units with the sequence number 1. You can select the room unit type “user interface” as long as the system does not have another interface with the same number.

If more interfaces are added to the system, their correct sequence number is either 2 or 3. Interface 2 is assigned to heating circuit 2 only, and interface 3 is assigned to heating circuit 3 only. All interfaces can adjust the settings for all heating circuits via

the parameter list, regardless of the connection. However, changes in for example operation mode and room setpoint only affect the heating circuits assigned to the user interface. The other operating lines presented below are not available for interfaces 2 and 3, because they can only be assigned to the heating circuit indicated by the interface sequence number.

### Line 42: Assigning the user interface to other heating circuits

This operating line is for selecting the heating circuits assigned to user interface 1, other than heating circuit 1. Here you should select **All zones**, so the operator unit 1 can be used to control all heating circuits connected to the system.

Assignment device 1 (line 42)	Heating circuits assigned to the user interface
All zones	User interface 1 can control heating circuits 1, 2 and 3.
Zone 1	User interface 1 can control heating circuit 1 only.
Zone 1 and 2	User interface 1 can control heating circuits 1 and 2.
Zone 1 and 3	User interface 1 can control heating circuits 1 and 3.

### Lines 44 and 46: Operation of zones 2 and 3 via user interface 1

Lines 44 and 46 are for selecting the connection of operation mode (Automatic, Comfort etc.) of heating circuits 2 and 3, and the room temperature setpoint, to the corresponding settings of heating circuit 1. Here you should select **Independently**, so heating circuits 2 and 3 can be controlled independently via operator unit 1.

Operation of zones 2 and 3 (lines 44 and 46)	Operation of heating circuits 2 and 3
Independently	Switching the operation mode or room temperature setpoint of heating circuit 1 does not affect the settings of heating circuits 2 and 3. Heating circuits 2 and 3 can be separately selected to be displayed in the heating circuit menu of user interface 1.
Jointly with zone 1	Changing the operation mode and room temperature setpoint of heating circuit 1 changes the same values for heating circuits 2 and 3. Heating circuits 2 and 3 cannot be separately selected for display in the heating circuit menu of user interface 1.

### Line 47: Room temperature's area of influence from user interface 1

Line 47 selects the area of influence for the room temperature measured by user interface 1 (room unit 1). Here you should select **For zone 1 only**.

Room temperature's area of influence from user interface 1 (line 47)	Area of influence
For zone 1 only	The temperature measured by room unit 1 is used for controlling heating circuit 1 only.
For all assigned zones	All heating circuits that are assigned to the user interface via line 42 use the room temperature measured by room unit 1 to control the heating.

In order to use the room temperature for controlling the heating circuits, the room unit must be installed in a location that is suitable for measuring temperatures, and the control method based on room temperature must be implemented.

## Line 48: Temporary Comfort mode's area of influence from user interface 1

Selects which heating circuits are influenced by the temporary Comfort mode of heating circuit 1.

Temporary Comfort mode's area of influence from user interface 1 (line 48)	Area of influence
For zone 1 only	Temporary Comfort mode selected for heating circuit 1 affects heating circuit 1 only.
For all assigned zones	All heating circuits assigned to the user interface via line 42 are switched on to a temporary comfort mode if the function is selected for heating circuit 1.
None	Heating circuit 1 does not support the temporary Comfort mode.

## 2.14 Relay test

Use the relay test to test the operation of actuators.

With the relay test, the power can be switched on to the controller's QX outputs one by one. This way, the functionality and electrical connections of actuators can be ensured before starting the heat pump. The relay test can be used during commissioning, maintenance, and troubleshooting. It is found in the diagnostics menu and in the sub-menu of parameter list "Input/output test". The line number of the relay test is 7700. Note that both the pump's QX output and the UX signal output have to be switched on in the speed-controlled pumps.

Use the relay test for bleeding the pipes if needed. Rotate the pump periodically for short times with the relay test and vent and fill (pressurize) the circuits between these short-term operating times. If needed, switch the positions of the change and control valves during bleeding.

1. Perform the relay test by selecting the desired QX output (and, if required, the UX signal output) and observing the operation of the actuator.
2. Finish the test by changing the relay test function setting (line 7700) to **no test**.
3. After the relay test, reset the heat pump (line 6711).

Connector	Output	Function	Marking	Additional information
R	QX8	Change-over valve Q3	Q3	Before the relay test, the change-over valve is in position B (B for building, heating circuit). <ul style="list-style-type: none"> <li>Switching the power on turns the valve to position A (A for aqua, DHW tank).</li> <li>When you switch the relay test off, the valve returns to position B.</li> </ul>
S	QX9	Heating circuit 1 pump Q2	Q2	When the test is activated, the pump should start to run. <ul style="list-style-type: none"> <li>For speed controlled pumps, see further instructions in the following chapter.</li> </ul>
T	QX10	Heating circuit 1 valve open Y1	Y1	The branch leading from the storage tank to the heating circuit opens (the circuit starts to take heat from the storage tank). <ul style="list-style-type: none"> <li>After the test, the valve remains in the position it was in at the end of the test.</li> </ul>
T	QX11	Heating circuit 1 valve closed Y2	Y2	The branch leading from the storage tank to the heating circuit closes (heating circuit's internal circulation). <ul style="list-style-type: none"> <li>After the test, the valve remains in the position it was in at the end of the test.</li> </ul>
U	QX12	Brine circuit (evaporator circuit) pump Q8	Q8	When the test is activated, the pump should start to run. <ul style="list-style-type: none"> <li>See further instructions for speed controlled pumps at the end of this section.</li> </ul>
V	QX13	Condenser circuit pump Q9	Q9	When the test is activated, the pump should start to run. <ul style="list-style-type: none"> <li>See further instructions for speed controlled pumps at the end of this section.</li> </ul>

## Relay test for speed controlled pumps

Perform the test for speed controlled pumps by activating the pump's QX output and signal output test. Finish the test by changing the relay test function setting (line 7700) to **no test** and setting the test value for UX output to ---.

Select the QX output that is connected to the pump.

Activate an UX output test for the pump. Select the UX output that is connected to the pump (see section *Automation factory settings* and electrical diagrams). Select a test value, for example 100, 50, and 0 per cent.

### Relay test for a speed controlled condenser circuit pump

Line	Connector	Output	Function	Marking	Additional information
7700	V	QX13	Condenser circuit pump Q9	Q9	When the test is switched on and the desired speed is selected on line 7710, the pump should start to run. <ul style="list-style-type: none"> <li>• Check that speed control works correctly by repeating the test with different speed settings on line 7710 (for example, to 100%, 50%, and 0%).</li> </ul>
7710	y	UX1	Output test UX1	UX1	

### Relay test for a speed controlled brine circuit pump

Line	Connector	Output	Function	Marking	Additional information
7700	U	QX12	Brine circuit pump Q8	Q8	When the test is switched on and the desired speed is selected on line 7716, the pump should start to run. <ul style="list-style-type: none"> <li>• Check that speed control works correctly by repeating the test with different speed settings on line 7716 (for example, to 100%, 50%, and 0%).</li> </ul>
7716	y	UX2	Output test UX2	UX2	

## 3 Heating circuit settings

### 3.1 Settings for heating circuits

#### Important settings and statuses

The following examples use heating circuit 1's line numbers. The setpoints for the heating circuits are found in the parameter list of each heating circuit's menu. If several heating circuits have been connected to the same heating line or storage tank, the flow temperature request sent to the heat pump is determined by the highest request.

In the menus, the heating circuits are also referred to as zones. Zone 1 refers to heating circuit 1, zone 2 to heating circuit 2, and zone 3 to heating circuit 3. Also see section *Assigning user interfaces to the heating circuits*.

Key setpoints for heating circuit 1

Menu	Line	Setting
Heating circuit 1	700	Operating mode
Heating circuit 1	710	Comfort setpoint max
Heating circuit 1	712	Reduced setpoint
Heating circuit 1	714	Frost protection setpoint
Heating circuit 1	720	Heating curve slope
Heating circuit 1	721	Heating curve displacement (parallel displacement)
Heating circuit 1	730	Summer/winter heating limit
Heating circuit 1	740	Flow temp. setpoint min. (lower limit)
Heating circuit 1	741	Flow temp. setpoint max. (upper limit)
Heating circuit 1	750	Room influence
Heat pump	2855 F	Switch-off temperature in space heating
Heating circuit 1	2839	Setting change time LKV/heating
Status	8000	State heating circuit 1
Diagnostics heat generation	8411	Return temp HP (return to condenser, sensor B71)
Diagnostics heat generation	8412	Flow temp HP (flow from condenser, sensor B21)
Diagnostics consumers	8700	Outside temperature
Diagnostics consumers	8703	Outside temp attenuated
Diagnostics consumers	8704	Outside temp composite
Diagnostics consumers	8743	Flow temp 1 (flow water temperature in heating circuit 1 buffer tank connection, sensor B1)
Diagnostics consumers	8744	Flow set value 1 (The setpoint of heating circuit 1's flow (from the heating curve))

## Heating circuit's operating mode and time programs

Three different levels can be saved for the room temperature setpoint. These setpoint values are, from the highest to the lowest, Comfort, Reduced, and Frost Protection. The value can be changed either automatically on the basis of the time program or manually.

Timer programs are enabled only when the heating circuit is in automatic-operating mode. A time program toggles the heating circuit's operating mode between Comfort mode and Reduced mode automatically. Comfort mode is used during the period specified in the time program. At other times, Reduced mode is used. Timer programs can be set up for each day of the week separately. Heating circuits should be kept in Automatic mode, because then they can be automatically disabled when the heating period ends (summer/winter heating limit). When using factory settings, the heating circuits have Automatic mode enabled, and the time program keeps Comfort mode on permanently.

Comfort	The setpoint of room temperature is the setpoint of Comfort mode (line 710). The heating circuit time programs are disabled. The Eco functions are not enabled, even if they were switched on.
Reduced	The setpoint of room temperature is the setpoint of Reduced mode (line 712). The heating circuit time programs are disabled. The Eco functions are enabled if they have been switched on.
Protection mode	The setpoint of room temperature is the setpoint of frost protection (line 714). The heating-circuit time programs are disabled. The Eco functions are enabled if they have been switched on.
Automatic	The timed control of the room temperature setpoint is on. The room temperature setpoint is toggled between Comfort mode and Reduced mode in line with the time program. In holiday programs, it is possible to select whether the mode changes from Comfort mode to Reduced mode or Frost Protection mode (line 648) during holidays. Eco functions are enabled.

## Standard settings for heating circuits

Comfort temperature	°C	22		Heating circuit 1 line 720	Heating circuit 1 line 741	Heating circuit 1 line 741	On demand
Parallel displacement	°C	0		Heating circuit 2 line 1020	Heating circuit 2 line 1041	Heating circuit 2 line 1041	line 2855
				Heating circuit 3 line 1320	Heating circuit 3 line 1341	Heating circuit 3 line 1341	
Heating system and floor structure	Weather zone	Design outside temperature	Flow temperature in the design outside temperature	Heating curve's slope	Flow upper limit	Flow lower limit	Switch-off temperature in space heating (on demand)
		°C	°C		°C	°C	
Floor heating, concrete structure, flagstone	I	-26	30	0.22	32	15-22	37
Floor heating, concrete structure, flagstone	II	-29	30	0.20	32	15-22	37
Floor heating, concrete structure, flagstone	III	-32	30	0.20	32	15-22	37
Floor heating, concrete structure, flagstone	IIII	-38	30	0.18	32	15-22	37
Floor heating, concrete structure, flagstone	I	-26	35	0.34	37	15-22	42
Floor heating, concrete structure, flagstone	II	-29	35	0.34	37	15-22	42
Floor heating, concrete structure, flagstone	III	-32	35	0.32	37	15-22	42
Floor heating, concrete structure, flagstone	IIII	-38	35	0.30	37	15-22	42
Floor heating, wooden structure, parquet, boarded or laminate	I	-26	40	0.48	42	15-22	47

<b>Comfort temperature</b>	<b>°C</b>	<b>22</b>		<b>Heating circuit 1 line 720</b>	<b>Heating circuit 1 line 741</b>	<b>Heating circuit 1 line 741</b>	<b>On demand</b>
<b>Parallel displacement</b>	<b>°C</b>	<b>0</b>		<b>Heating circuit 2 line 1020</b>	<b>Heating circuit 2 line 1041</b>	<b>Heating circuit 2 line 1041</b>	<b>line 2855</b>
				<b>Heating circuit 3 line 1320</b>	<b>Heating circuit 3 line 1341</b>	<b>Heating circuit 3 line 1341</b>	
<b>Heating system and floor structure</b>	<b>Weather zone</b>	<b>Design outside temperature</b>	<b>Flow temperature in the design outside temperature</b>	<b>Heating curve's slope</b>	<b>Flow upper limit</b>	<b>Flow lower limit</b>	<b>Switch-off temperature in space heating (on demand)</b>
		<b>°C</b>	<b>°C</b>		<b>°C</b>	<b>°C</b>	
Floor heating, wooden structure, parquet, boarded or laminate	II	-29	40	0.45	42	15-22	47
Floor heating, wooden structure, parquet, boarded or laminate	III	-32	40	0.44	42	15-22	47
Floor heating, wooden structure, parquet, boarded or laminate	IIII	-38	40	0.42	42	15-22	47
Floor heating, wooden structure, parquet, boarded or laminate	I	-26	45	0,60	47	15-22	52
Floor heating, wooden structure, parquet, boarded or laminate	II	-29	45	0.58	47	15-22	52
Floor heating, wooden structure, parquet, boarded or laminate	III	-32	45	0.56	47	15-22	52
Floor heating, wooden structure, parquet, boarded or laminate	IIII	-38	45	0.52	47	15-22	52

Comfort temperature	°C	22		Heating circuit 1 line 720	Heating circuit 1 line 741	Heating circuit 1 line 741	On demand
Parallel displacement	°C	0		Heating circuit 2 line 1020	Heating circuit 2 line 1041	Heating circuit 2 line 1041	line 2855
				Heating circuit 3 line 1320	Heating circuit 3 line 1341	Heating circuit 3 line 1341	
Heating system and floor structure	Weather zone	Design outside temperature	Flow temperature in the design outside temperature	Heating curve's slope	Flow upper limit	Flow lower limit	Switch-off temperature in space heating (on demand)
		°C	°C		°C	°C	
Radiator heating, new buildings (2013-), design 45/30 °C	I	-26	45	0,60	47	15-22	-
Radiator heating, new buildings (2013-), design 45/30 °C	II	-29	45	0.58	47	15-22	-
Radiator heating, new buildings (2013-), design 45/30 °C	III	-32	45	0.56	47	15-22	-
Radiator heating, new buildings (2013-), design 45/30 °C	IIII	-38	45	0.52	47	15-22	-
Radiator heating, (1980-), design 70/40 °C	I	-26	70	1.26	72	15-22	-
Radiator heating, (1980-), design 70/40 °C	II	-29	70	1.20	72	15-22	-
Radiator heating, (1980-), dimensioning 70/40 °C	III	-32	70	1.16	72	15-22	-
Radiator heating, (1980-), design 70/40 °C	IIII	-38	70	1.10	72	15-22	-
Radiator heating, older buildings, design 80/60 °C	I	-26	80	1.52	82	15-22	-

Comfort temperature	°C	22		Heating circuit 1 line 720	Heating circuit 1 line 741	Heating circuit 1 line 741	On demand
Parallel displacement	°C	0		Heating circuit 2 line 1020	Heating circuit 2 line 1041	Heating circuit 2 line 1041	line 2855
				Heating circuit 3 line 1320	Heating circuit 3 line 1341	Heating circuit 3 line 1341	
Heating system and floor structure	Weather zone	Design outside temperature	Flow temperature in the design outside temperature	Heating curve's slope	Flow upper limit	Flow lower limit	Switch-off temperature in space heating (on demand)
		°C	°C		°C	°C	
Radiator heating, older buildings, design 80/60 °C	II	-29	80	1.46	82	15-22	-
Radiator heating, older buildings, design 80/60 °C	III	-32	80	1.40	82	15-22	-
Radiator heating, older buildings, design 80/60 °C	IIII	-38	80	1.32	82	15-22	-
Floor heating in damp spaces, new buildings (2013-)	-	-	30	-	30	30	35
Floor heating in damp spaces, new buildings (2013-)	-	-	35	-	35	35	40

### 3.2 Heating curve settings

The heating system of a building is usually sized according to the calculated heating capacity. The heating capacity of the heating circuits is adjusted by changing their flow temperature. The flow temperature is usually adjusted according to outside temperature, because the need for heating capacity is typically most dependent on the temperature outside. In addition to the outside temperature, the temperature of the heating circuit can be controlled on the basis of room temperature measurements, or on the basis of a combination of the two. In addition to the outside and room temperatures, heating demand is influenced by solar radiation and internal heat sources, such as a sauna, lighting, domestic appliances and people. These heat sources can be taken into account by measuring the room temperature. Different parts of a building may have varying room temperatures and heating demands. Because of this, heating can be divided among several heating circuits, each connected to

spaces with similar heating demands. The return temperature from the heating circuits is dependent on the heat emission and discharge of the heating circuits, in addition to the flow temperature.

The heating curve is used to select the heating circuit's flow temperature in different outside temperatures. The heating curve is set by selecting the room temperature setpoint and also the heating curve slope and parallel displacement. In addition to adjusting the slope and displacement, the heating curve can be equipped with maximum and minimum limits (section *Adjusting the heating curve in different situations*). The values of the heating curve slope and the parallel displacement are appropriate if the room temperature is appropriate for the heating season regardless of the outside temperature. The heating curve slope and displacement should be changed only slowly (for example, once per 24 hours) and in small increments, because the temperatures of the building structures and indoor air change slowly.

Heating curve slope is set on line 720. If the room temperature is too low in very cold temperatures, a steeper adjustment curve is selected. If the room temperature is too high in very cold temperatures, a more graded adjustment curve is selected. The heating curve displacement is performed on line 721. If the room temperature is consistently too low in both very cold and milder temperatures, the curve is appropriate (line 720 is not changed) but is moved upward by increasing the value on line 721. If the room temperature is consistently too high in both very cold and milder temperatures, the curve is appropriate (line 720 is not changed) but is moved downward by decreasing the value on line 721. In control based on the heating curve, increases and decreases in the room temperature setpoint correspond to the heating curve displacement (line 721) in practice. Thus, the heating curve can also be displaced by changing the room temperature setpoint. For more detailed instructions on setting the heating curve in various situations, see section *Adjusting the heating curve in different situations*.

In an appropriately insulated, floor-heated building, a suitable heating curve slope is usually approximately 0.3...0.5. In an older radiator-heated building with poorer insulation the suitable slope is usually approximately 0.5...0.9. The suitable values must be found on a case-by-case basis, since heating systems, buildings, and usage habits vary.

### Upper and lower limits of the flow temperature of the heating circuit

The upper and lower limits of the temperature of the space heating circuit flow are set on lines 740 and 741. The heat circuit's flow setpoint does not breach the limits, even if the heating curve indicates a temperature outside the set limits. The limits are used in control based on both the heating curve and the room temperature. If the connection does not include a heating circuit tank, take the temperature differential on line 5810 and the switching differential on line 2840 into account in the limits (*Space heating without a buffer storage tank*).

In addition to the aforementioned limits, you can also set an upper limit to the temperature of the flow water leaving the condenser on line 2855 (F series). If this limit is exceeded, the heat pump shuts down (section *Space heating with a regulated storage tank*). The purpose of this function is to protect the heating circuit from temperatures that are too high. This limit should be set for floor heating if the system is not equipped with a heating circuit's buffer storage tank and the connected circuit control valve. If the flow water cannot exceed the limit on line 2855 even momentarily, the time set on line 2839 (section *DHW heating*) should be removed altogether (---).

The upper and lower limits of the temperature depend on the operating mode of the heating circuit and on the floor structure. The appropriate values should always be checked from the instructions provided by the heating-circuit manufacturer and supplier. For example, the flow temperature in floor heating circuits usually should be no higher than approximately 35–45 °C and no lower than approximately 25 °C. The desired heating effect is usually reached with a flow temperature of 30–35 °C for concrete floors, and 40–45 °C for wooden floors. The suitable values must be found on a case-by-case basis, since heating systems, buildings, and usage habits vary.

If the system is not equipped with a supplementary heat source, such as an electric immersion heater or an electric kettle, the upper limit of the heating circuit's flow water temperature must be set below the factory-set switch-off temperature (line 2844). This prevents the heating curve from requesting water that is hotter than the switch-off temperature. When setting the limit, pay attention to the switching differential, which designates how much above the setpoint the water temperature leaving the heat pump can be. Due to this the upper limit can be within 2...4 °C from the switch-off temperature, at most.

### **Room temperature setpoint**

The temperature of the heating circuit can be controlled on the basis of room temperature measurements. Control based on room temperature requires a sensor measuring room temperature in the heat pump controller. The measurement can be carried out by means of either a wall-mounted user interface (room unit) or a separate sensor measuring the room temperature. There can be several room units and temperature sensors. The impact of the room temperature measurement on the flow temperature of the heating circuit (room influence) is selected on line 750.

If the room influence is switched off (the value on line 750 is "---") or there is no room sensor, the flow temperature in the heating circuit is based only on the heating curve. In that situation, the room temperature setpoint is used to select the lowest flow temperature. For example, if the room temperature setpoint is 22 °C, the lowest flow temperature is 22 °C if a lower limit higher than the room temperature setpoint has not been set separately for the temperature (line 740). In control based on the heating curve, increasing and decreasing the room temperature setpoint corresponds to the heating curve displacement (line 721) in practice. Thus, the heating curve can also be displaced by changing the room temperature setpoint.

If the room temperature sensor is connected to the controller and the room influence value is 1–99%, the flow temperature is based on both the outside temperature (the heating curve) and the room temperature. In that case, the controller changes the flow temperature determined by the curve on the basis of the room temperature. The higher the proportion of room influence is set on line 750, the bigger the change is. If the value set for room influence is 100%, the flow temperature ignores the heating curve. In that case, the flow temperature is based only on the setpoint of room temperature and the change in the measured room temperature.

If the measured room temperature is a good representation of the temperature of the spaces connected to the heating circuit but the flow temperature should take the outside temperature also into consideration, then the level of room influence can typically be set to approximately 60%. If the measured room temperature is not a very good representation of the entire heating circuit's area of influence, then the selected room influence can be approximately 20%.

## Operating time after DHW heating

When the domestic water has been heated, the heat pump turns the flow into the heating circuit with the diverting valve and then operates for the switching duration set on line 2839, even if the heating circuit does not request heat at that moment. This lets the automation measure the heating circuit's return temperature (sensor B71), which is used to guide the compressor on and off. If the sensor's reading is below the setpoint and switch-off temperatures (section *Heat pump protection functions*), the heat pump is kept operational. The purpose of the function is to avoid unnecessary stoppages in heat pump's operation and heating after the DHW has been charged. The switch-off temperature on line 2844 is in effect during the switching time even if the switch-off temperature designed to protect the heating circuit on line 2855 (section *Heat pump's protection functions*) is in use. Having a switching time is not usually necessary in systems that are equipped with a heating circuit buffer storage tank.

### 3.2.1 Heating curve equation and diagrams

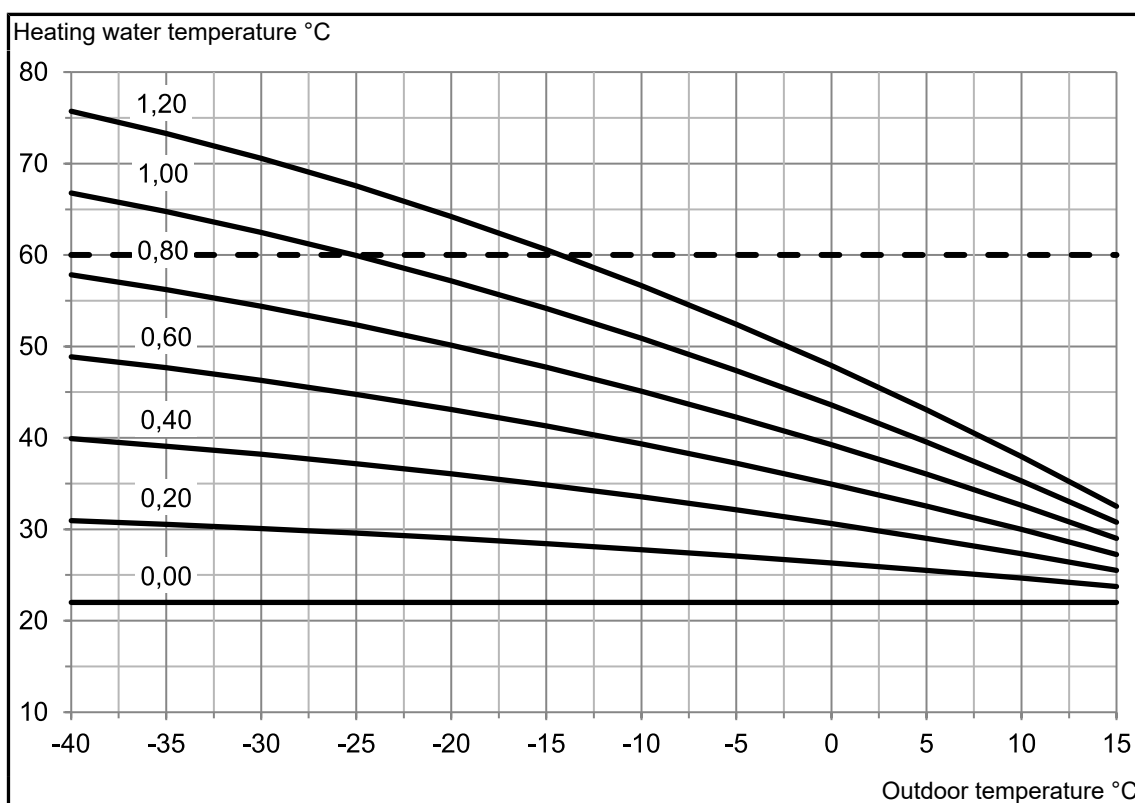
#### Heating curve equation

$$T_{meno} = T_{ha} + [2 + (T_{ha} + T_{ulkov}) - 0,005 \cdot (T_{ha} + T_{ulkov})^2] \cdot k$$

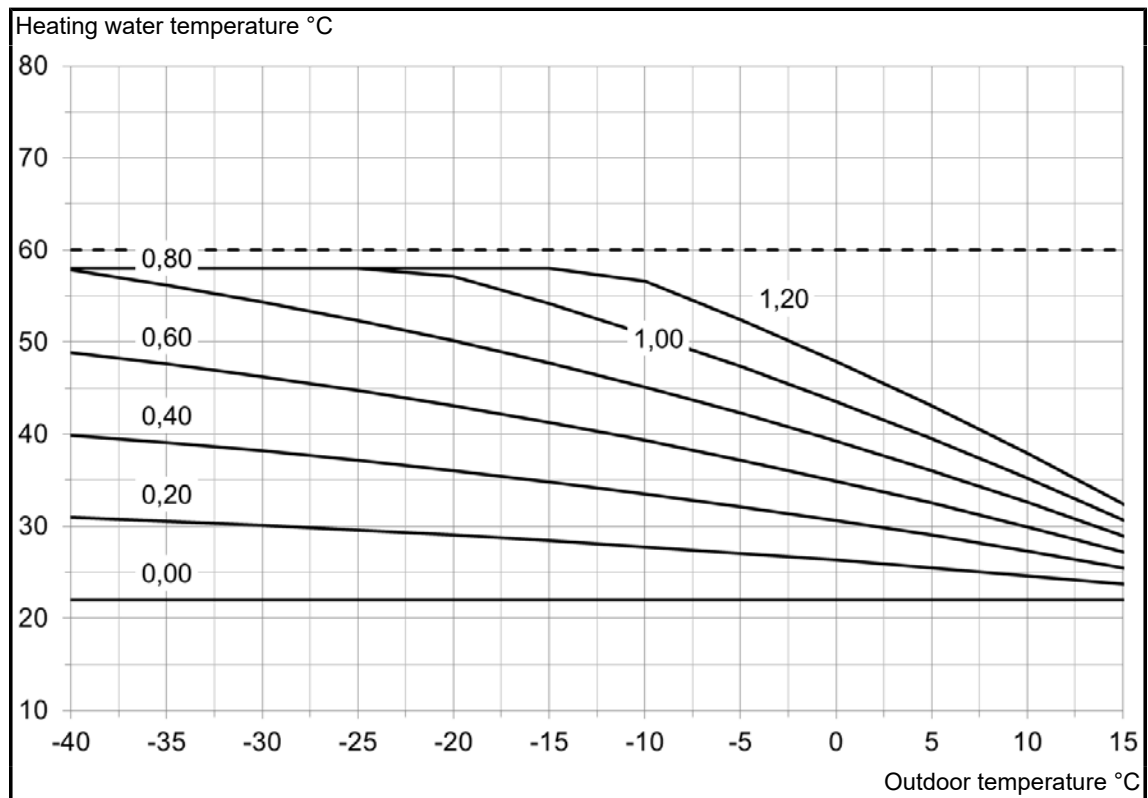
where  $T_{meno}$  is the heating circuit's flow temperature,  $T_{ha}$  is the room temperature setpoint,  $T_{ulkov}$  is the outdoor temperature, observing also the building's heat capacity (composite outside temperature, line 8704) and  $k$  is the heating curve slope.

#### Diagrams

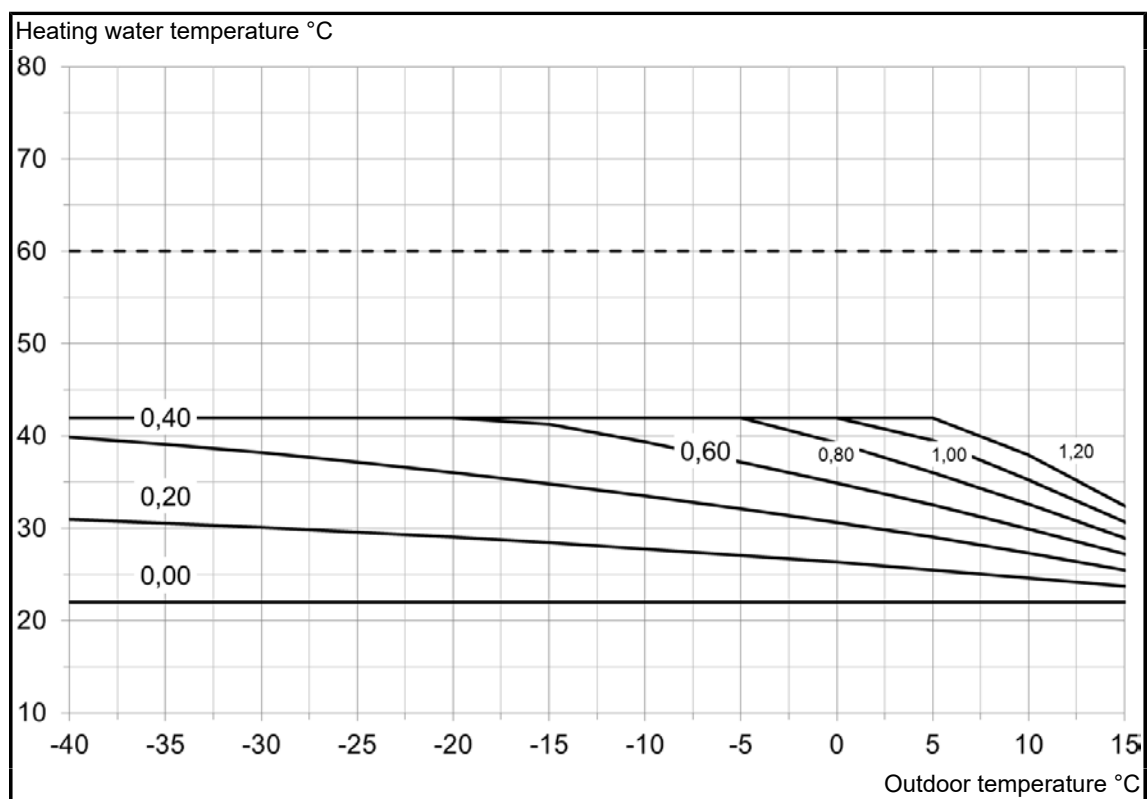
In the diagrams below, x-axis refers to the outdoor temperature (°C) and the y-axis to the heating flow temperature setpoint (°C).



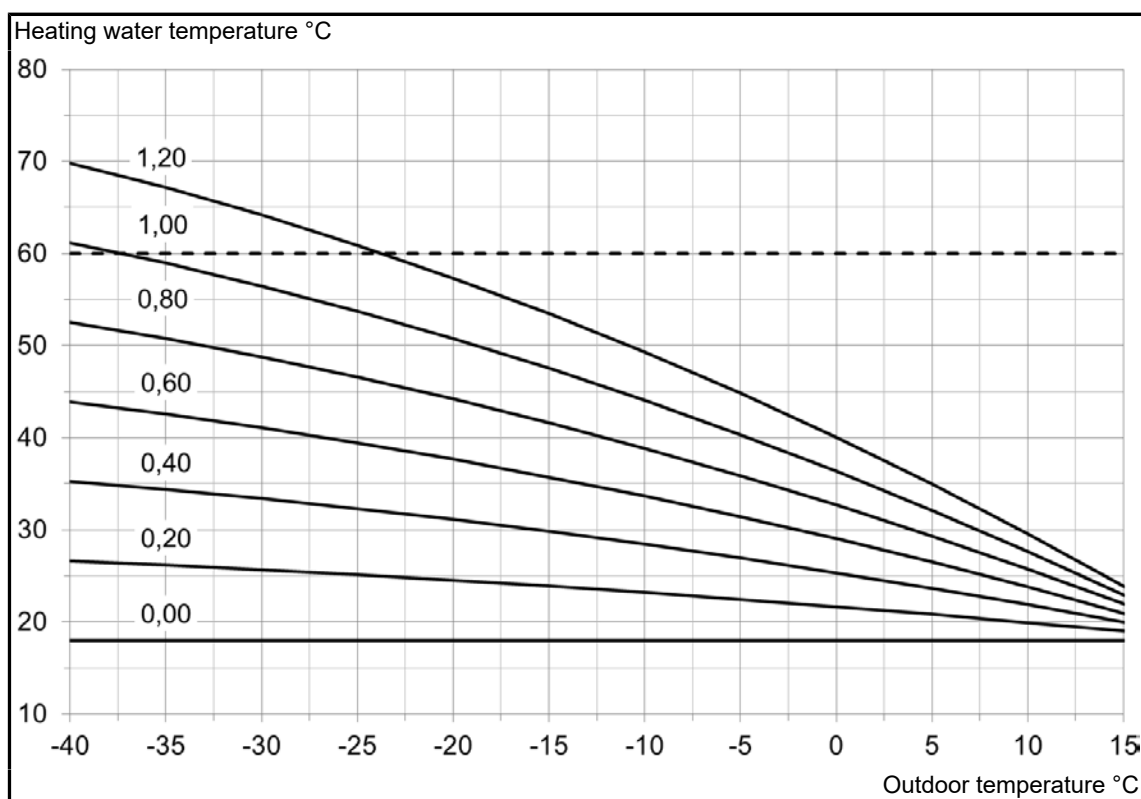
Heating curves when the room temperature setpoint is 22 °C, the heating curve displacement is 0 °C, and the upper and lower limits do not restrict the heating water temperature.



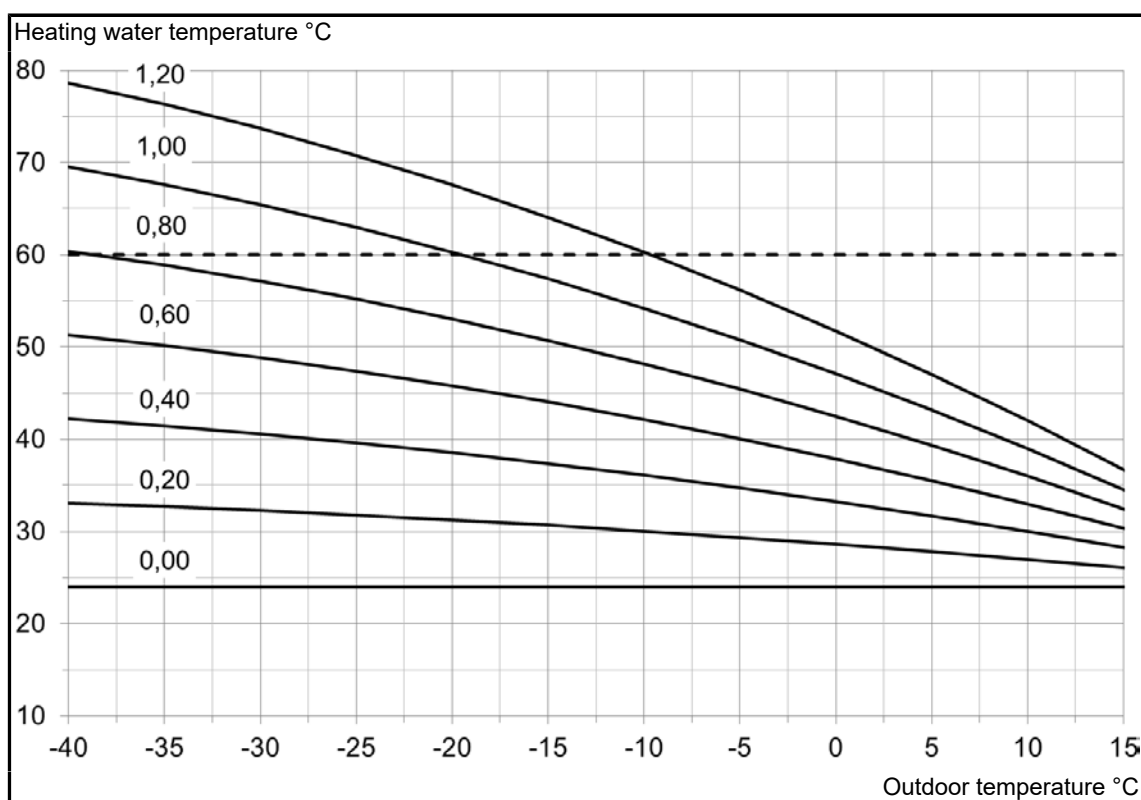
Heating curves when the room temperature setpoint is 22 °C, the heating curve displacement is 0 °C, and the upper limit of the heating circuit's flow temperature is 58 °C.



Heating curves when the room temperature setpoint is 22 °C, the heating curve displacement is 0 °C, and the upper limit of the heating circuit's flow temperature is 42 °C.



Heating curves when the room temperature setpoint is 18 °C, the heating curve displacement is 0 °C, and the upper and lower limits do not restrict the heating water temperature.



Heating curves when the room temperature setpoint is 24 °C, the heating curve displacement is 0 °C, and the upper and lower limits do not restrict the heating water temperature.

### 3.2.2 Heating curve tables

Heat pumps made for consumer use usually achieve a temperature of approximately 60...68 °C. For higher flow temperatures, a heat pump capable of higher temperatures, or an extra heat source installed in the heating circuit's flow line and capable of higher temperatures, such as an electric heating or oil boiler, is required.

#### Heating curves with room temperature setpoint at 22 °C

Outside temperature (°C)	Heating curve slope and heating circuit's flow temperature (°C)															
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
-50	22.0	26.8	31.6	36.4	41.2	46.0	50.8	55.7	<b>60.5</b>	<b>65.3</b>	<b>70.1</b>	<b>74.9</b>	<b>79.7</b>	<b>84.5</b>	<b>89.3</b>	<b>94.1</b>
-45	22.0	26.7	31.3	36.0	40.6	45.3	49.9	54.6	<b>59.2</b>	<b>63.9</b>	<b>68.6</b>	<b>73.2</b>	<b>77.9</b>	<b>82.5</b>	<b>87.2</b>	<b>91.8</b>
-40	22.0	26.5	31.0	35.4	39.9	44.4	48.9	53.3	57.8	<b>62.3</b>	<b>66.8</b>	<b>71.3</b>	<b>75.7</b>	<b>80.2</b>	<b>84.7</b>	<b>89.2</b>
-35	22.0	26.3	30.6	34.8	39.1	43.4	47.7	51.9	56.2	<b>60.5</b>	<b>64.8</b>	<b>69.0</b>	<b>73.3</b>	<b>77.6</b>	<b>81.9</b>	<b>86.1</b>
-30	22.0	26.0	30.1	34.1	38.2	42.2	46.3	50.3	54.4	58.4	<b>62.5</b>	<b>66.5</b>	<b>70.6</b>	<b>74.6</b>	<b>78.7</b>	<b>82.7</b>
-25	22.0	25.8	29.6	33.4	37.2	41.0	44.8	48.6	52.4	56.2	<b>60.0</b>	<b>63.8</b>	<b>67.5</b>	<b>71.3</b>	<b>75.1</b>	<b>78.9</b>
-20	22.0	25.5	29.0	32.6	36.1	39.6	43.1	46.6	50.1	53.7	57.2	<b>60.7</b>	<b>64.2</b>	<b>67.7</b>	<b>71.3</b>	<b>74.8</b>
-15	22.0	25.2	28.4	31.6	34.9	38.1	41.3	44.5	47.7	50.9	54.2	57.4	<b>60.6</b>	<b>63.8</b>	<b>67.0</b>	<b>70.2</b>
-10	22.0	24.9	27.8	30.7	33.6	36.4	39.3	42.2	45.1	48.0	50.9	53.8	56.7	<b>59.5</b>	<b>62.4</b>	<b>65.3</b>
-5	22.0	24.5	27.1	29.6	32.1	34.7	37.2	39.7	42.3	44.8	47.4	49.9	52.4	55.0	57.5	<b>60.0</b>
0	22.0	24.2	26.3	28.5	30.6	32.8	34.9	37.1	39.3	41.4	43.6	45.7	47.9	50.1	52.2	54.4
5	22.0	23.8	25.5	27.3	29.0	30.8	32.5	34.3	36.0	37.8	39.6	41.3	43.1	44.8	46.6	48.3
10	22.0	23.3	24.7	26.0	27.3	28.6	30.0	31.3	32.6	34.0	35.3	36.6	37.9	39.3	40.6	41.9
15	22.0	22.9	23.8	24.6	25.5	26.4	27.3	28.1	29.0	29.9	30.8	31.6	32.5	33.4	34.3	35.1
20	22.0	22.4	22.8	23.2	23.6	24.0	24.4	24.8	25.2	25.6	26.0	26.4	26.8	27.2	27.6	28.0
25	22.0	21.9	21.8	21.7	21.6	21.5	21.4	21.3	21.2	21.1	21.0	20.9	20.7	20.6	20.5	20.4
30	22.0	21.4	20.7	20.1	19.5	18.8	18.2	17.6	16.9	16.3	15.7	15.0	14.4	13.8	13.2	12.5

#### Heating curves with room temperature setpoint at 24 °C

Outside temperature (°C)	Heating curve slope and heating circuit flow temperature (°C)															
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
-50	24.0	28.9	33.7	38.6	43.4	48.3	53.2	58.0	<b>62.9</b>	<b>67.8</b>	<b>72.6</b>	<b>77.5</b>	<b>82.3</b>	<b>87.2</b>	<b>92.1</b>	<b>96.9</b>
-45	24.0	28.7	33.4	38.2	42.9	47.6	52.3	57.0	<b>61.8</b>	<b>66.5</b>	<b>71.2</b>	<b>75.9</b>	<b>80.6</b>	<b>85.4</b>	<b>90.1</b>	<b>94.8</b>
-40	24.0	28.6	33.1	37.7	42.2	46.8	51.3	55.9	<b>60.4</b>	<b>65.0</b>	<b>69.5</b>	<b>74.1</b>	<b>78.6</b>	<b>83.2</b>	<b>87.7</b>	<b>92.3</b>
-35	24.0	28.4	32.7	37.1	41.4	45.8	50.2	54.5	58.9	<b>63.2</b>	<b>67.6</b>	<b>72.0</b>	<b>76.3</b>	<b>80.7</b>	<b>85.0</b>	<b>89.4</b>
-30	24.0	28.1	32.3	36.4	40.6	44.7	48.9	53.0	57.1	<b>61.3</b>	<b>65.4</b>	<b>69.6</b>	<b>73.7</b>	<b>77.8</b>	<b>82.0</b>	<b>86.1</b>
-25	24.0	27.9	31.8	35.7	39.6	43.5	47.4	51.3	55.2	<b>59.1</b>	<b>63.0</b>	<b>66.9</b>	<b>70.8</b>	<b>74.7</b>	<b>78.6</b>	<b>82.5</b>
-20	24.0	27.6	31.3	34.9	38.5	42.2	45.8	49.4	53.1	56.7	<b>60.3</b>	<b>64.0</b>	<b>67.6</b>	<b>71.2</b>	<b>74.8</b>	<b>78.5</b>
-15	24.0	27.3	30.7	34.0	37.4	40.7	44.0	47.4	50.7	54.1	57.4	<b>60.7</b>	<b>64.1</b>	<b>67.4</b>	<b>70.8</b>	<b>74.1</b>
-10	24.0	27.0	30.0	33.1	36.1	39.1	42.1	45.2	48.2	51.2	54.2	57.2	<b>60.3</b>	<b>63.3</b>	<b>66.3</b>	<b>69.3</b>
-5	24.0	26.7	29.4	32.0	34.7	37.4	40.1	42.8	45.4	48.1	50.8	53.5	56.2	58.8	<b>61.5</b>	<b>64.2</b>
0	24.0	26.3	28.6	30.9	33.2	35.6	37.9	40.2	42.5	44.8	47.1	49.4	51.7	54.1	56.4	58.7
5	24.0	25.9	27.8	29.8	31.7	33.6	35.5	37.4	39.4	41.3	43.2	45.1	47.0	49.0	50.9	52.8

Outside temperature (°C)	Heating curve slope and heating circuit flow temperature (°C)															
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
10	24.0	25.5	27.0	28.5	30.0	31.5	33.0	34.5	36.0	37.5	39.0	40.5	42.0	43.5	45.0	46.5
15	24.0	25.1	26.1	27.2	28.2	29.3	30.4	31.4	32.5	33.5	34.6	35.7	36.7	37.8	38.8	39.9
20	24.0	24.6	25.2	25.8	26.4	27.0	27.6	28.1	28.7	29.3	29.9	30.5	31.1	31.7	32.3	32.9
25	24.0	24.1	24.2	24.3	24.4	24.5	24.6	24.7	24.8	24.9	25.0	25.1	25.2	25.3	25.4	25.5
30	24.0	23.6	23.2	22.7	22.3	21.9	21.5	21.1	20.7	20.2	19.8	19.4	19.0	18.6	18.1	17.7

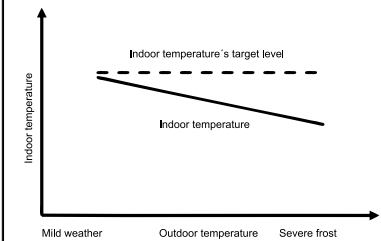
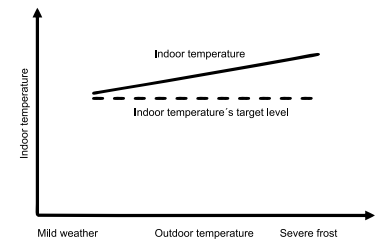
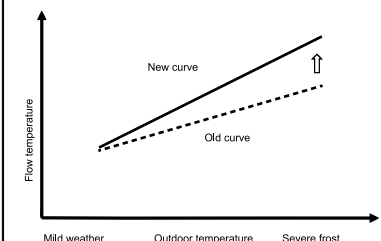
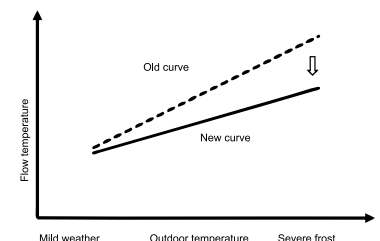
### Heating curves with room temperature setpoint at 18 °C

Outside temperature (°C)	Heating curve slope and heating circuit flow temperature (°C)															
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
-50	18.0	22.7	27.4	32.1	36.8	41.4	46.1	50.8	55.5	<b>60.2</b>	<b>64.9</b>	<b>69.6</b>	<b>74.3</b>	<b>78.9</b>	<b>83.6</b>	<b>88.3</b>
-45	18.0	22.5	27.0	31.5	36.1	40.6	45.1	49.6	54.1	58.6	<b>63.2</b>	<b>67.7</b>	<b>72.2</b>	<b>76.7</b>	<b>81.2</b>	<b>85.7</b>
-40	18.0	22.3	26.6	31.0	35.3	39.6	43.9	48.2	52.5	56.9	<b>61.2</b>	<b>65.5</b>	<b>69.8</b>	<b>74.1</b>	<b>78.5</b>	<b>82.8</b>
-35	18.0	22.1	26.2	30.3	34.4	38.5	42.6	46.7	50.8	54.9	<b>59.0</b>	<b>63.1</b>	<b>67.1</b>	<b>71.2</b>	<b>75.3</b>	<b>79.4</b>
-30	18.0	21.8	25.7	29.5	33.4	37.2	41.1	44.9	48.8	52.6	56.5	<b>60.3</b>	<b>64.2</b>	<b>68.0</b>	<b>71.9</b>	<b>75.7</b>
-25	18.0	21.6	25.2	28.7	32.3	35.9	39.5	43.0	46.6	50.2	53.8	57.3	<b>60.9</b>	<b>64.5</b>	<b>68.1</b>	<b>71.6</b>
-20	18.0	21.3	24.6	27.8	31.1	34.4	37.7	40.9	44.2	47.5	50.8	54.1	57.3	<b>60.6</b>	<b>63.9</b>	<b>67.2</b>
-15	18.0	21.0	23.9	26.9	29.8	32.8	35.7	38.7	41.6	44.6	47.6	50.5	53.5	56.4	<b>59.4</b>	<b>62.3</b>
-10	18.0	20.6	23.2	25.8	28.4	31.0	33.6	36.3	38.9	41.5	44.1	46.7	49.3	51.9	54.5	57.1
-5	18.0	20.2	22.5	24.7	26.9	29.2	31.4	33.6	35.9	38.1	40.4	42.6	44.8	47.1	49.3	51.5
0	18.0	19.8	21.7	23.5	25.4	27.2	29.0	30.9	32.7	34.5	36.4	38.2	40.1	41.9	43.7	45.6
5	18.0	19.4	20.8	22.2	23.7	25.1	26.5	27.9	29.3	30.7	32.2	33.6	35.0	36.4	37.8	39.2
10	18.0	19.0	19.9	20.9	21.9	22.8	23.8	24.8	25.7	26.7	27.7	28.6	29.6	30.6	31.6	32.5
15	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	23.9	24.4	24.9	25.4
20	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
25	18.0	17.5	17.0	16.4	15.9	15.4	14.9	14.3	13.8	13.3	12.8	12.2	11.7	11.2	10.7	10.1
30	18.0	16.9	15.9	14.8	13.7	12.6	11.6	10.5	9.4	8.4	7.3	6.2	5.1	4.1	3.0	1.9

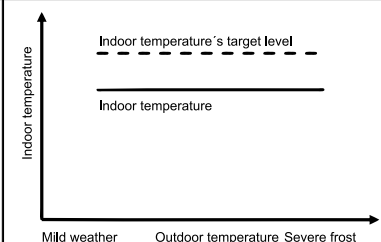
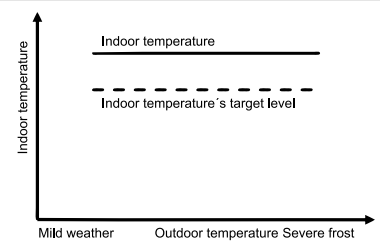
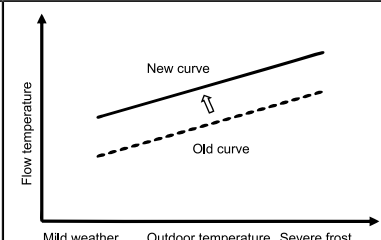
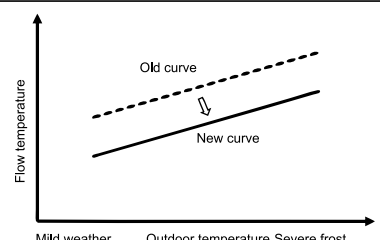
## 3.3 Adjusting the heating curve in different situations

### Indoor temperature too low or high in very cold weather

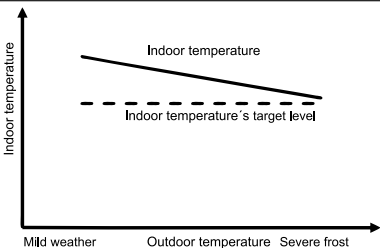
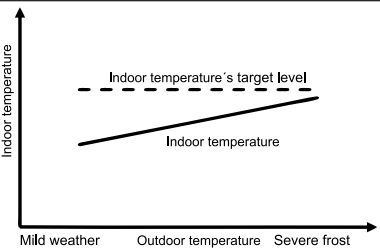
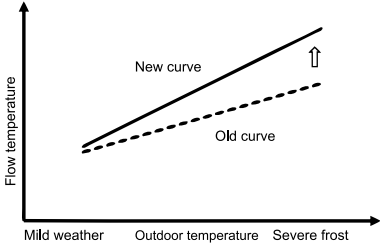
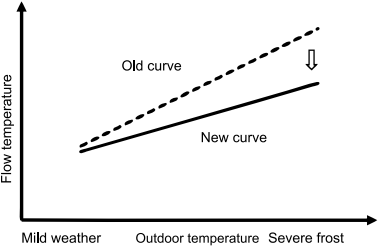
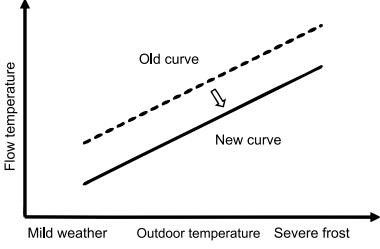
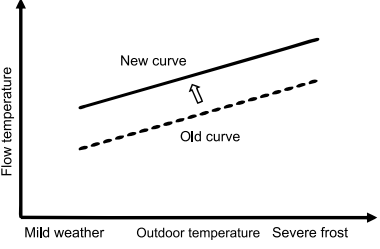
Problem:	Indoor temperature is too low in very cold weather.	Indoor temperature is too high in very cold weather.
Cause:	Heating curve is too gradual.	Heating curve is too steep.
Action:	Increase the heating curve slope (line 720).	Decrease the heating curve slope (line 720).
Menus:	Chapters <i>Heating curve</i> and <i>Parameter list</i> .	Chapters <i>Heating curve</i> and <i>Parameter list</i> .

Additional information:	Change the curve in small increments until a suitable indoor temperature is reached. Changing the curve affects indoor temperature with a delay of several hours, because the temperature of the building's structures changes slowly.	Change the curve in small increments until a suitable indoor temperature is reached. Changing the curve affects indoor temperature with a delay of several hours, because the temperature of the building's structures changes slowly.
		
		

### Indoor temperature steadily too high or low

Problem:	Indoor temperature remains steady, but is always too low.	Indoor temperature remains steady, but is always too high.
Cause:	Heating curve's slope is suitable, but the curve must be moved upward.	Heating curve's slope is suitable, but the curve must be moved downward.
Action:	Move the heating curve upward by means of either heating curve displacement (line 721) or raising the room temperature setpoint (line 710).	Move the heating curve downward by means of either heating curve displacement (line 721) or raising the room temperature setpoint (line 710).
Menus:	Chapter <i>Parameter list</i> .	Chapter <i>Parameter list</i> .
Additional information:	Change the curve in small increments until a suitable indoor temperature is reached. Changing the curve affects indoor temperature with a delay of several hours, because the temperature of the building's structures changes slowly.	Change the curve in small increments until a suitable indoor temperature is reached. Changing the curve affects indoor temperature with a delay of several hours, because the temperature of the building's structures changes slowly.
		
		

## Indoor temperature too high or low in mild weather

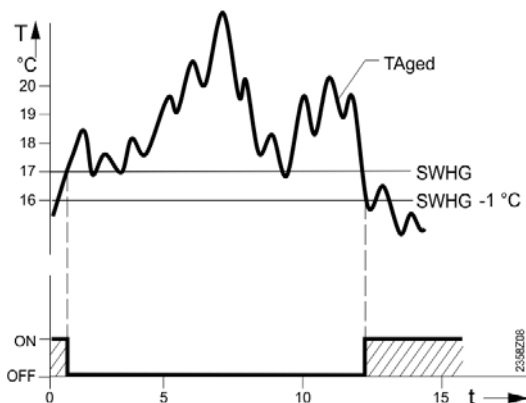
Problem:	Indoor temperature is too high in mild weather.	Indoor temperature is too low in mild weather.
Cause:	Heating curve is too gradual and parallel displacement is too high.	Heating curve is too steep.
Action:	Increase the heating curve's slope (line 720) and then move the heating curve downward by means of either heating curve displacement (line 721) or raising the room temperature setpoint (line 710).	Decrease the heating curve's slope (line 720) and then move the heating curve upward by means of either heating curve displacement (line 721) or raising the room temperature setpoint (line 710).
Menus:	Chapters <i>Heating curve</i> and <i>Parameter list</i> .	Chapters <i>Heating curve</i> and <i>Parameter list</i> .
Additional information:	Change the curve in small increments until a suitable indoor temperature is reached. Changing the curve affects indoor temperature with a delay of several hours, because the temperature of the building's structures changes slowly.	Change the curve in small increments until a suitable indoor temperature is reached. Changing the curve affects indoor temperature with a delay of several hours, because the temperature of the building's structures changes slowly.
		
Step 1		
Step 2		

### 3.3.1 Outside temperature limits for the heating season and day (ECO functions)

#### Limit temperature for the heating season (summer/winter heating limit)

The summer/winter heating function can be used to switch the heating on and off when the longer time span average of the outside temperature exceeds a predetermined value. This value is set for heating circuit 1 on line 730. If the outside temperature's average exceeds the setpoint, the heating circuit is switched off. The heating circuit is switched back on when the outside temperature is one degree below the setpoint. The function is not available if the heating circuit is set to Comfort mode (without a

time program). It uses the delayed outside temperature (line 8703), which takes the building's heat capacity into account (section *Outside temperature and the building's heat capacity*).



TAged: Outside temperature attenuated (line 8703)  
 SHWG: Switch-off limit of heating  
 SHGW-1 °C: Switch-on limit of heating  
 ON: heating on  
 OFF: heating off

Summer/winter heating limit

## 24-hour temperature limit

Using the 24-hour temperature limit, heating can be switched off when the outside temperature reaches a determined level in relation to the room temperature setpoint (line 710). The temperature differential is set on line 732. It can be set to exceed (+) or go below (-) the room temperature setpoint. If the outside temperature drops 1 °C below the aforementioned level, heating is switched back on.

If the room temperature setpoint on line 710 is for example 22 °C and the temperature differential selected on line 732 is -3 °C, heating is switched on when the outside temperature exceeds 19 °C (22 °C-3 °C). In the example presented above, heating is switched on when the outside temperature drops below 18 °C (19 °C-1 °C).

The function can be set to use the the current measured outside temperature (line 8700) or the composite outside temperature (line 8704), which takes the building's heat capacity into account (section *Outside temperature and the building's heat capacity*). This is selected on line 733. If the line's value is set to "yes", the function takes the heat capacity into account. Otherwise the current measured outside temperature is used.

### 3.3.2 Outside temperature and the building's heat capacity

The heating curve and other functions of the heating circuit use the outside temperature that takes the building's heat capacity into account. Changes in this temperature are slower and more gradual than changes in the outside temperature (figure 3). In this way, the heat accumulation capacity of the building structures and the time delay between changes in the outside temperature and changes in the indoor temperature will be taken into consideration. Noticing the heat capacity evens the changes in the flow temperature setpoint of the heating circuit.

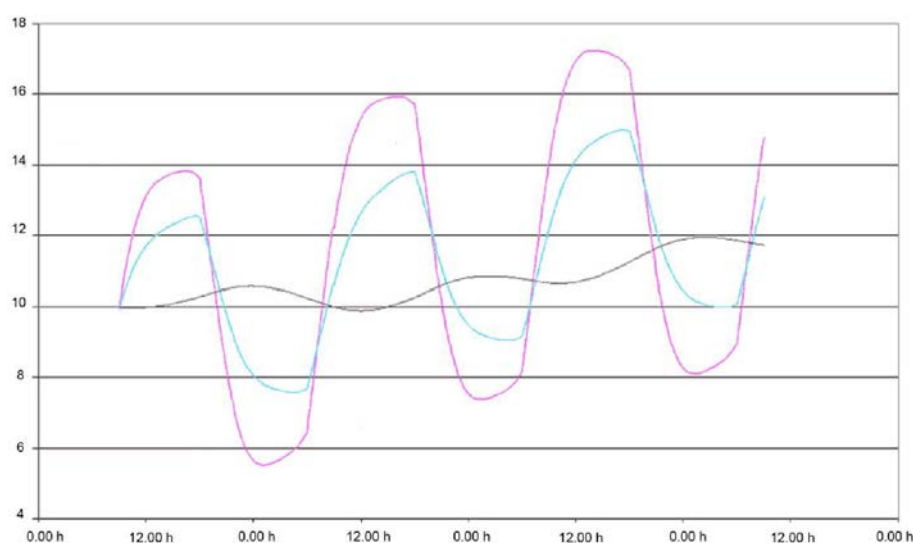
Automation uses two different outside temperatures that take heat capacity into account. Heating curve uses the composite outside temperature on line 8704. It follows the changes in outside temperature fairly quickly, but eliminates short-term peaks and lows. The composite outside temperature can also be used with the 24-hour heating limit (section *Outside temperature limits for the heating season and day*).

The attenuated outside temperature presented on line 8703 is used as the limit temperature for the heating period (chapter *Outside temperature limits* and subchapter *Limit temperature for the heating season (summer/winter heating limit)*). The attenuated temperature changes more slowly than the composite temperature. It rises and falls slowly as the average outside temperature rises, but does not take the temperature variation within the day into account.

The building's heat capacity is taken into account through the building's time constant. The time constant is selected on line 6110. The building's time constant is higher the better insulated the building is and the heavier the building structures are. The changes in the composite and attenuated outside temperature are slower (compared to momentary changes in the outside temperature) the greater the value of parameter 6110 is.

A time constant of 10...20 hrs is suitable for the majority of buildings. If the time constant is higher than 20 hrs, the flow temperature changes fairly slowly as the outside temperature changes. Correspondingly, if the time constant is lower than 10 hrs, the flow temperature changes fairly quickly as the outside temperature changes. If the time constant is set to 0, the building's heat capacity is not noticed. Then the composite and attenuated temperatures are always equal to the measured current outside temperature.

The tables below present reference values for the time constant. The time constant is calculated by adding the table values together. For example, for a brick-structured building that is insulated from the inside and has triple-glazed windows, the time constant is 8 h (brick) + 0 h (inside) + 6 h (triple-glazed) = 14 h in total.



Outside temperature and the building's time constant. Building's time constant 15 h.

### Framework influence on time constant

Framework	Concrete	Lightweight aggregate concrete	Brick	Wood	Stone	Low-energy building
Time constant (h)	14	10	8	8	18	25

### Insulation's influence on time constant

Insulation	Insulation inside framework	Insulation outside framework
Time constant (h)	0	3

### Window influence on time constant

Insulation and windows	Double-glazed	Triple-glazed
Time constant (h)	3	6

## 4 DHW and space heating settings

### 4.1 DHW heating

#### Important settings and statuses

Menu	Line	Setting
Domestic hot water	1600	Operating mode (on / off)
Domestic hot water	1610	Setpoint (normal setpoint)
Domestic hot water	1612	Reduced setpoint
Domestic hot water	1620	Release (time program)
DHW storage tank	5024	Switching differential
DHW storage tank	5030	Charging time limit (E series can also stop charging)
DHW storage tank	5031	Charging pause (F series)
Status	8003	State of the DHW
Diagnostics consumers	8830	Operation temperature 1 (sensor B3)
Diagnostics consumers	8831	DHW setpoint
Diagnostics consumers	8832	Operation temperature 2 (sensor B31)
Service/special operation	7093	Current DHW charging temperature

#### DHW temperature setpoint, switching differential and compressor control

Two different setpoints can be selected as setpoints for the DHW. The setpoints are a normal and a reduced setpoint. The setpoint in the DHW menu is the normal setpoint. The normal setpoint can be changed via the DHW menu or from the parameter list on line 1610. The reduced setpoint can be changed via the parameter list on line 1612. The domestic hot water from the service buffer tank is typically 2...10 °C hotter than the control sensor's reading. The temperature difference is dependent on the sensor's location in the tank and the tank's temperature stratification.

DHW heating is controlled based on the reading given by the DHW sensor (sensor B3, DHW temperature 1). DHW heating stops when the sensor reading reaches the setpoint for the DHW. Heating restarts when the water temperature falls lower than the setpoint by the amount of the switching differential. The differential is the sum of lines 5023 and 5024. The compressor starts when DHW heating begins. The starting temperature for the compressor is

Sensor B3	$\left( \begin{array}{c} \text{compressor} \\ \text{start temperature} \end{array} \right) = \left( \begin{array}{c} \text{DHW} \\ \text{setpoint} \\ \text{line 1610} \end{array} \right) - \text{line 5024 } ^\circ\text{C}$
-----------	--

The stopping temperature for the compressor is

Sensor B3	$\left( \begin{array}{c} \text{compressor's} \\ \text{stopping temperature} \end{array} \right) = \left( \begin{array}{c} \text{DHW} \\ \text{setpoint} \\ \text{line 1610} \end{array} \right)$
-----------	--

If the DHW setpoint is high, the compressor may not necessarily reach it. The compressor may switch off before the setpoint is reached either at the highest DHW charging temperature in the compressor selected in the settings (line 5032), the upper limit for the temperature of flow from the condenser (line 2844), the hot-gas temperature (line 2846), or the triggering threshold for the high pressure switch. If any of these limits are reached, recharging the DHW with the compressor is attempted as many times as indicated on line 2893 (including the first charging). Between charging attempts, the compressor is off for the off time that is specified on line 2835 or 2843. The longer off time is used. If the DHW setpoint is not reached after the maximum number of charging attempts permitted, the compressor is disabled temporarily and the DHW is heated to the setpoint by means of electric immersion heaters. The reached DHW temperature is automatically saved on line 7093.

Example		
Setting	Line	Value
DHW setpoint	1610, 1612, 8831	55 °C
Switching differential	5024	4 °C
Setpoint reduction B31 (also affects sensor B3's limit)	5023	1 °C
Compressor's starting temperature (DHW sensor B3/B31)		50 °C

## DHW time program

The DHW setpoint can be switched from normal to reduced via a time program, or with an external control message. The normal setpoint is used during the time selected in the time program. At other times, Reduced mode is used. In factory settings, the normal DHW setpoint is always selected. The setpoint can be changed via a time program by selecting the time program 4 for DHW on line 1620. After updating the user interface, the time program can be customized in the DHW menu of the regular display mode. When the time program is being used, the normal setpoint (line 1610) is in use when the program is ON, and the reduced setpoint (line 1612) is used when the program is OFF. In other words, the time program does not switch the DHW heating on and off, it only changes its setpoint. DHW heating is started normally after the temperature drops by the switching differential's (5024) amount below the setpoint currently in effect.

## Limiting the DHW charging time

The DHW charging time can be limited on line 5030. The DHW is heated until the DHW setpoint (line 1610) is reached or the time specified on this line has elapsed. The time runs from the moment DHW charging begins. If the time on line 5030 runs out before the temperature setpoint is reached, DHW charging is discontinued. With an E series controller the DHW heating is off for that duration set on line 5030. With an F series controller, heating is off for the duration set on line 5031. During this pause the heat pump is only available for spatial heating, and DHW is not heated. After the space heating portion of the cycle, the DHW is charged again until the setpoint is reached or the time set has elapsed. The charging time limitation is ignored if space heating has been switched off. The time limit can be switched off altogether, if the value on line 5030 is set to —. The purpose of the charging limitation is to prevent the building from cooling too much during a long DHW charging period. The charging can be restarted during the pause by choosing Recharging from the DHW menu as a temporary mode, or by switching the DHW charging off and then back on again.

### DHW temperature limit in compressor use

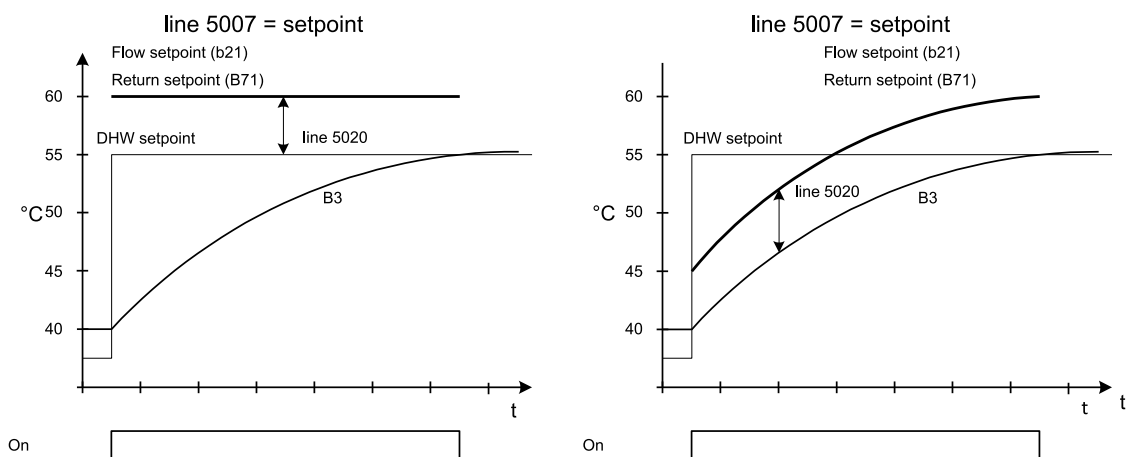
An upper limit can be set for the DHW charging temperature setpoint in compressor use, on line 5032. This value is compared to the reading from the DHW sensor, B3. When the DHW temperature reaches the value set on the aforementioned line, the heat pump compressor is switched off and the DHW is charged to its setpoint with the electric immersion heaters or another additional source of heat. During the approximately one-minute delay to switching off the compressor, the brief temperature increase does not switch the compressor off. The suitability of the value on line 5032 for the system must be determined through experimentation.

The heat pump controller uses primarily electric immersion heater K6 in the DHW storage tank in this operation and switches the diverting valve to the space heating position. In this way, the DHW can be heated while space heating is in operation. If immersion heater K6 has not been installed and configured for use, immersion heater K25/K26 in the flow from the condenser will be used. When these immersion heaters are used, the diverting valve is kept in the DHW position, because the immersion heaters are located before the diverting valve and DHW storage tank in the direction of the flow.

Example		
Setting	Line	Value
DHW setpoint	1610, 1612, 8831	55 °C
Switching differential	5024	5 °C
Setpoint reduction B31/B3	5023	0 °C
Aborting charging temperature	5032	52 °C
Compressor start temperature (sensor B3)		50 °C
Compressor stop temperature and immersion heater connection temperature (sensor B3)		52 °C

### Condenser circuit's electric immersion heater control

The setpoint used in counting the degree minutes of the electric immersion heaters can be based on either the DHW setpoint (a fixed value) or the measured temperature of the DHW (changes during heating). This is selected on line 5007. The boost to be set on line 5020 is added to this selected temperature value.



Effect of lines 5007 and 5020

### Flow sensor B21 installed

If the value on line 5007 is set to sensor B3, the condenser flow setpoint for electric immersion heaters is

Sensor B21	$\left( \begin{array}{c} \text{flow} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) = \left( \begin{array}{c} \text{DHW} \\ \text{temperature} \\ \text{measured} \\ \text{by sensor B3} \\ \text{line 8830} \end{array} \right) + \text{line 5020}$
---------------	--

If the value on line 5007 is set to **DHW setpoint**, the condenser flow setpoint for electric heaters is

Sensor B21	$\left( \begin{array}{c} \text{flow} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) = \left( \begin{array}{c} \text{DHW} \\ \text{setpoint} \\ \text{line 1610} \end{array} \right) + \text{line 5020}$
---------------	---

A fixed switching difference of 1 °C is used around the condenser flow setpoint to calculate the upper and lower limits for the electric heaters' setpoint. The lower limit for the electric heaters' setpoint is

Sensor B21	$\left( \begin{array}{c} \text{setpoint's} \\ \text{lower limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{flow} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) - 1$
---------------	--

Correspondingly, the upper limit of setpoint is

Sensor B21	$\left( \begin{array}{c} \text{setpoint's} \\ \text{upper limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{flow} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) + 1$
---------------	--

### Example: Flow sensor B21 installed

Setting	Line	Value
Charging request	5007	sensor B3
Flow setpoint boost	5020	7 °C
DHW temperature, measured by sensor B3	8830	48 °C
Condenser flow setpoint (heat pump setpoint)	8411	55 °C
Lower limit for electric heater setpoint (flow, sensor B21)		54 °C
Upper limit for electric heater setpoint (flow, sensor B21)		56 °C

### Example: Flow sensor B21 installed

Setting	Line	Value
Charging request	5007	setpoint
DHW setpoint	1610, 1612, 8831	50 °C
Flow setpoint boost	5020	7 °C
Heat pump setpoint (flow setpoint)	8411	57 °C
Lower limit for electric heater setpoint (flow, sensor B21)		56 °C
Upper limit for electric heater setpoint (flow, sensor B21)		58 °C

### Only return sensor B71 installed

If the heat pump is not equipped with flow sensor B21, return sensor B71 and the return setpoint are used to control the electric heaters. The temperature difference, produced by the heat pump's compressor over the condenser is displayed on line 2805. If the value on line 2805 is set to ---, automation will use the value 8 °C on line 2805 for calculation.

If the value on line 5007 is set to **sensor B3**, the return setpoint for the electric heaters is

Sensor B71	$\left( \begin{array}{c} \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) = \left( \begin{array}{c} \text{DHW} \\ \text{temperature} \\ \text{measured by} \\ \text{sensor B3} \\ \text{line 8830} \end{array} \right) - \text{line 2805} + \text{line 5020}$
------------	---

If the value on line 5007 is set to **DHW setpoint**, the return setpoint for the electric heaters is

Sensor B71	$\left( \begin{array}{c} \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) = \left( \begin{array}{c} \text{DHW} \\ \text{setpoint} \\ \text{line 1610} \end{array} \right) - \text{line 2805} + \text{line 5020}$
------------	--

The switching difference on line 2840 is used around the condenser's return setpoint to calculate the upper and lower limit of the electric heaters' setpoint. The lower limit of the electric heater setpoint is

Sensor B71	$\left( \begin{array}{c} \text{setpoint's} \\ \text{lower limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) - \frac{\text{line 2840}}{2}$
------------	---

Correspondingly, the upper limit of the immersion heater setpoint is

Sensor B71	$\left( \begin{array}{c} \text{setpoint's} \\ \text{upper limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) + \frac{\text{line 2840}}{2}$
------------	---

#### Example: Only return sensor B71 installed

Setting	Line	Value
Charging request	5007	sensor B3
Setpoint of condenser's temperature difference	2805	5 °C
Flow setpoint boost	5020	7 °C
Switching diff. of return temp.	2840	6 °C
DHW temp. measured by sensor B3	8830	48 °C
Return setpoint (heat pump setpoint)	8411	50 °C
Lower limit for electric heater setpoint (flow, sensor B21)		47 °C
Upper limit for electric heater setpoint (flow, sensor B21)		53 °C

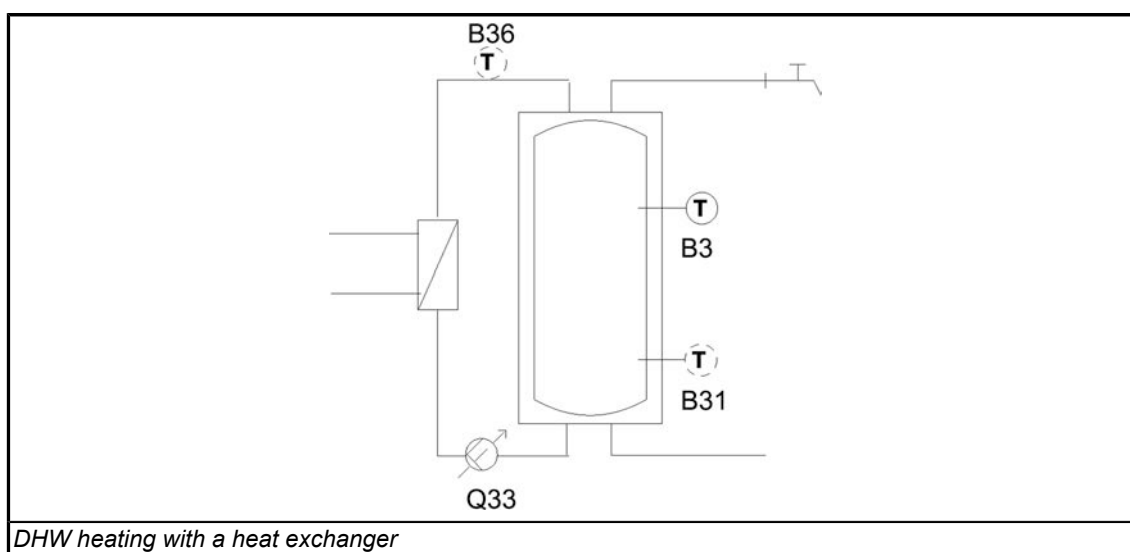
#### Example: Only return sensor B71 installed

Setting	Line	Value
Charging request	5007	setpoint
DHW setpoint	1610, 1612, 8831	50 °C
Setpoint of condenser's temperature difference	2805	5 °C
Flow setpoint boost	5020	7 °C
Switching diff. of return temp.	2840	6 °C

Setting	Line	Value
Return setpoint (heat pump setpoint)	8411	52 °C
Lower limit for electric heater setpoint (flow, sensor B21)		49 °C
Upper limit for electric heater setpoint (flow, sensor B21)		55 °C

### DHW storage tank heating with heat exchanger

The heat pump's automation supports several different heating connections for DHW. Presented below is DHW heating with a circuit that includes a heat exchanger and a circulation pump.



The circuit's pump Q33 starts when the DHW heating starts. The operating speed of the pump can be controlled with temperature sensor 36, which is installed after the exchanger. The setpoints for pump control are set in the DHW storage tank's menu. The setpoint for sensor B36 (line 8837) is

Sensor B36	$\left( \begin{array}{c} \text{sensor B36} \\ \text{setpoint} \end{array} \right) = \left( \begin{array}{c} \text{DHW} \\ \text{setpoint} \\ \text{line 1610} \end{array} \right) + \text{line 5140}$
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The boost set on line 5140 is typically around 1...3 °C. If the boost is significant, the return flow temperature from the DHW exchanger to the condenser will reach a high level during the end stage of the charging, because the controller will raise the operating speed of pump Q33 later. This could trigger the switch-off temperature (line 2844).

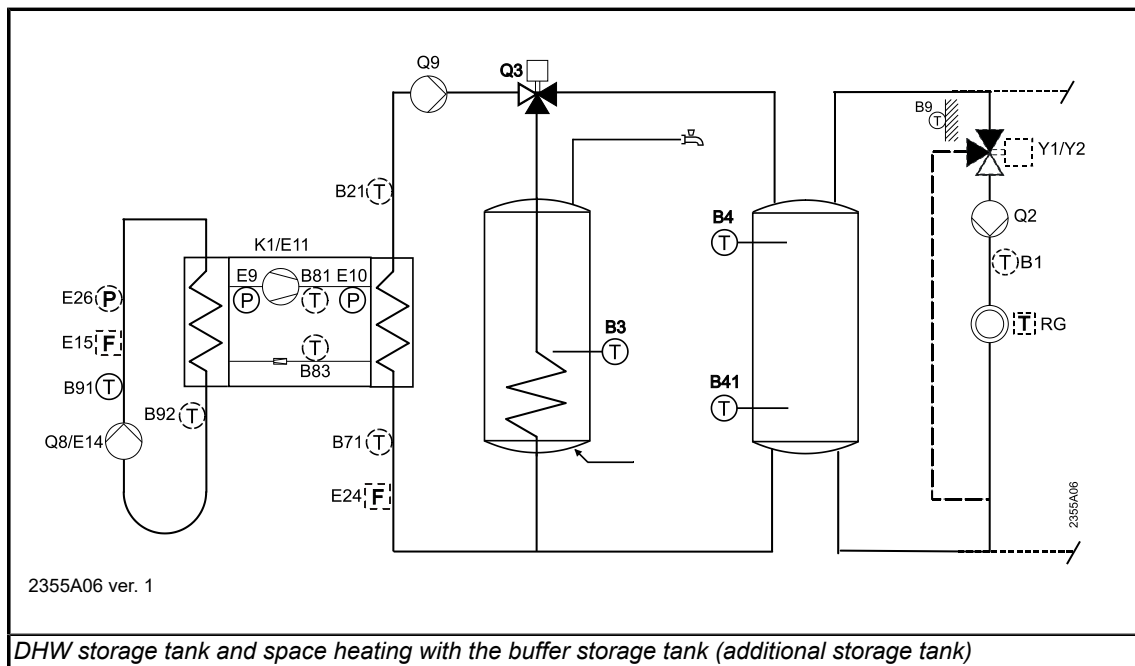
The starting speed of the pump is set on line 5109. The speed should be set to a reasonably high level so the pump's starting torque is sufficient. Typically 15...40 % is a suitable value. After the starting phase, the controller modulates the pump's speed (line 8826) between the limit values set on lines 5101 and 5102 using a PID mechanism and based on the setpoint of sensor B36. During initial charging, the controller limits the operating speed to a low level, because the reading on sensor B36 is low. The reading

increases toward the end of the charging, and the controller gradually increases the operating speed. The pump operates at full speed when sensor B36 reaches its setpoint. The lower limit (line 5101) is set to slightly exceed the lowest possible control message capable of starting the pump (typically 10...15 %). If the lower limit of the operating speed is not sufficient, the pump will not start. The upper limit (line 5102) is usually set to 100 %, enabling the pump to rotate at full speed as the charging is about to end. The pump stops when the overrun set on line 5147 is over after the DHW charging is finished. It is usually a good idea to disable the condenser pump's speed control (section *Pump speed control*) during DHW charging, and set the highest permitted speed to full (100 %) on line 2793.

A lower limit can be set for the flow temperature from the condenser to the DHW exchanger as a threshold to keep the pump Q33 from starting. The limit is set via a boost determined on line 5148. Before the pump is started, the reading on sensor B21 must exceed the DHW setpoint by the amount of the boost on line 5148. In this way, the pump Q33 is not started before the exchanger receives sufficiently warm water. The boost can also be negative, allowing you to set the pump to start before sensor B21's reading exceeds the DHW setpoint. A suitable boost value is usually -5...-15 °C, which lets the pump start early enough, and the condenser circuit's temperature does not close on the switch-off temperature.

The proportional band Xp set on line 5103 should be small enough to allow for a quick enough adjustment in the end stage of the pump's charging. The suitable value is typically approximately 10 °C. For the integral action time (restore time) T set on line 5104, the suitable value is typically approximately 40 s, and for the derivative action time set on line 5105, approximately 1 s.

## 4.2 Space heating with a regulated storage tank



In the context of automation, heating circuit's storage tank is called the buffer storage tank. A separate DHW storage tank and a heating circuit buffer storage tank can be replaced by a single storage tank, if needed, in which case the single tank is used as a storage tank for both the heating circuit and the DHW. In this case, sensor B3 is placed at the top of the tank and sensor B4 at the middle of the tank.

## Important setpoints and statuses

Menu	Line	Setting
Diagnostics consumers	8704	Outside temperature
Heating circuit 1	710	Comfort mode setpoint, heating circuit 1
Heating circuit 1	720	Heating curve slope, heating circuit 1
Heating circuit 1	721	Heating curve displacement, heating circuit 1
Heating circuit 1	741	Flow max. setpoint, heating circuit 1
Heating circuit 1	830	Mixing valve boost, heating circuit 1
Buffer storage tank	4720	Storage tank control sensor
Buffer storage tank	4722	Temperature differential of buffer storage tank and heating circuit
Buffer storage tank	4721	Heat generation switching differential
Buffer storage tank	4735	Setpoint reduction B42/B41
Heat pump (compressor)	2840	Switching diff. return temp.
Heat pump (condenser)	2805	Condenser's temperature differential
Status	8000-	Function statuses. From line 8000 onward.
Diagnostics heat generation	8395-	Statuses of compressors, electric immersion heaters etc. from line 8395 onward
Diagnostics consumers	8740-	Statuses of heating circuits etc from line 8740 onwards
Diagnostics consumers	8744	Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1
Diagnostics consumers	8981	Buffer tank temperature setpoint
Diagnostics heat generation	8411	Condenser flow setpoint for electric immersion heater (flow sensor B21 installed)
Heat generation status information	8411	Condenser return setpoint for electric immersion heater (only return sensor B71 installed)

## Compressor control

If the heating circuit is connected to the buffer storage tank, the heating circuit setpoint is made the buffer storage tank's setpoint and the buffer storage tank setpoint is used for starting and shutting off the compressor. The heat pump's compressor is switched on and off in accordance with the temperature of the buffer storage tank of the heating circuit. This temperature is measured with sensor B4. The measured temperature is compared to the setpoint of the buffer storage tank temperature.

The storage tank can also be controlled with combinations of sensors B4, B41, B42, and B71. The controlling sensors are selected on line 4720. For example, if sensors B4 and B41 are used (or B71 is used instead of B41), storage tank heating begins if the temperature at both sensors is lower than the compressor's starting temperature and, correspondingly, is stopped only if the reading of both sensors exceeds the shut-off temperature of the compressor. On line 4735, sensor B41 on the bottom of the storage tank can be given a lower setpoint than the top sensor, B4.

On line 4722, the lower limit of the storage tank's temperature is set as a temperature differential to the storage tank's setpoint (line 8981). The row's value can be positive or negative. With a positive value, the storage tank is always above the requested temperature for the heating circuit (storage tank setpoint). With a negative value, the storage tank is allowed to cool to a temperature lower than the requested temperature (storage tank setpoint).

The amount by which the heated storage tank's temperature exceeds the lower limit is selected on line 4721. In other words, line 4721 is for setting the switching differential for the storage tank's temperature, and line 4722 is for setting the level from which

the temperature is raised by the amount of the switching differential. The switching differential on line 4721 must be adjusted so that the duration of the heat pump's run time is sufficient. The run time must be at least 5 minutes. The suitable switching differential is dependent on the proportion of the storage tank's volume to the heat pump's capacity. The suitable differential for line 4721 is usually at least 5 °C. If the storage tank is small in proportion to the pump's capacity, the switching differential must be increased to achieve a run time that is sufficiently long.

The starting temperature for the compressor is  
Starting temperature of compressor is

Sensor B4	$\left( \begin{array}{c} \text{compressor's} \\ \text{starting temperature} \end{array} \right) = \left( \begin{array}{c} \text{storage tank} \\ \text{temperature} \\ \text{setpoint} \\ \text{line 8981} \end{array} \right) + \text{line 4722}$
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Correspondingly, stopping temperature of compressor is

Sensor B4	$\left( \begin{array}{c} \text{compressor's} \\ \text{stopping temperature} \end{array} \right) = \left( \begin{array}{c} \text{storage tank} \\ \text{temperature} \\ \text{setpoint} \\ \text{line 8981} \end{array} \right) + \text{line 4722} + \text{line 4721}$
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### Buffer storage tank temperature setpoint

The temperature setpoint for the buffer storage tank is equal to the heating circuit's flow setpoint (from the heating curve). If needed, a boost can be added to the flow setpoint in order to take the water cooling in the piping between the storage tank and control valve into account. The boost for heating circuit 1 is set on line 830. If the value on line 830 is set to for example 1 °C, a request is sent to the storage tank for a temperature that is 1 °C higher than the heating circuit's flow setpoint. The boosting mechanism for other heating circuits works in the same way. If several heating circuits are connected to the storage tank, the setpoint is determined on the basis of the highest temperature request.

The temperature setpoint for the upper part of the buffer storage tank is

Sensor B4	$\left( \begin{array}{c} \text{temperature} \\ \text{setpoint of} \\ \text{storage tank's} \\ \text{upper part} \\ \text{line 8981} \end{array} \right) = \left( \begin{array}{c} \text{heating circuit's} \\ \text{flow setpoint} \\ \text{from heating curve} \\ \text{line 8744} \end{array} \right) + \left( \begin{array}{c} \text{boost} \\ \text{line 830} \end{array} \right)$
--------------	--

The temperature setpoint for the lower part of the buffer storage tank is

Sensor B41	$\left( \begin{array}{c} \text{temperature} \\ \text{setpoint of} \\ \text{storage tank's} \\ \text{lower part} \\ \text{line 8982} \end{array} \right) = \left( \begin{array}{c} \text{temperature} \\ \text{setpoint of} \\ \text{storage tank's} \\ \text{upper part} \\ \text{line 8981} \end{array} \right) - \left( \begin{array}{c} \text{reduction} \\ \text{line 4735} \end{array} \right)$
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### Electric immersion heater control

Condenser circuit's heater is switched on and off based on degree minutes (section *In-line heater in the condenser line*). Degree minutes are calculated using the minimum and maximum limits of the setpoint. Switch-on minutes are calculated below the minimum limit, whereas switch-off minutes are calculated above the maximum limit. Degree minutes are therefore not calculated within the limits.

#### Flow sensor B21 installed

If flow sensor B21 is installed in the heat pump, the electric immersion heater is switched on and off on the basis of the storage tank's temperature setpoint and the reading of flow sensor B21 from the heat pump's condenser. A switching differential of 1 °C is used around the setpoint to calculate the upper and lower limit for the immersion heater's setpoint. Condenser flow setpoint is

Sensor B21	$\left( \begin{array}{c} \text{condenser} \\ \text{flow} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) = \left( \begin{array}{c} \text{storage tank} \\ \text{temperature} \\ \text{setpoint} \\ \text{line 8981} \end{array} \right)$
---------------	---

The lower limit of the electric heater setpoint is

Sensor B21	$\left( \begin{array}{c} \text{setpoint's} \\ \text{lower limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{storage tank} \\ \text{temperature} \\ \text{setpoint} \\ \text{line 8981} \end{array} \right) - 1\text{ °C}$
---------------	--

Correspondingly, the upper limit of the electric heater setpoint is

Sensor B21	$\left( \begin{array}{c} \text{setpoint's} \\ \text{upper limit} \\ \text{for imm heater} \end{array} \right) = \left( \begin{array}{c} \text{storage tank} \\ \text{temperature} \\ \text{setpoint} \\ \text{line 8981} \end{array} \right) + 1\text{ °C}$
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#### Only return sensor B71 installed

If the heat pump is not equipped with flow sensor B21, electric immersion heaters are controlled via return sensor B71. Return sensor B71's setpoint for electric immersion heaters is

Sensor B71	$\left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) = \left( \begin{array}{c} \text{storage tank} \\ \text{temperature} \\ \text{setpoint} \\ \text{8981} \end{array} \right) - \text{line 2805}$
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If the value on line 2805 is set to ---, automation will use the value 8 °C on line 2805 for calculation.

The switching differential for line 2840 is used around the return setpoint to calculate the upper and lower limit of the immersion heaters' setpoint. The lower limit of the immersion heater setpoint is

Sensor B71	$\left( \begin{array}{c} \text{setpoint's} \\ \text{lower limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) - \frac{\text{line 2480}}{2}$
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Correspondingly, the upper limit of the electric heater setpoint is

Sensor B71	$\left( \begin{array}{c} \text{setpoint's} \\ \text{upper limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) + \frac{\text{line 2480}}{2}$
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### Keeping the storage tank at a standard temperature

The lower limit of the storage tank's temperature setpoint can be kept as standard, regardless of the flow setpoint of the heating circuit. This is done by switching the additional virtual heating circuit on in the automation. The virtual circuit is set with a suitable lower limit for the flow temperature. If one of the non-virtual circuits does not give a higher request, the storage tank's setpoint is always kept on par with the lower limit of the virtual circuit's flow, at a minimum. It is always determined according to the highest requested temperature.

Heating circuit 3 should be used as the virtual heating circuit, so the other two circuits can be used regularly as actual heating circuits. The lower limit of the flow setpoint for circuit 3 is set first (line 1340). This prevents the storage tank's temperature setpoint (line 1341) from ever dropping below the limit. An upper limit should be set (line 1341) to the circuit to avoid the request temperature of the virtual circuit from rising above the set lower limit as the outside temperature drops. The upper limit is set at, for example, one degree above the lower limit. With these settings the storage tank's temperature setpoint varies by under 1 °C and rises above that only if the heating curve from heating circuit 1 or 2 requests a higher setpoint. The compressor stop and start temperatures normally take lines 4721 and 4722 into account.

Menu	Line	Setting	Setpoint
Configuration	5721	Heating circuit 3	On
Heating circuit 3	1470	With buffer (Heating circuit is connected to the storage tank.)	yes
Heating circuit 3	1340	Minimum flow temperature setpoint (This is altered.)	e.g. 45 °C
Heating circuit 3	1341	Maximum flow temperature setpoint (This is set 1 °C above the minimum.)	e.g. 46 °C

### Summary of the control of the compressor and immersion heaters

A request from the DHW storage tank <sup>1)</sup>	B21	B71	B10	Compressor 1 (K1)			Electric immersion heater after the condenser (K25/K26)		
				Sensor	Setp.	Sw.diff.	Sensor	Setp.	Sw.diff.
YES	-	-	-				On		
	-	-	ok	Storage tank setpoint (sensor B4)			B10	FLOW	±1 °C
	-	ok	-	Storage tank setpoint (sensor B4)			B71	RETURN	± line 2840 / 2 °C
	-	ok	ok	Storage tank setpoint (sensor B4)			B10	FLOW	±1 °C
	ok	-	-	Storage tank setpoint (sensor B4)			B21	FLOW	±1 °C
	ok	-	ok	Storage tank setpoint (sensor B4)			B21	FLOW	±1 °C
	ok	ok	-	Storage tank setpoint (sensor B4)			B21	STORAGE TANK	±1 °C
	ok	ok	ok	Storage tank setpoint (sensor B4)			B21	FLOW	±1 °C

Summary of the control of the compressor and immersion heaters in the buffer storage tank connection

FLOW: Temperature of the outgoing water from the condenser (flow)

RETURN: Temperature of the incoming water to the condenser (return)

### Examples

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	-10 °C
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	22 °C
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.50
Heating curve displacement, heating circuit 1	Heating circuit 1	721	0 °C
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	40 °C
Mixing valve boost, heating circuit 1	Heating circuit 1	830	0 °C
Temperature difference of buffer storage tank and heating circuit	Buffer storage tank	4722	-2 °C
Heat generation switching difference	Buffer storage tank	4721	6 °C
Switching difference of return temperature	Heat pump (compressor)	2840	6.0 °C

Setting	Menu	Line	Value
Condenser temperature difference	Heat pump (condenser)	2805	3.0 °C
Flow setpoint from the heating curve, heating circuit 1			36.4 °C
Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1	Diagnostics consumers	8744	36.4 °C
Buffer tank temperature setpoint	Diagnostics consumers	8981	36.4 °C
Compressor's starting temperature (storage tank temp., sensor B4)			34.4 °C
Compressor's stopping temperature (storage tank temp., sensor B4)			38.4 °C
Condenser flow setpoint for electric immersion heater (sensor B21 installed)	Heat generation status information	8411	36.4 °C
Lower limit for immersion heater setpoint (flow, sensor B21 installed)			35.4 °C
Upper limit for immersion heater setpoint (flow, sensor B21 installed)			37.4 °C
Condenser return setpoint for electric immersion heater (only return sensor B71 installed)	Heat generation status information	8411	33.4 °C
Lower limit for immersion heater setpoint (return, sensor B71)			30.4 °C
Upper limit for immersion heater setpoint (return, sensor B71)			36.4 °C

**Example:** Outside temperature –10 °C, buffer storage tank always hotter than heating circuit's request

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	–10 °C
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	22 °C
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.50
Heating curve displacement, heating circuit 1	Heating circuit 1	721	0 °C
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	40 °C
Mixing valve boost, heating circuit 1	Heating circuit 1	830	0 °C
Temperature difference of buffer storage tank and heating circuit	Buffer storage tank	4722	1 °C
Heat generation switching difference	Buffer storage tank	4721	6 °C
Switching difference of return temperature	Heat pump (compressor)	2840	6.0 °C
Condenser temperature difference	Heat pump (condenser)	2805	3.0 °C
Flow setpoint from the heating curve, heating circuit 1			36.4 °C
Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1	Diagnostics consumers	8744	36.4 °C
Buffer tank temperature setpoint	Diagnostics consumers	8981	36.4 °C
Compressor's starting temperature (storage tank temp., sensor B4)			37.4 °C
Compressor's stopping temperature (storage tank temp., sensor B4)			43.4 °C
Condenser flow setpoint for electric immersion heater (sensor B21 installed)	Heat generation status information	8411	36.4 °C
Lower limit for immersion heater setpoint (flow, sensor B21 installed)			35.4 °C

Setting	Menu	Line	Value
Upper limit for immersion heater setpoint (flow, sensor B21 installed)			37.4 °C
Condenser return setpoint for electric immersion heater (only return sensor B71 installed)	Heat generation status information	8411	33.4 °C
Lower limit for immersion heater setpoint (return, sensor B71)			30.4 °C
Upper limit for immersion heater setpoint (return, sensor B71)			36.4 °C

**Example:** Outside temperature  $-10\text{ °C}$ , buffer storage tank temperature always lower than heating circuit's request (mixing valve always open)

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	$-10\text{ °C}$
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	$22\text{ °C}$
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.50
Heating curve displacement, heating circuit 1	Heating circuit 1	721	$0\text{ °C}$
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	$40\text{ °C}$
Mixing valve boost, heating circuit 1	Heating circuit 1	830	$0\text{ °C}$
Temperature difference of buffer storage tank and heating circuit	Buffer storage tank	4722	$-7\text{ °C}$
Heat generation switching difference	Buffer storage tank	4721	$6\text{ °C}$
Switching difference of return temperature	Heat pump (compressor)	2840	$6.0\text{ °C}$
Condenser temperature difference	Heat pump (condenser)	2805	$3.0\text{ °C}$
Flow setpoint from the heating curve, heating circuit 1			$36.4\text{ °C}$
Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1	Diagnostics consumers	8744	$36.4\text{ °C}$
Buffer tank temperature setpoint	Diagnostics consumers	8981	$36.4\text{ °C}$
Compressor's starting temperature (storage tank temp., sensor B4)			$29.4\text{ °C}$
Compressor's stopping temperature (storage tank temp., sensor B4)			$35.4\text{ °C}$
Condenser flow setpoint for electric immersion heater (sensor B21 installed)	Heat generation status information	8411	$36.4\text{ °C}$
Lower limit for immersion heater setpoint (flow, sensor B21 installed)			$35.4\text{ °C}$
Upper limit for immersion heater setpoint (flow, sensor B21 installed)			$37.4\text{ °C}$
Condenser return setpoint for electric immersion heater (only return sensor B71 installed)	Heat generation status information	8411	$33.4\text{ °C}$
Lower limit for immersion heater setpoint (return, sensor B71)			$30.4\text{ °C}$
Upper limit for immersion heater setpoint (return, sensor B71)			$36.4\text{ °C}$

**Example:** Outside temperature  $-10\text{ °C}$ , compressor's switch-on threshold around the buffer storage tank's setpoint

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	-30 °C
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	22 °C
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.50
Heating curve displacement, heating circuit 1	Heating circuit 1	721	0 °C
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	40 °C
Mixing valve boost, heating circuit 1	Heating circuit 1	830	0 °C
Temperature difference of buffer storage tank and heating circuit	Buffer storage tank	4722	-2 °C
Heat generation switching difference	Buffer storage tank	4721	6 °C
Switching difference of return temperature	Heat pump (compressor)	2840	6.0 °C
Condenser temperature difference	Heat pump (condenser)	2805	3.0 °C
Flow setpoint from the heating curve, heating circuit 1			42.0 °C
Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1	Diagnostics consumers	8744	40.0 °C
Buffer tank temperature setpoint	Diagnostics consumers	8981	40.0 °C
Compressor's starting temperature (storage tank temp., sensor B4)			38.0 °C
Compressor's stopping temperature (storage tank temp., sensor B4)			44.0 °C
Condenser flow setpoint for electric immersion heater (sensor B21 installed)	Heat generation status information	8411	40.0 °C
Lower limit for immersion heater setpoint (flow, sensor B21 installed)			39.0 °C
Upper limit for immersion heater setpoint (flow, sensor B21 installed)			41.0 °C
Condenser return setpoint for electric immersion heater (only return sensor B71 installed)	Heat generation status information	8411	37.0 °C
Lower limit for immersion heater setpoint (return, sensor B71)			34.0 °C
Upper limit for immersion heater setpoint (return, sensor B71)			40.0 °C

**Example:** Outside temperature -30 °C, compressor's switch-on threshold around the buffer storage tank's setpoint, heating curve slope 0.80, flow temperature's upper limit 70 °C

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	-30 °C
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	22 °C
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.80
Heating curve displacement, heating circuit 1	Heating circuit 1	721	0 °C
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	70 °C
Mixing valve boost, heating circuit 1	Heating circuit 1	830	0 °C
Temperature difference of buffer storage tank and heating circuit	Buffer storage tank	4722	-2 °C
Heat generation switching difference	Buffer storage tank	4721	6 °C
Switching difference of return temperature	Heat pump (compressor)	2840	6.0 °C
Condenser temperature difference	Heat pump (condenser)	2805	3.0 °C
Flow setpoint from the heating curve, heating circuit 1			54.4 °C

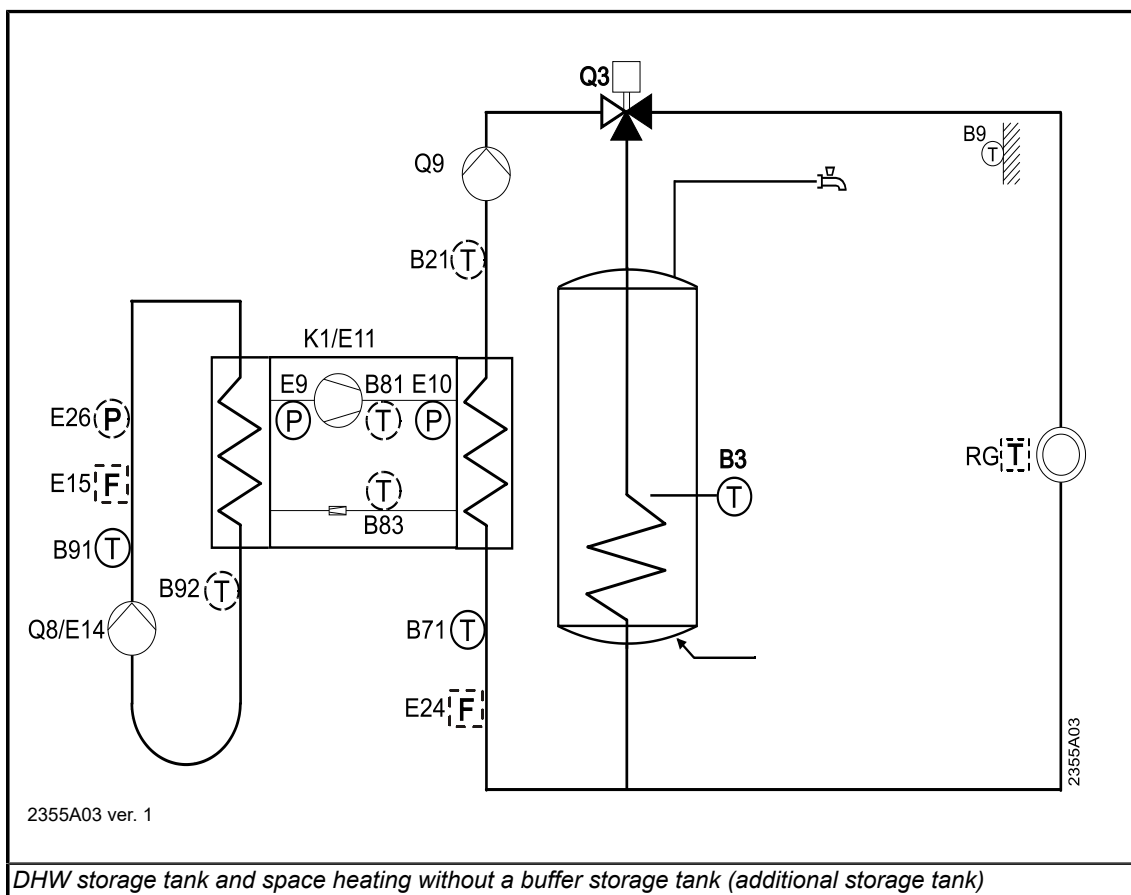
Setting	Menu	Line	Value
Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1	Diagnostics consumers	8744	54.4 °C
Buffer tank temperature setpoint	Diagnostics consumers	8981	54.4 °C
Compressor's starting temperature (storage tank temp., sensor B4)			52.4 °C
Compressor's stopping temperature (storage tank temp., sensor B4)			58.4 °C
Condenser flow setpoint for electric immersion heater (sensor B21 installed)	Heat generation status information	8411	54.4 °C
Lower limit for immersion heater setpoint (flow, sensor B21 installed)			53.4 °C
Upper limit for immersion heater setpoint (flow, sensor B21 installed)			55.4 °C
Condenser return setpoint for electric immersion heater (only return sensor B71 installed)	Heat generation status information	8411	51.4 °C
Lower limit for immersion heater setpoint (return, sensor B71)			48.4 °C
Upper limit for immersion heater setpoint (return, sensor B71)			54.4 °C

**Example:** Outside temperature +10 °C, compressor's switch-on threshold around the buffer storage tank's setpoint

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	+10 °C
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	22 °C
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.50
Heating curve displacement, heating circuit 1	Heating circuit 1	721	0 °C
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	40 °C
Mixing valve boost, heating circuit 1	Heating circuit 1	830	0 °C
Temperature difference of buffer storage tank and heating circuit	Buffer storage tank	4722	-2 °C
Heat generation switching difference	Buffer storage tank	4721	6 °C
Switching difference of return temperature	Heat pump (compressor)	2840	6.0 °C
Condenser temperature difference	Heat pump (condenser)	2805	3.0 °C
Flow setpoint from the heating curve, heating circuit 1			28.4 °C
Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1	Diagnostics consumers	8744	28.4 °C
Buffer tank temperature setpoint	Diagnostics consumers	8981	28.4 °C
Compressor's starting temperature (storage tank temp., sensor B4)			26.4 °C
Compressor's stopping temperature (storage tank temp., sensor B4)			32.4 °C
Condenser flow setpoint for electric immersion heater (flow sensor B21 installed)	Heat generation status information	8411	28.4 °C
Lower limit for immersion heater setpoint (flow, sensor B21)			27.4 °C
Upper limit for immersion heater setpoint (flow, sensor B21)			29.4 °C

Setting	Menu	Line	Value
Condenser return setpoint for electric immersion heater (only return sensor B71 installed)	Heat generation status information	8411	25.4 °C
Lower limit for immersion heater setpoint (return, sensor B71)			22.4 °C
Upper limit for immersion heater setpoint (return, sensor B71)			28.4 °C

### 4.3 Space heating without a buffer storage tank



### Important setpoints and statuses

Menu	Line	Setting
Heating circuit 1	710	Comfort mode setpoint, heating circuit 1
Heating circuit 1	720	Heating curve slope, heating circuit 1
Heating circuit 1	721	Heating curve displacement, heating circuit 1
Heating circuit 1	741	Flow max. setpoint, heating circuit 1
Heat pump (Compressor)	2840	Switching diff. return temp.
Configuration (Heat pump)	5810	Heating circuit temp. differential in -10 °C
Status		Function statuses. From line 8000 onward.
Diagnostics heat generation		Statuses of compressors, electric immersion heaters etc. from line 8395 onward

Menu	Line	Setting
Diagnostics consumers		Statuses of heating circuits etc. from line 8740 onwards
Diagnostics consumers	8744	Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1
Diagnostics heat generation	8411	Heat pump setpoint (return setpoint)

## Compressor control

The heat pump's compressor is controlled based on the condenser's return temperature and return setpoint (heat pump setpoint). Return sensor B71 is used to measure the temperature. The setpoint of the flow to the condenser can be based on a heating curve dependent on the outside temperature, the measured indoor temperature, or a combination thereof. The factory setting is adjustment based on the heating curve. Adjustment based on the indoor temperature requires that the temperature is measured. The measurement can be carried out by means of either wall-mounted user interfaces (room unit) or separate temperature sensors.

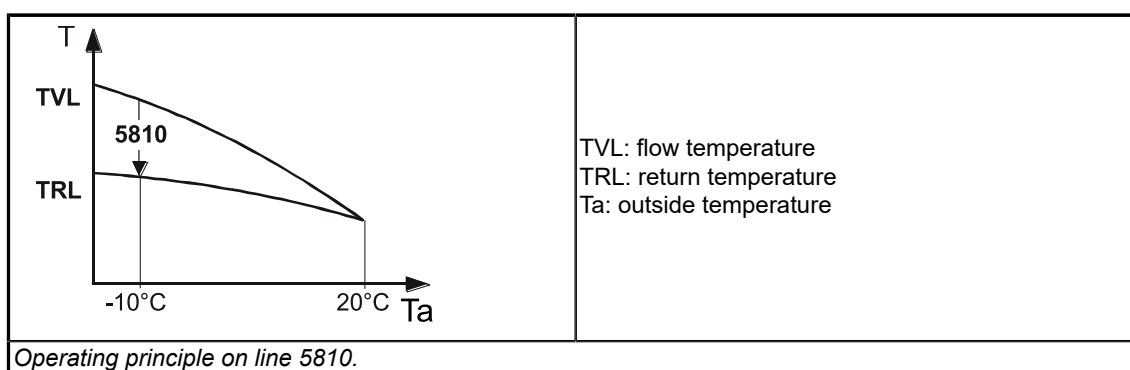
In the adjustment based on the heating curve, the compressor is controlled based on the heating circuit setpoint read from the heating curve, the calculated temperature differential (line 5810) of the condenser and the return switching differential (line 2840). Adjustment based on indoor temperature requires that indoor temperature is measured and the heating curve is not used. In composite adjustment, the controller adjusts the reading received from the curve based on the indoor temperature measurement.

### Condenser's calculated temperature difference

The controller calculates the return setpoint (heat pump setpoint) from the heating circuit's flow setpoint (heating curve) based on line 5810. The assumed temperature difference between the condenser flow and return is set on line 5810 for an outside temperature of  $-10^{\circ}\text{C}$ . The controller decreases and increases this value automatically in line with the outside temperature value ( $T_a$ ). The controller estimates that the temperature difference is smaller in warmer outside temperatures (there is less cooling in the heating circuit) and larger in colder outside temperatures (there is greater cooling in the heating circuit).

Condenser's calculated temperature difference is

$$\left( \begin{array}{c} \text{Temperature difference} \\ \text{calculated} \\ \text{according to} \\ \text{line 5810} \end{array} \right) = (\text{line 5810}) \cdot \frac{20 - T_a}{30}$$



### Condenser return setpoint

The compressor is controlled with the condenser's return setpoint (heat pump setpoint). Condenser's return setpoint is

Sensor B71	$\left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) = \left( \begin{array}{c} \text{heat circuit} \\ \text{flow} \\ \text{setpoint} \\ \text{from heating curve} \\ \text{line 8744} \end{array} \right) - \left( \begin{array}{c} \text{temp. diff.} \\ \text{calculated} \\ \text{based} \\ \text{on line 5810} \end{array} \right)$
---------------	--

Basically, the heating curve always displays the heating circuit's flow setpoint. However, the heating curve can be set to use the return setpoint directly if the value on line 5810 is set to 0 °C. In this case, the return setpoint is

Sensor B71 Line 5810=0	$\left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) = \left( \begin{array}{c} \text{heat circuit} \\ \text{flow} \\ \text{setpoint} \\ \text{from heating curve} \\ \text{line 8744} \end{array} \right)$
---------------------------------	---

An upper and lower limit can be assigned to the heating circuit's flow temperature, read from the heating curve. The lower limit for heating circuit 1 is set on line 740, and the upper limit is set on line 741. The limits are used in control based on both the heating curve and the room temperature. When setting the limits, take the calculated temperature difference on line 5810 and the switching differential on line 2840 into account. If the setpoint read from the heating curve exceeds the upper limit, the upper limit for flow is used as the heating circuit's flow setpoint instead. Thus, the condenser's return setpoint is

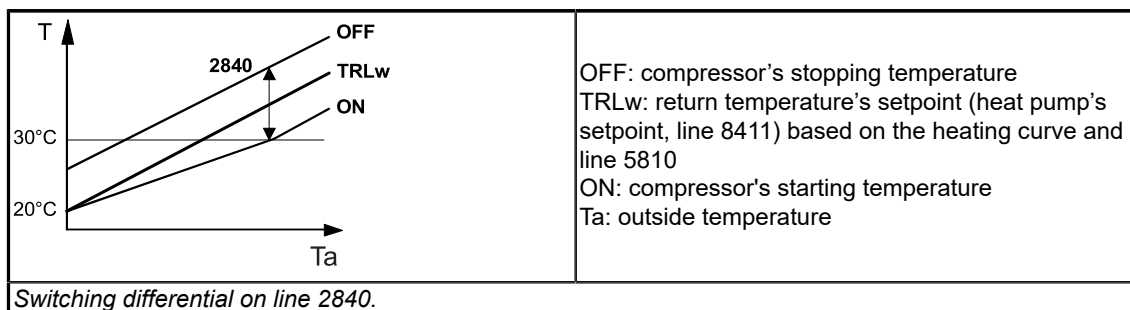
Sensor B71	$\left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) = \left( \begin{array}{c} \text{heating circuit} \\ \text{flow} \\ \text{upper limit} \\ \text{line 741} \end{array} \right) - \left( \begin{array}{c} \text{temp. diff.} \\ \text{calculated} \\ \text{based} \\ \text{on line 5810} \end{array} \right)$
---------------	--

If the setpoint goes below the lower limit, the lower limit of flow is used for calculation (line 740 for heating circuit 1).

### Compressor control

The switching differential set on line 2840 is used around the return setpoint in order to switch the compressor on and off. Increasing the switching differential increases the compressor's operating time, but also increases the temperature variation in the heating circuit. The switching differential also affects the cooling that the switch-off temperature (line 2844) requires (sub-section *Switch-off temperature* in section *Heat pump's protection functions*).

The value on line 2840 is divided equally between the two sides of the setpoint (figure 55). The controller reduces the lower limit of the switching differential automatically (directly proportionally) when the return setpoint is under 30 °C. This starts the compressor earlier when the return temperature drops below the setpoint, and the switching differential is reduced automatically at the same time, as the setpoint is reduced.



The upper limit of the switching differential affecting the compressor's stopping temperature stays constant as presented in the image above. The upper limit is

<p>Sensor B71</p>	$\left( \begin{array}{c} \text{switching differential's} \\ \text{upper limit} \\ \text{OFF} \end{array} \right) = \frac{\text{line 2840}}{2}$	<p>(17)</p>
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The lower limit of the switching differential affecting the compressor's starting temperature also stays constant if the return setpoint (line 8411 TRLw) is over 30 °C. The lower limit is

<p>Sensor B71</p>	<p>Return setpoint (line 8411) is over 30 °C</p> $\left( \begin{array}{c} \text{switching differential's} \\ \text{lower limit} \\ \text{ON} \end{array} \right) = \frac{\text{line 2840}}{2}$	<p>(18)</p>
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The upper limit of the switching differential affecting the compressor's starting temperature is reduced in direct proportion when the return setpoint drops below 30 °C. The lower limit is

<p>Sensor B71</p>	<p>Return setpoint (line 8411) is under 30 °C</p> $\left( \begin{array}{c} \text{switching differential's} \\ \text{lower limit} \\ \text{ON} \end{array} \right) = \frac{\text{line 2840}}{2} \cdot \frac{\text{TRLw} - 30}{10}$
-----------------------	---

Therefore the stop temperature for the compressor is

<p>Sensor B71</p>	$\left( \begin{array}{c} \text{compressor's} \\ \text{stopping temperature} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) + \frac{\text{line 2840}}{2} \text{ °C}$
-----------------------	---

Correspondingly, the starting temperature for the compressor is

Sensor B71	$\left( \begin{array}{c} \text{compressor's} \\ \text{starting temperature} \\ \text{ON} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) - \left( \begin{array}{c} \text{switching} \\ \text{differential's} \\ \text{lower limit} \\ \text{ON} \end{array} \right)$
---------------	---

### Condenser circuit's electric immersion heater control

Condenser circuit's heater is switched on and off based on degree minutes (section *In-line heater in the condenser line*). Degree minutes are calculated using the minimum and maximum limits of the setpoint. Switch-on minutes are calculated below the minimum limit, whereas switch-off minutes are calculated above the maximum limit. Degree minutes are therefore not calculated within the limits.

#### Flow sensor B21 installed

If flow sensor B21 is installed in the heat pump, the sensor and the condenser's return setpoint are used to calculate the electric immersion heater's degree minutes. Only the return setpoint is used for calculation, even though the flow sensor B21 is the measuring sensor.

If the value on line 5810 is larger than zero, a fixed switching differential of 1 °C is used around the return setpoint to calculate the upper and lower limit for the immersion heater's setpoint. The setpoint's lower limit for an immersion heater is

Sensor B21	$\left( \begin{array}{c} \text{setpoint's} \\ \text{lower limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) - 1\text{ °C}$
---------------	--

Correspondingly, the upper limit is

Sensor B21	$\left( \begin{array}{c} \text{setpoint's} \\ \text{upper limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) + 1\text{ °C}$
---------------	--

If the value on line 5810 is zero, the switching differential on line 2840 is used around the condenser's return setpoint to calculate the upper and lower limit of the immersion heaters' setpoint. The setpoint's lower limit for an immersion heater is

Sensor B21	$\left( \begin{array}{c} \text{setpoint's} \\ \text{lower limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) - \frac{\text{line 2840}}{2} \text{ °C}$
---------------	--

Correspondingly, the upper limit is

Sensor B21	$\left( \begin{array}{c} \text{setpoint's} \\ \text{upper limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) + \frac{\text{line 2840}}{2} \text{ } ^\circ\text{C}$
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Only return sensor B71 installed

If only return sensor B71 is installed in the heat pump, the sensor and the condenser's return setpoint are used to calculate the electric immersion heater's degree minutes. Like the compressor, the switching differential on line 2840 is used around the setpoint to calculate the upper and lower limit of the immersion heaters' setpoint. The setpoint's lower limit for an immersion heater is

Sensor B71	$\left( \begin{array}{c} \text{setpoint's} \\ \text{lower limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) - \frac{\text{line 2840}}{2} \text{ } ^\circ\text{C}$
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Correspondingly, the upper limit is

Sensor B71	$\left( \begin{array}{c} \text{setpoint's} \\ \text{upper limit} \\ \text{for imm. heater} \end{array} \right) = \left( \begin{array}{c} \text{condenser} \\ \text{return} \\ \text{setpoint} \\ \text{line 8411} \end{array} \right) + \frac{\text{line 2840}}{2} \text{ } ^\circ\text{C}$
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## Summary of the control of the compressor and immersion heaters

B21	B71	B10	5810	Compressor K1			Electric immersion heater after the condenser (K25/K26)		
				Sensor	Setp.	Switching differential	Sensor	Setp.	Sw. diff.
-	-	-		Off (Error 138: No control sensor)			Off		
-	-	ok		Off (Error 138: No control sensor)			B10	FLOW	±1 °C
-	ok	-		B71	RETURN	± 2840 / 2 °C	B71	RETURN	± 2840 / 2 °C
-	ok	ok	=0	B71	RETURN	± 2840 / 2 °C	B71	RETURN	± 2840 / 2 °C
			>0	B71	RETURN	± 2840 / 2 °C	B10	FLOW	±1 °C
ok	-	-		Off (Error 138: No control sensor)			B21	FLOW	±1 °C
ok	-	ok		Off (Error 138: No control sensor)			B21	FLOW	±1 °C
ok	ok	-	=0	B71	RETURN	± 2840 / 2 °C	B71	RETURN	± 2840 / 2 °C
			>0				B21	RETURN	±1 °C
ok	ok	ok	=0	B71	RETURN	± 2840 / 2 °C	B71	RETURN	± 2840 / 2 °C
			>0				B21	FLOW	±1 °C

*Summary of the control of the compressor and immersion heaters without a buffer storage tank.*

FLOW: Temperature of the outgoing water from the condenser (flow)

RETURN: Temperature of the incoming water to the condenser (return)

### Examples

**Example:** Outside temperature -10 °C, heating curve slope 0.50

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	-10 °C
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	22 °C
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.50
Heating curve displacement, heating circuit 1	Heating circuit 1	721	0 °C
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	40 °C
Switching difference of return temperature	Heat pump (Compressor)	2840	6.0 °C
Heating circuit temp. difference at the outside temperature of -10 °C	Configuration (Heat pump)	5810	4.0 °C
Flow setpoint from the heating curve, heating circuit 1			36.4 °C
Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1	Diagnostics consumers	8744	36.4 °C
Heating circuit's temperature difference based on line 5810 at the outside temperature of -10 °C			4.0 °C
Heat pump setpoint (return setpoint)	Heat generation status information	8411	32.4 °C

Setting	Menu	Line	Value
Return temperature's switching difference below the setpoint		2840 / 2	3.0 °C
Return temperature's switching difference above the setpoint		2840 / 2	3.0 °C
Compressor's start temperature (return, sensor B71)			29.4 °C
Compressor's stopping temperature (return, sensor B71)			35.4 °C
Lower limit for immersion heater setpoint (flow, sensor B21 installed)			31.4 °C
Upper limit for immersion heater setpoint (flow, sensor B21 installed)			33.4 °C
Lower limit for immersion heater setpoint (return, only sensor B71 installed)			29.4 °C
Upper limit for immersion heater setpoint (return, only sensor B71 installed)			35.4 °C

**Example:** Outside temperature  $-30\text{ °C}$ , heating curve slope 0.50, flow temperature's upper limit  $42\text{ °C}$

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	$-30\text{ °C}$
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	$22\text{ °C}$
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.50
Heating curve displacement, heating circuit 1	Heating circuit 1	721	$0\text{ °C}$
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	$40.0\text{ °C}$
Switching difference of return temperature	Heat pump (Compressor)	2840	$6.0\text{ °C}$
Heating circuit temp. difference at the outside temperature of $-10\text{ °C}$	Configuration (Heat pump)	5810	$4.0\text{ °C}$
Flow setpoint from the heating curve, heating circuit 1			$42.0\text{ °C}$
Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1	Diagnostics consumers	8744	$40.0\text{ °C}$
Heating circuit's temperature difference based on line 5810 at the outside temperature of $-30\text{ °C}$			$6.7\text{ °C}$
Heat pump setpoint (return setpoint)	Heat generation status information	8411	$33.3\text{ °C}$
Return temperature's switching difference below the setpoint		2840 / 2	$3.0\text{ °C}$
Return temperature's switching difference above the setpoint		2840 / 2	$3.0\text{ °C}$
Compressor's start temperature (return, sensor B71)			$30.3\text{ °C}$
Compressor's stopping temperature (return, sensor B71)			$36.3\text{ °C}$
Lower limit for immersion heater setpoint (flow, sensor B21 installed)			$32.3\text{ °C}$
Upper limit for immersion heater setpoint (flow, sensor B21 installed)			$34.3\text{ °C}$
Lower limit for immersion heater setpoint (return, only sensor B71 installed)			$30.3\text{ °C}$
Upper limit for immersion heater setpoint (return, only sensor B71 installed)			$36.3\text{ °C}$

**Example:** Outside temperature  $-30\text{ °C}$ , heating curve slope 0.80, flow temperature's upper limit  $70\text{ °C}$

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	-30 °C
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	22 °C
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.80
Heating curve displacement, heating circuit 1	Heating circuit 1	721	0 °C
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	70.0 °C
Switching difference of return temperature	Heat pump (Compressor)	2840	6.0 °C
Heating circuit temp. difference at the outside temperature of -10 °C	Configuration (Heat pump)	5810	4.0 °C
Flow setpoint from the heating curve, heating circuit 1			54.4 °C
Flow setpoint from the heating curve with line 741 taken into account, heating circuit 1	Diagnostics consumers	8744	54.4 °C
Heating circuit's temperature difference based on line 5810 at the outside temperature of -30 °C			6.7 °C
Heat pump setpoint (return setpoint)	Heat generation status information	8411	47.7 °C
Return temperature's switching difference below the setpoint		2840 / 2	3.0 °C
Return temperature's switching difference above the setpoint		2840 / 2	3.0 °C
Compressor's start temperature (return, sensor B71)			44.7 °C
Compressor's stopping temperature (return, sensor B71)			50.7 °C
Lower limit for immersion heater setpoint (flow, sensor B21 installed)			46.7 °C
Upper limit for immersion heater setpoint (flow, sensor B21 installed)			48.7 °C
Lower limit for immersion heater setpoint (return, only sensor B71 installed)			44.7 °C
Upper limit for immersion heater setpoint (return, only sensor B71 installed)			50.7 °C

**Example:** Outside temperature +10 °C

Setting	Menu	Line	Value
Outside temperature	Diagnostics consumers	8704	+10 °C
Comfort mode setpoint, heating circuit 1	Heating circuit 1	710	22 °C
Heating curve slope, heating circuit 1	Heating circuit 1	720	0.50
Heating curve displacement, heating circuit 1	Heating circuit 1	721	0 °C
Flow max. setpoint, heating circuit 1	Heating circuit 1	741	40 °C
Switching difference of return temperature	Heat pump (Compressor)	2840	6.0 °C
Heating circuit temp. difference at the outside temperature of -10 °C	Configuration (Heat pump)	5810	4.0 °C
Flow setpoint from the heating curve, heating circuit 1			28.6 °C
Flow setpoint from the heating curve with the upper limit taken into account, heating circuit 1	Heat consumers status information	8744	28.6 °C
Heating circuit's temperature difference based on line 5810 at the outside temperature of +5 °C			1.3 °C
Heat pump setpoint (return setpoint)	Heat generation status information	8411	27.3 °C
Return temperature's switching difference below the setpoint		2840 / 2	3.0 °C

Setting	Menu	Line	Value
Return temperature's switching difference above the setpoint (Notice the deduction on line 2840 with a return temperature setpoint below 30 °C)		2840 / 2	2.2 °C
Compressor's start temperature (return, sensor B71)			25.1 °C
Compressor's stopping temperature (return, sensor B71)			30.3 °C
Lower limit for immersion heater setpoint (flow, sensor B21 installed)			26.3 °C
Upper limit for immersion heater setpoint (flow, sensor B21 installed)			28.3 °C
Lower limit for immersion heater setpoint (return, only sensor B71 installed)			25.1 °C
Upper limit for immersion heater setpoint (return, only sensor B71 installed)			30.3 °C

## 4.4 Forced charging of storage tanks

With forced charging, storage tanks can be heated (charged) based on time or relay contact information. This way the storage tanks can be charged using a cheaper time-based feed-in tariff, for example.

### Forced charging of heating circuit's storage tank

Heating circuit's storage tank's (additional storage tank, buffer storage tank) forced charging can be started either scheduled or with relay contact information. Forced charging is enabled on line 4705. The time for scheduled forced charging is set on line 4711. Forced charging starts daily at the time set on line 4711. If no time is set, scheduled forced charging is not enabled. The maximum duration is set on line 4712. Relay contact control is enabled selecting low tariff as a vacant EX input's function. The contact can be open (NO) or closed (NC). Function E5 can also be used with smart-grid contact information (section *Smart grid*). Forced charging that has been set with relay contact information will stay active as long as the relay contact is active. Relay contact control can run in parallel with scheduled control, or without it.

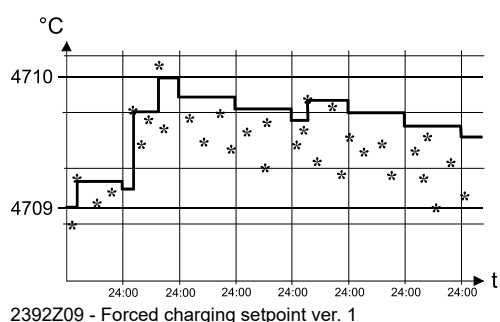
When forced charging is enabled, automation uses the highest setpoint that occurred in normal mode (section *Space heating with a regulated storage tank*) as the storage tank's setpoint and reduces it by 10 % daily, if a new, higher setpoint is not presented. When calculating the highest setpoint, automation only takes the setpoints that are within the lower and upper limits on lines 4709 and 4710, respectively, into account.. Give these lines equal values if you want to force charge the storage tank to the same temperature every time. If you want the upper limit to change according to temperature need, instead, but keep the lower limit fixed, then set the desired lower limit on line 4709, and set the upper limit on line 4710 to as hot as the heat pump (or heater) can possibly heat the storage tank.

Forced charging ends when the storage tank's temperature exceeds the storage tank's setpoint in forced charging. Forced charging is also halted if the heat pump is switched off during charging due to a limit or protection function. If the storage tank cools to 5 °C below the setpoint after the forced charging, forced charging starts again if it is still active according to the contact information or schedule. Scheduled forced charging also ends according to the time limit on line 4712 if the storage tank's setpoint has not been reached earlier. DHW is charged normally during forced charging. Forced

charging continues after the DHW is charged. IF DHW is also force charged with contact information, DHW is heated first, and heating circuit's storage tank is heated after that.

Line	Setting	Action
4705	Forced charging	<b>STOP</b> Forced charging is not in use. Forced charging is not in use regardless of schedules or contacts. <b>Demand:</b> Forced charging is prevented by summer usage (section <i>Outside temperature limits for the heating season and day</i> ) <b>Always:</b> Forced charging is always on.
4709	Min. forced charging value for heating	The setpoint of forced charging stays within these limits even if the heating circuits' requested temperatures are lower or higher. Set these close to one another if you wish to force charge the storage tank to the same temperature every time. The storage tank is always force charged to the lower limit temperature on line 4709 at the minimum.
4710	Max. forced charging value for heating	
4711	Forced charging time	Forced charging starts on a set schedule at a time selected here. If no time is set, scheduled forced charging is not in use.
4712	Forced charging maximum duration	You can set the duration of scheduled forced charging on this line. Forced charging will be on for the duration set here at the maximum, if the setpoint is not reached earlier.
4761	Forced charging with electric heater	<b>No:</b> Electric heater K16 is not used for force charging the storage tank <b>Yes:</b> Electric heater K16 is used for force charging the storage tank, if no other heat source (heat pump or supplementary heat source) is not able to start forced charging within one minute of the charging request. <b>Phase guard, forced shut-down</b> Electric heater K16 is used for force charging the storage tank if the smart-grid mode is set to forced (draw forced).
4750		If the storage tank's forced charging is started with the smart-grid function "forced" (draw forced), the setpoint on this line is used for the heating circuit's storage tank.
2911	For forced buffer charging	This is used to select whether the compressor is used for forced charging of the heating circuit storage tank.

Setpoints for forced buffer charging (buffer tank menu)



Marking	Description
*	Single storage tank temperature setpoint, determined normally according to the requested temperatures of heating circuits as described in section <i>Space heating with a regulated storage tank</i> .
line 4710	Upper limit for acknowledged individual storage tank temperature setpoints.
line 4709	Time limit for acknowledged individual storage tank temperature setpoints.

Determining the setpoint for forced charging

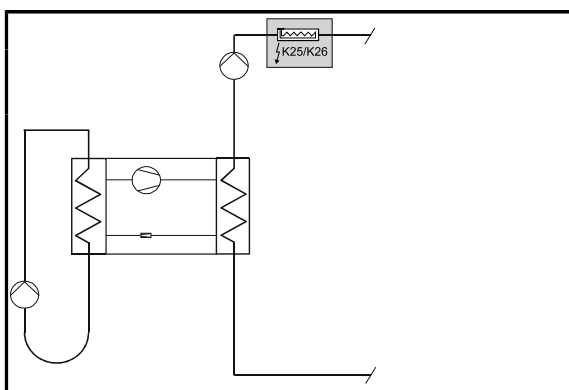
### Forced service buffer tank charging

Service buffer tank's forced charging is enabled by selecting either "low tariff" or "low tariff" and "time program 4" on line 1620. The low tariff function uses the same E5 contact information as heating circuit storage tank's forced charging. Relay contact

control is enabled selecting low tariff as a vacant EX input's function. The contact can be open (NO) or closed (NC). Function E5 can also be used with smart-grid contact information (section *Smart grid*).

Forced charging with function E5 starts DHW heating before the switching differential (line 5024) is reached. Forced charging always heats the storage tank to the normal setpoint regardless of the time program's (time program 4) setpoint. Forced charging will heat the storage tank only once if the relay contact information does not change between the charges. Normal switching differential and time program's setpoint are in use after the first forced charging, and remain in use until forced charging is switched on again. If forced charging with function E5 is in use for heating both the service buffer tank and the heating circuit's storage tank, the controller will heat the DHW first, and the heating circuit's tank second.

## 4.5 In-line heater in the condenser line

	<b>Functions</b> QX: electric heater stage 1 K25 QX: electric heater stage 2 K26 Electric heaters must always be equipped with overheat protection and connected behind a fuse and contactor. Automation's QX outputs are for controlling the heater's contactors only. Do not connect the heater to them directly. If the heater has a thermostat in addition to overheat protection, its setpoint must be set high enough so the thermostat does not prevent the heater from operating.
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### Important setpoints and statuses

Menu	Line	Setting
Heat pump	2880	Use electric flow (electric immersion heater's operating mode)
Heat pump	2881	Locking time
Heat pump	2882	Release integral, electric immersion heater in flow (switch-on degree minutes)
Heat pump	2883	Reset integral, electric immersion heater in flow (switch-off degree minutes)
Heat pump	2884	Release el. flow below OT (OT limit)
Heat pump	2885	Electric on below flow temp (flow temp. limit)
Diagnostics heat generation	8402	Electric immersion heater stage 1 status
Diagnostics heat generation	8403	Electric immersion heater stage 2 status

### Operating mode of electric immersion heater

The operating mode for electric immersion heaters K25/K26 is set on line 2880.

**SUBSTITUTE:** An electric heater is used only when emergency operation initiated by the automation is on (see lines 7141 and 7142) or when the temperature of the brine from the brine circuit drops below the lower limit defined on line 2816. The electric immersion heater is not on simultaneously with the compressor, and the lines for locking and degree minutes (lines 2881 and 2882) are ignored.

**HEATING CIRCUIT ALONGSIDE THE COMPRESSOR:** The electric immersion heater is switched on in the space heating mode alongside the compressor when the locking time on line 2881 has elapsed and the number of degree-minutes set on line 2882 has been exceeded. The electric immersion heaters are not in complementary use with the compressor during DHW heating. Electric immersion heaters are used in DHW heating only when the temperature limit on lines 2893 (sub-section *Switch-off temperature* in section *Heat pump's protection functions*) or 5032 (sub-section *DHW temperature limit in compressor use* in section *DHW heating*) is exceeded.

**DHW ALONGSIDE THE COMPRESSOR:** The electric immersion heater is switched on in the DHW heating mode to complement the compressor when the locking time on line 2881 has elapsed and the number of degree-minutes set on line 2882 has been exceeded. Electric immersion heaters are not available for space heating.

**HC+DHW ALONGSIDE THE COMPRESSOR:** The electric immersion heater is switched on in the space heating mode and in the DHW heating mode to complement the compressor when the locking time on line 2881 has elapsed and the number of degree-minutes set on line 2882 has been exceeded.

**END DHW STORAGE TANK CHARGING:** The electric heater is used only if the compressor has been switched off during DHW charging because of the switch-off temperature (line 2844), high pressure switch-off or hot-gas temperature limit (line 2846) and the maximum number of charging attempts (line 2893) has been reached. The electric immersion heater is not on simultaneously with the compressor, and the lines for locking and degree minutes (lines 2881 and 2882) are ignored.

**EMERGENCY OPERATION:** An electric immersion heater is used only when emergency operation is active (lines 7141 and 7142). The electric immersion heater is not on simultaneously with the compressor, and the lines for delay and degree-minutes (lines 2881 and 2882) are ignored.

**LEGIONELLA FUNCTION:** This corresponds to the "End DHW charging" mode with the exception that electric immersion heaters are used only when the Legionella function is on.

**END DHW STORAGE TANK CHARGING:** The electric immersion heater is used only if the compressor has been switched off during DHW charging because of the switch-off temperature (line 2844), high pressure switch-off or hot-gas temperature limit (line 2846) and the maximum number of charging attempts (line 2893) has been reached. The electric immersion heater is not on simultaneously with the compressor, and the lines for locking and degree minutes (lines 2881 and 2882) are ignored.

### **Switch-on locking time (delay time) and degree minutes**

A locking time (delay time) and degree minutes can be set for the switch-on of electric immersion heaters K25/26. The locking time is set on line 2881 and the degree minutes are set on line 2882. Heater stages are switched on when the immersion heaters' delay time has ended and the sum of the degree minutes has elapsed. The calculation of the delay begins when the compressor is switched on. During the delay, the electric immersion heaters are not switched on and degree minutes are not calculated. After the delay, the controller starts calculating the sum of the degree minutes. If flow sensor B21 is installed in the heat pump, the flow temperature is used to calculate the electric immersion heater's degree minutes. Otherwise, return temperature is used (sensor B71).

In switching on the immersion heaters, a degree minute is the remainder of the setpoint's lower limit and the measured temperature, calculated in one minute intervals. When the measured temperature is lower than the setpoint's lower limit, the calculation of degree minutes begins. If the measured temperature exceeds the lower limit, the sum and the degree minutes are reset.

The degree minutes for each minute are summed up as the sum of the degree minutes. When the sum exceeds the degree minutes limit set on line 2882, the first stage of the electric immersion heaters is switched on (K25). After this, the sum of the degree minutes is reset and the calculation starts again. When the sum of the degree minutes again reaches the value on line 2882, the second immersion heater stage is switched on (K26). The same procedure is followed with the third immersion heater stage (K25 + K26). The delay is used only before the calculation of the degree minutes of the first stage. If the degree minute value is set to zero, the heater stages are directly switched on below the setpoint's lower limit.

The time it takes to reach the degree minute sum depends on the difference between the setpoint's lower limit and the measured value. For example, if the degree minute sum is 20 °C min, it corresponds to a temperature difference of 10 °C for two minutes or a temperature difference of 5 °C for four minutes. If, for instance, the lower limit of the heaters' setpoint is 28 °C and the measured temperature is 25 °C, the degree minutes count is incremented by three degree minutes every minute if the measured temperature remains unchanged. Thus, in five minutes, the sum will be 15 degree minutes, and in ten minutes, 30 degree minutes. For example, if the degree-minute sum set on line 2882 is 30 degree minutes, the first immersion heater stage is switched on when 10 minutes have elapsed since the delay time ended. After this, the calculation of the sum for the next immersion heater stage will begin. If the temperature rises during this time above the upper limit for the immersion heaters, the calculation of degree-minutes for that stage is stopped and the sum is reset.

### **Switch-off degree minutes**

Heater stages are switched off when the the sum of the switch-off degree minutes is reached. The degree minutes for switch-off are set on line 2882. The switch-off does not take the locking time into account.

In switching off the immersion heaters, a degree minute is the remainder of the setpoints' upper limit and the measured temperature, calculated in one minute intervals. When the measured temperature exceeds the setpoints' upper limit, the calculation of degree minutes begins. If the measured temperature drops below the upper limit, the sum and the degree minutes are reset. The switch-off degree minutes are usually set to zero so the heater stages are switched off immediately after the measured temperature exceeds the upper limit of the heaters' setpoint.

### **Temperature limits**

An outside temperature limit can be set to the electric immersion heater on line 2884. The heater is not taken into use above this value. This setting also applies to DHW heating. This setting should not be taken into use if DHW needs to be heated also with an electric immersion heater. If the line value is set to for example -15 °C, the electric immersion heater is not available for use until the outside temperature drops below -15 °C.

A flow temperature limit can be set on line 2885, below which the immersion heater is always immediately switched on. If the line value is set to for example 8 °C, the electric immersion heater is always immediately switched on when the flow temperature drops below 8 °C. This function can be used for frost protection, among other things. The flow temperature limit does not prevent the immersion heater from switching on in other normal operating situations. The function only switches the immersion heater on when the flow temperature drops below the set lower limit.

The functions on lines 2884 and 2885 can be enabled simultaneously. If the value on line 2884 is set to for example -2 °C and the value on line 2885 to 8 °C, the electric immersion heater is switched on if the outside temperature is below -2 °C and the flow temperature is below 8 °C.

These temperature limits are not available in Emergency mode. In Emergency mode, the electric immersion heater is switched on regardless of the temperature limits on lines 2884 and 2885.

### **Switching off the electric immersion heater**

#### Heater used in emergency operation only

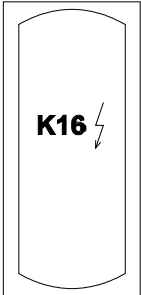
Set the value on line 2880 to Substitute or Emergency operation if you want the heater to be switched off during normal operation. This enables the heater to be switched on during emergency operation only.

#### Disabling the heater completely

The electric heater can be entirely decommissioned in the configuration menu by first selecting the option No function for outputs QX1 and QX2 and then switching the heater's fuse to OFF position. Take into account that after doing this the electric immersion heater is not available for any functions, including emergency operation. Complete decommission is not recommended. Do not switch to heater's fuse to OFF position before removing the heater from automation use in the manner described above.

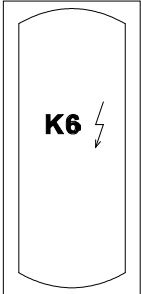
## **4.6 Electric immersion heater in the storage tank**

Automation can control an electric immersion heater in the heating circuit's storage tank (K16). The heater is switched on if the heat pump is unable to produce heat due to a fault condition, or if the storage tank's frost protection has been switched on. It is controlled with a sensor selected on line 4760. Usually this is sensor B4. The heater is switched on during a heat pump fault condition if the reading on the selected sensor drops 1 °C below the storage tank's setpoint. Correspondingly, the heater is switched off once the reading is 1 °C above the setpoint. The electric immersion heater is switched on during frost protection when the storage's temperature drops below 5 °C and stays switched on until the temperature has risen to 10 °C. In addition to the previously mentioned functions, the heater can also be used for force charging the buffer storage tank (section *Forced charging of storage tanks*).

	<p><b>Functions</b>          QX: Buffer tank's electric immersion heater K16</p>
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### Electric heater in service buffer tank

The electric immersion heater (K6) located in the service buffer tank can be controlled with the automation. The service buffer tank's electric heater is utilized instead of the condenser circuit heaters K25 and K26. If the connection has a diverting valve, it switches to space heating as the resistor is switched on.

	<p><b>Functions</b>          QX: DHW's electric immersion heater K6</p>
--	---

Heater K6 can be used, for example, heating the domestic water to a higher temperature after the compressor has reached the temperature level set on line 5032. To do this, select the option "substitute" on line 5060, "24 h" or "release of domestic hot water" on line 5061, and "DHW sensor" on line 5062. This makes the compressor available for space heating (the diverting valve turns) and heater K6 takes care of the final heating of domestic water once sensor B3 observes a temperature that is above the setpoint on line 5032.

Line	Setting	Action
5060	El. imm. heater optg mode	<p><b>Substitute:</b> The electric immersion heater is used only if the heat pump is unable to charge the DHW. Charging can be limited by the compressor temperature limit (line 5032), a time limit (line 5030) or the switch-off temperature (2844), or some type of a fault status (discharge). The temperature, to which the DHW could be heated via the heat pump before the immersion heater switches on, is saved on line 7093.</p> <p><b>Summer:</b> DHW is heated by the immersion heaters in the storage tank if the heating circuits are off due to summer usage (the Eco function). In this case, the compressor is not switched on.</p> <p><b>Always:</b> DHW is always heated only with the immersion heaters in the storage tank. The compressor is not used to charge the DHW.</p> <p><b>Emergency operation:</b> The immersion heaters in the storage tank are used for heating the DHW only when the heat pump is in emergency operation.</p> <p><b>LEGIONELLA FUNCTION:</b> The immersion heaters in the storage tank are used only when the Legionella function is active.</p>
5061	Release of el. immersion heater	<p><b>24 h:</b> Heater K6 is always available for operation, regardless of the operating purpose selected on line 5060.</p> <p><b>Release of domestic hot water:</b> The heater is available for the function selected on line 5060 when DHW heating is on as set on line 1620.</p> <p><b>Time program:</b> Electric immersion heater K6 is available for the function on line 5060 according to time program 4. It is unavailable outside of this time period.</p>
5062	El. immersion heater control	Electric immersion heater K6's control sensor. Here you should select the DHW sensor, putting the heater under sensor B3's control.

*Settings of the service buffer tank's electric immersion heater in the DHW menu*

## 5 Cascade connection

### 5.1 Cascade connection

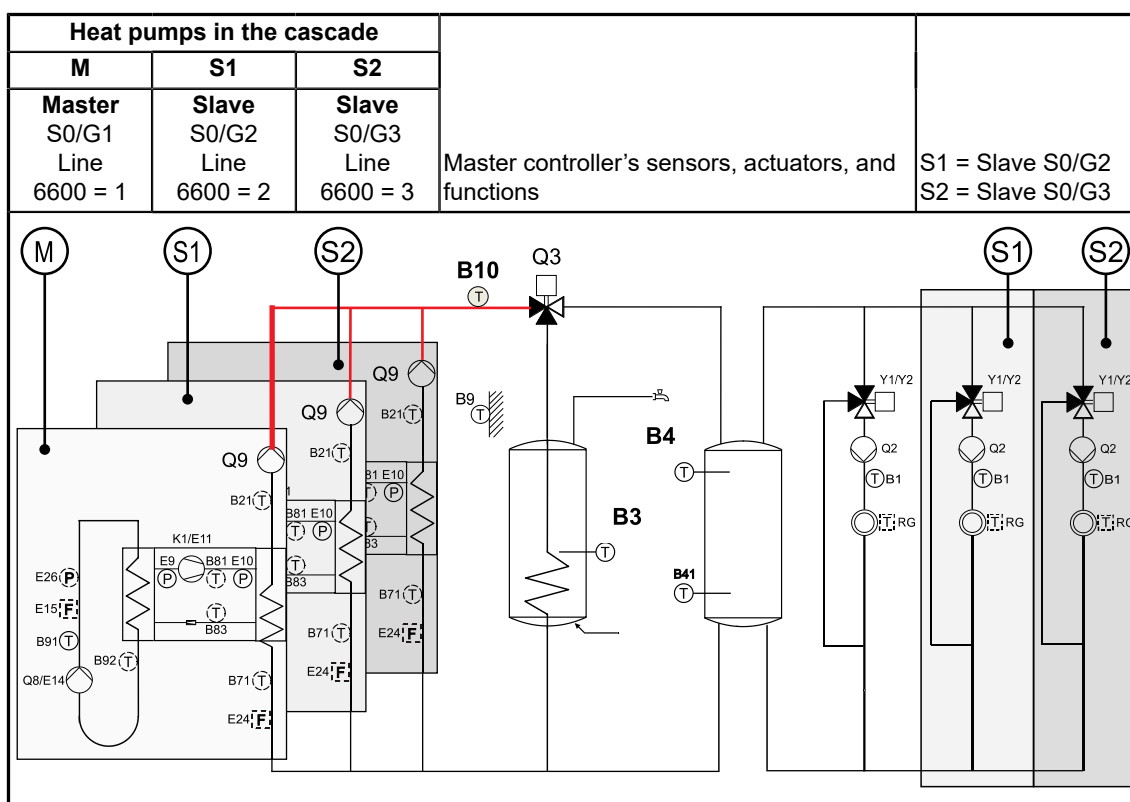
In a cascade connection, two or more heat pumps are connected to a system that is controlled by a single heat pump controller. One of the RVS61 heat pump controllers connected to the system operates as the master controller (which controls the entire system), and the other RVS61 controllers operate as slaves (which are controlled by the master controller). Heat pump controllers are connected to each other through an LBP bus. The system may contain up to 16 controllers (heat pumps).

The controllers are connected via an LPB bus (DB+/MB-).

- Connect the outdoor temperature sensor (B9) to the master controller.

If the system includes several heat pumps (several A1.0 controllers), connect sensors B3, B4, B10 and B9 to the A1.0 controller that controls the entire system, and disconnect the sensors from the other A1.0 controllers.

- Disconnect the sensors by disconnecting the sensor's connector from the relevant controller.
- If necessary, the disconnected sensors can be used for other functions.

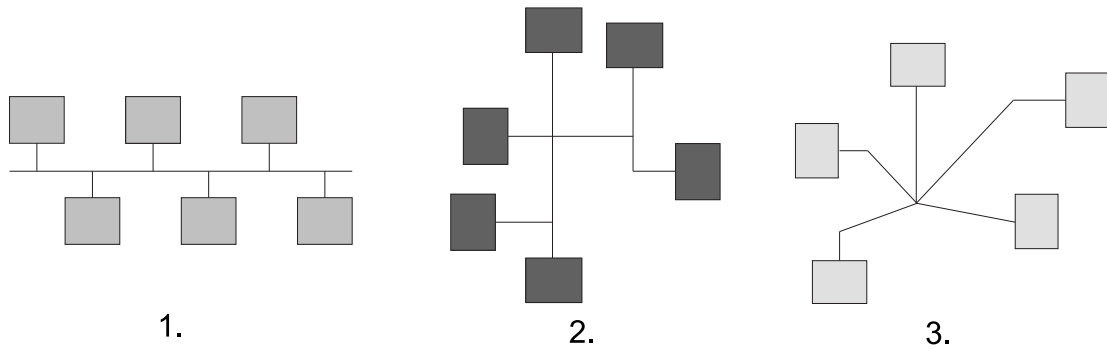


## 5.2 LPB bus configuration

The system's controllers are connected to an LPB bus (DB+/MB–). Any remote access devices will also be connected to the same bus.

- Use twisted pair cables with a minimum wire cross-sectional area of  $0.75 \text{ mm}^2$ .  
Over long distances, use  $1.5 \text{ mm}^2$  wires.
- Do not arrange the bus as a closed loop.

The permitted topologies are presented below.



Cascade bus topology ver. 1

The minimum voltage between the bus's DB+ and MB– connectors is 9.5 V DC.

- If the voltage is smaller, the electrical resistance in the bus cables is too great.
  - Check the cables and if necessary, use cables with a greater wire cross-sectional area.
- If there is no voltage present, the bus has short-circuited.
- If the voltage is negative, the polarity is incorrect.

### Bus addresses

Each device in the bus has its own address. Set the device address from the user interface itself (line 6600).

- The device address of the master controller is always 1.
- Slave controllers can have any free address between 2 and 16.
- Do not use addresses 8 and 5, since these are reserved for the OCI700 connection cable and a remote connection device.

Enable the cascade by using the user interface to change each slave controller's device address to any free address (such as 3) and connecting the slave controller to the bus. Once the slave addresses have been changed and the bus cable connected, the cascade function will be enabled, and the cascade menu will be displayed in the master controller.

After the cascade has been enabled, make the necessary changes in the master and slave controllers' settings. The settings are presented in the table below. An example of a cascade consisting of four RE96 heat pumps is presented in the figure at the end of this section.

Menu	Line	Line name	Master (S0/G1)	Slave 1 (S0/G2)	Slave 2 (S0/G2)
LPB	6600	Device address (G)	1	2	3
LPB	6601	Segment address (S)	0	0	0
LPB	6640	Clock use	Master	Slave with remote setting	Slave with remote setting
Configuration	5710	Heating circuit 1	On	Off	Off
Configuration	5800	Heat source	Brine	Externally brine (If a common brine circuit pump is in use)	Externally brine (If a common brine circuit pump is in use)

Slave controllers' unused BX inputs and outputs can be disabled, but this is not necessary.

If there is a remote access device in the bus, it should be set as the master for clock use, and the master controller's line 6640 setting should be set to **Slave with remote setting**. This way, the entire system's time will be automatically kept up to date through the remote access device and, if necessary, the time can be changed from any controller.

### Bus segments

If necessary, the bus can be divided into several segments. The device addresses within these segments are independent from the rest of the system.

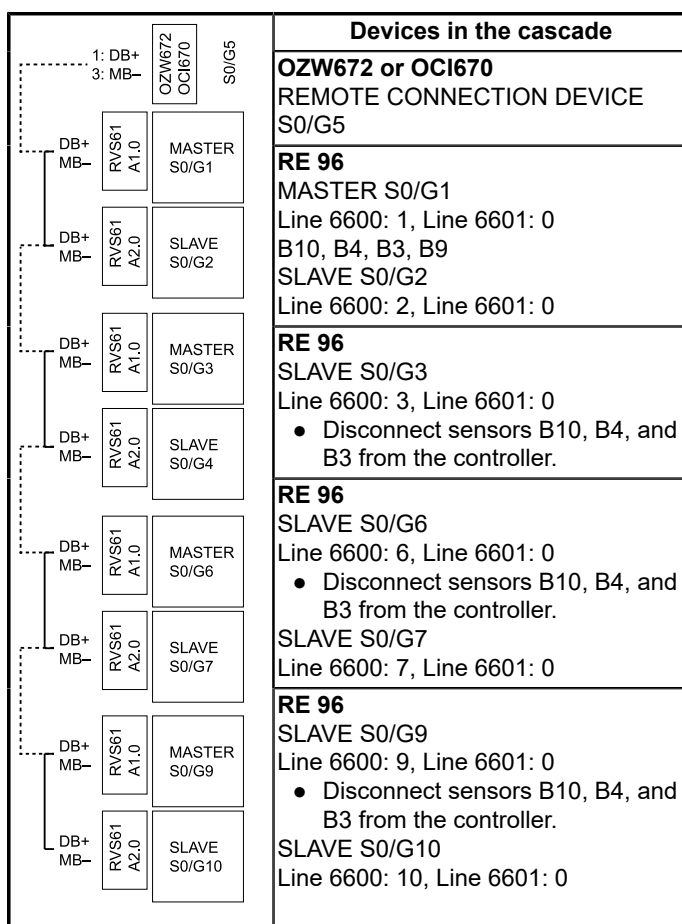
Select the segment ID from line 6601.

- The address for the segment's master is always 1.
- The address for the remote access device's segment is always 0.

The segment ID and the device address constitute the controller's entire address. The address can be, for example, S0/G1 or S0/G2, which means segment 0's (S0) master (G1) and its first slave (G2).

The ACS program can only be connected to device address 1 (the master controller). Any slave controllers connected to the bus will be displayed in the program through the master controller. As usual, the program can be used to copy the settings across all controllers connected to the bus through the master controller.

If you want to specifically connect to a slave controller using the ACS program, the controller needs to be disconnected from the bus and its device address changed to "1" via the controller's user interface. If the value on line 5800 is set to **externally brine**, the slave controller's PI diagram will show any and all components that can be present in the refrigerant circuit. Otherwise, the diagram will correspond to the actual controller settings. If you want to check the slave controller's wiring diagram for the refrigerant circuit, temporarily set the value on line 5800 to **Brine circuit**.



### 5.3 Important setpoints and statuses

Menu	Line	Setting	Action
Buffer storage tank	4721	Heat generation switching difference	Select a value that is large enough. Usually about 10 °C is suitable. This gives sensor B10 an adequate operating range and sensor B4 will not halt all the compressors in the cascade at once.
Buffer storage tank	4722	Temperature difference of buffer storage tank and heating circuit	Usually about 0 °C is suitable. This value starts the storage tank charging as soon as the tank's setpoint has been reached.
Cascade	3510	Control strategy	Select "Late on, late off".
Cascade	3511	Minimum power range	0 % to be chosen.
Cascade	3512	Maximum power range	100 % to be chosen.
Cascade	3514	Stage sequence	Select "Serial, last stage release".
Cascade	3516	Max sources forced charging	The maximum number of compressor circuits, used for forced charging of buffer tank (line 4705)
Cascade	3517	Outdoor temperature of source forced charging	If the forced charging of storage tank is on, there is always at least one compressor circuit for it. The controller increases the number of circuits for forced charging, depending on the outdoor temperature, until the max. amount set on line 3516 is in use.
Cascade	3530	Release integral source segment	Switch-on degree minutes in heating mode.

Cascade	3531	Reset integral source segment	Switch-off degree minutes in heating mode.
Cascade	3533	Start-up delay	Delay time before counting the switch-on degree minutes in heating mode. Is counted from the start-up of first compressor.
Cascade	3538	Substitute value for common supply water sensor B10	If common supply water sensor B10 is not installed, this value is used as a substitute. It is recommended to select "median source value", so that the average value of the cascade's supply water sensors B21 is the substitute value, or "highest source value", so the highest value from B21 is used.
Cascade	3540	Automatic source segment changeover current	Change interval of running order. The running order of compressor circuits changes after this time. In this change previously first started moves last in starting order. At the beginning, the running order of bus addresses is 1, 2, 3, 4. After the change, the order is 2, 3, 4, 1 and after the next change 3, 4, 1, 2 and so on.
Cascade	3541	Automatic source segment exclusion	Those compressor circuits, which running order stays the same, can be selected here. If here is chosen e.g. first source, the bus address 1 starts always first, but the running order of others changes in time intervals on line 3540.
Cascade	3544	Leading source	This is in use only, if the automatic changeover on line 3540 is not in use. On this line, is chosen the compressor circuit, first on-engaged and last off-engaged in this case.
Cascade	3590	Temperature difference min.	On this line can be set min. permissible temperature difference between the cascade's flow sensor B10 and return sensor B70. If the temperature difference is lower, last started heat pump will be shut off regardless of other running conditions.
Cascade	ACS	Cascade's neutral zone in heating mode	Neutral zone around the cascade's supply water sensor B10. The factory setting is 4 °C.
DHW storage tank	5020	Supply water setpoint boost	The setpoint for sensor B10 is this much higher than the DHW setpoint (line 1610). The suitable value is usually 1...2 °C.
Configuration	5800	Heat source	Section <i>Shared brine circuit pump</i>
Configuration	5803	Device address external device	Section <i>Shared brine circuit pump</i>

Configuration	6117	Focused setpoint compensation	Offset added to the setpoint for each of the cascade's heat pump (line 8411) compared to the setpoint for the shared flow sensor (sensor B10, line 8139). The purpose of the setpoint is to prevent heat pumps that are running from shutting down when the next compressor unit switches on. At this point, the flow temperature rises rapidly and may exceed a heat pump's own setpoint (line 8411). Usually, this setting should be set to 20 °C. If the system includes several cascades and the setpoint is transferred between the cascades through Ux and Hx connections, a suitable setpoint is 0... 5 °C.
Diagnostics cascade (master)	8100	Priority source 1	Running order of heat pump (master) in device address 1. If the ordinal number is 1, the device is started as first. If the ordinal number is 2, the device is started as second.
Diagnostics cascade (master)	8101	Status of source 1	Status of heat pump (master) in device address 1. If the status is released, the heat pump is on, if some internal temperature limit (e.g. switch-off temperature) does not limit this.
Diagnostics cascade (master)	8100	Priority source 2	Running order of heat pump (slave) in device address 2.
Diagnostics cascade (master)	8101	Status of source 2	Status of heat pump (slave) in device address 2.
Diagnostics cascade (master)	8183	Flow temperature of cascade	Temperature of cascade's supply water sensor B10.
Diagnostics cascade (master)	8139	Cascade's flow setpoint	Setpoint of cascade's supply water sensor B10.
Diagnostics cascade (master)	8150	Source segment changeover current	Time for changing the running order of heat sources (line 3540).

## 5.4 Compressor control

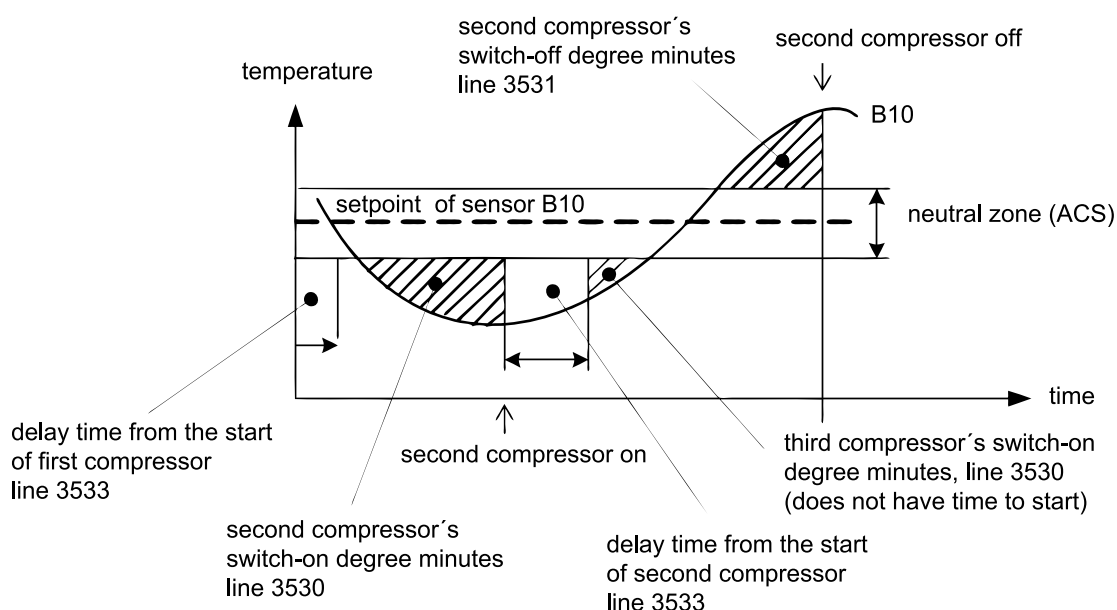
The compressor circuit that is first in the starting order will start normally as indicated in sub-sections on compressor control in sections *DHW Heating*, *Space heating without a buffer storage tank*, and *Space heating with a regulated storage tank*. Switching on and off of next starting compressor circuits is based on the setpoint of shared flow sensor B10. The neutral zone is around the setpoint of sensor B10. The setpoint of neutral zone is divided equally between the two sides of the setpoint. Lower limit of neutral zone is

Sensor B10	$\left( \begin{array}{c} \text{setpoint's} \\ \text{lower limit} \\ \text{of sensor B10} \end{array} \right) = \left( \begin{array}{c} \text{setpoint of} \\ \text{sensor B10} \\ \text{line 8139} \end{array} \right) - \frac{\text{neutral zone}}{2}$
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and, correspondingly, the upper limit is

Sensor B10	$\left( \begin{array}{c} \text{setpoint's} \\ \text{upper limit} \\ \text{of sensor B10} \end{array} \right) = \left( \begin{array}{c} \text{setpoint of} \\ \text{sensor B10} \\ \text{line 8139} \end{array} \right) + \frac{\text{neutral zone}}{2}$
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If the value of sensor B10 is inside the area, degree-minutes are not counted. Counting of switch-on degree-minutes (line 3530) is started, when the delay time on line 3533 has passed and the value of sensor B10 falls below the lower limit of setpoint. Counting of switch-off degree-minutes (line 3531) is correspondingly started, when the value of sensor B10 exceeds the upper limit of setpoint. There is no delay time in the switch-off. The factory setting of neutral zone is 2...4 °C. The value can be changed with ACS program.



Cascade control

## Heating of DHW storage tank

The compressor that is first in running order will start and stop normally, when prompted to do so by sensor B3 as indicated in the sub-section on compressor control in section *DHW Heating*. After the start of the first compressor, the controller will wait one minute and, after that, start to count switch-on degree-minutes set on line 3530 based on the value of sensor B10. The delay set on line 3533 is not in use. Sensor B10 setpoint is

Sensor B10	$\left( \begin{array}{c} \text{setpoint of sensor B10} \\ \text{line 8139} \end{array} \right) = \left( \begin{array}{c} \text{setpoint} \\ \text{of DHW} \\ \text{line 1610} \end{array} \right) + \text{line 5020}$
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The next compressor in running order starts, when the switch-on degree-minutes run out. If the degree-minutes are set to zero, the next compressor circuit starts immediately, when the value of sensor B10 goes below the lower limit of sensor's B10 setpoint. In the switch-off the last started compressor circuit is analogously shut down, when the switch-off degree-minutes run out. If the degree-minutes are set to zero, the last started compressor circuit is shut down immediately, when the value of sensor B10

goes below the lower limit of sensor's B10 setpoint. If the value of sensor B3 exceeds the setpoint of DHW storage tank before the sensor B10, all compressors are shut down along with the first started compressor.

### Heating of the buffer storage tank in the heating circuit

The compressor that is first in running order will start and stop normally, when prompted to do so by sensor B3 as indicated in the sub-section on compressor control in section *Space heating with a regulated storage tank*. After the start of the first compressor, the controller will wait for delay time on line 3533 and after that start to count degree-minutes set on line 3530 based on the value of cascade's flow sensor B10. Sensor B10 setpoint is the same as the setpoint of heating circuit's buffer tank

Sensor B10	$\left( \begin{array}{c} \text{setpoint of sensor B10} \\ \text{line 8139} \end{array} \right) = \left( \begin{array}{c} \text{buffer tank's setpoint} \\ \text{line 8981} \end{array} \right)$
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The next compressor in running order starts, when the switch-on degree-minutes run out. If the degree-minutes are set to zero, the next compressor circuit starts immediately, when the value of sensor B10 goes below the lower limit of sensor's B10 setpoint. In the switch-off the last started compressor circuit is analogously shut down, when the switch-off degree-minutes run out. If the degree-minutes are set to zero, the last started compressor circuit is shut down immediately, when the value of sensor B10 goes below the lower limit of sensor's B10 setpoint. If the value of sensor B4 exceeds the setpoint of buffer storage tank before the sensor B10, all compressors are shut down along with the first started compressor.

## 5.5 Shared brine circuit pump

A shared brine circuit pump can be defined for the cascade. The shared pump will always start when the first compressor in the running order starts, even if it is not in the compressor circuit that is controlled by the particular controller. By default, the cascade's shared brine circuit pump is connected to the master controller in accordance with the electrical drawings, and the slave controllers will request the master controller to activate the output via the bus.

Connect the pump using the regular brine pump output (Q8) in any of the controllers connected to the cascade.

- Select the controller to which the shared pump is connected on line 5803.
- By default, the setting for the line is **1**, which is the master controller's device address.

Enable the shared brine circuit pump by setting the option on line 5800 to **externally brine**.

- Enable this option in all controllers that use the shared brine circuit pump, except for the controller to which the shared pump is connected.
- As a rule, set the value on line 5800 to **externally brine** in all slave controllers, and leave the value unchanged in the master controller.

The controllers that use the shared pump may also have their own brine circuit pump output Q8 configured. As usual, the output is activated when the compressor circuit controlled by the relevant controller starts, even if the controller sends out a

request for the shared brine circuit pump to turn on via the bus. This means that if required, the shared brine circuit pump can be used as an additional pump alongside the compressor circuit's own brine circuit pump.

## 5.6 Shared condenser circuit pump

Shared condenser-circuit pump can be defined to the cascade. The pump is taken into use by choosing the pump Q25 for the function of master controller QX-output. The output can be selected to free input (connected through a fuse), or it can be changed to replace the Q9-output of condenser pump. When using the condenser pump output, there is a fuse ready for the pump in the electrical center. However, the pump fuse size must be ensured before installing, because the fuse is usually dimensioned for one compressor circuit pump. The pump Q25 starts always, when any compressor circuit starts.

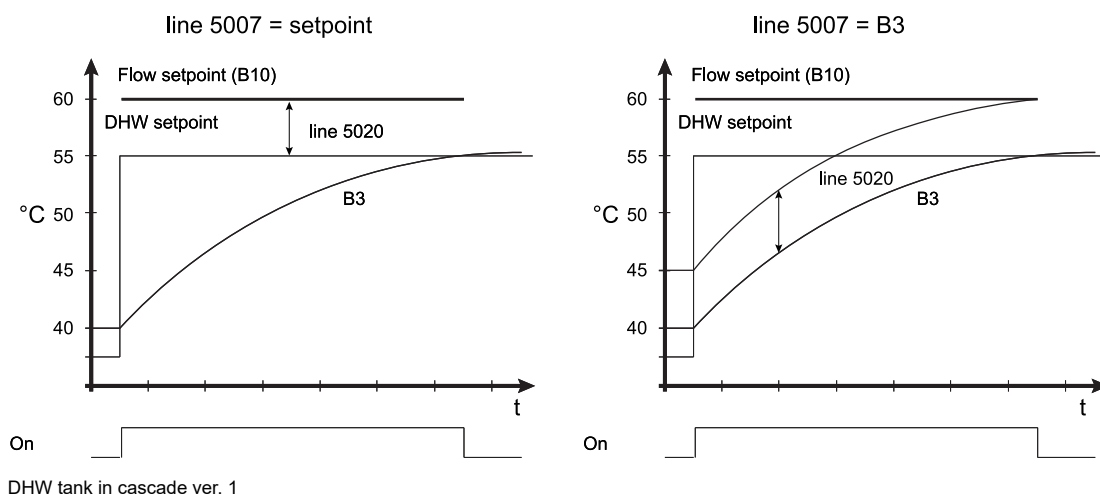
It is usually better to use own condenser circuit pump for each compressor circuit. This way, the flow, heated in turned on compressor circuits, does not go off nor cool off, when going through condensers. Using two pumps also enables that some of the circuits can heat the DHW storage tank while the others heat the heating circuit storage tank at the same time. If the system uses only one pump, the flow through the turned off circuits can be prevented with the engine shutoff valves. Installing own condenser-circuit pump for each compressor circuit is, however, usually simpler solution than the engine shutoff valves.

## 5.7 Heating DHW and buffer tanks in a cascade

### DHW storage tank heating

The first compressor in the start order will switch on and off in the usual manner (section *DHW heating* ) based on the input from sensor B3. After the start of first compressor the controller waits one minute and after that starts to count switch-on degree-minutes set on line 3530 based on the value of sensor B10. The minutes are counted based on the difference between the sensor's value and setpoint. The delay set on line 3533 is not in use. The setpoint of sensor B10 that is used in counting the degree minutes can be based on either the DHW setpoint (a fixed value) or the measured temperature of the DHW (changes during heating). This is selected on line 5007. The boost to be set on line 5020 is added to this selected temperature value.

## Effects lines 5007 and 5020



If “setpoint” is selected on line 5007, sensor B10’s setpoint is used for DHW heating:

Sensor B10	$\left( \begin{array}{c} \text{sensor B10 setpoint} \\ \text{line 8139} \end{array} \right) = \left( \begin{array}{c} \text{DHW setpoint} \\ \text{line 1610} \end{array} \right) + \text{line 5020}$
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If “sensor B3” is selected on line 5007, sensor B10’s setpoint is used for DHW heating:

Sensor B10	$\left( \begin{array}{c} \text{sensor B10 setpoint} \\ \text{line 8139} \end{array} \right) = \left( \begin{array}{c} \text{DHW setpoint} \\ \text{line 8830} \end{array} \right) + \text{line 5020}$
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The next compressor in running order starts, when the switch-on degree-minutes run out. If the degree-minutes are set to zero, the next compressor circuit starts immediately, when the value of sensor B10 goes below the lower limit of sensor’s B10 setpoint. In the switch-off the last started compressor circuit is analogously shut down, when the switch-off degree-minutes run out. If the degree-minutes are set to zero, the last started compressor circuit is shut down immediately, when the value of sensor B10 goes below the lower limit of sensor’s B10 setpoint. If the value of sensor B3 exceeds the setpoint of DHW storage tank before the sensor B10, all compressors are shut down along with the first started compressor.

### Buffer tank heating

The first compressor in the running order starts and stops normally as presented in section *DHW heating*. After the start of first compressor the controller waits for delay time on line 3533 and after that starts to count degree-minutes set on line 3530 based on the value of cascade’s supply water sensor B10. Sensor B10 setpoint is the same than the setpoint of heating circuit’s buffer tank:

Sensor B10	$\left( \begin{array}{c} \text{sensor B10 setpoint} \\ \text{line 8139} \end{array} \right) = \left( \begin{array}{c} \text{buffer storage tank's setpoint} \\ \text{line 8981} \end{array} \right)$
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The next compressor in running order starts, when the switch-on degree-minutes run out. If the degree-minutes are set to zero, the next compressor circuit starts immediately, when the value of sensor B10 goes below the lower limit of sensor's B10 setpoint. In the switch-off the last started compressor circuit is analogously shut down, when the switch-off degree-minutes run out. If the degree-minutes are set to zero, the last started compressor circuit is shut down immediately, when the value of sensor B10 goes below the lower limit of sensor's B10 setpoint. If the value of sensor B4 exceeds the setpoint of buffer storage tank before the sensor B10, all compressors are shut down along with the first started compressor.

## **5.8 Domestic hot water connection in a cascade**

In a cascade the service buffer tank can be heated with all the heat pumps in the system, or just a portion of them. If you want to use all the pumps, the change valve is connected to the master controller and the pumps (condensers) are piped behind this valve. By doing this, the system functions like an ordinary single-pump system.

### **One heat pump heating DHW only**

The cascade can be piped and programmed so that only one heat pump unit (one condenser) heats the domestic water. This pump's automation directs the flow with a change valve to either DHW heating or the space heating storage tank. The function is enabled by selecting a dedicated circuit for DHW (DHW dedicated) on line 5736 in the desired pump.

The change valve is placed so that it directs the flow to either the service buffer tank or in the shared line that goes to the space heating storage tank. Sensor B10 is placed in the line leading going to the heating circuit's storage tank, i.e. the line where the condensers of both units are connected after change valve Q3.

## 6 Other settings

### 6.1 Smart grid

#### Electric utility prevention E6

Heat pump's compressor and electric heaters can be overdriven to OFF state with relay contact information. Relay contact control is enabled by selecting electric utility prevention as a vacant EX input's function. The contact can be open (NO) or closed (NC). Function E6 can also be used with smart-grid contact information (see below). Forced OFF state will stay active as long as the relay contact is active.

#### Smart-grid relay contact information E61 and E62

Contact information control for smart-grid is enabled by giving vacant EX inputs functions E61 and E62. The contacts can be open (NO) or closed (NC). With these two relay contacts four operating modes in total are possible. These operating modes are presented in the table below.

E61 status	E62 status	Smart-grid mode (line 8458)	Action
1	0	1 Locked (draw locked)	Corresponds to the electric utility prevention function E6 (see above). Compressor and all electric heaters switched off.
0	0	2 Free (draw free)	Normal mode. No limits or forced charging.
0	1	3 Requested setpoint (draw wish)	Corresponds to the low tariff function E5 (forced charging) (section <i>Forced charging of storage tanks</i> ).
1	1	4 Forced (draw forced)	Forced charging on (section <i>Electric immersion heater in the storage tank</i> and section <i>Forced charging of storage tanks</i> ). Corresponds to state 3 (low tariff E5) with the difference that line 4750 is used as the heating circuit storage tank's setpoint, and the electric immersion heater K16 can be selected for parallel use with the compressor on line 4761.

Smart-grid relay contact information

### 6.2 Pump speed control

Speed control options depend on the pump's model and connection.

Adjusting the speed affects the temperature difference over the heat exchanger. Decreasing the pump speed (smaller flow) increases the temperature difference, and increasing the speed (larger flow) reduces it. The temperature difference between the flow and return in the condenser circuit is typically approximately 5...12 °C, and in the brine circuit (evaporator circuit) it is ca. 3...4 °C. If the flow is not sufficient (too large a temperature difference) in the evaporator or condenser circuit, the heat pump's performance may be compromised. The temperature difference is not always

an accurate indicator of a suitable flow because the flow rate causes changes in the collecting and output capacity. For this reason the brine circuit should be usually kept at full capacity if it is possible and justifiable after the coefficient of performance and electricity consumption are considered.

The lowest permitted speed must be set so that the discharge does not turn out too small and the temperature difference does not grow too large. The suitable minimum speed is usually ca. 15...40 %. The value varies on a case-by-case basis, because it is dependent on the heating system. When setting the lowest permitted speed, the minimum value of the pump's control signal should be taken into account. For small speed-controlled pumps, it is usually approximately 7...13 %. If the control signal's level is below the lower limit, the pump usually won't start.

The control signal's level can be maxed at full speed (standard signal) or at its minimum value. This is selected in the settings of the UX control signal output. In the heat production's status information, "100 %" always indicates full speed, and "0 %" indicates that the pump has stopped. Note that in the input/output test, the UX outputs' signal level is always displayed at the actual level, so that 100 % corresponds to the full pump speed with a direct signal (standard signal), and with an inverse signal it indicates a stopped pump. Smaller PWM-controlled pumps in condenser and evaporator circuits usually use the inverse control signal. When it is used, the full rotational speed (100 %) corresponds to the smallest value of the signal, and the lowest speed (0%) corresponds to the largest value of the signal. Usually these pumps have an additional protection mechanism for cable break-ups, based on the inverse signal. The mechanism sets the pump on full speed if the control signal is completely cut off. DHW and solar circuit pumps usually utilize the direct signal, allowing the pump to adjust to minimum speed if the control signal is cut off.

## Important setpoints and statuses

Menu	Line	Setting
Heat pump	2790	Type of condenser circuit pump control (Charging pump modulation)
Heat pump	2792	Condenser circuit pump min. speed (Charging pump min. speed)
Heat pump	2793	Condenser circuit pump max. speed (Pump speed max)
Heat pump	2804	Maximum permitted temperature differential for condenser (DT)
Heat pump	2805	Req temp diff condenser
Heat pump	3009	Type of brine circuit pump control (Modulation source pump)
Heat pump	3010	Brine circuit pump max. speed (Maximum speed of source pump)
Heat pump	3011	Brine circuit pump min. speed (Minimum speed of source pump)
Heat pump	2823	Req temp diff evaporator (Evaporator difference setting)
Diagnostics heat generation	8425	Temperature differential, condenser
Diagnostics heat generation	8426	Temperature differential, evaporator
Heat generation status information	8405	Brine pump speed in rpm (100 % is always the maximum pump speed)
Heat generation status information	8407	Condenser pump's speed (100 % is always the maximum pump speed)
Input/output test	7711	Voltage
Input/output test	7712	PWM signal UX1
Input/output test	7717	Voltage UX2
Input/output test	7719	PWM signal UX2

*Key setpoints in pump speed control*

## Condenser circuit pump speed control

The speed of the condenser circuit's pump can be controlled via automation if the pump is equipped with speed control that is connected to the automation. The pump speed control settings are accessed from the heat pump menu in the parameter list. The speed control method for a condenser pump is selected on line 2790 for space heating, and for DHW charging, the ACS computer program is used.

It is possible to select the minimum (line 2792) and maximum pump speed (line 2793). The maximum pump speed set on line 2793 cannot be lower than the minimum pump speed set on line 2792. The upper limit for the condenser pump's speed (line 2793) is also in effect during DHW charging. Because of this, DHW charging must be taken into account when setting the upper limit. The upper limit should not be set too low. It should be kept at 100%, so the automation may use the condenser pump's maximum speed during DHW charging if needed. The speed can be adjusted for space heating after this by choosing the appropriate control method on line 2790, which is either temperature difference or the heat pump's setpoint.

### Condenser circuit's control methods in space heating

The maximum permissible temperature difference (minimum flow) is set on line 2804. If the differential is exceeded, automation will not reduce the condenser pump's speed. Line 2804 requires a setpoint so that the control methods based on the setpoint and temperature difference can be accessed. A suitable setpoint for line 2804 is 10...15 °C.

No influence: The condenser pump's speed is the maximum speed defined on line 2793. An exception to this is the frost protection mode, in which the pump speed is the minimum speed defined on line 2792. This operation mode is the factory-set default. The factory setting for the maximum speed is full speed, or 100%. Line 2804 does not require a setpoint.

Heat pump setpoint: The temperature of the flow from the condenser is kept at the setpoint (at sensor B21) by adjusting the pump speed. The automation adjusts the pump speed between the maximum and minimum speed (lines 2792 and 2793). The setpoint for sensor B21 is either the flow or return setpoint, depending on the value on line 5810. The maximum temperature difference set on line 2804 is taken into account in controlling.

Condenser's temperature differential: The temperature difference over the condenser is kept at the setpoint (measured with sensors B21 and B71) by adjusting the pump speed. The temperature difference is set on line 2805. The automation adjusts the pump speed between the maximum and minimum speed (lines 2792 and 2793). The maximum temperature difference set on line 2804 is taken into account in controlling.



#### Line 5805's effect on the condenser pump automatic modulation

If the value on line 5805 is upstream/before, automatic modulation is in effect when electric immersion heaters are on. If the value on line 5805 is downstream/after, the condenser pump operates at full speed when electric immersion heaters are on. Line 5805 does not affect the operating speed if the setting on line 2790 is None and the operating speed is set manually on line 2793.

#### Adjusting the condenser circuit in DHW heating

The control method for DHW heating is set in the ACS program, in the condenser menu, on line "Mod". Cond.pump. DHW. The control method options are similar to space heating (see the previous sub-section). It is usually recommended to select the condenser's temperature difference option. This is selected in the program, on line "Req. T Cond. DHW". A suitable setpoint is usually 6...8 °C.

If the line value is set to None, the heating control method selected on line 2790 has no effect on the condenser pump's speed during DHW charging. The pump will operate at the maximum permissible speed set on line 2793 (100 %). If the value is set to --- instead, the control method (line 2790) is available during DHW charging. This temperature difference connected to space heating should not generally be used, because DHW charging can be set up with its own temperature difference, as described previously.

The E-series controller uses the same limits for both DHW and space heating (lines 2792 and 2793). In series F controllers, independent upper and lower limits for DHW can be set on lines 2776 and 2777.

## Brine circuit pump speed control

The speed of the brine (evaporator) circuit's pump can be controlled via automation if the pump is equipped with speed control that is connected to the automation. The pump speed control settings are accessed from the heat pump menu in the parameter list. It is possible to select from two distinct control methods (line 3009) for the speed adjustment connected to the automation, along with the minimum (line 3011) and maximum pump speed (line 3010). The higher the percentages set on these lines, the higher the pump speed. The maximum pump speed set on line 3010 cannot be lower than the minimum pump speed set on line 3011.

### Methods for controlling the speed of brine circuit's pump

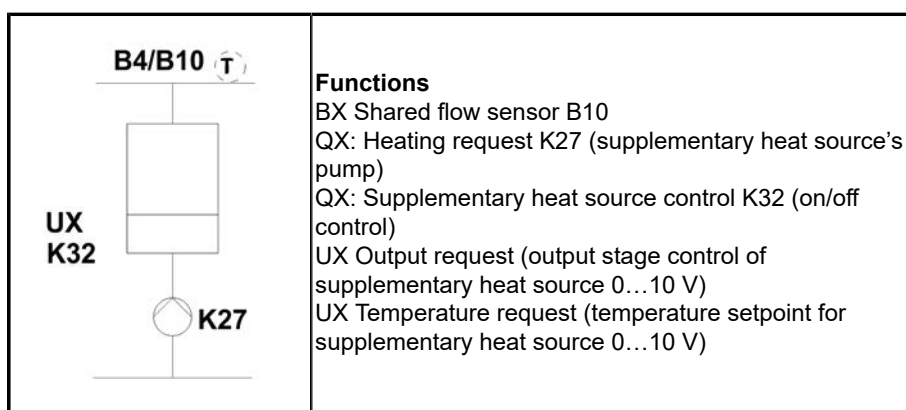
The control method of brine circuit's (evaporator circuit) pump's speed is selected on line 3009.

**No influence:** The evaporator pump's speed is the maximum permissible speed defined on line 3010. This operation mode is the factory-set default. The factory setting for the maximum speed is full speed, or 100%.

**Evaporator's temperature difference:** The temperature difference over the evaporator is kept at the setpoint (measured with sensors B91 and B92) by adjusting the pump speed. The temperature difference is set on line 2823 (the line's factory setting is 3 °C). The automation adjusts the pump speed between the maximum and minimum speed (lines 3011 and 3010).

## 6.3 Supplementary heat source

The heat pump's automation can be used to give an I/O instruction and a control signal to an external, heating circuit's supplementary heat source. Such source can be, for instance, an electric immersion heater connected to the storage tank, an electric or oil boiler, or another heat pump.



The supplementary heat source is commissioned by selecting the temperature sensor B10, saving the sensors from line 6200 and activating at least function K27. Function K27 must be selected for use even if the connection is made to function K32 or UX).

### Controlling sensor

The controlling sensor is selected on line 3725. Shared flow sensor B10 or storage tank sensor B4 can be used as the controlling sensor. Usually it is a good idea to use sensor B10. In this way, both sensors have their own distinctive, separate functions. The sensor's installation location in the heating system is selected based on the location of the supplementary heat source. If the supplementary heat source is in the heating circuit's buffer storage tank (electric immersion heater in the storage tank), the sensor is placed in the buffer tank's sensor pocket (usually located in the top half), or in the storage tank's immediate vicinity in the pipeline between the tank and the heating circuit. If an electric or oil boiler is used as a supplementary heat source after the storage tank, the sensor is placed in the pipe between the boiler and the heating circuit, before the circuit's three-way valve.

#### Heating request K27

A pump of the supplementary heat source can be connected to the function K27. The function can also be used to control the supplementary heat source, if the overrun time (line 3705) is to be noticed in the switch-off after the degree minutes (line 3720) have been completed.

Function K27 is switched on when the temperature measured by the supplementary heat source's control sensor (B10) drops below the supplementary heat source's setpoint (line 8586) for long enough to complete the additional heat source's degree minutes (line 3720). The function is switched off if the temperature measured by the control sensor exceeds the supplementary heat source's setpoint, the degree minutes of the excess (line 3720) are completed, and the temperature remains above the setpoint for the duration of the overrun (line 3705). With the overrun, the additional source's pump can be kept operational for a set time even if a control signal (K32 or UX) shuts down the additional source before it.

#### Heating request K32 (control)

Control for the supplementary heat source can be connected to function K32. Function K32 is switched on when the temperature measured by the supplementary heat source's control sensor (B10) drops below the supplementary heat source's setpoint (line 8586) for long enough to complete the supplementary heat source's degree minutes (line 3720). The function is switched off if the temperature measured by the control sensor exceeds the supplementary heat source's setpoint, and the degree minutes of the excess (line 3720) are completed. K32 is identical to K27 with the exception that the switch-off does not take the overrun into account after the degree minutes (line 3705).

#### Output request UX (control with a 0...10 V signal)

By using an output request, the supplementary heat source can be controlled with a 0...10 V signal. The automation increases the control voltage gradually if the reading on the supplementary heat source's control sensor (B10) drops below the setpoint. Correspondingly, the control signal is reduced if the reading exceeds the setpoint. This function should be used for controlling the supplementary heat source via a control signal.

The upper limit of the control signal's voltage can be reduced in the UX output settings. This makes it possible to, for instance, limit the supplementary heat source's output by limiting the control signal. For example, if the supplementary heat source is a 7-stage electric boiler with a 0...10 V signal, one stage equals a 1,4 V increase in the

control signal. If the upper limit of the control signal is set to for example 6 V, the signal employs only the first five stages, because switching the sixth stage would require a control signal that is over 6 V.

#### Heating request UX (control with a 0...10 V signal)

The supplementary heat source's automation can be given a temperature setpoint by using a heating request. A control signal of 0 V always corresponds to a temperature of 0 °C, and a signal of 10 V corresponds to 100 °C by default. The corresponding temperature of the upper signal limit 10 V can be adjusted in the UX output settings.

### **Important setpoints and statuses**

Setpoints of a supplementary heat source are found in the menu "supplementary source". The menu is visible only after the commissioning of supplementary heat source functions. When a supplementary source is used, the supplementary buffer's switch-on threshold on line 4722 must be at least 0 °C (for example +0...3 °C). This prevents the supplementary storage tank from cooling below the setpoint before the compressor starts.

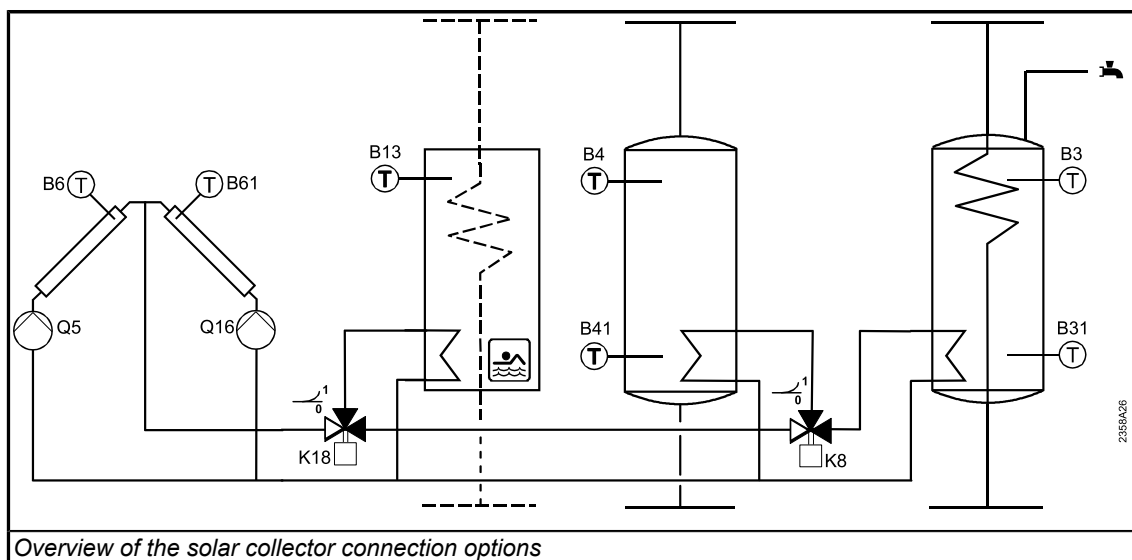
After the start of first compressor the controller waits for delay time on line 3533 and after that starts to count degree-minutes set on line 3530 based on the value of cascade's supply water sensor B10. Sensor B10 setpoint is the same than the setpoint of heating circuit's buffer tank

Sensor B10	$\left( \begin{array}{c} \text{sensor B10 setpoint} \\ \text{line 8139} \end{array} \right) = \left( \begin{array}{c} \text{buffer storage tank's setpoint} \\ \text{line 8981} \end{array} \right)$
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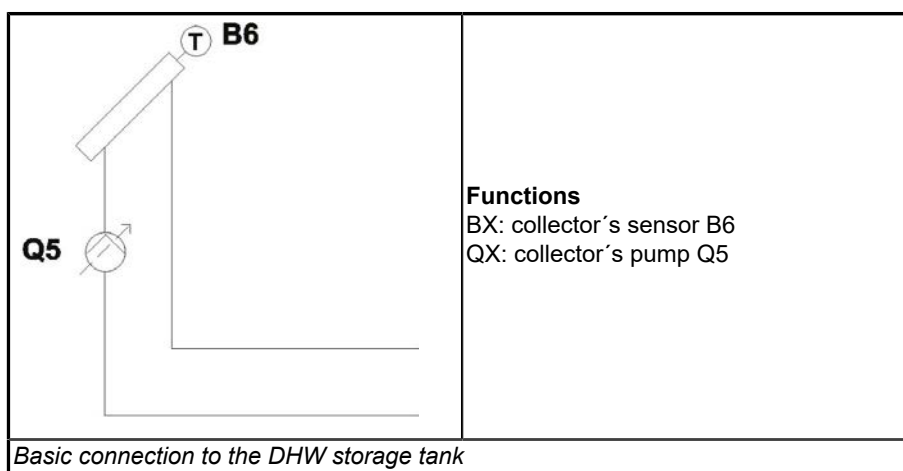
The next compressor in running order starts, when the switch-on degree-minutes run out. If the degree-minutes are set to zero, the next compressor circuit starts immediately, when the value of sensor B10 goes below the lower limit of sensor's B10 setpoint. In the switch-off the last started compressor circuit is analogously shut down, when the switch-off degree-minutes run out. If the degree-minutes are set to zero, the last started compressor circuit is shut down immediately, when the value of sensor B10 goes below the lower limit of sensor's B10 setpoint. If the value of sensor B4 exceeds the setpoint of buffer storage tank before the sensor B10, all compressors are shut down along with the first started compressor.

## **6.4 Solar collector**

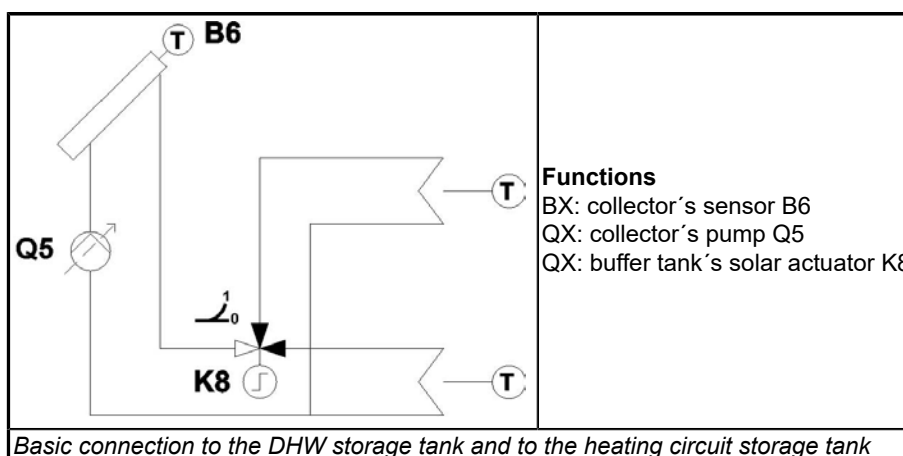
Automation supports several different solar collector connections. This manual presents the functions of the two most typical basic connections. All connections are presented in the technical manuals for the automation system.



Solar collector's functional block is taken into use by configuring at least the collector pump Q5 into use as well as configuring and connecting the collector's temperature sensor B6. In addition, collector connection has to be selected for use from the menu of DHW storage tank and/or heating circuit buffer tank. Operating speed of pump Q5 can be controlled through UX/ZX-output. In addition, the sensor B63 can be installed to the supply pipe and the sensor B64 to the return pipe to measure supply and return temperatures.



In addition, switch-on to the DHW storage tank is selected on line 5093.



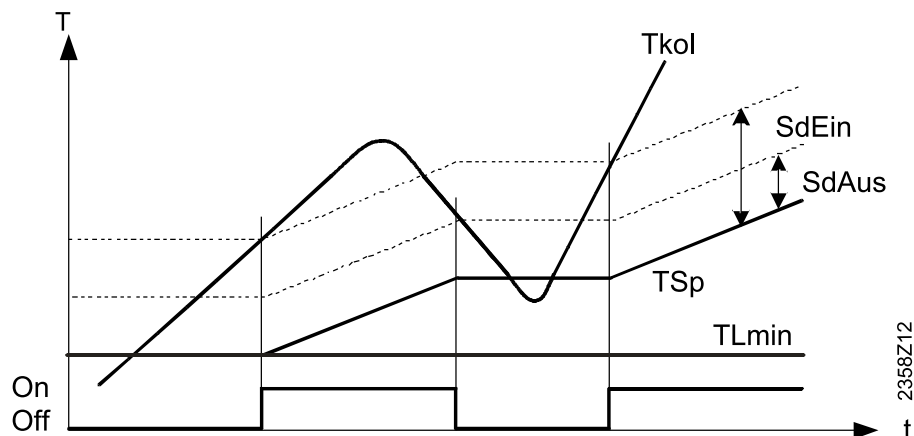
In addition, switch-on to the storage tank is selected on lines 4783 and 5093. Change valve K8 must be configured to use even if it was not installed. This connection is used in addition to the two separate storage tanks also in the combined DHW and heating circuit storage tank.

### Important setpoints and statuses

Menu	Line	Setting	Action
Buffer storage tank	4783	With solar integration	Selected, if the solar collector is connected to the buffer storage tank.
DHW storage tank	5093	With solar integration	Selected, if the solar collector is connected to the DHW storage tank. Additionally, function K8 is enabled for the QX output.
Status	8007	State solar	Status info solar
Solar	3810	Temperature differential on	The collector's temperature must exceed the DHW storage tank's temperature by this amount before starting the collector's pump. The collector temperature must also exceed the value on line 3812.
Solar	3811	Temperature differential off	If the collector's pump is on and the collector's temperature exceeds the DHW storage tank's temperature by this amount only, the collector's pump is stopped.
Solar	3812	Minimum charging temperature, DHW	Collector's temperature (sensor B6) must be above this to be able to heat the DHW.
Solar	3813	Temperature differential on, buffer storage tank	The collector's temperature must exceed the heating circuit storage tank's temperature by this amount before starting the collector's pump. The collector temperature must also exceed the value on line 3815. If "not in use" is selected, the controller will use the value on line 3810.
Solar	3814	Temperature differential off, buffer storage tank	If the collector's pump is on and the collector's temperature exceeds the heating circuit's buffer storage tank's temperature by this amount only, the collector's pump is stopped. If "not in use" is selected, the controller will use the value on line 3811.
Solar	3815	Minimum charging temperature, DHW	Collector's temperature (sensor B6) must be above this to be able to heat the heating circuit's buffer storage tank.
Solar	3822	Charging priority of storage tank	Primarily heated storage tank After the primarily heated storage tank, the DHW or buffer storage tank is heated. Lastly, the swimming pool will be heated. If "None" is selected, the controller will heat the DHW or buffer storage tank in increments of 5 °C until the setpoint is reached. After this, the swimming pool will be heated.

Menu	Line	Setting	Action
Solar	3830	Collector start function	The collector's pump will be rotated for a time specified on line 3831 with intervals defined here, even if charging is not in progress. In this way, the collector's temperature will be measured more reliably (depending on the sensor's position).
Solar	3831	Minimum running time of collector pump	The running time of the collector, affected by the interval function on line 3830.
Solar	3832	Collector start function on	Start time of the interval function on line 3830.
Solar	3833	Collector start function off	End time of the interval function on line 3830.
Solar	3834	Collector start function gradient	If the ascending speed of the collector's temperature exceeds this value (minutes per degree), the collector pump is started.
Solar	3835	Min collector temp start fct	The collector pump is started only if the collector' temperature exceeds this level.
Solar	3840	Collector frost protection	Frost prevention of the collector. If the collector's temperature drops below this level, the collector pump is started, and heat is transferred from the storage tank to the collector. The pump is shut down when the collector's temperature exceeds its setpoint by 1 °C.
Solar	3850	Condenser overtemp protection	If the collector's temperature exceeds this level, the collector pump is kept on (storage tank charging will continue) until the storage tank's temperature reaches the safety limit.
DHW storage tank	5050	Charging temp. max.	If the temperature on line 3850 is exceeded, the DHW storage tank is heated using the collector (the collector's pump is kept on) until the desired temperature is reached.
DHW storage tank	5051	Storage tank temp. max.	If the DHW temperature exceeds this level, the collector's pump is stopped, overriding the function on line 3850. The pump is restarted when the storage tank's temperature drops 1 °C below the maximum temperature.
Buffer storage tank	4750	Charging temp. max. in solar heating	For the heating circuit's buffer storage tank. Equivalent to the DHW buffer storage tank's function on line 5050.
Buffer storage tank	4751	Storage tank temperature max.	For the heating circuit's buffer storage tank. Equivalent to the DHW buffer storage tank's function on line 5051.
Diagnostics heat generation (solar)	8499	Collector pump 1	Status info for solar collector pump Q5 (on/off)
Diagnostics heat generation (solar)	8510	Collector temperature 1	Solar collector sensor B6 temperature

## Solar heating control



Functions of solar collector control

Legend	Description	Menu	Line
Tkol	Collector's temperature (sensor B6)	Heat generation status information	8510
SdEin	Temperature difference On	Solar	3810
SdAus	Temperature difference Off	Solar	3811
TSp	Storage tank's or swimming pool's temperature	Heat consumers status information	DHW storage tank: 8830 Buffer storage tank: 8980 Swimming pool:
TLmin	The lower limit of collector's temperature (sensor Q6) before starting the collector's pump (pump Q6)	Solar	DHW storage tank: 3812 Buffer storage tank: 3815 Swimming pool: 3818

## 6.5 Cooling

Line	Setting	Action
730	Summer/winter heating limit	Heating is switched off in this temperature (to summer usage).
901	Operating mode	Cooling is switched on in the Automatic mode if the room temperature setpoint on line 902 is exceeded and the time program on line 907 allows it.
902	Comfort setpoint max	Cooling is switched on when the room temperature exceeds this value. Lines 918-920 also affect the connection temperature. This requires that room temperature measuring and room influence are commissioned (line 928).
907	Release	Time program for cooling.
908	Supply water sp/OT 25 °C	Supply water temperature 25/35 degrees is entered on lines 908 and 909. The supply water temperature is determined by a line that runs via these points and the outside temperature.
909	Supply water sp/OT 35 °C	see 908
912	Cooling limit in OT:	Cooling is in use only if the outside temperature exceeds this value.
913	Locking time after heating	Cooling can be switched off after this time has elapsed since heating use.

Line	Setting	Action
918	Summer comp. start OT	The setpoint for room temperature in cooling use can be raised for hot outside temperatures by accessing lines 918, 919 and 920. The largest value for the increase is entered on line 920. This value is in use when the outside temperature exceeds the value on line 919. The setpoint increase is enabled when the outside temperature exceeds the value on line 918. The increase between the outside temperatures determined on lines 918 and 919 goes from zero to the value determined on line 920 in direct proportion. The purpose of the increase can be comfort-related, saving energy or avoiding condensation.
919	Summer comp. end OT	see 918
920	Summer comp sp increase	see 918
923	Supply w. min. sp/OT 25 °C	This line is used to determine the minimum value for the supply water setpoint on line 908.
924	Supply w. min. sp/OT 35 °C	This line is used to determine the minimum value for the supply water setpoint on line 909.
928	Room influence	When "----" is selected, supply water's temperature depends on the selected cooling curve and outside temperature. If the value is set to 100 %, the temperature is based on the difference between the room sensor and room temperature's setpoint. With values 1-99 composite outside temperature control (graph) and room sensor control is used; the room sensor corrects the temperature given by the graph up or downward.
932	Room temperature limitation	Cooling circuit's pump is stopped, if the room temperature drops below the setpoint for room temperature in cooling use (line 902, taking lines 918-920 into account) by this amount. The pump starts once the room temperature is above the setpoint. This setting is only used when the room sensor and room influence (line 928) are used.
937	Plant fr.pr., CC pump	If "yes" is selected, the cooling circuit pump is switched on when the plant's frost protection (line 6120) is active.
938	Mixing valve subcooling	This temperature difference is reduced from the temperature that cooling requests from the control valve's heat pump or storage tank. This can be used, for example, to take the heating of cooling water prior to the control valve into account.
939	Actuator type	Cooling control valve type.
940	Switching differential two-position	If the control valve for cooling is a two-way valve, this is used to set the valve's switching differential. If the flow temperature exceeds the setpoint by the temperature differential entered here, the valve opens. Conversely, the valve is closed if the temperature is below the setpoint by the amount entered as the differential.
941	Actuator running time	The running time of the three-way valve motor between the extreme positions.
942	Mixing valve P-zone Xp	The proportional band of the PI controller controlling the three-way valve. The proportional band indicates how much the quantity to be adjusted must change for the actuator to move from one extreme position to the other. Thus, the proportional band is the change in flow temperature (in degrees Celsius) in the heating circuit that causes the regulator to move from one extreme position of the valve motor to the other. Increasing the value usually results in steadier adjustment, slower adjustment, and greater deviation from the setpoint after the adjustment. Decreasing the value usually results in less steady adjustment, faster adjustment, and a smaller deviation from the setpoint after the adjustment. The deviation after the adjustment is corrected with the I-action of the PID controller.

Line	Setting	Action
943	Mixing valve res.time Tn	The integral action time (restore time) of the PI controller in the three-way valve. The integral action time refers to the time over which the actuator moves the distance determined by the proportional band. The integral action time is the time in which the I-action achieves the same change in the control quantity as the P-action (in a gradual change in the quantity of difference). The greater the integral action time, the smaller the effect of the I-action. An integral action time that is too short may result in unstable control.
945	Mixing valve heat. on	Selects the mixing valve's position in heating use. This setting is only used when the heating and cooling circulation both run through the same pipes. If "open" is selected, the mixing valve is always fully open in heating use, and only regulates during cooling use. If "regulation" is selected, the valve regulates the flow temperature in heating and cooling use.
946	Dew point sensor stop time	A dew point sensor can be connected to the controller's Hx input. The sensor's contact can either opening or closing. The sensor is switched on and the direction of the contact is selected in the Hx input lines of the configuration menu. Cooling stops when the sensor gives a stop signal. It is started again when the time determined here has elapsed since the end of the stop signal.
947	Flow sp. cor. hygros	A humidity controller (hygrostat) can be connected to the controller's Hx input. It is selected for use in the configuration menu's Hx input lines. When the hygrostat gives a signal, the flow setpoint is increased by the amount determined here. This setpoint is also used when relative humidity measurement is enabled (see line 948).
948	Flow sp. boost start r.h.	Relative humidity measurement can be connected to the controller's Hx inputs (DC 0...10 V) The measurement settings are selected in the Hx input lines of the configuration menu. When the relative humidity exceeds the value defined here, the controller will start to increase the flow setpoint. The larger the relative humidity, the larger the setpoint will be. The largest value for the increase is entered on line 947.
950	Flow temp. diff. dew point	The controller can calculate the dew point based on the relative humidity measurement (0...10 V) and room temperature measurement. This line determines how many degrees above the dew point the flow water temperature is kept. Relative humidity measurement is connected to an Hx input. The room temperature can be measured with a room unit inside the room (for example, temperature measurement in a remote control) or with a 0...10 V temperature measurement connected to an Hx input.
953	Relative room humidity	This line is for selecting the relative humidity measurement input that the dew point supervision uses.
954	Room temperature measuring	This line is for selecting the temperature measurement input that controls the cooling. If no input is selected, temperature is measured with the room unit (remote control for example) connected to the heating/cooling circuit in question. Thus, in cooling use, the room unit's temperature will control both the room temperature and dew point supervision. If an input is selected here, and a room unit measuring the temperature is being used simultaneously, dew point supervision is done with a temperature sensor connected to an Hx input and room temperature is regulated with the room unit's temperature sensor. If only a temperature sensor in an Hx input is used, that sensor is used for both supervising the dew point and controlling the room temperature.
962	With buffer	The line is used to select whether a cooling circuit is connected to a buffer storage tank. The tank must be the same one that is used for heating. If "yes" is selected, the cooling circuit must be connected to draw the water from the buffer storage tank.

Line	Setting	Action
963	Primary controller/ syst. pump	The line used to select whether a cooling circuit is connected to a main line controlled by the primary controller or, instead, whether there is an additional pump in the cooling circuit (Q14). Instructions on using this function are also provided on line 872 and in the primary controller's settings, starting on line 2110.
969	Optg mode changeover	Selects which operating mode cooling switches to after the Hx input receives a signal.
3000	Cool. max. s.o. temp.	If the return sensor (B71) observes a temperature that exceeds this value, the compressor is shut down.
3002	Cooling min. source temp.	If the ground circuit's return sensor (B92) observes a temperature that is below this value, cooling is switched off.
3004	Pass/act cool switch c. diff.	If the ground circuit's return sensor's (B92) temperature is this much colder than the cooling circuit flow (storage connection) or return (direct connection) water, passive cooling is switched on.
3007	Pass. cool. during operation	Whether the condenser pump is on during passive cooling.
3008	Cond. pump cool. temp. difference	Temperature difference between flow and return in active cooling. If this is set to zero, the flow setpoint (graph) and compressor control are based on the return temperature. If a value that is larger than zero is entered, the cooling water setpoint (graph) is based on the flow temperature, and compressor control is based on the return temperature. The return setpoint controlling the compressor is equal to flow temperature + this value.
4723	Switching differential	Buffer storage tank's temperature (B4) may rise (+) or fall (-) by this amount compared the cooling circuit setpoint (cooling graph) before the storage tank's cooling starts.
4721	Running temperature	The storage tank is cooled by this amount from the temperature level determined on line 4723.
5807	Cooling	Off, passive, active, or passive and active
5808	Cooling system	Cooling distribution pipework to the cooling circuits. In a two-pipe connection cooling and heating water share the same piping to the circuits. In a four-pipe connection they have independent pipes.

## 6.6 Heat pump's protection functions

### Switch-off temperature

Set the upper limit of the heating circuit's flow (section *Heating curve settings*) slightly below the switch-off temperature. This prevents the heating curve from requesting water that is hotter than the switch-off temperature.

#### Series E controller

The upper temperature limit for the flow leaving the heat pump's condenser is set on line 2844. This limit is called the switch-off temperature. Its purpose is to protect the heat pump from temperatures that are too high. If the flow temperature (sensor B21) exceeds the setpoint on line 2844, the compressor is switched off. It is kept switched off until the temperature in the condenser's flow and return sensors (B71 and B21) has fallen below the switch-off temperature by the amount of the switching differential, and the compressor's off time has elapsed (line 2842). The value on line 2840 is used as the switching differential. The minimum value for the differential is 7 °C. If the value on

line 2840 is less than that, the minimum value is used. The switch-off temperature must be set slightly lower than the temperature that triggers the heat pump's high pressure switch.

If DHW heating with the compressor stops at the switch-off temperature, charging is attempted again with the compressor after the off time selected on line 2835 or 2843 is completed, and until the number of charging attempts indicated on line 2893 is reached. The longer off time of these two is used. After this, the DHW is charged to its setpoint with the electric immersion heaters (K25/K26 or K6). The delay time or degree-minutes is not taken into account in connection of the immersion heaters.

#### Series F controller

The flow from the heat pump's condenser can have two upper limits. They are set on lines 2844 and 2855. The switch-off temperature on line 2844 that was presented above is for protecting the heat pump from temperatures that are too high. It is in effect during DHW heating and for the duration of the switching time set on line 2839 (sub-section *Heating curve* in section *Settings for heating circuits*) after DHW has been heated. The purpose of the switch-off temperature on line 2855 is to protect the heating circuit from temperatures that are too high. It is in effect only during space heating, otherwise 2844 is used. If line 2855 is not enabled, line 2844 is in use also during space heating.

When the system switches from DHW heating to space heating (the change valve turns from the DHW position to the space heating position), the switch-off temperature on line 2855 is enabled only after the switching time on line 2839. The higher switch-off temperature on line 2844 is in effect during the switching time. The switching time on line 2839 must be disabled if the heating circuit has to be protected from excessive temperature right after the DHW has been charged.

#### Observing the switch-off temperature with the electric immersion heater on

If the electric immersion heater is chosen to locate after the sensor B21 (after/downstream) on line 5805, the automation switches the compressor off at the switch-off temperature (measured by sensor B21) also then, when the immersion heater is in use. If the electric immersion heater is chosen to locate before the sensor B21 (before/upstream) on line 5805, the automation does not switch the compressor off at the switch-off temperature (measured by sensor B21), if the immersion heater is on. With the latter setting the heat pump can produce water that is hotter than the compressor's output temperature, when both the compressor and immersion heater are in use. This setting line is not in use, if the supply water sensor B21 is not installed to the heat pump.

### **Temperature limits of brine circuit**

#### Lower temperature limit of brine circuit

The minimum permissible temperature of brine circuit is set on line 2816. If the brine circuit's temperature drops below this temperature (the sensor is selected on line 5804), circuit's pump and compressor are switched off for the time set on line 2822. This way, the brine circuit is allowed to recover and to warm up. Brine circuit's pump and compressor are restarted after this. If the brine circuit's temperature is still below the permissible minimum limit, the heat pump enters a fault state (section *Fault situations*).

The min. permissible temperature of brine circuit must be set slightly higher than the temperature, that triggers the heat pump's low pressure switch. Also the freezing temperature of the brine is to be noticed in the temperature limit. Typically, the temperature limit is ca.  $-5^{\circ}\text{C}$ .

In starting phase, the brine circuit's temperature must rise to the increase, set on line 2817 and higher than the lower limit, set on line 2816 within the waiting time, set on line 2821. Time is calculated from the fluid pump start. If this condition is not actualized, the heat pump is switched off and the fault must be reset manually. At the same time, emergency-operation mode is automatically activated if the value selected on line 7142 is automatic. If, e.g., the value on line 2816 is  $-6^{\circ}\text{C}$ , and the value on line 2817 is  $3^{\circ}\text{C}$ , and the value on line 2821 is ten minutes, the brine circuit temperature (sensor selected on line 5804) must even momentarily increase above the temperature of  $-4^{\circ}\text{C}$  within ten minutes from the startup of the brine circuit's pump.

#### Upper temperature limit of brine circuit

If the brine inlet temperature (sensor B91) exceeds the value on line 2814, the compressor is not switched on but the fluid pump runs for the time set on line 2821 (from fluid pump startup). If the brine temperature during this time drops to one degree below this limit, the compressor is started. If the brine temperature does not fall below this limit (by at least one degree lower) during the time set on line 2821, the controller waits for a new starting attempt for the duration of the compressor's off time (line 2843). If the brine inlet temperature is not in use, the brine outlet temperature is used here (sensor B92). This function can be switched off altogether, if the value on line 2814 is set to —.

### **Running and OFF times**

#### Compressor's shortest runtime

The compressor's minimum running time is set on line 2842. The compressor will be on for the duration of this time even if the temperature setpoint was reached. This ensures among other things the circulation of the compressor's lubricating oil in the system. Do not shorten the running time's factory setting.

#### Compressor's minimum OFF time

The compressor's minimum off time is set on lines 2843 and 2835. Off time is enabled when the compressor stops to the setpoint or due to some protective function.

The off time on line 2843 is in use when the heat pump's setpoint is reached, but the pump's state does not change from space heating to DHW heating, or vice versa. This may occur for example when the heating circuit's setpoint is reached and the compressor is stopped. In this type of situation the compressor will be off for the time set on line 2843, even if the heating circuit has gone below its setpoint during the off time. Do not shorten the off time's factory setting.

The off time on line 2835 is in effect when the heat pump's state changes from space heating to DHW heating, or vice versa. This may occur when the DHW setpoint has been reached but space heating does not yet request heat (i.e. the heating circuit's temperature is in its setpoint). In this type of situation the compressor will be off for the time set on line 2835, even if the heating circuit has gone below its setpoint during the off time. Do not shorten the off time's factory setting.

Off times are disabled when the heat pump goes directly from space heating to DHW heating (or vice versa) without shutting the compressor down. This occurs when the heating circuit's setpoint has not been reached (the compressor has not been shut down) before the DHW's heating request, or when the DHW setpoint is reached as the heating circuit requests heat. In both cases the compressor stays on without off time after the change valve has turned.

#### Minimum OFF time for pumps

The minimum off time for pumps is set on line 6123. Off time's purpose is to prevent the pump's regulating electronics from breaking due to too frequent starts. A suitable off time for pumps is typically approximately 120 seconds. The compressor and electric immersion heater will not start before the pumps' off time has concluded. If the off times on lines 2843 and 2835 are in use, the pump off time is not entirely necessary, because these two other off times prevent the pumps from starting too frequently.

#### **The upper temperature limit for hot gas**

The upper temperature limit for the hot gas is set on line 2846. The compressor is switched off if this hot gas temperature is exceeded (sensor B81). The hot gas temperature must fall at least this far below the limit set on line 2846 before the compressor is permitted to run. Temperature factory setting is typically ca. 120 °C. The temperature limit can not be raised.

#### High and low pressure switches

High and low pressure switches are installed to the heat pump refrigerant circuit. Cut-off pressures for switches are shown in the equipment technical data. The switch-off temperature of heat pump's condenser circuit (line 2844) and the lower limit of brine circuit temperature (line 2816) are set so, that the switches do not trigger under ordinary operating circumstances. However, the rapid rise or fall in temperature may trigger the pressure switch. The pressure switch automatically returns to normal mode, when the pressure reaches the switch-back pressure.

## **6.7 Valve-controlled heating circuit selection**

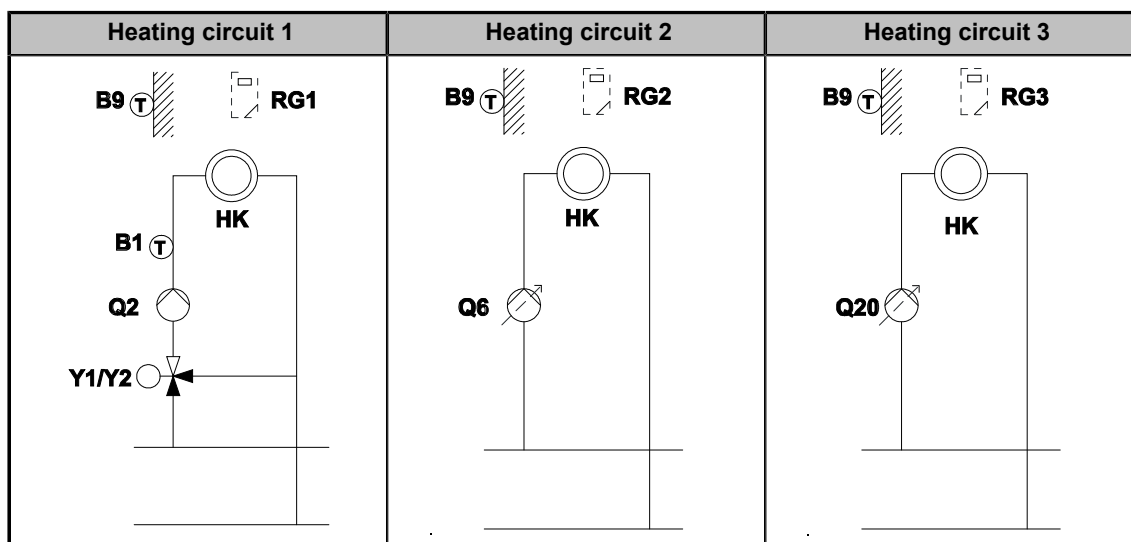
Only change these settings if the heating circuits' connections differ from the device's factory settings. Factory settings are presented in the electrical diagrams of each model and their respective installation chapters. Outputs, marked blank, have no function. A function to those can be freely chosen. The function can be changed, if needed.

The heat pump automation comprises a user interface, master controller and parallel auxiliary controllers. The automation can be used to control one service buffer tank, one heating circuit storage tank and three heating circuits. The automation controller can be used to control one heating circuit regulated by a control valve (mixing valve) and two additional circuits, without a control valve. Two other valve-regulated heating circuits can be enabled by connecting two or more auxiliary controllers in parallel with the master controller. The heating-circuit control valve can be a two- or three-way valve. The connections described in this section of the manual use a three-way valve.

Heating circuit's storage tank can be either controlled or uncontrolled. An uncontrolled tank does not have a temperature measurement function connected to the automation, and the automation does not regulate the tank's temperature. The only function of such

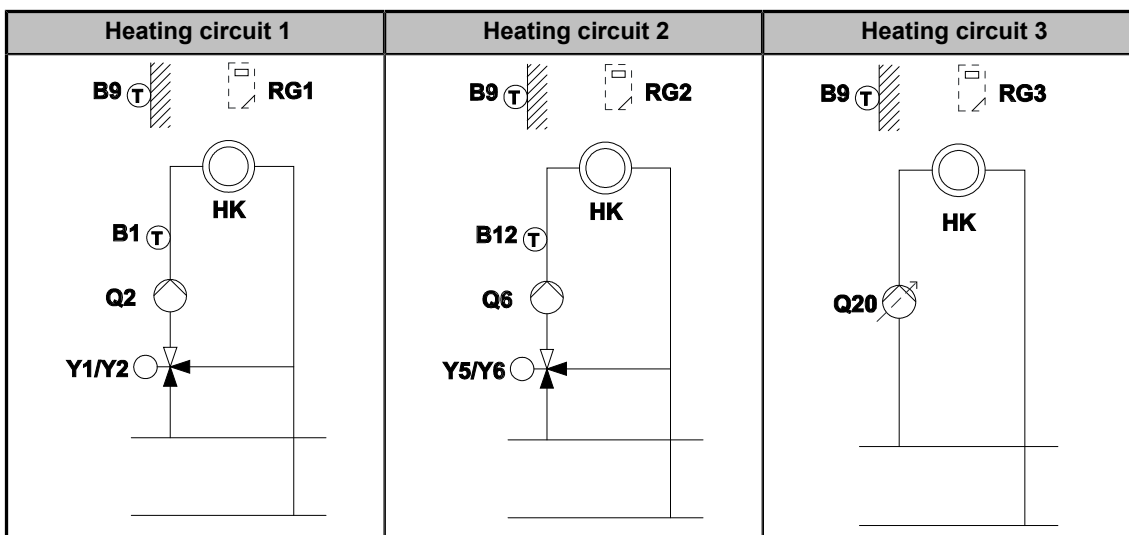
a storage tank is to provide the system more volumetric capacity. In the connected heating circuits the condenser pump pumps the heating water directly to the circuits, which are not equipped with a control valve. The connection principle and control methods are presented in section *Space heating without a buffer storage tank*. A controlled storage tank is equipped with a temperature sensor that is connected to the automation, and the automation regulates the tank's temperature. In this connection the condenser pump circulates the water between the storage tank and the condenser, and the heating circuits' pumps circulate the water between the storage tank and the heating circuits. Heating circuits are almost always equipped with control valves. Connection principle and control are presented in section *Space heating with a regulated storage tank*.

Connecting the circuits to the storage tank is selected in the heating circuit settings. The connection for heating circuit 1 is selected on line 870, for heating circuit 2 on line 1170, and for heating circuit 3 on line 1470. An automation block diagram matching the buffer storage tank connection is enabled when the selected line value is "Yes" and sensor B4 is connected and configured for use.



Connection options with a master controller (no auxiliary controllers)

A circuit regulated with a three-way valve can also act as heating circuit 2, which leaves circuits 1 and 3 without a control valve. All three can also be uncontrolled. Pumps can be left unconnected in uncontrolled circuits if the circuit has its own pump, or if the circuit uses the condenser circuit's pump.



Connection options with a master controller and one auxiliary controller

A circuit regulated with a three-way valve can also act as heating circuit 3, which leaves circuit 1 or 2 uncontrolled and without a control valve. All three can also be uncontrolled. Pumps can be left unconnected in uncontrolled circuits if the circuit has its own pump, or if the circuit uses the condenser circuit's pump.

### Selecting the regulated heating circuit connected to an extension module

The extension modules of the heat pump can be used to control any of the three heating circuits regulated by a mixing valve. The heating circuit for extension module 1 is selected on line 7300. The inputs and outputs of the heating circuit selected on this line are automatically enabled in the extension module; they do not need to be configured separately. The inputs and outputs are shown in the table below.

The extension module inputs and outputs selected on line 7300

Line 7300: Function extension module 1	BX21	QX21	QX22	QX23
None	None	None	None	None
Heating circuit 1	B1	Y1	Y2	Q2
Heating circuit 2	B12	Y5	Y6	Q6
Heating circuit 3	B14	Y11	Y12	Q20

If a temperature sensor is not connected to the extension module's temperature input (BX21), the module automatically assumes that the circuit does not have a temperature sensor and control valve. Therefore, the heating circuit selected on line 7300 may only contain a heating-circuit pump without a control valve and temperature sensor. The uncontrolled circuit's pump can be left unconnected to the heat pump's automation if the circuit has its own pump or it uses the condenser circuit's pump (Q9). However, in these two cases the auxiliary controller's valve control (line 7300 for aux. controller 1) stays reserved for that heating circuit, even if valve control is disabled. If the circuit does not have a mixing valve, it is a good idea to enable the heating circuit on lines 5710, 5715 and 5721, and then configure the circuit pump to a vacant QX output, if necessary. In this way, the auxiliary controller's valve control can be used by some other heating circuit, or for some other control function.

## 6.8 Other setpoints

### Heating circuit 1

Line	Setpoint	Description
716	Comfort setpoint max.	The maximum setpoint for the Comfort temperature.
726	Heating curve adaption	An automatic selection of the heating curve. There must be a temperature sensor in the heated space, and the room influence (line 799) value must be 1–99%.
742	Flow temp setpoint room stat	The line that sets the fixed flow temperature if the thermostat is requesting heating. Using this setting requires a room thermostat.
744	Swi-on ratio room stat	Change of the fixed flow temperature in line with the room thermostat, set on line 742, on the basis of the room temperature and earlier heat need. The available range is 1–99%. If you select “---” here, the fixed value is not changed.
760	Room temperature limitation	If the temperature measured by the room sensor exceeds the room temperature setpoint (line 710) by this much, the heating-circuit pump is switched off and the heating request is not sent. When the room temperature falls below the room temperature setpoint (line 710), heating is switched on.
770	Boost heating	Temporary raising of the Comfort temperature in moving from a reduced room temperature to the Comfort temperature. Thereby, the room warms up more quickly from the reduced temperature to the Comfort temperature.
780	Quick setback	Shutting of the heating-circuit pump and control valve for a while in moving from the Comfort mode temperature to the reduced temperature or frost protection temperature.
790	Optimum start control max.	A setting designed for reaching the Comfort temperature more or less at the time specified by the time program instead of just changing the setpoint from the Reduced mode temperature to the Comfort temperature at the time specified by the time program. The regulator switches on the heating no earlier than the number of hours specified here before the setpoint would switch from the reduced temperature to the Comfort temperature in line with the time program.
791	Optimum stop control max	A setting designed for reaching the reduced temperature more or less at the time specified by the time program instead of just changing the setpoint from the Comfort temperature to the reduced temperature at the time specified by the time program. The regulator switches off the heating no earlier than the number of hours specified here before the setpoint would switch from the Comfort temperature to the reduced temperature in line with the time program.
794	Heat-up gradient	Specification for lines 790 and 791 of how long (in minutes) it takes the heating system to raise the room temperature by one degree.
800	Reduced setp increase start	The reduced setpoint of the room temperature is increased from this temperature in colder temperatures (directly proportionally between lines 800 and 801).
801	Reduced setp increase end	The temperature at which the reduced setpoint of the room temperature has been increased so much that it is equal to the Comfort setpoint of the room temperature. This setting can be used, for example, when the time program is used for moving (e.g., at nighttime) from the room temperature Comfort mode to the reduced mode but in cold temperatures, heating the space from Reduced mode back to Comfort mode would take too long.

Line	Setpoint	Description
810	Frost prot. plant HC pump	A setting that, when on, causes the heating circuits' pumps to switch on when the plant's frost protection in accordance with line 6120 is switched on.
813	Frost protection, room model	If there is no room sensor in use, the automation will calculate an estimate of the room temperature. If the calculated temperature is below the frost protection temperature for flow (line 714), heating switches on until the calculated temperature exceeds the protection temperature by one degree.
820	Overtemp prot pump circuit	Switching off the heating-circuit pump if the flow temperature exceeds the temperature according to the curve.
832	Actuator type	Mixing valve type (three-way or two-way valve).
833	Switching differential two-position	The temperature difference between the two-way valve's on and off modes.
834	Actuator running time	The running time of the three-way valve motor between the extreme positions.
835	Mixing valve Xp	The proportional band of the PI controller controlling the three-way valve. The proportional band indicates how much the quantity to be adjusted must change for the actuator to move from one extreme position to the other. Thus, the proportional band is the change in flow temperature (in degrees Celsius) in the heating circuit that causes the regulator to move from one extreme position of the valve motor to the other. Increasing the value usually results in steadier adjustment, slower adjustment, and greater deviation from the setpoint after the adjustment. Decreasing the value usually results in less steady adjustment, faster adjustment, and a smaller deviation from the setpoint after the adjustment. The deviation after the adjustment is corrected with the I-action of the PID controller.
836	Mixing valve Tn	The integral action time (restore time) of the PI controller in the three-way valve. The integral action time refers to the time over which the actuator moves the distance determined by the proportional band. The integral action time is the time in which the I-action achieves the same change in the control quantity as the P-action (in a gradual change in the quantity of difference). The greater the integral action time, the smaller the effect of the I-action. An integral action time that is too short may result in unstable control.
861	Excess heat draw	If this is on, the heating circuit may request heat through the bus from another controller (from another heat source or storage tank).
870	With buffer	The line used to select whether a heating circuit is connected to a buffer storage tank. If this heating circuit is connected to the storage tank (either directly or through a main line with a primary controller), select Yes. This function requires the use of buffer sensor B4.

Line	Setpoint	Description
872	With prim. contr. / system pump	<p>The line used to select whether a heating circuit is connected to a main line controlled by the primary controller or instead there is an additional pump in the heating circuit (Q14). The primary controller controls the three-way valve of the heat distribution line connected to the buffer storage tank (a main line with a primary controller). If the heating circuit is connected to the heat distribution line with a primary controller and controlled by the heat pump automation (the main line), the setpoint selected here is "Yes."</p> <p>The precontroller is a kind of heat source for the heating circuits installed behind it. The heating circuits (or the mixing valves of the heating circuit) installed behind the primary controller indicate to the primary controller the desired water temperature. This is the setpoint that the primary controller attempts to achieve with sensor B15. The precontroller adds the mixing valve boost (line 2130) to this setpoint when the precontroller conveys the heat need information to its heat source. If more than one heating circuit is connected behind the primary controller (e.g., heating circuits 1 and 2), the heating circuit's highest temperature request determines the primary controller setpoint. For example, with the primary controller, three heating circuits can be installed in the buffer storage tank. In one of them, the temperature level is considerably higher than in the other two. A circuit with a higher temperature level can be connected to the storage tank directly, and the other two circuits can be connected to the main line with a primary controller. The precontroller then adjusts the temperature of the flow from the storage tank to a lower level for the two lower-temperature circuits. These two lower-temperature circuits may still have separate three-way valves, which are used to adjust the temperature precisely for each circuit.</p> <p>The precontroller's own heat source is usually the buffer storage tank connected to the heat pump. This is the case if the value selected on line 2150 is "After buffer." The precontroller adjusts the temperature of the main line from the buffer storage tank. Alternatively, the precontroller's heat source can be another external storage tank. In that case, the value selected on line 2150 is "Before buffer." In this case, the precontroller adjusts the temperature of the buffer storage tank's return.</p> <p>The heat distribution circuit may have a system pump (Q14) as an additional pump. The pump may be in the aforementioned precontrolled circuit (in the main line downstream from the three-way valve) or separate, without a three-way valve, if no precontroller action is needed. The system pump can be used either as a circulating pump for the precontrolled main line (the main line circulating pump) or for additional pump in heat distribution lines with a large pressure loss. Instructions on using this function are also provided in the precontroller settings, starting at line 2110.</p>
882	Pump speed min.	A speed-controlled heating-circuit pump can be connected to inputs Zx and Ux. The minimum speed that the controller can generate for the pump can be set here. For example, if the control message is 0–10 V and the setting here is 40%, the minimum control message is 4 V.
883	Pump speed max	A setting that can be used if a speed-controlled heating-circuit pump is connected to inputs Zx and Ux. The maximum speed that the controller can generate for the pump can be set here. For example, if the control message is 0–10 V and the setting here is 100%, the maximum control message is 10 V.
900	Optg mode changeover	The heating-circuit mode is changed in accordance with this line if this function is selected for the Hx input (H1 or H3) and the input receives a control message.

## Buffer storage tank (heating circuit buffer storage tank)

Line	Setpoint	Description
4708	Forced charging setp. cooling	In the use of cooling, the forced charging of the buffer (buffer storage tank) is stopped when the tank temperature reaches the value defined here.
4723	Temp. difference of buffer tank's cooling circuit	Compressor start temperature in cooling = storage tank temperature setpoint + line 4723 + 1 °C. Compressor shut-off temperature in cooling = storage tank temperature setpoint – line 4723.
4724	Buffer tank's min. temp. in heating	If the storage tank temperature falls below this limit in heating, the heating circuits are switched off (the mixing valve is closed and the circulating pump is switched off).
4726	Buffer tank's max. temp. in cooling	If the storage tank temperature rises above this limit in cooling, the heating circuits are switched off (the mixing valve is closed and the circulating pump is switched off). When the storage tank temperature falls to 1 °C below this limit, the cooling circuits are switched on again.
4728	Rel. temp. difference in storage tank heating	Reading, calculated with this function, is added to the value on line 4722. If the value on this line is 0%, the function of this line is off and nothing is added to line 4722. The higher the risk setpoint and the higher the reading set on this line, the higher the increase. Increase = (storage tank's temperature setpoint – 20 °C) * line 4728 / 100.
4749	Min. charging setpoint, solar	The buffer tank is always heated by means of solar heating to at least this temperature, depending on the storage tank's heating need.
4755	Recooling temperature	If the storage tank is heated above the setpoint on line 4750 to the temperature on line 4751 with a solar collector, the storage tank is cooled as soon as possible to the points specified on lines 4756 and 4757, until the storage tank's temperature has reached the temperature specified on this line. The storage tank can be cooled by means of the DHW storage tank and heating circuits (line 4756) or via the solar heat collectors (line 4757) on cold nights, for example.
4756	Recooling of DHW storage tank/heating circuit	See line 4755.
4757	Recooling of collector	See line 4755.
4760	Charg. sensor el. imm. heater	The electric immersion heater (K16) in buffer tank can be switched on (if it is controlled by heat pump automation) when the buffer tank undergoes forced charging (see line 4705), the heat pump is not on (e.g., in lockout mode), or frost protection for the buffer tank is on. This line is used to select which temperature sensor is used to control the electric immersion heater. This setting has no effect if immersion heater K16 has not been enabled.
4761	Forced charging electric	This line is used for selecting whether the electric immersion heater in the buffer tank is used for heating the storage tank, if no other heat source (heat pump, solar collector, etc.) has been able to start within one minute from the start of forced charging.

## Domestic hot water

Line	Setpoint	Description
1601	Optg mode selection Eco	If this mode is on, the DHW is charged only if the DHW temperature decreases below the reduced setpoint or if the Legionella function is on.
1614	Nominal setpoint max	Maximum DHW charging temperature.
1620	DHW heating release	<p>The method used for changing of the DHW temperature setpoint between normal and reduced mode temperature. If the selected method is 24 h, the normal DHW temperature is used throughout the day. If the selected control method is "Time program 4/DHW," the DHW setpoint can be controlled independently by means of time program 4.</p> <p>If time programs for HCs is selected as the control method, the DHW setpoint adheres to the heating-circuit time program such that the start temperature for the heating-circuit time program is moved one hour earlier (if the value selected on line 5010 is "Several times/day"). Therefore, if the time program for heating circuit 1, for example, switches from Reduced temperature to the normal temperature at 6am, the DHW setpoint changes from the reduced temperature to the normal temperature at 5am (the end time of the time program will not change). The DHW setpoint switches from reduced to normal when the setpoint of heating circuit 1 switches from reduced to comfort during the current 24 hr period and from the corresponding normal setpoint to reduced, once all heating circuits have switched from the comfort mode to the reduced setpoint. If any heating circuit remains in the comfort mode throughout the 24 hr period, the DHW setpoint is not decreased from normal to the reduced setpoint.</p> <p>If "Low-tariff" is selected as the control method, DHW charging starts when the low tariff input (E5) is active.</p>
1630	Charging priority	<p>A setting determining the controller action applied to heating circuits if the DHW and the heating circuits request heat simultaneously. This parameter affects only heating-circuit pumps and control valves, not the functioning of the heat pump's condenser pump.</p> <p>If you select "None," it is possible to simultaneously perform DHW charging and building space heating, if this is possible in the pipe connection. Domestic hot water and spaces can be heated simultaneously when the DHW and the heating circuit are connected to the same storage tank. In a connection of this type, the heating circuit is connected directly to the storage tank and the DHW circulates in the storage tank through a closed spiral. With "None" selected as the setpoint, the pump of the storage tank's connected heating circuit (e.g., Q2) is kept on and the control valve is kept open during DHW charging. The DHW can be heated simultaneously with the spaces also when the system is equipped with a separate DHW storage tank and the heating circuit is connected directly to the change valve of the heat pump condenser (this switches the flow either to the heating circuit or to the DHW storage tank) and through a buffer storage tank where the heat pump automation does not control the temperature. In this case, the heating-circuit pump (e.g., Q2) is kept on while the DHW storage tank is being heated.</p> <p>If the selection here is "Absolute," the building space is not heated during DHW charging, even if it was otherwise possible in the pipe connection (the heating-circuit pumps are switched off and the three-way valve is closed). Usually, the value "None" should be selected here.</p>

Line	Setpoint	Description
1640	Legionella prevention function	A setting that switches the Legionella function on and off. This function can be set to start either periodically at the interval defined on line 1641 and at the time set on line 1644, or at a set time (line 1644) on a certain day of the week (line 1642). When the function is switched on at the aforementioned time, the DHW setpoint is increased to the value given on line 1645 and that value is maintained for the amount of time set on line 1646.
1641	Legionella funct periodically	The interval (in days) for starting of the Legionella function when the value on line 1640 is "Periodically."
1642	Legionella funct weekday	The day of the week for starting of the Legionella function when the value on line 1640 is "Fixed weekday."
1644	Legionella function time	The start time of the Legionella function. The time when the DHW setpoint is increased to the value on line 1645. After this, the DHW temperature is kept at said setpoint for the amount of time set on line 1646. If a time has not been set (the value is "---"), the function is started when DHW charging is launched at the normal setpoint for the first time on the day when the Legionella function is scheduled to start; if the DHW temperature setpoint is in Reduced mode for the entire day, the function is started when the day changes (at midnight).
1645	Legionella function setpoint	The DHW temperature setpoint when the Legionella function is on. This DHW temperature, measured with sensor B3 or sensors B3 and B31, must be reached. The sensor is selected on line 5022.
1646	Legionella function duration	The duration of maintaining the DHW storage tank temperature at the temperature set on line 1645. The clock starts when the DHW temperature exceeds the value on line 1645. If the temperature falls below this setpoint, the clock stops and restarts when the temperature again exceeds this setpoint.
1647	Legionella funct circ pump	If yes is selected here, the DHW circulating pump connected to the controller is kept on when the Legionella function is on.
1648	Temperature difference of circulating water circuit during legionella function	If a temperature sensor (sensor B39) is connected to the DHW circulation, the DHW temperature (measured with sensor B39) must reach the value set on line 1645 (for the time set on line 1646) less the value of this line. If this setting is not used (as value ---), no requirements are set for the temperature of the circulation water.
1660	Release of circulation pump	The schedule followed by the DHW circulation pump.
1661	Circulation pump cycle	If this function is on, the DHW circulation pump is periodically first on for 10 minutes and then off for 20 minutes when it is being used in accordance with the time program (line 1660).
1663	Circulation setpoint	If the temperature sensor (B39) for DHW circulation is in use and the circulation water temperature (measured by sensor B39) falls below this value, the circulation pump (Q4) is started. The circulation pump is on for at least 10 minutes or until this setpoint is reached. If this value is less than 8 °C lower than the DHW setpoint, the controller uses the DHW setpoint minus 8 °C here.
1680	Optg mode changeover	The state that the DHW enters if the changeover function has been enabled in the Hx input (H1 or H3) and a control message is received in the input.

## DHW storage tank

Line	Setpoint	Description
5010	Charging	The DHW charging time. This setting is used only when DHW charging is controlled with the same time program as the heating circuit (line 1620).
5022	Type of charging	If only sensor B3 (the top-section sensor) is being used, the Recharging function is always enabled. The DHW is charged until sensor B3 reaches the DHW setpoint. With the option "Full charging," both sensor B3 (top sensor) and sensor B31 (bottom sensor) must reach the DHW setpoint. With the option "Full charge 1st time day," the option "Full charging" is used in the first DHW charging of the day and the option "Recharging" is used thereafter. With the Legionella function option, the aforementioned charging options are also applied when the Legionella function is in use.
5040	Discharging protection	If this setting is always on and pump Q3 is used for DHW charging, pump Q3 is started only when the heat pump supply water (sensor B21 or B71) is at least 0.5 times hotter than the DHW temperature measured (with sensor B3 or B31) by the value on line 5020. If the flow temperature falls below the DHW setpoint less 1/8 of the value on line 5040 during charging, the charging pump (Q3) is switched off again. If the option "Automatic" is selected here, this setting is applied only when the heat pump is in lockout mode.
5041	Discharging prot. sensor	This setting is used to select whether the discharging protection on line 5040 uses sensor B3 or B31.
5057	Recooling of collector	This function can be used to recool the DHW storage tank to the solar collectors (in cloudy weather).
5070	Automatic push	If the selected option is "Off," forced charging of the DHW can be started only manually. A manual start can be performed from the DHW menu or through the LPB bus. An older version of the user interface can be used for manual start by keeping the user interface DHW button depressed for 3 seconds. If the selected option is "On," forced charging of the DHW is started if the DHW temperature falls below the DHW setpoint by twice the value on line 5024.
5071	DHW charging prior. time limit	If forced charging of the DHW has been initiated, the DHW is charged for the time period defined here. It overrides the space heating need (this corresponds to the absolute priority on line 1630).
5090	With buffer	If the DHW storage tank is connected to the heating-circuit storage tank, the value "Yes" can be selected here, in which case it is possible to transfer heat from the heating-circuit storage tank to the DHW storage tank, if needed (lines 5021 and 5130).
5093	Solar integration	If a solar collector is connected to the DHW storage tank, select "Yes" here.

## Heat pump

Line	Setpoint	Description
2886	Compensation heat deficit	If this is on, the heating water temperature (measured with sensor B21 or B71) is compared to the heating water setpoint (the heating curve value) over a longer time span. If the measured value exceeds the setpoint over a longer time span, the compressor off time is extended, and the measured value is lower than the setpoint, the compressor off time is reduced. This function is not in use during DHW charging or if there is a storage tank in any heating circuit.
2889	Duration error repetition	If the number of error situations (e.g., trips of the high pressure switch) during this time is higher than permitted for the error situation in question (the number defined in the ACS program), the heat pump initiates a lockout and must be reset manually.
2893	Number DHW charge attempts	The number of attempts to charge the DHW with the compressor after the first charging attempt (n + 1) if the DHW setpoint is not reached until another limit, such as the switch-off temperature (line 2844), is reached. A new charging attempt is initiated when the time defined on line 2843 has elapsed from the previous charging attempt. After the number of charging attempts set here, DHW charging is completed with electric immersion heaters. On line 7093, the controller saves the temperature to which the DHW was charged with the compressor. If this saved temperature is lower than the value defined on line 7092, a notification is shown on the screen.
2894	Delay 3-ph current error	If electrical interference (undervoltage or phase sequence) is of shorter duration than the time defined here, it is not noted as an error.
2895	Delay flow switch	If the flow switch signal is of shorter duration than the time defined here, it is not noted as an error.
2896	Brine circuit flow guard active	This line specifies taking into consideration the flow switch connected to an Ex input.
2908	OT limit with DHW charging	This is used to select whether lines 2809 and 2910 are taken into consideration during DHW charging.
2909	Release below outside temp	If the outside temperature is lower than this, the heat pump is used for heating (prior to this, another source of heat can be used).
2910	Release above outside temp.	If the outside temperature is lower than this, the heat pump is used for cooling (prior to this, another source of cooling can be used).
2911	For forced buffer charging	This is used to select whether the heat pump is used for forced charging of the heating-circuit storage tank. Forced charging can be switched on via line 4705.
2912	Full charging buffer	If the value selected here is "Off," the compressor is stopped when the storage tank temperature reaches its setpoint. If the value selected here is "On," the compressor stays on for the duration of the running time set on line 2842, even if the storage tank temperature has reached its setpoint. The setpoint of the storage tank temperature is determined on the basis of the setpoints of the heating circuits (or the precontrolled heat distribution circuit) connected to the tank, to which a mixing valve boost is added. The sensors used for measuring the setpoint are specified on line 4720.
2922	Condenser overtemp protection	This function can be used to cool the condenser by starting the condenser pump when the switch-off temperature set on line 2844 is reached. The condenser pump is started if the storage tank requests heat and its temperature (measured by sensor B4) is lower than the flow temperature (measured by sensors B21 and B71) at which the compressor is allowed to restart (see parameter 2844).
2923	Condens prot buffer sensor	This line is used to select the storage tank sensor to be used by parameter 2922.

## Condenser

Line	Setpoint	Description
2789	Condenser pump with DHW	This is used to indicate whether the condenser pump (Q9) is on during DHW charging.
2800	Frost prot. plant cond. pump	The condenser pump is on/off when the plant's frost protection (line 6120) is on.
2801	Control cond. pump	This is used to select when the condenser pump is to be on. If the value selected here is "Parallel compr. operation," the pump is on whenever the compressor is on or when the electric immersion heaters installed in the condenser line are on. If the value selected here is "Temp. request," the pump is on whenever a heating circuit or the DHW requests heat. With this setting, the pump is on even when the compressor is off but there is heat in the buffer storage tank installed in the condenser line. In the automatic mode, the controller decides independently when the condenser pump is to be on.
2802	Prerun time cond. pump	The condenser pump starts this much earlier than the compressor.
2803	Overrun time cond pump	The condenser pump runs this much longer after the compressor is stopped.
2806	Max dev temp diff cond	This is used to define by how much the temperature differential across the condenser may deviate from the setpoint on line 2805 before a message on the deviation is shown on the screen.
2809	Temp frost alarm	If sensor B21's reading drops below this value, the heat pump is stopped. It can only be started by resetting the automation.
2810	Condenser frost protection	If the reading from both sensor B21 and sensor B71 drops below this limit in heating, the condenser pump is started. If the temperature does not reach this limit + 1 °C within the time set with parameter 2811 (or within two minutes if line 2811's value is less than two minutes), the electric immersion heaters are switched on. After this, the controller waits again for the time set on line 2811 (or at least two minutes) and then switches the compressor on if the temperature still does not exceed the value of this line + 1 °C. If the temperature in either of the aforementioned stages exceeds the value of this line + 1 °C, the immersion heaters (or immersion heaters and the compressor) are kept on for the duration of the overrun time defined on line 2811.
2811	Overrun cond frost protect	See line 2810.

## Evaporator

Line	Setpoint	Description
2814	Source temp max	If the brine inlet temperature (sensor B91) exceeds this value, the compressor is not switched on but the fluid pump runs for the time set on line 2821 (from fluid pump start). If the brine temperature during this time drops to one degree below this limit, the compressor is started. If the brine temperature does not fall below this limit (by at least one degree) during the time set on line 2821, the controller waits for a new starting attempt for the duration of the compressor's off time (line 2843). If the brine inlet temperature is not in use, the brine outlet temperature is used here.
2819	Prerun time source	The evaporator pump starts this much earlier than the compressor.
2820	Overrun time source	The evaporator pump runs for this period of time after the compressor is switched off.
2823	Req temp diff evaporator	This value is the targeted temperature difference across the condenser (measured by sensors B91 and B92).
2824	Max. dev. temp. diff. evap.	If the temperature difference across the condenser deviates from the parameter 2823 setpoint by more than this, a notification is shown onscreen (if the compressor has been on for a minimum of three minutes). If this line is disabled (value "---"), line 2823 too is not enabled.

### Compressor

Line	Setpoint	Description
2835	Compressor lockout	If the compressor has been switched off, the compressor is not switched back on again until the time set on this line has elapsed.
2836	Start swi-off temp red	This can be used to reduce the switch-off temperature (line 2844) in inverse proportion to the evaporation temperature (brine temperature). The colder the brine, the lower the switch-off temperature. Reducing the switch-off temperature begins when the evaporation temperature drops below the value set here. The switch-off temperature is not reduced further when it has been reduced to the level set on line 2837. The function is switched off by disabling line 2837 (set the value to ---).
2837	Swi-off temp max reduced	See parameter 2836.
2839	'Set' time ch'over DHW/HC	The compressor runs for this time period after DHW charging is switched to space heating, even if there was no need for heat at the time of making the switch.
2841	Keep compr run time min	This is used to select whether the time periods on lines 2841 and 2842 are in use.
2842	Compressor run time min.	Every time the compressor is started, it is kept running at least for this amount of time (starting from compressor start), even if there is no longer a heating request. This parameter is in use if the value selected on line 2841 is "Yes."
2843	Compressor off time min	Every time the compressor is switched off, it is kept off at least for this amount of time, even if a new heating request has been made in the meantime.
2845	Red switch-off temp max	This is the amount by which the line-2844 switch-off temperature is reduced during DHW charging and storage tank forced charging and also when two compressors are on at the same time. If this limit is reached, DHW charging is completed with immersion heaters (if the value on line 2880 is not "Substitute"). After this, the compressor remains on for the time set on line 2839 even if there is no need for heat in the heating circuits.
2846	Hot-gas temp max	The compressor is switched off if this hot-gas temperature is exceeded (it is measured by sensor B81 or B82).

Line	Setpoint	Description
2847	Swi diff hot-gas temp max	The hot-gas temperature (as measured by sensor B81 or B82) must fall at least this far below the limit set on line 2846 before the compressor is permitted to run.
2848	Reduction hot-gas temp max	DHW charging and storage tank forced charging are suspended if the hot-gas temperature (measured by sensor B81 or B82) is only this much lower than the upper limit defined on line 2846. Charging is restarted when the hot-gas temperature has fallen below the upper limit defined on line 2846 by the sum of this line and line 2847.
2849	Setpoint hot-gas temp	If the hot-gas temperature (measured by sensor B81) rises above this level, output K31 is switched on (if output K31 has been activated in the configuration).
2850	SD setp hot-gas temp	If the hot-gas temperature (measured by sensor B81) becomes this much lower than the level set on line 2849, output K31 is switched off.
2851	Cont'type setp. hot-gas temp.	If the value selected here is "NO," output K31 is open (the loop is open) when the upper limit set on line 2851 has not been exceeded. When this is selected, output K31 is closed (the loop is closed) if the value on line 2851 is exceeded. With the selection "NC," the direction of operation is reversed.
2852	LP delay on startup	If the low pressure switch is triggered for a period shorter than this when the compressor starts, the triggering is ignored.
2853	LP delay during operation	If the low pressure switch is triggered for a period shorter than this when the compressor is in continuous use, the triggering is ignored.

## Compressor 2

Line	Setpoint	Description
2860	Lock stage 2 with DHW	If the selected value is "On," the second compressor is kept switched off for the duration of DHW charging.
2861	Release stage 2 below OT	If the selected value is "On," the second compressor is enabled only when the outside temperature is lower than the value set here. The outside temperature used is the attenuated outside temperature given on line 8703.
2862	Locking time stage 2/mod	The second compressor is kept switched off for this period, even if the need for heat entails it being started after starting of the first compressor. The calculation of line 2863's degree-minutes starts only when the time set here has elapsed from the start of the first compressor.

Line	Setpoint	Description
2863	Release integral stage 2/mod	<p>The second compressor is enabled when the sum of the degree-minutes for the flow temperature has reached this value. The calculation of degree-minutes begins when the time set on line 2862 has elapsed. A degree-minute in this case is the difference between the flow setpoint of the heating circuit and the measured value. These differences are summed up at one-minute intervals. When the sum calculated (in other words, total degree-minutes) exceeds the value set here, the second compressor is started.</p> <p>For example, a setpoint of 100 means a 10-degree temperature difference for 10 minutes or a 5-degree temperature difference for 20 minutes.</p> <p>If, after the first minute, for example, the flow setpoint is 45 degrees and the measured value is 25 degrees, the number of degree-minutes is 20 (= 45–25). If after the next minute, the setpoint is still 45 degrees and the measured flow temperature is 30 degrees, the number of degree-minutes is 15 (=45–30). After two minutes, the sum of the degree-minutes is thus 35 °C-min (20 + 15).</p>
2864	Reset integral stage 2/mod	<p>When both compressors are on, the second compressor is switched off when the degree-minute sum exceeds this value. In this context, a degree-minute is the difference between the measured value for the heating-circuit flow and the heating-circuit flow setpoint. The degree-minute calculation method is shown on line 2863.</p>
2865	Compr sequence changeover	<p>The compressors' switch-on sequence is reversed when the compressor that starts first has been on for the time set here. This setting is used to ensure that the two compressors run for approximately the same time in the long term.</p>

## Configuration

Line	Setpoint	Description
5700	Presetting	The preset plant diagram in accordance with the Siemens manual. Each option changes approximately twenty lines. The same outcome is achieved by changing these lines manually one by one.
6014	Function of mixing group 1	<p>A parameter, used to select for what the three-way mixing valve, controlled by the heat pump main controller, is used. This option also locks certain BX, QX, and EX inputs and outputs even if they would otherwise be freely selectable. For more precise information see the automation manual.</p>
6120	The plant's frost protection.	<p>The plant's frost protection. This setting can be used to switch on the selected pumps separately (e.g., the condenser pump Q9 or the heating circuit pumps Q2, Q6, and Q20), in accordance with the outside temperature, even if they otherwise would not be switched on (e.g., because of a heating request). Each pump has its own link to this parameter. The pumps attached to this parameter are used in the following manner: If the outside temperature is below –4 °C, the selected pumps are always on. If the outside temperature is between –3 and 4 °C, the pumps are on for a period of 10 minutes every 6 hours, and if the temperature is above 1.5 °C, the pumps are always off unless they e.g. are on because of the need for heat. This setting has no effect on how the pumps are started in response to heating requests, for example.</p>
6123	Blocking a pump restart	The time for which the circulating pumps are off before they are restarted after stopping. At the same time, the compressor and the electric immersion heaters are off. This setting is used to allow the NTC immersion heater of low-energy pumps to cool down before restart.
5710	Heating circuit 1	Switching of heating circuit 1 on/off.
5715	Heating circuit 2	Switching of heating circuit 2 on/off.

Line	Setpoint	Description
5721	Heating circuit 3	Switching of heating circuit 3 on/off.
5712	Operation mode of mixing valve 1	This setting is active only if it is used solely in cooling connections.
5734	Basic position for DHW diff. control valve (Q3)	This line is used to select to which position the change valve (space heating or DHW heating), connected to output Q3, stays, if there is no need for DHW or space heating. Usually, heating circuit should be selected.
5803	LPB address of the controller supervising the shared brine pump	If several heat pumps in the cascade are using the same brine circuit pump, this setting can be used to select to which device, connected to the LPB, the shared pump is connected.
5806	Type el imm heater flow	A setting in line with the connection sequence of the electric immersion heater stages, see the table below.

#### Connection sequence of electric immersion heater stages

	3-stage		2-stage, excluding		2-stage, complementary		1-stage	
Contactor	K25	K26	K25	K26	K25	K26	K25	K26
0	0	0	0	0	0	0	0	0
1	1	0	1	0	1	0	1	0
2	0	1	0	1	1	1	---	---
3	1	1	---	---	---	---	---	---

#### Solar collector

Line	Setpoint	Description
3816	Swimming pool temperature difference On	The collector's temperature must exceed the swimming pool's temperature by this amount before starting the collector's pump. The collector temperature must also exceed the value on line 3812. If "not in use" is selected, the controller will use the value on line 3810.
3817	Swimming pool temperature difference Off	If the collector's pump is on and the collector's temperature exceeds the swimming pool's temperature by this amount only, the collector's pump is stopped. If "not in use" is selected, the controller will use the value on line 3811.
3818	Minimum charging temperature for swimming pool	The collector's temperature must exceed this before the collector's pump is started during swimming pool heating.

#### Other settings

Line	Setpoint	Description
7092	DHW min. charging temperature with a compressor	If the temperature on line 7093 is below the value on this line, the user interface will display a service notification (a wrench symbol). If this temperature can be exceeded at the next DHW charging, the service notification disappears. This monitoring can be switched off.
7093	Current DHW temperature with a compressor	The DHW storage tank temperature (B3/B31) to which the DHW can be heated with the heat pump before the high pressure switch-off or switch-off temperature (line 2844), or the upper limit of hot gas temperature (line 2846).
7119	Economy function on/off	This can be used to disable the option of using line 7120.

Line	Setpoint	Description
7141	Emergency operation	This line is used to switch on emergency operation. In this case, only the electric immersion heaters controlled by the heat pump are used for heating.
7142	Automatic emergency operation mode in fault condition	This line is used to select whether emergency operation is switched on only manually via line 7141 or if emergency operation switches on automatically in the case of a fault, if needed.
7150	Simulation outside temp.	This line can be used to set the outside temperature manually. The setting is valid for 5 hours, after which it is disabled automatically. This setting line can be used, for example, during commissioning in the summer.

## 7 Inputs and outputs

### 7.1 Intended use of inputs and outputs

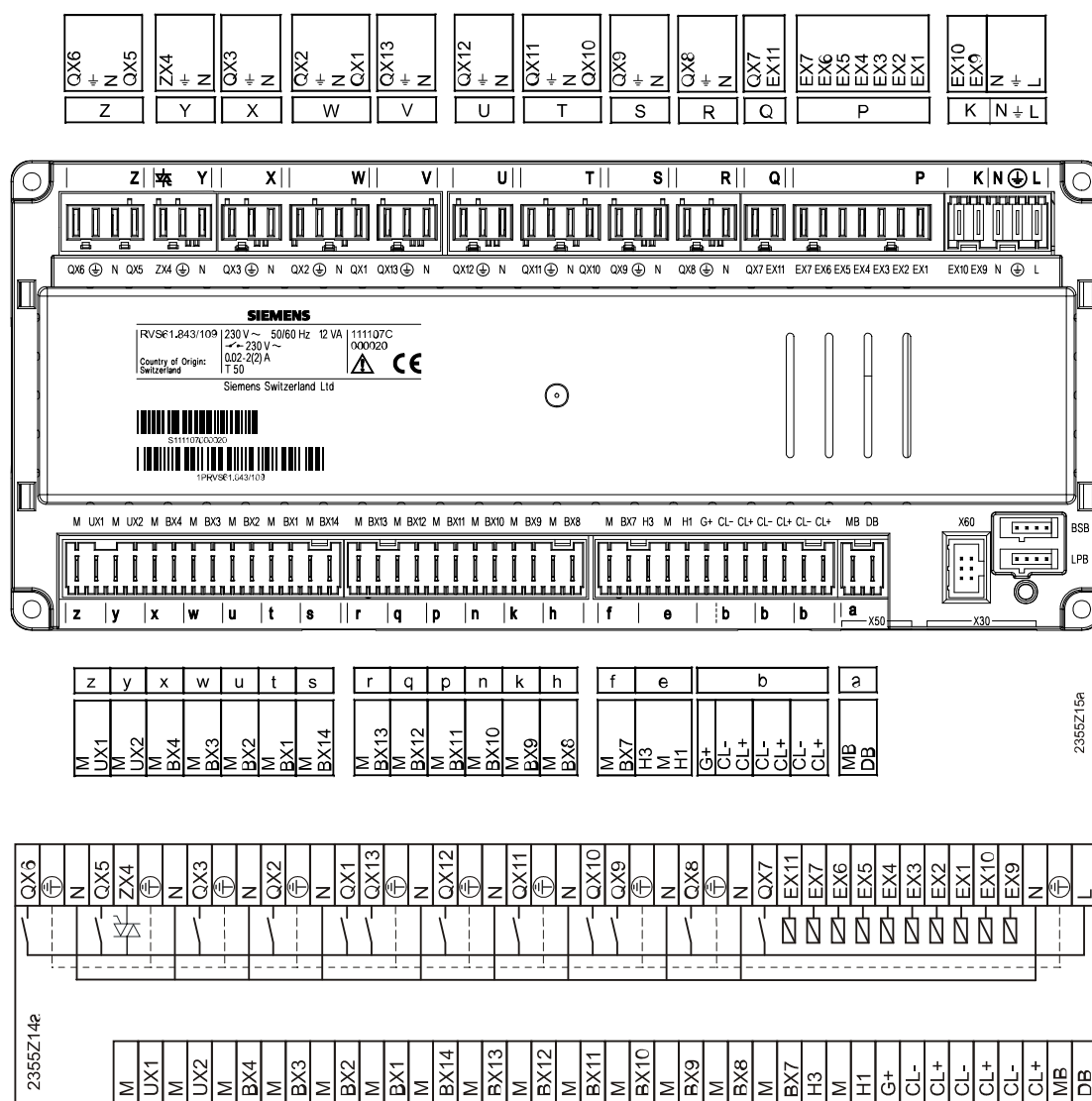
BX	Temperature input	temperature sensors	NTC 10 kOhm (outdoor sensor) NTC 1 kOhm, solar collector NTC 10 kOhm or Pt1000)
EX	230 V input	control signals, voltage control, grid-power monitoring, pressure switches	120 V...230 V control signals
HX	Low voltage input	control signals, electricity meter, energy meters, pressure sensors etc.	digital, analog 0...10 V, pulse, frequency
QX	230 V output	actuators controlled by automation, additional heat source control, etc.	
UX	Low voltage output	speed of rotation for pumps, additional heat source control, etc.	0...10 V, PWM
ZX	TRIAC output	control signals	
GX	Sensor's voltage	operating voltage for active sensors 5 V or 12 V	5 V (4.75...5.25 V) or 12 V (11.4...12.6 V), SELV, 20 mA
DB MB (M)	LPB bus	additional controllers, remote access devices, cascade connection reserved addresses: 0.5 OZW672 remote connection, 0.8 OCI700 connection cable	Copper cable, length at most 250 m. The minimum cross-sectional area for the wires is 0.5 mm <sup>2</sup> . If the cable is pulled for several meters, use an area of at least 1.5 mm <sup>2</sup> . The most recommended option is a twisted pair cable (instrumentation cable). Unshielded cables must be at least 150 meters away from charged conductors. DB: bus + (terminals 1 and 2 of remote access devices) MB (M): bus – (terminals 3 and 4 of remote access devices) Bus voltage is approximately +9.5 V.
CL+ (BSB) CL– (M)	BSB bus	user interfaces, remote connection	cross-sectional area at least 0.50 mm <sup>2</sup> , length at most 200 m CL+ (BSB): bus + CL– (M): bus and user interfaces backlight –
G+	User interfaces backlight	user interfaces backlight	DC +12 V 88 mA SELV user interfaces' backlight +
BSB	BSB bus	user interfaces with a flat cable	
LBP	LPB bus	OCI 700 service cable and Siemens ACS790 program	
M	Low voltage ground	bus and temperature sensor ground	
X60	LPB bus (Equipment)	antenna for wireless devices or Modbus converter.	
X30 and X50	BSB bus (Equipment)	additional controllers and user interfaces integrated to the device	

BX	Temperature input	temperature sensors	NTC 10 kOhm (outdoor sensor) NTC 1 kOhm, solar collector NTC 10 kOhm or Pt1000)
WX21	Expansion valve	unipolar expansion valve	
GX	supply voltage 5 V or 12 V	supply voltage of pressure sensors and other sensors	
FX23	voltage input for QX23 relay		

Inputs EX5, EX6 and EX7 are always reserved for the voltage and phase control, and inputs EX9 and EX10 for pressure switches. See the detailed electrical specifications of inputs and outputs from automation and bus system manuals. Connections M, MB and CL- have been interconnected inside the controller.

## 7.2 Master controller

Additional information on model-specific functions is presented in electrical diagrams. Outputs that have been marked blank have no function. A function to those can be freely chosen. The function can be changed, if needed.

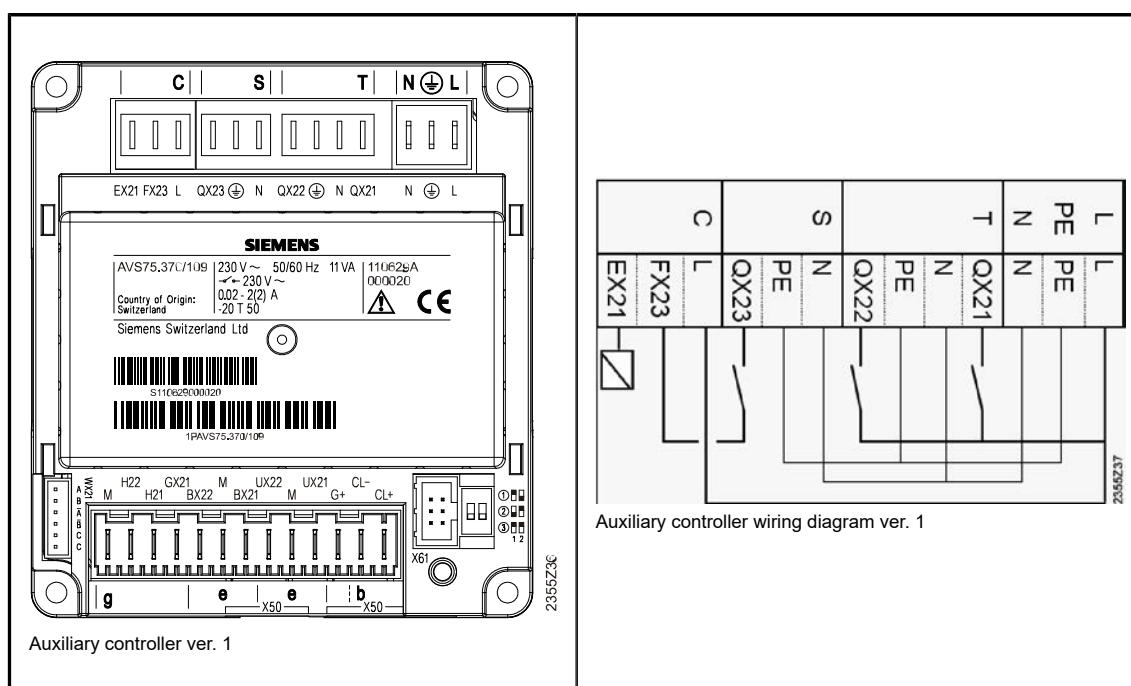


Master controller ver. 1

## 7.3 Auxiliary controllers

There can be three auxiliary controllers in total. Model-specific functions have been presented in the electrical diagrams of each model and their respective installation chapters. Outputs, marked blank, have no function. A function to those can be freely chosen. The function can be changed, if needed.

The function for auxiliary controller 1 is usually selected on line 7300. This selection locks some of the controller's inputs and outputs while other connections remain freely available. Typically the auxiliary controller regulates heating circuit 2's three-way valve. The tables presented on the following page correspond to this connection.



### DIP switch positions

DIP switch	Address
① 1 2	Address 1: Auxiliary controller 1
② 1 2	Address 1: Auxiliary controller 2
③ 1 2	Address 1: Auxiliary controller 3

### Supply current outputs (capital letters in connectors)

Line	Connector	Output	Action	Marking	Additional information
7301 (7300)	T	QX21	Heating circuit 2 valve open Y5	Y5	If the heating circuit has a control valve, otherwise vacant. Selected via line 7300.*
7302 (7300)	T	QX22	Heating circuit 2 valve closed Y6	Y6	If the heating circuit has a control valve, otherwise vacant. Selected via line 7300.*
7303 (7300)	S	QX23	Heating circuit 2 pump Q6	Q6	If the heating circuit contains a pump, otherwise vacant. Selected via line 7300.*

\*See chapter *Valve-controlled heating circuit selection*.

Function for outputs Q21, Q22 and Q23 is also selected on line 7300.

### Temperature sensors (small letters in connectors)

Line	Connector	Input	Action	Marking	Additional information
7307 (7300)	e	BX21	Heating circuit 2 supply water B12	B12	If the heating circuit has a control valve, otherwise vacant. Selected via line 7300.*
7308	e	BX22			

\*See chapter *Valve-controlled heating circuit selection*.

The function for input BX21 is also selected on line 7300.

### Low voltage inputs (small letters in connectors)

Line	Connector	Input	Action	Marking	Additional information
7321	g	H21			
7331	g	H22			

### Sensor voltage (small letters in connectors)

Line	Connector	Input	Action	Marking	Additional information
7341	g	GX21			

### Supply current inputs (capital letters in connectors)

Line	Connector	Input	Action	Marking	Additional information
7342	C	EX21			

### Control signals (small letters in connectors)

Line	Connector	Output	Action	Marking	Additional information
7348	e	UX21			
7355	e	UX22			

## 7.4 Most common additional connections and connection changes

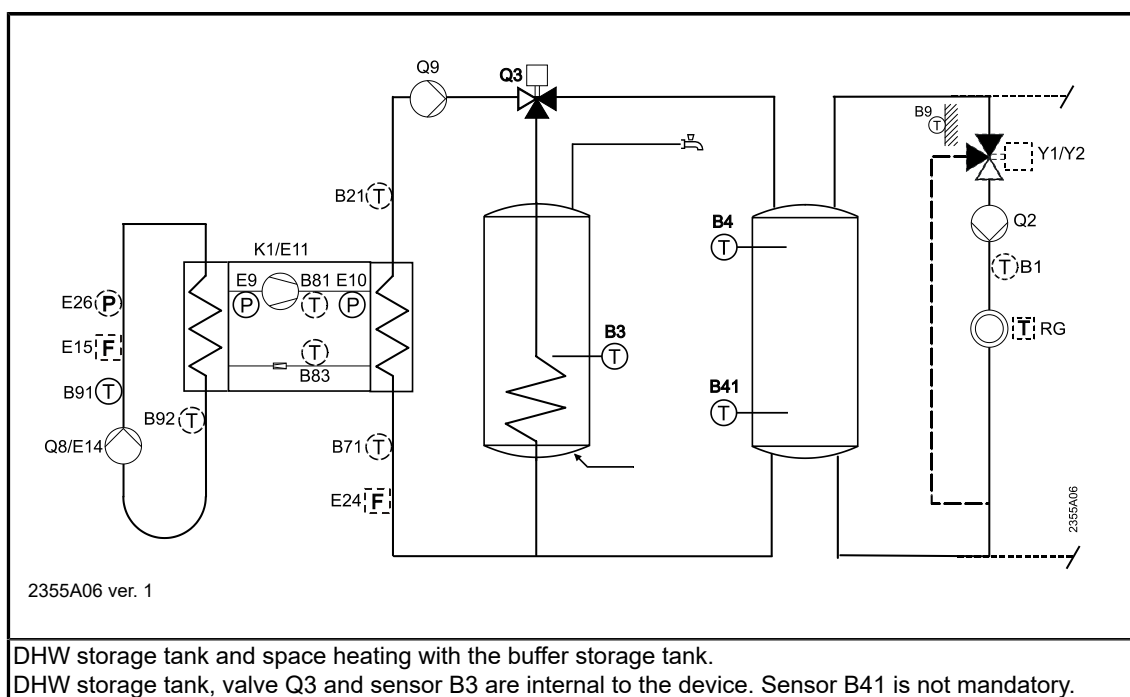
Automation settings must correspond to the pipe coupling. If necessary, change the input and output functions from the automation settings to correspond to the pipe coupling and the sensors in use. For making major changes, you should use the Siemens ACS790 computer program, because the program will automatically draw a principle pipe coupling, corresponding to the settings.

Automation recognizes the pipe coupling on the basis of the selected inputs and outputs and the connected temperature sensors. Any of the available functions can be chosen to free inputs and outputs. Remove from the controllers the additional temperature sensors, to which is not selected a function from the settings. Sensors can be removed either by disconnecting the quick coupling from the controller or the sensor wires from the quick coupling. If you disconnect the wires from the quick coupling, protect the bare wire ends so that they cannot cause a short circuit. Reset and save the temperature sensors in the automation memory after the changes by choosing “yes” on lines 6200 (save the sensors) and 6201 (reset the sensors).

In addition to the heat pump, storage tanks, and heating circuits, the automation can control a solar power system; cooling; and an additional heat source, such as electric heating or an oil boiler. Additional functions of the automation (block diagrams) are enabled by selecting the inputs and outputs required by the feature, such as inputs from temperature sensors and outputs of pumps' and valves' control, as well as by connecting the devices and temperature sensors to the selected inputs and outputs. The automation is equipped with control blocks for dozens of individual connections.

### Cube Inverter+

#### Automation-controlled heating circuit storage buffer tank and control valve



Changes to factory settings			
Menu	Line	Line name	Setpoint
Heating circuit 1	870	With buffer	Yes
Configuration	5930	Sensor input BX1	Buffer tank temperature B4
Configuration	6014	Function of mixing group 1	Heating circuit 1

## Electrical connections

TEMPERATURE SENSORS (SMALL LETTERS IN CONNECTORS)					
Line	Connector	Input	Action	Marking	Additional information
5930	t	BX1	Buffer tank temperature B4	B4	Space heating circuit storage tank
5940 (6014)	p	BX11	Heating circuit 1 supply water B1	B1	Supply water pipe of heating circuit 1

The function for input BX11 is selected on line 6014. See chapter *Valve-controlled heating circuit selection*.

SUPPLY CURRENT OUTPUTS (CAPITAL LETTERS IN CONNECTORS)					
Line	Connector	Output	Action	Marking	Additional information
5899 (6014)	S	QX9	Heating circuit 1 pump Q2	Q2	
5900 (6014)	T	QX10	Heating circuit 1 valve open Y1	Y1	
5901 (6014)	T	QX11	Heating circuit 1 valve closed Y2	Y2	

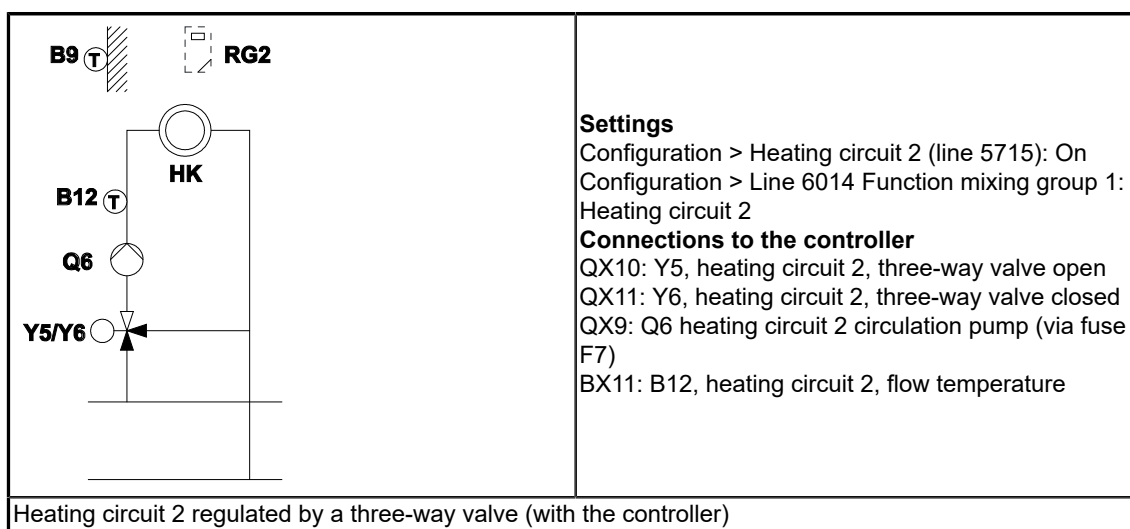
The functions for outputs Q9, Q10 and Q11 are selected on line 6014. See chapter *Valve-controlled heating circuit selection*.

### Things to consider during installation

In this connection, the mixing shunt of the master controller is utilized in heating circuit 1. If another heating circuit (heating circuit 2) equipped with a mixing valve needs to be added, an auxiliary controller must to be installed.

### Heating circuit 2 regulated by a three-way valve

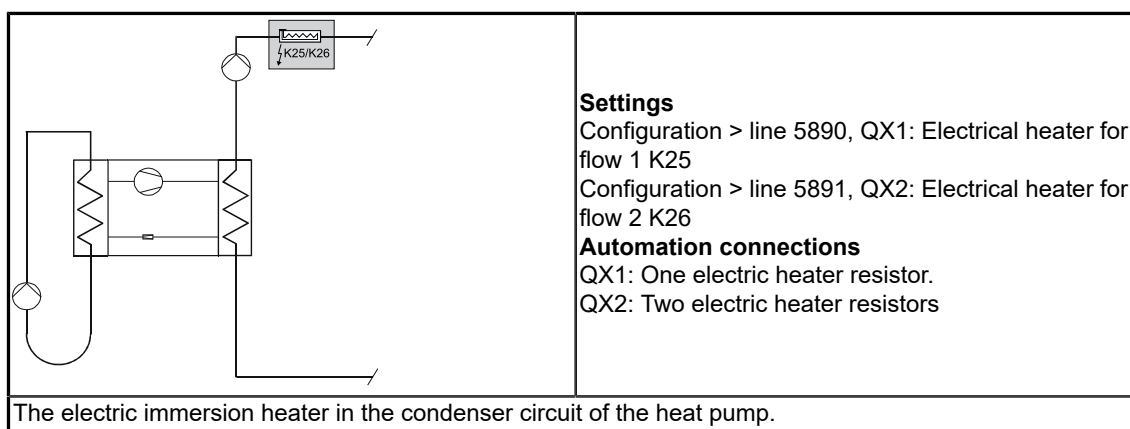
The master controller has one functional block for the heating circuit's mixing valve. In models with an integrated DHW tank, heating circuit 1 is usually connected directly from the condenser to the heating circuit, leaving the mixing valve's functional block to be utilized with heating circuit 2. Heating circuit 2 is commissioned by performing the connections presented in this manual and electrical diagrams, and by switching the circuit on according to the instructions in chapter *Switching on heating circuit 2* in the heat pump's automation instructions.



## Eco Inverter+

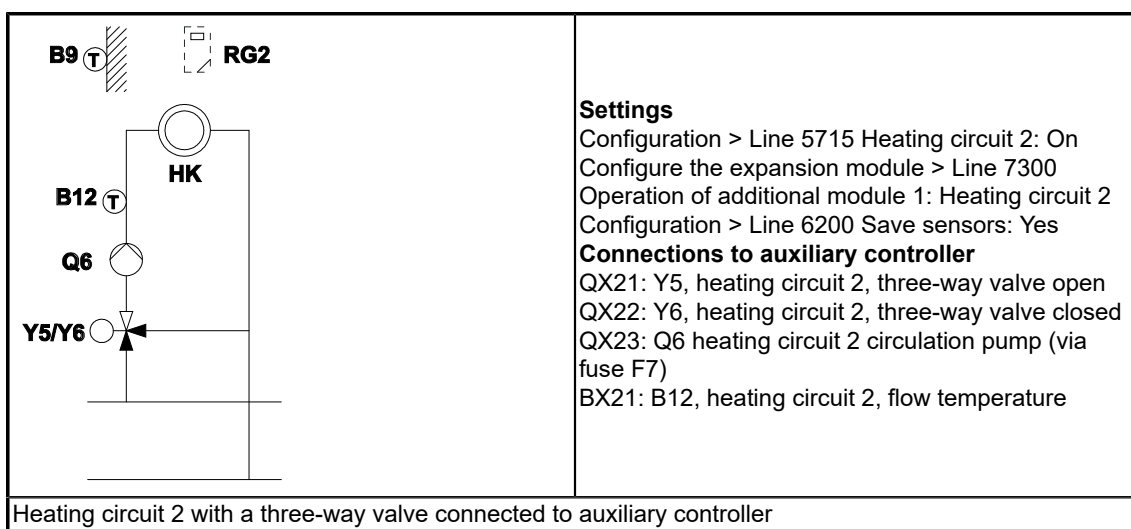
### Electric immersion heater in the condenser line

The heat pump's switchboard is delivered with two contactors (K2 and K3) and a circuit breaker F2 for an electric heater installed in condenser line. The contactors' control signals have been connected to automation controller outputs QX1 and QX2. The heater is commissioned by selecting "electric heater 1 K25" for output QX1 on line 5890, and "electric heater 2 K26" for output QX2 on line 5891. The heater must be equipped with overheat protection if it is not included in the default assembly.



### Heating circuit 2 with a three-way valve and auxiliary controller

The heat pump can be equipped with an optional auxiliary controller. It adds three-way valve control to heating circuit 2. Heating circuit 2 is commissioned by performing the connections presented in this manual and electrical diagrams, and by switching the circuit on according to the instructions in section *Switching on heating circuit 2* in the heat pump's automation instructions.



SUPPLY CURRENT OUTPUTS (CAPITAL LETTERS IN CONNECTORS)					
Line	Connecto	Output	Action	Marking	Additional information
7301 (7300)	T	QX21	Heating circuit 2 valve open Y5	Y5	
7302 (7300)	T	QX22	Heating circuit 2 valve closed Y6	Y6	
7303 (7300)	S	QX23	Heating circuit 2 pump Q6 (Through fuse F7)	Q6	

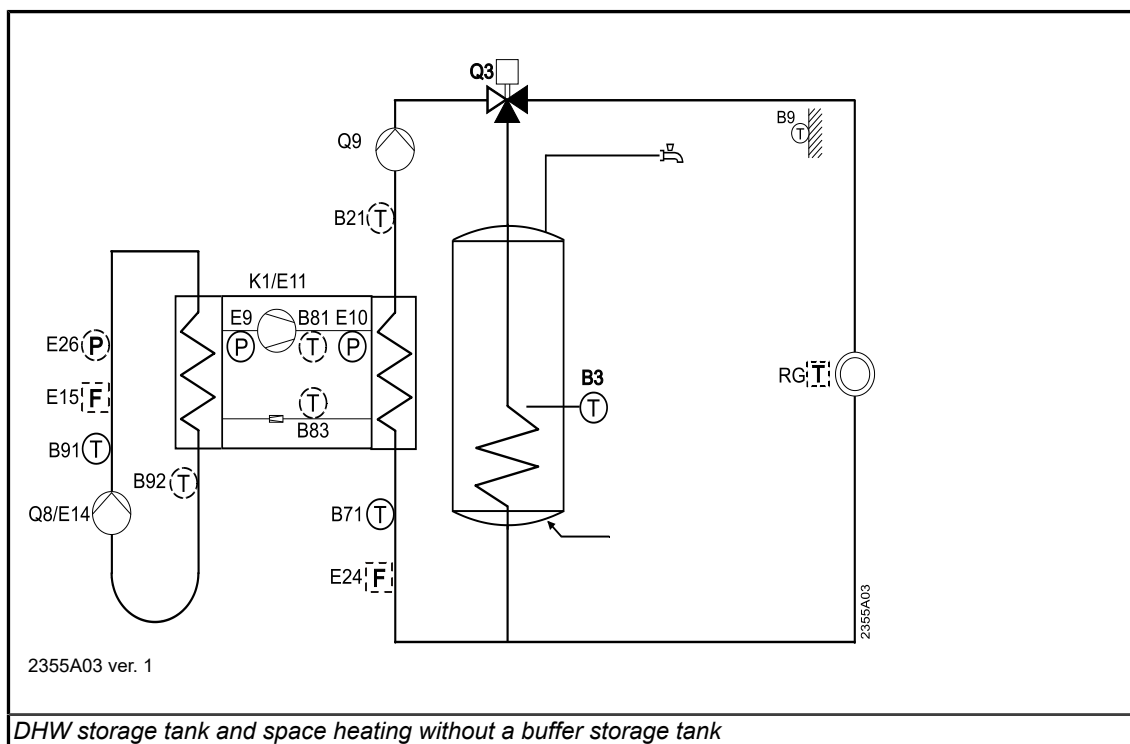
The function for outputs Q21, Q22 and Q23 is selected on line 7300.

TEMPERATURE SENSORS (SMALL LETTERS IN CONNECTORS)					
Line	Connecto	Input	Action	Marking	Additional information
7307 (7300)	e	BX21	Heating circuit 2 supply water B12	B12	

The function for input BX21 is selected on line 7300.

CONTROL SIGNALS (SMALL LETTERS IN CONNECTORS)					
Line	Connecto	Output	Action	Marking	Additional information
7348	e	UX21	(Heating circuit 2 pump Q6)	(Q6)	On demand, if the pump is equipped with speed control.
7349	e	UX21	Signal logic output UX21		On demand, if the pump is equipped with speed control. Standard or inverse, depending on the pump.
7350	e	UX21	Signal output		On demand, if the pump is equipped with speed control. 0...10 V or PWM depending on the pump

## Space heating without a buffer storage tank

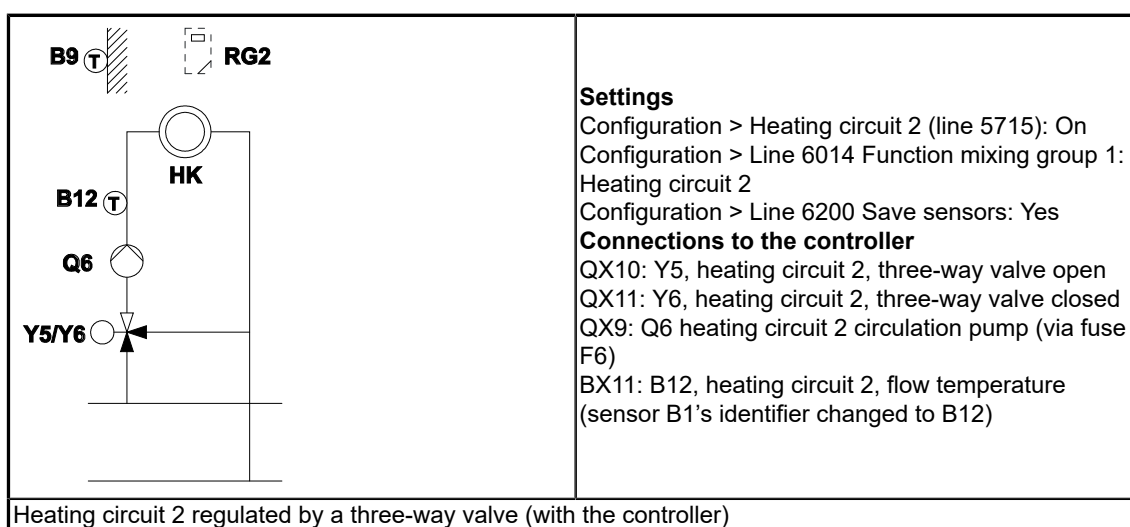


## AUTOMATION CONNECTION CHANGES

Detach temperature sensors B4 and B1 from the pump's master controller. Save the changes by selecting Yes on lines 6200 and 6201.

## Heating circuit 2 with a three-way valve

The heat pump's switchboard and automation are delivered with the connections and a temperature sensor for heating circuit 1 controlled with a three-way valve. In this coupling, heating circuit 1 has been connected directly to the heat pump's condenser circuit. This lets the electrical connections, temperature sensor (B1) and automation functions be used by heating circuit 2, configured and connected parallel to heating circuit 1. Make the corresponding changes to the device identifiers in the electrical diagrams manually.



## 8 Status messages and troubleshooting

### 8.1 Status messages

#### General

Menu	Line	Setting	Description
Fault	6800	History 1	Last fault time
Fault	6801	Error code 1	Last fault message
Service/ special operation	7093	Current DHW charging temperature	DHW temperature last reached with a compressor.
Service/ special operation	7120	Eco use	Eco use on/off. In eco mode the heat pump heats DHW only.
Service/ special operation	7141	Emergency operation	Emergency operation (electric heater heating) on/off
Service/ special operation	7150	Simulation outside temp.	Bypassing the outside temperature sensor and setting the temperature manually. In effect for five hours, after which the sensor is commissioned.
Input/output test	7705...		Input and output status messages.
Status	8000	State heating circuit 1	See <i>Heating circuit status</i> below.
Status	8001	The state of heating circuit 2.	See <i>Heating circuit status</i> below.
Status	8002	The state of heating circuit 3.	See <i>Heating circuit status</i> below.
Status	8003	State of the DHW	See <i>DHW status</i> below.
Status	8006	State heat pump	See <i>Heat pump status</i> below.
Status	8010	Additional storage tank (buffer storage tank) state	See <i>Additional storage tank (buffer storage tank) status</i> below
Status	8050	History 1	Last anomalous state time
Status	8051	State code 1	Last anomalous state message time
Heat generation status information	8400	Compressor 1	Compressor on/off
Heat generation status information	8402	Electrical heater for flow 1	Electric immersion heater stage 1 (K25) on.
Heat generation status information	8403	Electrical heater for flow 2	Electric immersion heater stage 2 (K26) on.
Heat generation status information	8403	Source pump	Brine circuit pump on/off.

Menu	Line	Setting	Description
Heat generation status information	8405	Brine pump speed in rpm	Brine circuit pump's speed (for speed-controlled pumps), 100 % always corresponds to full pump speed.
Heat generation status information	8406	Condenser pump	Condenser circuit pump on/off.
Heat generation status information	8407	Condenser pump's speed	Condenser circuit pump's speed (for speed-controlled pumps), 100 % always corresponds to full pump speed.
Heat generation status information	8410	Return temperature for heat pump	Condenser circuit sensor B71's temperature.
Heat generation status information	8411	Heat pump's flow temperature	Condenser circuit sensor B21's temperature.
Heat generation status information	8425	Condenser temperature difference	
Heat generation status information	8426	Temperature differential, evaporator	
Heat generation status information	8427	Brine return temperature	Brine temperature from the brine circuit (sensor B91).
Heat generation status information	8428	Brine min. return temperature	Lowest brine temperature from the brine circuit (sensor B91).
Heat generation status information	8429	Brine flow temperature	Brine temperature when entering the brine circuit (sensor B92).
Heat generation status information	8440	Minimum remaining off time 1	Compressor's remaining off time before it can start again.
Diagnostics consumers	8700	Outside temperature	Measured outside temperature (sensor B9)
Diagnostics consumers	8703	Outside temp attenuated	Section <i>Outside temperature and the building's heat capacity</i>
Diagnostics consumers	8704	Outside temp composite	
Diagnostics consumers	8730	Heating circuit pump 1	Heating circuit 1 pump on/off
Diagnostics consumers	8735	LP1 pump speed in rpm	Heating circuit pump speed (for speed-controlled pumps)
Diagnostics consumers	8743	Flow temperature 1	Heating circuit 1 flow temperature (sensor B1)
Diagnostics consumers	8744	Flow setpoint 1	The setpoint of heating circuit 1's flow (sensor B1)
Diagnostics consumers	8830	DHW temperature 1	DHW charging sensor's temperature (sensor B3)

Menu	Line	Setting	Description
Diagnostics consumers			
Diagnostics consumers	8980	Buffer tank temperature 1	Supplementary buffer sensor B4's temperature
Diagnostics consumers	8981	Buffer setpoint	Buffer tank temperature setpoint
Diagnostics consumers	9031...	Relay output QX	QX relay outputs' state

## Heat pump status

The heat pump's status information (line 8006) indicates the state of the pump's compressor and electric heater.

Status	
No request	Heat pump's compressor and electric immersion heater are off, because the setpoints for space and DHW heating have been reached. The heat pump starts when one of the two heating modes requests more heat.
Compressor's off time in effect	A start request has been sent to the compressor, but its off time has not yet elapsed. The compressor starts after the off time if heat requesting (additional storage tank or DHW) is still on.
Flow active	Condenser circuit's pump is on (prerun), but the compressor has not yet started.
Compressor 1 on	Heat pump compressor is on.
Switch-off temp. max. (Locked, flow temperature max.)	Heat pump's flow water (sensor B21) temperature exceeds the switch-off temperature (section <i>Heat pump's protection functions: Temperature limits of brine circuit</i> ). The heat pump will restart when the compressor's off time has elapsed and flow temperature has cooled sufficiently.
Compressor ready for operation	Compressor is ready to operate, for example after stopping due to switch-off temperature.
Overrun time active	Compressor has been switched off, but the overrun time for the brine or condenser circuit's pump is still on.
Source temperature lower limit, brine	Brine circuit's temperature drops below the safety limit (section <i>Heat pump's protection functions: Running and off times</i> ).

Compressor and electric immersion heater on simultaneously	Section <i>Electric immersion heater in the condenser line</i> .
Emergency operation	Heat pump's compressor is not operating due to a fault state (section <i>Fault situations</i> )
Electric immersion heater on	<p>Heat pump's electric heater is on, but the compressor is off.</p> <ul style="list-style-type: none"> <li>Electric heater's locking time and degree minutes are at zero and the compressor has not yet started due to condenser circuit pump's prerun time.</li> <li>The highest DHW charging temperature with a compressor (section <i>DHW heating: DHW temperature limit in compressor use</i>) is enabled and DHW's temperature (sensor B3) has exceeded the highest charging temperature, but DHW setpoint (line 1610) has not yet been exceeded.</li> <li>DHW charging temperature with a compressor has stopped to the switch-off temperature and heating continues with an electric heater until the setpoint is reached. The number of charging attempts is set on line 2893.</li> </ul>

### Heating circuit status

Heating circuit 1's state is reported on line 8000. Heating circuit 2's state is reported on line 8001.

Status	
Comfort mode	Heating circuit uses a Comfort mode setpoint.
Reduced heating	Heating circuit uses a reduced setpoint.
Protection mode	Heating circuit uses a Protection mode setpoint.
Overrun time active	Heating circuit is about to switch off.
Summer usage	Summer/winter heating limit is on
STOP	Heating in the heating circuit is off.

### Additional storage tank (buffer storage tank) status

Status	
Charged, target temperature	Buffer storage tank has been heated to the temperature setpoint.
Producer released / Source released	Buffer storage tank's temperature is below the setpoint and the compressor or other heat source has been given a running request.

### Domestic hot water status

The line number for the DHW state is 8003.

Status	
Charged, rated temperature	DHW has been heated to the normal setpoint set on line 1610: sensor B3 observes a higher temperature than the setpoint.
Charging, rated temperature	The heat pump heats the domestic water to the normal setpoint on line 1610.
Overrun time active	DHW temperature exceeds the setpoint (sensor B3), but the compressor has not yet shut down.
STOP	DHW heating is off or has stopped to a switch-off temperature and the compressor's off time has not yet ended.

## 8.2 Fault situations and troubleshooting

Heat pump's automation saves abnormal situations as statuses. The latest anomalous status is saved in the status menu on lines 8050 and 8051 (history 1 and state code 1), and the second to last on lines 8052 and 8053 (history 2 and state code 2).

If the status is repeated enough times within a set time frame (line 2889), the heat pump enters a fault state. The latest fault status is found in the fault menu on lines 6800 and 6801 (history 1 and error code 1). The amount of permitted fault statuses before entering the fault state is presented in the table below for the most common faults (can be modified with the ACS program).

The heat pump's compressor is not available for use under a fault condition. A fault state requires that the heat pump's automation is reset before its compressor can be restarted. Reset the automation in the fault menu on line 6711 (section *Resetting the heat pump*). The reason for the fault must be investigated before resetting.

Status	Permitted amount
107: Hot gas temperature	2
222: Higher pressure	3
225: Lower pressure	2
226: Compressor's overload	2
355: Phase order	2
385: Undervoltage	2

### Emergency operation

During a fault state the heat pump enters the emergency operation mode automatically, if the automatic emergency operation function is enabled on line 7142. When emergency operation is active, the automation uses the connected electric heaters or some other heat source, like an electric boiler. Typically electric heaters K25 and K26 connected to the automation are used. Heating will continue in emergency operation mode only if an electric heater or some other heat source has been connected to the automation. The emergency operation mode can be switched off on line 7141. Emergency operation switches off automatically after the automation has been reset. Reset the automation in the fault menu on line 6711 (section *Resetting the heat pump*).

### Troubleshooting

Faultless operation of the heat pump requires an adequate flow (adequately small temperature difference) and a suitable temperature level in the brine and condenser circuits. The temperature sensors and actuators must be properly installed for the automation to work properly. If these basic requirements are met, the heat pump's adjustment and troubleshooting can be done by changing the setpoint values. See the technical data for the temperatures differences corresponding to the flows and the maximum output temperature.

### Brine circuit temperature and underpressure

Underpressure and the lower limit temperature in the brine circuit are caused by an inadequate flow or entry temperature in the circuit. If the automation reports that there is underpressure, check the brine circuit's

- valves
- filters
- pump's operation (rotation, rotational speed)
- liquid flow when the device operates from a temperature difference (line 8426)
- lowest temperature level of the liquid when the device is running (line 8428)
- frost resistance and adequacy of liquid
- dimensioning.

Use a flow meter to measure the brine circuit's flow if required: The temperature difference does not always indicate the brine circuit's flow properly, because the flow impacts the output and thus, the temperature difference. The temperature sensor reading may also be incorrect due to the sensor, its location or isolation, or some other factor.

### Switch-off temperature and overpressure

The switch-off temperature and overpressure are caused by an inadequate flow in the condenser circuit, excessive return temperature from the circuit to the condenser, or by an overly high request temperature in the heating circuit.

If the automation gives an indication of a switch-off temperature or overpressure, check the heating circuit and DHW settings first. Pay special attention to the heating curve's temperature request, and the DHW setpoint, neither of which may not be too high. Also take the upper and lower limits of the heating curve's setpoint into account. If required, reduce the heating curve's slope (line 720) or its upper limit (line 741) and the domestic hot water setpoint (line 1610).

The excessive return temperature can be caused by an inadequate heat release to heating or by a needlessly large flow in the condenser circuit. The temperature difference between the supply and return temperatures can be increased by reducing the flow. A suitable difference is usually approximately 5...7 °C.

If the switch-off temperature or overpressure keep on occurring despite the setpoints, check the condenser circuit's

- valves
- filters
- pump's operation (rotation, rotational speed)
- water flow when the device operates from a temperature difference (line 8425)
- highest return and supply water temperature (lines 8410 and 8411)
- flow routes and heat release.

## 8.3 State codes and error codes

QTY: Number of permitted state messages before they become error messages.

STATE: State message, until the permitted state message quantity is reached and they become error messages. If the table reads ---, the state message becomes an error message directly.

HP: Heat pump is operational if the error or state message is active.

Error message	Sensor/ connector	QTY	State	HP	Description
10: Outside sensor	B9	0	---	Yes	Sensor is missing or faulty. Check the sensor and its connection. Change the sensor if necessary.
26: Shared flow sensor 1	B10	0	---	Yes	
27: Shared flow sensor 2	B11	0	---	Yes	
30: Flow sensor 1	B1	0	---	Yes	
31: Cooling flow sensor 1	B16	0	---	Yes	
32: Flow sensor 2	B12	0	---	Yes	
33: Heat pump flow sensor	B21	0	---	Yes	
35: Source inlet sensor	B91	0	---	No	
36: Hot gas sensor 1	B81	0	---	Yes	
37: Hot gas sensor 2	B82	0	---	Yes	
38: Precontroller flow sensor	B15	0	---	Yes	
39: Evaporator sensor	B84	0	---	No	
44: Heat pump return sensor	B71	0	---	Yes	
45: Source outlet sensor	B92	0	---	No	
46: Cascade return sensor	B70	0	---	Yes	
47: Shared return sensor	B73	0	---	Yes	
48: Refrigerant sensor, liquid	B83	0	---	Yes	
50: DHW sensor 1	B3	0	---	Yes	
52: DHW sensor 2	B31	0	---	Yes	
54: DHW flow sensor	B35	0	---	Yes	
57: DHW circulation sensor	B39	0	---	Yes	
60: Room sensor 1		0	---	Yes	
65: Room sensor 2		0	---	Yes	
68: Room sensor 3		0	---	Yes	
70: Buffer tank sensor 1	B4	0	---	Yes	
71: Buffer tank sensor 2	B41	0	---	Yes	
72: Buffer tank sensor 3	B42	0	---	Yes	
73: Collector sensor 1	B6	0	---	Yes	
74: Collector sensor 2	B61	0	---	Yes	
76: Special temperature sensor 1	BX	0	---	Yes	

Error message	Sensor/ connector	QTY	State	HP	Description
81: LBP short circuit/ communication		0	---	Yes	LBP bus has short-circuited. Check the cable and connections.
81 (remote connection device): No bus input					The connection between the remote connection device and heat pump's controller has been cut off. This may be caused by a power cut-off from the heat pump or by a faulty cable.
82: LBP address collision		0	---	Yes	Two controllers in a cascade have the same LBP address. Check the addresses from the LBP menu.
83: BSB short circuit		0	---	Yes	BSB bus has short-circuited. Check the cable and connections.
84: BSB address collision		0	---	Yes	Two user interfaces are used for the same purpose. Set separate purposes on line 40.
85: BSB wireless data transfer		0	---	Yes	Remote controller's range does not reach the antenna connected to the controller.
98: Additional module 1		0	---	Yes	Connection to auxiliary module has been cut off. Check the module's flat cable and change it if necessary. If there is no auxiliary module, select "yes" on lines 6200 (save sensors) and 6201 (remove sensors).
99: Additional module 2		0	---	Yes	
100: Two time hosts		0	---	Yes	Multiple controller's or remote connection devices in cascade have been selected as the masters for time. Choose one controller as the time master from the LBP menu and set the others as slaves remotely.
106: Source temperature too low		0	---	No	See section <i>Heat pump protection functions</i> and section <i>Fault situations</i> .
107: Hot gas, compressor 1		2	Hot gas, compressor 1	No	Hot gas temperature is too high. This may be caused by expansion valve's perheating. If the error message keeps occurring, reach out to a refrigeration specialist to check the superheating.
108: Hot gas, compressor 2		2	Hot gas, compressor 2	No	
117: Water pressure too high	Hx	0	---	Yes	The Hx input has been assigned for pressure monitoring and the pressure in the monitored circuit is too high. Check the circuit's pressure and reduce it if required. Deselect the supervision if required.

Error message	Sensor/ connector	QTY	State	HP	Description
118: Water pressure too low	Hx	0	---	No	The Hx input has been assigned for pressure supervision and the pressure in the supervised circuit is too low. Check the circuit's pressure and increase it if required. Deselect the supervision if required.
121: Flow temperature LP1		0	---	Yes	Heating circuit 1's supply water sensor B1 gives a false reading. Check the sensor and its connection. Change the sensor if necessary.
122: Flow temperature LP2		0	---	Yes	Heating circuit 1's supply water sensor B12 gives a false reading. Check the sensor and its connection. Change the sensor if necessary.
134: Joint error, heat pump	E20	2	Fault	No	EX input has been configured with an error message that is active.
138: No heat pump control sensor		0	---	No	Sensor B71 or B4 missing. Sensor B71 is used for controlling the heat pump when the space heating circuit is not equipped with a buffer storage tank (additional storage tank). The buffer storage tank is controlled with sensor B4. Check the operation and connection of sensor B71/B4. Change the sensor if necessary.
146: Sensor/actuator configuration		0	---	Yes	The connection requires a sensor or actuator that has not been configured for use. Configure the inputs and outputs of the required sensors and actuators for operation.
171: Alarm contactor 1 active	H1/H31	0	---	Yes	Hx input has been configured with an alert message that is active.
172: Alarm contactor 2 aktiivinen	H2/H21/ H22/H32	0	---	Yes	
173: Alarm contactor 3 active	EX	0	---	Yes	
174: Alarm contactor 4 active	H3/H33	0	---	Yes	
176: Water pressure 2 too high	Hx	0	---	Yes	The Hx input has been assigned for pressure monitoring and the pressure in the monitored circuit is too high. Check the circuit's pressure and reduce it if required. Deselect the supervision if required.

Error message	Sensor/ connector	QTY	State	HP	Description
177: Water pressure 2 too high	Hx	0	---	No	The Hx input has been assigned for pressure supervision and the pressure in the supervised circuit is too low. Check the circuit's pressure and increase it if required. Deselect the supervision if required.
201: Frost protection alert	B21	0	---	No	Temperature measured by sensor B21 is below the frost protection limit.
222: Overpressure of heat pump operation	E10	2	Overpressure of heat pump operation	No	Section <i>Fault situations</i>
223: Overpressure in heat pump start	E10	0	---		
224: Overpressure in DHW start	E10	0	---		
225: Underpressure	E9	2	Underpressure		
226: Compressor 1 overload	E11	2	Overload, compressor 1	No	Compressor's motor protection (fuse) is in OFF position. If the fuse was triggered during operation, contact the maintenance personnel.
227: Compressor 2 overload	E12	2	Overload, compressor 1	No	Compressor's motor protection (fuse) is in OFF position. If the fuse was triggered during operation, contact the maintenance personnel.
228: Heat source's flow guard	E15	2	Heat source's flow guard	No	A flow guard that is unable to recognize the flow has been selected for input Hx. Check the flow and the guard. Decommission the flow guard if required.
229: Heat source's pressure guard	E15	2	Heat source's pressure guard	No	Hx input is selected for pressure supervision and the pressure in the supervised circuit is not within the permitted limits. Check the circuit's pressure. Decommission the pressure guard if required.
230: Source pump's overload	E14	2	Source pump's overload	No	Brine circuit's motor protection (fuse) is in OFF position. If the fuse was triggered during operation, contact the maintenance personnel.
243: Swimming pool sensor	B13	0	---	Yes	
260: Flow sensor 3	B14	0	---	Yes	
320: DHW charging sensor	B36	0	---	Yes	Sensor B36 (Cube) has an erroneous reading. Check the sensor and its connection. Change the sensor if necessary.
321: DHW consumption sensor	B38	0	---	Yes	Sensor B38 has an erroneous reading. Check the sensor and its connection. Change the sensor if necessary.

Error message	Sensor/ connector	QTY	State	HP	Description
324: BX, same sensors		0	---	Yes	Two BX inputs have been configured for the same sensor or actuator. Check the configuration and the automatic configuration of inputs on lines 6014, 7300 and 7375.
325: BX/ additional module, same sensors		0	---	Yes	
326: BX/ mixing group, same sensors		0	---	Yes	
327: Additional module, same function		0	---	Yes	
328: Mixing group, same function		0	---	Yes	
329: Additional module mixing group, same function		0	---	Yes	
330: BX1 no function		0	---	Yes	A sensor has been connected to the terminal but no function has been selected. Select a function for the sensor or remove it from the terminal.
331: BX2 no function		0	---	Yes	
332: BX3 no function		0	---	Yes	
333: BX4 no function		0	---	Yes	
334: BX5 no function		0	---	Yes	
335: BX21 no function		0	---	Yes	
336: BX22 no function		0	---	Yes	
337: B1 no function		0	---	Yes	
338: B12 no function		0	---	Yes	
339: Collector pump Q5 missing		0	---	Yes	A solar collector has been enabled from the service buffer tank's or an additional storage tank's settings, but an associated sensor or actuator has not been configured. Configure the required actuators for operation.
340: Collector pump Q16 missing		0	---	Yes	
341: Collector sensor B6 missing		0	---	Yes	
342: Sensor B31 missing (collector)		0	---	Yes	
343: Solar connection missing		0	---	Yes	The solar collector's actuators have been configured for use, but the connection to the service buffer tank or an additional storage tank is missing (lines 5093 and 4783).

Error message	Sensor/ connector	QTY	State	HP	Description
344: Solar collector function K8 missing		0	---	Yes	The solar collector's change valve has been enabled on line 5840, but it has not been assigned to any QX output. Having the valve is not mandatory for the piping if a combined DHW and heating circuit storage tank is in use. However, the valve must be enabled in the system. Select function K8 for a vacant QX output or change the setting on line 5840.
353: Cascade sens. B10 missing		0	---	Yes	Sensor B10 missing. Configure the sensor for use, connect it to the automation and install it in the piping.
355: 3-phase current asym.	E21/E22/E23	2	3-phase asymmetry	No	Automation's phase guard reports that there are faults. If the report concerns a device that is being installed and the compressor rotates in the wrong direction, switch the order of two phases with one another in the heat pump's current supply. Then try restarting the device. If the report is about a previously installed pump, check whether the phase order of the building's current supply has changed. If the fault cannot be located, contact maintenance.
358: Soft starter	E25	2	---	No	Soft starter's error message is configured to an EX input and the message is active. Fault in the soft starter. Check the connections and the soft starter's operation.
361:Source sens B91 miss		0	---	Yes	
362: Source sens. B92 missing		0	---	Yes	Sensor B92 is configured for use, but it has not been installed or it is malfunctioning. Check the sensor and connections. Change the sensor if necessary.
441:BX31 no function		0	---	Yes	A sensor has been connected to the terminal but no function has been selected. Select a function for the connection or remove it from the terminal.
442:BX32 no function		0	---	Yes	
443:BX33 no function		0	---	Yes	
444:BX34 no function		0	---	Yes	
445:BX35 no function		0	---	Yes	
446:BX36 no function		0	---	Yes	
447:BX6 no function		0	---	Yes	
452:HX1 no function		0	---	Yes	

Error message	Sensor/ connector	QTY	State	HP	Description
453:HX3 no function		0	---	Yes	
454:HX31 no function		0	---	Yes	
455:HX32 no function		0	---	Yes	
456:HX33 no function		0	---	Yes	
457:BX7 no function		0	---	Yes	
462:BX8 no function		0	---	Yes	
463:BX9 no function		0	---	Yes	
464:BX10 no function		0	---	Yes	
465:BX11 no function		0	---	Yes	
466:BX12 no function		0	---	Yes	
467:BX13 no function		0	---	Yes	
468:BX14 no function		0	---	Yes	
469:HX21 no function		0	---	Yes	
470:HX22 no function		0	---	Yes	
493: Outdoor temperature sensor	B9	0	---	Yes	Outside temperature sensor has not been installed or it is malfunctioning. Check the sensor and connections. Change the sensor if necessary



Contact information of Oilon dealer:

Date of installation:



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