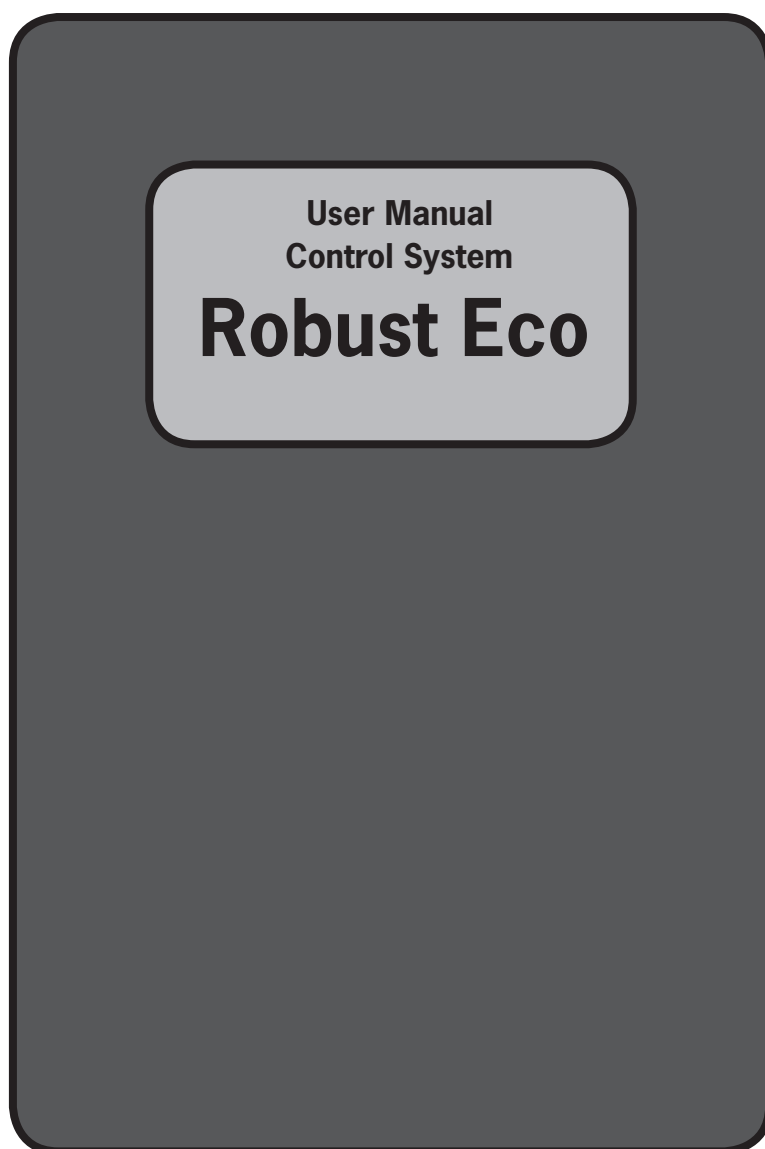


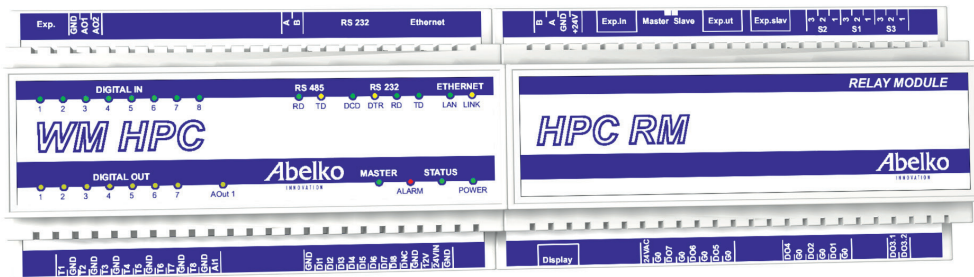


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1 Introduction

WM HPC is the control system that is mounted in and controls the heat pump. The control system can work in either master or slave mode. One pump in each plant, which can consist of one to eight heat pumps, must be configured as the master. In addition to controlling slave heat pumps, a control system in master mode can control expansion modules for a hot water charge system (WCS), tap water control (TWC), cooling, and up to eight shunt group modules.



The WM HPC designated as the master controls the plant's primary supply temperature. An outdoor temperature sensor, a primary supply temperature sensor, and the system primary circulation pump are all connected to the master control system. The master can also control auxiliary heating, which may be electrical, district heating, or oil or another kind of burner.

WM HPC has an operator panel on the front of the heat pump where the user can see and change settings, alarms, temperature set points, etc. WM HPC also has a web based user interface that is unlocked by purchasing a licence. The web interface makes it possible to monitor the plant and adjust settings over a network, modem, or the Internet from any computer with a web browser. With the web interface unlocked it is also possible to receive alarms from the controller by e-mail.

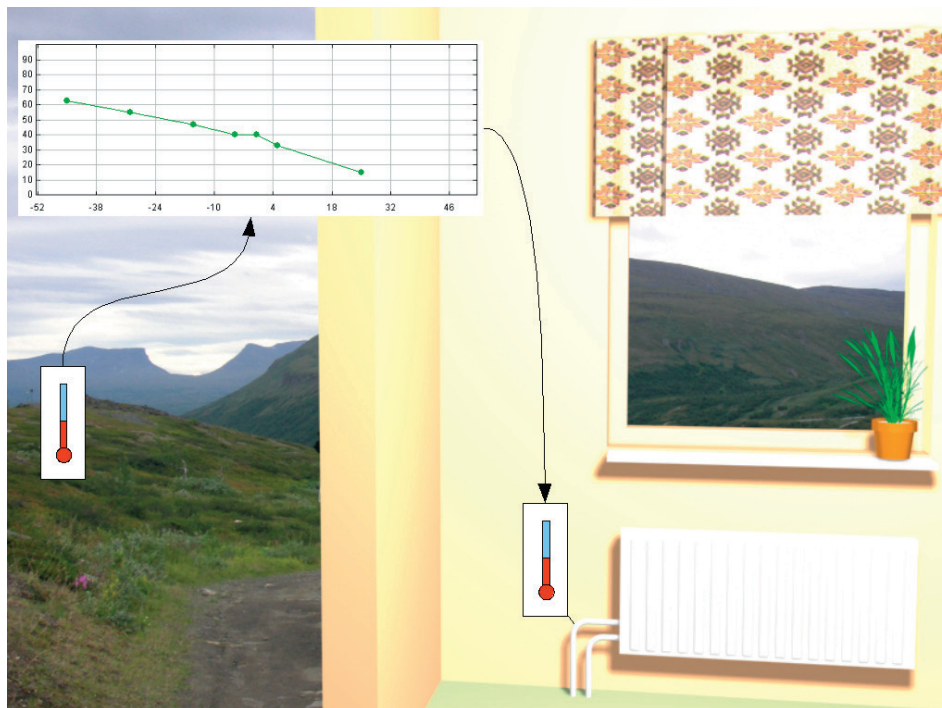
2 Functional description

2.1 Heating

2.1.1 Primary supply temperature

The heating control in WM HPC allows a building to be maintained at a comfortable temperature. It controls one or more heat pumps that produce heat, and can also start auxiliary heating when necessary. The primary supply is the pipe that provides heat to the building's radiators and other heat consumers.

The primary supply is maintained at a temperature that is based on the outdoor temperature. This temperature is measured and the desired primary supply temperature is looked up in a curve. This curve must be adjusted to fit the temperature needs of the specific building it is to control. The temperature that is looked up is used as a set point for the integral control.



2.1.2 Integral control

The integral control decides whether the heat pump, or several heat pumps, should run, and also if the auxiliary heater is needed. A heat pump can only be either on or off, and will therefore produce too much or too little heat. The goal for the control system is to produce just enough heat to keep the primary supply temperature close to the set point.

The integral value is calculated by adding the difference between the primary supply temperature and the set point to the integral every minute. The integral therefore has the unit degree minutes and represents the plant's energy balance. If the primary supply temperature is one degree above the set point for

one hour straight the integral value will grow to 60. If the supply temperature is too low, the integral value will decrease and become negative. When the temperature is precisely right the integral will not change at all.

There is a setting in the controller called Start hp1. This setting is for the integral value at which the first heat pump should start. It is a negative number. When the heat pump starts, it may be that it produces more heat than necessary. The integral value will then increase, and when it passes zero the heat pump is turned off. The primary supply temperature will, at average, have had the same temperature as the set point. Since a building's temperature changes slowly, the variations in the primary supply will not make a noticeable difference in room temperature.

The setting Delta start hp decides how much below Start hp1 the integral must drop before the next heat pump is started, and how much below that before the third starts, and so on, if the plant has multiple heat pumps.

If all the heat pumps are running but the integral still drops, then the auxiliary heater is needed. Start extra heater decides how much below the starting value for the last heat pump the integral must drop before the auxiliary heater is started. When it has dropped to the limit Full extra heater below the start limit or the last heat pump, the auxiliary heater will work at maximum power. Exactly how the auxiliary heater works depends on what type it is.

The integral is allowed to drop a little bit more according to the setting Integral dead zone, but then it is not allowed to become lower. On the positive side it is limited by the setting Integral max limit.

The integral value can be read on the pump display.



2.1.3 Auxiliary heater

The control system has one relay output Block. extra heater and one analogue 0 to 10 V output Extra heater, which can be used to control auxiliary heating of different types. When the plant is commissioned, the type of auxiliary heater, if any, is defined in the control system.

2.1.3.1 Burner

The auxiliary heater can consist of a burner for oil, gas, wood chips, or some other fuel. The burner must have its own control system and be capable of generating a constant high water temperature. The signal Block. extra heater can be used to turn off the burner completely. The analogue signal Extra heater controls a shunt valve that shunts out as much heat as needed from the burner subsystem.

The blocking of the burner is released when the integral reaches the limit for starting the auxiliary heater. When the burner starts it may be full of fairly cold water, and it will take a while for the burner to achieve the right water temperature. The shunt valve is therefore locked in the closed position for a period of time defined by the setting Heat up delay. After that time the burner is assumed to be able to deliver energy.

The shunt valve is controlled proportionally, so that it is fully open when the integral has reached the limit for full auxiliary heat and is closed when at the start limit.

When the shunt valve has been closed for a certain time it is reasonable to believe that the burner won't be needed for a while. It is turned off by the signal Block. extra heater. How long the delay should be before the burner is turned off is decided by the setting Burner off delay.

2.1.3.2 Electrical heater

An auxiliary heater in the form of an electrical heater with only one power setting is controlled using the signal Block. extra heater. The heater is started when the integral passes the limit for starting the auxiliary heater, and is turned off when it rises above the limit for starting the last heat pump.

When the heater is started it is controlled not only by the integral, but also by the controller error. If the difference between the primary supply temperature and the set point is greater than the value Turn off limit, the heater is turned off. As long as the integral value is not above the start limit for the last heat pump it is turned on again if the controller error goes below Turn on limit.

2.1.3.3 0 to 10 V

If the auxiliary heat comes from a district heating network, the WM HPC controls a shunt using the analogue signal Extra heater. This mode of auxiliary heat can also be used for other types of heaters that can be controlled with a proportional signal. One example is electrical heating with multiple power steps controlled by an analogue input.

The signal Extra heater is at 100% (10 V) when the integral has reached the auxiliary heater maximum limit and is zero at the auxiliary heater start limit.

A district heating system will usually not need the signal Block. extra heater, but it is still available. The blocking is lifted when the integral passes the auxiliary heater start limit, and is blocked again when it rises above the start limit for the last heat pump.

2.1.4 Seasonal stop

During the warm season there is usually no need to warm the building. However, the outdoor temperature may temporarily (at night time) fall enough

for the control system to start a heat pump. To avoid this, the functions for seasonal stop can be used.

When the outdoor temperature is persistently above the limit Heat stop limit seasonal stop is activated. This means that no heat pumps are allowed to produce heat, and the auxiliary heater is blocked. Furthermore the main circulation pump is stopped.

What is meant by persistently is defined by the time limit Activation time lim.

In order for the seasonal stop to be released, the outdoor temperature must be at least Heat stop hyst degrees below Heat stop limit for at least Deactiv. time lim hours.

The seasonal stop could cause the main circulation pump to stand still for a long time. There is therefore a pump exercise function. Once every day the circulation pump is started and run for one minute. The pump exercise times can be adjusted.

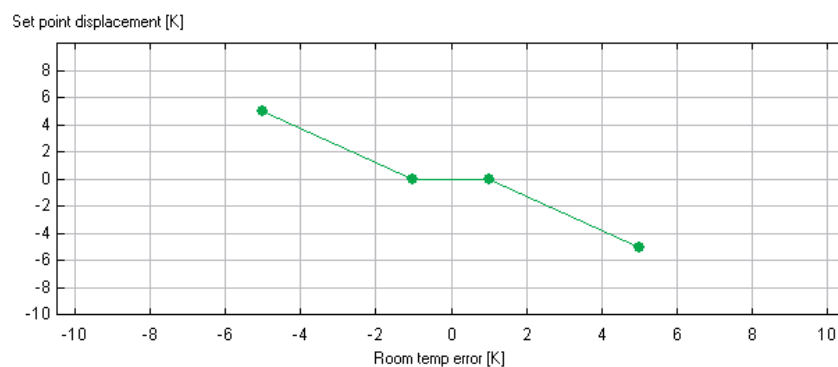
The auxiliary heater can be blocked earlier, at lower temperatures. There is a separate outdoor temperature limit and hysteresis for blocking the auxiliary heating, but without the time limits.

2.1.5 Room temperature feedback and curve displacement

It is possible to connect a room temperature sensor to the control system for the master pump. Using the room temperature feedback function, the primary supply temperature set point can be adjusted if the indoor temperature gets too warm or too cold.

In the controller, the desired room temperature is set Room set point and the feedback strength is adjusted. Zero deviation in the curve Curve room temp feedback corresponds to a perfect room temperature. It is a good idea to not have any curve adjustment for deviations close to zero, in order to avoid self excitation.

The room temperature feedback function can be complemented with a time based adjustment of the room temperature set point. In the week schedule



Calendar room temp desired time periods when a different temperature set point is desired can be entered. How much the set point is to be adjusted is entered in the setting Calendar offset.

The setting Curve offset provides a mean to manually shift the whole set point curve for the primary supply temperature, affecting the set point equally for all outdoor temperatures.

2.1.6 Temperature limits and forced starts and stops

The primary supply set point curve, together with room feedback and manual adjustment, can result in virtually any value for the primary supply set point. In order to ensure that the primary supply temperature stays within reasonable limits there are settings for how high and low the set point may be. These settings are Max system temp and Min system temp.

The integral changes relatively slowly. After a system restart, for example after a power failure, it may take a while for heat production to start, as the integral starts at zero. In order to speed up the heating after a restart it is possible to activate forced start conditions. If the primary supply temperature falls more than Lim force hp start degrees below the set point, the integral is forced to the starting value for the first heat pump, unless that limit has already been passed. If the controller error falls below Lim force eh start, the integral is set to the start auxiliary heater limit.

Forced stops works in a similar way when the primary supply temperature gets significantly higher than the set point. The auxiliary heater is stopped when the controller error is two degrees below Lim force hp start. The heat pumps are stopped exactly at the Lim force hp start limit.

The forced starts and stops are inactivated if these settings are set to zero.

2.2 Hot water

2.2.1 Basic settings

Every pump has a setting that decides whether it can be used to make hot water or not. Heat pumps that can produce hot water have a switchover valve that switches from heat production to hot water production.

The factory setting is that hot water production is stopped when the operating pressure switch is triggered. This setting can be changed so that it instead stops when a temperature limit is reached.

2.2.2 System settings

The master pump controller contains settings to define whether the plant uses double jacketed hot water heaters or a heat exchanger. If the plant uses a heat exchanger, the WCS module is needed.

2.2.3 Hot water production

The sensor Hot water start sensor measures the temperature of the water going in to the hot water heater. When this falls below a certain limit (Start limit) a hot water pump is started to produce hot water. Hot water production has priority over building heating, so if there is a pump already running to heat the building it switches over to produce hot water.

If the temperature continues to drop, more heat pumps are used to produce hot water. The setting Delta limit next hp decides how much the temperature is allowed to drop between each heat pump start.

If the heat pumps are set to stop producing hot water at a certain temperature, they will be stopped in the same manner as they were started as the hot water heating temperature starts to reach the Stop limit setting. However, the default setting is that the pumps continue to produce hot water until the operating pressure switch is activated.

When a heat pump stops producing hot water it will instead produce heat for the building, if there is a demand for heat.

2.2.4 Top-Up function

Before hot heat production is turned off, the Top-Up function performs a check to see whether it can top up the hot water first. If the hot water temperature is lower than Top up temp limit degrees over the limit Start limit it will produce hot water instead of stopping immediately. The Top-up function is by default inactivated.

2.2.5 Systems with hot water heat exchanger and WCS

The WCS-module measures one charge temperature Wcs temperature and controls one charger circulation pump and one valve.

If the heat pump hot gas circuit is connected to the heat exchanger for hot water production the hot gas function should be activated. This causes the charger pump to always be on. Otherwise it runs only when the heat pump is producing hot water.

When the charger pump is running the valve is controlled to keep the charge temperature constant. Directly after the charge pump is started the valve opens fully, and is kept fully open for a number of seconds defined in the setting Wcs ctrl start delay.

The set point for the charger temperature is defined in the setting Wcs set-point. The controller is a PD-controller with the controller parameters Wcs p-area and Wcs d-factor.

2.2.6 Final hot water heater with TWC

The TWC (Tap Water Control) module monitors and controls an electrical hot water heater to ensure that the water at the tap points is the right temperature. The module controls the electrical heater and measures temperatures on both the outgoing water and the re-circulated water. If either of these temperatures falls outside the set limits alarms are generated.

When the heater starts and stops is decided by high and low limits on both the outgoing and re-circulated water. The upper limit for outgoing temperature has the highest priority to avoid burn hazards. Different start delays are used for the outgoing and return temperature limits.

A special legionella function is designed to ensure that all legionella bacteria in the final heater are killed. A week schedule defines when to start a legionella heat run. When started the heater will be on until the water reaches the legionella stop temp. The week schedule is not activated in the factory default setting, but can be set to run once a week if heater seldom reaches high temperatures in normal operation.

2.3 Heat pump restrictions

2.3.1 Time restrictions

The heat pump has two time conditions that must be met if it is to be allowed to start. One states that when stopped it must be standing still for at least five minutes before it can start again. The other states that any two starts must be at least 20 minutes apart. This time limit can be changed using the setting Min start interval.

The display on the pump shows whether it is blocked by a time condition, and how many seconds are left until it is allowed to start again.

2.3.2 Return temperature

If the temperature on the pump return reaches a threshold, an alarm is generated and the pump stops. This alarm is inactivated when the pump is making hot water, and the alarm does not prevent the pump from making hot water. The default setting for the threshold is 48 °C.

2.3.3 Brine flow guard / pressure guard

In each heat pump there is a setting that tells whether the brine flow is monitored by an external flow guard or pressure guard. If a flow guard is activated there is an alarm with an adjustable delay that stops the pump on error.

If the pressure guard is selected a choice can be made whether the alarm should stop the pump or not.

2.3.4 Brine monitoring

In the master pump controller a function for brine monitoring can be activated.

This function can be used, for example, to avoid very low brine temperatures, to prevent freezing on the tubing.

The brine temperature sensors on all running pumps are used in the monitoring. For outgoing brine there is a low temperature limit. For incoming brine there is both a low and a high temperature limit. If any of these limits are exceeded for a preset period of time a temperature violation has occurred. The number of running heat pumps is then limited to one less than those currently running. If the temperature violation persists, the number of running pumps is limited further.

When the temperature violation ceases, the limitation is gradually lifted.

2.4 Shunt groups

Up to eight shunt modules can be connected to the control system. A shunt module can control one circulation pump and one shunt valve, and measure one temperature. The purpose of the shunt module is to control the measured temperature using the shunt valve. The functionality can be configured for the cases described below.

The controller is a PI-controller. An alarm is generated if the controller error exceeds a settable limit.

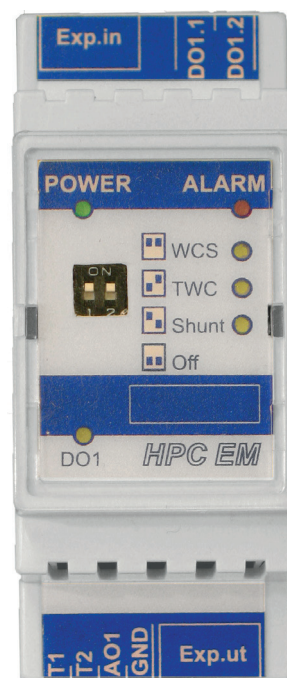
2.4.1 Outdoor compensated curve

If the outdoor compensated curve function is selected for the shunt group, the controller set point will be dependent on the outdoor temperature. A curve is used to define different set points for different temperatures.

The circulation pump and the shunt valve will be closed if the outdoor temperature exceeds the limit Shunt 1 outdoor temp. stop. The pump and the controller are started again when the outdoor temperature falls below the limit with a hysteresis. While stopped the circulation pump is exercised at regular intervals.

2.4.2 Curve with seasonal stop

Curve with seasonal stop is the same functionality as is used in the outdoor compensated curve, but with the difference that it uses the master heat pump's settings for seasonal stop to stop the circulation pump and shunt con-



troller. When this functionality is selected, there are no individual stop limits for the shunt group.

2.4.3 Constant heat

Constant heat is used to maintain a constant temperature, independent of the outdoor temperature. In all other respects, the functionality is equivalent to that of the outdoor compensated curve.

2.4.4 Constant cooling

Constant cooling is used to control a cooling circuit at a constant temperature.

This function is similar to that for constant heat, but is designated for cooling. This means that the circulation pump and controller are stopped when the outdoor temperature falls below a configurable stop limit.



2.5 Cooling

With a cooling system the cold side of the heat pumps are used to generate comfort cooling, or cooling for other purposes. To control a cooling system the module HPC-CM is used.

2.5.1 Cooling tank and integral control

A cooling tank is used to store chill water. The temperature in the tank is measured and compared to a set point. The difference is integrated, and just as for heat production the cooling integral is used to control how the tank is cooled. When the temperature in the cooling tank gets too high the integral becomes more positive. When the cooling integral passes the limit Start pas-sive cool. The system begins cooling the tank using passive cooling. This means that the brine is circulated through the cooling tank and the bore hole without any heat pump being started. The energy from the cooling tank is transported to the bore hole.

A prerequisite for passive cooling to work is that the brine temperature is lower than the temperature in the cooling tank. The limit Temp diff limit defines how much cooler it has to be for the valve to the tank to open. There is also a

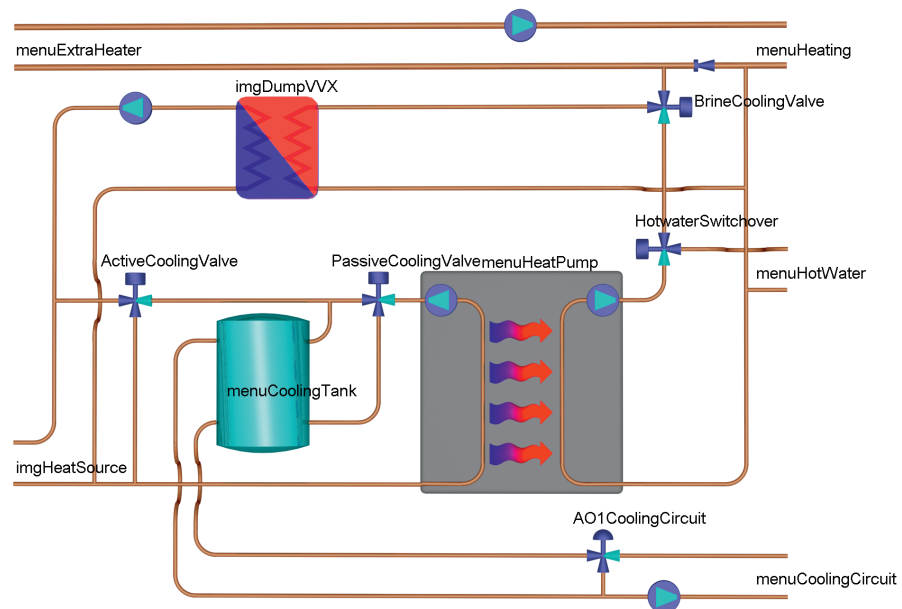


delay from the start of the brine circulation pump to the opening of the valve, so that cold brine fluid has time to be pumped up from the hole.

As the cooling integral passes the limit for active cooling a heat pump is started. The heat pump will lower the temperature on the brine before it enters the cooling tank. If the integral continues to rise, more heat pumps will be started.

The valve for active cooling will change position and disconnect the bore hole.

The brine will then circulate only through the cooling tank and the heat pumps, so that maximum heat is removed from the cooling tank.



2.5.2 Surplus heat dumping

The heat produced when a heat pump is started for cooling is, as a first option, used to make hot water or to warm the building, if such demands exist. When these demands are met, the heat has to be dumped. This can be done in two ways. One way is to move the heat from the heat pumps warm side, through a heat exchanger, over to the brine and store it in the bore hole. The other option is to vent it away using a surplus chiller. The surplus chiller is activated by the Config cooling setting.

If the surplus chiller is used, a PI-controller is used to control cooling fans, with settings for set point, P-area, and I-time.

2.5.3 The cooling circuit controller

A cooling circuit is used to move the cold from the cooling tank to where it is needed. A shunt valve and a controller keep the temperature on the cooling circuit constant. This controller has settings for set point, P-area, and I-time.

The HPC-CM module has inputs for a humidity sensor that measures both room temperature and relative humidity. When connected, the dew point control can be activated. The control system will then calculate the dew point, and if necessary raise the cooling circuit set point to avoid condensation.

2.5.4 Blocking cooling

The cooling circuit can be blocked by low outdoor temperature. A temperature limit, with hysteresis, blocks the use of active cooling. Another limit blocks passive cooling. When passive cooling is blocked, the cooling circuit controller and circulation pump are stopped. The circulation pump is exercised at regular intervals.

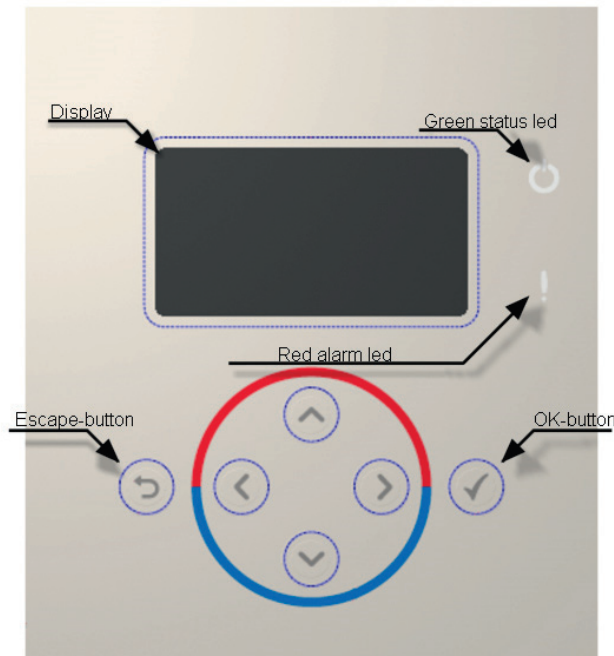
3 Using the controller

3.1 The operator panel

The operator panel on the front of the pump has a display, a six button keypad, and two indicator LEDs. The green LED indicates that the control system for the heat pump is running and working. If it is flashing the display is powered, but it cannot communicate with the control computer.

When the system is running, the arrow keys are used to navigate menus and to change settings. The Ok-button is used to enter a menu, and to start and finish the editing of a setting. The escape button is used to back out from a menu and to abort editing without saving the value.

The red alarm LED is lit when an alarm is active. If there are alarm that needs to be acknowledged the LED will flash.



When the operator panel is started it first runs a “boot loader” software. This software waits until it can communicate with the control system and checks if the main program needs to be updated. During this time the red LED will blink very fast. If the main operator panel program loses communication with the control system for a minute or more it will start the boot loader again. This happens if the WM HPC is restarted.

3.2 Menus

On the top level there are 11 menus that you can scroll through using the left and right arrow keys. In the controller for a slave pump there are fewer menus.

If you don't touch the buttons on an operator panel for 15 minutes, it will enter a basic mode where it shows an overview menu. In the controller for a master pump it will alternate between three overview menus. If an alarm becomes active, the active alarms menu is shown.

The menus Heat pump state, Master state, and Hp overview are overview menus. It is not possible to use the up and down arrow keys in these menus. A slave heat pump has only the Heat pump state overview menu.

In the other menus, Active alarms, Alarm history, Operation mode, Information, Settings, Accessory modules, System settings, and Language, individual menu elements can be selected using the up and down arrow keys. The active menu element will be indicated by underlining. Sub menus are written in capital letters and marked with ... A selected sub menu is opened when Ok is pressed. If the selected menu element is a value or setting that can be changed, the editing mode is entered when Ok is pressed. The value to be edited then starts to blink, and is changed using the up and down arrow keys. Some values can only be increased or decreased; others are edited one number or letter at a time. Select the number to edit using the right and left arrow keys. To end and save an edit, press the Ok button. To abort, press escape.

To return to a menu on a higher level, press escape.

Before entering the edit mode for the first time the user will be prompted for a password. The password is a four letter code, default set to 1234. Edit one letter at a time and then press OK. If the wrong password is entered three times there is a delay before a new attempt can be made. Once entered the user will be logged in until logging out by pressing escape at the top menu level, or until after 15 minutes of inactivity.

3.3 Alarms

The menu Active alarms shows all the alarms that are currently active, if there are any. The alarms monitor the occurrence of errors. Some alarms indicate serious malfunctions that may cause the heat pump to be damaged, or disabled. These alarms are classified as A-alarms, and the heat pump cannot run as long as an A-alarm is active. Other alarms are classified as B-alarms, which does not necessarily mean that the fault is not serious, but it will not prevent the heat pump from starting.

Alarms can work in three different ways. Some alarms need to be acknowledged before they become inactive. Before acknowledging, make sure that the fault causing the alarm has been corrected. Other alarms will automatically become inactive when the fault condition is gone. The third kind of alarm will automatically become inactive, but will remain in the list of active alarms until acknowledged. This is to make sure that the operator notices the event.

If one alarm in the list of active alarms is selected and Ok is pressed, more information about that alarm is displayed. Press Ok again to acknowledge the

alarm. The operator acknowledging an alarm gets the opportunity to enter a signature of up to three letters.

In the menu Alarm history all alarms, events and errors that have occurred lately can be seen. One alarm at a time is displayed in chronological order, with the most recent displayed first. Change the displayed alarm using the up and down arrows. Alarms are first noted in the list when they become active, and then again when they become inactive or are acknowledged. Errors are alarms that concern the internal workings of the control computer. A system restart is an example of an occurrence that is noted as an event in the alarm history. It is thus possible to see whether there has been a power failure.

3.4 Operation mode

In the menu Operation mode, the heat pump and the whole plant, or parts of it, can be turned off and on. The heat pump mode should normally be set to Auto, but can also be set to Standby, Only Heat, or Only Hotwater.

If it is the master heat pump, similar settings are available for the master functionality, along with settings to inactivate expansion modules.

3.5 Information

The menu Information has several sub menus with different types of information about the status of the system. Under Temperatures all measured temperatures are listed, as well as some calculated temperatures and integral values. Exactly what is in this list depends on the configuration.

Operation mode lists status information about the heat pump and the rest of the system. Under Running time run time information is found.

Under Databases the values stored in databases are listed. First select one category and press Ok, then select a value. Press Ok to display a graphical plot showing how the value has changed in recent time. The seconds category contains values that changes fast, like shunt signals. The last 20 minutes of history can be viewed. Minutes displays temperatures and signals that changes more slowly. One value is saved every minute, and the last 24 hours can be seen.

Hours saves one value every hour and the history of the last thirty days can be seen. Hours Mean, Max and Min are similar, but do not store instant values but the mean value, highest and lowest values of the hour respectively.

The database plot is shown with current time at the rightmost position. The x axis has a fixed scaling and the y axis is auto scaled to fit the data. The grid and labels can be hidden to not obscure the plot by pressing the down key.

3.6 Settings

The menu Settings has sub menus with settings for different parts of the system. In a slave pump controller there are only heat pump settings, but the master has much more. These settings are briefly explained below.

3.6.1 Heat pump Operational mode

This setting decides what the heat pump can do. Standby means that the heat pump is turned off and Auto that it is controlled by the master controller. Heat only and Tap water only are settings that allow the master to control the heat pump, but only to make heat or tap water.

Hot water production

This setting tells the control system whether this heat pump can be used to make hot water or not.

Compressor delay

When the heat pump starts, the compressor is started some seconds after the brine pump. This setting decides how long the delay should be.

Min start interval

In order to prevent the heat pump from starting and stopping too often, this setting decides the minimum time between two starts.

Control press delay

If the control pressostat is active for longer than this setting specifies, an alarm is generated and the heat pump is stopped.

Cp while heating

This setting enables or disables the alarm for the control pressostat when the heat pump provides heat and hot water (if “hot water stop” control pressostat is selected).

Hot water stop cond.

This setting decides whether the heat pump should stop making hot water when the hot water temperature limit is reached, or whether it should continue as long as possible until the control pressostat triggers.

Return temp limit

Alarm limit for high temperature on heat pump return. When the alarm is triggered, the heat pump is stopped until the temperature drops. This alarm is disabled when the heat pump is making hot water.

Maxrettemp hw delay

The return temperature alarm is also blocked for a while when it has stopped making hot water. This setting decides for how long.

Tempdiff Brine

This is an alarm limit that triggers an alarm when the difference between the brine inlet and outlet temperatures becomes greater than the limit. A large

difference makes the heat pump less efficient and is an indicator of low brine flow, which may be caused by a clogged filter.

Pressure/flow guard

This setting tells the control system whether the brine flow is monitored using a flow guard or a pressure guard.

Alarm delay

Alarm delay for flow guard.

Alarm class

This setting decides whether the brine flow alarm should be an A-alarm or a B-alarm.

3.6.2 Heating

Control curve supply temp

A set point curve that determines the primary supply temperature set point at different outdoor temperatures. Each point in the curve can be edited, and there is a setting Curve offset that provides parallel displacement of the whole set point curve.

Room temp feedback

This setting activates or disables room temperature feedback.

Room set point

Room temperature set point, used only when room temperature feedback is activated.

Curve room temp feedback

A curve that decides how much the set point curve is to be adjusted at different room temperature deviations from the set point.

Calendar room temp

A week schedule that decides at what times the room temperature set point should be adjusted. Can be used to lower temperatures at night. The setting Calendar offset decides how much the room set point is to be adjusted when the week schedule is active.

Max system temp

The highest value allowed for the primary supply set point.

Min system temp

The lowest value allowed for the primary supply set point.

Integral max limit

The highest positive value allowed for the heat integral.

Start hp1

Integral limit for start of the first heat pump.

Delta start hp

Setting that determines how much the integral is allowed to sink between starts of additional heat pumps.

Start extra heater

Determines, after all the heat pumps have been started, how much the integral is allowed to sink before the extra heater is allowed to start.

Full extra heater

Determines, after all heat pumps have been started, how much the integral is allowed to sink before the extra heater is run at maximum power.

Integral dead zone

Determines, after the extra heater is at maximum power, how much the integral is allowed to sink before the value is limited.

Lim force hp start

If the primary supply temperature falls below the set point more than this setting allows, one heat pump is immediately started, unless one is already running to make heat.

Lim force eh start

If the primary supply temperature falls below the set point more than this setting allows, the integral value is set to the limit for the start of the extra heater, unless that limit has already been passed.

3.6.3 Extra heater

Extra heater type

This setting defines the type of extra heater that is controlled by the system.

Additional shunt function

With this feature, you can choose whether to use temperature control or integral control. Temperature control means that the shunt valve regulates towards the setpoint. Integral control means that the shunt regulates towards the integral value.

Heat up delay

Heat up delay time, from when the extra heater blocking is released, starting the burner, until the shunt valve starts to use heat from the burner subsystem.

Burner off delay

Delay from when the valve is shut off completely until the burner is turned off.

Turn on limit

An extra heater in the form of an electric heater that can only be on or off is controlled not only by the integral value, but also by temperature limits. If the primary supply temperature sinks below the set point more than this limit allows, the heater will be started, provided that the integral is within the work area for the extra heater.

Turn off limit

The electric extra heater will be turned off if the primary supply temperature exceeds the set point by more than this limit allows.

3.6.4 Heat stop

Heat stop limit

Outdoor temperature limit for blocking heat production.

Heat stop hyst

This setting determines how much below the stop limit the outdoor temperature must fall for the heat production blocking to be lifted.

Activation time lim

This setting determines how long time the outdoor temperature must exceed the stop limit before heat stop is activated.

Deactiv. time lim

Time limit for how long time the condition for lifting the heat blocking must be fulfilled before the block is lifted.

Pump exercise interval

Time interval for pump exercise of the main circulation pump during heat stop.

Pump exercise time

This setting determines how long the main circulation pump is to run during pump exercise.

3.6.5 Brine control

Brine control

Activates the brine control function with limitation of the maximum allowed number of running pumps.

Brine out min temp

Lowest allowed temperature for outgoing brine.

Brine in min temp

Lowest allowed temperature for incoming brine.

Brine in max temp

Highest allowed temperature for incoming brine.

Time limit

Time limit before the number of running pumps is limited.

3.6.6 Hot water

Start limit

Temperature limit for when a heat pump is started to make hot water.

Delta limit next hp

Temperature step size for the start of additional heat pumps to make hot water. Is also used to reduce the number of running heat pumps as the temperature approaches Stop limit.

Stop limit

Temperature limit for when hot water production should stop, for the heat pumps not set to stop when the control presostat is triggered.

Top up function

Activation and deactivation of the top up function.

Top up temp limit

This setting determines how much below Stop limit the temperature must be for the top up function to be allowed to order a heat pump to produce hot water instead of stopping.

3.6.7 WCS wcs**setpoint**

Set point for the water charge system.

WCS p-area

P-area for the WCS-controller.

WCS d-factor

D-factor for the WCS-controller.

WCS ctrl start delay

When the circulation pump is started, the valve is first completely opened. This setting decides how long the valve is to be kept fully open before the WCS controller takes over.

Min valve signal

If the valve should not close completely, this setting defines the minimum shunt signal.

3.6.8 TWC Start**temp out**

Temperature limit on the hot water outlet for starting the heater.

Stop temp out

Temperature limit on the hot water outlet for stopping the heater.

Start temp return

Temperature limit on the hot water recirculation return for starting the heater.

Stop temp return

Temperature limit on the hot water recirculation return for stopping the heater.

Start delay out

Delay time for starting the heater due to low hot water outlet temperature.

Start delay return

Delay time for starting the heater due to low hot water recirculation return temperature.

Alarm limit TWC out

Temperature limit for the low outlet temperature alarm.

Alarm delay TWC out

Alarm delay for the low outlet temperature alarm.

Alarm limit TWC in

Temperature limit for the low recirculation return temperature alarm.

Alarm delay TWC in

Alarm delay for the low recirculation return temperature alarm.

Legionella stop temp

Stop temperature for the legionella run function.

Legionella calendar

Week schedule for start of legionella runs.

3.6.9 Shunt groups

Each of the eight shunt groups that can be installed in the system has its own sub menu. Settings for a shunt group can be changed even if it is not active or installed.

Shunt 1 controller type

Select the shunt group function.

Shunt 1 curve setting

Set point curve where the set point for different outdoor temperatures is set. Only for outdoor temp compensated shunt groups.

Shunt 1 set point

Set point for shunt groups keeping a constant temperature.

Shunt 1 outdoor temp. stop

Outdoor temperature at which the circulation pump and controller for the shunt group is stopped.

Shunt 1 hysteresis

Hysteresis for restarting the circulation pump and controller.

Shunt 1 p-area

P-area for the shunt controller.

Shunt 1 i-time

I-time for the shunt controller.

Shunt 1 pump exercise time

This setting determines how long time the circulation pump should be exercised during each 24 hour period when stopped due to the outdoor temperature limit.

3.6.10 Cooling

The first element in the menu for cooling is the setting Config cooling, which determines the cooling module's operation mode. Below this are sub menus for settings regarding cooling subsystems.

3.6.10.1 Cooling tank

Tank set point

Set point for the temperature in the cooling tank.

Hysteresis, forced start and forced stop of cooling

If the cooling tank temperature exceeds set point "cooling tank" with the value set on the hysteresis, the cooling production is forced to restart, although the integral is not met. The same is also applicable if the cooling tank temperature falls below the set value of hysteresis, then it is forced to stop even though the integral value has not yet reached 0.

Start passive cool.

Integral value for the start of passive cooling.

Start active cool.

This setting determines how much the integral should rise over the start point for passive cooling before active cooling is started.

Delta start hp

Integral step size for the start of additional heat pumps for active cooling.

Temp diff limit

To be able to cool the cooling tank with the brine fluid the brine temperature must be lower than the temperature in the cooling tank. This setting determines how much cooler it has to be before the valve to the cooling tank is opened. Setting the value to zero disables the control completely.

Circulation delay

To allow cold water to be pumped up from the bore hole to the cooling tank before the valve is opened this setting defines a delay that begins when a brine circulation pump is started. Longer pipes make longer delays necessary.

3.6.10.2 Cooling circuit

Cool circ. set point

Set point for the cooling circuit.

Dew point control

Activates and deactivates the dew point control. Dew point control requires an air humidity sensor.

P-area

P-area for the cooling circuit controller.

I-time

I-time for the cooling circuit controller.

Pump exerc. interval

Pump exercise interval for the cooling circuit circulation pump.

Pump exerc. time

This setting determines how long time the pump is run when exercised.

3.6.10.3 Blocking Active block limit

Outdoor temperature limit for blocking active cooling. Below this temperature active cooling will not be used.

Hysteresis active

Hysteresis for blocking active cooling. The outdoor temperature must rise above Active block limit by at least this much for active cooling to be unblocked.

Passive block limit

Outdoor temperature limit for blocking passive cooling. Below this temperature no cooling is used.

Hysteresis passive

Hysteresis for blocking passive cooling. The outdoor temperature must rise above Passive block limit by at least this much for passive cooling to be unblocked.

3.6.10.4 Surplus cooler

The settings in this menu are used only if the plant has a surplus chiller.

Cooler set point

Set point for the surplus chiller controller. This is the temperature it will try to cool down to.

P-area

P-area for the surplus chiller controller.

I-time

I-time for the surplus chiller controller.

3.6.11 Manual override

The manual override sub menu lists all the outputs and some other signals that can be manually overridden. In one setting the value to override the controller is chosen, and another activates and deactivates the override. When a manual override is deactivated the controller instantly takes over the signal.

In the event that an operator forgets to deactivate a manual override, the signal will automatically return to automatic after 30 minutes. It will also return to automatic when the system is restarted.

The first item in the menu is the setting for fast mode. This setting can be

used when the system is tested, and makes the integral change 60 times faster than normal. This setting will not automatically be disabled.

3.7 Expansion modules

This menu is used to install and uninstall expansion modules. Every type of expansion module has its own sub menu. All connected and working modules are listed under respective menu. In these menus they are identified using the serial number. The serial number is printed on each module.

3.7.1 Slave pumps

It is not necessary to activate a slave heat pump in order for it to start to work. They will start to work as soon as they are connected and powered. If a slave pump loses its connection to the master it will raise an alarm. If an alarm is also desired in the master controller, the slave pump has to be active.

To remove a slave pump without raising an alarm in the master it has to be deactivated. The serial number seen in the menu is the serial number of the controller unit WM HPC. You can read it on the left terminal connector on the lower side. If a WM HPC is replaced in a heat pump the master will see it as a completely new heat pump. The old one then has to be deactivated and the new one activated.

3.7.2 WCS, TWC, and Cooling

There can only be one of each of these three module types installed in the system. If there is more than one of the same kind it will not work. WCS, TWC, and Shunt are actually the same module, HPC EM. The functionality is selected by dip switches on the front, and if these are set wrong the module will be shown in the wrong sub menu list.

These modules will not work until activated.

3.7.3 Shunt groups

Up to eight shunt modules can be connected and active in one system. All shunt modules are listed in the shunt menu. You not only select whether a shunt module is to be activated or not, you must also assign it to a shunt group. In the settings menu there are settings for shunt groups one through eight. In the expansion module menu you decide which module is in shunt group one, two, etc.

A shunt module is an HPC EM with the dip switches set to shunt functionality. The serial number is printed on the front of the module.

3.8 System settings

Under system settings there are settings related to the control system itself, the WM HPC.

3.8.1 Serial number

This menu shows the serial number for the WM HPC.

3.8.2 Menu navigation

This setting turns menu navigation on and off. When active, a menu code is shown for every menu when navigating the operator panel. This code tells you where in the menu tree you currently are.

3.8.3 Clock

In this menu the internal clock can be set. The clock is used for the week schedule for room temperature and to set time stamps on alarms and events. The clock has internal backup and can keep running for a few days without external power.

3.8.4 Password

In the password menu you can change the password for the operator panel. The default password is 1234.

General alarm

In sub-menu Sum alarm you can select inactive, A and B alarms or A alarm.

3.8.5 Network

In this menu you can see and change network settings such as IP-number, net mask, and gateway.

3.8.6 Email

In this menu you can see and change settings for e-mail and e-mail recipients. However, the E-mail sending of alarm messages can only be activated through the web interface.

3.8.7 Sms

In this menu you can see and change settings regarding SMS. SMS can only be used when a compatible GSM/GPRS modem is installed. SMS sending of alarm messages can only be activated from the web interface.

The first setting is a max limit for how many alarms are allowed to be sent during a 24 hour period. This limit is there to prevent badly set alarm limits and frequently reoccurring errors from spending too much money on SMS. When the max limit has been reached, a final SMS is sent informing the receiver that no more SMS will be sent until the SMS alarm is acknowledged.

Up to four phone numbers for SMS receivers can be defined. Remember that the complete number, including the country code, has to be entered. The test function can be used to send a test SMS to verify that the modem and telephone numbers are working.

Modbus

In this menu you can see and change settings for e-mail and e-mail recipients. However, the E-mail sending of alarm messages can only be activated through the web interface.

3.8.8 Restart

This menu contains a command to restart the heat pump controller system without an interruption in power.

3.8.9 Factory settings

This menu contains a command to reset all settings to factory default. The password and network settings are left unchanged.

3.8.10 Local backup

The WM HPC contains an option allowing you to save all present settings internally. These saved settings can later be reactivated. When reactivated, all settings are overwritten with the saved settings. The password and network settings are left unchanged.

3.8.11 Version numbers

This menu allows you to read the version numbers for the firmware, application script, and web pages. When there are problems this can be important information for the support to know.

3.8.12 Software upgrade

Software upgrade is a command to temporarily set the passwords for web access to standard values so that you can upgrade software in the WM HPC, even if you do not have the web licence. The password for the config login level is set to "ef56" for 30 minutes. At the same time the web user interface will be disabled. What you can do is to run an upgrade software that uses Ethernet to upgrade software in the controller.

After 30 minutes the web passwords are reset to the values you get when you buy the web license, regardless what they were before.

3.8.13 Restore passwords

Restore passwords resets the passwords for web access to the passwords you get when buying a web licence. This command can be used when the passwords have been changed and forgotten.

The password for operator panel access is not affected. If this password is forgotten it can be changed from the web interface.

3.9 Language

In this menu you select the language you prefer to use on the operator panel. The menus on the top level are ordered in a circular manner, so that all menus can be reached regardless of stepping to the right or the left. If the first thing you want to do after power up is to set the language, the language menu is one or a few steps to the left.

Step down to the language setting and press OK. When the text is blinking use up and down arrow keys to select language, and then press OK again.

Clear alarm log

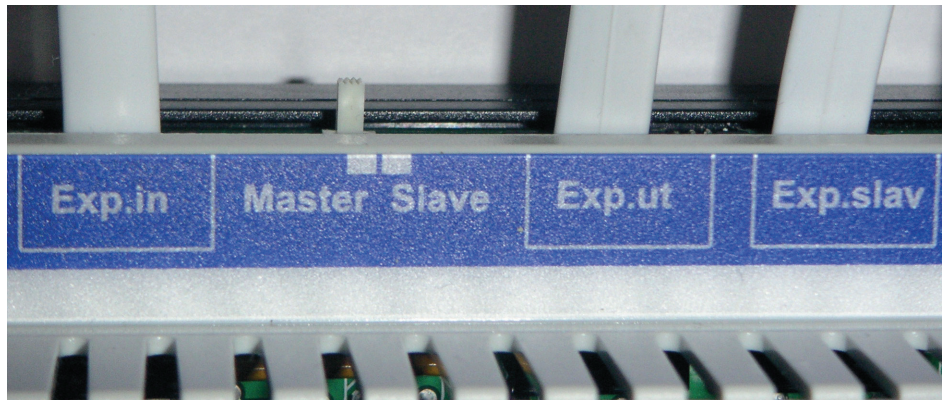
Removes all the alarms in the alarm log.

4 Commissioning

4.1 Basic settings

4.1.1 Master or slave

Each plant must have exactly one heat pump configured as master. If there is more than one pump the others have to be configured as slaves. The master/ slave setting is done by a small switch in the controller cabinet. The switch is on the upper side of the HPC-RM module. Set this switch to the rightmost position to make the heat pump the master, or leftmost to make it a slave. The control system has to be restarted for a change to take effect.



When the controller computer WM HPC has started and is ready, which takes about a minute, the green status LED is lit. If the master LED is also lit, the device is in master mode. If not it is in slave mode.

When connecting slave pumps and expansion modules to a master, connect a cable from Exp. out on the master HPC RM to either the Exp. in on an expansion module or Exp. slave on a slave pump HPC RM. Continue by connecting Exp. out to the next expansion module or slave pump. It does not matter how expansion modules and slave pumps are mixed.

4.1.2 Settings in each heat pump

In each heat pump, regardless of whether it is a master or slave, configurations have to be set as to whether it is connected to make hot water or not. In the menu Settings/Heat pump you will find the setting Hot water production (8.1.2) where this is defined.

In the same menu you will also find the setting Pressure/flow guard (8.1.9), which tells the controller system what kind of guard is installed to monitor the brine flow. This also has to be correct before the plant can be used.

4.1.3 Extra heater

In the master pump you have to configure the type of extra heater connected to the system. This is done in the menu Settings / Extra heater with the setting Extra heater type (8.3.1).

4.1.4 Expansion modules

First check that each HPC-EM module has the correct function set on the dip switches for the task it is assigned to do. An HPC-EM can be used as a WCS, TWC, or Shunt module, and the corresponding LED should blink until activated in the master. The green power LED should be lit if the module is correctly connected to the master. This is also true for the cooling module HPC-CM. If the power LED is blinking this means that the module has power, but cannot communicate with the master. This is the case for example during the time the master is booting after a power reset.

In the master pump go to the menu Accessory modules. This menu contains sub menus for each type of expansion module where connected units are listed. Activate the units that are to be used. Even slave pumps can be activated. This makes it possible to get an alarm in the master if communication with one of them stops working.

4.1.5 Cooling

If a cooling module has been installed as described above there is one basic setting that has to be set. You have to define whether or not an air humidity sensor for dew point control has been connected. Go to the menu Settings / Cooling / Cooling circuit in the master and find the setting Dew point control (8.10.3.2). Set this to active if the sensor is connected.

4.2 Testing the installation

Before the system is handed over to the automatic controller the functionality of all its components should be verified. If the instructions for basic settings have been followed the communication between heat pumps and expansion modules has been verified at the same time. The next step is to verify that sensors and actuators are working.

4.2.1 Sensor verification

Many of the sensors are monitored by alarms that will indicate if the sensor wiring is faulty. The first step is therefore to check and get rid of all alarms.

However, not all sensors have alarms, and the absence of an alarm is not a guarantee that a sensor has been correctly installed and is working. You should therefore check that all sensors display reasonable readings. You can do this in the menu Information, under Temperatures. All temperatures in the system can be viewed in this list.

4.2.2 Checking actuators

The control system has control over switching valves, shunt valves, and circulation pumps. You should verify that all of these are working before letting the controller take control. The brine pump, compressor, and radiator pump, situated inside the heat pump, can be run manually using switches on the front of the electrical cabinet, after the front cover of the heat pump has been removed. The main thing to check is that the phase sequence is correct for the compressor.



All other pumps and valves can be run manually by using the menu Settings / Manual override. It contains a list of all outputs that can be controlled manually.

Select an output, set the desired manual value and then select that it should be run manually. The output assumes the set value until changed back to auto. To prevent outputs from unintentionally being left in manual override mode an output will automatically revert to auto mode after 30 minutes.

Run pumps and valves to verify that they work and are going in the right direction. It might also be a good idea to run pumps manually until all air in the system has been vented.

When done set all actuators to auto, both in the menu and on the switches on the cabinet front.

4.3 Starting the controller

When starting to use the controller, it might be suitable to start with the expansion modules, if any are installed. You do that by setting the correct automatic operation mode for the corresponding function in the menu Operation mode. You should then proceed with checking the settings for this function and, for example, set correct values as set points.

After that, activate the master pump using the setting Operational mode, which is the first setting in the menu Operation mode. Also activate the main control system (Master mode), which is the next menu item. Go through and

adjust the settings regarding heat and hot water. Among the important things to do is to adjust the set point curve for heat so that it corresponds to the needs of the specific building.

The last step would be to activate the slave pumps using their respective operator panels. For each slave pump, the setting Operational mode in the menu Operation mode should also be changed to auto.

It is also possible to activate only parts of the system. You could, for example, choose not to activate all heat pumps in the plant, or to activate only heat, only hot water, or only cooling. You could also delay the activation of a cooling module or shunt group that is not ready. The important thing is that the brine circuit is working and that there is a working receiver for the produced heat, and of course that all of the sensors and actuators in the activated parts are working.

4.4 Fine tuning

When the system is finally up and running, some work still remains. There is a sliding grade from working to optimal performance, and the process of getting closer to optimal performance involves fine tuning. The factory default settings are selected to be a starting point, and to work in most plants, but differences between plants makes it impossible to have factory defaults that are optimal.

To fine tune controllers that have a P-area, I-time, or in the case of a WCS, a D-factor, the system must be up and running. The database plots found under Databases / Information are good tools to see how current settings are working for the controller. P-areas and I-times that are too small make the control signal overshoot or, in a worst case, oscillate uncontrollably. Too large a P-area and too long an I-time make the controller slow and it takes too long to reach the set point value. The D-factor dampens overshoot and makes a controller more stable, allowing a smaller P-area. Too large a D-factor makes the controller slow and jittery, and might cause the controller to oscillate.

Selecting suitable settings for the integral control for heating and cooling is a balance between comfort and economy. Fewer starts and stops are better for a heat pump, and larger values on Start hp1 and Delta start hp give this result. This does, however, also result in larger swings in the primary supply temperature. Having a larger Start extra heater ensures that the extra heater is not started unless really necessary, but also allows the temperature to drop further.

The slope of the room temperature compensation curve is a kind of P-factor for the controller. Incorrectly set room temperature compensation can cause the primary supply temperature to oscillate, and due to the high inertia of a building heating system this can be a very low frequency oscillation. Too weak compensation on the other hand does not do a very good job at all at keeping the room temperature constant.

The main factor to get a comfortable room temperature is to adjust the out-door compensated set point curve. This is a job that has to be done continuously until all outdoor temperatures have been tested. Temperatures that are too high are not only bad for comfort, but also bad economically. Room temperature compensation should not be used as a substitute for adjusting the set point curve. It should be used to take care of factors other than the outdoor temperature, such as sunshine and wind, and other internal unintentional heat sources.

Adjusting the heat stop and cooling stop limits requires knowledge about the building and how it works in different weather situations. The main purpose of these functions is to save money by avoiding heating or cooling the building when it is not really necessary. What you typically want to avoid is heating the building during the night and cooling it during the day, or worse, heating and cooling at the same time.

In summary, there is some fine tuning to do. Much can be done when commissioning, but some things that are weather dependent cannot be optimised until the weather is there. Fine tuning will get you better comfort and smaller energy bills.

5 External control systems

5.1 OPC-server and SCADA-systems

When managing larger groups of buildings it is not uncommon that a supervisory building management system is used to supervise all control equipment in the buildings. This can be a so called SCADA system. OPC is an open standard for transferring information from, for example, PLC-systems to SCADA systems or other applications.

For the WM HPC there is an OPC server software available. This can be run on a central server at the building manager. The server software gathers information from WM HPCs in the buildings through TCP/IP and makes it possible for the SCADA system to get this information through OPC.

5.2 Alarm management and e-mails

The most important information from a control system in a building is most likely the alarms that tells if something is wrong. With the web licence comes the possibility to send alarm using e-mail. These e-mails are designed to be readable both by humans and machines. As alarms by e-mail becomes more and more common alarm distribution systems that can receive alarms by e-mail and re-distribute to relevant personnel also becomes more common. E-mail thus becomes another way to connect WM HPC to superior supervisory systems.

5.3 Control by external PLC

In some cases there may be a need to control the heat pump from another control system than the one in the WM HPC. The alarms and protective functions built in to the heat pump should still be active, and there is therefore a special mode in the WM HPC for external control.

If a heat pump is set to slave mode without being connected to a master heat pump it will signal an alarm that communication with master has failed. By grounding the temperature inputs for outdoor temperature and hot water start temperature the WM HPC will enter external controller mode. The communication alarm will be silent and the pump can be started by grounding the primary supply temperature sensor input. The heat pump will stop when the sensor input is open, which means that the heat pump can be controlled using a simple relay.

The slave pump settings in the WM HPC are still valid, except for the setting regarding hot water. The hot water switchover valve must be controlled by the external control system. The WM HPC still manages the protective alarms and timeouts, and will ensure that the heat pump will not start again until it has been standing still for at least five minutes after a stop.

5.4 The sum alarm relay output

The heat pump control system has an alarm output that sends out 24 VAC as soon as any A or B alarm is active. This signal can be used to send information to a superior control system.

6 List of alarms

Alarm name	Class	Automatic reset	Acknowledge required	Explanation
High return temp	B	X		The temperature on the heat pump return is too high for the heat pump to work efficiently. The heat pump has ceased to produce heat.
Temp diff brine	B		X	The difference in temperature between incoming and outgoing brine is large. This may be due to low flow rate.
Compressor current	A		X	The current overload protection for the compressor has triggered.
Brine pump current	A		X	The current overload protection for the brine pump has triggered.
High pressure	A		X	The high pressure guard has triggered.
Low pressure	A		X	The low pressure guard has triggered.
Low brine flow	A/B		X	The flow guard for brine has triggered.
Brine pressure	A/B		X	The pressure guard for brine has triggered.
Compressor heat	A		X	The temperature overload protection for the compressor has triggered.
Control pressostat	B	X		The controller pressostat has been triggered for a long time.
Sensor supply temp	B	X		A fault in the heat pump's supply temperature sensor has been detected.
Sensor return temp	B	X		A fault in the heat pump's return temperature sensor has been detected.
Broken outdoor temp	B	X		A fault in the outdoor temperature sensor has been detected. The control system assumes the outdoor temperature is zero.
Sensor hot water	B	X		A fault in the temperature sensor for hot water has been detected.
Sensor hot gas temp	B	X		A fault in the sensor for hot gas temperature has been detected.
Sensor brine in	B	X		A fault in the heat pump's incoming brine temperature sensor has been detected.
Sensor brine out	B	X		A fault in the heat pump's outgoing brine temperature sensor has been detected.
Sensor prim. supply	B	X		A fault in the primary supply line temperature sensor has been detected.
Hpc rm communication	A	X		Communication error with the HPC RM module. This module contains the heat pump's relays.
24 vac power fail	A	X		A power failure on 24 VAC has occurred.
Communication master	A	X		Communication with the master pump has failed.
High brine in temp	B	X		The incoming brine temperature is too high. The alarm is part of the brine control function.

Alarm name	Class	Automatic reset	Acknowledge required	Explanation
Low brine in temp	B	X		The incoming brine temperature is too low. The alarm is part of the brine control function.
Low brine out temp	B	X		The outgoing brine temperature is too low. The alarm is part of the brine control function.
Shunt 1 sensor	B	X		Temperature sensor for shunt group 1 is faulty.
Shunt 1 ctrl err	B	X		Large controller error on shunt group 1.
Shunt 2 sensor	B	X		Temperature sensor for shunt group 2 is faulty.
Shunt 2 ctrl err	B	X		Large controller error on shunt group 2.
Shunt 3 sensor	B	X		Temperature sensor for shunt group 3 is faulty.
Shunt 3 ctrl err	B	X		Large controller error on shunt group 3.
Shunt 4 sensor	B	X		Temperature sensor for shunt group 4 is faulty.
Shunt 4 ctrl err	B	X		Large controller error on shunt group 4.
Shunt 5 sensor	B	X		Temperature sensor for shunt group 5 is faulty.
Shunt 5 ctrl err	B	X		Large controller error on shunt group 5.
Shunt 6 sensor	B	X		Temperature sensor for shunt group 6 is faulty.
Shunt 6 ctrl err	B	X		Large controller error on shunt group 6.
Shunt 7 sensor	B	X		Temperature sensor for shunt group 7 is faulty.
Shunt 7 ctrl err	B	X		Large controller error on shunt group 7.
Shunt 8 sensor	B	X		Temperature sensor for shunt group 8 is faulty.
Shunt 8 ctrl err	B	X		Large controller error on shunt group 8.
Wcs sensor error	B	X		Faulty temperature sensor at the WCS module.
Wcs controller error	B	X		Large controller error on the WCS module.
Sensor error twc	B	X		Faulty temperature sensor for TWC module.
Twc out temp	B	X		The temperature on outgoing water from the TWC module is outside the limits.
Twc return temp	B	X		The temperature on recirculated water to the TWC module is outside the limits.
Ctrl err cooling c	B	X		Large controller error on the cooling circuit.
Sensor cooling tank	B	X		A fault in the cooling tank temperature sensor has been detected.
Sensor surplus cool	B	X		A fault in the excess cooler temperature sensor has been detected.
Sensor cooling t out	B	X		A fault in the cooling tank outlet temperature sensor has been detected.
Sensor cooling circ.	B	X		A fault in the cooling circuit temperature sensor has been detected.
Slave pump missing	B	X		Communication with one or several slave pumps has stopped working.

7 Digital inputs and outputs

On the front of the WM HPC unit there are led indicating the status of digital inputs and outputs. Below are tables of what the different inputs and outputs are connected to.

DIGITAL IN	Usage
DI1	High compressor current
DI2	High pump current
DI3	Control pressostat
DI4	High pressure switch
DI5	Low pressure switch
DI6	Flowsensor
DI7	Discharge pipe temp
DI8	External brine start

DIGITAL OUT	Usage
D01	Start/stop compressor
D02	Start/stop brinepump
D03	Start/stop rad.pump
D04	Channel 36
D05	Block. extra heater
D06	Sum alarm
D07	System pump

8 Menu overview

