3006842-2026-07-02

GB

EXcon+ User Manual

COMMISSIONING TECHNICIAN

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EXHAUSTO

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1. DOCUMENT CONVENTION

Commands and names that appear in the user interface, are written in bold typeface in this guide. Example: Activate the **Setpoint** button. Also, particularly important information is written in bold typeface.

2. SPECIAL INFORMATION FOR THE COMMISSIONING TECHNICIAN

Chapter 10.1.4 Reset & backup settings, 10.4 Balancing and 10.5 Export report, contain information that is particularly relevant for the commissioning technician.

3. WHERE TO FIND ADDITIONAL INFORMATION

You will always be able to find additional information on Exhausto's home page:
https://www.exhausto.dk/

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4. THE START SCREEN

4.1 Login via direct cable connection

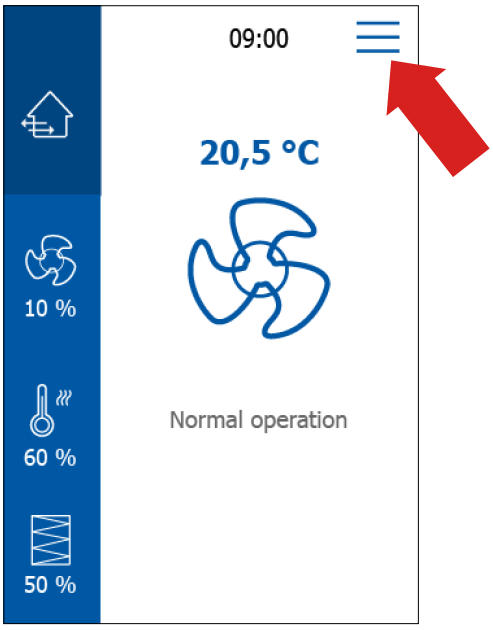
If your laptop is connected directly to the HMI TCP/IP port on the controller, the IP-address is 10.200.2.100

4.2 Login via the BMS TCP/IP port

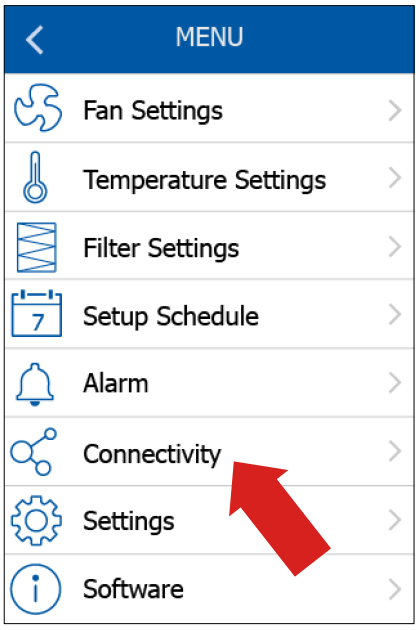
If you are using the BMS TCP/IP port you will need to find the IP-address first. You will find the IP address in the AHU's touch panel named EXCON+HMI-TOUCH.

Follow these steps:

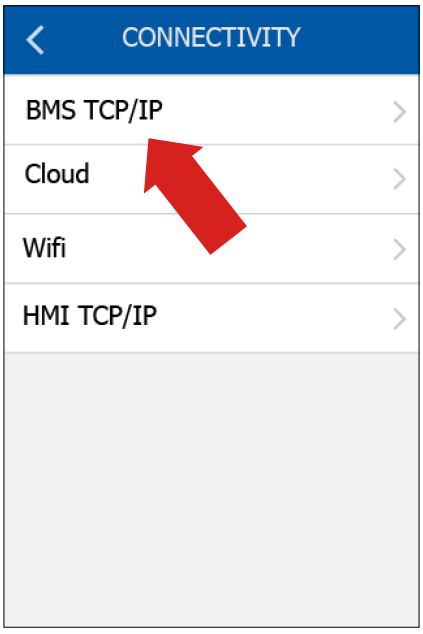
1) Click on the menu symbol (the three small horizontal lines) in the upper right corner of the HMI.



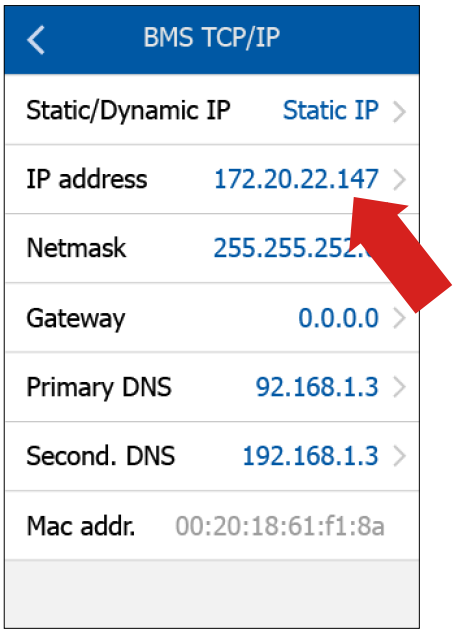
2. Press **Connectivity**.



3. Click on BMS TCP/IP.



4. Then you will see the IP Address.



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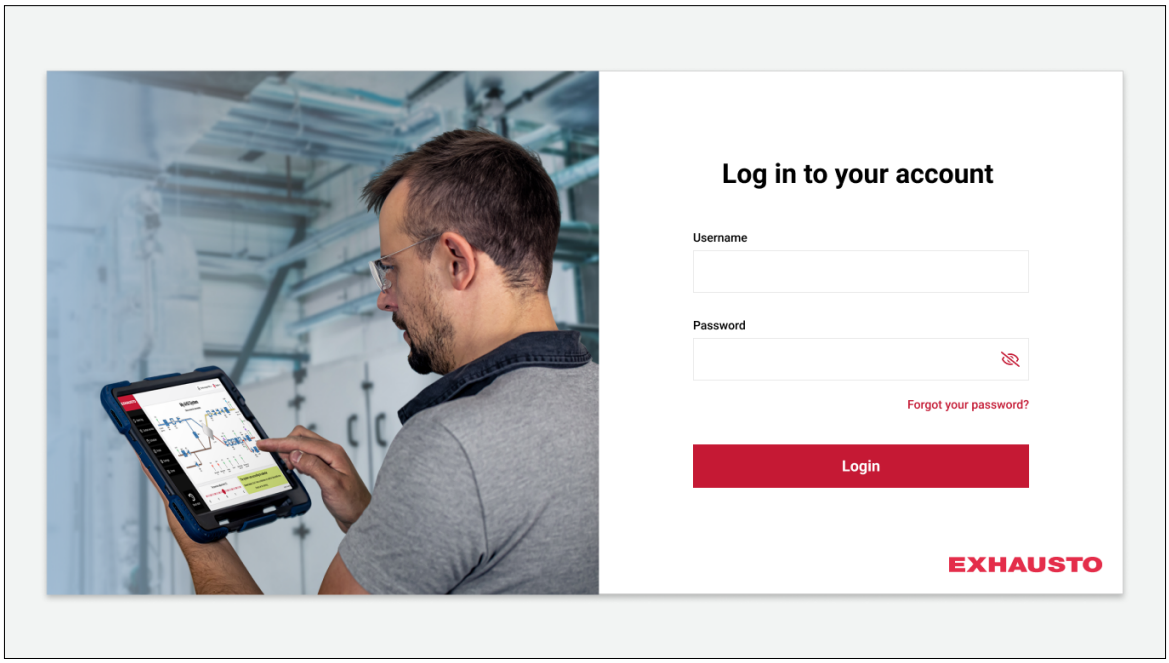
1. Enter the IP address in your internet browser. You will then be presented with the following screen:



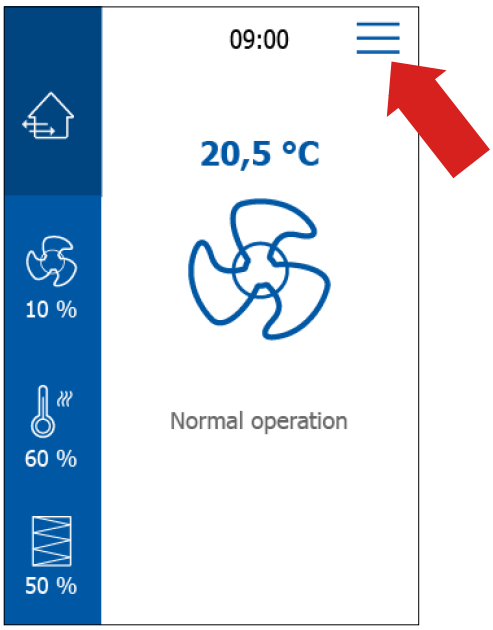
Enter the following in the login screen:
Username: service
Password: 333333 (Remember to change your password the first time you log in.)

Click on the **Login** button to go to the home screen.

4.3 Login via Wifi

If you wish to establish a WiFi connection to the controller, you must first activate Wifi in the HMI. This is how you activate these WiFi settings:

1) Activate the menu in the upper right corner:



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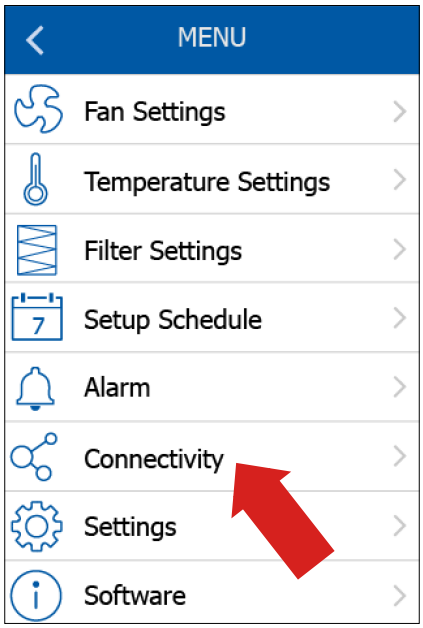
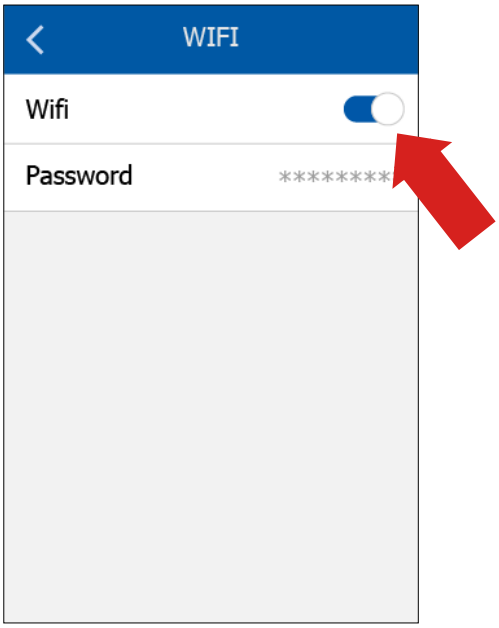
2) Click on Connectivity



4) Activate Wifi



Having activated the WiFi network, you must connect to the WiFi network ”EXcon+ – XY”, where XY is the unit name for your particular HVAC unit.

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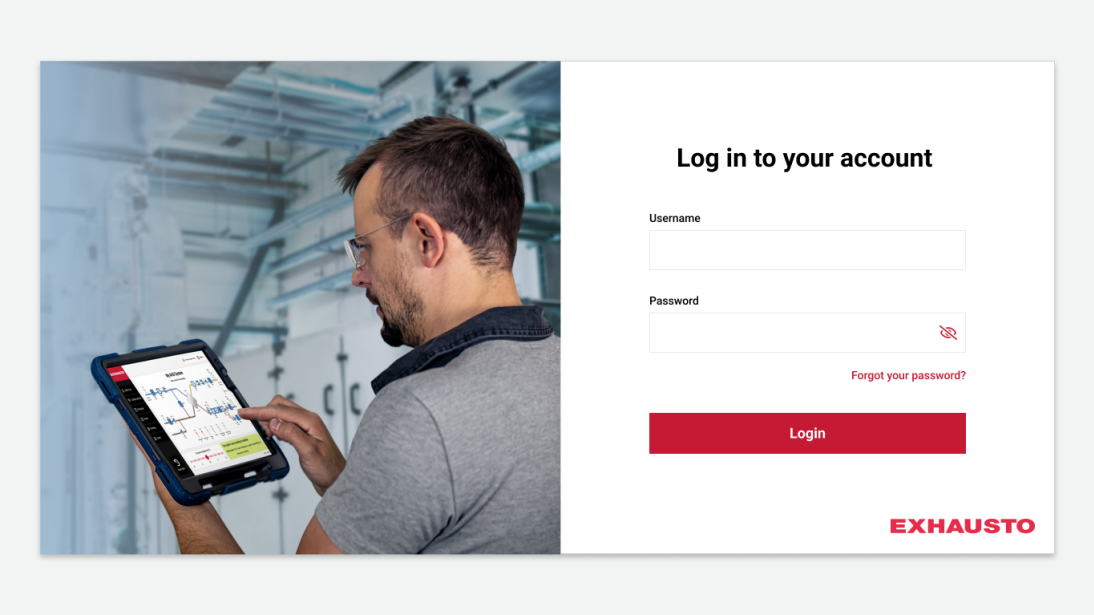
5) Enter the IP address 10.200.3.1 in your login device. Then you will also see the login screen:

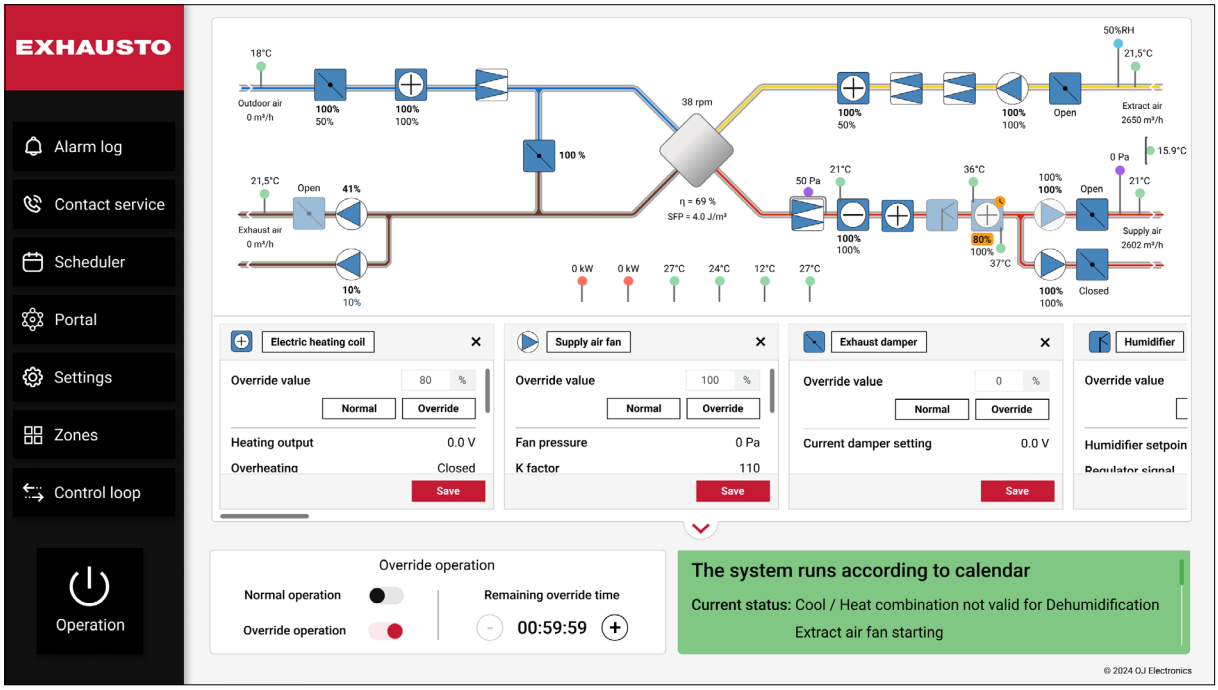


4.4 The Home screen

Log in to the EXcon+ controller's web interface as described above.

You will then be presented with the Home screen.

Here, you can click on any visible component in the main window: Filter, sensor, heat recovery unit, etc. You will notice that it is possible to click on several components and have data for each component neatly arranged in small windows, see below:



This ability is particularly useful if you need to monitor and compare data from various components. The visual status information and the detailed component data offer you the ability to perform a quick analysis of the system's performance. It is recommended to use this screen as the central information tool. Here, you immediately become aware of the system status. This enables you to quickly identify any required corrective actions.

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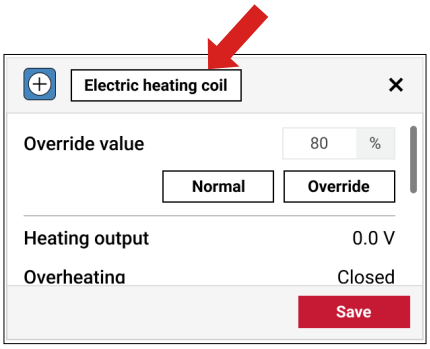
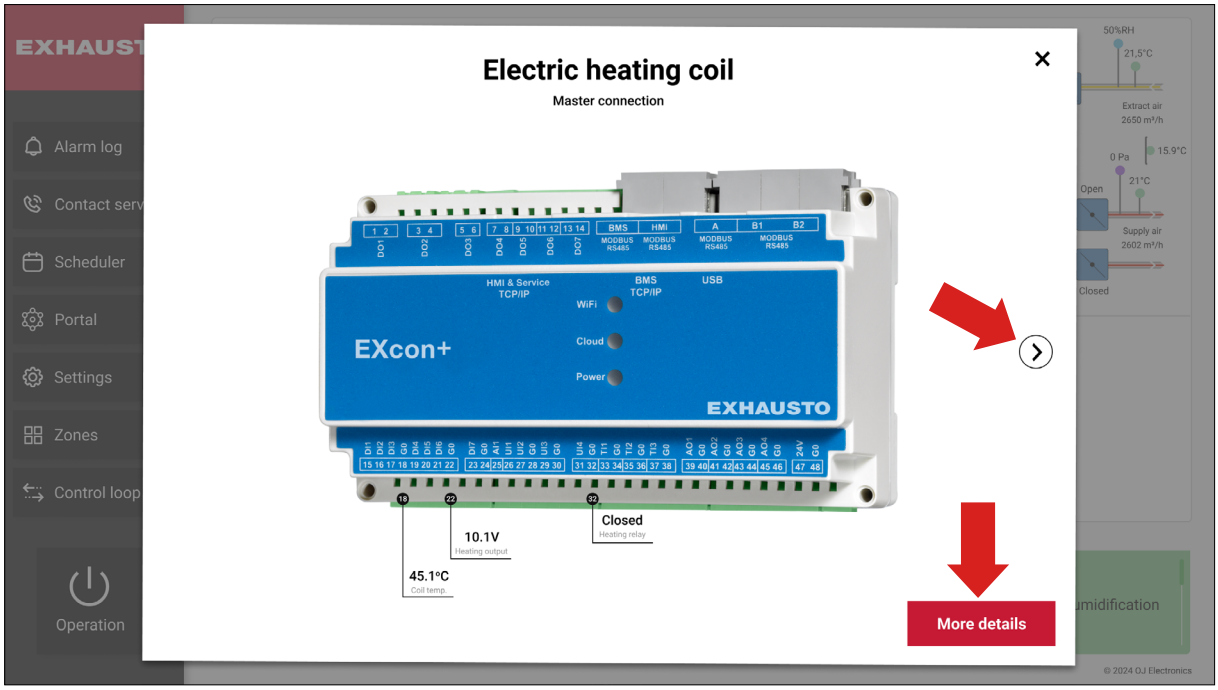
4.5 How to get detailed component information

A small shadow beneath the heading of the dialog box indicates, that the heading is a button. See below. Then you can click on this heading to get further information.



For example, click on the Electrical heating coil heading, to see the following information:



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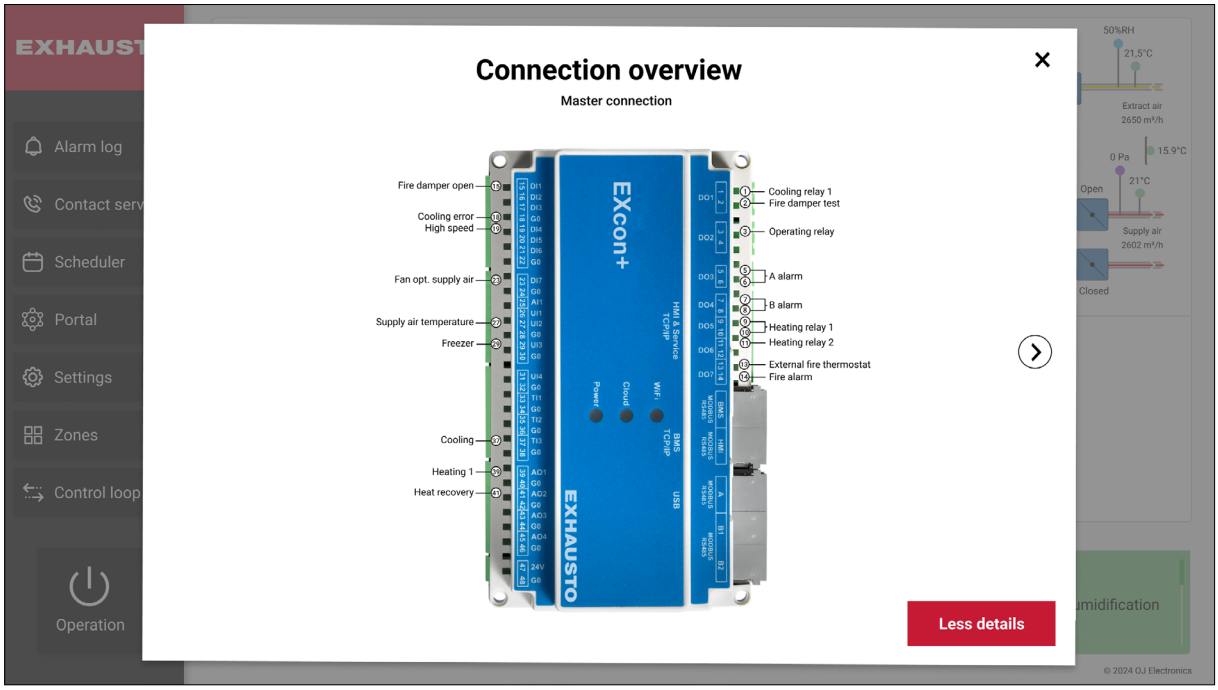
This is the procedure you must follow to obtain detailed component information. If you click on the small arrow pointing to the right, you can browse through the system components. Here you can find basic information about pin out and signals. If you click on **More details**, you will see the following



4.6 System status

At the bottom right on the Home screen, you see the current system status.

The green colour at the bottom of the screen indicates that there are no active alarms. Here you also have the information, that the system is running according to the calendar. This is because a calendar-based program has been configured for the air handling system. Your system is following this calendar.

A yellow colour at the bottom of the screen indicates that a B-alarm has been raised. Also, if a yellow colour appears in a component, it indicates that the component has an error and that it needs service. A B-alarm means that the system is running with reduced performance due to an error.

A red colour at the bottom of the screen indicates that an A-alarm has been raised. Also, if a red colour appears in a component, it indicates that the component has an error and that it needs service. An A-alarm means that the system has come to a stop due to an error. Service is required since some repair is necessary to bring the unit back into operation.

A grey colour at the bottom of the screen indicates that the AHU is in stop mode and there are no errors.

Note: The system may be displaying a green colour – even if it has stopped running. This is the case if the system is running according to calendar, but there is a period in the calendar where the system is set to pause operation. Note also, that a boost overwrites the current calendar setting. A boost however, will not alter the system status. So, no matter if the system status is green or yellow etc., a boost will not alter the status.

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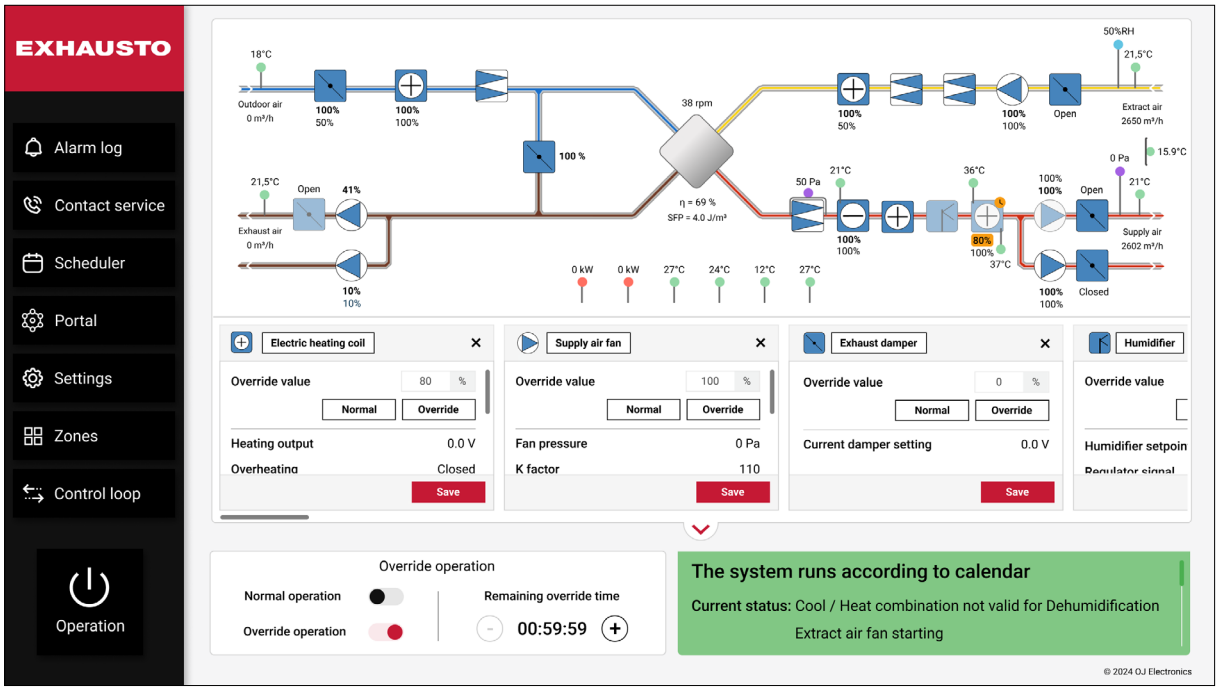
4.7 Adjusting the Temperature

At the bottom left on the Home screen, you can adjust the temperature if you want to fine-tune the temperature setpoint during cold or warm periods.

4.8 The Override Function

The purpose of the **Override** function is to give you a tool that can be used to test that the outputs work as intended. This is especially important during service and maintenance. With the **Override** function, you can check every component to make sure that it is working properly.



When is the Override function available?

Override is possible in Stop. (Not Fans and dampers)
Override is possible in normal operation. (All components)
Override is not possible during transition from stop to normal operation. (Damper opening, Extract air fan starting).
Override is not possible during the transition from normal operation to stop. (Damper closing)
Override is not possible in Alarm Stop. (A-alarms)
Override is possible if B-Alarms are active, both in stop and normal operation.

These steps explain how to override the speed of the Supply air fan. However, the same steps apply to all other components.

1. Click on the component you wish to manually override – in this case the Supply air fan.
2. Change control mode from Normal operation to Override operation by sliding the **Override operation** button to the right.
3. Now you can change the settings that you wish to change. You can do this for all clickable components. Notice, that you can both increase or decrease the override time as you see fit.

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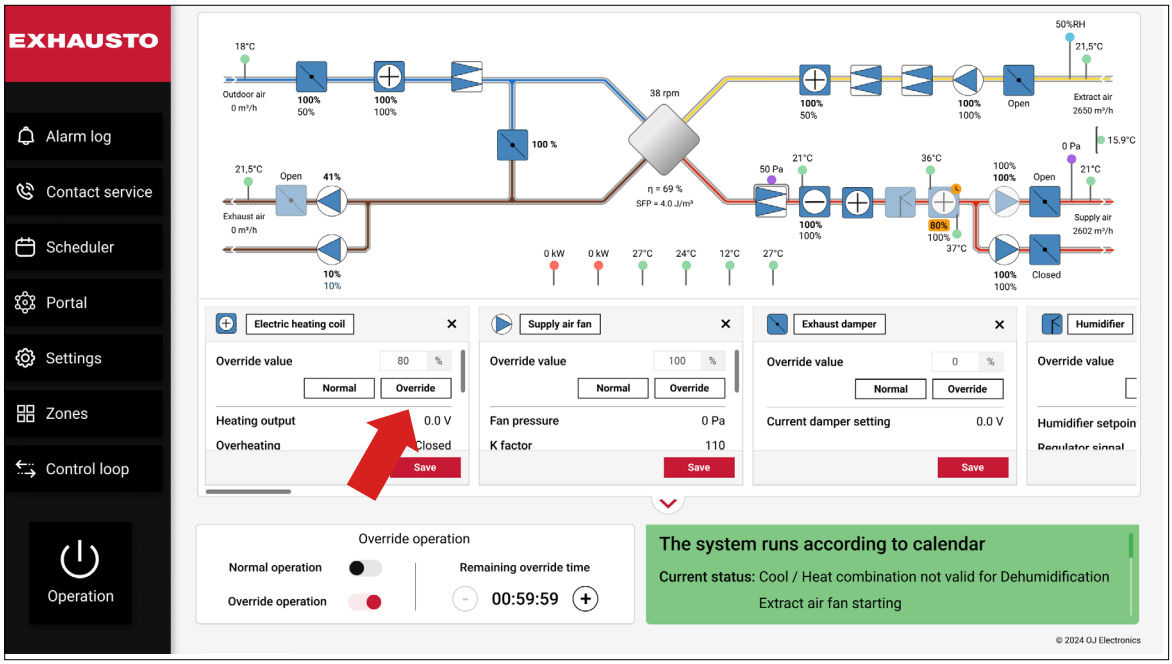
4. When you have made the changes, you must click on **Override** for the new settings to be applied, see below.

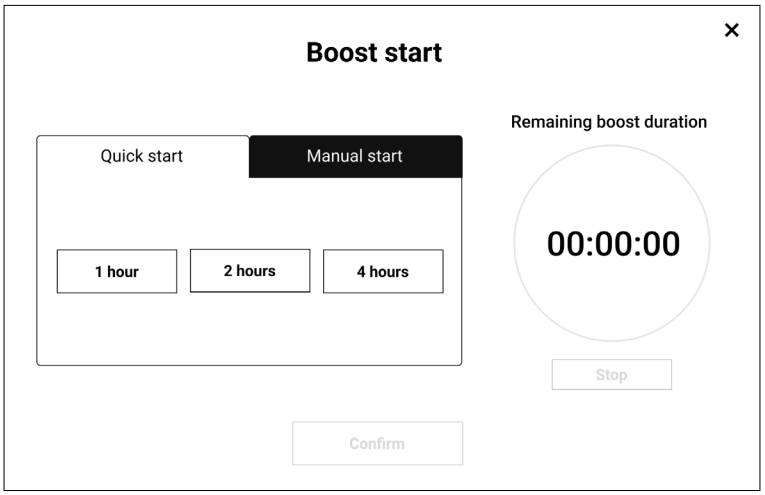


Note: Components with values that have been overwritten will be highlighted. You might often need to remember what you have changed, and the highlighted features will help you do so. In this way, you can easily revert several changes to their prior state.
The **Override** state is either terminated when the set time has elapsed, or when you click on **Normal operation**.

5. BOOST START

When you click on **Boost start**

in the lower left corner, you will see the following screen:



A boost is a way to increase the airflow and pressure, so you quickly achieve the desired temperature and air quality. Under the **Quick Start** tab (see above), you can run a boost for either 1, 2, or 4 hours. Once you have clicked on one of these buttons, a count-down timer is displayed on the right side of the screen. This timer tells you exactly how much time remains before the boost operation has finished.

If you click the **Manual** start tab, you can program the system to start and stop a boost at a specific date and time.

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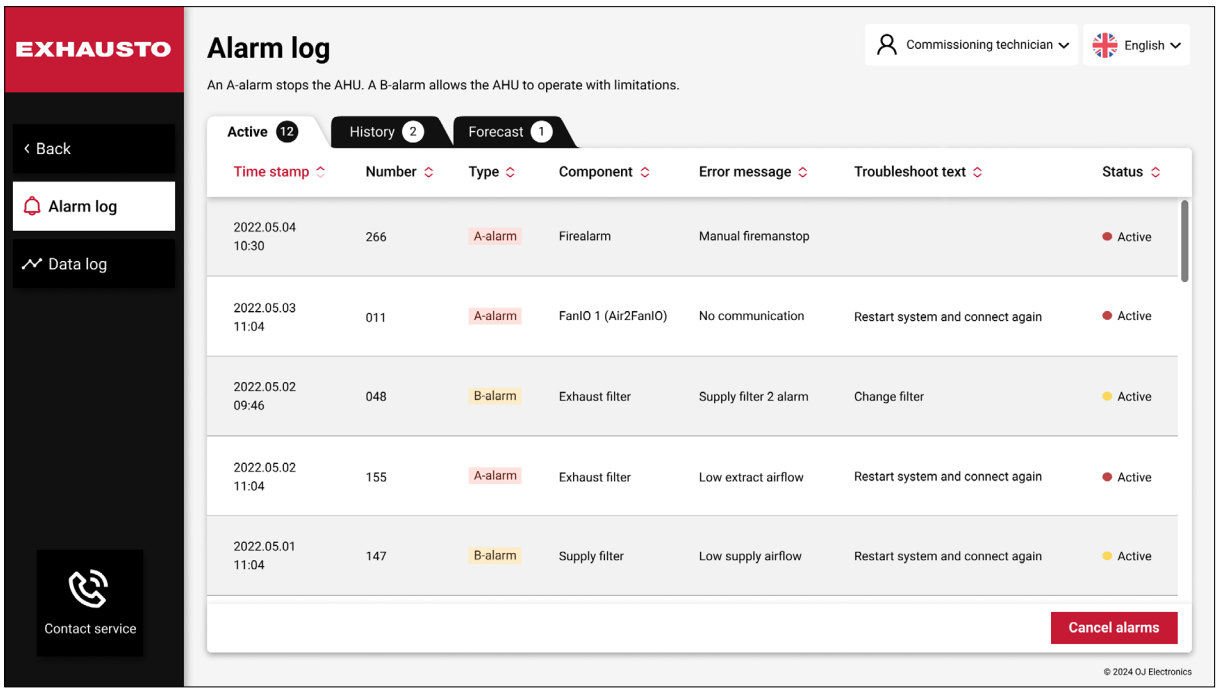
5.1 The Alarm log

The alarm log is basically a list of system errors. If you click on the bell icon Alarm log to open the alarm log, you will see the following screen:



At first, you will see all the active alarms.

Often, it is easier to find the information you need if you sort the alarm log. The alarm log can be sorted according to **Time stamp, Number, Type** (priority), **Component, Error message, Troubleshoot text**, or **Status**. Just click on the column headings to sort the errors the way you want.

Note, that you can cancel the alarms by clicking the **Cancel alarms** button in the lower right corner.

Under the **History** tab, you will find the previous errors. Under the **Forecast** tab, you can see errors that the system has forecasted to occur within the next 5-30 minutes. When the time for the forecasted alarm has arrived, it will be transferred to the **Active** tab.

Also note: A complete alarm list with settings and corrective actions can be downloaded from https://www.exhausto.dk/.

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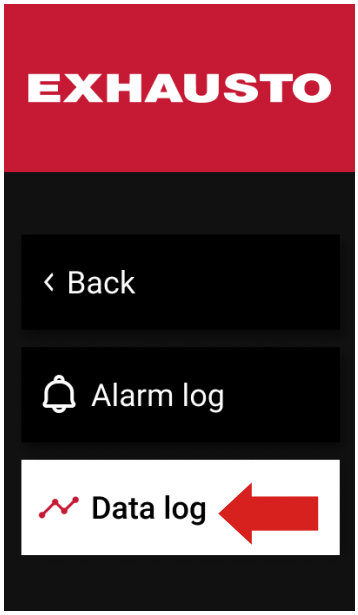
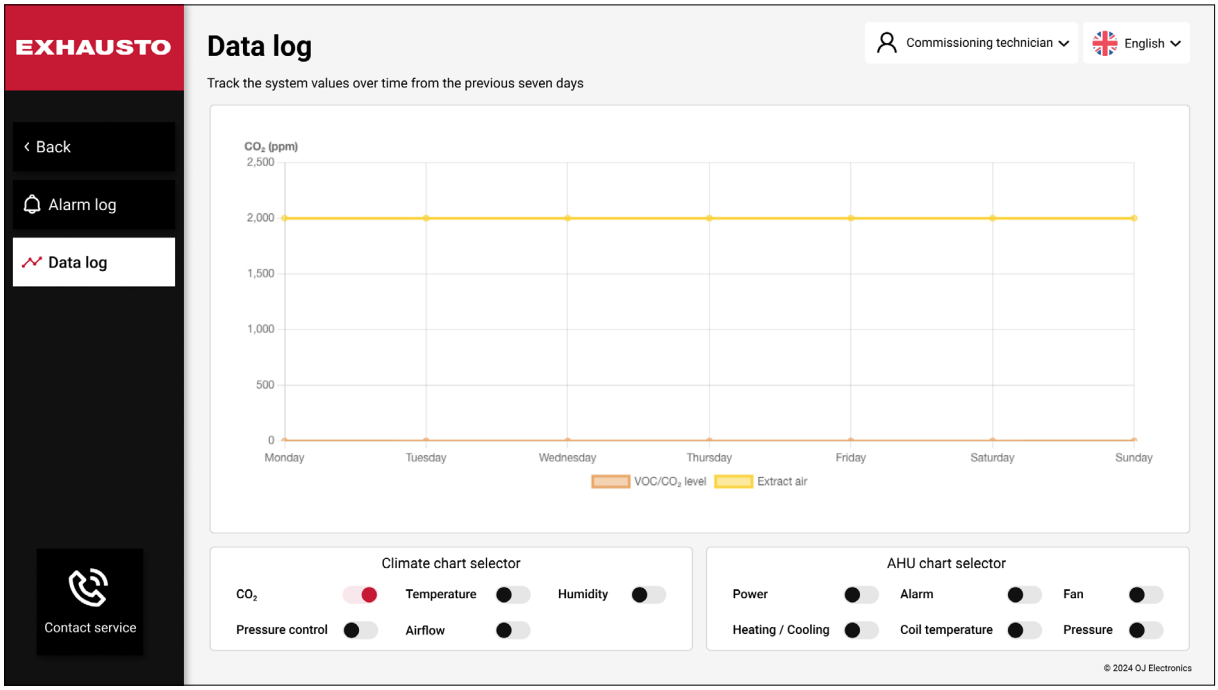
6. DATA LOG

You will find the **Data log** under the Alarm log, see below.



The **Data log** is a useful diagnostic tool that gives you a visual representation of selected climate and AHU parameters over time. You can choose between climate parameters (**Climate chart selector**) and other parameters (**AHU chart selector**). These parameters can be displayed over time in a chart.

Each chosen parameter will be displayed on the Y-axis, while the X-axis always represents time. With this tool, you can quickly find and analyse anomalies in the system's performance. It can help you debug the system and improve its performance in key areas. The Data log provides you with a valuable amount of runtime data that eases your job as a commissioning technician. For example, with the knowledge acquired from analysing the Data log, you can easier and earlier locate faulty or inaccurate system components that need replacement.



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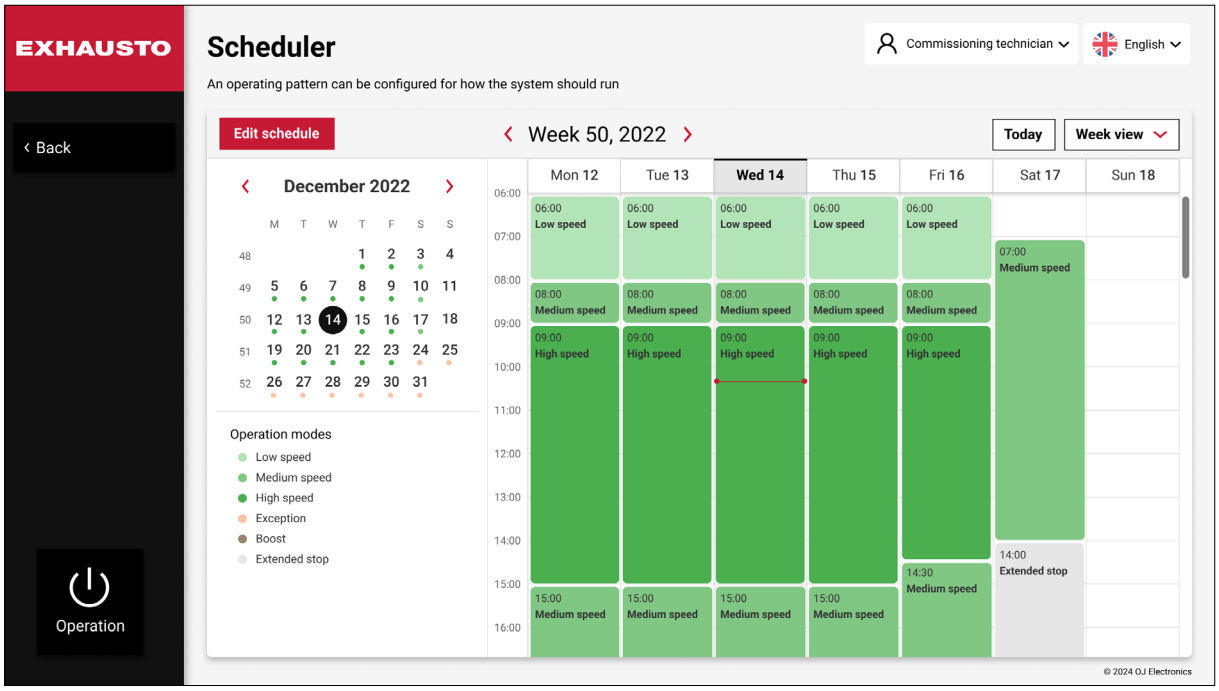
7. CONTACT SERVICE

Click on the phone symbol Contact service to find information about how to contact service.

8. SCHEDULER

Click on the **Scheduler** icon to open the **Scheduler** planning tool:



8.1 Operation

Click on the **Operation** button Operation to open the **Operation** window.

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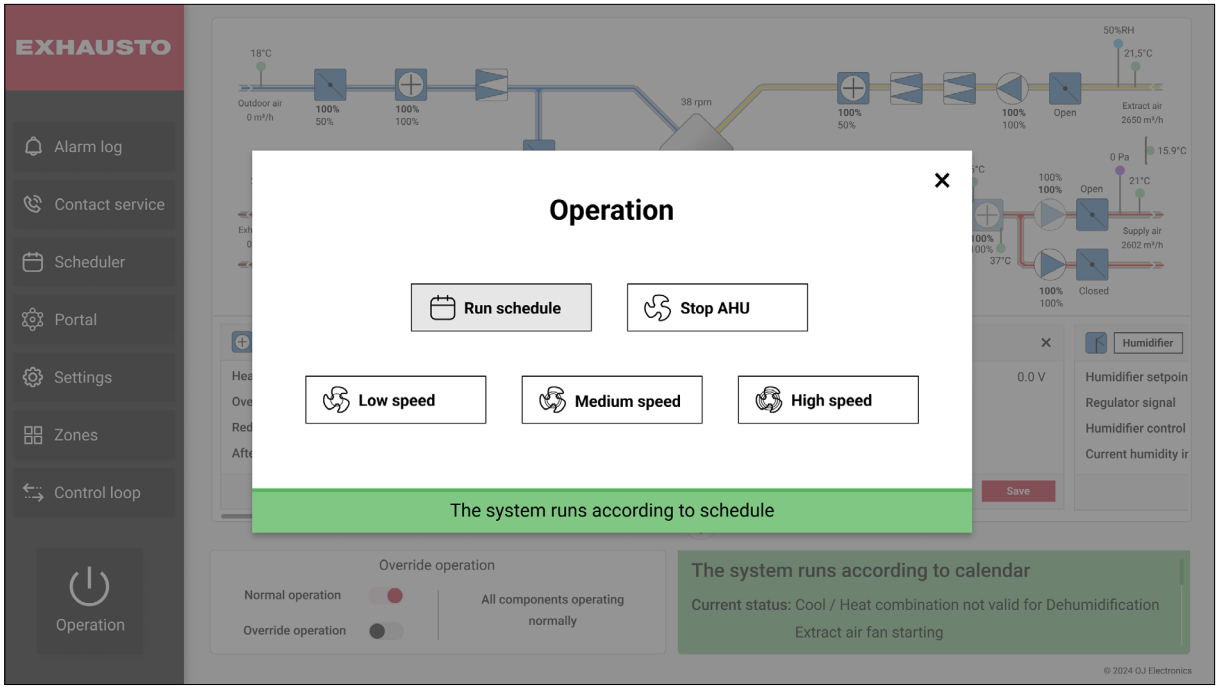
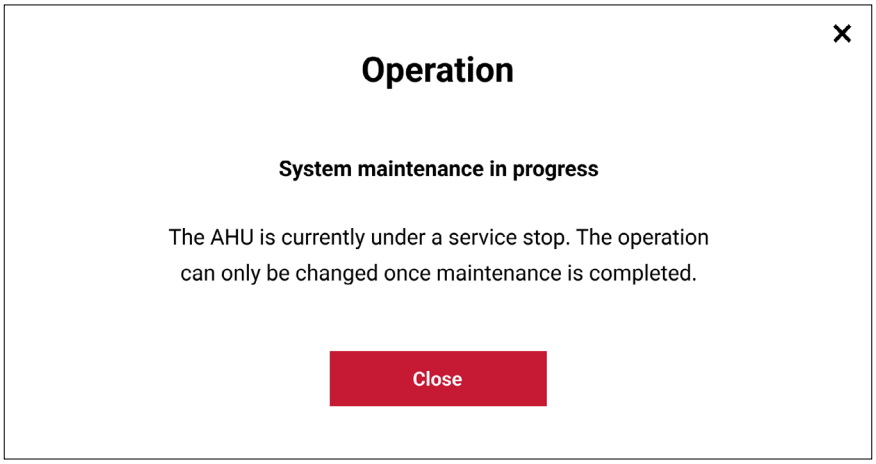


If you click on **Run Schedule**, the HVAC system will run according to schedule.
If you click on **Stop AHU**, the HVAC system will stop, no matter what you have programmed in Scheduler.
If you click on **Low speed**, **Medium speed**, or **High speed**, the system will run permanently on either low, medium, or high speed.

Note: If **Service stop** has been activated (see below), and you are using the web interface, you will not be able to change the operation. In this case, you can only see a text about the current status.



Service stop can only be activated/deactivated from the operation panel located on the Air Handling Unit, or if your login device has a cable connection to the AHU. Remote access will not be able to start the Air Handling Unit.

OBS: A service stop is not a safety stop. You still need to switch off the mains before accessing parts inside the Air Handling Unit.

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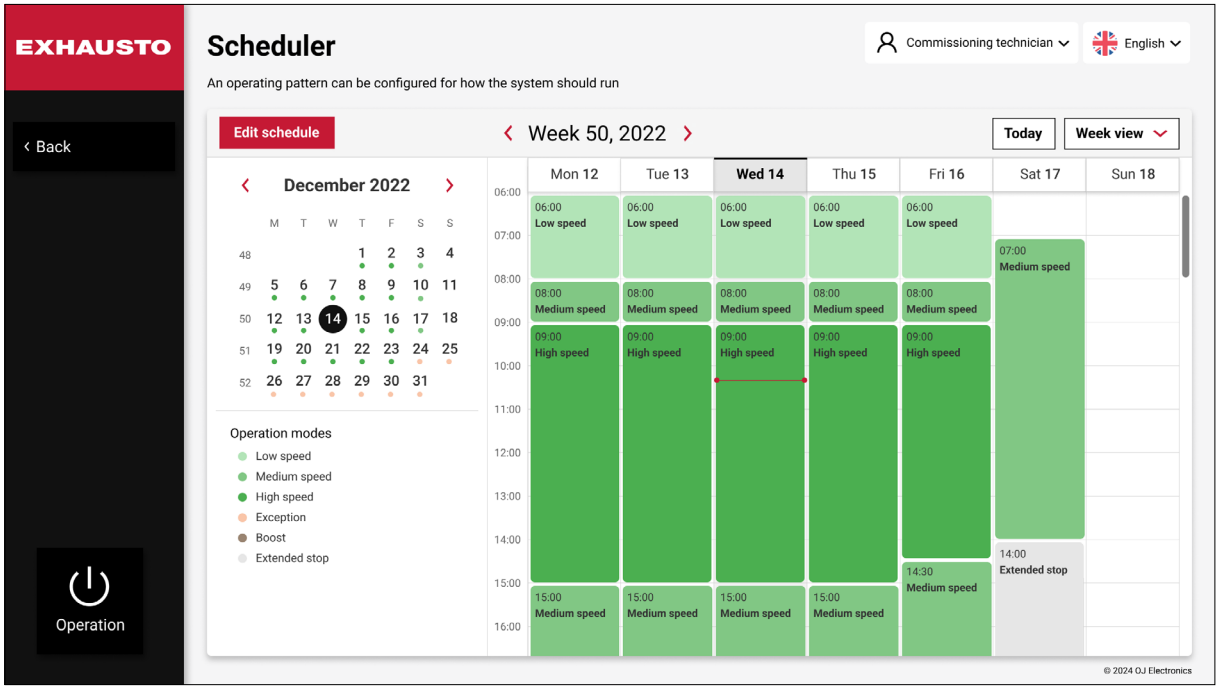
When you close the **Operation** Window, you will return to the scheduler:



Here you can program the operation modes for the system on a daily, weekly, monthly, and yearly basis. In the example above, we have a school where all Mondays, Tuesdays, Wednesdays, and Thursdays are identical. All Fridays are also identical. Saturdays are alike, and Sundays are alike too.

Monday to Thursday:

Time	Activity
06:00	The school opens for cleaning and preparations with the system starting at low speed.
08:00	The first pupils arrive and the system switches to medium speed.
09:00	All pupils have arrived and the system switches to high speed.
15:00	The first pupils start leaving the building and the system switches to medium speed.
17:00	The system is stopped for the day.

Fridays:

06:00	The school opens for cleaning and preparations with the system starting at low speed.
08:00	The first pupils arrive and the system switches to medium speed.
09:00	All pupils have arrived and the system switches to high speed.
14:30	The first pupils start leaving the building and the system switches to medium speed.
17:00	The system is stopped for the day.

Saturdays:

07:00	The school's library is open, and the system starts up at medium speed.
14:00	The system is stopped for the day.

Sundays: The system is stopped during the entire day.

Operation modes explained:

- **Low speed:**
  The system runs at the lowest air exchange setpoint and consumes the least amount of energy.
- **Medium speed:**
  The system runs at the medium air exchange setpoint, and it will also have a medium energy consumption.

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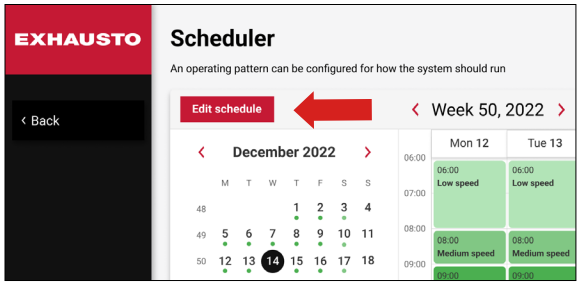
- **High speed:**
  The system will run according to the highest air exchange setpoint, and it will secure the best air quality.
- **Exception:**
  Exceptions are periods (or days) when the system is not running the usual schedule. This can be holidays or special events.
- **Boost:**
  In Boost mode the system runs at high speed for a limited period to quickly achieve a noticeable improvement in air quality and temperature.
- **Extended stop:**
  Extended stop is an alternative to a complete stop. In Extended stop, the system can be activated under 3 circumstances:
  1) When summer night cooling is activated. Summer night cooling is a cooling mode that seeks to benefit from the lower night-time temperatures to obtain cooling while maintaining a low energy consumption.
  2) When a PIR (motion) sensor detects movements and initiates a system start.
  3) When Night heating is activated. Night heating is used to keep the building warm during the night if the ventilation system is the only heat source in the building.

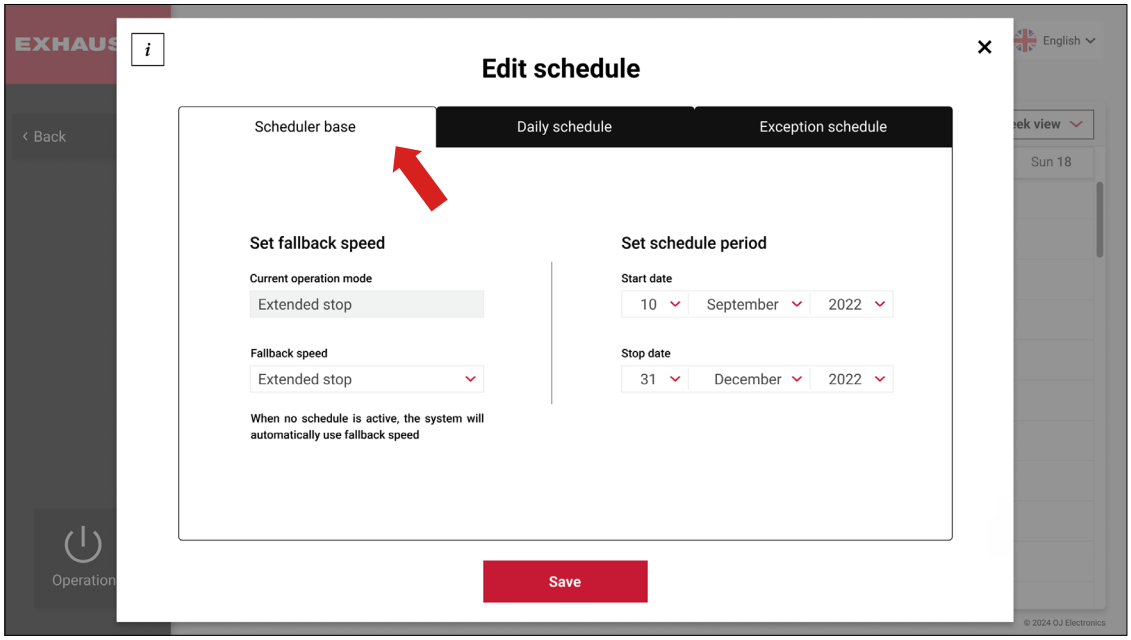
In the Scheduler, each operation mode has its own colour. By taking a glance at the colour of the time frames in the calendar, you immediately know what operation mode is active. By clicking on the **Week view** icon (in the upper right corner) it is possible to switch between three views: **Week view, Year view**, and **Exception view**.

If you click on **Today**, you will see the HVAC program for today. If you prefer to see the HVAC program for the whole week, then you must choose **Week view**.

8.2 Edit schedule



This is where you define the different periods and apply a suitable operation mode. When you click **Edit schedule**, you will see the following screen:



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8.3 Scheduler base

If you click on **Scheduler base** (on the previous page) you will see 4 sections:

Current operation mode
Here, you see the current operation mode. In the above example, **Extended stop** has been activated.

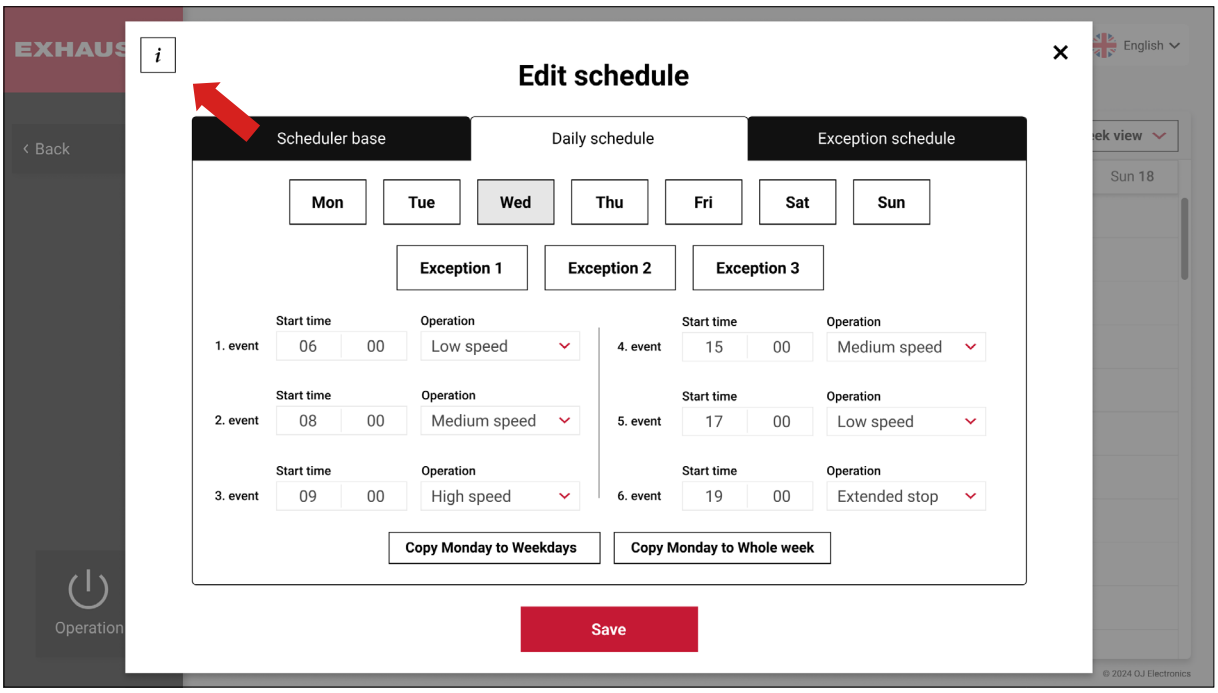
Fallback speed
Fallback speed is the operation mode the system will run when nothing else has been programmed. As a commissioning technician, you can use this setting to define whether **Stop, Low speed, Medium speed, High speed**, or **Extended stop** shall be used as fallback speed.

Start date
On the right side of the Scheduler base, you can set the start date for the scheduled period.

Stop date
This is where you set the stop date for the scheduled period.

8.4 Daily schedule

The daily schedule is used to define the hourly event periods on a chosen weekday. It can have a maximum of 6 events per day.



Note: You can always click on the i button [i] in the upper left corner to get information relating to the current screen.

This screen is where you program the daily operations. You can add up to 6 different events for one day. In the example above, the system is being programmed to run Event 1 in Low speed from 06.00 to 08.00 o'clock. Event 2 goes from 08.00 until 09.00 where the system must run at medium speed, and so on. When you have finished programming the events for a day, you may either copy this daily calendar to other weekdays or to whole weeks, see next page:

Tip: Use the function **Copy Monday to Weekdays** if several weekdays are alike. Or use **Copy Monday to Whole week** if all days are alike. This will save you some time.

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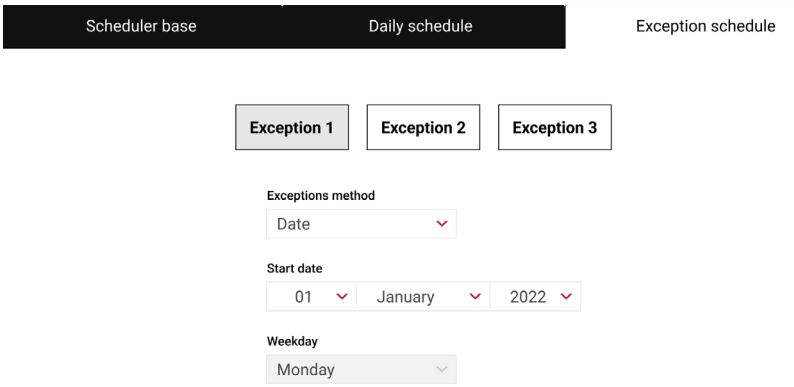
8.5 Exception schedule



You can program 3 exceptions, that is, where the system is not running the usual schedule. If several exceptions affect the same time period, exception 1 will take priority over exception 2. Exception 2 will take priority over exception 3.

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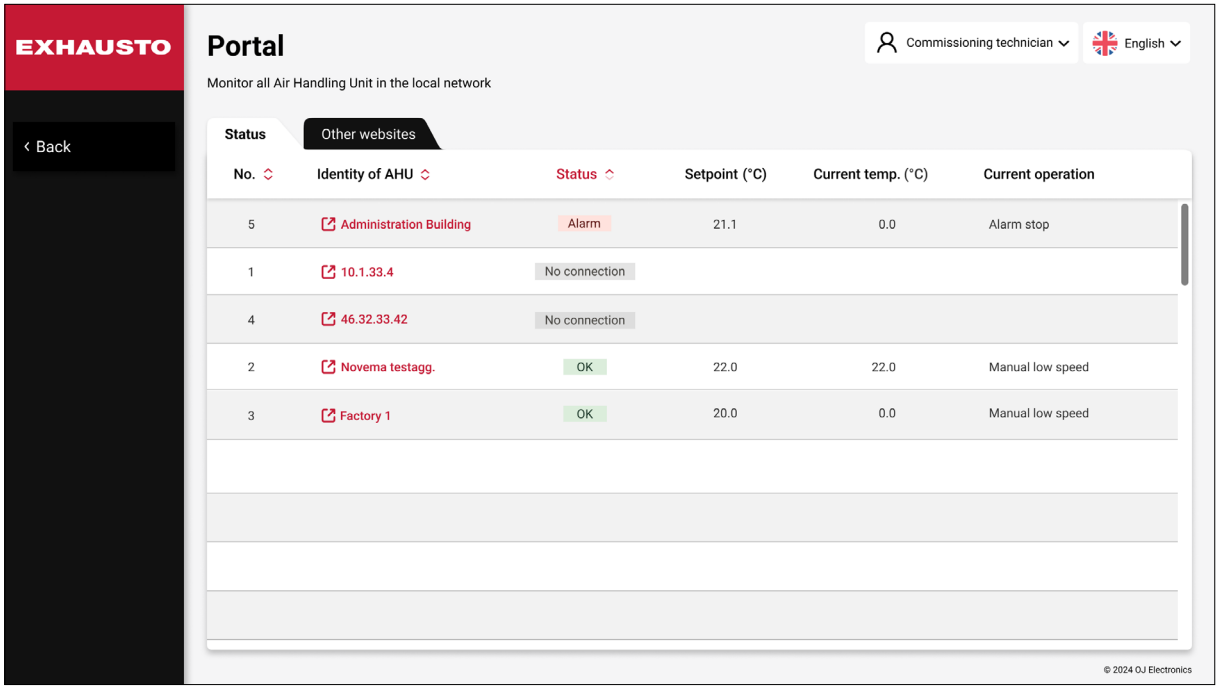
9. PORTAL

If you click the Portal **Portal** button, you will gain access to an overview page where you can monitor all air handling units in the system.

Note, that the **Portal** button is only visible if other HVAC systems have been configured.



If other EXcon+ AHUs in the local network have been configured, you can see if an alarm has been raised for these AHUs. You can also click directly on the link to these AHUs and go to these web pages to perform the monitoring or corrective actions.

9.1 The Status tab

If you have several AHUs in one building, all AHUs (together with various other information) will be listed here. Here you can see:

1. The name of the relevant AHU
2. The alarm status for the AHU
3. The AHU's temperature setpoint
4. The AHU's current temperature
5. The AHU's current operation mode

If you click on the names of the listed AHUs, you will go directly to their web pages.

9.2 Other websites screen

Here you may find links to relevant websites, which you can use as bookmarks for easy access to further information.

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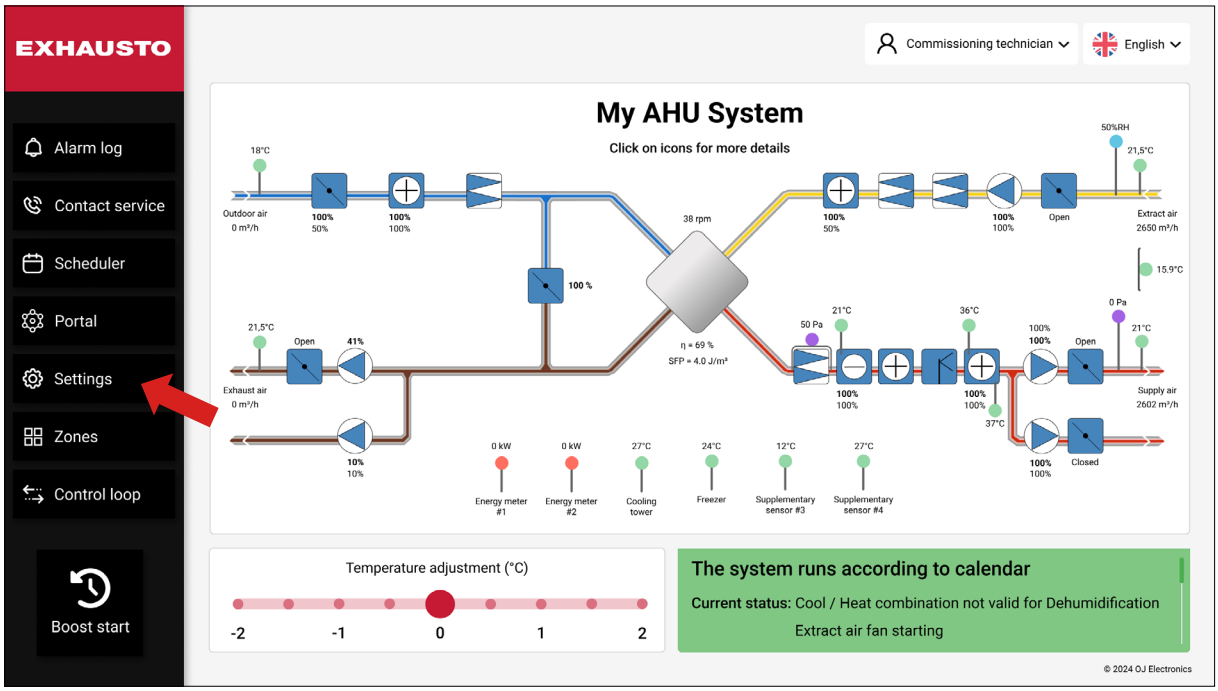
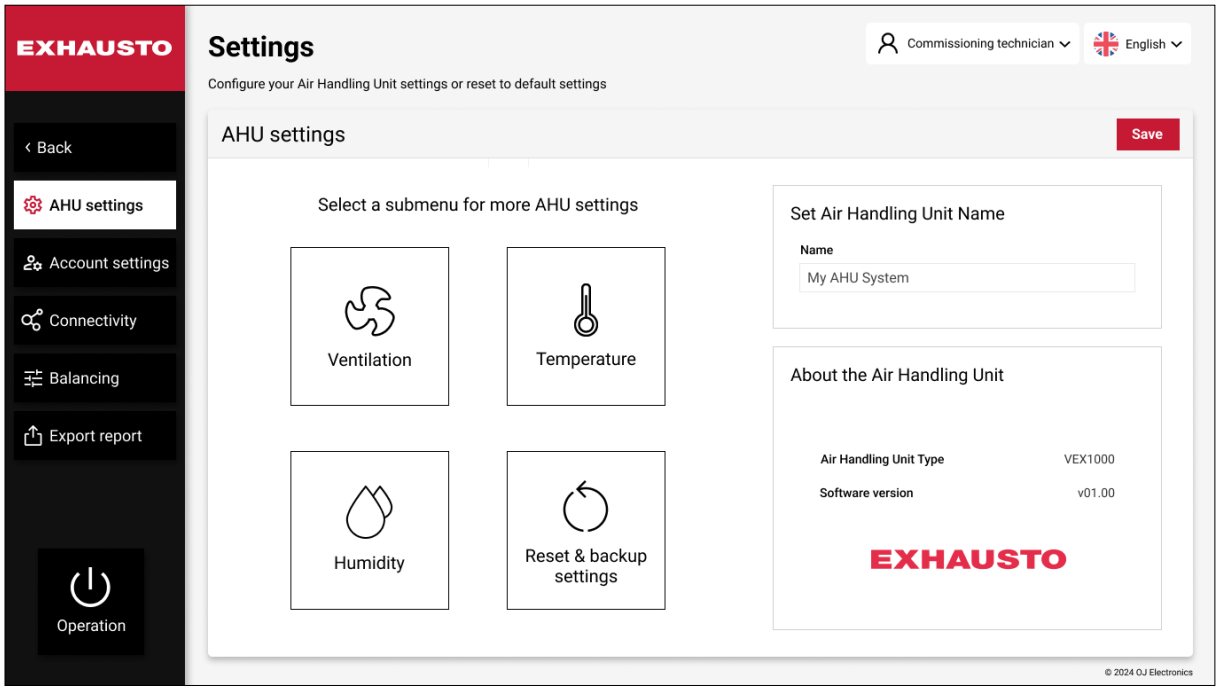
10. SETTINGS



10.1 AHU Settings

Under **Settings**, you can gather much useful information and perform a wide range of adjustments. The **AHU Settings** section contains 4 main categories: **Ventilation, Temperature, Humidity**, and **Reset & backup settings.**



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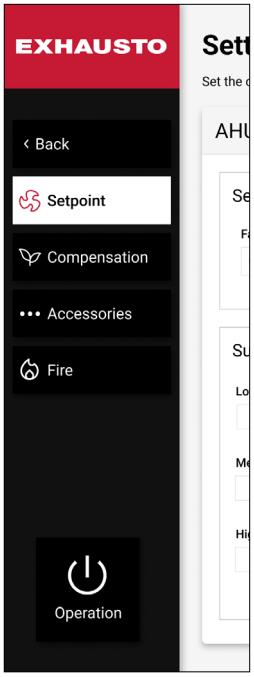
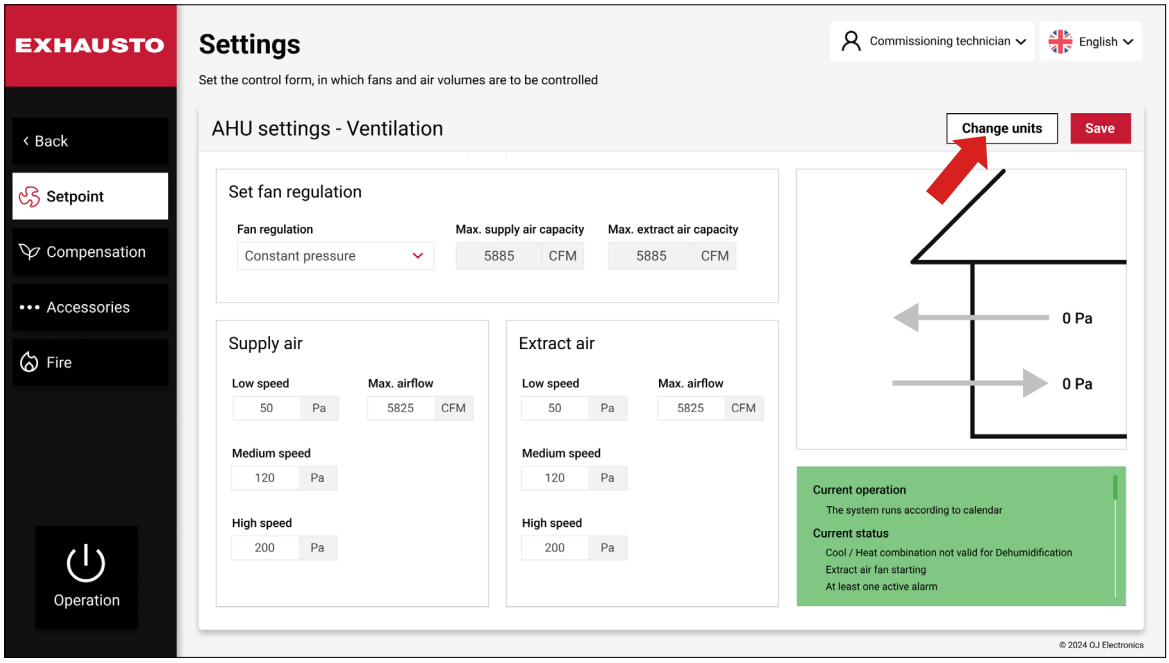
10.1.1 Ventilation

When you enter the **Ventilation settings** section, you are presented with the **Setpoint** window as well as **Compensation, Accessories** and **Fire** features on the left. See below:



10.1.1.1 Setpoint

In the **Setpoint** window (see above) you can choose which fan regulation method shall be active, and you can adjust the setpoints for the air exchange. The sketched house to the right illustrates the ventilated facility. You will notice that the “house” is a dynamic picture showing the present operating conditions for the ventilated facility. If **Constant pressure** is set as fan regulation method, the current supply and exhaust pressures inside the “house” will be shown in the pressure unit selected under **Pressure unit** (Pa or WG). You can change the pressure unit with the **Change unit** button, see below. Likewise, if **Constant air flow** is set as fan regulation method, the depicted airflow inside the “house” will be shown in the airflow unit, that you have selected under **Airflow unit** (m3/h, l/s, or CFM). You can also change the air flow unit with the **Change unit** button, see below.



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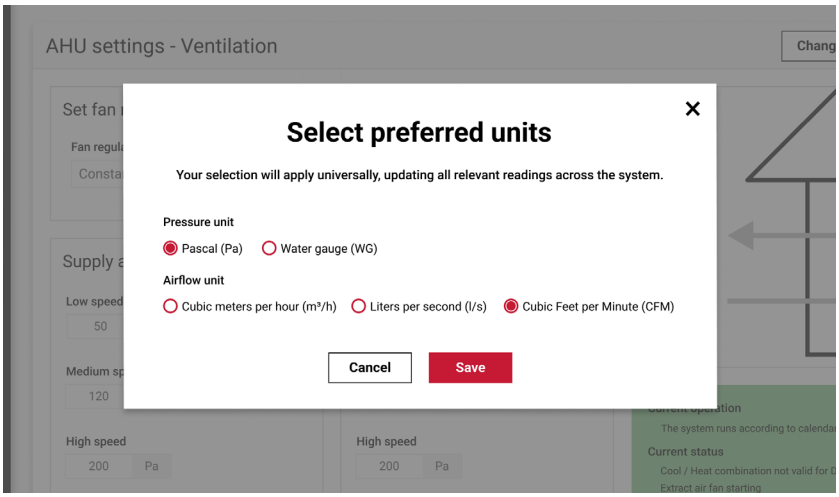
Change units:
Click on the Change units button if you wish to change the pressure and airflow units, see below:



Airflow unit:
Here you can select which unit shall be used when displaying the airflow: m3/h, l/s, or CFM (Info: CFM is an abbreviation for cubic feet per minute).

Pressure unit:
Pascal or WG (Inch water gauge)

The **Set fan regulation** section:
Constant pressure is the default fan regulation method in most HVAC systems. Below, you will find some background information about the supported fan regulation methods. Use the dropdown list to select a fan regulation method.

10.1.1.2 The fan regulation methods explained

Constant pressure
The Supply and Extract fan speeds are individually controlled to maintain duct air pressure according to the setpoints (Pa, WG). The duct pressure is maintained, even if Variable Air Volume (VAV) dampers have been installed in the ducts.

* The Supply and Extract duct pressures shall be measured by pressure transmitters.

Constant airflow
The Supply and Extract fan speeds are individually controlled to maintain duct air volume according to the setpoints (m3/h, l/s, CFM). Increased internal pressure drops due to filter clogging are automatically compensated.

* The Inlet cone pressure in both fans shall be measured by pressure transmitters.

Extract air slave
The Supply fan speed is controlled to maintain duct air pressure according to the setpoint (Pa, WG). The Extract fan speed is controlled to maintain the same Extract air volume as measured in the Supply air duct, with an optional offset of up to +/-50%. Balanced ventilation is maintained, even if Variable Air Volume (VAV) dampers have been installed in the supply duct, and none have been installed in the extract duct.

* The Supply duct pressure shall be measured by a pressure transmitter.
* The Inlet cone pressure in both fans shall be measured by pressure transmitters.

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Supply air slave
The Extract fan speed is controlled to maintain duct air pressure according to the setpoint (Pa, WG). The Supply fan speed is controlled to maintain the same Supply air volume as measured in the Extract air duct with an optional offset of up to +/-50%. Balanced ventilation is maintained even if Variable Air Volume (VAV) dampers have been installed in the extract duct, and none have been installed in the supply duct.

* The Extract duct pressure shall be measured by a pressure transmitter.
* The Inlet cone pressure in both fans shall be measured by pressure transmitters.

Constant VOC/CO2
The Extract fan speed is controlled to maintain Extract air quality according to the setpoint (ppm). The air volume decreases to the minimum airflow setpoint in case of low VOC/CO2. The Supply fan speed is controlled to maintain the same Supply air volume as measured in the Extract air duct with an optional offset of up to +/-50%. Balanced ventilation is maintained at all operation points.

* The Inlet cone pressure in both fans shall be measured by pressure transmitters.
* The Extract duct or room Air Quality shall be measured by a VOC or CO2 transmitter.

Mixing dampers
If your Air Handling Unit includes Mixing dampers, the VOC/CO2 level is controlled by recirculation.
This reduces the heating/cooling energy consumption when the CO2 levels are fine.

Recirculation VOC/CO2
The system must be configured with a VOC or CO2 sensor, either positioned in the room as a room sensor or in the extract duct as a duct sensor.

* If the CO2 concentration in the room rises, the recirculation damper is regulated in a modulated way (0 - 100%) towards the closed position. The Outdoor air damper is regulated towards 100% open – on the condition that the “Maximum outdoor air” setting has not been reached.
* If the CO2 level in the room falls, the recirculation damper is regulated in a modulated way (0 - 100%) towards the open position. The Outdoor air damper is regulated towards closed – on the condition that the “Minimum outdoor air” setting has not been reached.

Fan optimizer
The Supply and Extract fan speeds are individually controlled to maintain duct air volume according to the Fan optimizer 0-10V input signals. Increased internal pressure drops due to filter clogging are automatically compensated.

* The Inlet cone pressure in both fans shall be measured by pressure transmitters.
* The air volume setpoints shall be controlled by a 0-10V signal, for example from Belimo COU24-A-MP.

Fan optimizer slave
The Supply fan speed is controlled to maintain duct air volume according to the Fan optimizer 0-10V input signals. The Extract fan speed is controlled to maintain the same Extract air volume as measured in the Supply air duct with an optional offset of up to +/-50%. Balanced ventilation is maintained even if Variable Air Volume (VAV) dampers have been installed in the supply duct and none have been installed in the extract duct.

* The Inlet cone pressure in both fans shall be measured by pressure transmitters.
* The Supply air volume setpoint shall be controlled by a 0-10V signal, for example from Belimo COU24-A-MP.

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Green Zone
The Supply and Extract fan speeds are individually controlled to maintain optimized duct air pressure according to setpoints from an OJ ZoneMaster in an advanced dual duct VAV system.

* The OJ ZoneMaster is a part of an OJ Electronics GreenZone system.
* Fan setpoints are communicated by Modbus RS485 between the EXcon+ and the OJ ZoneMaster.

Green Zone slave
The Supply fan speed is controlled to maintain optimized duct air pressure according to setpoint(s) from an OJ ZoneMaster in a VAV system. The Extract fan speed is controlled to maintain the same Extract air volume as measured in the Supply air duct with an optional offset of up to +/-50%. Balanced ventilation is maintained even if Variable Air Volume (VAV) dampers have been installed in the supply duct, and none have been installed in the extract duct.

* The Inlet cone pressure in both fans shall be measured by pressure transmitters.
* The OJ ZoneMaster is a part of an OJ Electronics GreenZone system.
* Fan setpoints are communicated by Modbus RS485 between the EXcon+ and the OJ-ZoneMaster.

Constant motor speed
The Supply and Extract fan speeds are individually controlled by fixed setpoints. Duct pressure and air volume are unregulated and depend on actual loads and internal pressure drops, for example in filters.

* No sensors are required.

Dynamic pressure (Patented “courbe montante”)
The Supply and Extract fan pressure setpoints are individually and dynamically adjusted depending on the air flow value in order to compensate for the duct pressure loss. The ductwork pressure loss curve is defined by Min. and Max. duct pressure settings and corresponding Min. and Max. Air flow settings. This avoids excessive duct pressure in VAV systems and saves energy.

Setpoint range: 0 - 5000 Pa depending on the pressure transmitter. 0 - 300.000 m3/h, l/s, CFM depending on the max. airflow settings.

The Inlet cone pressure in both fans must be measured by pressure transmitters.

0-10V Exhaust slave
The Supply fan speed is controlled to maintain duct air volume according to the 0-10V input signal within the set Air volume range. The Extract fan speed is controlled to maintain the same Extract air volume as measured in the Supply air duct with an optional offset of up to +/-50%. Balanced ventilation is maintained, even if Variable Air Volume (VAV) dampers are fitted in the supply duct, and none are in the extract duct.

- The Inlet cone pressure in both fans must be measured by pressure transmitters.
- The Supply air volume setpoint must be controlled by a 0-10V signal, for example from a potentiometer enabling the user to adjust the fan speed, a temperature transmitter increasing the fan speed at high temperatures, a CO2 sensor increasing the fan speed at high CO2 levels, or a VAV 0-10V output.

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0-10V Supply slave
The Extract fan speed is controlled to maintain duct air volume according to the 0-10V input signal within the set Air volume range. The Supply fan speed is controlled to maintain the same Supply air volume as measured in the Extract air duct with an optional offset of up to +/-50%. Balanced ventilation is maintained, even if Variable Air Volume (VAV) dampers are fitted in the extract duct and none are in the supply duct.

- The Inlet cone pressure in both fans must be measured by pressure transmitters.
- The Supply air volume setpoint must be controlled by a 0-10V signal, for example from a potentiometer enabling the user to adjust the fan speed, a temperature transmitter increasing the fan speed at high temperatures, a CO2 sensor increasing the fan speed at high CO2 levels, or a VAV 0-10V output.

Exhaust backup fan
In the event of a malfunction of the Exhaust fan, the Exhaust backup fan starts up. In order to balance out the fan wear, the operation automatically alternates between the Exhaust fan and the Exhaust backup fan every 1st Tuesday of each month at 06:00 hours. Alarm signals must be available from the Exhaust fans.

- The Exhaust backup fan must be of the same type as the Exhaust fan.

Supply backup fan
In the event of a malfunction of the Supply fan, the Supply backup starts up. In order to balance out the fan wear, the operation automatically alternates between the Supply fan and the Supply backup fan every 1st Tuesday of each month at 06:00 hours.

- Alarm signals must be available from the Supply fans.
- The Supply backup fan must be of the same type as the Supply fan.

Max. air capacity:
Here you can see the maximum air volume your Air Handling Unit is designed for.

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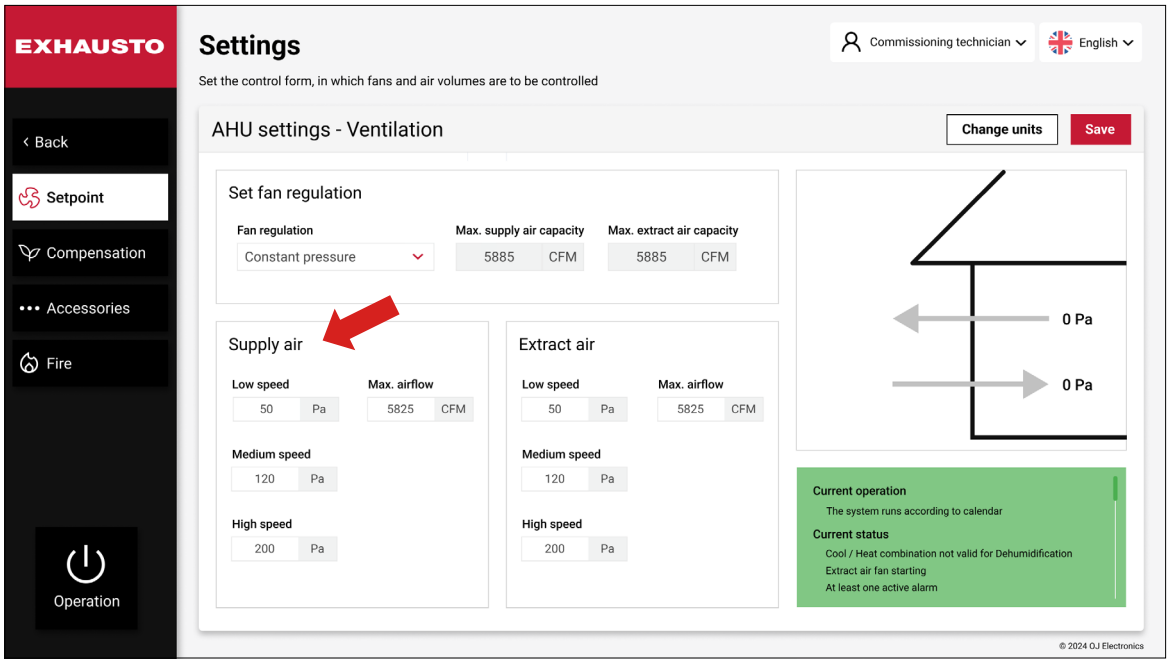
The Supply air section



Both in the **Supply air** and in the **Extract air** section, you can define the **Low speed, Medium Speed, High speed**, and **Max. airflow** setpoints.

Note the dependency between the chosen **Fan regulation** method and the available options in the **Supply** and **Extract air** sections. If for example:

* **Fan regulation** is set to **Supply air slave**, the **Supply air** section displays the input field **Offset supply air**. Moreover, the **Extract air** section will then contain the **Low speed**, **Medium speed**, and **High speed** fields.

Also, if

* **Fan regulation** is set to **GreenZone slave**, the **Supply air** section contains the read-out field **Fan speed** showing the fan speed as a percentage. The **Extract air** section will then contain the input field **Offset extract** air with a percentage value.

Note: The dependencies will become visible if you browse through the fan regulation methods and view their effects on the displayed fields in the **Supply** and **Extract air** sections.

See above for a description of all fan regulation methods.

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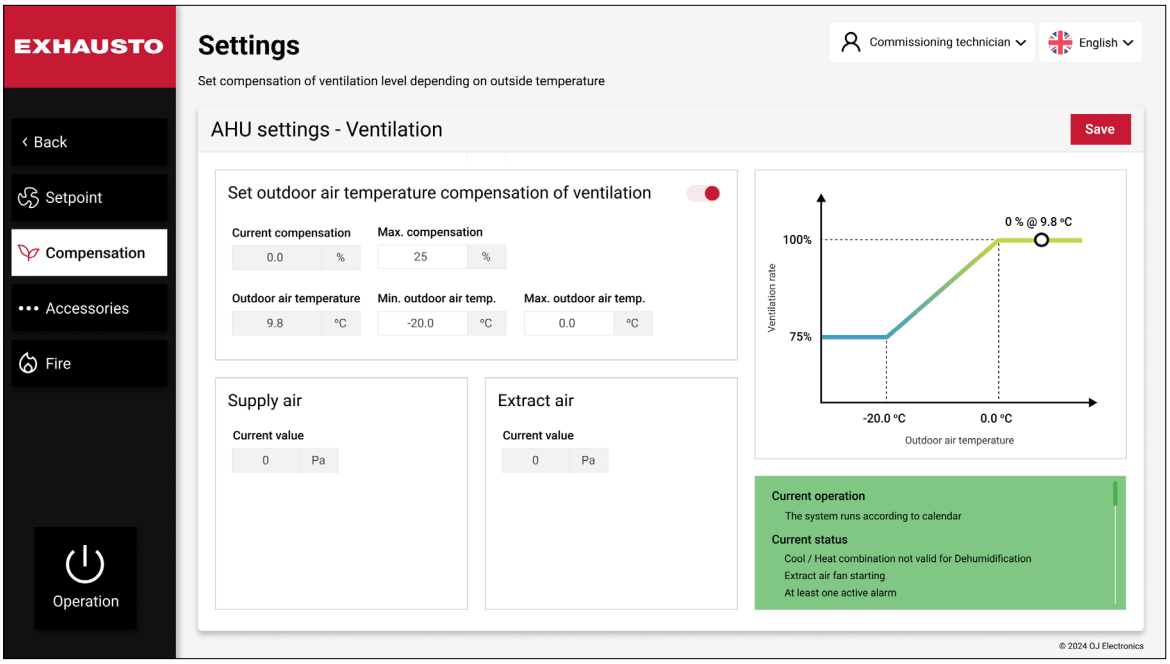
10.1.1.3 Compensation

The compensation function reduces the air exchange rate during periods with low outdoor air temperatures. The purpose of the compensation function is to reduce the amount of energy consumed by the ventilation system, when both the outside air temperature drops, and the absolute humidity in the outdoor air is low. The reduction in the intake of outdoor air means that less outdoor air needs to be heated and the lower intake of dry air helps maintain the building's humidity levels. In the **Compensation** window shown below, you can define the relation between temperature drop and the reduction in the intake of outdoor air.

In the diagram on the right side of the picture below, the compensation is shown by means of a curve. It displays how the ventilation rate is reduced at low outdoor temperatures.



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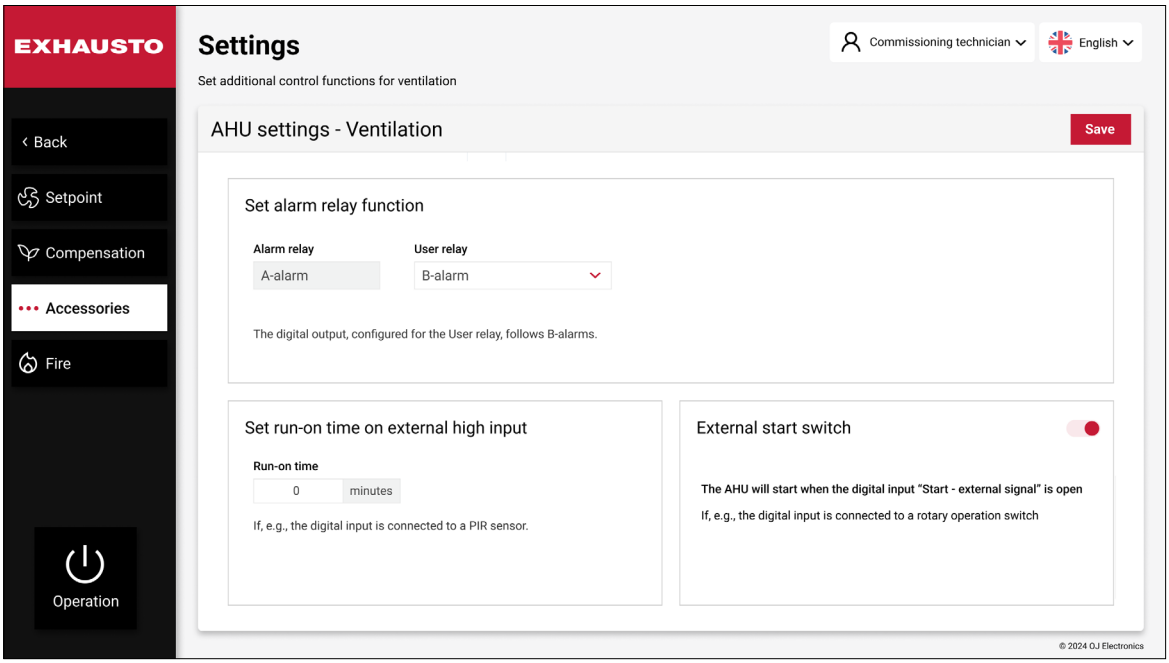
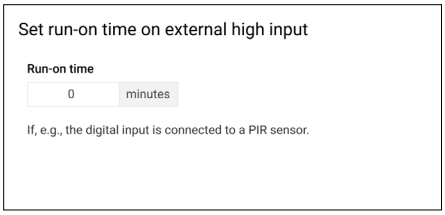
10.1.1.4 Accessories



The **Set alarm relay** function

The controller has two digital outputs that can be customized as an **Alarm relay** and a **User relay**. This window shows the current setting defining the conditions under which these relays operate. As a commissioning technician, you can change the User relay settings.

The section **Set run-on time on external high input**



A PIR sensor (motion sensor) can automatically start or increase ventilation from the low speed to the high speed setpoint when there are people present.

* A PIR sensor must be connected to the Air Handling Unit controller.

Run-on time is the period during which the Air Handling Unit operation stays at high speed after a trigger event from a PIR sensor ends. A passing person triggering the PIR sensor will start the Air Handling Unit for a short time. If the person returns within for example, 4 minutes, the Air Handling Unit will start again. Starting and stopping is prevented if the Run-on time is set to 5 minutes.

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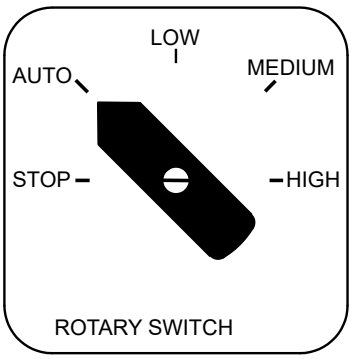
The **External start switch**
This function must be used if you use an operation mode switch, like this 5-step external rotary switch:



When the **External start switch** is activated:

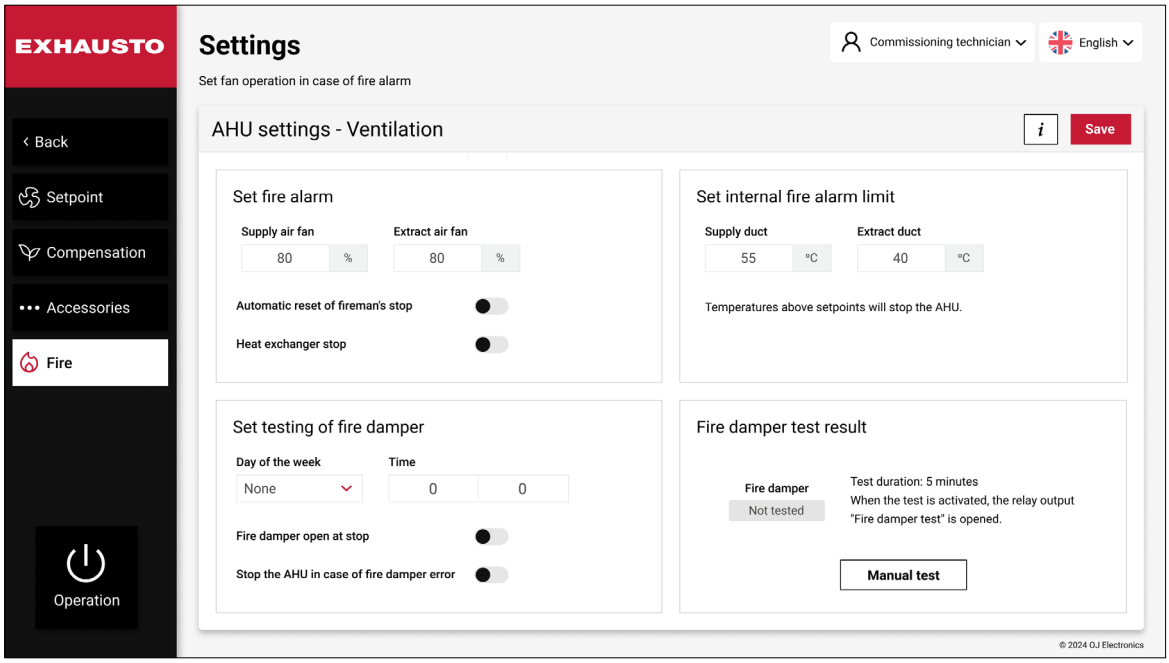
- If you are using a rotary switch with multiple positions to control the AHU, you must make sure the toggle switch is activated. In this mode, the AHU will start when the rotary switch is turned to a position that opens the circuit.

When the **External start switch** is deactivated:

- If you use a basic switch to control the AHU, you must make sure the toggle switch in the system settings is deactivated. The AHU will then start operating when the switch is turned on (closing the circuit).

10.1.1.5 Fire

Fire alarm



This dialog box is used for setting fan operations in case of fire alarms.

Set fire fan speed
The fan speed will follow these settings if a fire is detected in the building (the digital Fire input is open). However, this only applies if the system has not been brought to a Service stop.

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Set Internal fire alarm limit:
If the temperature exceeds the value set for **Supply duct** or **Extract duct**, a fire alarm (an A-alarm) is activated. The system then stops, dampers are closed, and all heating and cooling systems are shut down.

Set testing of fire damper:
The fire damper test enables you to systematically test the fire dampers' functionality.
The test stops the AHU, and this function disconnects the fire dampers' power supply, thus closing them. The dampers are closed using the "Spring return" function. If smoke evacuation dampers are installed, they will always be in an opposite position to the fire dampers. See the wiring diagram in Appendix B - Fire and smoke damper wiring diagram.

The option box Day of the week

The following options regarding testing days are available:

None = No fire damper testing is performed
All days = Testing is performed every day
Every 2nd day = Testing is performed every second day
Monday = Testing is performed every Monday
Tuesday = Testing is performed every Tuesday
Wednesday = Testing is performed every Wednesday
Thursday = Testing is performed every Thursday
Friday = Testing is performed every Friday
Saturday = Testing is performed every Saturday
Sunday = Testing is performed every Sunday

The option box Time
The exact hours and minutes for the testing to occur can be freely entered here.

Fire damper open at stop
This switch can be activated to specify whether the fire dampers are to stay open (ON) or closed (OFF) when the system is stopped, for example at night.

Stop the AHU in case of fire damper error
If the fire damper test is completed with errors, you may select whether the AHU must continue or discontinue operation.

Info on external signals
To test a fire damper, the system uses at least one digital input, which allows the fire damper to respond when it is closed. It also uses one digital output, which allows a signal to be sent to the fire damper.

If the fire damper does not confirm the digital input signal "Fire damper closed" within 180 seconds, an alarm is activated indicating that the fire damper test has failed.
The digital input should be connected to the damper motor's response switch for the closed damper.

See the illustrated example of an electrical wiring diagram in Appendix B - Fire and smoke damper wiring diagram.

Fire damper test result
Here, you can see the test results, and with the Manual test button, you can activate an instant testing of the fire damper. Note, that a fire damper error raises a B-alarm.

Info on the digital input Fire damper open
A digital input can also be configured to indicate that the fire damper is open. An alarm for lacking response on an open fire damper will only be raised if the digital input for "Fire damper open" receives no response.

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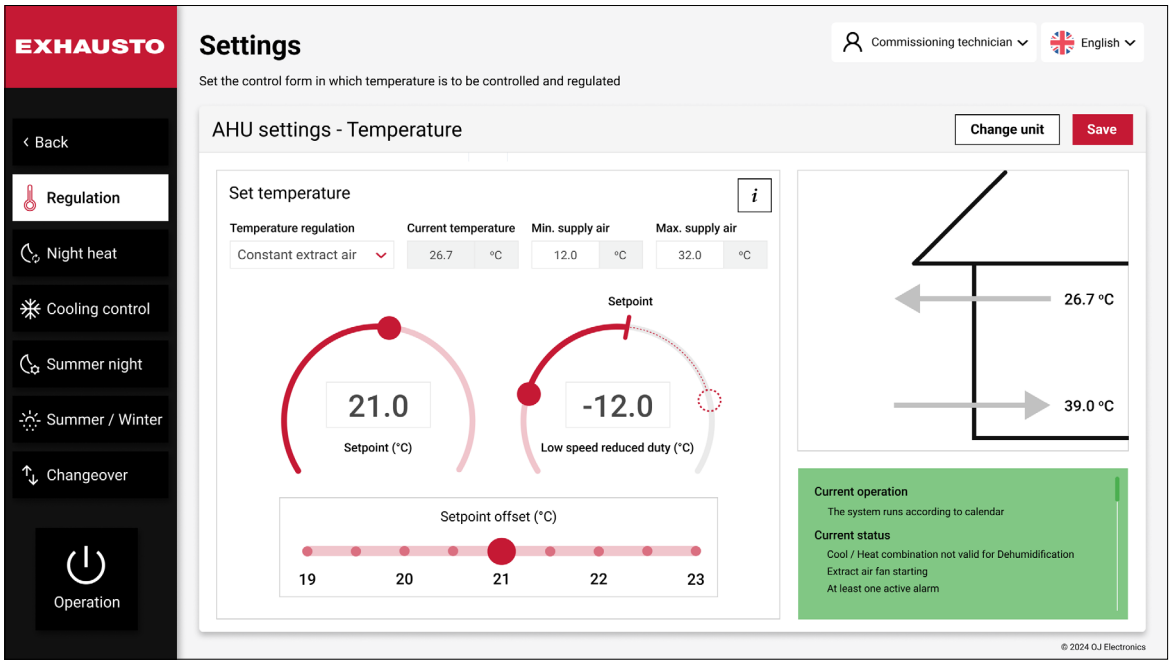
10.1.2 Temperature

10.1.2.1 Regulation

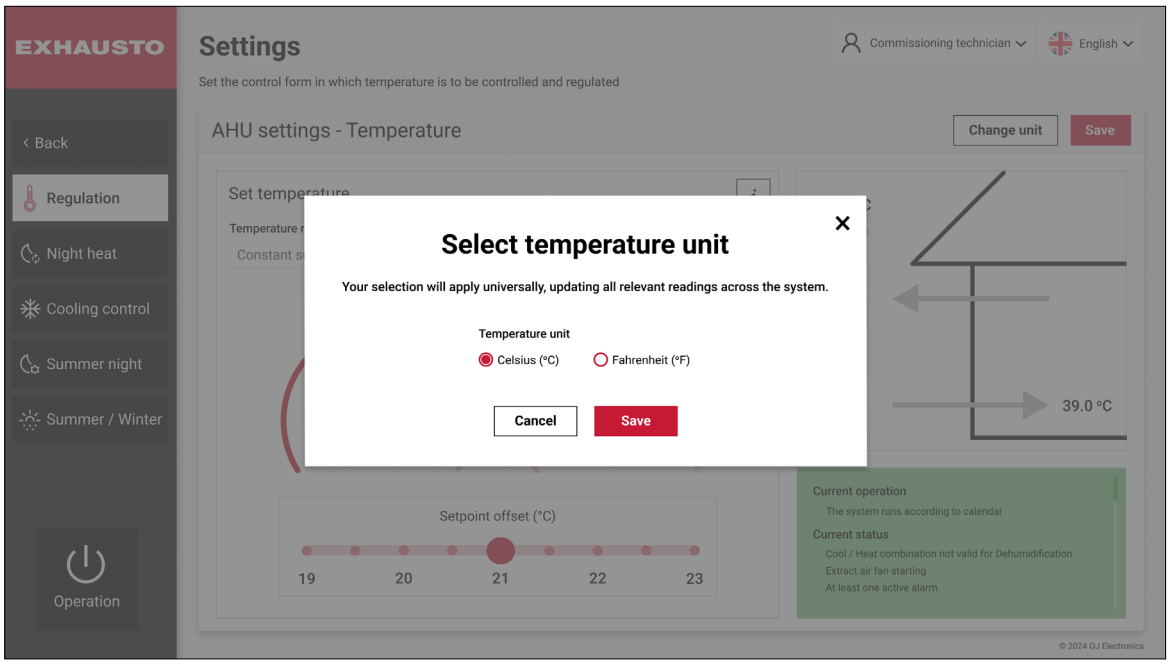
The temperature control settings are used to control and regulate a range of temperature-related parameters.

If you have not configured an external temperature setpoint, the following screen will be shown:



Change unit

Click on the **Change unit** button if you wish to change the temperature unit from Celsius to Fahrenheit or vice versa, see below:



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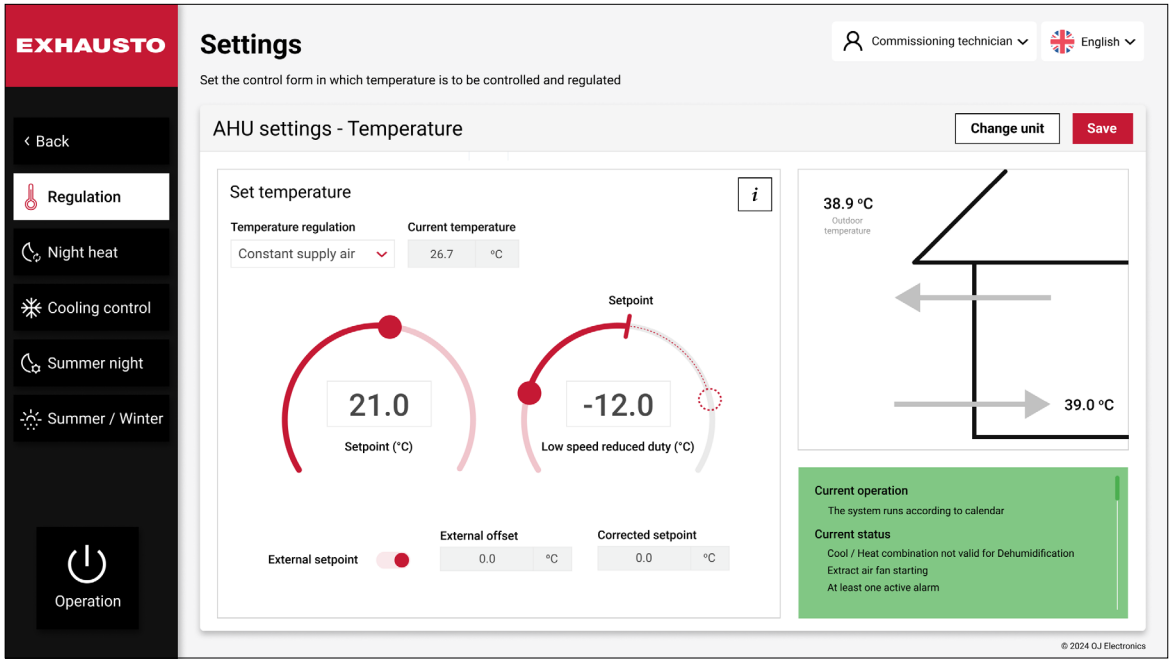
Temperature settings

You need to know which **Temperature regulation** method must control the temperature settings. If for example, you choose **Constant extract air**, you have the options shown on the previous page.

In the middle of the screen, you can specify the temperature setpoint for the current temperature control mode.

If you have configured an external temperature setpoint, the following screen will be visible:



When activating the **External setpoint**, the **External offset** and **Corrected setpoint** become visible. The External offset is set by the small flywheel on the remote temperature control panel.

The **External outdoor air temperature sensor** is to be activated, if there is a physical external outdoor air temperature sensor installed in the HVAC system, and you want its temperature reading to be used.

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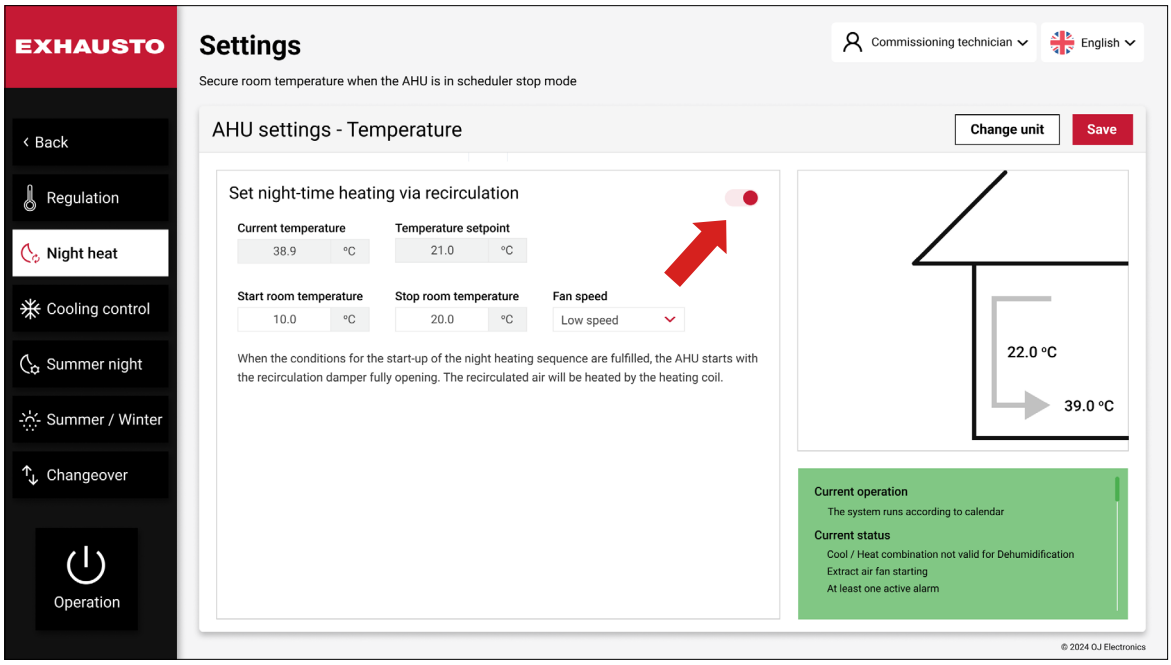
10.1.2.2 Night heating



Night heating is used to keep the building warm during the night if the ventilation system is the only heat source in the building.

The AHU starts, and the room air is recirculated. If the room temperature drops, the room air is also heated.

Info: During recirculation, the outdoor air damper and the exhaust air damper are closed. The supply air damper, the room air damper, and the recirculation damper are all open.

Note: The room temperature must be measured by a room temperature sensor.

In the **Night heat** window, you can set up the system to make use of recirculation heating. You must slide the round button by the arrow, to the right, to activate this function.

In the example above, recirculation is set to start, when the room temperature falls below 10 °C. Also, if the room temperature exceeds 20 °C, the recirculation function is no longer needed, and therefore, it will be deactivated.

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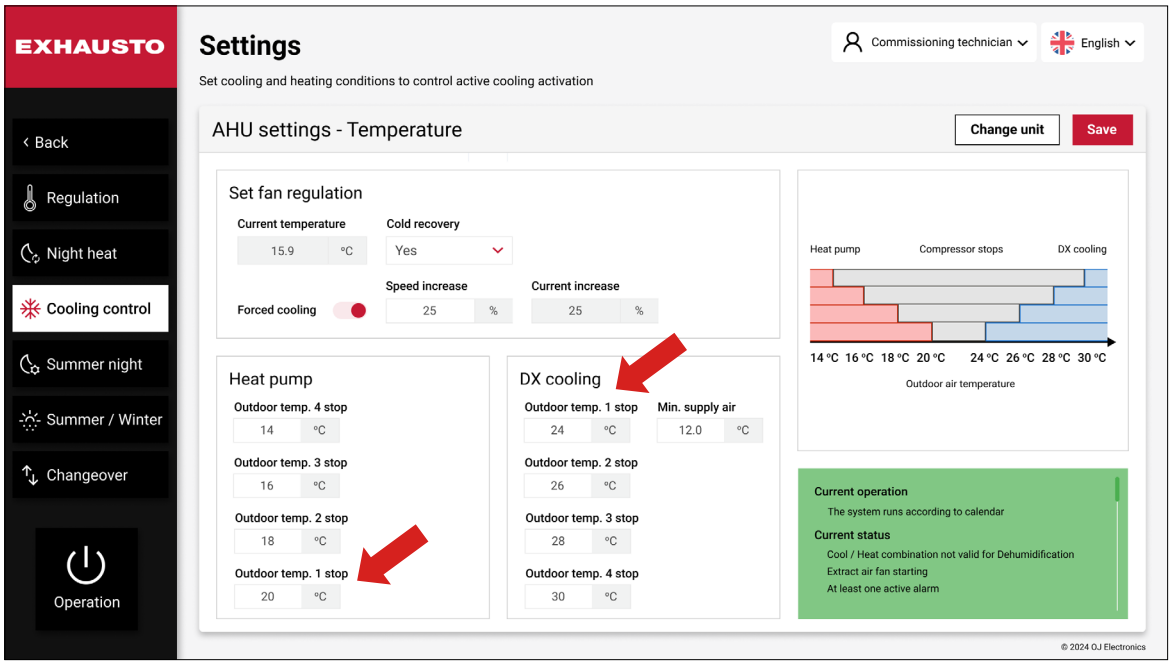
10.1.2.3 Cooling Control



The overall purpose of the configuration options above is to obtain a desirable balance between energy consumption and room comfort.

Notice, that the dialog box above has a dynamic design: It varies depending on the number of compressors installed in the system. In the above configuration you have a system with a heat pump, 4 compressors and a DX cooling coil.

In the **Heat pump** and **DX cooling** sections, you can define outdoor temperature setpoints, that determine when the Heat pumps and cooling compressors will be activated. In the example shown, the first heat pump compressor starts when the outdoor air temperature falls below 20 °C. This is defined in the **Outdoor temp. 1. stop** box (see the arrows). The second compressor will be activated below 18 °C, that is when the outside temperature drops further. This is also visualized in the red, grey, and blue diagram on the right.

In the **DX cooling** section, the opposite takes place. The first DX cooling compressor will be activated when the outdoor temperature (**Outdoor temp. 1. stop**) exceeds 24 °C. The second compressor will be activated above 26 °C, and so on for the remaining 2 compressors. Notice, that not all compressors need to be active when the system is running.

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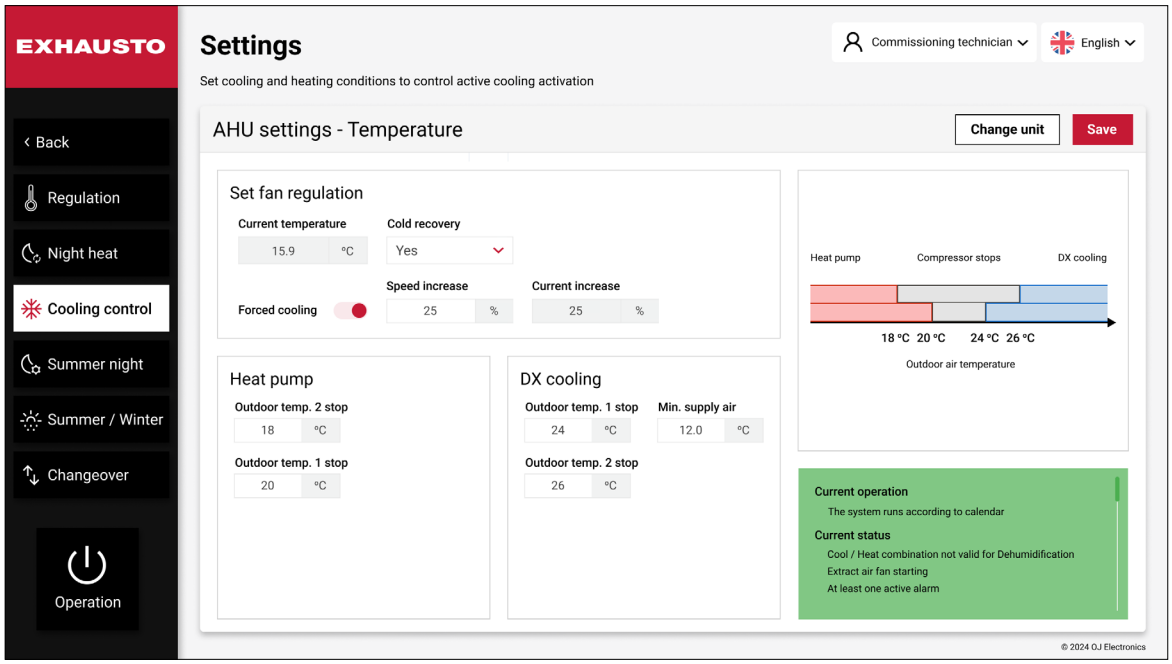
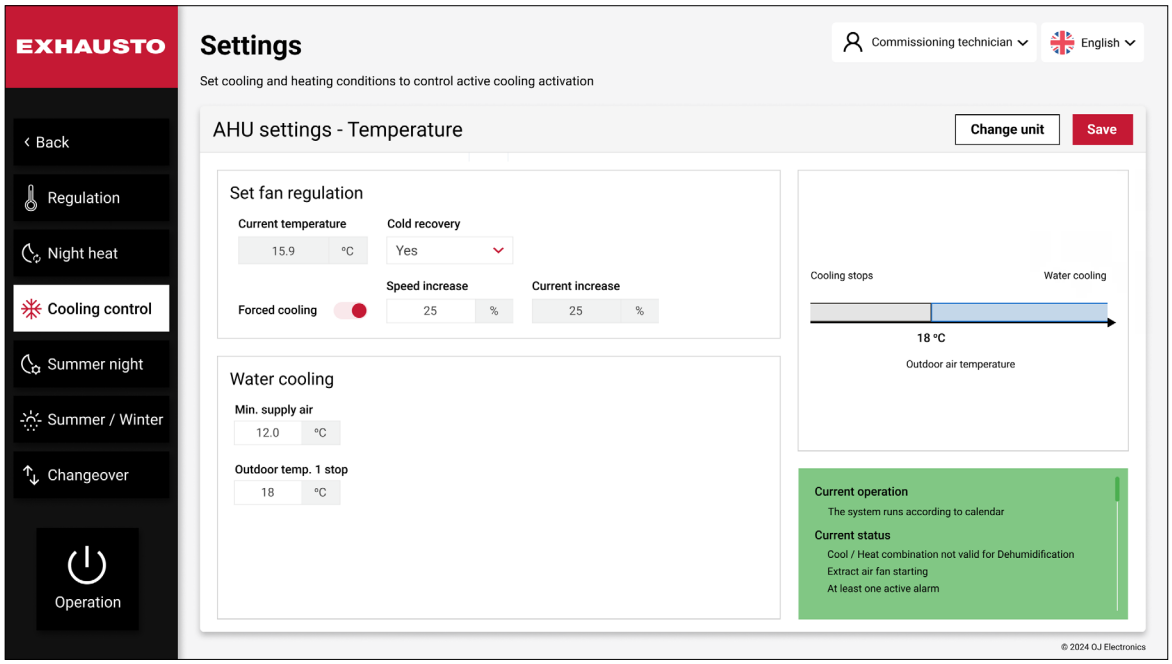
If the HVAC system only comprises 2 compressors, the dialog box will look like this:



If a water-based cooling coil is integrated in the system, the dialog box will also change. Then it will look like this:



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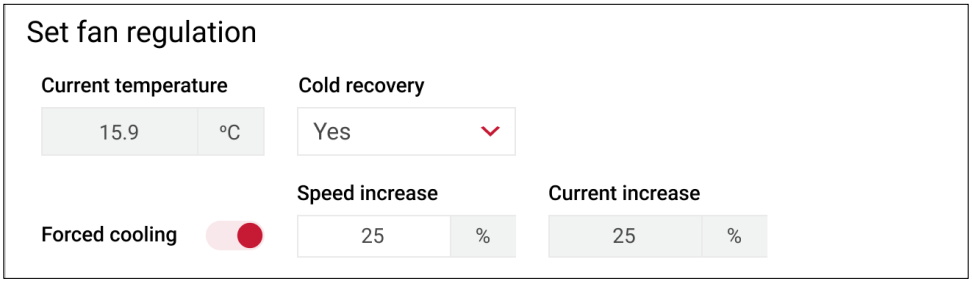
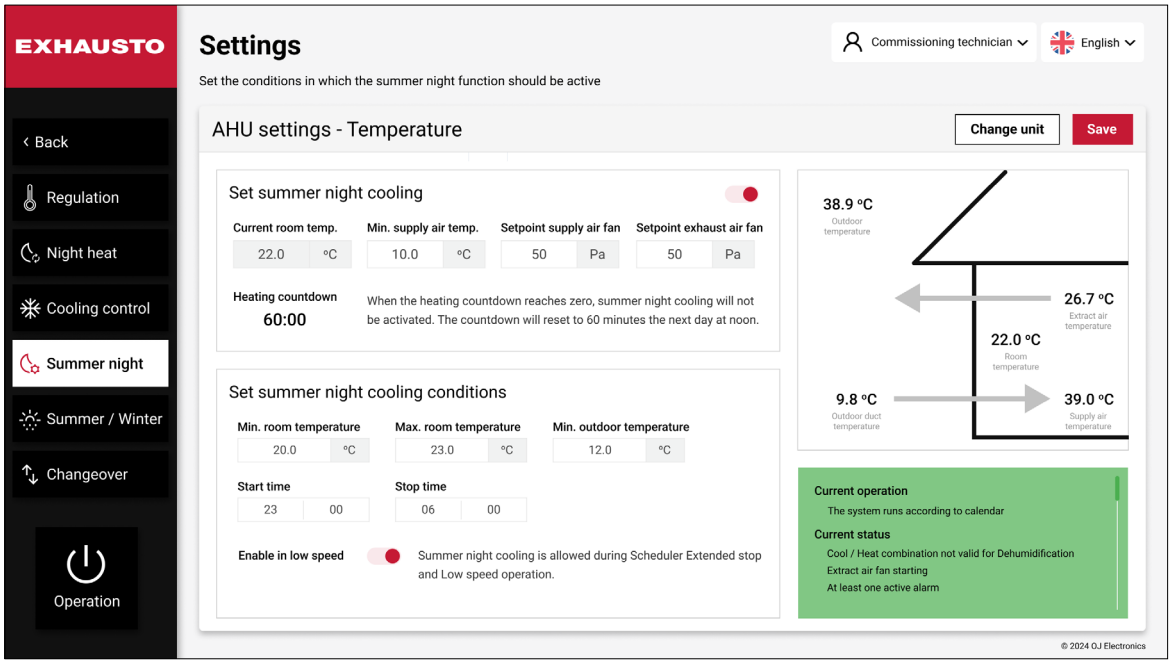
Set fan regulation



In the **Set fan regulation** window shown above, the **Current temperature** is shown. Next to the **Current temperature**, you can see whether the heat exchanger will be used for cooling recovery or not.

If you activate **Forced cooling** just below, the airflow will increase if cooling is active. This will allow more heat to be removed from the building. Here, you also see the **Current increase**, and you can set the **Speed increase** in percent.

10.1.2.4 Summer night



Summer night cooling: Standard sensors
Cold outside air during the night is utilized for energy-effective cooling and increased comfort. Summer night cooling starts a 10-minute temperature test run once every night if the conditions are met.

* Outdoor Air, Supply Air, and Extract Air temperatures shall be measured by duct temperature sensors (PT-1000).

Summer night cooling: Additional sensors
Cold outside air during the night is utilized for energy-effective cooling and increased comfort. Summer night cooling starts and restarts anytime during the night if the conditions are met.

* Supply Air temperatures shall be measured by duct temperature sensors.
* Outdoor Air shall be measured by a dedicated Outdoor temperature sensor outside the ducts.
* Room temperature shall be measured by a dedicated room temperature sensor outside the ducts.

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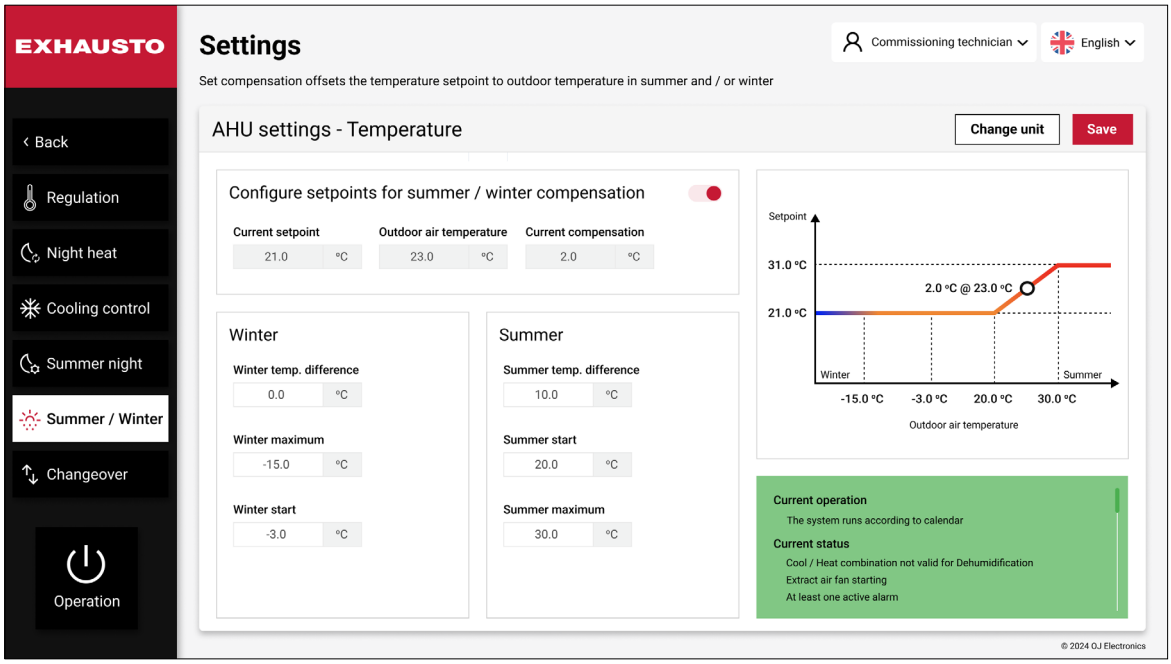
The Summer night cooling only starts when:

* **Schedule** is selected, AND the AHU is in the status **Stop** or **Low speed**.
* There was less than 60 minutes of heating demand between Summer night cooling Stop time and 12.00 noon, during the latest operation period.
* The room temperature is above the set **Max. room temperature**.
* The Outdoor temperature is a minimum of 2 ^{0}C below the Room/Extract temperature.
* The Outdoor temperature is above the set **Min. Outdoor temperature**.
* The set **Start time** has been passed.

The Summer night cooling will stop when:

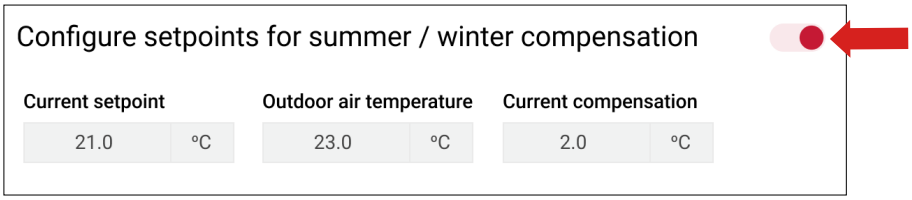
* Scheduler sets the AHU in the status **Low speed, Medium speed**, or **High speed**.
* The Operation mode is changed to Stop, **Low speed, Medium speed,** or **High speed.**
* The room temperature is below the set **Min. room temperature**.
* The Outdoor temperature is not below the Room/Extract temperature.
* The Outdoor temperature is below the set **Min. Outdoor temperature**.
* The set **Stop time** has been passed.
* The Supply Air temperature is below the set **Min. supply air temp**.

10.1.2.5 Summer / Winter



The Summer/Winter compensation adds an offset to the temperature setpoint depending on the current Outdoor temperature.

When clicking the **Configure setpoints for Summer / Winter compensation** button, it is possible to set temperature compensation parameters for summer and winter operations.



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Summer/winter compensation can be activated when sliding the round button in the upper right corner to the right. When selected, temperature setpoint compensation offsets will be according to the settings in the **Summer** or **Winter** sections. The difference will be visually reflected in the diagram on the right.

Please note: The function is only available when one of the following temperature regulation methods is in use:

- Constant supply air
- Constant extract air
- Constant room

Note, that Summer / Winter compensation is not available when the temperature regulation method is:

- Supply air slave temperature

The **Winter** section
The temperature setpoint can be increased at low outdoor temperatures. This will help keep a comfortable room temperature if the building envelope has limited insulation.

Winter temp. difference – Here you define the maximum winter compensation offset you want to add to the setpoint.

Winter start – The outdoor temperature at which the winter compensation function is activated.

Winter maximum – This is the outdoor temperature at which the winter compensation level reaches maximum.

The Summer section
At high outdoor temperatures, the temperature setpoint can be increased or decreased. An increased temperature setpoint will reduce the risk of causing air conditioning colds and reduce energy spent on cooling.
A decreased temperature setpoint will help keep a comfortable room temperature if the building envelope has limited insulation.

Summer temp. difference
Here you define the maximum summer compensation offset, that you want to add to the setpoint. You can enter a positive or a negative value.

Summer start - The outdoor temperature at which the summer compensation function is activated.

Summer maximum – This is the outdoor temperature at which the summer compensation level reaches maximum.

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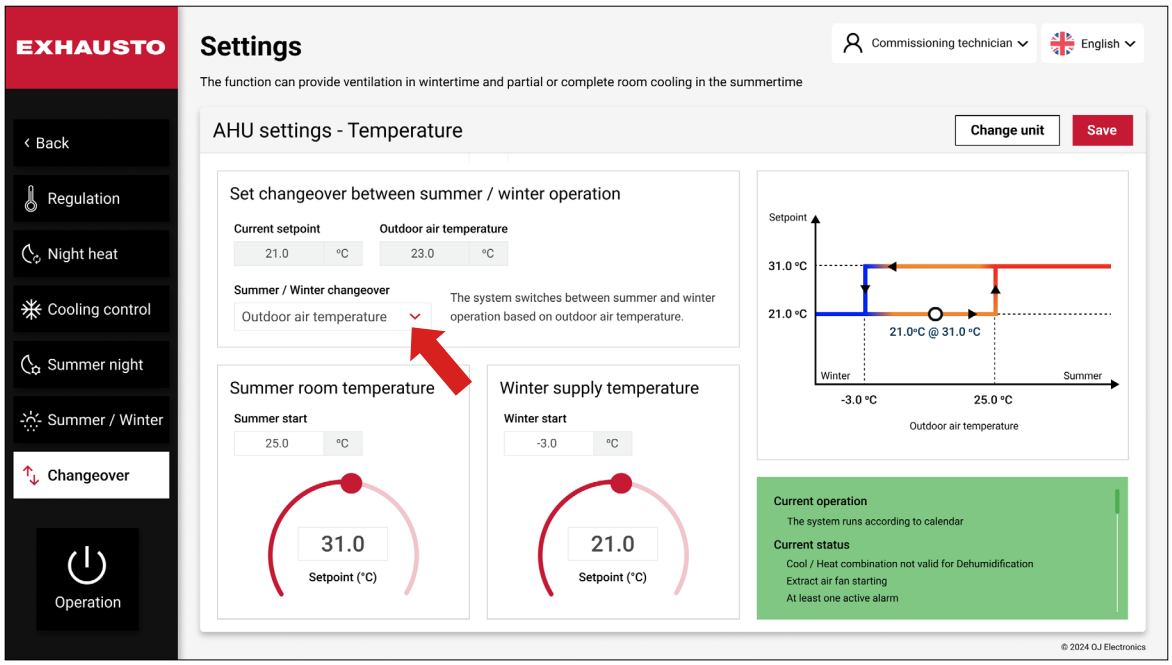
10.1.2.6 Changeover



Use the drop-down button **Summer / Winter changeover** (see the red arrow above) to control the switchover between summer and winter operation.

During the summer period, the temperature control loop is set to **Room temperature**, thus allowing the AHU to cool the room. In the winter period, the temperature control loop is set to **Supply Air temperature**, so the ventilation system works well in combination with radiators or floor heating. The changeover is done automatically according to the Outdoor temperature or calendar dates.

When activated, the switch between summer and winter operation can follow 4 different criteria:

- Outdoor air temperature
- Calendar
- Summer
- Winter

Note, that the function is only available if one of the following temperature control types is used:
- Constant extract temperature
- Constant room temperature

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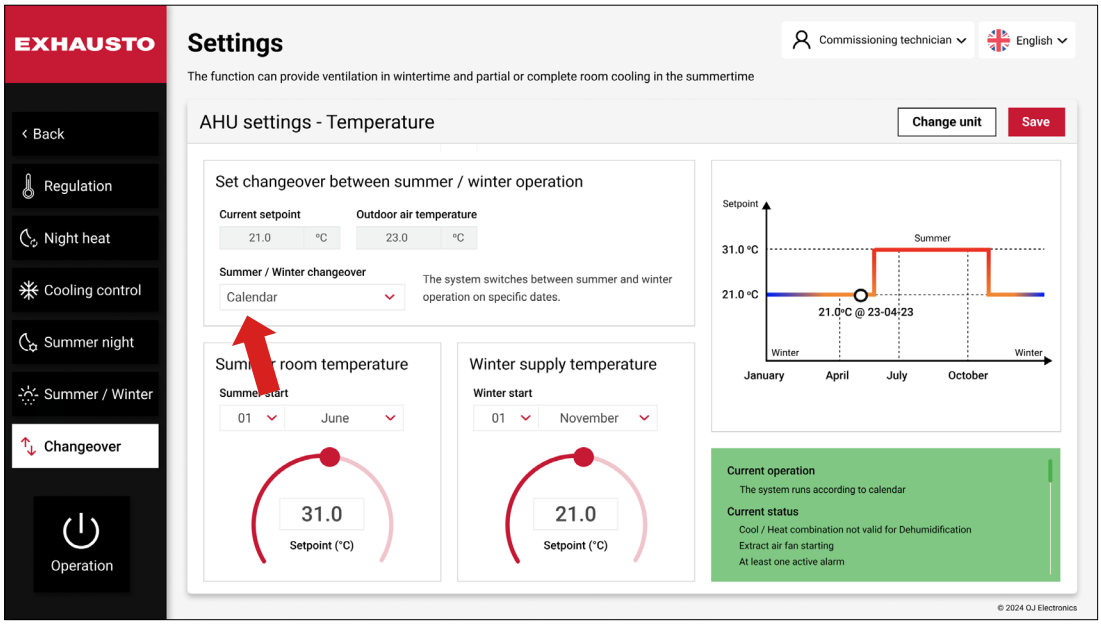
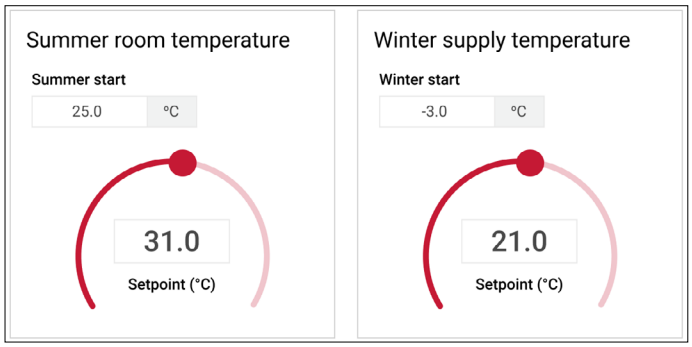
1. If you select **Off** on the **Summer / Winter changeover** dropdown list, there will be no switch between summer and winter operation.:

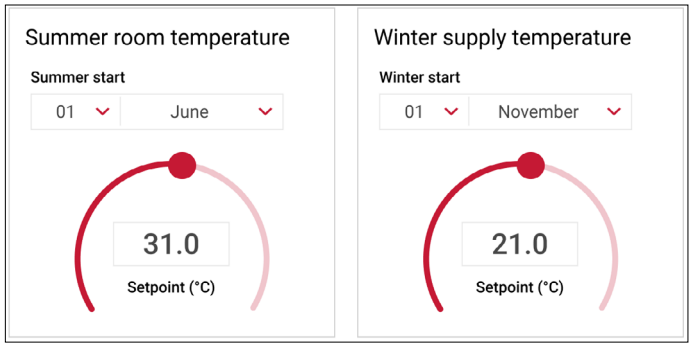


2. If you select **Outdoor air temperature** you will be presented with these options:



Here you can set the summer **Room temperature setpoint** and the **Summer start** outdoor temperature. In the illustrated example above, the control loop will switch to summer operation when the outdoor air temperature (**Summer start**) reaches 25°C. It will switch back to Winter operation when the outdoor air temperature (**Winter start**) falls to -3°C.

3. If you choose a calendar-based approach, the settings will look similar to this:



With a calendar-triggered changeover between summer and winter operation, you must choose a specific date for the changeover. In this case the outdoor air temperatures will have no influence on the timing for the changeover.

4. If you choose Summer or Winter operation, the system will run permanently according to the temperature setpoint defined under Summer or Winter.

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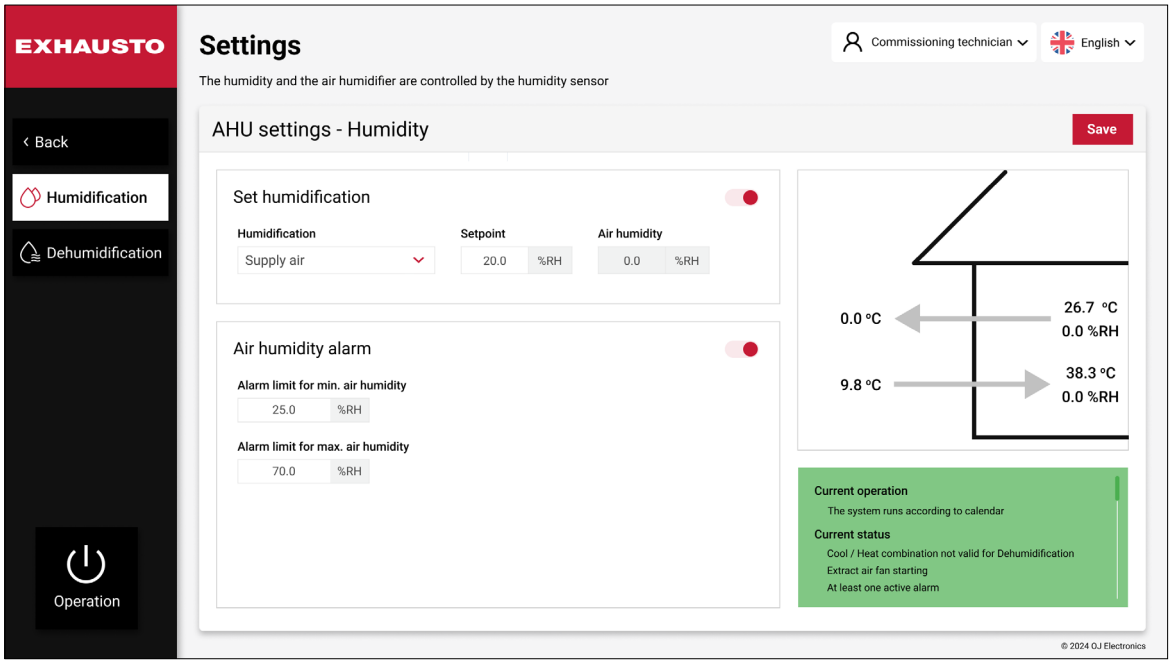
10.1.3 Humidity

10.1.3.1 Humidification

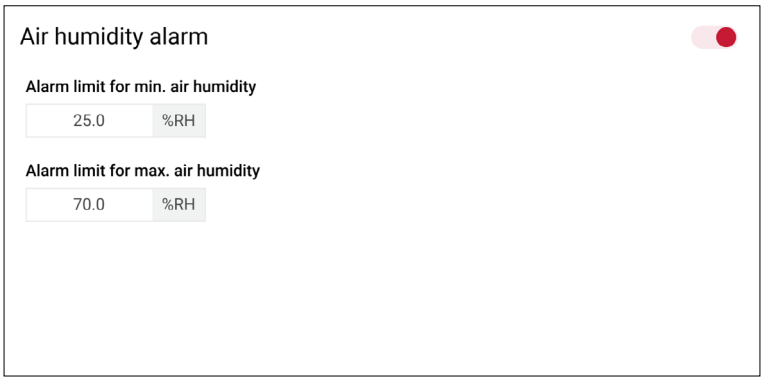


The humidifier is used to raise the moisture content of the supply air.
Supply air humidity can either be controlled by a supply setpoint or by an extract setpoint. In the example above, **Supply air** has been chosen.

Setpoint
Here, you can specify the setpoint (in relative humidity percentage) for the current humidification method (supply/extract).

Air humidity
Actual humidity reading for the selected control sensor.

The section **Air humidity alarm**



Here you can activate **Air humidity alarms**. If this setting is active, you can define the alarm limits for minimum and maximum air humidity.

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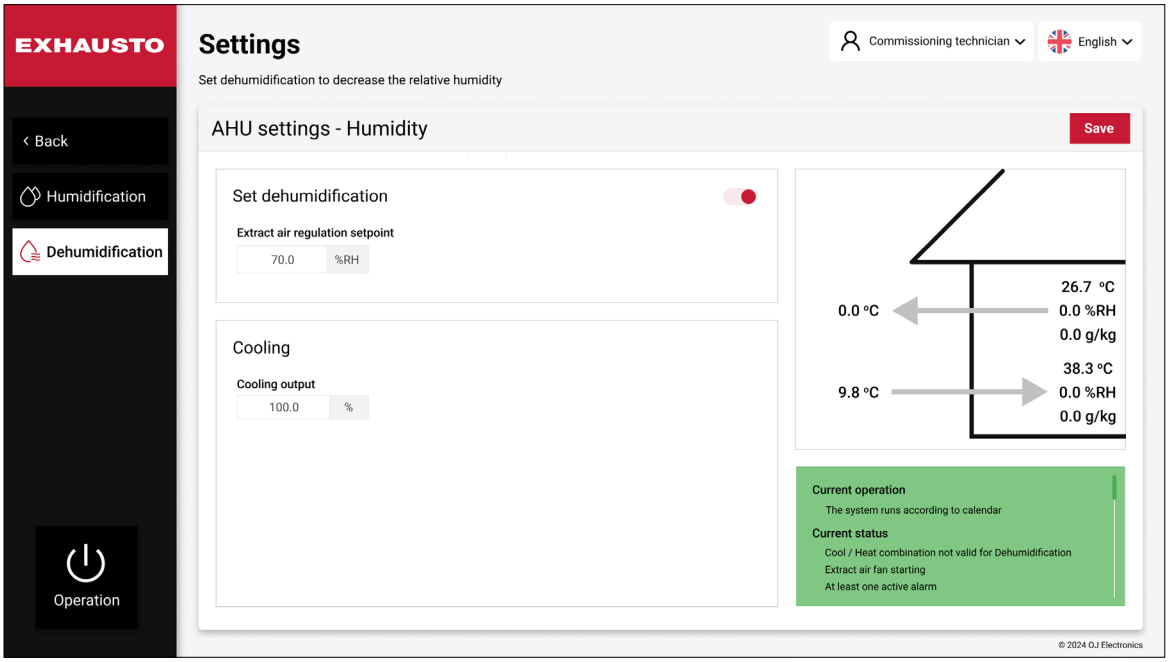
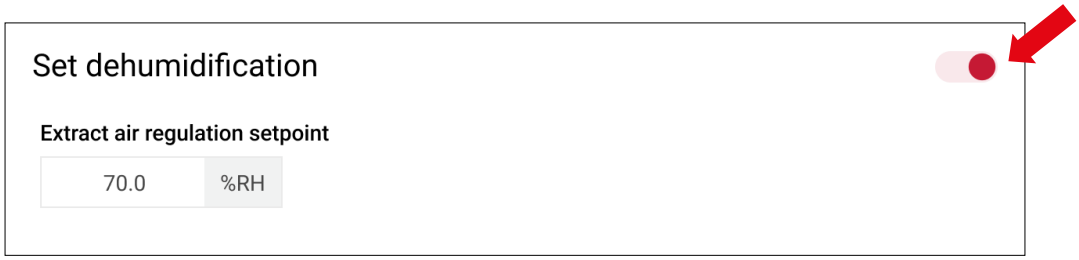
10.1.3.2 Dehumidification



Info: This function is used to lower the relative humidity in the room or in the supply air duct.

Set dehumidification



Slide the round button by the arrow to the side to activate or deactivate the dehumidification function.

Supply Air regulation setpoint
Here you can specify the setpoint (in relative humidity percentage) for the supply air.

Extract Air regulation setpoint
Here you can specify the setpoint (in relative humidity percentage) for the extract air.

Dehumidification is accomplished by controlling the power of the installed cooling element according to the calculated dew point temperature. The after-heating element ensures that the temperature in the supply air is maintained according to the temperature setpoint.

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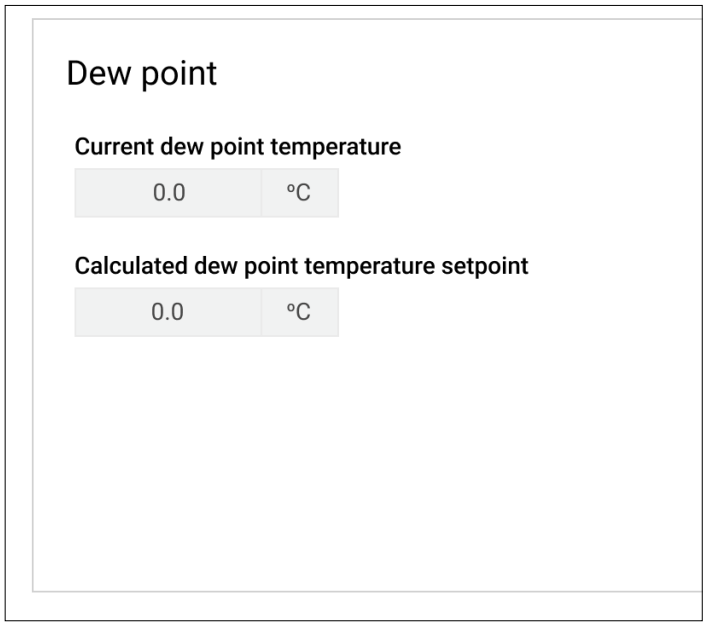
Dew point



Current dew point temperature: Here, the current dew point temperature is shown.

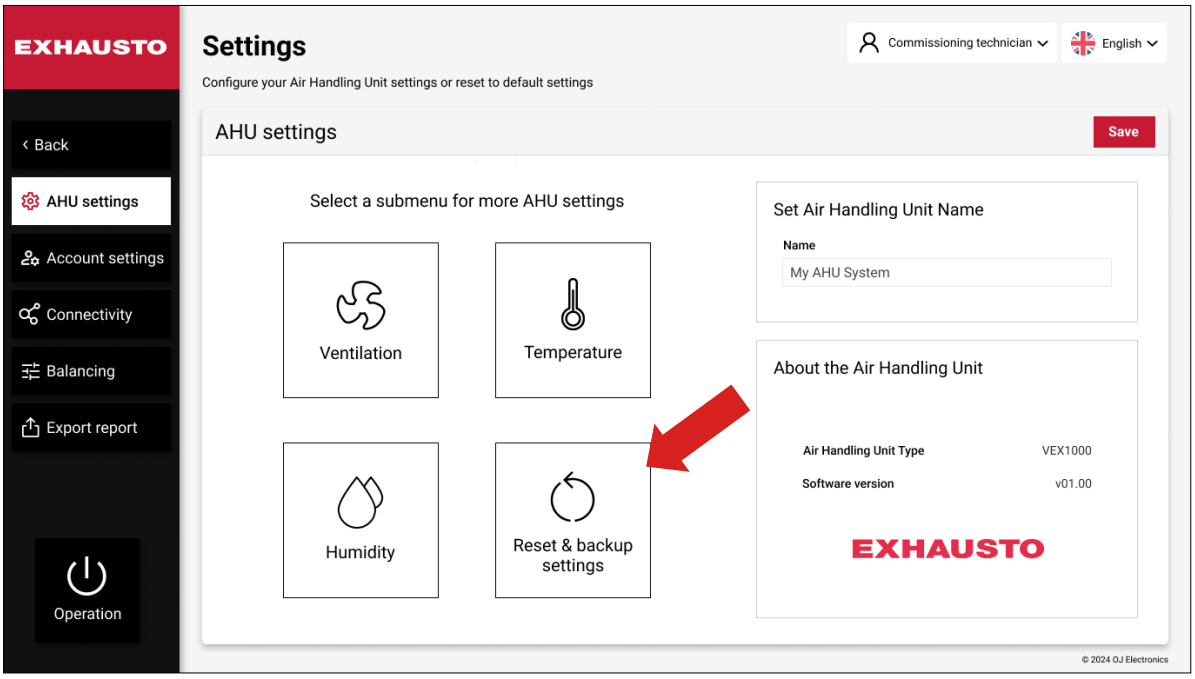
Calculated dew point temperature setpoint: Here, the calculated dew point temperature setpoint is shown.

If no dew point temperature sensor is installed, you can set the cooling output power used for dehumidification.

10.1.4 Reset & backup settings

When the factory setting procedure is completed, the current settings will be saved in the AHU controller as a factory backup file. This will allow commissioning users to restore the factory settings. This is the case, even if some changes have been made during the commissioning.

Click on **Settings** in the main menu to access the **Reset & backup settings.**



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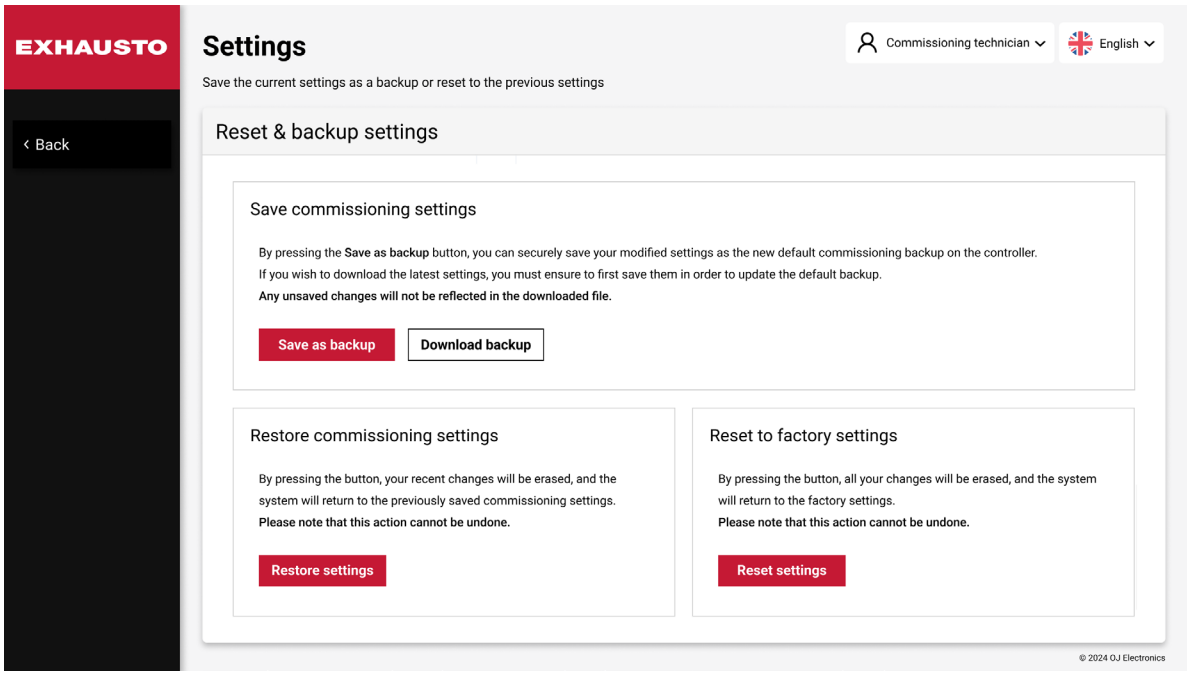
Having clicked on the **Reset & backup settings** button, your screen will look like this:

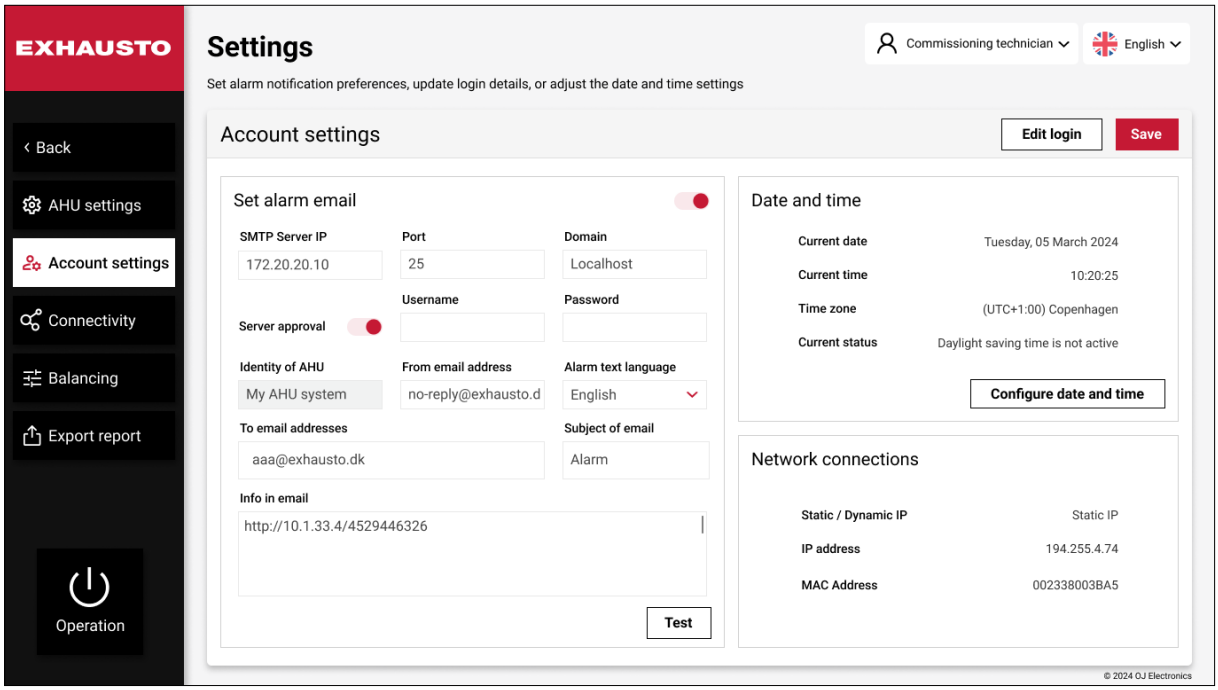


Here, you can perform the following actions:

- Save the commissioning settings.
- Restore the commissioning settings.
- Reset to factory settings.

10.2 Account settings

When you click on **Account settings** (under **Settings** in the main menu), you will see the following screen:



Here, you can configure both login, time and date, network, and email settings.

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10.2.1 How to configure an email server

10.2.1.1 The Set alarm email section

As a commissioning technician you will need to configure an email server to activate the email notification system. This detailed setup is necessary to ensure that relevant and needed information is sent to the appropriate recipients when issues or alarms occur. Below, you will find information on how to perform this configuration.

Setting	How to configure this setting
Set alarm email	Activate this option for sending email alarms.
SMTP Server IP	Write the IP address of the network server SMTP service. The SMTP Server IP address must be a local server. Also, it must be on the same IP network as the EXcon+. No external SMTP Server can be used.
Port	Enter the port number for the email server.
Domain	Here you write the domain name of the EXcon+ controller (Localhost). No spaces are allowed in the name.
Server approval	Select server approval if the network SMPT server requires it.
Username	Here you write the username for the AHU under which this AHU is created on the SMTP server.
Password	Here you write the password that fits the username.
Identity of AHU	Here your AHU name is shown, for example, ”My AHU system”.
From email address	Fake email address for the EXcon+ controller. The address must be in standard format including @ + domain name (.dk).
Alarm text language	Select the language that is to be used in the alarm text field.
To email address	Here you type in the email addresses of the people who are to receive the alarm emails from this AHU.
Subject of email	Here you write the text for the subject field in the email that shall be sent from this AHU.
Info in email	Here you write an info text for the receiver. This must be a text that explains to the receiver how to take action when receiving alarms from this AHU.

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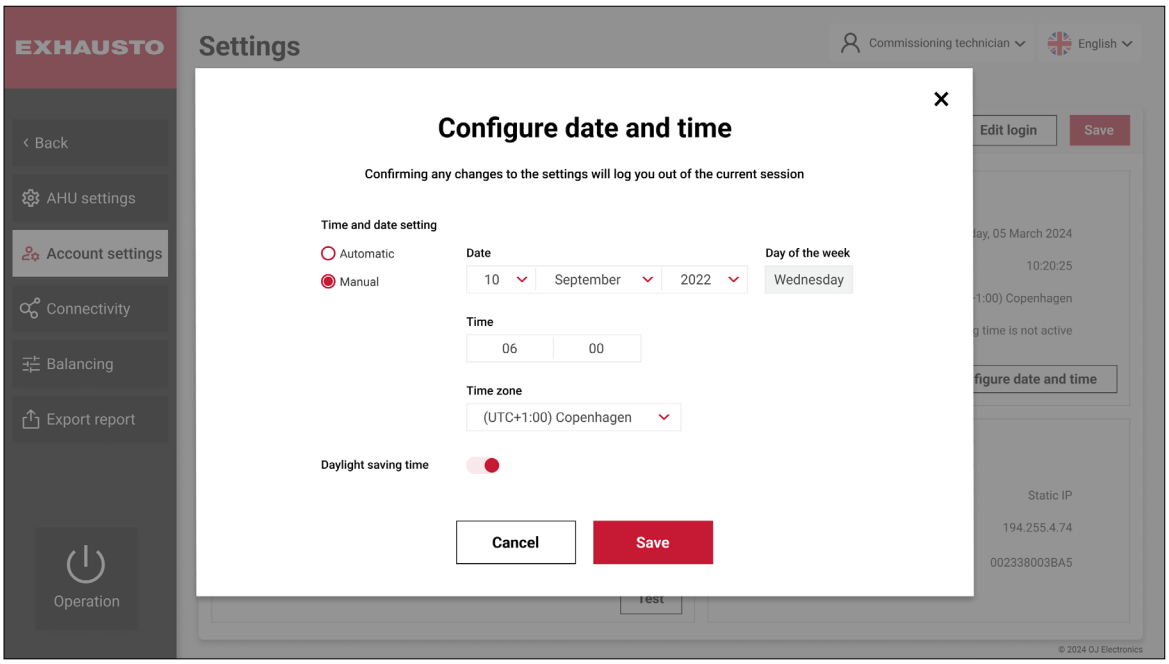
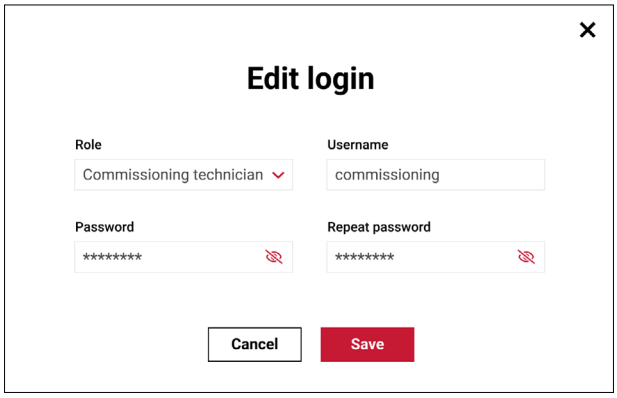
10.2.1.2 How to set date and time

In this section, you can see the system's date and time. If you need to configure the date and time settings, you must click on the button **Configure date and time**. Here, you can choose between **Automatic** and **Manual** Time and Date settings. Also, you can adjust for **Daylight saving time** and configure the **Time zone**, see below.



How to configure login for various users

Click on the **Edit Login** button under **Account settings:**



Here, you can change the username and password for all lower user types. For this to take effect, you must use the **Role** field.
You can edit these settings for the following user types:

* Facility managers pro
* Commissioning technicians

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Network connections

Here you are provided with basic information about the network, such as Static or Dynamic IP address, IP address, and MAC Address.

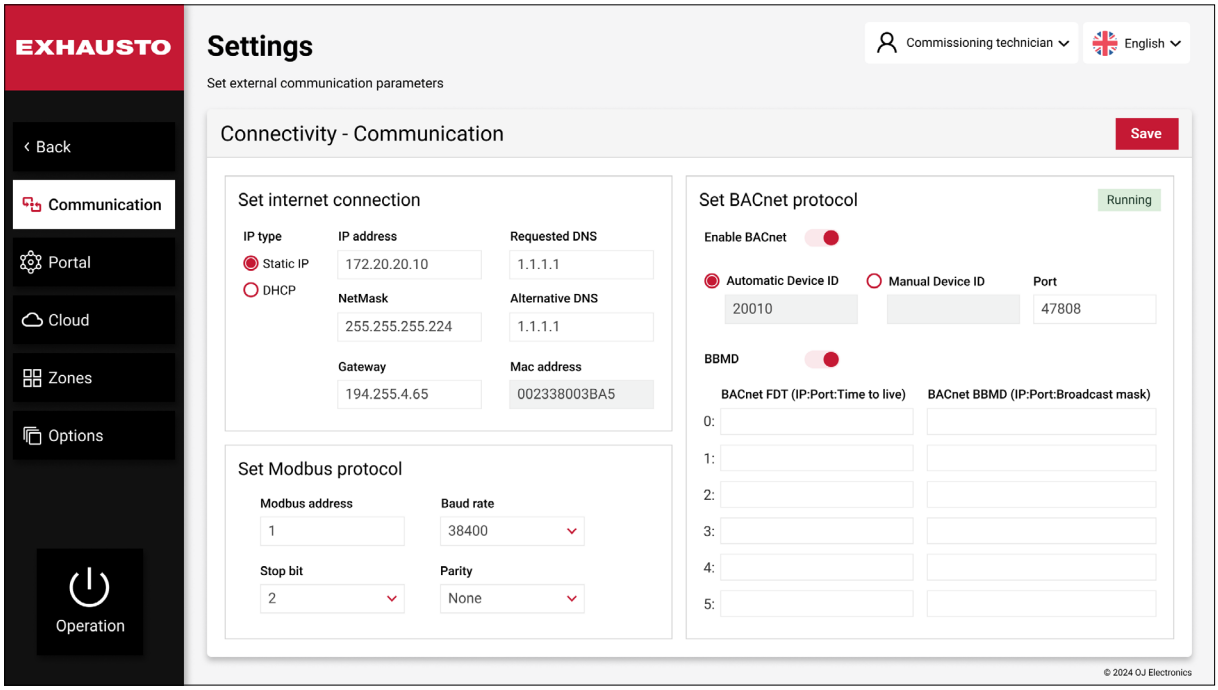
Note: This information is provided not only for your own ability to fix errors in the system but also for you to pass on to the IT department.

Remember to always click the **Save** button to save your changes.

If you click on **Connectivity** on the left side of the screen, you will see the screen in the next paragraph:

10.3 Connectivity

10.3.1 Communication



The Communication settings are important for establishing and maintaining an internet connection for your AHU. As a commissioning technician, you can set the AHU's IP address, configure the Modbus protocol and enable BACnet.

If you choose **DHCP** in the **Set internet connection** section, you will have an IP address assigned from the DHCP server on the local network. If you choose Static IP, you will have to specify these settings manually.

The Modbus settings in the lower left section are used for configuring the AHU´s Modbus RTU connection. These settings are used to configure how the AHU communicates with external devices or systems, such as a BMS. Note, that the Modbus address must be distinct in order to identify the AHU.

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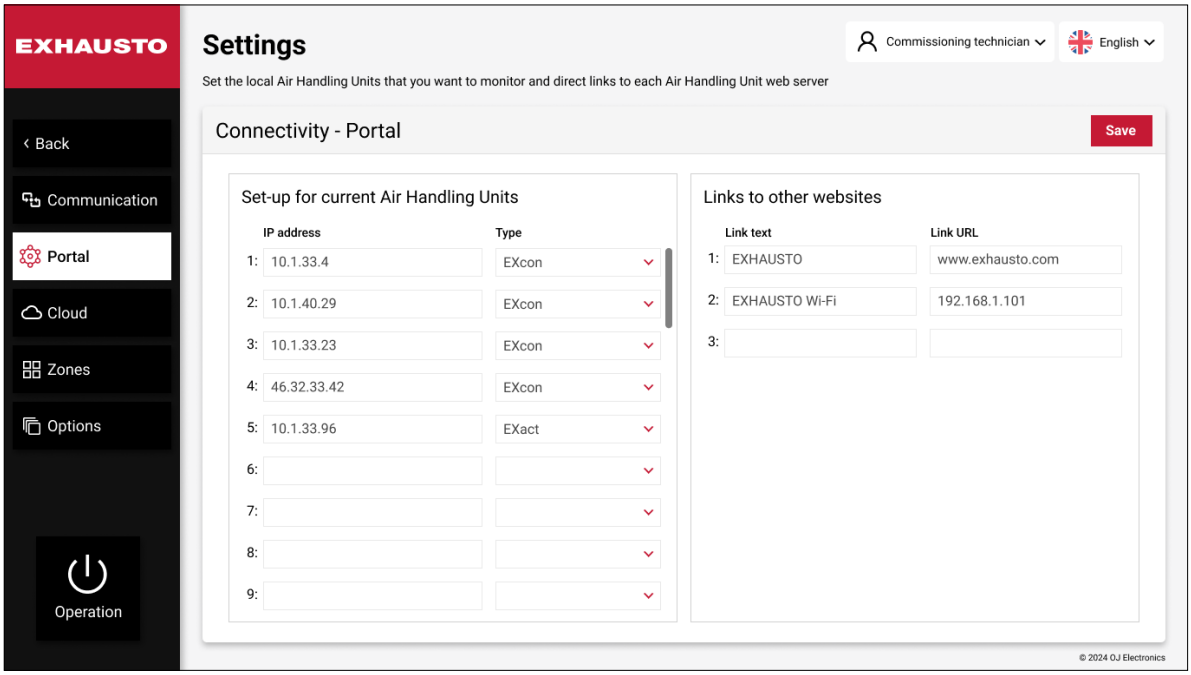
10.3.2 Portal

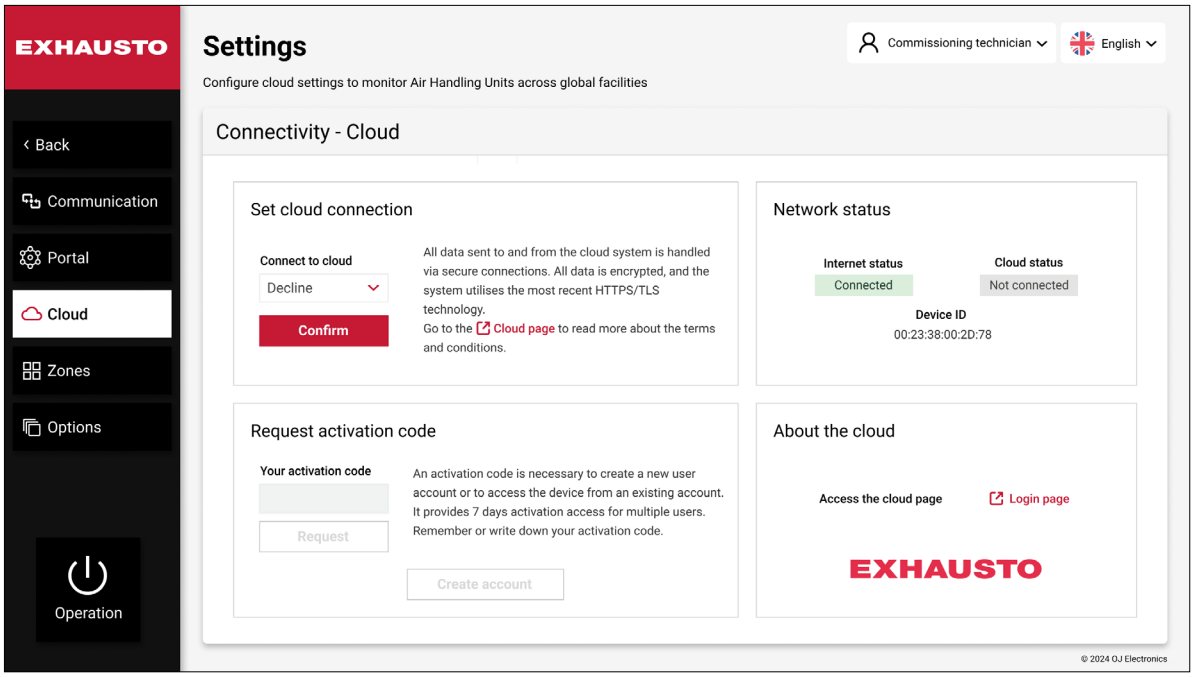
Go to **Settings, Connectivity** to find the **Portal** section.



Here you can set the IP addresses of the HVAC systems that you want to see. Also, this is where you set up any links to relevant websites.

10.3.3 Cloud

Go to **Settings, Connectivity** to find the **Cloud** section.



In this section, you will be asked to accept the terms and conditions. Also, this is where you ask for an activation code. Here you can see if the system has Cloud access, and you can directly reach the Cloud page.

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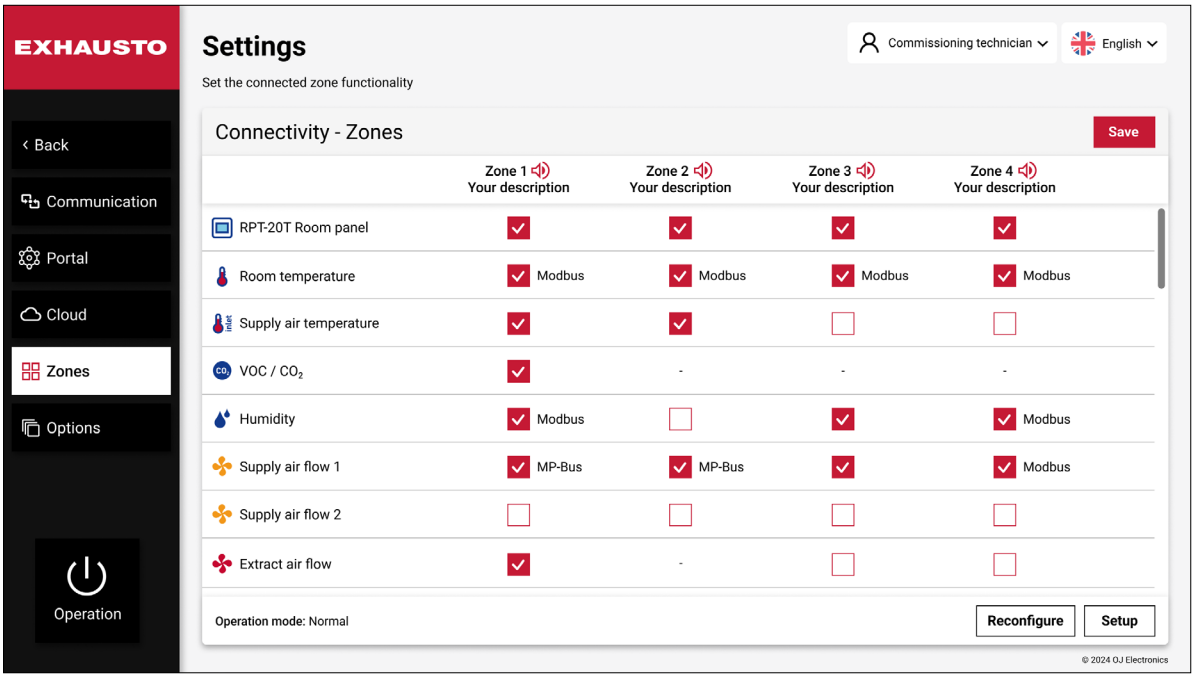
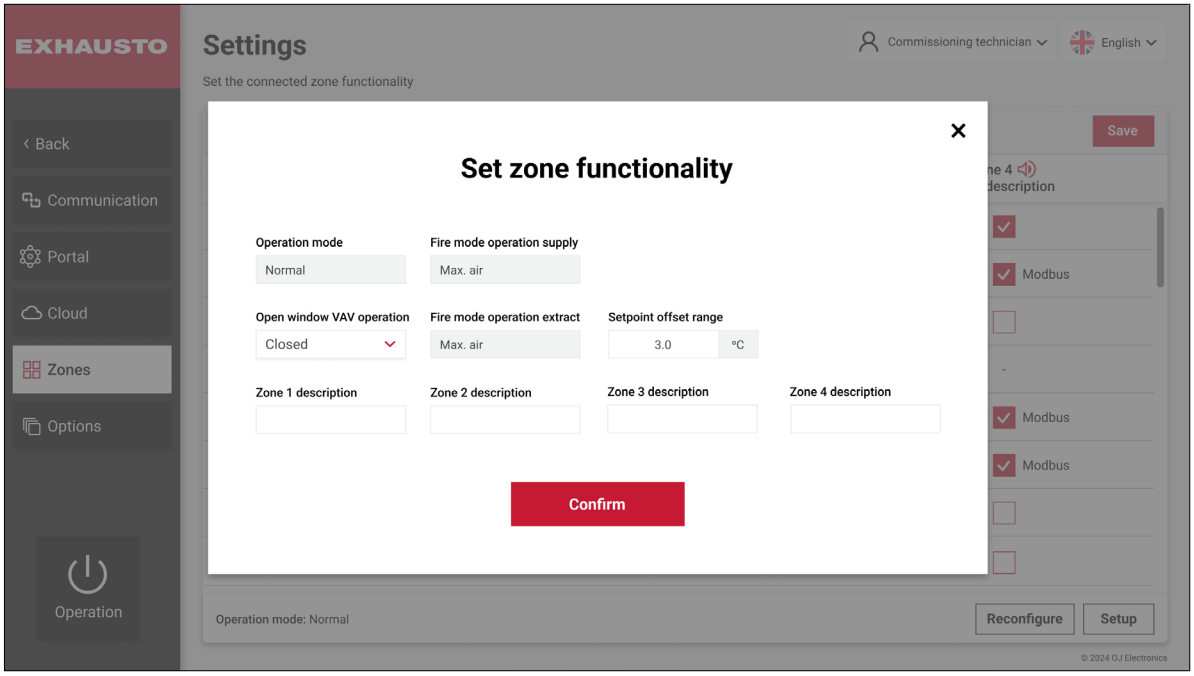
10.3.4 Zones

Go to **Settings, Connectivity** to find the **Zones** section.
The EXcon+ system supports up to 4 individual zones (4 room controllers). The Zones section is only shown if one or more room controllers are connected. Connected Zone Modules and components will automatically be detected by the Zone Module and selected in the **Settings** window. Analog (0-10V) damper actuators must be selected manually.



When to use the "Reconfigure" button
Only if you add or remove a Zone Module to or from the system, will it be necessary to reconfigure the system. You do this by pressing the **Reconfigure** button.

Set zone functionality
Use the **Setup** button in the lower right corner to enter the **Set zone functionality** dialog box. Here, you can configure various Zone options, see below:



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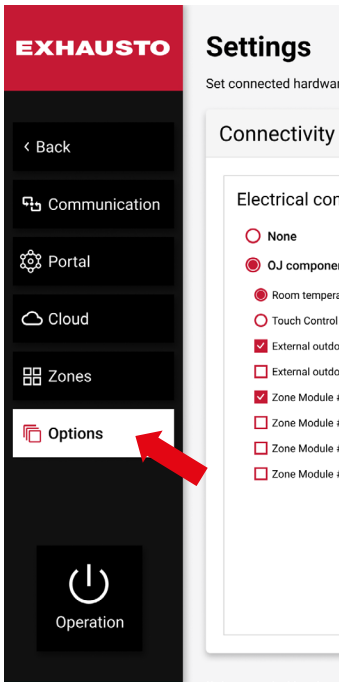
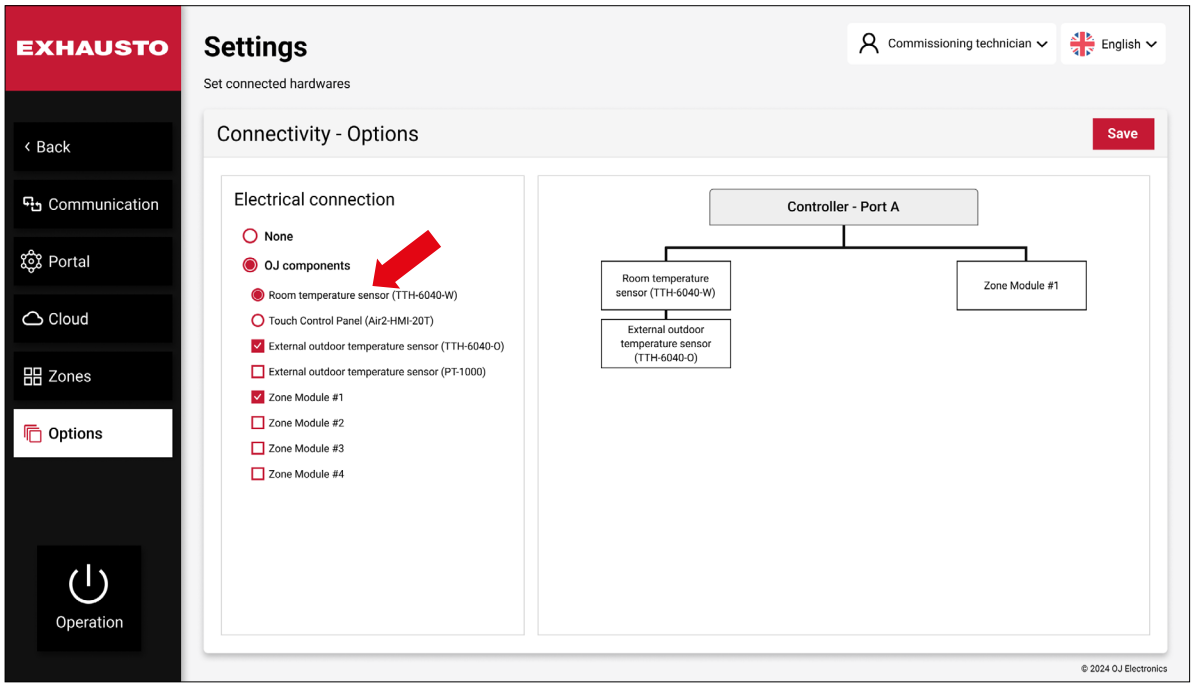
10.3.5 Options

Go to **Settings, Connectivity** to find the **Options** section (see below). Click on **Options**.



In the **Electrical connection** section under the **Options** settings, you can select optional components to connect to the AHU. Click on **OJ Components** to see a list of available components.



Physically, the external Modbus components must be connected to the **RS485** port A on the controller. These settings are used for connecting components supported by OJ Electronics, for example, room temperature sensors, 2-inch touch control panels, external outdoor temperature sensors, and zone modules. For ease of overview, the connection diagram is illustrated graphically to the right. This may come in handy when you are working on rather complex AHUs.

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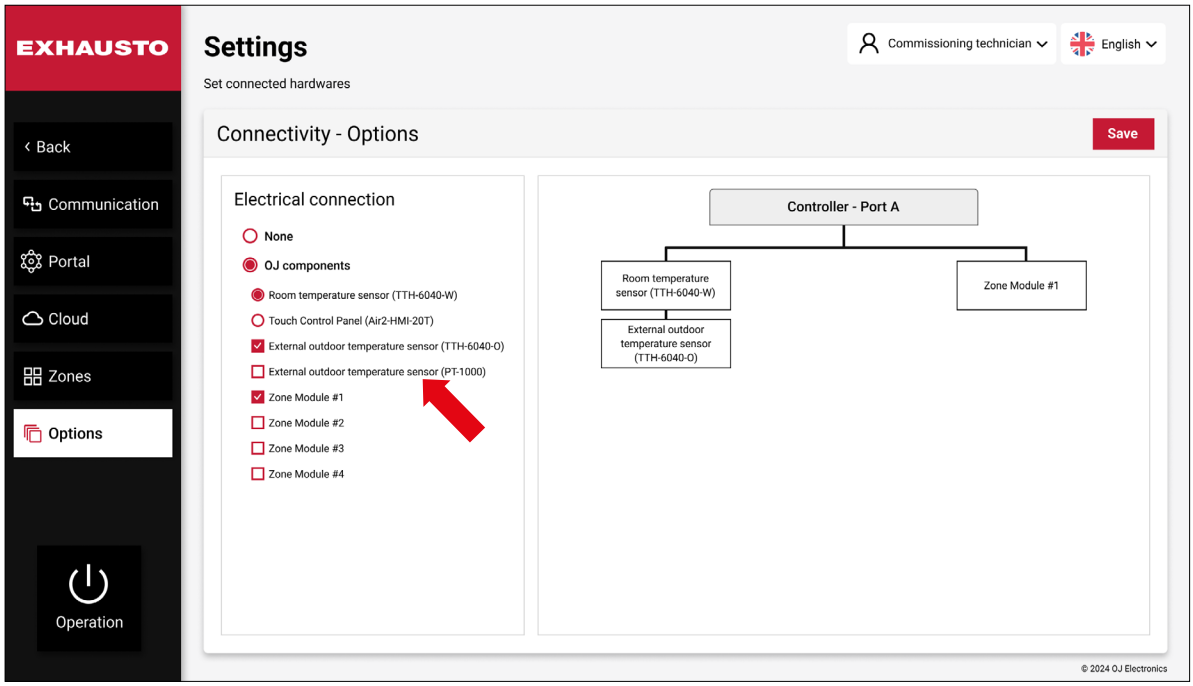
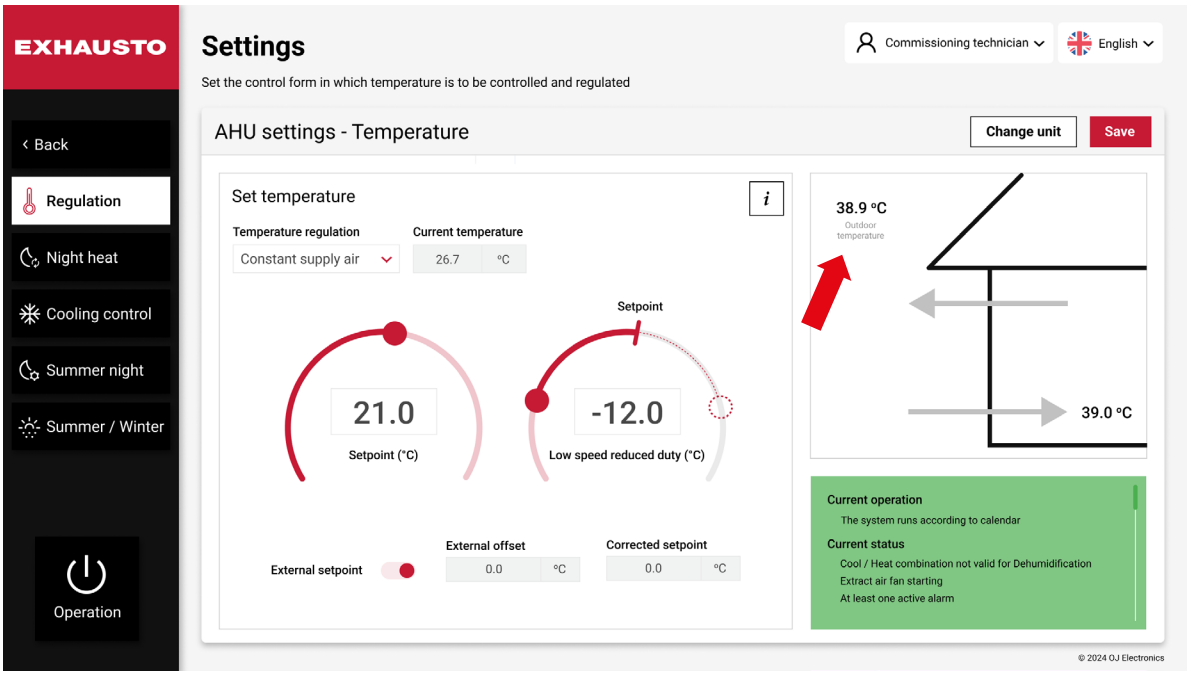
Example:

How to turn on the PT-1000 external outdoor temperature sensor
Click on **Settings, Connectivity, Options**. See picture:



Here, you click on External outdoor temperature sensor (PT-1000), see the arrow above. When you go back to **Settings, Temperature** you will see the outdoor air temperature displayed. See the arrow below:



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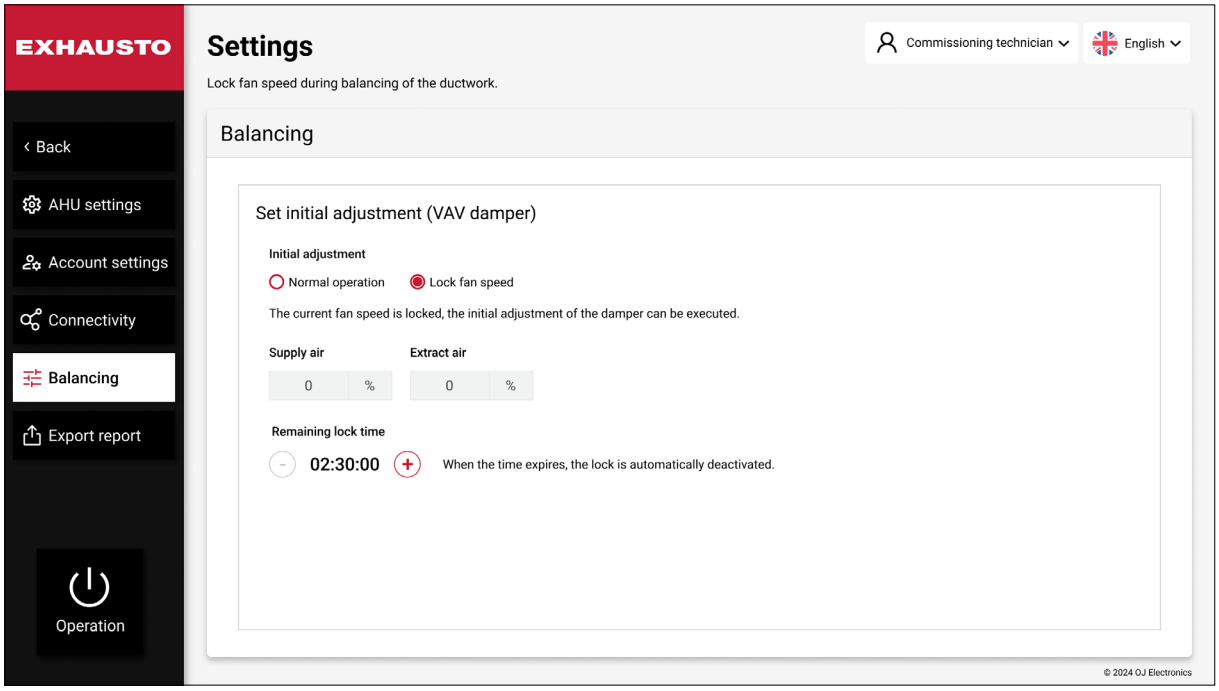
10.4 Balancing

Balancing enables you to maintain a consistent fan speed while adjusting the air distribution, such as calibrating manual dampers in a Constant Air Volume (CAV) system.

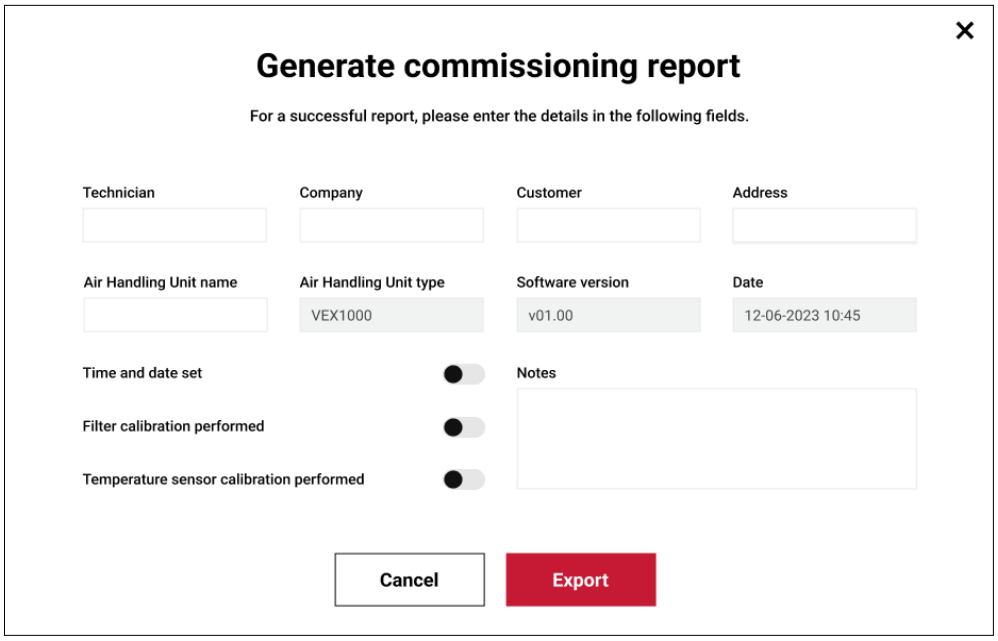
Click on **Settings, Balancing** in the main menu to access Balancing.

Selecting **Lock fan speed** will set the fan speed to the current value. The fans will remain at this speed until the timer runs out. When this period has elapsed the system will automatically return to normal operation.
If the balancing job finishes before the time runs out, you can manually return the function to normal operation.



10.5 Export report

Under **Export Report** under **Settings** in the main menu, you can generate a fully detailed commissioning report (pdf file) documenting the setup of the complete Air Handling Unit.



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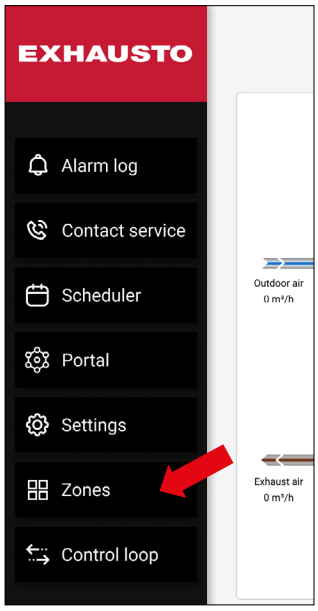
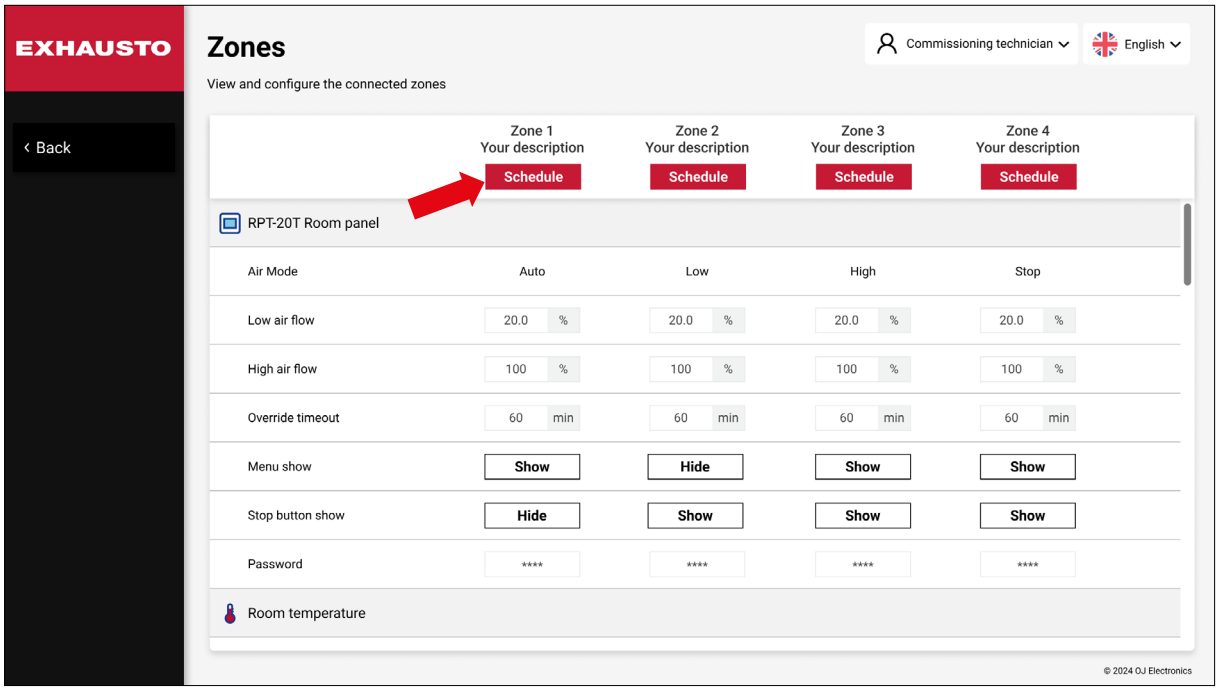
11. ZONES

You will find the **Zones** section in the main menu, see below.



The EXcon+ system supports up to 4 individual zones (4 room controllers). The Zones section is only shown if one or more room controllers have been connected. If you click the **Zones** button in the lower-left corner of the main menu, you will see the following screen:



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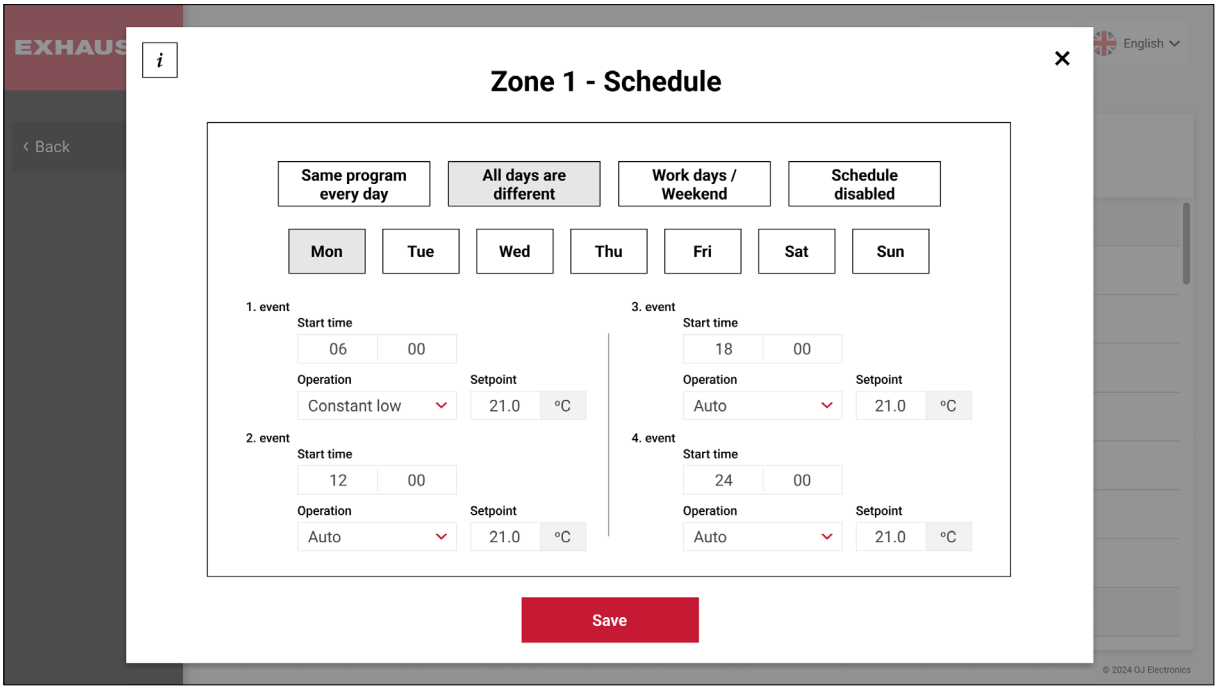
Here, you can monitor the data displayed for the components in the various zones. Most importantly, you can alter the settings for the individual components. Click, for example, on the red **Schedule** button by the arrow near **Zone 1**, see previous page. Then you will see the following screen:



Here, you can change the specific settings for Zone 1. Likewise, you can change the settings for the other zones.

Note: Under Settings => Connectivity => Zones you also have a **Zones** Section. This is where you configure which hardware components go into the individual zones. Here, you can also change the name of the different zones, like “Production”, “Common room”, “lounge” etc.

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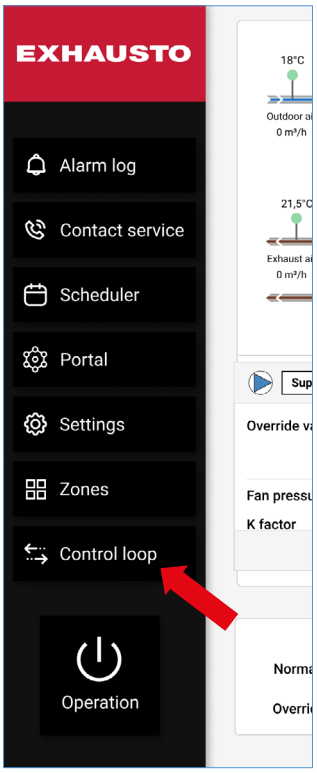
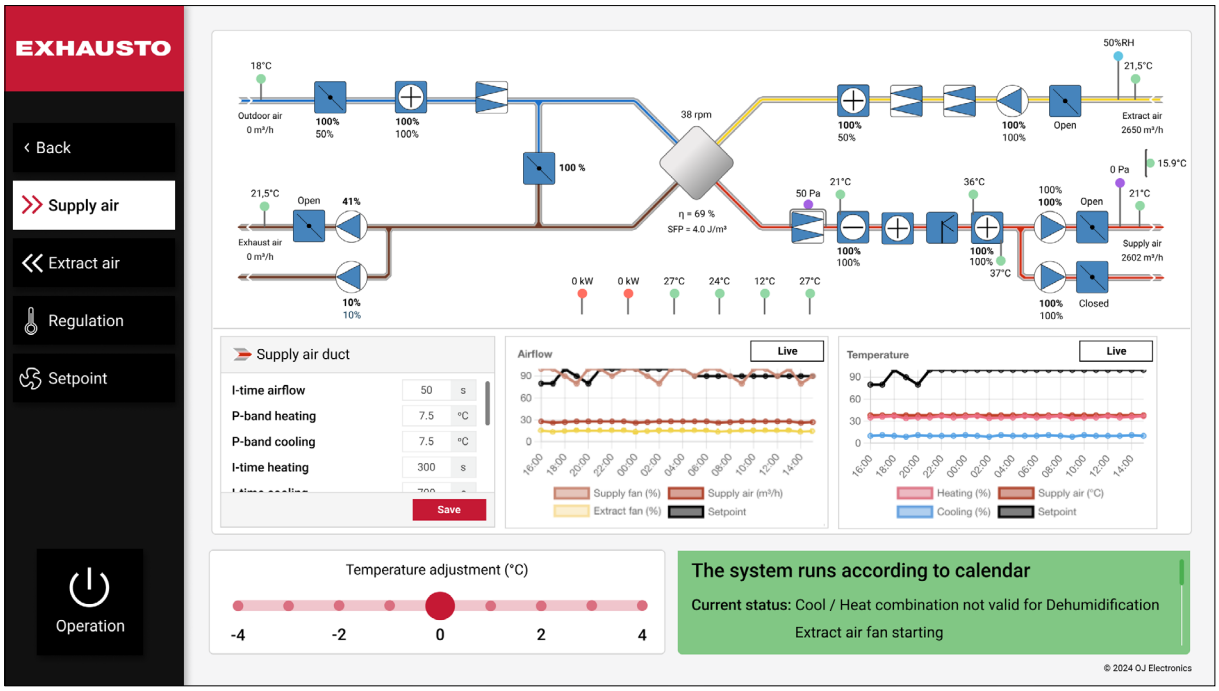
12. CONTROL LOOP

Click on **Control loop** on the Home screen (see below) to access the Control loop functions.



You will then be presented with a system overview looking similar to this:



Here you can set and finetune the control loops. First, you need to complete the fan settings and then you can proceed to the temperature settings. Note, that you will need to complete the supply air temperature settings before the extract air temperature settings.

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12.1 Supply Air Fan settings

Click on **Setpoint** in the menu to the left. Select the desired fan regulation type and enter the corresponding setpoints. Go back to the Supply air page and click on the **Operation** button in the lower left corner. Switch to either High speed, Medium speed or Low speed operation.

Monitor the live **Airflow** graph by clicking on the **Live** button.
If reaching the fan speed setpoint is a slow process, you can decrease the **I-time Airflow** setting. Moreover, if the fan speed is fluctuating, you can increase the **I-time Airflow** setting.

12.2 Extract Air Fan settings

Click on the **Extract air** button in the menu on the left side of the screen.

Monitor the live **Airflow** graph by clicking on the **Live** button. If reaching the fan speed setpoint is a slow process, you can decrease the **I-time Airflow** setting. Moreover, if the fan speed is fluctuating, you can increase the **I-time Airflow** setting.

12.3 Supply Air Temperature settings

Click on the **Regulation** button in the menu on the left side of the screen. Select **Constant supply air** and enter a temperature setpoint.

Go back to the **Supply air** page. Then click on the **Operation** button and switch to High speed, Medium speed, or Low speed. Alternatively, you can adjust the temperature setpoint in increments by using the **Temperature adjustment** slider.

Monitor the live Temperature graph by clicking on the **Live** button. If reaching the supply air temperature setpoint is a slow process, you can decrease the I-time settings for heat recovery and coils. And you can decrease the P-band Heating or P-band Cooling settings.

If the temperature is fluctuating, you can increase the **I-time** settings and increase the **P-band Heating** or the **P-band Cooling** settings.

12.4 Extract Air Temperature settings

Click on the **Regulation** button in the menu on the left side of the screen. Select **Constant Extract air** or **Constant Room** as temperature regulation. Enter both a temperature setpoint and temperature limits for the supply air temperature control loop. Go back to the **Extract air** page. Then click on the **Operation** button and switch to High speed, Medium speed, or Low speed. Alternatively, you can adjust the temperature setpoint in increments by using the **Temperature adjustment** slider.

Monitor the live **Temperature** graph by clicking on the **Live** button.
If reaching the supply air temperature setpoint is a slow process, you can decrease the **I-time** settings for heat recovery and coils. And you can decrease the **P-band Heating** or **P-band Cooling** settings.

If the temperature fluctuates, you can increase the **I-time** settings and increase the **P-band Heating** or **P-band Cooling** settings.

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12.5 Supply Air Duct

Supply Air Duct	Value	Units	Short explanation
I-time airflow	####	s	I time for the supply air fan control loop
P-band heating	###.#	°C	P band for the heating control loop
P-band cooling	###.#	°C	P band for the cooling control loop
I-time temperature	#####	s	I time for Mixing dampers
I-time heating	###	s	I time for Heater 1 coil
I-time heating 2	###	s	I Time for Heater 2 coil
I-time heat pump	###	s	I time for Heat pump coil
I-time cooling	###	s	I time for Cooling coil
I-time heat recovery	###	s	I time for the heat recovery unit
I-time heat combi	###	s	I timer for the combi coil

12.6 Extract Air Duct

Extract Air Duct	Value	Units	Short explanation
I-time airflow	####	s	I time for the supply air fan control loop
P-band heating	###.#	°C	P band for the heating control loop
P-band cooling	###.#	°C	P band for the cooling control loop
I-time heating	###	s	I time for Heater 1 coil
I-time heating 2	###	s	I Time for Heater 2 coil
I-time heat pump	###	s	I time for Heat pump coil
I-time cooling	###	s	I time for Cooling coil
I-time heat recovery	###	s	I time for the heat recovery unit
I-time heat combi	###	s	I timer for the combi coil

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13. APPENDIX A - COMPONENTS

13.1 Fans

The fan operation depends both on how advanced the AHU system is, and on whether the fan is Modbus controlled, 0-10V controlled, or Start/Stop controlled.

13.1.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din
Start/Stop				X	X
0-10V		X		X	X
DV Drives Ventilation	X				
Swiss Rotors fan	X				
EBM Papst fan	X				
Ziehl Abegg fan	X				

13.1.2 Flow calculation

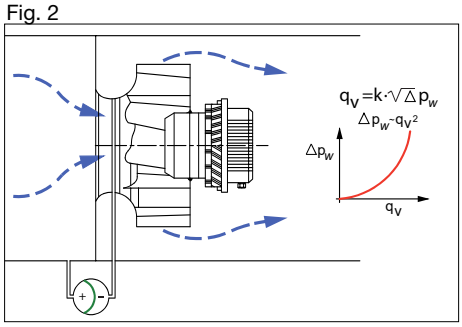
This formula calculates air volume [V] through a fan:

$V = k \cdot \sqrt{\Delta P}$

V=Air volume
ΔP= Pressure drop across the fan's inlet cone (See fig.2)
k=The fan's k-factor as informed by the fan manufacturer.

The k-factor must be scaled to l/s (liters per second).

Fig. 2



13.1.3 Supply Air Fan and Supply Air Backup fan

13.1.3.1 Start/stop and 0-10V control

Supply fan	Value	Units	Short explanation
Delayed start	###	Sec.	The time delay between start of the exhaust fan and start of the supply fan.
K factor	###		A constant used to convert the pressure drop across the fan's inlet cone into Air volume. The value depends on the actual fan used.
Reduce airflow			This function reduces the fan speed in case of too low supply temperature when all heater setpoints are at maximum. (100%).
	No		No fan speed reduction allowed.
	Only supply air		Only Supply fan speed reduction allowed.
	Both fans		Both Supply and Extract fan speed reduction allowed.
Speed	###	%	Current fan speed set point (0-100%)
Fan pressure	###	Pa	Current pressure drop measured across the fan's inlet cone. This value is used for Air volume calculation in combination with the K factor.
Start relay			A digital output (Relay) is used to start and stop the fan.
	Disconnected		Fan stopped
	Closed		Fan started
Start relay			A digital output (Relay) is used to start and stop the backup fan.
	Disconnected		Backup fan stopped
	Closed		Backup fan started.
Freq. conv. Alarm			A digital input is used to monitor the fan.
	No		The fan is OK
	Yes		The fan is not operating as expected. Service is needed.

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13.1.3.2 Swiss rotor Fan Modbus controlled

Supply fan	Value	Units	Explanation
Speed	###	%	Override setpoint
K factor	###		A constant used to convert the pressure drop across the fan's inlet cone into air volume. The value depends on the actual fan used.
Reduce airflow			This function reduces the fan speed in case of too low supply temperature when all heater setpoints are at maximum (100%).
	No		No fan speed reduction allowed.
	Only supply air		Only Supply fan speed reduction allowed.
	Both fans		Both Supply and Extract fan speed reduction allowed.
Delayed start		Sec.	Time delay from Exhaust fan was started until the Supply fan starts.
Rpm out	###	rpm	Current fan revolutions per minute
Internal temperature	###.#	°C	Current Internal temperature in the Fan
DC-Bus voltage	###	V	Current Internal DC voltage in the Fan
Stator current	#,###	A	Current Stator current in the Fan motor
Power in	#,###	W	Current Fan Power consumption.
Fan pressure		Pa	Current pressure drop measured across the fan's inlet cone. This value is used for Air volume calculation in combination with the K factor.
Master error code	##		7 = motor failed to start repeatedly 6 = under or overvoltage 5 = motor disconnected/faulty 4 = internal frequency converter fault 3 = temperature protection active 2 = active overcurrent protection 1 = slow blink = standby 0 = always on (operating normally)
Drift days	####	Days	Current Accumulated operation hours converted to whole days.
Drift minutes	##:##	Min.	Current Accumulated operation minutes not converted to whole days.
Motor			Current Fan operation status
	Off		Fan stopped
	On		Fan started
Alarm reset			Current Fan Alarm reset status
	Off		Fan alarm not reset
	On		Fan alarm reset
Rotation direction			Setting the Fan rotation Clockwise or Counterclockwise
	CCW		Counterclockwise
	CW		Clockwise
Percent set	##:##	%	Current fan speed set point (0-100%)
Min. RPM	###	RPM	Minimal allowed speed
Max. RPM	###	RPM	Max rpm allowed in normal operation
HW software version	#####		Hardware version in fan
SW software version	#####		Software version in fan

13.1.3.3 EBM Papst Fan Modbus controlled

TBD

13.1.3.4 Ziehl Abegg Fan Modbus controlled

TBD

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13.1.3.5 DV Drive

13.1.3.5.1 Frequency converter mode (FC-DV)

Supply fan	Value	Units	Short explanation
Current speed		%	Override setpoint
DV type			Drive Ventilation
	DV-1005		One Phase drive 0.5 kW
	DV-1007		One Phase drive 0.7 kW
	DV-1011		One Phase drive 1.1 kW
	DV-3015		Three Phase drive 1.5 kW
	DV-3024		Three Phase drive 2.4 kW
	DV-3030		Three Phase drive 3.0 kW
	DV-3040		Three Phase drive 4.0 kW
	DV-3055		Three Phase drive 5.5 kW
	DV-3065		Three Phase drive 6.5 kW
	DV-3075		Three Phase drive 7.5 kW
	DV-3110		Three Phase drive 10 kW
	DV-3150		Three Phase drive 15 kW
Specific Fan Power		J/m3	Specific fan power is calculated from the drive's power consumption and the fan's air volume.
Power rating		W	Current power consumption
Frequency		Hz	Current output frequency to the Fan motor
Motor current		mA	Current output current to the Fan motor
Operating time		Days	Accumulated operation time is displayed as days.
Fan pressure		Pa	Current pressure drop measured across the fan's inlet cone. This value is used for Air volume calculation in combination with the K factor.
K factor			A constant used to convert the pressure drop across the fan's inlet cone into Air volume. The value depends on the actual fan used.
Reduce airflow			This function reduces the fan speed in case of a too-low supply temperature when all heater setpoints are at maximum (100%).
	No		No fan speed reduction allowed.
	Only supply air		Only Supply fan speed reduction allowed.
	Both fans		Both Supply and Extract fan speed reduction allowed.
Delayed start		Sec.	The time delay between start of the exhaust fan and start of the supply fan.
Min. frequency		Hz	The minimum output frequency to the Fan motor (Speed at Fan setpoint 0%)
Max. Frequency		Hz	The maximum output frequency to the Fan motor (Speed at Fan setpoint 100%)
Ramp up time		Sec.	The minimum ramp-up time for a setpoint change from 0% to 100%.
Ramp down time		Sec.	Minimum ramp-down time for a setpoint change from 100% to 0%.
Max. Current		mA	Max. allowed output current to the Fan motor
Switch frequency			The switch frequency modulating the drive's output frequency.
	Auto		The drive automatically changes between Low and High switching frequencies.
	Low		The drive always uses a Low switching frequency
	High		The drive always uses a High switching frequency
Voltage at min. Freq.		V	The min. output voltage to the Fan motor. This is when the fan is operating at min. frequency.
Frequency for max. Voltage		Hz	Above this frequency is the max. output voltage used on the Fan motor.
V/F characteristic			This parameter can change the Drives output Voltage/ Frequency characteristic.

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Supply fan	Value	Units	Short explanation
Rotation direction for supply motor controller			Setting the Fan rotation Clockwise or Counterclockwise
	CCW		Counterclockwise
	CW		Clockwise
Supply voltage 3x230V			Configuration of the drive to 3x400V or 3x230V input voltage.
	No		3x400V
	Yes		3x230V

13.1.3.5.2 EC controller mode (EC-DV)

TBD

13.1.4 Exhaust/Extract Air Fan and Exhaust Backup fan

13.1.4.1 Start/stop and 0-10V control

Extract fan	Value	Units	Short explanation
Exhaust fan			
Delayed start	###	Sec.	Time delay between start of the exhaust fan and start of the supply fan.
K factor	###		A constant used to convert the pressure drop across the fan's inlet cone into Air volume. The value depends on the actual fan used.
Speed	###	%	Override setpoint
Fan pressure	###	Pa	Current pressure drop measured across the fan's inlet cone. This value is used for Air volume calculation in combination with the K factor.
Start relay			A digital output (Relay) is used to start and stop the fan.
	Disconnected		Fan stopped
	Closed		Fan started
Start relay			A digital output (Relay) is used to start and stop the back-up fan.
	Disconnected		Backup fan stopped
	Closed		Backup fan started.
Freq. conv. Alarm			A digital input is used to monitor the fan.
	No		The fan is OK
	Yes		The fan is not operating as expected. Service is needed.

13.1.4.2 Swiss rotor Fans Modbus controlled

Exhaust fan	Value	Units	Explanation
Speed	###	%	Override setpoint
K factor	###		A constant used to convert the pressure drop across the fan's inlet cone into Air volume. The value depends on the actual fan used.
Reduce airflow			This function reduces the fan speed in case of too low supply temperature when all heater setpoints are at maximum (100%).
	No		No fan speed reduction allowed.
	Only supply air		Only Supply fan speed reduction allowed.
	Both fans		Both Supply and Extract fan speed reduction allowed.
Delayed start		Sec.	Time delay from Exhaust fan was started until the Supply fan starts.
Rpm out	###	rpm	Current fan Revolutions per minute
Internal temperature	###.# [°C, F]	°C	Current Internal temperature in the Fan
DC-Bus voltage	###	V	Current Internal DC voltage in the Fan

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Exhaust fan	Value	Units	Explanation
Stator current	#,###	A	Current Stator current in the Fan motor
Power in	#,###	W	Current Fan Power consumption.
Fan pressure		Pa	Current pressure drop measured across the fan's inlet cone. This value is used for Air volume calculation in combination with the K factor.
Master error code	##		7 = motor failed to start repeatedly 6 = under or overvoltage 5 = motor disconnected/faulty 4 = internal frequency converter fault 3 = temperature protection active 2 = active overcurrent protection 1 = slow blink = standby 0 = always on (operating normally)
Drift days	####	Days	Current accumulated operation hours converted to whole days.
Drift minutes	##:## [Min.]	Min.	Current accumulated operation minutes not converted to whole days.
Motor			Current Fan operation status
	Off		Fan stopped
	On		Fan started
Alarm reset			Current Fan Alarm reset status
	Off		Fan alarm not reset
	On		Fan alarm reset
Rotation direction			Setting the Fan rotation Clockwise or Counter-clockwise
	CCW		Counterclockwise
	CW		Clockwise
Percent set	##:##	%	Current fan speed set point (0-100%)
Min. RPM	###	RPM	Minimal allowed speed
Max. RPM	###	RPM	Max rpm allowed in normal operation
HW software version	#####		Hardware version in fan
SW software version	#####		Software version in fan

13.1.4.3 EBM Papst Fan Modbus controlled

TBD

13.1.4.4 Ziehl Abegg Fan Modbus controlled

TBD

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13.15 DV Drives

13.15.1 Frequency converter mode (FC-DV)

Extract fan	Value	Units	Short explanation
Exhaust fan			
Speed	### [%]		Override setpoint
Current speed	###	%	Current fan speed set point (0-100%)
DV type			Drive Ventilation
	DV-1005		One Phase drive 0.5 kW
	DV-1007		One Phase drive 0.7 kW
	DV-1011		One Phase drive 1.1 kW
	DV-3015		Three Phase drive 1.5 kW
	DV-3024		Three Phase drive 2.4 kW
	DV-3030		Three Phase drive 3.0 kW
	DV-3040		Three Phase drive 4.0 kW
	DV-3055		Three Phase drive 5.5 kW
	DV-3065		Three Phase drive 6.5 kW
	DV-3075		Three Phase drive 7.5 kW
	DV-3110		Three Phase drive 10 kW
	DV-3150		Three Phase drive 15 kW
K factor			A constant used to convert the pressure drop across the fan's inlet cone into Air volume. The value depends on the actual fan used.
Delayed start		Sec.	Time delay between start of the exhaust and start of the supply fan.
Min. frequency		rpm	The minimum output frequency to the Fan motor (Speed at Fan setpoint 0%)
Max. Frequency		rpm	The maximum output frequency to the Fan motor (Speed at Fan setpoint 100%)
Ramp up time		Sec.	Minimum ramp up time for a setpoint change from 0% to 100%.
Ramp down time		Sec.	Minimum ramp down time for a setpoint change from 100% to 0%.
Max. Current		mA	Max. allowed output current to the Fan motor
Switch frequency			The switching frequency modulating the drive's output frequency.
	Auto		The drive automatically changes the switch frequency between Low and High.
	Low		The drive always uses a Low switching frequency
	High		The drive always uses a High switching frequency
Voltage at min. freq.		V	The min. output voltage to the Fan motor. This is when the fan is operating at min. frequency.
Frequency for max. Voltage		Hz	Above this frequency is the max. output voltage used on the Fan motor.
V/F characteristic			This parameter can change the Drives output Voltage/Frequency characteristic.
Rotation direction for supply motor controller			Setting the Fan rotation Clockwise or Counterclockwise.
	CCW		Counterclockwise
	CW		Clockwise
Supply voltage 3x230V			Configuration of the drive to 3x400V or 3x230V input voltage.
	No		3x400V
	Yes		3x230V

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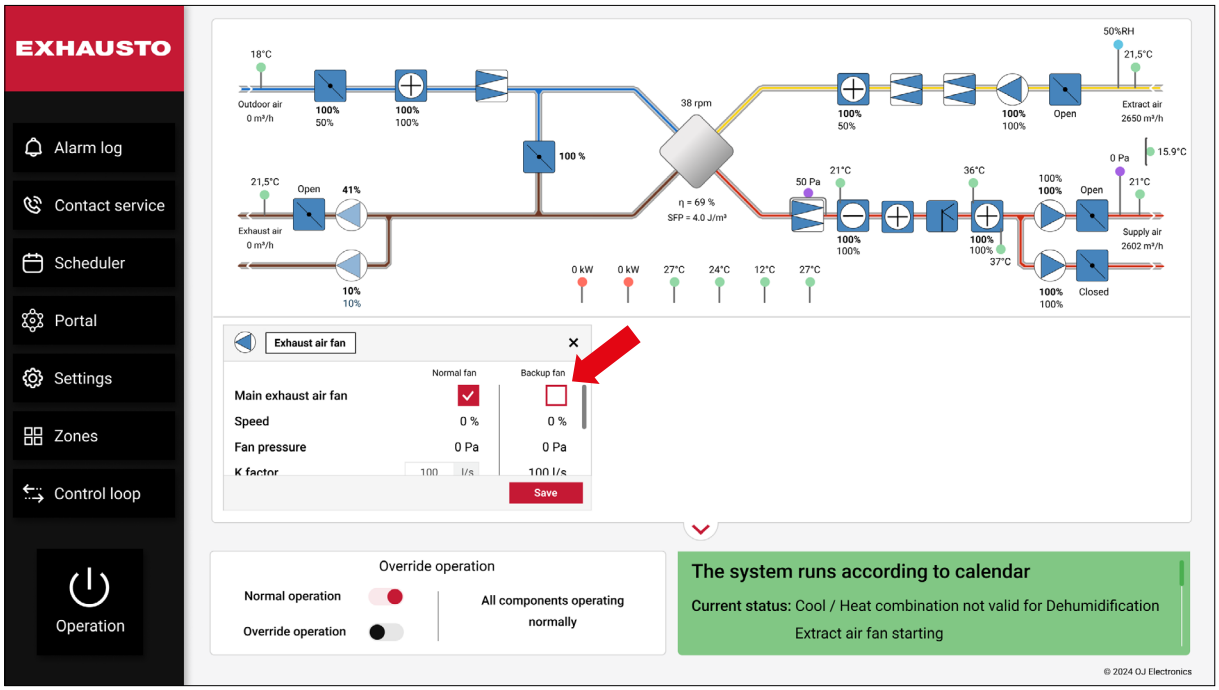
13.15.2 EC controller mode (EC-DV)

DV Drive Modbus controlled in EC controller mode (EC-DV)

TBD

13.2 Backup fans



Backup fans are used if there is a risk that critical issues or hazardous situations might occur if there is a faulty fan. In normal operation the primary fans are active, and the backup fans are inactive. In case there is an alarm on the primary fans, the backup fans start up automatically, and they keep the ventilation running. Should a failure on both fans occur, the system will raise an “A”-alarm. See Control sequence figure on the next page.

Dampers

- The supply air damper follows the Main supply air fan operation.
- The supply air backup damper follows the Main supply air backup fan operation.
- The exhaust air damper follows the Main exhaust air fan operation.
- The exhaust air backup damper follows the Main exhaust air backup fan operation.

Normal fan and Backup fan test

A checkmark in the **Main Exhaust Air fan** under **Normal Fan**, will cause the system to use the normal fan as the main fan. See arrow above.
A checkmark in the **Main Exhaust Air fan** under **Backup Fan**, will cause the system to use the backup fan as the main fan.
By moving the checkmark between the 2 settings, you can force an alternation between the two fans and verify that both fans are working.
A similar setting is available for the supply air fan.

Automatic Fan Alternation

To balance out fan wear, the system will switch between the main fan and the backup fan the **first Tuesday at 6.00 am every month**. This will also ensure that both fans can operate without triggering any alarms.

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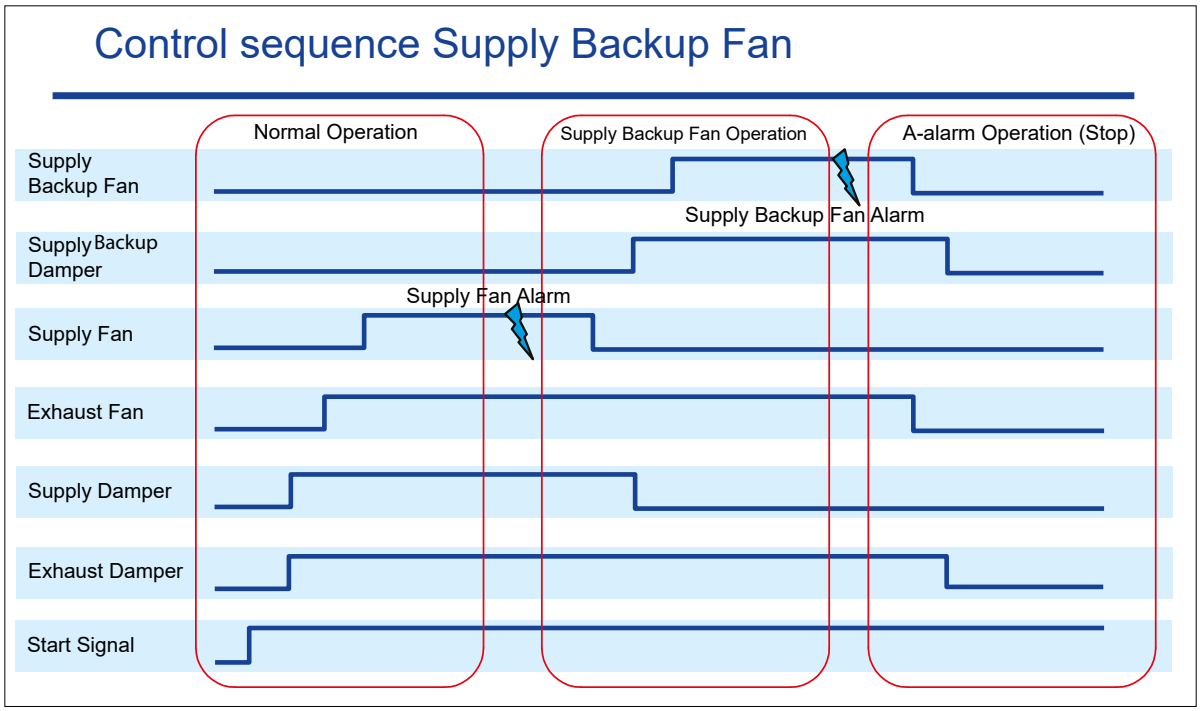
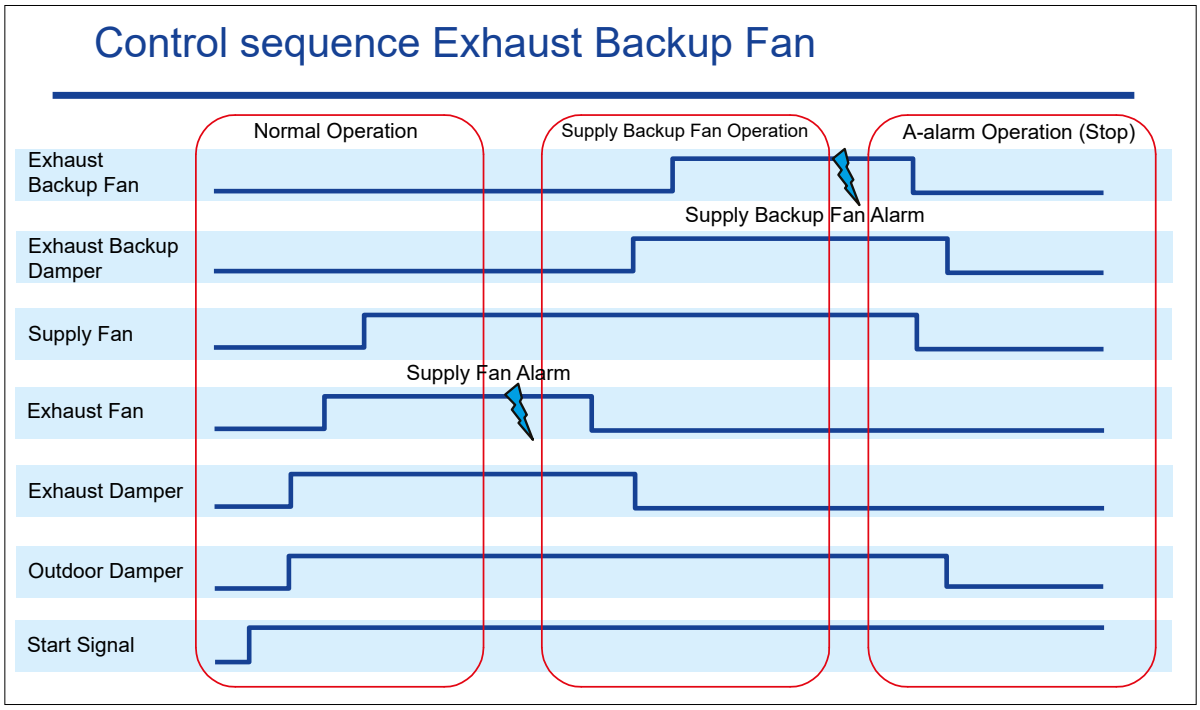
Control sequence backup fans





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13.3 Dampers

The Damper control and monitoring depend on how advanced the AHU system is built and whether Belimo Direct Modbus damper actuators are installed.

13.3.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din
On/Off				X	
Modulated 0-10V		X			
Belimo Direct Modbus	X				

13.3.2 Outdoor Air damper, Exhaust Air damper, and Exhaust Air Backup damper

13.3.2.1 On/Off

Outdoor air damper	Value	Units	Short explanation
Fan delay	### [s]		Delay from damper opens until the Exhaust fan starts.
Damper delay	### [s]		Delay from fan stops until dampers close.
Damper			On/Off damper status
	Closed		Damper closed
	Open		Damper open

13.3.2.2 Modulated 0-10V

Outdoor air damper	Value	Units	Short explanation
Fan delay	### [s]		Delay from damper opens until the exhaust fan starts.
Damper delay	### [s]		Delay from fan stops until dampers close.
Correction factor			Output voltage pitch. Default 1.0.
Offset	### [%]		Output voltage offset.
Gain factor damper			Default 100. See Appendix C - Control Sequence
Damper	### [%]		Override setpoint
Current damper setting	### [V]		Output voltage to the damper actuator.
Damper motor			Damper actuator input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.

13.3.2.3 Belimo Direct Modbus

Outdoor air damper	Value	Units	Short explanation
Fan delay	### [s]		Delay from damper opens until the exhaust fan starts.
Damper delay	### [s]		Delay from fan stops until dampers close.
Correction factor			Output voltage pitch. Default 1.0.
Offset	### [%]		Output voltage offset.
Gain factor damper			Default 100. See Appendix C - Control Sequence
Damper	### [%]		Override setpoint
Damper setpoint	### [%]		Setpoint to the damper actuator
Damper setpoint, current	### [%]		Current damper actuator position
Damper setpoint, absolute	### []		Current absolute actuator position
Test run			Test the damper actuator by an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Start		Start test run
Firmware version	###		Actuator software version
Serial number	###.###.###		Actuator serial number

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13.3.3 Extract Air damper, Supply Air damper and Supply Air Backup damper

13.3.3.1 On/Off

Supply air damper	Value	Units	Short explanation
Fan delay	### [s]		Delay from damper opens until the exhaust fan starts.
Damper delay	### [s]		Delay from fan stops until dampers close.
Damper			On/Off damper status
	Closed		Damper closed
	Open		Damper open.

13.3.3.2 Belimo Direct Modbus

Supply air damper	Value	Units	Short explanation
Fan delay	### [s]		Delay from damper opens until the exhaust fan starts.
Damper delay	### [s]		Delay from fan stops until dampers close.
Damper	### [%]		Override setpoint
Damper setpoint	### [%]		Setpoint to the damper actuator
Damper setpoint, current	### [%]		Current damper actuator position
Damper setpoint, absolute	### []		Current absolute actuator position
Test run			Test the damper actuator by an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Value		Start test run
Firmware version	###		Actuator software version
Serial number	###.###.###		Actuator serial number

13.3.4 Drying damper

13.3.4.1 On/Off

Drying damper	Value	Units	Short explanation
Drying time	### [s]		Duration of filter drying operation before the AHU stops.
Damper			On/Off damper status
	Closed		Damper closed
	Open		Damper open.

13.3.4.2 Belimo Direct Modbus

Drying damper	Value	Units	Short explanation
Drying time	### [s]		Duration of filter drying operation before the AHU stops.
Damper	### [%]		Override setpoint
Damper setpoint	### [%]		Setpoint to the damper actuator
Damper setpoint, current	### [%]		Current damper actuator position
Damper setpoint, absolute	### []		Current absolute actuator position
Test run			Test the damper actuator by an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Start		Start test run
Firmware version	###		Actuator software version
Serial number	###.###.###		Actuator serial number

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13.3.5 Recirculation damper and Mixing damper

13.3.5.1 On/Off

Recirculation	Value	Units	Short explanation
Damper			On/Off damper status
	Closed		Damper closed
	Open		Damper open.

13.3.5.2 Modulated 0-10V

Recirculation/Mixing damper	Value	Units	Short explanation
Damper	### [%]		Override setpoint
Current damper setting	###,# [V]		Output voltage to the damper actuator.
Correction factor	##,# []		Output voltage pitch. Default 1.0.
Offset	##,# [V]		Output voltage offset.
Gain factor damper	#### []		Default 100. See Appendix C - Control Sequence
Damper motor			Damper actuator input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Software version HTH-6202	##.## []		Humidity sensor sw version
Temperature HTH-6202	###,# [°C]		Humidity sensor temperature
Absolute air humidity HTH-6202	###,# [g/kg]		Calculated absolute humidity
Relative air humidity HTH-6202	###,# [%RH]		Humidity sensor relative humidity
Software version HTH-6203	##.## []		Humidity sensor sw version
Temperature HTH-6203	###,# [°C]		Humidity sensor temperature
Absolute air humidity HTH-6203	###,# [g/kg]		Calculated absolute humidity
Relative air humidity HTH-6203	###,# [%RH]		Humidity sensor relative humidity
Software version HTH-6204	##.## []		Humidity sensor sw version
Temperature HTH-6204	###,# [°C]		Humidity sensor temperature
Absolute air humidity HTH-6204	###,# [g/kg]		Calculated absolute humidity
Relative air humidity HTH-6204	###,# [%RH]		Humidity sensor relative humidity

13.3.5.3 Belimo Direct Modbus

Recirculation/Mixing damper	Value	Units	Short explanation
Damper	### [%]		Override setpoint
Correction factor	##,# []		Output voltage pitch. Default 1.0.
Gain factor damper	#### []		Default 100. See Appendix C - Control Sequence
Software version HTH-6202	##.## []		Humidity sensor sw version
Temperature HTH-6202	###,# [°C]		Humidity sensor temperature
Absolute air humidity HTH-6202	###,# [g/kg]		Calculated absolute humidity
Relative air humidity HTH-6202	###,# [%RH]		Humidity sensor relative humidity
Software version HTH-6203	##.## []		Humidity sensor sw version
Temperature HTH-6203	###,# [°C]		Humidity sensor temperature
Absolute air humidity HTH-6203	###,# [g/kg]		Calculated absolute humidity
Relative air humidity HTH-6203	###,# [%RH]		Humidity sensor relative humidity
Software version HTH-6204	##.## []		Humidity sensor sw version
Temperature HTH-6204	###,# [°C]		Humidity sensor temperature
Absolute air humidity HTH-6204	###,# [g/kg]		Calculated absolute humidity
Relative air humidity HTH-6204	###,# [%RH]		Humidity sensor relative humidity
Damper setpoint	### [%]		Setpoint to the damper actuator
Damper setpoint, current	### [%]		Current damper actuator position
Damper setpoint, absolute	### []		Current absolute actuator position

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Recirculation/Mixing damper	Value	Units	Short explanation
Test run			Test the damper actuator by an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Start		Start test run
Firmware version	###		Actuator software version
Serial number	###.###.###		Actuator serial number

13.4 Filters

The filter monitoring depends both on how advanced the AHU system is, and on whether pressure drop and air volume are measured.

13.4.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din
Timer					
Pressure switch					X
Pressure transmitter	X				
Pressure transmitter and Air volume	X				

13.4.2 Outdoor Air Filter, Supply Air Filter, Extract Air filter 1, Extract Air Filter 2

13.4.2.1 Timer settings

Outdoor air Filter	Value	Units	Short explanation
Number of days to filter change	### [days]		Current count down until filter change alarm
	Reset		Restart the countdown
Filter change interval	### [hours]		Count down setpoint
Alarm triggered			
	No		Filter alarm timer is still counting down
	Yes		Filter alarm timer value is Zero. Filter service is needed.

13.4.2.2 Pressure switch

Outdoor air Filter	Value	Units	Short explanation
Alarm triggered			A digital input is used to monitor the filter.
	No		The filter is OK
	Yes		The filter pressure drop is above the pressure switch level. Filter service is needed.

13.4.2.3 Pressure transmitter

Outdoor air Filter	Value	Units	Short explanation
Current pressure drop	### [Pa]		Current pressure drop across the filter
Alarm limit static	### [Pa]		Filter alarm is released if the current pressure drop is above the alarm limit.
Alarm triggered			A pressure transmitter is used to monitor the filter.
	No		The filter is OK.
	Yes		The filter pressure drop is above the alarm level. Filter service is needed.

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13.4.2.4 Pressure transmitter and Air volume: Dynamic filter monitoring

Outdoor air Filter	Value	Units	Short explanation
Current pressure drop	### [Pa]		Current pressure drop across the filter
Alarm type			
	Static		Use the static setpoint as alarm level
	Dynamic		Use the flow-dependent dynamic alarm level.
Filter pressure reference			Flow-dependent filter pressure reference on a clean filter.
	Not measured		The pressure reference value has not been measured.
	OK		The pressure reference value measurement has been successfully completed.
	Measure		Start measuring flow-dependent pressure reference values on a clean filter.
Alarm limit static	### [Pa]		Filter alarm is released if the current pressure drop is above the alarm limit.
Alarm limit is dynamic	### [Pa]		Filter alarm is released if the current pressure drop is above the dynamic alarm limit.
Alarm limit is dynamic	### [%]		The alarm limit is x % above the flow-dependent pressure reference table.
Alarm triggered			A pressure transmitter is used to monitor the filter.
	No		The filter is OK.
	Yes		The filter pressure drop is above the alarm level. Filter service is needed.

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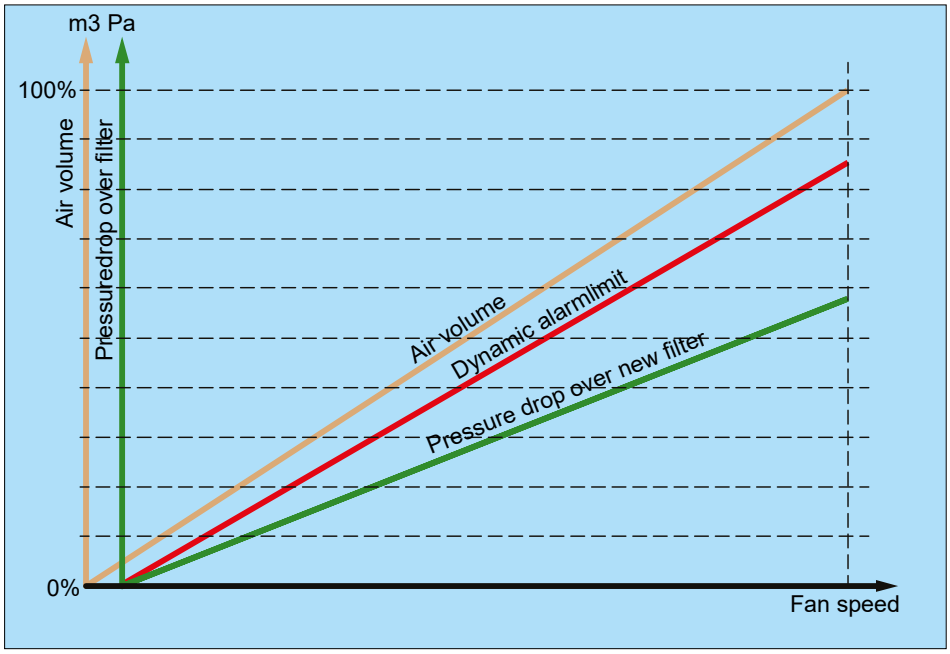
13.4.2.5 Dynamic Filter Monitoring

Info: This function can only be used when filter pressure drops are measured by pressure transmitters and the corresponding air volume also is measured.

The dynamic filter alarm limit represents a percentage increase (see the red graph in the diagram) in relation to flow dependent pressure drop across a new filter (see the green graph).



A re-measurement of the “Pressure drop over a new filter” can be performed by following these steps:

1. Make sure that all filters are new and clean.
2. Click on “Measurement”.

Now the system automatically runs this sequence:
1. All fans stop.
2. The system performs a zero-calibration of the pressure transmitters.
3. The fans will slowly start up from 30 –> 70% (see the orange graph) in 10% steps and simultaneously create pressure reference tables for all filters (see the green graph).
4. The measurement is completed, and the filter reference status becomes OK.

Note: If the flow and filter pressure doesn’t increase during the 10% steps, the re-measurement will have failed, and the monitoring status becomes “Not measured”.

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13.5 Heat recovery

The heat recovery control depends both on how advanced the AHU system is, and on the de-icing strategy.

13.5.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
Counterflow, Cross flow						
Bypass damper On/Off				X		X
Bypass damper 0-10V		X				X
0-10V, Dynamic ice detection	X	X				X
Belimo Direct Modbus	X					X
Rotor Heat Exchanger						
0-10V		X		X	X	X
0-10V, Dynamic ice detection	X	X		X	X	X
DRHX	X					X
DRHX, Dynamic ice detection	X					X
Run around coil						
0-10V		X		X	X	X
Belimo Direct modbus	X					X
Mixing dampers (See Mixing dampers)	X	X				X

13.5.2 Counterflow Heat Exchanger, Cross flow Heat exchanger and Double Crossflow Heat Exchanger

Bypass damper On/Off and Bypass damper 0-10V

Crossflow heat exchanger	Value	Units	Explanation
Ice protection	###,# [°C]	°C	Exhaust air temperature setpoint for full ice protection (100% supply air bypass)
Ice protection P-band	###,# [°C]	°C	Ice protection is active at Exhaust temperatures lower than Ice protection P-band + Ice protection setpoint
Ice protection in progress			Current Ice protection status
	No		Ice protection not active
	Yes		Ice protection active
Gain factor, heat recovery	### []		Default 100. See Appendix C - Control Sequence
Alarm in case of low efficiency			Alarm settings
	No		No alarm in case of low heat recovery efficiency
	Yes		Alarm in case of low heat recovery efficiency
Current efficiency: correction factor, heat exchanger efficiency	###,#	%	Calibration value for Heat recovery efficiency reading
Alarm level, efficiency	###	%	Alarm is released if the heat efficiency is lower than setpoint
Heat recovery	###	%	Override setpoint
Analogue output	###,#	V	Current output voltage for the Bypass damper actuator.
Current efficiency	###	%	Current heat recovery efficiency

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13.5.3 Bypass damper 0-10V, Dynamic ice detection

Crossflow heat exchanger	Value	Units	Explanation
De-icing type			De-icing strategy
	Static		Use the static setpoint as De-icing trigger level.
	Dynamic		Use the flow dependent dynamic setpoint as De-icing trigger level.
Crossflow heat exchanger pressure drop	###	Pa	Current pressure drop across the heat exchanger measured from Extract air to Exhaust air.
De-icing pressure, static	###	Pa	De-icing starts if the current pressure drop is above the setpoint.
De-icing pressure, dynamic	### [%]	%	De-icing starts if heat exchanger pressure drop is x % above the flow dependent pressure reference table.
Status, de-icing			Flow dependent heat exchanger pressure drop reference on a clean heat exchanger without ice.
	Not calibrated		The pressure reference values have not been measured
	Ok		The pressure reference value measurement has been successfully completed.
	Measure		Start measuring flow dependent pressure reference values on a clean heat exchanger without ice.
Current de-icing	###	Pa	Current De-icing trigger level.
De-icing time	### [s]	%	Duration of the De-icing sequence
Current remaining time of de-icing sequence	###	s	Current remaining time of the De-icing sequence
Ice protection in progress			Current Ice protection status
	No		Ice protection not active
	Yes		Ice protection active
Gain factor, heat recovery	### []		Default 100. See Appendix C - Control Sequence
Alarm in case of low efficiency			Alarm settings
	No		No alarm in case of low heat recovery efficiency
	Yes		Alarm in case of low heat recovery efficiency
Current efficiency: correction factor, heat exchanger efficiency	###,#	%	Calibration value for Heat recovery efficiency reading
Alarm level, efficiency	###	%	Alarm is released if the heat efficiency is lower than setpoint
Heat recovery	###	%	Override setpoint
Analogue output	###,#	V	Current output voltage for the Bypass damper actuator.
Current efficiency	###	%	Current heat recovery efficiency

13.5.4 Bypass damper Belimo Direct Modbus

Bypass damper	Value	Units	Explanation
Damper	###	%	Override setpoint
Damper setpoint	###	%	Setpoint to the damper actuator
Damper setpoint, current	###	%	Current damper actuator position
Damper setpoint, absolute	### []		Current absolute actuator position
Test run			Test the damper actuator by an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Start		Start test run
Firmware version	###		Actuator software version
Serial number	###.###.###		Actuator Serial number

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13.5.5 Rotary Heat Exchanger

13.5.5.1 0-10V

Rotary heat exchanger	Value	Units	Explanation
Gain factor, heat recovery	### []		Default 100. See Appendix C - Control Sequence
Alarm from heat exchanger, select alarm type			Alarm settings
	A		Stop the AHU if active rotor alarm.
	B		Keep the AHU running if active rotor alarm.
Alarm in case of low efficiency			Alarm settings
	No		No alarm in case of low heat recovery efficiency
	Yes		Alarm in case of low heat recovery efficiency
Current efficiency: correction factor, heat exchanger efficiency	###,#	%	Calibration value for Heat recovery efficiency reading
Alarm level, efficiency	###	%	Alarm is activated if the heat efficiency is lower than setpoint.
Outdoor air	##### m^3/h	l/s	Current outdoor Air volume.
Heat recovery	###	%	Override setpoint
Current efficiency	###	%	Current heat recovery efficiency
	No		Motor not overloaded.
	Yes		Motor overloaded. Check, that the rotor only requires normal torque.

13.5.5.2 0-10V, Dynamic Ice detection

Rotary heat exchanger	Value	Units	Explanation
Rotor pressure reference, de-icing			Flow dependent Rotor pressure reference on a clean rotor without ice.
	Not measured		The pressure reference values have not been measured
	Ok		The pressure reference value measurement has been successfully completed.
	Measure		Start measuring flow dependent pressure reference values on a clean rotor without ice.
Rotor de-icing			Enable rotor de-icing operation
	No		Rotor de-icing operation disabled.
	Yes		Rotor de-icing operation enabled
Pressure, start of de-icing	###	%	De-icing starts if Rotor pressure drop is x % above the flow dependent pressure reference table.
Rotor alarm	###	%	Dirty rotor alarm is activated if the rotor pressure drop is x % above the flow dependent pressure reference table and the temperature is above 0°C.
Gain factor, heat recovery	### []		Default 100. See Appendix C - Control Sequence
Alarm from heat exchanger, select alarm type			Alarm settings
	A		Stop the AHU if there is an active rotor alarm.
	B		Keep the AHU running if there is an active rotor alarm.
Alarm in case of low efficiency			Alarm settings
	No		No alarm in case of low heat recovery efficiency
	Yes		Alarm in case of low heat recovery efficiency
Current efficiency: correction factor, heat exchanger efficiency	###,#	%	Calibration value for Heat recovery efficiency reading
Alarm level, efficiency	###	%	Alarm is activated if the heat efficiency is lower than setpoint.

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Rotary heat exchanger	Value	Units	Explanation
Outdoor air	##### m^3/h	l/s	Current outdoor Air volume.
Heat recovery	###	%	Override setpoint
Current efficiency	###	%	Current heat recovery efficiency
	No		Motor not overloaded.
	Yes		Motor overloaded. Check the rotor only requires normal torque.
Current pressure drop	###	Pa	Current pressure drop across the rotor measured from Extract air to Exhaust air.

13.5.6 DRHX Drives

Rotary heat exchanger	Value	Units	Explanation
Gain factor, heat recovery	### []		Default 100. See Appendix C - Control Sequence
Alarm from heat exchanger, select alarm type			Alarm settings
	A		Stop the AHU if there is an active rotor alarm.
	B		Keep the AHU running if there is an active rotor alarm.
Alarm in case of low efficiency			Alarm settings
	No		No alarm in case of low heat recovery efficiency
	Yes		Alarm in case of low heat recovery efficiency
Current efficiency: correction factor, heat exchanger efficiency	###,#	%	Calibration value for Heat recovery efficiency reading
Alarm level, efficiency	###	%	Alarm is activated if the heat efficiency is lower than the setpoint.
Outdoor air	##### m^3/h	l/s	Current outdoor Air volume.
Heat recovery	###	%	Override setpoint
Current efficiency	###	%	Current heat recovery efficiency
Control type			Connected Rotor drive type
	None		No DRHX connected
	DRHX 3P01		1 Nm motor drive.
	DRHX 3P02		2 Nm motor drive.
	DRHX 3P04		4 Nm motor drive.
	DRHX 3P08		8 Nm motor drive.
	DRHX 3P14		14 Nm motor drive.
Purging time	####	s	Duration of purging rotation
Purging interval	#### [min]	min	Duration of Rotor stop before activation of purging rotation.
Rotation motor speed	###	%	Motor speed during purging operation.
Direction of rotation			Motor control.
	CCW		Counterclockwise rotation
	CW		Clockwise rotation.
Motor max. Speed	####	rpm	Motor speed at 100% setpoint
Torque in stop	###	%	Applied torque when the motor is stopped. Some torque is required in order to prevent rotor windmilling.
Motor min. speed	####	rpm	Motor speed at 0% setpoint.
Current value	###	%	Current motor speed.
Control type			Connected Rotor drive type
	None		No DRHX connected
	DRHX 3P01		1 Nm motor drive.
	DRHX 3P02		2 Nm motor drive.
	DRHX 3P04		4 Nm motor drive.
	DRHX 3P08		8 Nm motor drive.
	DRHX 3P14		14 Nm motor drive.
Motor rpm	####	rpm	Current motor rpm
Motor current	##### [mA]	mA	Current motor current
Operating time	####	days	Accumulated operation time displayed as days.

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Rotary heat exchanger	Value	Units	Explanation
Holding torque	###	%	Applied torque when the motor is stopped. Some torque is required in order to prevent rotor windmilling.
Software version	#.##		Software version in DRHX drive
Rotation alarm			Current Rotor rotation status
	No		Rotor rotation is OK
	Yes		No Rotor Rotation, Check belt, Rotor and drive.
Vlo alarm triggered			Current Mains voltage status
	No		Mains voltage is OK.
	Yes		Mains voltage is too low.
Vhi alarm triggered			Current Mains voltage status
	No		Mains voltage is OK.
	Yes		Mains voltage is too high.
Ihi alarm triggered			Current Motor status
	No		Motor is OK.
	Yes		Motor draws too much current. Check wiring, Motor windings and spinning the rotor only requires normal torque.
Temp. alarm triggered			Current Rotor drive temperature status
	No		Drive temperature is OK
	Yes		Rotor drive is too hot. Check for excessive ambient temperature, Torque overload and Motor winding failure.
Overload alarm			Current Motor overload status
	No		Motor not overloaded.
	Yes		Motor overloaded. Check, that the rotor only requires normal torque.

13.5.7 DRHX Drives, Dynamic Ice detection

Rotary heat exchanger	Value	Units	Explanation
Rotor pressure reference, de-icing			Flow dependent Rotor pressure reference on a clean rotor without ice.
	Not measured		The pressure reference values have not been measured
	Ok		The pressure reference value measurement has been successfully completed.
	Measure		Start measuring flow dependent pressure reference values on a clean rotor without ice.
Rotor de-icing			Enable rotor de-icing operation
	No		Rotor de-icing operation disabled.
	Yes		Rotor de-icing operation enabled.
Pressure, start of de-icing	###	%	De-icing starts if the rotor pressure drop is x % above the flow dependent pressure reference table.
Rotor alarm	###	%	Dirty rotor alarm is activated if the rotor pressure drop is x % above the flow dependent pressure reference table and the temperature is above 0°C.
Gain factor, heat recovery	### []		Default 100. See Appendix C - Control Sequence
Alarm from heat exchanger, select alarm type			Alarm settings
	A		Stop the AHU if there is an active rotor alarm.
	B		Keep the AHU running if there is an active rotor alarm.
Alarm in case of low efficiency			Alarm settings
	No		No alarm in case of low heat recovery efficiency
	Yes		Alarm in case of low heat recovery efficiency
Current efficiency: correction factor, heat exchanger efficiency	###,#	%	Calibration value for Heat recovery efficiency reading
Alarm level, efficiency	###	%	Alarm is activated if the heat efficiency is lower than the setpoint.

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Rotary heat exchanger	Value	Units	Explanation
Outdoor air	##### m^3/h	l/s	Current outdoor Air volume.
Heat recovery	###	%	Override setpoint
Current efficiency	###	%	Current heat recovery efficiency
Control type			Connected Rotor drive type
	None		No DRHX connected
	DRHX 3P01		1 Nm motor drive.
	DRHX 3P02		2 Nm motor drive.
	DRHX 3P04		4 Nm motor drive.
	DRHX 3P08		8 Nm motor drive.
	DRHX 3P14		14 Nm motor drive.
Purging time	####	s	Duration of purging rotation
Purging interval	#### [min]	min	Duration of Rotor stop before activation of purging rotation.
Rotation motor speed	###	%	Motor speed during purging operation.
Direction of rotation			Motor control.
	CCW		Counterclockwise rotation
	CW		Clockwise rotation.
Motor max. Speed	####	rpm	Motor speed at 100% setpoint
Torque in stop	###	%	Applied torque when the motor is stopped. Some torque is required in order to prevent rotor windmilling.
Motor min. speed	####	rpm	Motor speed at 0% setpoint.
Current value	###	%	Current motor speed.
Control type			Connected Rotor drive type
	None		No DRHX connected
	DRHX 3P01		1 Nm motor drive.
	DRHX 3P02		2 Nm motor drive.
	DRHX 3P04		4 Nm motor drive.
	DRHX 3P08		8 Nm motor drive.
	DRHX 3P14		14 Nm motor drive.
Motor rpm	####	rpm	Current motor rpm
Motor current	##### [mA]	mA	Current motor current
Operating time	####	days	Accumulated operation time displayed as days.
Holding torque	###	%	Applied torque when the motor is stopped. Some torque is required in order to prevent rotor windmilling.
Software version	#.##		Software version in DRHX drive
Rotation alarm			Current Rotor rotation status
	No		Rotor rotation is OK.
	Yes		No Rotor Rotation, Check belt, Rotor and drive.
Vlo alarm triggered			Current Mains voltage status
	No		Mains voltage is OK.
	Yes		Mains voltage is too low.
Vhi alarm triggered			Current Mains voltage status
	No		Mains voltage is OK.
	Yes		Mains voltage is too high.
Ihi alarm triggered			Current Motor status
	No		Motor is OK
	Yes		Motor uses too much current. Check wiring, Motor windings and spinning. The rotor only requires normal torque.

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Rotary heat exchanger	Value	Units	Explanation
Temp. alarm triggered			Current Rotor drive temperature status
	No		Drive temperature is OK.
	Yes		Rotor drive is too hot. Check for excessive ambient temperature, Torque overload and Motor winding failure.
Overload alarm			Current Motor overload status
	No		Motor not overloaded.
	Yes		Motor overloaded. Check, that the rotor only requires normal torque.
Current pressure drop	###	Pa	Current pressure drop across the rotor measured from Extract air to Exhaust air.

13.5.8 Run around coil Heat exchanger

13.5.8.1 0-10V

	Value	Units	Explanation
Heat recovery	###	%	Override setpoint
Analogue output	###,#	V	Current output voltage for the heat recovery valve actuator.
Recovery relay			Circulator pump status
	Closed		Circulator pump started.
	Disconnected		Circulator pump stopped.
Recovery sensor	###,# [°C]	°C	Current return water temperature.
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.
	Auto		The circulator pump starts when heat recovery is required.
	Outdoor air temp.		The circulator pump starts at low outdoor temperatures.
Pump start	###,# [°C]	°C	Outdoor temperature setpoint for start of circulator pump.
Recovery temperature, alarm	###,# [°C]	°C	Alarm is active if the return water temperature is below setpoint + the current outdoor temperature.
Outdoor air temperature	###,# [°C]	°C	Current outdoor air temperature
Standby heating	###,# [°C]	°C	Return water temperature setpoint keeps the heating coil and pipes heated during AHU stop. (frost protection)
Frost protection	###,# [°C]	°C	Heating coil return water temperature setpoint for full frost protection (100% heating)
Frost P-band	###,# [°C]	°C	Frost protection range = P-band + Frost protection setpoint.
Frost alarm	###,# [°C]	°C	Return water temperatures below setpoint trigger a Frost alarm.
Gain factor, heat recovery	###,# []		Default 100. See Appendix C - Control Sequence
Alarm in case of low efficiency			Alarm settings
	No		No alarm in case of low heat recovery efficiency
	Yes		Alarm in case of low heat recovery efficiency
Current efficiency: correction factor, heat exchanger efficiency	###,#	%	Calibration value for Heat recovery efficiency reading
Alarm level, efficiency	###,#	%	Alarm is activated if the heat efficiency is lower than setpoint.
Motor valve			Heat recovery valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Sensor correction: Recovery liquid temp.	###,# [°C]	°C	Calibration value for Temperature sensor reading
Current efficiency	###	%	Current heat recovery efficiency
Valve setpoint	###	%	Setpoint to the damper actuator

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13.5.8.2 Belimo Direct Modbus

	Value	Units	Explanation
Heat recovery	###	%	Override setpoint
Analogue output	###,#	V	Current output voltage for the heat recovery valve actuator.
Recovery relay			Circulator pump status
	Closed		Circulator pump started
	Disconnected		Circulator pump stopped
Recovery sensor	###,# [°C]	°C	Current return water temperature.
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.
	Auto		The circulator pump starts when heat recovery is required
	Outdoor air temp.		The circulator pump starts at low outdoor temperatures.
Pump start	###,# [°C]	°C	Outdoor temperature setpoint for start of circulator pump.
Recovery temperature, alarm	###,# [°C]	°C	Alarm is active if the return water temperature is below setpoint + the current outdoor temperature.
Outdoor air temperature	###,# [°C]	°C	Current outdoor air temperature
Standby heating	###,# [°C]	°C	Return water temperature setpoint keeps the heating coil and pipes heated during AHU stop. (frost protection)
Frost protection	###,# [°C]	°C	Heating coil return water temperature setpoint for full frost protection (100% heating)
Frost P-band	###,# [°C]	°C	Frost protection range = P-band + Frost protection setpoint.
Frost alarm	###,# [°C]	°C	Return water temperatures below setpoint trigger a Frost alarm.
Gain factor, heat recovery	###,# []		Default 100. See Appendix C - Control Sequence
Alarm in case of low efficiency			Alarm settings
	No		No alarm in case of low heat recovery efficiency
	Yes		Alarm in case of low heat recovery efficiency
Current efficiency: correction factor, heat exchanger efficiency	###,#	%	Calibration value for Heat recovery efficiency reading
Alarm level, efficiency	###,#	%	Alarm is activated if the heat efficiency is lower than setpoint.
Sensor correction: Recovery liquid temp.	###,# [°C]	°C	Calibration value for Temperature sensor reading
Current efficiency	###	%	Current heat recovery efficiency
Valve setpoint	###	%	Setpoint to the damper actuator
Test run			Test the damper actuator by an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Start		Start test run
Valve setting, current	###,#	%	Current damper actuator position
Valve setting, absolute	###,#	%	Current absolute actuator position
Firmware version	### []		Actuator software version
Serial number	###(1)-###(2)-###(3) []		Actuator Serial number

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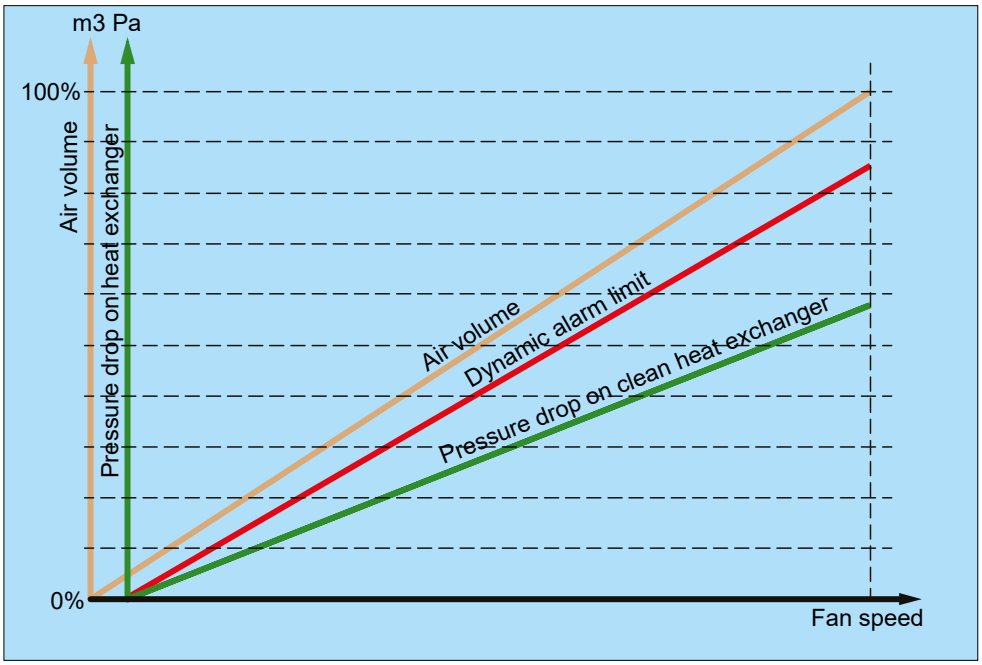
13.5.9 Heat Recovery, Dynamic Ice Detection

The function can only be used when the heat recovery pressure drop is measured by pressure transmitters and the corresponding air volume also is measured.
The dynamic ice detection limit is a percentage increase (see the red graph in the diagram) in relation to flow dependent pressure drop across a clean heat recovery device without ice (see the green graph).



Re-measurement of **Pressure drop** across a “clean heat exchanger” can be done following these steps:

1. Make sure that the heat exchanger is both without ice, and that it is clean.
2. Click on “Measurement”.

Now the system automatically runs this sequence:
1. All fans stop.
2. The system makes a zero-calibration of the pressure transmitters.
3. The fans will slowly start up from 30 –> 70% (see the orange graph) in 10% steps and simultaneously build a pressure reference table for the heat exchanger (see the green graph).
4. The measurement is completed and the Heat exchanger **Rotor pressure reference, de-icing** status becomes OK.

Note: If the flow and pressure doesn’t increase during the 10% steps, the re-measurement will have failed, and the monitoring status becomes “Not measured”.

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13.6 Heating coils

The heat control depends both on how advanced the AHU system is, and on how the frost protection is made.

13.6.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
Water coil						
0-10V control		X		X	X	X
Belimo Direct Modbus	X			X	X	X
Electric coil		X		X	X	X
Gas coil		X		X	X	X

13.6.2 Heating 1

13.6.2.1 Water coil 1

13.6.2.1.1 0-10V control

Water heating coil 1	Value	Units	Short explanation
Heating	###	%	Override setpoint
Heating output	###,#	V	Current output voltage to the heating valve.
Heating relay 1			Circulator pump status.
	Disconnected		Circulator pump stopped.
	Closed		Circulator pump started.
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.
	Auto		The circulator pump starts when active heating is required.
	Outdoor air temp.		The circulator pump starts at low outdoor temperatures.
Pump start	###,# [°C]	°C	Outdoor temperature setpoint for start of circulator pump.
Frost protection	###,# [°C]	°C	Heating coil return water temperature setpoint for full frost protection . (100% heating)
Frost alarm	###,# [°C]	°C	Return water temperatures below setpoint trigger a Frost alarm.
Frost P-band	###,# [°C]	°C	Frost protection range = P-band + Frost protection setpoint.
Start-up heating	###	%	Valve setpoint during AHU start up.
Standby heating	###,# [°C]	°C	Return water temperature setpoint keeping the heating coil and pipes heated during AHU stop. (frost protection)
Water heating coil temp.	###,# [°C]	°C	Current return water temperature.
Gain factor, heat 1	### []		Default 100. See Appendix C - Control Sequence
Motor valve			Heating valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Sensor correction: Water heating coil 1	###,# [°C]	°C	Calibration value for Temperature sensor reading

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13.6.2.1.2 Belimo Direct Modbus

Water heating coil 1	Value	Units	Short explanation
Heating	###	%	Override setpoint
Heating output	###,#	V	Current output voltage to the heating valve.
Heating relay 1			Circulator pump status
	Disconnected		Circulator pump stopped.
	Closed		Circulator pump started.
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.
	Auto		The circulator pump starts when active heating is required.
	Outdoor air temp.		The circulator pump starts at low outdoor temperatures.
Pump start	###,# [°C]	°C	Outdoor temperature setpoint for start of circulator pump.
Frost protection	###,# [°C]	°C	Heating coil return water temperature setpoint for full frost protection. (100% heating)
Frost alarm	###,# [°C]	°C	Return water temperatures below setpoint. Frost alarm triggered.
Frost P-band	###,# [°C]	°C	Frost protection range = P-band + Frost protection setpoint.
Start-up heating	###	%	Valve setpoint during AHU start up.
Standby heating	###,# [°C]	°C	Return water temperature setpoint keeping the heating coil and pipes heated during AHU stop. (frost protection)
Water heating coil temp.	###,# [°C]	°C	Current return water temperature.
Gain factor, heat 1	### []		Default 100. See Appendix C - Control Sequence
Motor valve			Heating valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Sensor correction: Water heating coil 1	###,# [°C]	°C	Calibration value for Temperature sensor reading
Valve setpoint	###	%	Setpoint to the heating valve
Valve setpoint, current	###	%	Current heating valve position.
Valve setpoint, absolute	### []		Current absolute heating valve position.
Test run			Test the valve actuator by an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Start		Start test run
Firmware version	###		Actuator software version
Serial number	###.###.###		Actuator Serial number

13.6.2.2 Electric Coil 1

	Value	Units	Comments
Electric heating coil 1			
Regulation mode			El heater control
	0-10V		Heating controlled by an Analogue output
	1 Step		Heating section 1 controlled by an Analogue output and Heating section 2 by a Digital output.
	2 Step		Heating section 1 controlled by an Analogue output. Heating section 2 and 3 by Digital outputs.
	Binary		Heating section 1 and 2 controlled by Digital outputs.
Heating coil, airflow monitor OK			Heating conditions
	Not OK		Heating cannot be activated if the airflow status is Not OK.
	OK		Heating can only be activated if the airflow status is OK.
After-cooling time		s	Min. Fan operation time after heater shut down.

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	Value	Units	Comments
Min. airflow, 100% heating		m^3/h	Minimum current airflow allowing 100% heating.
Min. airflow, 0% heating		m^3/h	Minimum current airflow allowing 0% heating
Gain factor, heat 1			Default 100. See Appendix C - Control Sequence
Heating	###	%	Override setpoint
Heating output	###	V	Current output voltage to the electric heater.
Overheating			Status El heater overheating switch
	Closed		Electric heater not overheated
	Disconnected		Electric heater overheated.
Reduced heating			Heating conditions
	No		Heating power not reduced due to low air volume
	Yes		Heating power is reduced due to low air volume
Aftercooling time	###	s	Current remaining Min. Fan operation time after heater shut down.
Heating relay 1			Heating coil control
	Disconnected		Section 1 Off
	Closed		Section 1 On
Heating relay 2			Heating coil control
	Disconnected		Section 2 Off
	Closed		Section 2 On

13.6.2.3 Gas coil 1

Gas heater 1	Value	Units	Short explanation
Heating	###	%	Override setpoint
Heating output	###,#	V	Current output voltage to the gas-heater.
Heating relay 1			Heating coil control
	Disconnected		Gas heater Off
	Closed		Gas heater On
Min. airflow, 100% heating	#####	m^3/h	Minimum current airflow allowing 100% heating.
Min. airflow, 0% heating	#####	m^3/h	Minimum current airflow allowing 0% heating
After-cooling time	###	s	Min. fan operation time after heater shut down.
Reduced heating			Heating conditions
	No		Heating power not reduced due to low air volume.
	Yes		Heating power is reduced due to low air volume.
Gain factor, heat 1	### []		Default 100. See Appendix C - Control Sequence
Minimum heating time	###	s	
Gas heater alarm			Gas heater alarm handling
	B		A gas heater alarm doesn't stop the AHU.
	A		A gas heater alarm stops the AHU.

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13.6.3 Heating 2

13.6.3.1 Water coil 2

13.6.3.1.1 0-10V control

Water heating coil 2	Value	Units	Short explanation
Heating	###	%	Override setpoint
Heating output2	###,#	V	Current output voltage to the heating valve.
Heating relay 21			Circulator pump status
	Disconnected		Circulator pump stopped
	Closed		Circulator pump started.
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.
	Auto		The circulator pump starts when active heating is required.
	Outdoor air temp.		The circulator pump starts at low outdoor tempera-tures.
Pump start	###,# [°C]	°C	Outdoor temperature setpoint for start of circulator pump.
Frost protection	###,# [°C]	°C	Heating coil return water temperature setpoint for full frost protection (100% heating)
Frost alarm	###,# [°C]	°C	Return water temperatures below setpoint trigger a Frost alarm.
Frost P-band	###,# [°C]	°C	Frost protection range = P-band + Frost protection setpoint.
Start-up heating	###	%	Valve setpoint during AHU start up.
Standby heating	###,# [°C]	°C	Return water temperature setpoint keeping the heating coil and pipes heated during AHU stop. (frost protection)
Water heating coil temp.	###,# [°C]	°C	Current return water temperature.
Gain factor, heat 2	### []		Default 100. See Appendix C - Control Sequence
Motor valve			Heating valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Sensor correction: Water heating coil 2	###,# [°C]	°C	Calibration value for Temperature sensor reading

13.6.3.1.2 Belimo Direct Modbus

Water heating coil 2	Value	Units	Short explanation
Heating	###	%	Override setpoint
Heating output 2	###,#	V	Current output voltage to the heating valve.
Heating relay 21			Circulator pump status
	Disconnected		Circulator pump stopped
	Closed		Circulator pump started.
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.
	Auto		The circulator pump starts when active heating is required.
	Outdoor air temp.		The circulator pump starts at low outdoor tem-peratures.
Pump start	###,# [°C]	°C	Outdoor temperature setpoint for start of circulator pump.
Frost protection	###,# [°C]	°C	Heating coil return water temperature setpoint for full frost protection. (100% heating)

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Water heating coil 2	Value	Units	Short explanation
Frost alarm	###,# [°C]	°C	Return water temperatures below setpoint trigger a Frost alarm.
Frost P-band	###,# [°C]	°C	Frost protection range = P-band + Frost protection setpoint.
Start-up heating	###	%	Valve setpoint during AHU start up.
Standby heating	###,# [°C]	°C	Return water temperature setpoint keeping the heating coil and pipes heated during AHU stop. (frost protection)
Water heating coil temp.	###,# [°C]	°C	Current return water temperature.
Gain factor, heat 2	### []		Default 100. See Appendix C - Control Sequence
Motor valve			Heating valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Sensor correction: Water heating coil 2	###,# [°C]	°C	Calibration value for Temperature sensor reading
Valve setpoint	###	%	Setpoint to the heating valve
Valve setpoint, current	###	%	Current heating valve position.
Valve setpoint, absolute	### []		Current absolute heating valve position.
Test run			Test the valve actuator by an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Start		Start test run
Firmware version	###		Actuator software version
Serial number	###.###.###		Actuator Serial number

13.6.3.2 Electric Coil 2

	Value	Units	Comments
Electric heating coil 2			
Regulation mode			Electric heater control
	0-10V		Heating controlled by an analogue output.
	1 Step		Heating section 1 controlled by an analogue output and Heating section 2 by a digital output.
	2 Step		Heating section 1 controlled by an analogue output. Heating section 2 and 3 by digital outputs.
	Binary		Heating section 1 and 2 controlled by digital outputs.
Heating coil, airflow monitor OK			Heating conditions
	Not OK		Heating cannot be activated if the airflow status is Not OK.
	OK		Heating can only be activated if the airflow status is OK.
After-cooling time		s	Min. Fan operation time after heater shut down.
Min. airflow, 100% heating		m^3/h	Minimum current airflow allowing 100% heating.
Min. airflow, 0% heating		m^3/h	Minimum current airflow allowing 0% heating
Gain factor, heat 2			Default 100. See Appendix C - Control Sequence
Heating	###	%	Override setpoint
Heating output 2	###	V	Current output voltage to the electric heater.
Overheating 2			Status for the electric heater overheating switch
	Closed		Electric heater not overheated.
	Disconnected		Electric heater overheated.
Reduced heating			Heating conditions
	No		Due to low air volume, the heating power is not reduced.
	Yes		Due to low air volume, Heating power is reduced.
Aftercooling time	###	s	Current remaining Min. Fan operation time after heater shut down.

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	Value	Units	Comments
Heating relay 21			Heating coil control
	Disconnected		Section 1 Off
	Closed		Section 1 On
Heating relay 22			Heating coil control
	Disconnected		Section 2 Off
	Closed		Section 2 On

12.6.3.3 Gas coil 2

Gas heater 2	Value	Units	Short explanation
Heating	###	%	Override setpoint
Heating output 2	###,#	V	Current output voltage to the Electric heater.
Heating relay 21			Heating coil control
	Disconnected		Gas heater Off
	Closed		Gas Heater On
Min. airflow, 100% heating	#####	m^3/h	Minimum current airflow allowing 100% heating.
Min. airflow, 0% heating	#####	m^3/h	Minimum current airflow allowing 0% heating
After-cooling time	###	s	Min. Fan operation time after heater shut down.
Reduced heating			Heating conditions
	No		Heating power not reduced due to low air volume
	Yes		Heating power reduced due to low air volume
Gain factor, heat 2	### []		Default 100. See Appendix C - Control Sequence
Minimum heating time	###	s	
Gas heater alarm			Gas heater alarm handling
	B		A gas heater alarm doesn't stop the AHU.
	A		A gas heater alarm stops the AHU.

13.7 Preheating coils

The heat control depends both on how advanced the AHU system is built, and on how the frost protection is made.

13.7.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
Water coil						
0-10V control		X		X	X	X
Belimo Direct Modbus	X			X	X	X
Electric coil		X		X	X	X
Gas coil		X		X	X	X

13.7.2 Water Coil

13.7.2.1 0-10V control

Water preheating coil, preheater	Value	Units	Explanation
Setpoint preheating	###,# [°C]	°C	Preheater temperature setpoint
Heating	###	%	Override setpoint
Analogue heating output	###,#	V	Current output voltage to the heating valve.
Current temperature	###,# [°C]	°C	Current preheater temperature.
Water heating coil temp.	###,# [°C]	°C	Current return water temperature.
Pre-heating coil relay 1			Circulator pump status
	Disconnected		Circulator pump stopped.
	Closed		Circulator pump started.
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.

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Water preheating coil, preheater	Value	Units	Explanation
	Auto		The circulator pump starts when active heating is required.
	Outdoor air temp.		The circulator pump starts at low outdoor temperatures.
Pump start	###,# [°C]	°C	Outdoor temperature setpoint for start of circulator pump.
Frost protection	###,# [°C]	°C	Heating coil return water temperature setpoint for full frost protection (100% heating)
Frost alarm	###,# [°C]	°C	Return water temperatures below setpoint triggers a Frost alarm.
Frost P-band	###,# [°C]	°C	Frost protection range = P-band + Frost protection setpoint.
Start-up heating	###	%	Valve setpoint during AHU start up.
Standby heating	###,# [°C]	°C	Return water temperature setpoint keeping the heating coil and pipes heated during AHU stop. (frost protection)
Water heating coil temp.	###,# [°C]	°C	Current return water temperature.
P-band	###,# [°C]	°C	If the preheater is slow reaching the temperature setpoint, you can decrease the P-band. If the temperature is fluctuating, you can increase the P-band.
I-time	###	s	If the preheater is slow reaching the temperature setpoint, you can decrease the I-time. If the Preheater temperature is fluctuating, you can increase the I-time settings.
Motor valve			Heating valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Sensor correction: Pre-heating coil	###,# [°C]	°C	Calibration value for Temperature sensor reading
Sensor correction: Pre-heating coil return water sensor	###,# [°C]	°C	Calibration value for Temperature sensor reading
I-time	###	s	If the preheater is very slow reaching the temperature setpoint, you can reduce the I-time. If the preheater temperature is fluctuating, you can increase the I-time settings.
Motor valve			Heating valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Sensor correction: Pre-heating coil	###,# [°C]	°C	Calibration value for Temperature sensor reading
Sensor correction: Pre-heating coil return water sensor	###,# [°C]	°C	Calibration value for Temperature sensor reading

13.7.2.2 Belimo Direct Modbus

Water preheating coil, preheater	Value	Units	Explanation
Setpoint preheating	###,# [°C]	°C	Preheater temperature setpoint
Heating	###	%	Override setpoint
Analogue heating output	###,#	V	Current output voltage to the heating valve.
Current temperature	###,# [°C]	°C	Current preheater temperature.
Water heating coil temp.	###,# [°C]	°C	Current return water temperature.
Pre-heating coil relay 1			Circulator pump status
	Disconnected		Circulator pump stopped.
	Closed		Circulator pump started.
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.

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Water preheating coil, preheater	Value	Units	Explanation
	Auto		The circulator pump starts when active heating is required.
	Outdoor air temp.		The circulator pump starts at low outdoor temperatures.
Pump start	###,# [°C]	°C	Outdoor temperature setpoint for start of circulator pump.
Frost protection	###,# [°C]	°C	Heating coil return water temperature set-point for full frost protection (100% heating)
Frost alarm	###,# [°C]	°C	Return water temperatures below setpoint trigger a frost alarm.
Frost P-band	###,# [°C]	°C	Frost protection range = P-band + Frost protection setpoint.
Start-up heating	###	%	Valve setpoint during AHU start up.
Standby heating	###,# [°C]	°C	Return water temperature setpoint keeps the heating coil and pipes heated during AHU stop. (frost protection)
Water heating coil temp.	###,# [°C]	°C	Current return water temperature.
P-band	###,# [°C]	°C	If the preheater is very slow reaching the temperature setpoint you can decrease the P-band. If the temperature is fluctuating, you can increase the P-band.
I-time	###	s	If the preheater is very slow reaching the temperature setpoint, you can decrease the I-time. If the preheater temperature is fluctuating, you can increase the I-time settings.
Motor valve			Heating valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Sensor correction: Pre-heating coil	###,# [°C]	°C	Calibration value for Temperature sensor reading
Sensor correction: Pre-heating coil return water sensor	###,# [°C]	°C	Calibration value for Temperature sensor reading
Valve setpoint	###	%	Setpoint to the heating valve
Valve setpoint, current	###	%	Current heating valve position.
Valve setpoint, absolute	### []		Current absolute heating valve position.
Test run			Test the valve actuator with an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Start		Start test run.
Firmware version	###		Actuator software version
Serial number	###.###.###		Actuator serial number

13.7.2.3 Electric coil

Electric pre-heating coil	Value	Units	Explanation
Regulation mode			Electric heater control
	0-10V		Heating controlled by an Analogue output.
	1 Step		Heating section 1 controlled by an analogue output and Heating section 2 by a digital output.
	2 Step		Heating section 1 controlled by an analogue output. Heating section 2 and 3 by digital outputs.
	Binary		Heating section 1 and 2 controlled by Digital outputs.

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Electric pre-heating coil	Value	Units	Explanation
Aftercooling time	####	s	Minimum fan operation time after heater shut down.
Min. airflow, 100% heating	#####	m^3/h	Minimum current airflow allowing 100% heat-ing.
Min. airflow, 0% heating	#####	m^3/h	Minimum current airflow allowing 0% heating
P-band	###,# [°C]	°C	P-band for the preheater control loop
I-time	####	s	I-time for the preheater control loop
Setpoint preheating	###,# [°C]	°C	Preheater temperature setpoint
Heating	###	%	Override setpoint
Analogue heating output	###	V	Current output voltage to the Electric heater.
Heating relay 1			Heating coil control
	Disconnected		Section 1 Off
	Closed		Section 1 On
Heating relay 2			Heating coil control
	Disconnected		Section 2 Off
	Closed		Section 2 On
Current temperature		°C	Current preheater temperature
Pre-heating coil, airflow monitor OK			Heating conditions
	Not OK		Heating cannot be activated if the airflow status is Not OK.
	OK		Heating can only be activated if the airflow status is OK.
Overheating alarm			Status Electrical heater overheating switch.
	No		Electric heater not overheated.
	Yes		Electric heater overheated.
Output reduction			Heating conditions
	No		Heating power not reduced due to low air volume.
	Yes		Heating power reduced due to low air volume.
Sensor correction: Pre-heating coil	###,# [°C]	°C	Calibration value for Temperature sensor reading

13.7.2.4 Gas coil

Gas heating coil	Value	Units	Explanation
Heating	###	%	Override setpoint
Current temperature	###,# [°C]	°C	Current preheater temperature
Heating coil, airflow monitor OK			Heating conditions
	Not OK		Heating cannot be activated if the airflow status is Not OK.
	OK		Heating can only be activated if the airflow status is OK.
Heating output	###,#	V	Current output voltage to the Gas heater.
Min. airflow, 100% heating	#####	m^3/h	Minimum current airflow allowing 100% heating.
Minimum airflow for start of gas heater	#####	m^3/h	Minimum current airflow allowing 0% heating
Aftercooling time	###	s	Min. Fan operation time after heater shut down.
Reduced heating			Heating conditions
	No		Heating power not reduced due to low air volume
	Yes		Heating power is reduced due to low air volume
Minimum heating time	###	s	Minimum Gas heater operation time.
Gas heater alarm			Gas heater alarm handling
	B		A gas heater alarm doesn't stop the AHU
	A		A gas heater alarm stops the AHU
Setpoint preheating	###,# [°C]	°C	Preheater temperature setpoint
P-band	###,# [°C]	°C	P band for the preheater control loop
I-time	###	s	I time for the preheater control loop

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13.8 Cooling coils

The cooling control depends both on how advanced the AHU system is, and on the cooling power source.

13.8.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
Water cooling coil						
0-10V control		X		X	X	X
Belimo Direct Modbus	X			X	X	X
DX cooling coil		X	X	X	X	X
External DX cooling		X		X	X	X

13.8.2 Water Cooling coil

13.8.2.1 0-10V control

	Value	Units	Short explanation
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.
	Auto		The circulator pump starts when active cooling is required.
	Outdoor air temp.		The circulator pump starts at high outdoor temperatures.
Pump start	###,# [°C, F]	°C	Outdoor temperature setpoint for start of circulator pump.
Motor valve			Cooling valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Cooling	###	%	Override setpoint
Analogue cooling output	###,#	V	Current output voltage to the cooling valve.
Cooling relay 1			Circulator pump status
	Disconnected		Circulator pump stopped.
	Closed		Circulator pump started.

13.8.2.2 Belimo Direct Modbus

	Value	Units	Short explanation
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.
	Auto		The circulator pump starts when active cooling is required.
	Outdoor air temp.		The circulator pump starts at high outdoor temperatures.
Pump start	###,#	°C	Outdoor temperature setpoint for start of circulator pump.
Cooling	###	%	Override setpoint
Cooling relay 1			Circulator pump status
	Disconnected		Circulator pump stopped
	Closed		Circulator pump started.
Valve setpoint	###,# [%]		Setpoint to the cooling valve
Valve setting, current	###,# [%]		Current cooling valve position.
Valve setting, absolute	###,# []		Current absolute cooling valve position.
Test run			Test the valve actuator by an end-to-end position test run.
	Not active		Test run not active
	Active		Test run in progress
	Start		Start test run
Firmware version	###		Actuator software version
Serial number	###.###.###		Actuator Serial number

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13.8.3 DX Cooling coil

	Value	Units	Comments
Regulation			Compressor control
	2 Step		Two sequential compressors
	3 Step Bin		One small and one large compressor.
	4 Step		Two cooling circuits. Each has two sequential compressors.
	15 Step Bin		Two cooling circuits. Each has one small and one large compressor.
Min. airflow	#####	m^3/h	DX cooling can only be activated if the current air volume is above this setpoint.
1st step modulating			Set controller output control voltage to Compressor 1.
	No		Compressor 1 is On/Off controlled.
	Yes		Compressor 1 is speed controlled by a drive. Setting to Yes is only possible if “Analog cooling output sequential” is set to No.
Min. cooling time	###	s	Minimum compressor operation time.
Max. restart per hour	###	hours	Maximum compressor restarts per hour. (Only active if Min. stop time is set to 0)
Aftercooling time	###	s	Min. Fan operation time after compressor shut down.
Low pressure circuit 1 alarm	###	Bar	Alarm in case of low compressor suction pressure. Check the thermodynamic circuit and refrigerant filling.
High pressure circuit 1 alarm	###	Bar	Alarm in case of high compressor Discharge pressure. Check the thermodynamic circuit and condenser air flow.
Low pressure circuit 2 alarm	### [Pa]	Bar	Alarm if low compressor suction pressure. Check the thermodynamic circuit and refrigerant filling.
High pressure circuit 2 alarm	### [Pa]	Bar	Alarm if high compressor Discharge pressure. Check the thermodynamic circuit and condenser air flow.
Min. voltage low pressure 1	###	V	Minimum output voltage from suction pressure transmitter in circuit 1.
Min. pressure low pressure 1	### [Pa]	Bar	Pressure at Minimum output voltage from suction pressure transmitter in circuit 1.
Max. voltage low pressure 1	###	V	Maximum output voltage from suction pressure transmitter in circuit 1.
Max. pressure low pressure 1	### [Pa]	Bar	Pressure at Maximum output voltage from suction pressure transmitter in circuit 1.
Min. voltage high pressure 1	###	V	Minimum output voltage from discharge pressure transmitter in circuit 1.
Min. pressure high pressure 1	### [Pa]	Bar	Pressure at Minimum output voltage from discharge pressure transmitter in circuit 1.
Max. voltage high pressure 1	###	V	Maximum output voltage from discharge pressure transmitter in circuit 1.
Max. pressure high pressure 1	### [Pa]	Bar	Pressure at Maximum output voltage from discharge pressure transmitter in circuit 1.
Min. voltage low pressure 2	###	V	Minimum output voltage from suction pressure transmitter in circuit 2.
Min. pressure low pressure 2	### [Pa]	Bar	Pressure at Minimum output voltage from suction pressure transmitter in circuit 2.
Max. voltage low pressure 2	###	V	Maximum output voltage from suction pressure transmitter in circuit 2.
Max. pressure low pressure 2	### [Pa]	Bar	Pressure at Maximum output voltage from suction pressure transmitter in circuit 2.
Min. voltage high pressure 2	###	V	Minimum output voltage from discharge pressure transmitter in circuit 2.
Min. pressure high pressure 2	### [Pa]	Bar	Pressure at Minimum output voltage from discharge pressure transmitter in circuit 2.
Max. voltage high pressure 2	###	V	Maximum output voltage from discharge pressure transmitter in circuit 2.
Max. pressure high pressure 2	### [Pa]	Bar	Pressure at Maximum output voltage from discharge pressure transmitter in circuit 2.

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	Value	Units	Comments
Freq. conv. compressor 1			Controller management of Compressor 1 Oil boost
	No		Compressor Oil boost is NOT managed by the Controller output voltage to Compressor 1.
	Yes		Compressor Oil boost is managed by the Controller output voltage to Compressor 1.
Min. Stop time	###	s	Time before compressors are allowed to restart.
Min. frequency	###	Hz	Minimum Compressor drive output frequency.
Max. Frequency	###	Hz	Maximum Compressor drive output frequency
Boost time	###	s	Duration of compressor operation at Oil boost speed.
Boost frequency	###	Hz	Compressor drive output frequency at Oil boost speed.
Under frequency 1	###	Hz	Low frequency detection level for Oil boost triggering.
Operating period 1	###	s	Low frequency detection duration triggering an Oil boost cycle
Under frequency 2	###	Hz	Very low frequency detection level for Oil boost triggering.
Operating period 2	###	s	Very low frequency detection duration triggering of an Oil boost cycle
Cooling	###	%	Override setpoint
Analogue cooling output	###	V	Output voltage to the compressor drive
Cooling relay 1			Compressor 1 status
	Disconnected		Compressor 1 stopped.
	Closed		Compressor 1 started.
Cooling relay 2			Compressor 2 status
	Disconnected		Compressor 2 stopped
	Closed		Compressor 2 started.
Cooling relay 3			Compressor 3 status
	Disconnected		Compressor 3 stopped
	Closed		Compressor 3 started.
Cooling relay 4			Compressor 4 status
	Disconnected		Compressor 4 stopped.
	Closed		Compressor 4 started.
Low pressure cooling circuit 1	###	Bar	Current suction pressure in circuit 1.
High pressure cooling circuit 1	###	Bar	Current discharge pressure in circuit 1.
Low pressure cooling circuit 2	###	Bar	Current suction pressure in circuit 2.
High pressure cooling circuit 2	###	Bar	Current discharge pressure in circuit 2.
Cooling error compr. 1			Compressor 1 status
	No		Compressor 1 OK
	Yes		Compressor 1 alarm. Check compressor overheating, Check the thermodynamic circuit. Check compressor drive.
Cooling error compr. 2			Compressor 2 status
	No		Compressor 2 OK
	Yes		Compressor 2 alarm. Check compressor overheating. Check the thermodynamic circuit. Check compressor drive.
Cooling error compr. 3			Compressor 3 status
	No		Compressor 3 OK
	Yes		Compressor 3 alarm. Check compressor overheating. Check the thermodynamic circuit. Check compressor drive.
Cooling error compr. 4			Compressor 4 status
	No		Compressor 4 OK
	Yes		Compressor 4 alarm. Check compressor overheating. Check the thermodynamic circuit. Check compressor drive.
Alarm triggered			DX cooler status.

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	Value	Units	Comments
	No		DX cooler OK
	Yes		DX cooler alarm. Check compressor overheating. Check the thermodynamic circuit. Check compressor drive.
Cooling time relay 1	###	s	Current compressor 1 operation time.
Cooling time relay 2	###	s	Current compressor 2 operation time.
Cooling time relay 3	###	s	Current compressor 3 operation time.
Cooling time relay 4	###	s	Current compressor 4 operation time.
Restarting relay 1	###		Current number of compressor 1 restarts the last 60 minutes.
Restarting relay 2	###		Current number of compressor 2 restarts the last 60 minutes.
Restarting relay 3	###		Current number of compressor 3 restarts the last 60 minutes.
Restarting relay 4	###		Current number of compressor 4 restarts the last 60 minutes.
Current stopping time, relay 1	###	s	Current remaining compressor 1 stop time.
Current stopping time, relay 2	###	s	Current remaining compressor 2 stop time.
Current stopping time, relay 3	###	s	Current remaining compressor 3 stop time.
Current stopping time, relay 4	###	s	Current remaining compressor 4 stop time.
DX Compressor relay 1 blocked due to low outdoor air temperature			Compressor 1 operating conditions
	No		Low outdoor temperature doesn't' stop compressor 1.
	Yes		Low outdoor temperature doesn't allow compressor 1 to start.
DX Compressor relay 2 blocked due to low outdoor air temperature			Compressor 2 operating conditions
	No		Low outdoor temperature doesn't' stop compressor 2.
	Yes		Low outdoor temperature doesn't allow compressor 2 to start.
DX Compressor relay 3 blocked due to low outdoor air temperature			Compressor 2 operating conditions
	No		Low outdoor temperature doesn't' stop compressor 3.
	Yes		Low outdoor temperature doesn't allow compressor 3 to start.
DX Compressor relay 4 blocked due to low outdoor air temperature			Compressor 3 operating conditions
	No		Low outdoor temperature doesn't' stop compressor 4.
	Yes		Low outdoor temperature doesn't allow compressor 4 to start.
Heat pump Oil/Defrost input active			External Heat pump status
	No		External Heat pump is in normal operation mode.
	Yes		External Heat pump is de-icing or running an Oil boost.
Analog cooling output sequential			Select one or two output voltages. Forced to No if "1st step modulating" is set to Yes.
	No		One output voltage to the compressor drive
	Yes		Two output voltages to the cooling units
Min. frequency	###	Hz	Minimum compressor drive output frequency.
Max. Frequency	###	Hz	Maximum Compressor drive output frequency
Boost time	###	s	Duration of compressor operation at Oil boost speed.
Remaining boost	##		Current remaining time during an active oil boost cycle.

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13.8.4 External DX cooling

	Value	Units	Short explanation
Regulation			Compressor control
	1 Step		Two sequential compressors
	2 Step		One small and one large compressor.
	3 Step		Two cooling circuits. Three sequential compressors.
	3 Step Bin		Two cooling circuits, Three compressors of different sizes.
	4 Step		Two cooling circuits. Each has two sequential compres-sors.
	15 Step Bin		Two cooling circuits. Each has one small and one large compressor.
Min. airflow	#####	m3/h	DX cooling can only be activated if the current air volume is above this setpoint.
1st step modulating			Compressor control
	No		Compressor 1 is On/Off controlled.
	Yes		Compressor 1 is speed controlled by a drive.
Min. cooling time	###	s	Minimum compressor operation time.
Max. restart per hour	###	/h	Maximum compressor restarts per hour. (Only active if Min. stop time is set to 0)
Min. Stop time	###	S	Time before compressors are allowed to restart.
Cooling	###	%	Override setpoint
Analogue cooling output	###	V	Output voltage to the compressor drive
Cooling relay 1			Compressor 1 status
	Disconnected		Compressor 1 stopped
	Closed		Compressor 1 started.
Cooling relay 2			Compressor 2 status
	Disconnected		Compressor 2 stopped
	Closed		Compressor 2 started.
Cooling relay 3			Compressor 3 status
	Disconnected		Compressor 3 stopped
	Closed		Compressor 3 started.
Cooling relay 4			Compressor 4 status
	Disconnected		Compressor 4 stopped
	Closed		Compressor 4 started.
Cooling error compr. 1			Compressor 1 status
	No		Compressor 1 OK
	Yes		Compressor 1 alarm. Check compressor overheating, Check the thermodynamic circuit. Check the compressor drive.
Cooling error compr. 2			Compressor 2 status
	No		Compressor 2 OK
	Yes		Compressor 2 alarm. Check compressor overheating. Check the thermodynamic circuit. Check the compressor drive.
Cooling error compr. 3			Compressor 3 status
	No		Compressor 3 OK
	Yes		Compressor 3 alarm. Check compressor overheating. Check the thermodynamic circuit. Check the compressor drive.
Cooling error compr. 4			Compressor 4 status
	No		Compressor 4 OK
	Yes		Compressor 4 alarm. Check compressor overheating. Check the thermodynamic circuit. Check the compressor drive.
Alarm triggered			DX cooler status.
	No		DX cooler OK
	Yes		DX cooler alarm. Check compressor overheating. Check the thermodynamic circuit. Check the compressor drive.
Cooling time relay 1	###	s	Current compressor 1 operation time.
Cooling time relay 2	###	s	Current compressor 2 operation time.

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	Value	Units	Short explanation
Cooling time relay 3	###	s	Current compressor 3 operation time.
Cooling time relay 4	###	s	Current compressor 4 operation time.
Restarting relay 1	###		Current number of compressor 1 restarts the last 60 minutes.
Restarting relay 2	###		Current number of compressor 2 restarts the last 60 minutes.
Restarting relay 3	###		Current number of compressor 3 restarts the last 60 minutes.
Restarting relay 4	###		Current number of compressor 4 restarts the last 60 minutes.
Current stopping time, relay 1	###	s	The current remaining compressor 1 stop time.
Current stopping time, relay 2	###	s	The current remaining compressor 2 stop time.
Current stopping time, relay 3	###	s	The current remaining compressor 3 stop time.
Current stopping time, relay 4	###	s	The current remaining compressor 4 stop time.
Heat pump Oil/Defrost input active			External Heat pump status
	No		External Heat pump is in normal operation mode.
	Yes		External Heat pump is de-icing or running an Oil boost.

13.9 Combi coils

The temperature control depends both on how advanced the AHU system is built, and on the heating/cooling power source.

13.9.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
Combi coil						
0-10V control		X		X	X	X

13.9.2 0-10V control

	Value	Units	Short explanation
Analog cooling output sequential			
	No		Analogue outputs control two external heat pumps in parallel.
	Yes		Analogue outputs control two external sequential heat pumps.
Pump operation			Circulator pump operating conditions
	Constant		The circulator pump is always On.
	Auto		The circulator pump starts when active heating or cooling is required.
	Outdoor air temp.		The circulator pump starts at high outdoor temperatures for cooling and at low outdoor temperatures for heating.
Pump start heating	###,#	°C	Outdoor temperature setpoint for start of circulator pump.
Pump start cooling	###,#	°C	Outdoor temperature setpoint for start of circulator pump.
Start-up heating	###,#	%	Valve setpoint during AHU start-up.
Standby heating	###,# [°C, F]	°C	Return water temperature setpoint keeping the combi coil and pipes heated during AHU stop. (frost protection)
Gain factor multi-purpose battery	### []		Default 100. See Appendix C - Control Sequence

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	Value	Units	Short explanation
Motor valve			Combi coil valve input voltage range.
	0-10 V		Start modulation from 0 volt.
	2-10 V		Start modulation from 2 volt.
Heating/cooling released via ext. Modbus			Combi coil operation control
	No		Heating/cooling release is not controlled by the BMS system.
	Yes		Heating/cooling release is controlled by the BMS system.
Cooling	###,#	%	Override setpoint
Heating	###,#	%	Override setpoint
Analogue cooling output	###,#	V	Current output voltage to the cooling valve/ external heat pump.
Analogue cooling output 2	###,#	V	Current output voltage to external heat pump 2.
Heating relay			External heat pump 1 status.
	Disconnected		External heat pump 1 stopped
	Closed		External heat pump 1 started for heating.
Cooling relay 1			External heat pump 1 status
	Disconnected		External heat pump 1 stopped
	Closed		External heat pump 1 started for cooling.
Cooling relay 2			External heat pump 2 status
	Disconnected		External heat pump 2 stopped
	Closed		External heat pump 2 started for cooling.
Combi-coil pump relay			Circulator pump status
	Disconnected		Circulator pump stopped
	Closed		Circulator pump started.
Water heating coil temp.	###,# [°C, F]	°C	Current Return water temperature.
Heat pump Oil/Defrost input active			External Heat pump status
	No		External Heat pump is in normal operation mode.
	Yes		External Heat pump is de-icing or running an Oil boost.
Frost protection heating	###,# [°C, F]	°C	Heating coil return water temperature setpoint for full frost protection (100% heating)
Frost alarm heating	###,# [°C, F]	°C	Return water temperatures below setpoint. Frost alarm triggered.
Frost alarm cooling	###,# [°C, F]	°C	Return water temperatures below setpoint. Frost alarm triggered.
Frost P-band	###,# [°C, F]	°C	Frost protection range = P-band + Frost protection set-point.

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13.10 Reversible Heat pump

The temperature control depends both on how advanced the AHU system is built, and on the de-icing strategy.

13.10.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
Reversible Heat pump		X	X	X	X	X
External DX coil		X		X	X	X

13.10.2 DX cooling & heat pump.

TBD

13.10.3 Extern DX cooling and heat pump

TBD

13.11 Humidifiers

TBD

- Control signals
- Humidifier types

13.12 Temperature sensors

13.12.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
PT-1000 and NTC						X
Modbus temperature sensors	X					

13.12.2 PT-1000 and NTC temperature sensors

Supplementary sensor 1, Supplementary sensor 2, Supplementary sensor 3 and Supplementary sensor 4.

Supplementary sensor 1	Value	Units	Explanation
Sensor designation	Supplementary sensor 1		Customized text label.
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction Supplementary sensor 1	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

13.12.3 Dewpoint temperature sensor

Dewpoint temperature	Value	Units	Explanation
Sensor designation	Dewpoint temperature		Current duct temperature after the cooling coil. The reading is used in the de-humidification control loop.
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction: Dewpoint temperature	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

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13.12.4 Water heating coil 1 inlet, Water heating coil 2 inlet, Combi coil inlet, Pre-heating coil inlet and Water cooling coil inlet

Water heating coil 1, inlet	Value	Units	Explanation
Sensor designation	Water heating coil 1		Current water coil inlet temperature
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction: Water heating coil 1, inlet	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

13.12.5 Water heating coil 1 return water, Water heating coil 2 return water, Combi coil return water, Preheater coil return water and Water cooling coil return water

Water heating coil 1, return water	Value	Units	Explanation
Sensor designation	Water heating coil 1		Current water coil return temperature. The reading is used in the frost protection control loop.
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction: Combi-coil/ heating, return water	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

13.12.6 Heater 1, Heater 2

Heat1 temperature	Value	Units	Explanation
Sensor designation	Heat1 temperature		Current duct temperature right after the heater.
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction: Heat2 temperature	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

13.12.7 Pre-heater coil

Pre-heating coil, air	Value	Units	Explanation
Sensor designation	Pre-heating coil		Current duct temperature right after the preheater. The reading is used in the Preheater control loop.
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction: Pre-heating coil, air	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

13.12.8 Heat pump

Heat pump, inlet	Value	Units	Explanation
Sensor designation	Heatpump		Current Exhaust duct temperature between heat recovery and the heating mode evaporator. The reading is used in the heat pump control loop.
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction: Heat pump, inlet	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

13.12.9 Outdoor air temperature (external sensor), Supply air temperature, Extract air temperature, Outdoor air temperature, Room temperature and Exhaust air temperature

Outdoor air temperature (external sensor)	Value	Units	Explanation
Sensor designation	Outdoor air (external sensor)		The reading is used in the temperature control loops.
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction: Outdoor air temperature (external sensor)	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

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13.12.10 Run around coil sensor

Run around coil sensor	Value	Units	Explanation
Sensor designation	Run around coil		Inlet temperature in the heating coil. The reading is used for heat recovery alarm.
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction: Run around coil temperature sensor	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

13.12.11 Heat recovery efficiency

Heat recovery efficiency temperature sensor	Value	Units	Explanation
Sensor designation	Heat recovery efficiency		Temperature in the supply air after the heat recovery. The reading is used for heat recovery efficiency alarm.
Current value	###,# [°C, F]	°C	Current temperature reading
Sensor correction: Heat recovery efficiency temperature sensor	###,# [°C, F]	°C	Calibration value for Temperature sensor reading

13.13 Pressure sensors

13.13.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
Pressure switch					X	
0-10V pressure sensors			X			
Modbus Pressure sensors	X					

13.13.2 Pressure switch

Filter outdoor air, Filter Supply air, Filter Extract air and Filter2 Extract air

Filter outdoor air	Value	Units	Explanation
Sensor designation	Filter outdoor air		
Alarm triggered			A pressure switch is used to monitor the filter.
	Ok		The filter is OK
	Alarm		The filter pressure drop is above the alarm level. Filter service is needed.

13.13.3 Modbus Pressure sensors

Filter outdoor air, Filter Supply air, Filter Extract air and Filter2 Extract air

Filter outdoor air	Value	Units	Explanation
Sensor designation	Filter outdoor air		
Current value	###,# [Pa]	Pa	Current pressure drop across filter
Zero calibration			Zero calibrate all Modbus pressure sensors.
	Manual		Manual start of Zero-calibration
	Auto		Zero calibration starts automatically when the Air Handling Unit is stopped.
Calibrate			Start a Zero-calibration.
Attempt calibration	##### [Min.]		Time delay before next zero-calibration attempt. An automatic zero-calibration is skipped if the pressure reading isn't stable.

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Filter outdoor air	Value	Units	Explanation
Latest calibration [DD/MM-YYYY]			Time stamp for latest zero-calibration.
	YYYY	Year	
	MM	Month	
	DD	Day	
		Minute	

13.13.4 Supply air duct and Extract duct

Supply air duct	Value	Units	Explanation
Sensor designation	Supply air		
Current value	###,#	Pa	Current pressure in ventilation duct.
Zero calibration			Zero-calibration of all Modbus pressure sensors.
	Manual		Manual start of zero calibration
	Auto		Zero calibration starts automatically when the Air Handling Unit is stopped.
Calibrate			Start a zero-calibration.
Attempt calibration	##### [Min.]		Time delay before next zero-calibration attempt. An automatic zero-calibration is skipped if the pressure reading isn't stable.
Latest calibration [DD/MM-YYYY]			Time stamp for latest zero-calibration.
	YYYY	Year	
	MM	Month	
	DD	Day	
		Minute	

13.13.5 Supply air fan, Supply air backup fan, Extract air fan and Extract air backup fan

Supply air fan	Value	Units	Explanation
Sensor designation	Fan pressure		
Current value	###,# [Pa]	Pa	Current pressure drop across fan inlet cone. The reading is used for air volume calculation.
Zero calibration			Zero-calibration of all Modbus pressure sensors.
	Manual		Manual start of zero-calibration
	Auto		Zero-calibration starts automatically when the Air Handling Unit is stopped.
Calibrate			Start a zero-calibration.
Attempt calibration	##### [Min.]		Time delay before next zero-calibration attempt. An automatic zero-calibration is skipped if the pressure reading isn't stable.
Latest calibration [DD/MM-YYYY]			Time stamp for latest zero-calibration.
	YYYY	Year	
	MM	Month	
	DD	Day	
		Minute	

13.13.6 Rotary heat exchanger (outdoor air/supply air)

Rot. heat exchanger (outdoor air/supply air)	Value	Units	Explanation
Sensor designation	Rotary heat exchanger		
Current value	###,#	Pa	Current pressure drop across the rotor heat exchanger. The reading is used for air volume calculation.
Zero calibration			Zero-calibration of all Modbus pressure sensors.
	Manual		Manual start of zero-calibration
	Auto		Zero-calibration starts automatically when the Air Handling Unit is stopped.
Calibrate			Start a zero-calibration.

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Rot. heat exchanger (outdoor air/supply air)	Value	Units	Explanation
Attempt calibration	##### [Min.]		Time delay before next zero-calibration attempt. An automatic zero-calibration is skipped if the pressure reading isn't stable.
Latest calibration [DD/MM-YYYY]			Time stamp for latest zero-calibration.
	YYYY	Year	
	MM	Month	
	DD	Day	
		Minute	

13.13.7 Rotary heat exchanger, de-icing (exhaust air/extract air) and Crossflow heat exchanger pressure

Rot. heat exchanger, de-icing (exhaust air/extract air)	Value	Units	Explanation
Sensor designation	Rotary heat exchanger		
Current value	###,#	Pa	Current pressure drop across rotor heat exchanger. The reading is used for ice detection.
Zero calibration			Zero-calibration of all Modbus pressure sensors.
	Manual		Manual start of zero-calibration
	Auto		Zero-calibration starts automatically when the Air Handling Unit is stopped.
Calibrate			Start a zero-calibration.
Attempt calibration	##### [Min.]		Time delay before next zero calibration attempt. An automatic Zero calibration is skipped if the pressure reading isn't stable.
Latest calibration [DD/MM-YYYY]			Time stamp for latest zero-calibration.
	YYYY	Year	
	MM	Month	
	DD	Day	
		Minute	

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13.14 Humidity sensors

13.14.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
Modbus Humidity sensors	X					

13.14.2 Supply air humidity sensor, Extact air humidity sensor, Exhaust air humidity sensor, Mixed air humidity sensor and Outdoor air humidity sensor

Supply air humidity sensor	Value	Units	Explanation
Sensor designation	Air humidity		Relative humidity in the duct.
Current value	###,# [%RH]	[%RH]	Current relative humidity

13.15 VOC sensors

13.15.1 Control signals

	Modbus RS485	Aout	Ain	Dout	Din	Tin
Modbus VOC sensors	X					

13.15.2 VOC Sensor, extract air and VOC Sensor, room

VOC Sensor, extract air	Value	Units	Explanation
Sensor designation	VOC		Volatile Organic Compounds in the air.
Current value	####	ppm	Current VOC level

13.16 Energy Meters

TBD

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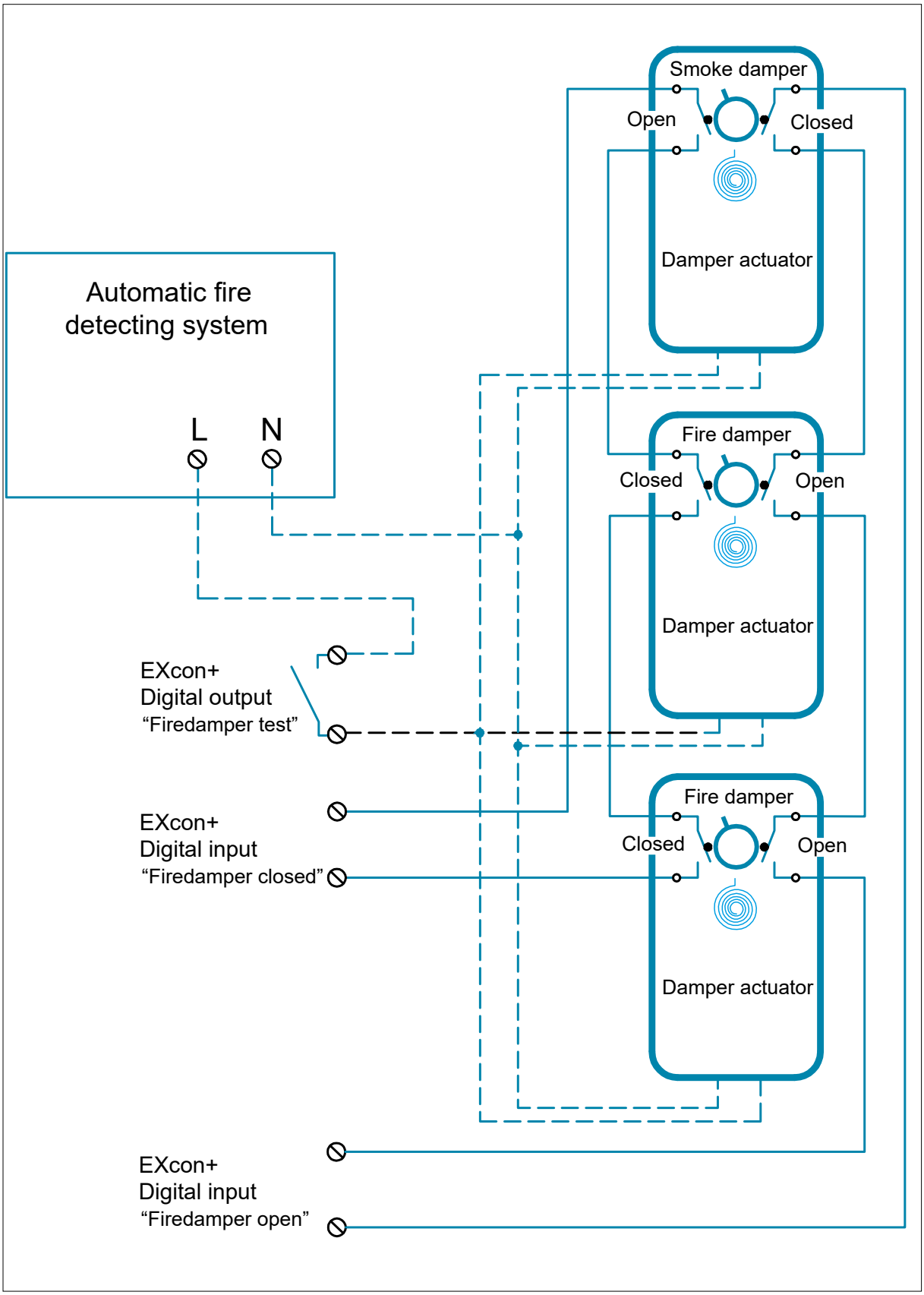
14. APPENDIX B – FIRE AND SMOKE DAMPER WIRING DIAGRAM



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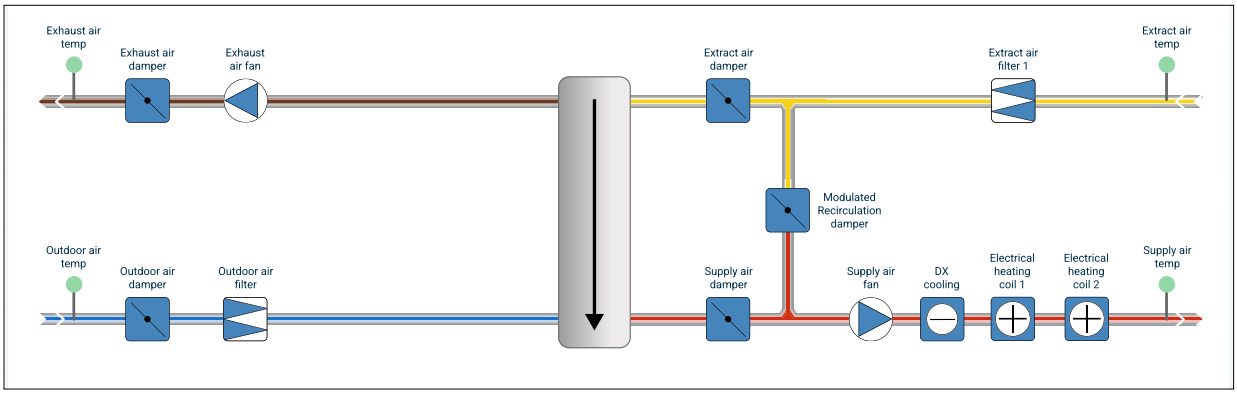
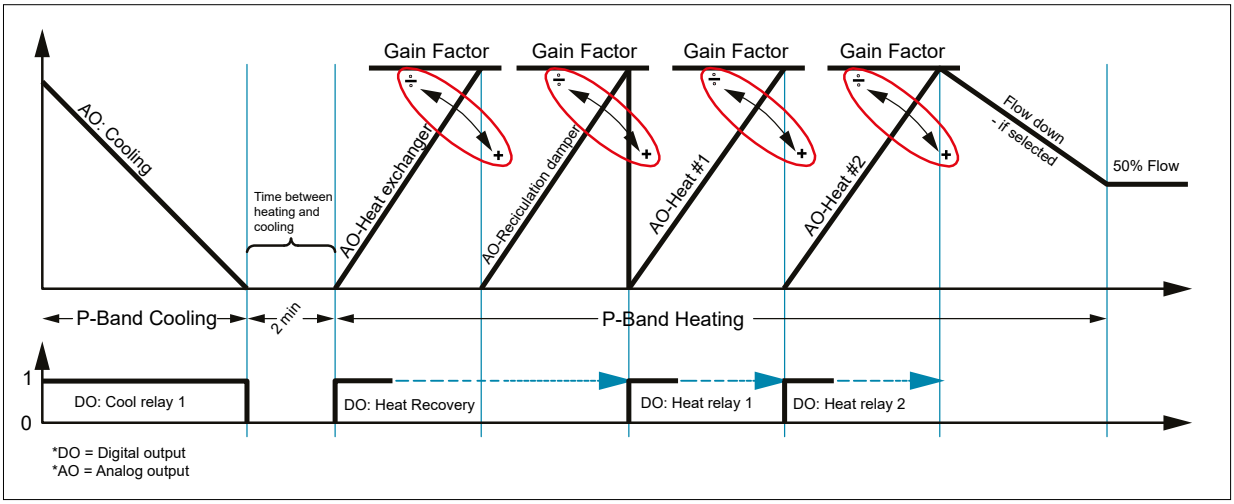
15. APPENDIX C – CONTROL SEQUENCE

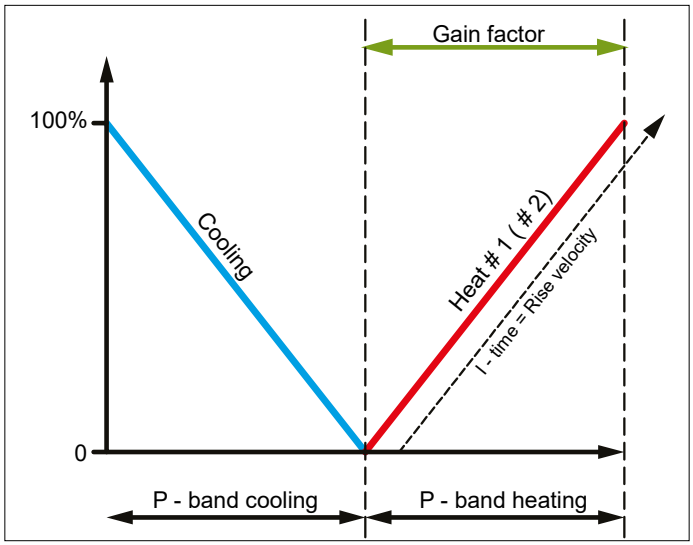
The temperature control sequence for a configuration like the one below, has one cooling stage and four heating stages.





The control sequence has a two-minute switching delay between heating and cooling mode.

The control sequence has separate P-bands for heating and cooling. Each stage has its own I-time and a Gain factor.



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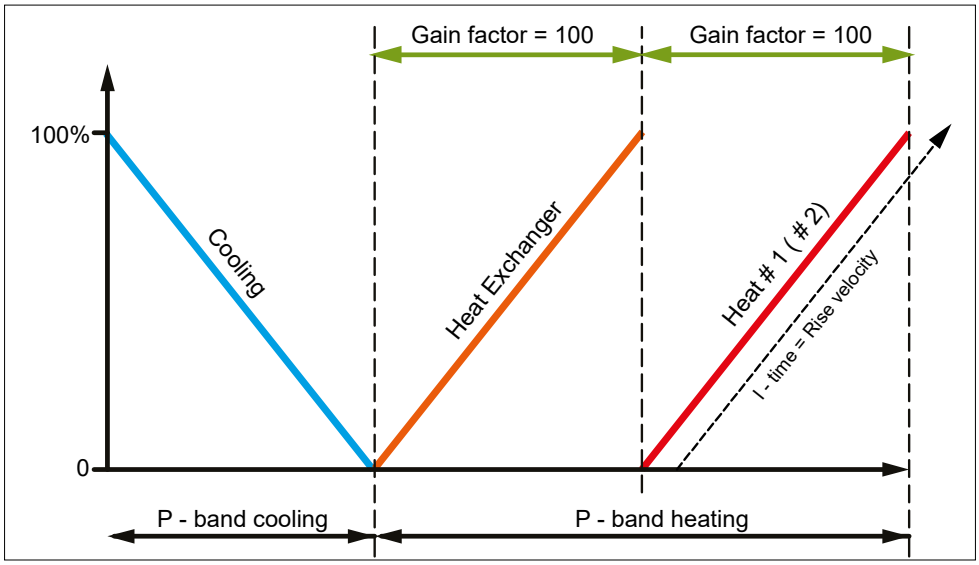
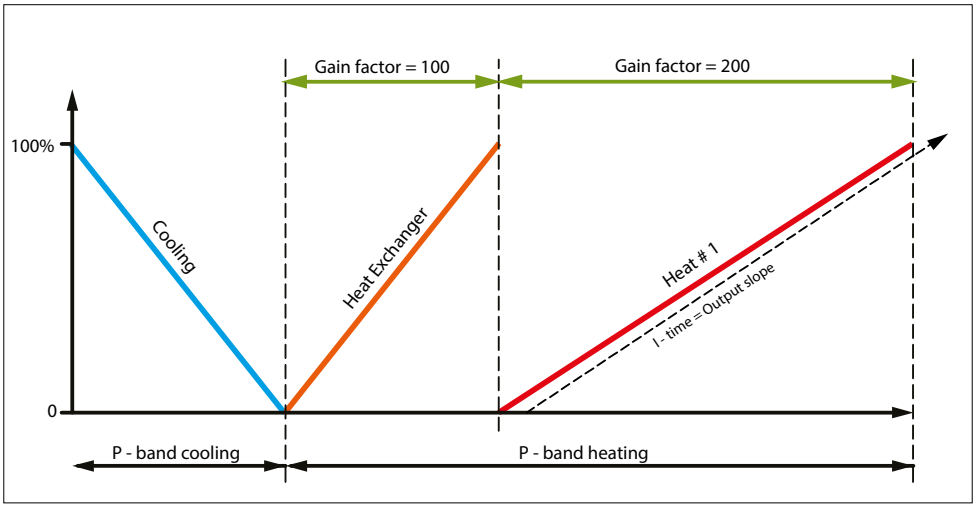
The control loop uses half of the error signal as a “here-and-now-reaction” (P-band) and the output slope is influenced by the integral signal (I-time).
The Gain factor can be used to even out the control loop response in case of large differences in the heating stage output power. An increased value takes more space in the P-band. A decreased value will take up less space. The gain factor has only effect if there are multiple heating stages. The default and normally used Gain factor value is 100.



In the example below, the Gain factor setting supports a two times higher heating power from Heat#1 than from the Heat exchanger.



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