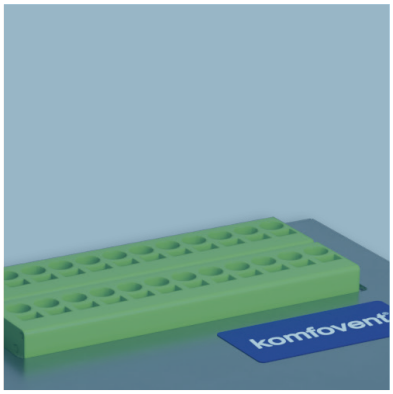
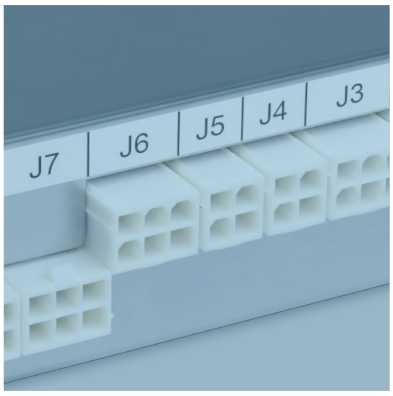
komfovent®



C5 Controller



FUNCTIONS DESCRIPTION

EN

EN

CONTENT

1. START-UP

AHU can be started by pressing ON/OFF button. Depending on what ventilation mode or functions are selected, after button was pressed, unit will start or will go into stand-by mode (for example if stand-by is programmed for the weekly schedule). If electrical power was interrupted during AHU operation, unit will automatically restart on the previous operation mode, when power is restored.

After AHU is started, air damper outputs are activated. On CF units at the same time by-pass damper is closed and heat-exchanger open.

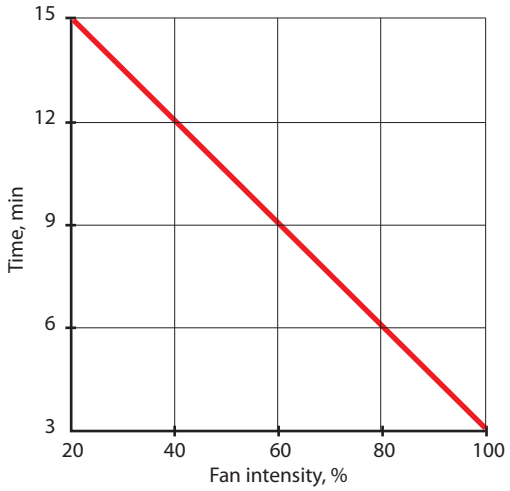
- On units with rotary heat exchanger after 45 s delay fans and rotary wheel are started.
- On units CF exchangers after 90 s delay fans are started.

2. ROTARY HEAT-EXCHANGER CONTROL

45 s after AHU is started rotary starts on max. speed (temperature conditions are ignored) and runs for 3–15 min. Duration depends on the requested airflow intensity.

After this time temperature conditions are checked and further rotary operation depends on the control type.

Initial recuperation time



2.1. Rotary exchangers with 0..10 V control

If outdoor (B3) and extract (B2) air temperature difference is more than 1°C, rotary wheel is started if one of the following conditions is true:

a. There is heating demand (supplied air temperature is lower than set-point) and it is possible to return heat (indoor temperature is higher than outdoor)
b. There is cooling demand (supplied air temperature is higher than set-point) and it is possible to return cold (indoor temperature is lower than outdoor).

When conditions are not met – exchanger is stopped with 90 s delay. If heaters/coolers are working, it is stopped at first, when demand disappears and exchanger is stopped after 3–15 min. delay according airflow (see above).

Exchanger rotation speed is regulated by PI law in the 6–100% range, according heating/cooling demand.

If hygroscopic rotary wheel is used, it does not stop completely, but slows down to minimum speed (6%), in order not to accumulate humidity, bacteria and odors. This function can be disabled in the "factory" level (*Configuration → Rotary heat exchanger*).

▼ROTARY HEAT EXCHANGER

Kp	200	
Ki	40	
Efficiency for forced defrost	60	%
Lowest efficiency allowed	20	%
Modbus control	☐	
Hygroscopic	☑	

2.1.1. Frost prevention

Frost prevention is controlled according heat-exchanger efficiency and is activated under following conditions:

- Rotary wheel runs on max. speed (control signal is 10V)
- Outdoor temperature (B3) <-5°C or exhaust temperature (B4 or B11) <2°C

Function monitors heat exchanger efficiency. If it is constantly decreasing (>3% in 30 min. period), defrost procedure starts. Defrost also will be started if efficiency drops below set limit (F*actory level → Configuration → Rotary heat exchanger → Efficiency for forced defrost*).

During defrost, rotation speed is decreased to 6%. Defrost is performed in four stages with different duration: 2 min., 5 min., 10 min. and 10 min. After each stage, in case if efficiency did not exceed critical limit, longer defrost stage is started after 15 min. delay. If after 3 defrost cycles, efficiency is still out of range, alarm 16A (Heat exchanger icing) is indicated.

Additionally, if the unit is off and any of the unit sensors detect air temperature <5°C, exchanger is started each 30 min. and runs on max. speed for 30 s.

2.2. ON/OFF type rotary exchangers

If outdoor (B3) and extract (B2) air temperature difference is more than 1°C, rotary wheel is started if one of the following conditions is true:

a. There is heating demand (supplied air temperature is lower than setpoint) and it is possible to return heat (indoor temperature is higher than outdoor)
b. There is cooling demand (supplied air temperature is higher than setpoint) and it is possible to return cold (indoor temperature is lower than outdoor).
c. Outdoor temperature (B3) is more than 10°C lower than supply setpoint (set or calculated).

When conditions are not met – exchanger is stopped with 90 s delay. If heaters/coolers are working, it is stopped at first, when demand disappears and exchanger is stopped after 3–15 min. delay according airflow (see above).

2.2.1. Frost prevention for ON/OFF type rotor heat exchanger

Function starts when outdoor temperature (B3) bellow -5°C or exhaust temperature (B4 or B11 depending on AHU model) bellow 2°C. Function monitors differences in recuperation efficiency. If efficiency is constantly dropping (decreased >3% in a period of 30 min.), defrosting procedure starts. Also forced defrost can be started earlier if efficiency drops below critical limit (Factory->Configuration->Rotor heat exchanger->Efficiency for forced defrost). During defrost rotor is fully stopped, thus warm air from the premises is warming up the rotary wheel. Defrost is performed in four cycles with different duration: 2 min, 5 min, 10 min and 10 min. After each defrost cycle, efficiency is checked and in case if it is still not OK, longer defrost cycle starts after 15 min. If efficiency does not improve enough after all defrost cycles, AHU is stopped and alarm message 16A (Heat exchanger icing) is generated.

2.3. Clean up function

If rotary heat exchanger is stopped for longer than 4 hours during unit operation, it will be started for 1 min. on max. speed, to blow out possible dust build-up.

2.4. Rotory heat-exchanger low efficiency indication (from C5 firmware version 2.250)

On the units with rotary heat exchanger, that has C5 firmware version 2.250 or later, forced defrost algorithm is disabled. Instead of parameter "Efficiency for forced defrost" (Factory level → Configuration → Rotary heat exchanger → Efficiency for forced defrost), it is changed to parameter "Low efficiency warning". In cases if outdoor temperature (B3) is below -5°C and exchanger efficiency falls below low efficiency setting, warning message „Low heat exchanger efficiency" will be generated after 5 min. delay. AHU operation is not stopped.

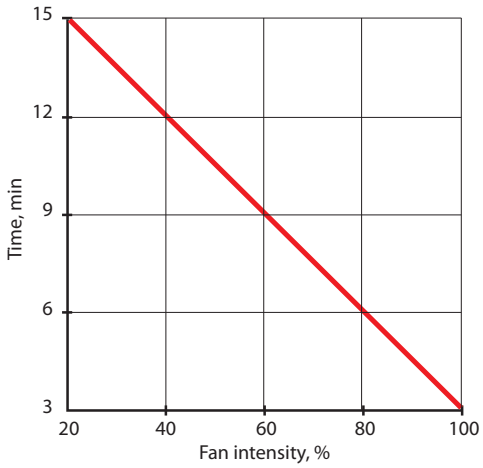
3. LIQUID COUPLED (RUN-AROUND) HEAT EXCHANGER CONTROL

Liquid coupled heat exchanger is controlled by regulating mixing valve (0..10 V signal) and starting/stopping circulation pump. Conditions and algorithm of the control is the same as rotary exchanger with 0..10 V speed regulation.

4. PLATE OR COUNTER FLOW (CF) HEAT EXCHANGER RECUPERATION CONTROL

Recuperation on units with plate and CF heat exchangers is controlled by modulating (0..10 V signal) by-pass damper, which at the same time opens/closes the exchanger by the same amount. By-pass damper is open when there is no need for recuperation, so all air from outside is redirected around the exchanger and supplied in to the premises. When unit is off, by-pass is fully open and exchanger fully closed. When unit is started, signal for the by-pass damper to close is provided and fans is started with 90 s delay, when exchanger is fully open. Despite temperature conditions, full recuperation is performed for 3–15 min. Duration depends on the requested airflow intensity.

Initial recuperation time



After this time temperature difference between outdoor (B3) and extract (B2) air is checked. If it is more than 1°C, recuperation is started if one of the following conditions is true:

a. There is heating demand (supplied air temperature is lower than setpoint) and it is possible to return heat (indoor temperature is higher than outdoor)
b. There is cooling demand (supplied air temperature is higher than setpoint) and it is possible to return cold (indoor temperature is lower than outdoor).

When conditions are not met – after 90 s delay by-pass damper opens and exchanger closes.

Recuperation is controlled by modulating by-pass damper according PI law in the range of 0–100%, where 100% mean full recuperations and fully closed by-pass damper. If heaters/coolers are working, it is stopped at first, when demand disappears and recuperation is stopped after 3–15 min. delay according airflow (see above).

5. FROST PROTECTION OF PLATE AND CF HEAT EXCHANGERS

Frost protection function activates when outdoor temperature (B3) drops below 0°C. At this moment pressure drop over exchanger is monitored:

- VERSO Standard uses pressure sensor (B13) with 0..10 V output.
- VERSO PRO uses pressure sensors integrated to the C5 controller board.

Measured real pressure P_r is compared with a theoretical pressure P_t curve (tested in the laboratory, for each AHU model). When $P_r > 1{,}7 \times P_t$ defrost procedure starts after 60 s delay. During defrost, by-pass damper opens and exchanger is fully closed, thus all cold outdoor air goes directly in to the heaters and warm, extracted air defrosts recuperator. Defrost is performed until P_r decreases and stabilizes (minimum 150 s, maximum 30 min.). Defrost is confirmed as successful, if $P_r < P_t + 30\%$. If defrost was not successful – it is restarted after 10 min. After 3 consecutive unsuccessful tries an alarm 16A (Heat exchanger icing) is generated and AHU stops. In case if after defrost P_r is smaller than theoretical pressure it is memorized and will be used as new P_t in the future.

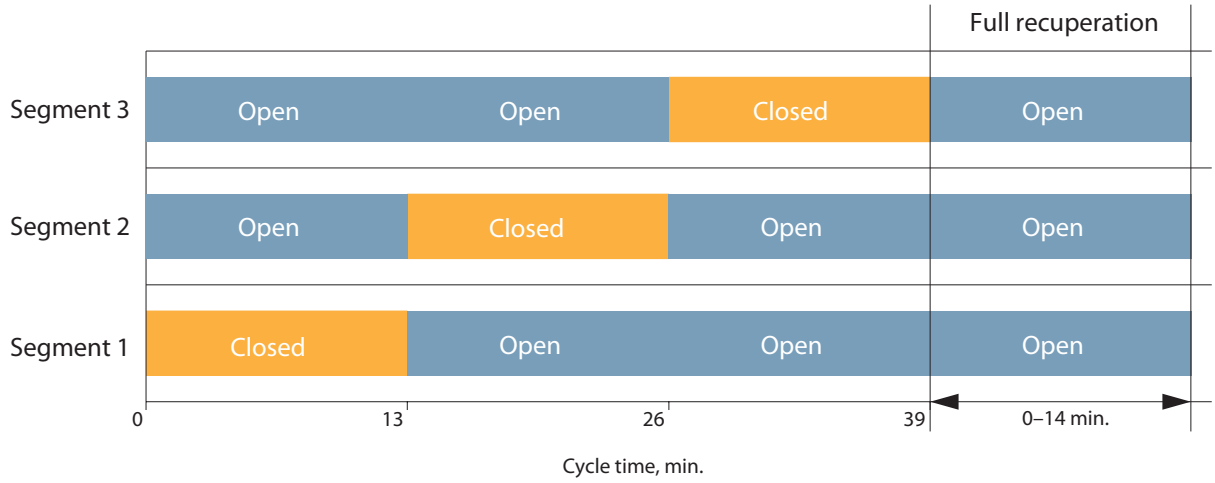
5.1. Frost prevention with 3+1 multi damper system (optional)

For frost prevention, besides standard cold air by-pass algorithm (described above), additionally can be ordered 3+1 multi-level frost prevention option (only for VERSO PRO units). It consists of:

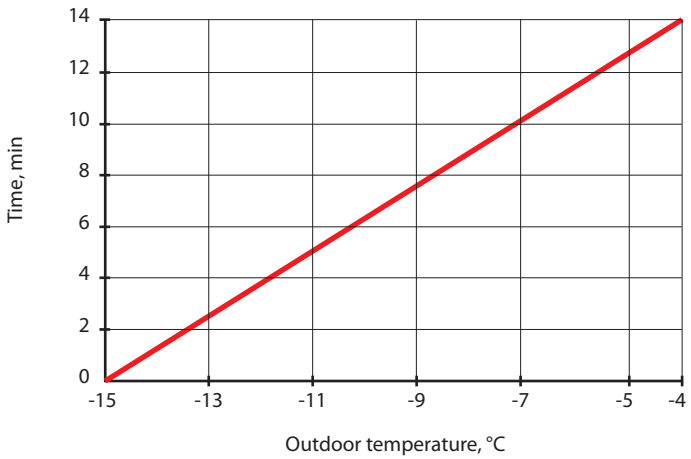
- Three defrost damper segments
- By-pass damper
- Four damper actuators

Frost prevention function starts when outdoor temperature falls below -4°C. By-pass damper is constantly closed, so all airflow is let through the segmented dampers. Consecutively each damper segment is closed. Each segment keeps closed for 13 min., while two others are open. After all segments has closed and opened, all air is let through the exchanger for full recuperation. Duration of full recuperation depends on outdoor temperature, thus whole frost preventive cycle is between 39 and 53 minutes. At the end of the cycle, outdoor temperature condition is checked (hysteresis ±1°C) and if needed process is restarted. When outdoor temperature drops below -15°C, full recuperation is not done and segments closing/opening intervals are the same as before.

Closing sequence of damper segments



Duration of full recuperation



5.2. Frost protection without pressure drop monitoring (old type discontinued AHU's)

If AHU do not have pressure sensors for monitoring pressure drop over heat exchanger, frost protection is done according recuperator efficiency. Function starts under following conditions:

- Maximum recuperation (control signal 10 V, by-pass fully closed).
- Outdoor temperature (B3) bellow -5°C or exhaust temperature (B4 or B11 depending on AHU model) bellow 2°C.

Function monitors differences in recuperation efficiency. If efficiency is constantly dropping (decreased >3% in a period of 30 min.), defrosting procedure starts. Also forced defrost can be started earlier if efficiency drops below critical limit (*Factory → Configuration → Plate heat exchanger → Efficiency for forced defrost*). During defrost, by-pass damper opens and exchanger is fully closed, thus all cold outdoor air goes directly in to the heaters and warm, extracted air defrosts recuperator. Defrost is performed in four cycles with different duration: 10 min., 15 min., 30 min. and 30 min. After each defrost cycle, efficiency is checked and in case if it is still not OK, longer defrost cycle starts after 15 min. If efficiency does not improve enough after all defrost cycles, AHU is stopped and alarm message 16A (Heat exchanger icing) is generated.

5.3. CF heat exchanger pressure calibration (C5 firmware version 2.330 or later)

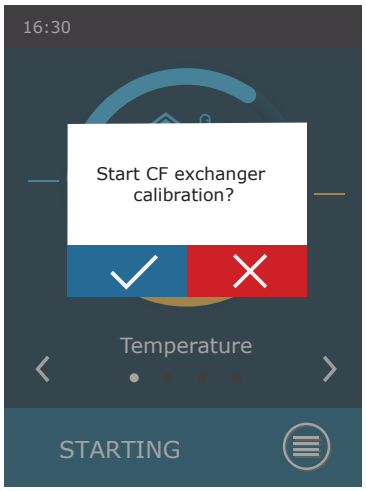
On AHU's that already has CF exchanger pressure curve coefficients set (manufactured before 2020 June), defrost is done according theoretical curves. If defrost issues are experienced, it is possible to calibrate more precise pressure curves by performing CF pressure calibration. This can be done on any AHU with CF type heat exchanger and running C5 firmware version 2.330 or later. On AHU's manufactured from 2020 June, CF pressure calibration is mandatory and will be prompted during first start-up.

Regardless if precise calibration was performed or theoretical pressure curves are set, defrost function work the same way as described in paragraph 5.

On AHU's that runs without CAV regulation (k factor = 0), CF exchanger calibration function is not available.

5.3.1. Calibration start

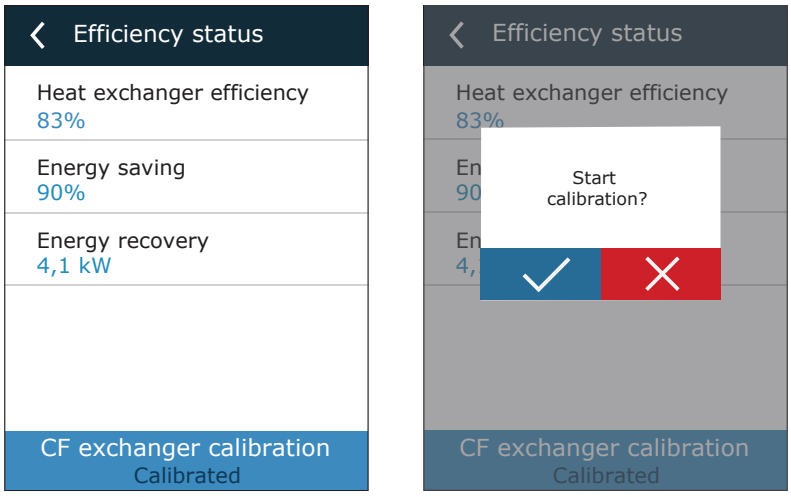
During start-up, CF calibration pop-up message will appear (control panel with latest firmware is needed[1]) prompting to run calibration, which can be accepted or rejected.



If calibration is canceled during start-up, CF pressure will be treated as not calibrated and 113B or 114B message will be shown in alarms. If calibration was not performed during start-up, it can be started:

- During another start of AHU
- After deleting of 113B or 114B message
- Manually from "Efficiency" window

[1] If control panel with incompatible firmware is used, pop up window will not be shown and calibration can be started only via PC.



▼EFFICIENCY STATUS

Heat exchanger thermal efficiency		---
Heat exchanger recovery		8.6 W
Thermal energy saving		100 %
CF exchanger calibration	Calibrated	Run

When started, calibration can be canceled at any time by stopping the AHU.

5.3.2. Calibration algorithm and conditions

During calibration, actual pressure drop over exchanger is measured:
- VERSO Standard uses pressure sensor (B13) with 0..10 V output.
- VERSO PRO/ PRO2 uses pressure sensors integrated to the C5 controller board.

Pressure is measured for 3 minutes under three different airflows (total calibration time ~9 minutes). Clean exchanger pressure (P_t) curve is generated based on three pressure points:
- 1st point: Airflow set to 20% of the designed maximum airflow of AHU
- 2nd point: Average airflow value, between user set maximum and 20% of AHU maximum.
- 3rd point: Maximum airflow set by the user in ventilation modes (by default Comfort1)

Conditions for successful calibration:
- Pressure difference between measured points must be >10Pa
- Pressure at 1st point must be > 0Pa
- Pressure must increase when increasing airflow 1st Pa < 2nd Pa < 3rd Pa
- If during 3rd point calibration airflow cannot be reached, pressure will be measured under the maximum airflow that was reached during calibration.

During calibration:
- AQC, REC, MTC, DCV, OCV, SNC, Weekly schedule functions are blocked.
- Airflow will not change if adjusting ventilation modes, or using OVR.
- Emergency protections operates as usual, critical alarms will stop the AHU and cancel calibration.
- Triggering External stop, Fire alarm, OVR (Stand-by) cancel calibration
- VAV mode runs as normal, however it is not recommended, since pressure changes in the duct system during calibration, will affect fan speed.

5.3.3. Automatic calibration in case of frost possibility

If CF exchanger calibration was canceled, not performed or failed and there are no default theoretical pressure coefficients set, CF frost protection cannot operate normally. Thus if during AHU operation any temperature sensor detects air temperature of < 0°C, CF exchanger calibration will start automatically and will be performed the same way as described in 5.3.2.

If automatic calibration fails, it will restart automatically without a delay. Three consecutive unsuccessful automatic calibrations will stop AHU operation and generate 46A alarm. Same alarm also will be generated if automatic calibration is canceled (for example by stopping AHU).

Further operation of AHU is possible, only when successful calibration is performed, or outdoor temperature becomes positive.

6. HEAT EXCHANGER EFFICIENCY CALCULATION

Heat exchanger efficiency is calculated according measurements from air temperature sensors:

VERSO Standard CF
$\eta\%=100x(B15-B3)/(B2-B3)$

VERSO Standard R
$\eta\%=100x(B2-B4)/(B2-B3)$

VERSO PRO
$\eta\%=100x(B14-B3)/(B2-B3)$

RHP Standard
$\eta\%=100x(B15-B3)/(B2-B3)$

RHP PRO
$\eta\%=100x(B2-B11)/(B2-B3)$

Efficiency calculation starts after 3 min. of continuous heat exchanger operation, when temperatures are stabilized.

If efficiency drops below critical limit of 20% (Can be changed in *Factory → Lowest efficiency allowed*) AHU is stopped after 5 min. delay and 15A alarm (Heat exchanger failure) generated. Alarm will not be generated if:

- Temperature difference between outdoor and room air (B2 and B3) less than 4 degrees.
- Recuperation request less than 100% (control signal 10V).

7. AIRFLOW CONTROL

Airflow control mode can be selected on the control panel or web server (*User* and *Service* levels).

7.1. CAV (Constant air volume)

Constant air volume is maintained by measuring static pressure difference ΔP before the fan and on the fan inlet ring. ΔP is measured by pressure sensors on the C5 board (VERSO Standard and RHP Standard units) or on the VM extension module board (VERSO PRO and RHP PRO units). Each type of the fan inlet ring has a main characteristic – *k* factor specified by fan manufacturer. Actual airflow is calculated according to the formula:

$$Q\ [m^3/h] = k\sqrt{\Delta P}$$

Airflow is maintained by regulating fan intensity. When system resistance changes (for example dirty filters), fan signal is adjusted to keep the exact airflow selected by user. Desired airflow can be set separately for supply and for extract airflows. Measuring units can be selected from: m^3/h, m^3/s, l/s.

If airflow measured by controller do not match actual measurements in the duct system (measurements must be done by qualified engineer using certified measurement equipment), it can be corrected automatically within ±15% range. (*Service → Alarm/Status → CAV Status*):

▼CAV STATUS

Supply flow calibration	Factory
Actual supply flow	1330 m³/h
Measured supply flow	
Extract flow calibration	Factory
Actual extract flow	1330 m³/h
Measured extract flow	
Reset factory defaults	Reset

CAV airflow measurement can be disabled (only for custom projects), by changing k factor to 0 (*Factory → Configuration → Fan settings*).

In this case requested and actual airflow will be approximate. Fan intensity control signal will be directly related to selected airflow, where 10 V is equal to maximum airflow of the AHU and 2V is equal to 20% intensity.

7.2. VAV (Variable air volume)

In VAV mode, duct pressure has priority over actual airflow maintenance. Constant duct pressure is maintained by regulating fan speed. Pressure is measured by duct mounted pressure sensors (ordered separately). One or two duct sensors can be used. If only one sensor is used, it will be mounted in the supply or extract duct, where constant pressure will be maintained. Another airflow will be regulated in parallel (Master/Slave configuration). If both ducts has separate dedicated VAV sensors, duct pressure will be maintained independently for both flows.

Since desired pressure in the ducts can be set not directly, but making a conversion from requested airflow, VAV calibration must be performed, before enabling VAV function.

Before calibration:

- Pressure sensors must be mounted in the ducts (one or two can be used)
- VAV dampers in the premises should be open in their operating position and in all the rooms it could be supplied maximum airflow that will be needed during VAV operation.
- AHU should be operating in any ventilation mode with CAV airflow control.
- VAV pressure sensor range must be specified in the software (Service → Modes → Flow control mode). Pressure value that is equal to 10 V sensor signal must be entered (Sensor measuring range is set by DIP-switches or jumpers on the sensor).

▼FLOW CONTROL MODE

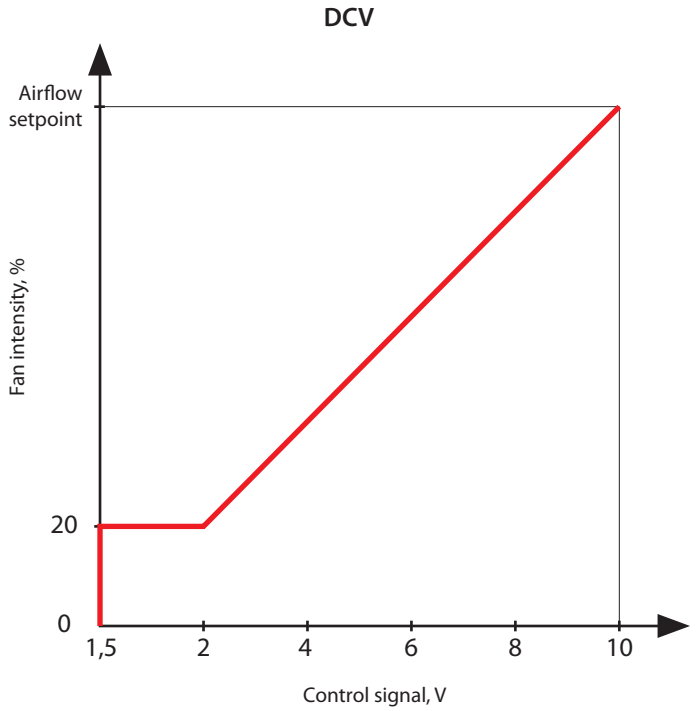
Mode	CAV	
VAV sensor range	500	Pa
Supply VAV sensor		Pa
Extract VAV sensor		Pa

Calibration is started from the control panel or computer. During the calibration, AHU automatically switch to its maximum designed intensity and waits until airflow is reached (within +/- 5% range). After 60 s signal from VAV pressure sensors is measured and nominal duct pressure is calculated [Pa]. Pressure values for supply and extract are filled in to the software automatically. This pressure is assigned to the maximum airflow setting, thus whenever the different airflow is requested, it will be recalculated to the pressure which will be maintained in the ducts. After VAV calibration it is also possible to select measuring units as [Pa]. In that case during VAV operation in the ventilation modes it will be possible to set duct pressure directly instead of conversion from the airflow. More about VAV function and its settings read in the "VAV installation manual".

VAV function has priority over AQC function.

7.3. DCV (Directly controlled volume)

If this control mode is selected, AHU will operate in CAV, but additionally it will be possible to correct the fan intensity by external 0..10 V signal (for example from potentiometer). 10 V will be equal to the selected airflow, and 2 V to the minimum airflow (20% of the designed maximum flow). Signal for the fan speed correction to be connected to the B6 and B7 terminals on the C5 board. Both fans can be controlled independently, by supplying different voltage. If control voltage is <1,5V, corresponding fan will be stopped.



8. TEMPERATURE CONTROL

Temperature is maintained according PI regulation. If there is conditiona to recover heat or cold from the premises at first heat exchanger will be activated. If it is not enough to reach the setpoint – additional heating/cooling devices are started. Following temperature control modes can be selected:

- **Supply** – supplied air temperature is maintained according readings from B1 sensor (+5..40°C range). B1 sensor to be mounted after all heating/cooling devices in the supply duct.
- **Extract** – setpoint of the desired extracted air temperature (+5..40°C range) is compared with actual extracted temperature measured by B2 sensor inside of the AHU. From the temperature difference according PI regulation it is calculated what temperature air should be supplied. Additionally supply air temperature will be limited by temperature difference parameters (Service → Modes → Temperature control mode).

▼TEMPERATURE CONTROL MODE

Mode	Extract	
Max supply/indoor temp. diff. when cooling	8.0	°C
Max supply/indoor temp. diff. when heating	4.0	°C

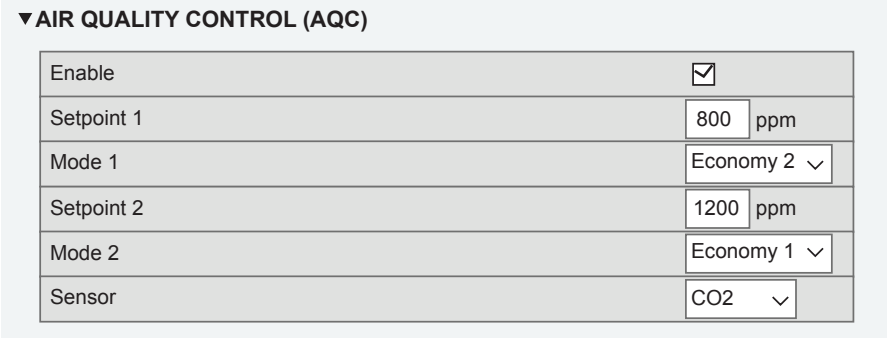
- **Room** – mode operates the same way as extract temperature control, but for the room temperature measurement it is used room mounted 0..10 V temperature sensor (0..50°C temperature range). Temperature sensors to be connected to the B8 terminals on the C5 board. This temperature control mode is blocked when following functions are enabled: AQC, ODD and REC according AQC.
- **Balance** – the same temperature air which was extracted (measured by B2), will be supplied (measured by B1). Function can be used to avoid conflicts between building heating and ventilation systems.

9. FUNCTIONS

9.1. Air quality control (AQC)

Air quality function is for fan intensity regulation, depending on the air quality inside of the ventilated premises. For function operation sensor must be connected to the B8 terminals on C5 board. In the software sensor type must be specified:

- CO2 – carbon dioxide (default setting), range [0...2000ppm];
- VOCq – volatile organic compound sensor [0...100%], where maximum signal corresponds to best air quality;
- VOCp – volatile organic compound sensor [0...100%], where maximum signal corresponds to worst air quality;
- RH – relative humidity sensor, range [0...100%RH];
- TMP – temperature sensor, range [0...50°C];



In the function settings it is possible to set two different setpoints for two different operation modes, so setpoint will be automatically changed in case when mode changes (for example according weekly schedule). When AHU operates in any ventilation mode, which is not selected in the AQC settings, function will not start. It is recommended to select ventilation modes with low airflow (Economy1 or Economy2), so intensity will be low in case when air quality is OK. If B8 sensor readings will exceed user setpoint, fan intensity will be constantly increasing (PI regulation), until actual air quality level will stop or will start decreasing. If air quality will not improve over time, maximum designed airflow will be reached. If air quality is improving – fan intensity is also decreasing until it comes back to initial ventilation mode at a time, when air quality level drops bellow setpoint.

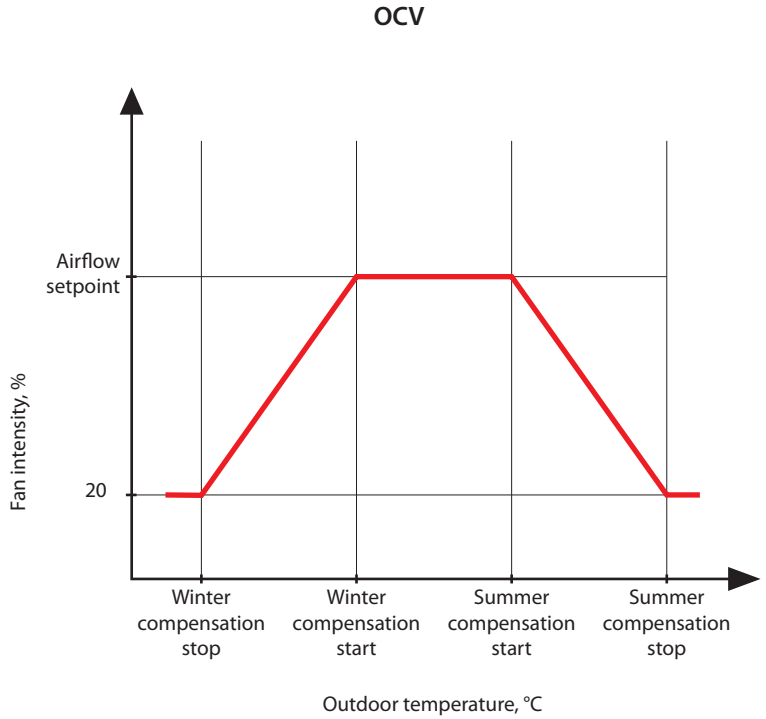
During function operation, it is constantly checked (in 30 min. intervals) that faster fan speed is actually improving air quality. If air quality is getting worse after speed was increased, AQC function is terminated for 30 min. (only if VOC, or RH sensor is used).

AQC is blocked if any of the following functions is active: SNC, MTC, REC, OCV, HUM Indoor or HUM Indoor+Supply.

9.2. Outdoor compensated ventilation (OCV)

Function corrects ventilation intensity according actual outdoor temperature, so less heating/cooling power will be needed in the extreme temperatures.

Four temperatures can be set – two for summer and two for winter conditions. In between those temperatures AHU will operate on the selected airflow. Airflow will be decreased proportionally when outdoor temperature will be high (summer compensation) or low (winter compensation):



▼OUTDOOR COMPENSATED VENTILATION (OCV)

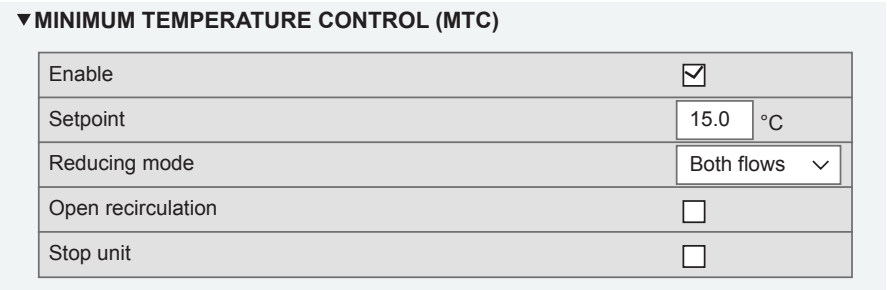
Enable	☑	
Winter compensation stop	-20.0	°C
Winter compensation start	0.0	°C
Summer compensation start	20.0	°C
Summer compensation stop	40.0	°C

OCV is blocked if at the same time SNC or REC functions are active.
OCV has priority over AQC.

9.3. Minimum temperature control (MTC)

Function slows down ventilation speed, when heating capacity is too low to reach certain temperature (+15°C by default). When outdoor temperature (B3) drops below +5°C and signal for heaters and heat exchanger reached 100%, but minimum temperature cannot be achieved, MTC function starts with 5 min. delay. According to the settings only supply or both flows are reduced gradually (5% each 5 min.). Airflow will be reduced to minimum 20%. On RHP units airflow will be reduced to minimum airflow limit which allows heat-pump to start.

It is possible to set that unit can be stopped, if minimum temperature is not reached. In the units with recirculation section, it can be used to warm up the supplied air.



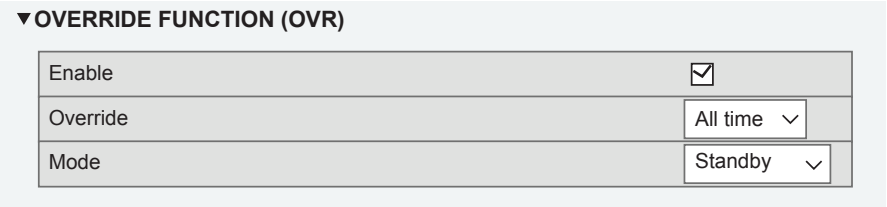
When outdoor temperature (B3) is above +5°C, MTC function does not reduce airflow, but limits cooling signal instead. Thus in case of high cooling demand, cooling signal will be reduced or switched off completely if supply air temperature is bellow MTC setpoint. In that way, too cold air will not be supplied.

If dehumidification with integrated heaters/coolers are used, MTC function will be limiting supply temperature by reducing cooling signal, in cases when heater (operating on >95% capacity), cannot reheat the air to MTC setpoint.

MTC has priority over AQC, OCV and VAV functions.

9.4. Override (OVR)

AHU can be controlled by external "dry" contact, which start OVR function when closed. It has dedicated connection terminals on the C5 board. It can be connected any device with open/close contact: thermostat, hydrostat, motion detector or etc. OVR function has highest priority and ignores current user settings. OVR settings allows to choose when the contact will be active (during other time it will not start OVR) and what ventilation mode will be started when contact is closed. Selecting "Standby" will stop the unit operation:



OVR can be activated also when unit is stopped. Function is active until contact is closed. When opening contact – AHU returns to previous ventilation mode.

9.5. Summer night cooling (SNC)

The summer night cooling function is focused on the energy saving during summer: using cool outside air at night, it is possible to cool down the hot premises, i.e., to remove the excess heat accumulated in the premises during the day. During the function operation the current ventilation rate is set to the maximum ventilation intensity (100%) and cooling is achieved by supplying outside air without recuperation or additional heating/cooling.

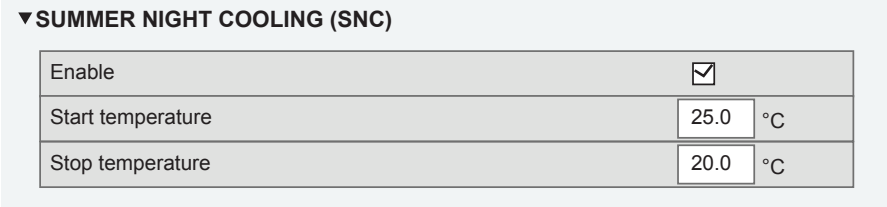
The summer night cooling function can start at night (from 00:00h to 06:00h a.m.) at any time, when below conditions is fulfilled:

- $12°C < T_{outdoor} < T_{extract} – 2,5°C$
- $T_{extract} > T_{start}$

The function stops and the AHU returns to the previous operating mode, if one of following is true:

- $T_{extract} < T_{stop}$;
- $T_{outdoor} < 12°C$;
- $T_{outdoor} > T_{extract} - 2,5°C$;
- It is 06:00 a.m. or later;
- OVR function has been activated;

Temperatures T_{start} and T_{stop} can be defined by the user.



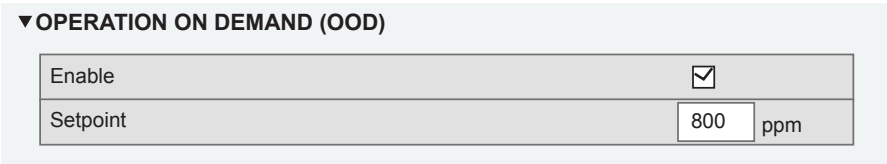
The function can also start, when AHU is stopped at night. At 0:00 and at 03:00 a.m. AHU will start for 3 min. to check all conditions needed for SNC function. This is done only if:

- During operation of the unit the day before, maximum outdoor temperature was not less than 15°C;
- Room temperature control mode with external sensor is used and $T_{room} > T_{start}$.

During SNC function operation, following functions is blocked: AQC, OCV, REC.

9.6. Operation on demand (OOD)

Function starts the AHU when it is stopped, if air quality in the premises is above set value. Air quality will be measured by room mounted sensor providing 0..10 V signal. Sensor to be connected to B8 terminals on C5 board. Sensor type is the same as specified in AQC function settings.

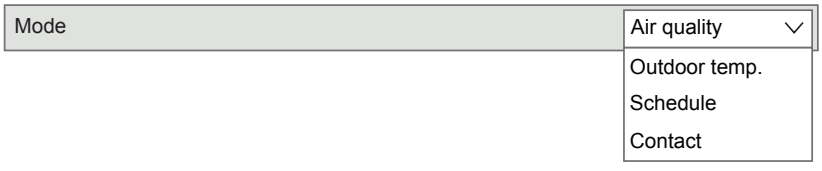


When air quality exceeds setpoint, AHU will be started on the user selected ventilation mode (last mode, the unit was operating on)

OOD function will switch off, when air quality will fall 10% below setpoint. Minimum operation time of OOD function is 30 min.

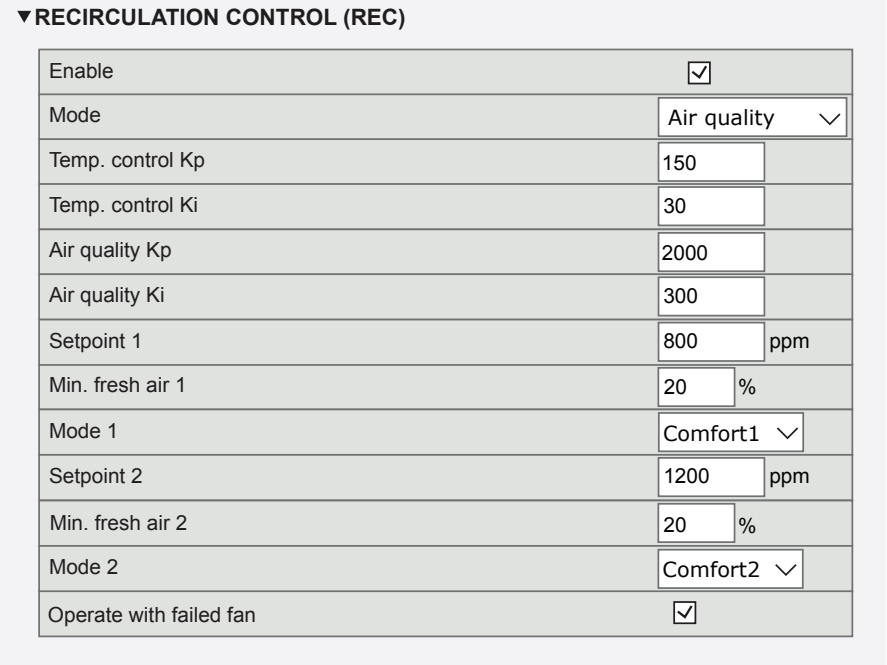
9.7. Recirculation control (REC)

This function is only available on the units with additional recirculation section. Function can open recirculation damper, thus all or part of the extracted air will be returned back to the premises. Recirculation can be controlled in four different ways (configured in Service → Functions → Recirculation control):



9.7.1. REC according air quality

Depending on the pre-determined sensor type (same as used in the AQC function), the user defines the air quality set-point, based on which the recirculation rate will be calculated. It is possible to set two different setpoints for two different operation modes. When air quality is OK (level is bellow setpoint), extracted air is recirculated. When air quality is getting worse – recirculation damper starts closing and more fresh air is supplied, to keep the air quality level below setpoint. User can also determine the minimum fresh air value (%) to avoid full recirculation in case of good indoor air quality. Possible values for minimum fresh air are: 0%, 20..90%, 100%.



During recirculation, extract air fan becomes isolated, because all the recirculated air is going through the supply fan (when fans are on the different sides of the recirculation section). Since extract fan cannot run less than 20% of the designed unit airflow, it can be situations when recirculation function will increase the fresh air intake and reduce recirculated air to ensure extract fan operation. This may happen when desired air volume is low and required fresh air percentage will provide less air than 20% of the unit maximum flow.

Since temperature has higher priority than REC function, calculated or user defined recirculation level may be corrected according to heating/cooling demand, ignoring actual air quality level. For example if recirculated extract air will increase supply air temperature above setpoint, recirculation will be limited or not used and more cool fresh air will be supplied.

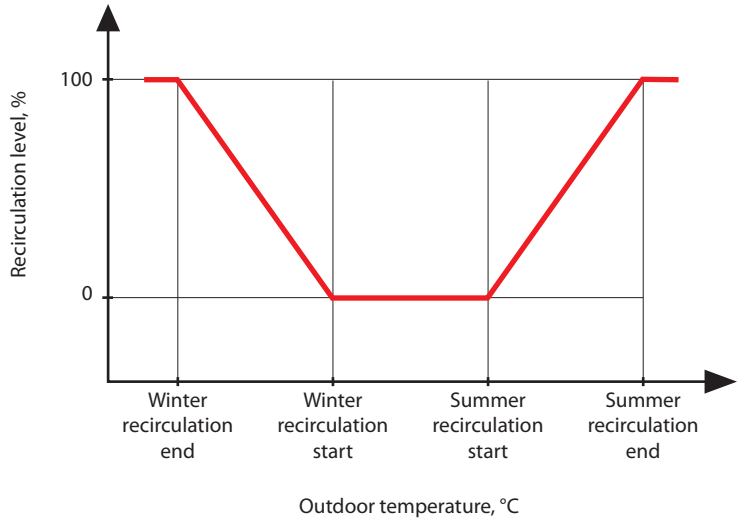
9.7.2. REC according outdoor air temperature

Recirculation level is controlled according user defined outdoor temperature setpoints: recirculation start (no recirculation, 100% fresh air), recirculation end (100% extracted air is returned and fresh air is fully closed). This function will reduce heating/cooling demand in the building under extreme outdoor temperatures.

▼RECIRCULATION CONTROL (REC)

Enable	☑
Mode	Outdoor temp.
Temp. control Kp	150
Temp. control Ki	30
Winter recirculation end	-40.0 °C
Winter recirculation start	15.0 °C
Summer recirculation start	20.0 °C
Summer recirculation end	50.0 °C
Operate with failed fan	☑

REC according outdoor temperature



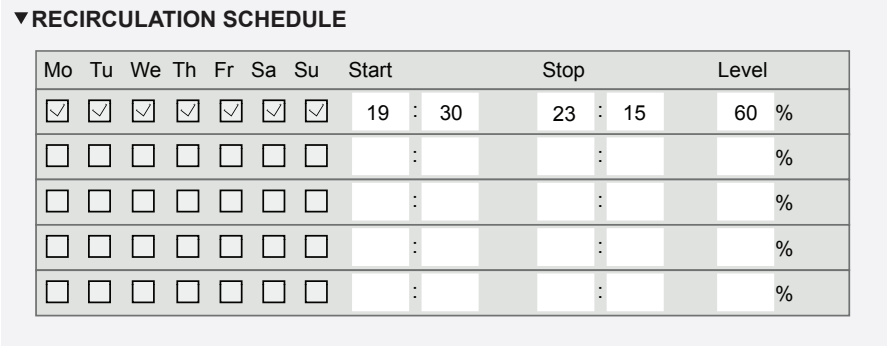
9.7.3. REC according weekly schedule

The recirculation rate (%) is defined for the preferred period of time.

▼RECIRCULATION CONTROL (REC)

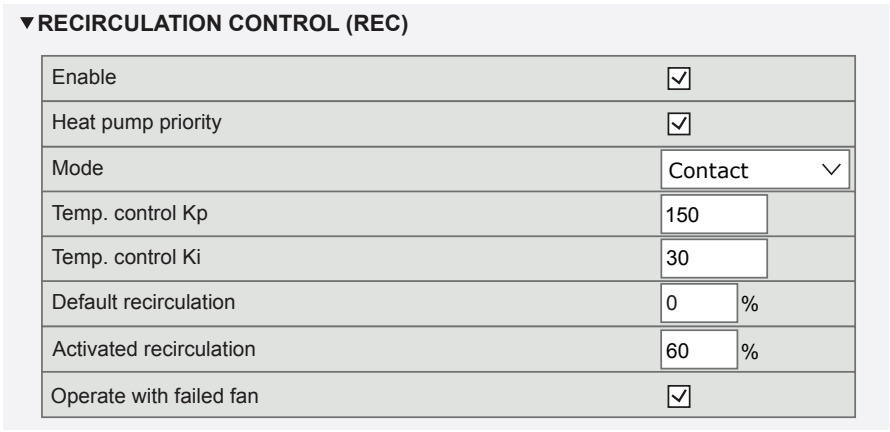
Enable	☑
Mode	Schedule
Temp. control Kp	150
Temp. control Ki	30
Operate with failed fan	☑

Schedule can be programmed in the “User” level. Up to 5 recirculation events can be set for each day of the week.



9.7.4. REC by external contact

Recirculation can be controlled by the external „dry“ contact (terminals 4 and 8 on the C5 board). It can be connected switch, thersmostat, motion detector or other equipment, which will open recirculation damper. Different recirculation levels can be adjusted separately for closed or open contact.



9.7.5. Limitations

If recirculation section is inside of the ventilation unit, together with a signal for the recirculation damper actuator proportionally it will be reduced extract air fan speed and outdoor air intake damper position.

If „Heat pump priority“ option is selected, REC will be blocked whenever it will be a signal for the heat pump to start (despite actual air volume).

It is possible to fully open recirculation damper in case of extract fan failure, so the AHU will not be stopped and air from the premisses will be returend back.

REC function blocks AQC operation.

9.8. Humidity control (HUM)

Humidity control function is used to maintain user defined humidity level in the supplied or extracted air. It is possible to set two different humidity setpoints for two different operation modes, so setpoint will be automatically changed when mode changes (for example according weekly schedule). When AHU operates in any ventilation mode, which is not selected in the HUM settings, function will not start.

▼HUMIDITY CONTROL (HUM)

Enable	☐
Setpoint 1	50 %RH
Mode 1	Comfort1
Setpoint 2	60 %RH
Mode 2	Comfort2
Mode	Indoor+Supply
Dehumidifying with cooler and heater	☐
Dehumidifying cooler	Heat pump
Dehumidifying heater	Water
Indoor Kp	200
Indoor Ki	12
Supply Kp	4000
Supply Ki	50
Minimum supply relative humidity	5 %
Maximum supply relative humidity	90 %
Max supply/indoor humid. dif. when humidifying	25 %
Max supply/indoor humid. dif. when dehumidifying	25 %

For function operation it is needed to connect additional one or two humidity sensors, according to what humidity control mode will be used.

Mode	Supply

Supply
Indoor+Supply
Indoor

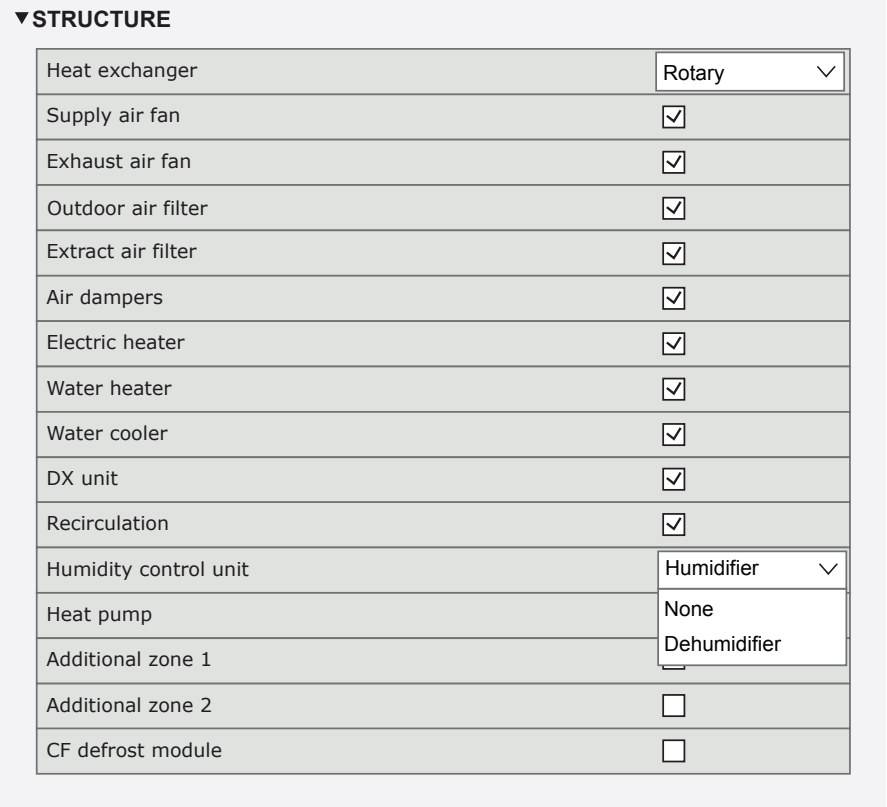
- **Supply.** Humidity of supplied air is maintained. Duct mounted humidity sensor with 0..10V output must be connected to the B9 terminals on the C5 board. Sensor must be installed in the supply duct.
- **Indoor.** Humidity in the premises is maintained. Room mounted (in the room where humidity level will be maintained) or duct mounted (in the extract air duct) humidity sensor (0..10V) can be used. Sensor to be connected to B8 terminals on the C5 board. For limitation of supplied air humidity additional hydrostat can be connected to B9 terminals. Hydrostat should supply >2V DC to the B9 input in cases when supply humidity is out of critical range, so humidifier/dehumidifier will be stopped.
- **Indoor+Supply.** Humidity in the premises is maintained. Room mounted (in the room where humidity level will be maintained) or duct mounted (in the extract air duct) humidity sensor (0..10V) can be used. Sensor to be connected to B8 terminals on the C5 board. Additionally it is needed supply air humidity sensor (duct mounted, 0..10 V output) to be connected to B9 terminals. Sensor will control humidity of supply air within user defined limits, so too dry or too humid air will not be supplied. Max difference between indoor and supplied air humidity can be selected separately for humidifying and dehumidifying modes.

Minimum supply relative humidity	5 %
Maximum supply relative humidity	90 %
Max supply/indoor humid. dif. when humidifying	25 %
Max supply/indoor humid. dif. when dehumidifying	25 %

9.8.1. Humidification

0..10 V signal directly represents requested humidifier capacity between 0 and 100%. When humidifying demand appears, control signal for external humidifier is provided out of TG3 terminals. Signal is calculated according PI regulation, based on the difference between humidity setpoint and actual humidity level. If Indoor+Supply mode is selected, humidifier signal is additionaly corrected to keep supply air humidity within specified limits.

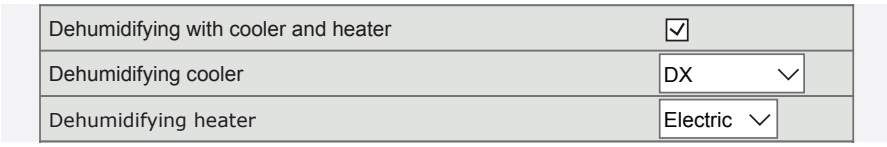
Humidifier control signal is available only if humidifier is configured in the “Factory” level:



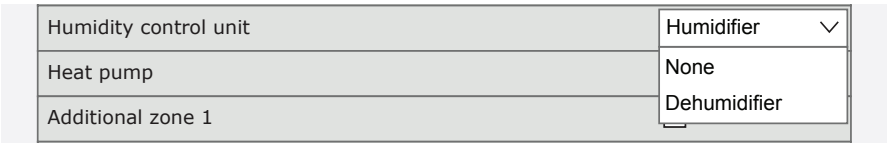
9.8.2. Dehumidification

Dehumidification can be performed with integrated heaters and coolers (if there is both in the AHU) or by providing 0..10 V control output for external dehumidifier (TG3 terminals).

When integrated heaters/coolers are used for dehumidification, supply air is cooled down for condensation to start and then reheated to the desired temperature. According humidity setpoint cooling signal needed to dehumidify the air to a certain level is calculated. Heater signal is increased until temperature setpoint is achieved. Since humidity has higher priority, temperature setpoint may not be reached in case if heater capacity will not be enough. This should be taken in to account when selecting cooler and heater capacities during order. Also for dehumidification it is a must that cooler is installed before the heater. Dehumidification with integrated heaters/coolers is enabled in the “Service” level. Additionally it is needed to select which of the integrated heaters/coolers will be used for this function (in case if there is more heating/cooling devices inside).



If dehumidification should be performed by external dehumidifier it should be activated in the “Factory” level. 0..10 V signal will be provided from TG3 terminals on the C5 board:



9.8.3. Air humidifying and dehumidifying

To control humidification and dehumidification at the same time is only possible when there is external humidifier connected and dehumidification is done with integrated heaters/coolers inside of the AHU. To control external dehumidifier and humidifier at the same time is not possible. For humidifier control, there is 0..10 V signal provided from TG3 terminals. External humidifier must be activated in the “Factory” level (see paragraph “Humidification”). Dehumidification with internal heaters/coolers is activated in “Service” level (see paragraph “Dehumidification”).

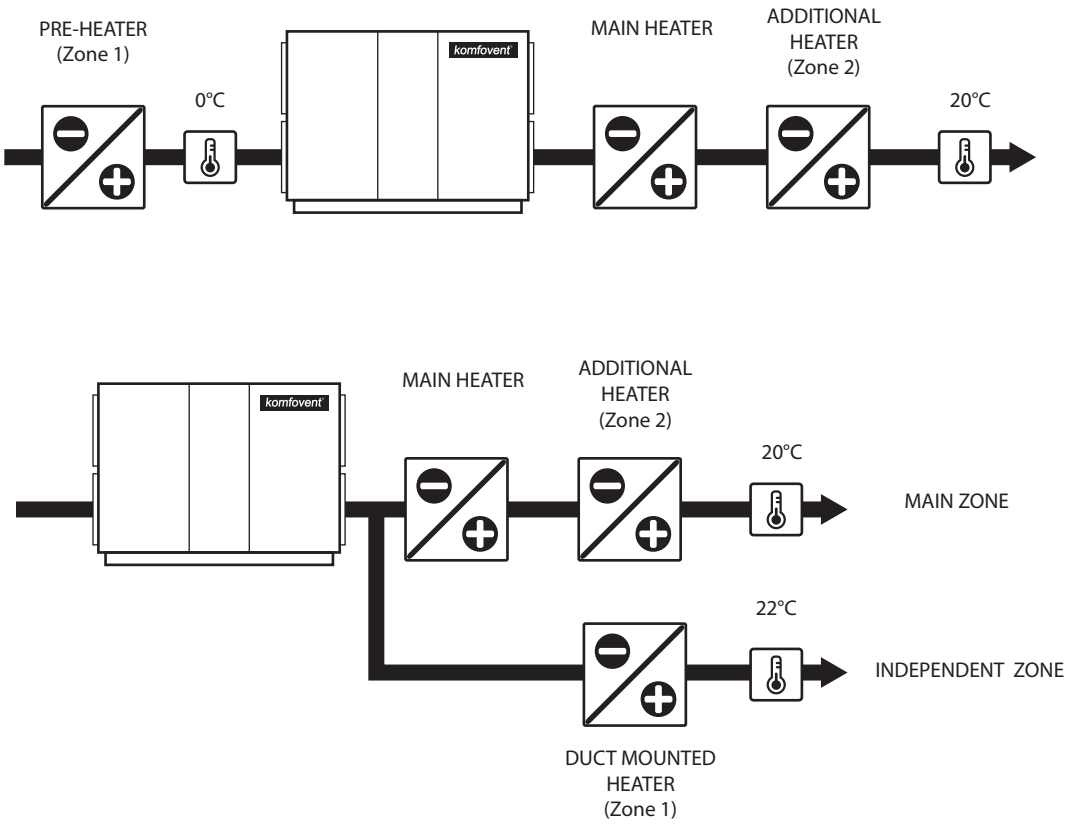
9.8.4. Delays and limitations

HUM starts (if needed) after 300 s delay since start of the AHU.
To start HUM function, actual airflow must be >10% of designed maximum unit airflow.
HUM function is blocked during SNC operation.
HUM function is blocked during cooling-down procedure of heaters/coolers/HP
Delay to switch between humidification and dehumifdification modes is 300 s.
HUM function can be blocked in “Special” ventilation mode (check mark must be removed).
Recuperation with heat exchanger is done according temperature conditions and humidity level is ignored. For example if indoor temperature is higher then outside, exchanger will be started to return heat, despite the air will be cooled down afterwards, to get dehumidification.
When “Indoor“ or “Indoor+Supply” modes are used, during HUM operation following functions are disabled:
– AQC;
– REC according AQC (additionally it is blocked for 10 min. after HUM stopped).

9.9. Zone control

This function allows to have up to three different temperature zones in the same ventilation system. Temperature in the main zone will be maintained by the existing heaters/coolers of the AHU. Different temperatures in two additional zones can be maintained, by connecting two zone modules, which will control additional duct mounted heaters/coolers and temperature sensors connected.

If needed, zone modules can also control additional heaters/coolers to be used in the same airflow as additional steps, when main heater/cooler power is not enough. In that case additional temperature sensors is not needed and only one main temperature set-point is used.



For the control of independent temperature zones or pre-heater, check mark option “Independent” and enter desired temperature setpoint.

▼1ST ADDITIONAL ZONE CONTROL (ZN1)

Enable	☑
Setpoint	-10.0 °C
Kp	120
Ki	8
Independent	☑

In cases when zone module is used for additional heating/cooling steps and should start when the capacity of main heaters/cooler is not enough, leave the “Independent” check box empty.

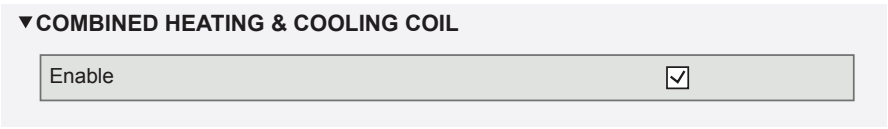
Independent	☐

Additionally, for such regulation, it is needed to configure “Heating/cooling sequence” (Service level → Functions) and select the order in which heating/cooling devices and zone modules should operate.

More information about zone control possibilities read in the “Zone control installation manual”.

9.10. Combined heating & cooling

The function is used to control combined water coil (heater and cooler in one). Control of the mixing valve actuator (TG1 output) and circulation pump (SG1 output) is provided in the heating and cooling modes. However it is needed feedback from the heating system in which mode combined coil should work. This is done by connecting open/close signal to terminals 4 and 8 on the C5 board. In heating mode contacts should be open and closing contacts will activate cooling mode. For example water thermostat can be connected here, which will close contact in case of cold water circulating in the system.

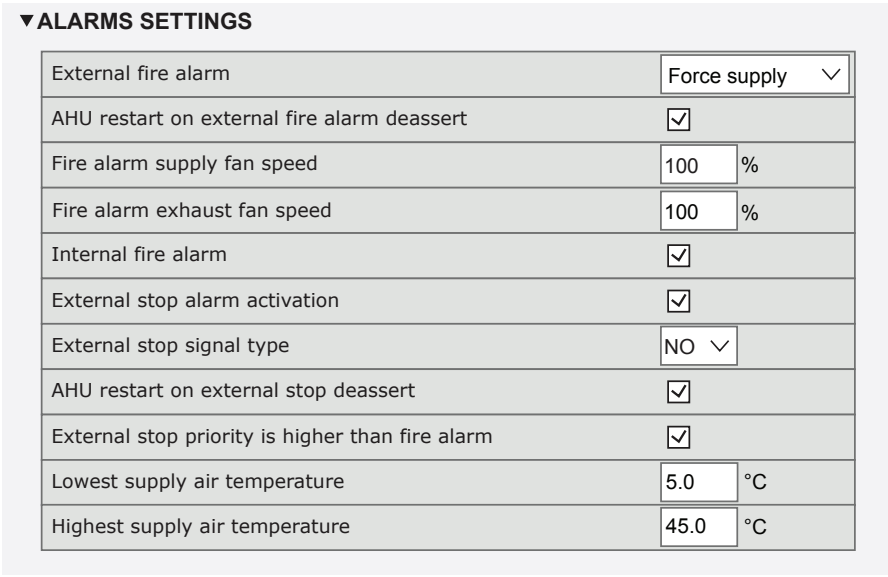


This function is only available if there was water heater and water cooler activated in the factory level.

Function cannot be used together with REC according external contact, since the same input is used for switching between heating/cooling modes.

9.11. Emergency stop and alarm configuration

It is possible to configure (Service → Functions → Alarm settings) emergency conditions for the AHU to stop or to take other actions.



9.11.1. External fire alarm

C5 controller board has terminals 6 and 8 for building fire system connection. It is NC (normally closed) contact and by disconnecting it fire alarm will be generated. By default it is set, that in case of fire alarm AHU will stop (Unit off) without any delays. All active functions will be ignored.

Other options:

- **Force supply** – exhaust fan is stopped and supply fan is forced to set intensity (Fire alarm supply fan speed), where 100% is equal to 10V fan control signal.
- **Force exhaust** – supply fan is stopped and exhaust fan is forced to set intensity (Fire alarm exhaust fan speed), where 100% is equal to 10V fan control signal.
- **Force both** – fans are forced to set intensity

In case if fan forcing is set, during fire alarm additionally overheating protection of the forced fan is disabled. Also damper actuator output it activated (terminals 37/38/39 on the C5 board) for the by-pass damper, in case if smoke extraction must be connected directly to the exhaust fan (by-passing heat exchanger). Water heater frost protection works as usual, so if fan is forced during winter time and return water temperature is falling, water circulation pump will start and 3-way valve will be opened, to avoid coil freezing.

After fire alarm is over and terminals on the board (6 and 8) are reconnected, by-default AHU stays in the fire alarm mode. To return AHU into normal operation it is needed to delete the alarm message in the "Alarm" screen on the control panel or computer.

In case if it is a must to restart AHU automatically after fire alarm is over, following option should be enabled:

AHU restart on external stop deassert	☑

Then when terminals are reconnected, alarm message will be automatically deleted and AHU will return to previous operation mode.

9.11.2. Internal fire alarm

If supply temperature (B1) reach >70°C , or exhaust temperature (B2) reach >50°C, AHU is stopped and „Internal fire alarm" message is indicated. To restore previous operation heat source must be eliminated and alarm message deleted. It is possible to disable this function, by removing check-mark:

Internal fire alarm	☑

9.11.3. External stop

In case of emergency unit can be stopped by external stop contact. It can be thermostat, sensor or switch connected to this contact. In the settings it is possible to choose will it be alarm generated when stop contact is activated. Depending on the device connected to the external stop contacts it is possible to select signal type between normally closed (NC) and normally open (NO).

External stop alarm activation	☑
External stop signal type	NO ⌄
AHU restart on external stop deassert	☑
External stop priority is higher than fire alarm	☑

If it is needed, that AHU will restart automatically after external stop deactivation, corresponding check mark must be on. If external fire alarm will be used together with external stop function, it must be specified which function will have priority in case if both contacts are activated at the same time.

9.11.4. Critical limits for supply air temperature

Minimum and maximum critical temperature limits are set. If reached – AHU will be stopped after 10 min. delay and corresponding alarm of too low or too high temperature will be generated.

Lowest supply air temperature	5.0	°C
Highest supply air temperature	45.0	°C

Exceptions:
- During AHU start-up, delay for the alarm is 3 min.
- If frost protection of water heater is active, AHU will be stopped without delay.
- If supply temperature set point is the same as lowest temperature allowed, critical temperature limit is automatically decreased by 2 degrees.

9.12. Heating/cooling sequence

These settings allow to set up in what order heating/cooling devices will be turned on when demand appears. Heat exchanger has highest priority and will always be started first (it's position in a queue cannot be changed). After unit start up, if there is heating/cooling demand first stage heater/cooler will be started together with heat exchanger on the capacity calculated according PI regulation (exception: DX has 5 min. delay).

▼HEATING/COOLING SEQUENCE

Stage 1	Heat pump
Stage 2	Water
Stage 3	Electric
Stage 4	DX
Stage 5	Zone1
Stage 6	Zone2
Min. switching delay between heating/cooling	20 min

Other stages are started after 5 min., since previous stage has reached 100% capacity. Control signal is calculated according PI regulation, comparing actual supply temperature with supply temperature setpoint (set or calculated).

If in the sequence there are stages, that physically are not installed and not specified in the AHU configuration, it will not be controlled and it will be switched to the next available stage.

Delay for switching between heating and cooling is configurable. Delay is started after last operating heater control signal reach 0%.

9.13. Pressure auto balance (C5 firmware version 2.390 or later)

Function can be ordered in advance. By maintaining pressure difference between supplied and extracted air flows, function prevents air mixing through heat exchanger gaskets and sealing brushes. Also it increase efficiency of purge sector (if mounted) for rotary exchangers.

Function hardware consists of additional pressure sensor inside of C5 controller board and modulated air damper mounted on the extract air duct (room side). Pressure difference between supply and extract flows is measured. Set pressure difference (default 25Pa) is maintained by modulating extract air damper (closing of the extract damper increases pressure difference).

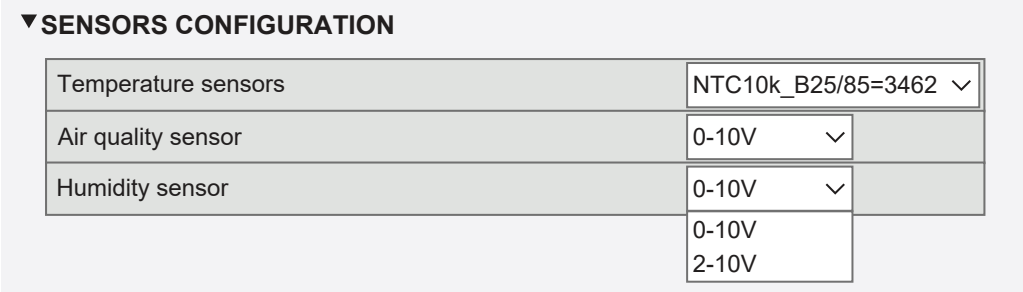
▼PRESSURE AUTO-BALANCE

Pressure difference	25 Pa
Kp	150
Ki	300

Actual pressure readings and extract damper position can be seen in the "Inputs/Outputs" window.

9.14. Sensor signal range selection (C5 firmware version 2.390 or later)

For AQC, OOD, HUM and REC according AQC functions, it is possible to select sensor signal range between 0..10V or 2..10V. If needed, selection is available in the *Service-> Settings-> Sensor configuration*



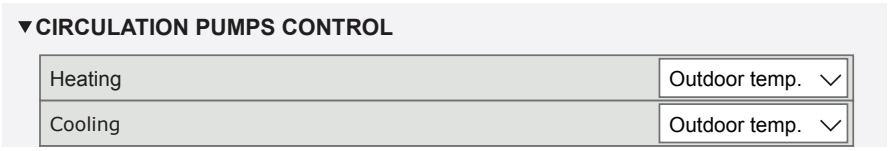
9.15. Cool down of electrical heaters/coolers and integrated heat pump

When unit is stopped during operation of heaters/coolers (electrical heater, DX unit, integrated heat pump), additionally for 1..9 minutes heater cool down procedure with fans is started. Cool down time depends on the accumulated heat in the heater and airflow intensity. During cool down fans are running on the same intensity as before stopping the unit if it is in the range of 33%-90%. Otherwise fan intensity is adjusted to fit in these limits. Heat exchanger operation is not stopped.

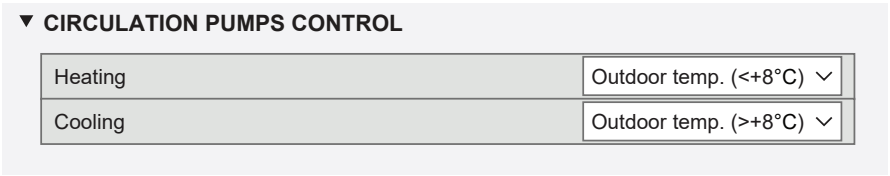
10. WATER CIRCULATION PUMPS CONTROL

By default hot water (HW) and cold water (CW) pumps are controlled on demand, it means that in heating demand HW pump starts and in cooling demand CW pump starts. Pumps start if there is at least 1% signal to the corresponding 3-way valve. In all cases pumps will be stopped after 5 min. delay.

Also it is possible to control pumps according outdoor temperature:



firmware v2.370 or earlier



firmware v2.380 or later

- HW pump starts when outdoor (B3) is <8°C
- CW pump starts when outdoor (B3) >8°C
- In other outdoor temperatures pumps runs on demand

After switching on or restarting main power HW pump is started for 5 min. if:

- Frost protection is activated
- Operation according outdoor temperature is selected.

After 5 min. temperature conditions is checked and HW pump will be controlled according it.

When frost protection of water heater is active, HW pump is started if any of the temperature sensors measures <8°C or temperature after heat exchanger (measured or calculated) is <11°C.

Additionally pump training procedure can be configured, to start pumps for short time when it is not in operation, to prevent pump dry-out. Training interval and duration can be specified. After pump training procedure is performed, additionally for the same time 3-way valve will open/close.

Train interval	12 h
Train time	2 min
Train heating	☑
Train cooling	☑

10.1. Water pump/coil alarm indication (firmware 2.290 or later)

On updated C5 controller boards (version 7), there is dedicated connection terminals (No. 47-48) where water pump alarm signal (NC) or frost protection thermostat can be connected. Terminals must be closed in normal operation of water pump or thermostat and opened if there is an alarm. Function works for selected water pumps and alarm on the unit is generated only when particular water pump should be running (there is heating/cooling demand or frost protection is running). If pump should not be in operation at the moment – alarm input is not be checked.

Depending on the application it is possible to select:

- alarm type A – unit will be stopped and alarm message (45A – Water pump/coil alarm) indicated, if contacts are open
- alarm type B – unit will keep operating, but warning message (112B – Water pump/coil alarm) will be displayed if contacts are open.

Also alarm delay can be configured (default is 30 s).

Heating pump protection relay	☐
Cooling pump protection relay	☐
Protection relay delay	30 s
Protection relay alarm	A type

11. WATER HEATER COIL FROST PROTECTION

Water heater frost protection settings are available in the “Factory” level:

▼WATER HEATER

Alarm temperature (0 - No freeze protection)	8.0	°C
Kp	200	
Ki	12	
Kp for freeze protection	100	
Ki for freeze protection	30	
Protection temperature when AHU is on	25.0	°C
Protection temperature when AHU is off	35.0	°C
Heat exchanger Kp for freeze protection	40	
Heat exchanger Ki for freeze protection	10	
Protection temperature with heat exchanger (0 - No protection)	12.0	°C

Frost protection is enabled when “Alarm temperature” is set to >0°C.

HW pump will be started if any of the temperature sensors measures <8°C. 3-way valve is controlled by 0..10 V signal according PI regulation to maintain temperature of return water (B5 temperature sensor). Maintained temperatures can be configured:

Protection temperature when AHU is on	16.0	°C
Protection temperature when AHU is off	35.0	°C

Setting “Protection temperature with heat exchanger” defines minimum air temperature (measured or calculated) which is maintained after heat exchanger. This prevents stopping of heat exchanger in cases when low supply temperature set-point is set during operation of frost protection and heat recovery is not needed.

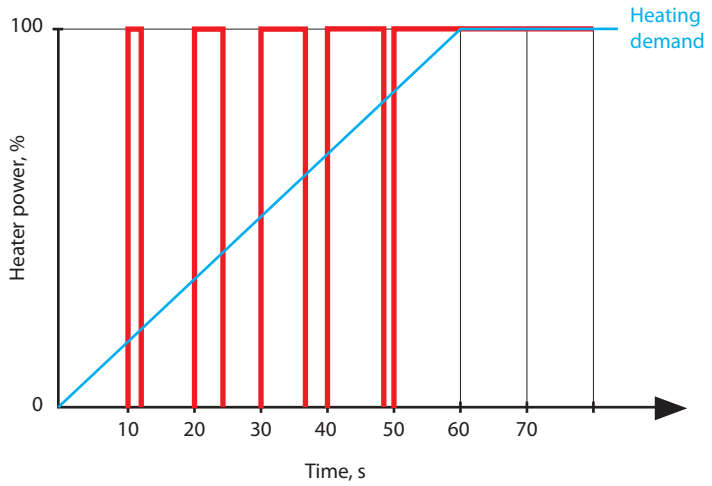
Alarm temperature (Default 8°C) is critical limit of the return water temperature, bellow which AHU will be stopped and alarm message “11A. Return water low temperature” generated.

12. ELECTRICAL HEATER CONTROL

Electrical heater is controlled by PWM (pulse width modulation) and/or discrete signal (depends on the AHU type and size). Minimum actual airflow, for electrical heater to start is 20% of the AHU designed flow. Heater capacity is calculated according PI regulation, when temperature setpoint cannot be reached by heat exchanger or previous heating stages.

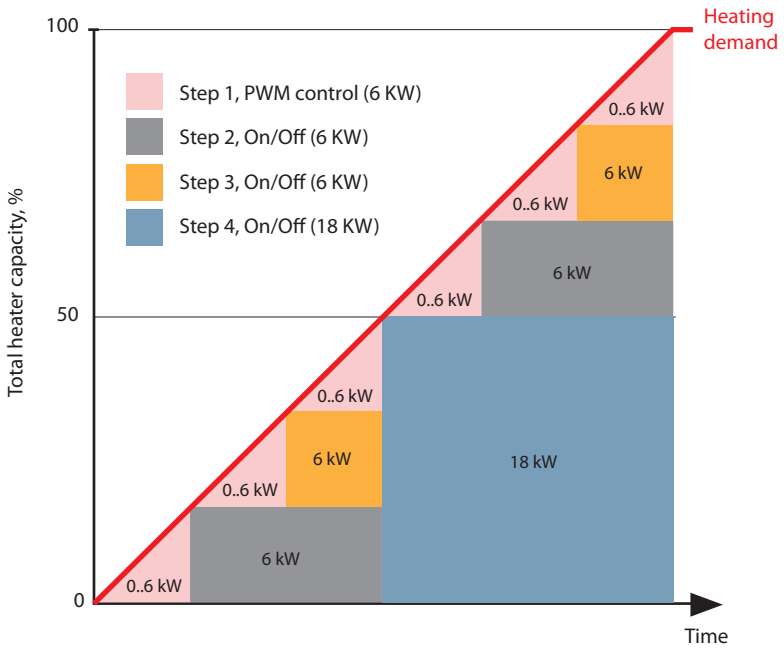
If it is 1 step electrical heater – it will be controlled by PWM signal:

Electrical heater PWM example



When electrical heater consists of two or more steps, first will be controlled by PWM signal, and others by discrete signal. Thus when first heating step is not enough, it is turned off and second step is started on full power (On/Off). Growing heating demand is maintained precisely by PWM signal of the step 1.

4 step electrical heater (36 kW) example



13. DIRECT EXPANSION UNIT (DX) CONTROL

Two different control modes for DX units are available: stepping and modulating. In both options DX can also be controlled in heating and cooling modes. Type of DX and other related settings are configured in "Factory" level:

▼DX UNIT

Type	Modulating
Stepping control	Binary
Stepping count	1 step
Stepping changeover heating	☐
Modulating signal type	0..10V
Min. voltage	0.0 V
Max. voltage	10.0 V
Invert signal	☐
Temperature curve coefficient A	2.5
Temperature curve coefficient B	5.0
Lowest outdoor temp.	-10.0 °C
Modulating Kp	150
Modulating Ki	6

In heating mode DX operation can be limited by outdoor temperature, thus it will be stopped when outdoor temperature falls below certain limit. Lowest temperature allowed depends on the DX unit model (follow instruction manual provided by DX unit manufacturer):

Lowest outdoor temp.	-10.0 °C

13.1. Stepping type DX

This control mode is used for ON/OFF type DX units. It is possible to control up to 3 separate DX units (Stepping count → 3 steps), that should be connected to DX1, DX2 and DX3 terminals on the C5 board.

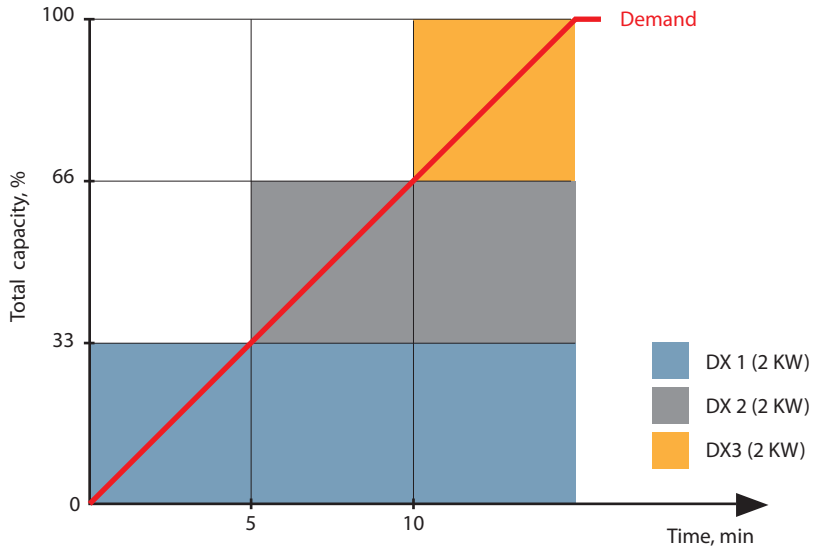
Type	Stepping
Stepping control	Sequence
Stepping count	3 steps
Stepping changeover heating	☑

DX steps are started one after another with 5 min. delay, when previous step was not enough to reach temperature setpoint. When temperature is reached, separate DX units are turned off also with 5 min. delay between steps. It is possible to turn steps on and off in sequence (Stepping control → Sequence) or according binary code (Stepping control → Binary).

Stepping control	Sequence
	Binary

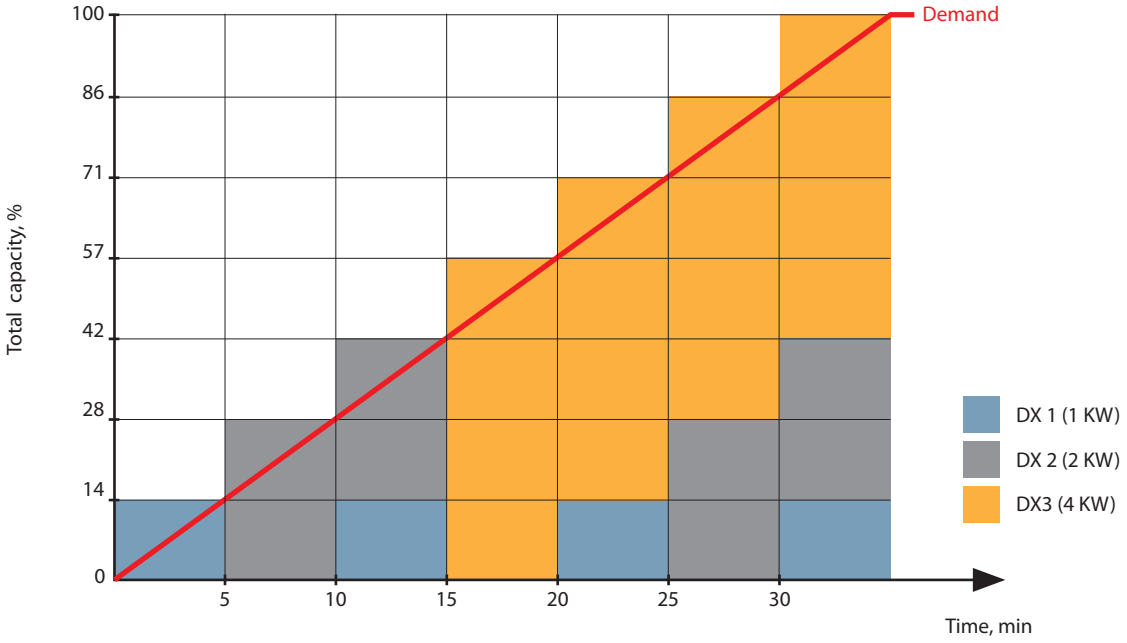
Sequence control is recommended when all DX units connected are the same capacity. So when heating demand is growing, all DX units will be started/stopped in the same sequence:

Sequence control example



Binary control mode is recommended when all DX units has different capacities. If for example each of DX units is two times bigger than previous, out of the 3 units it is possible to have 7 steps with different capacities and to maintain temperature more accurate if compared to sequence control:

Binary control example

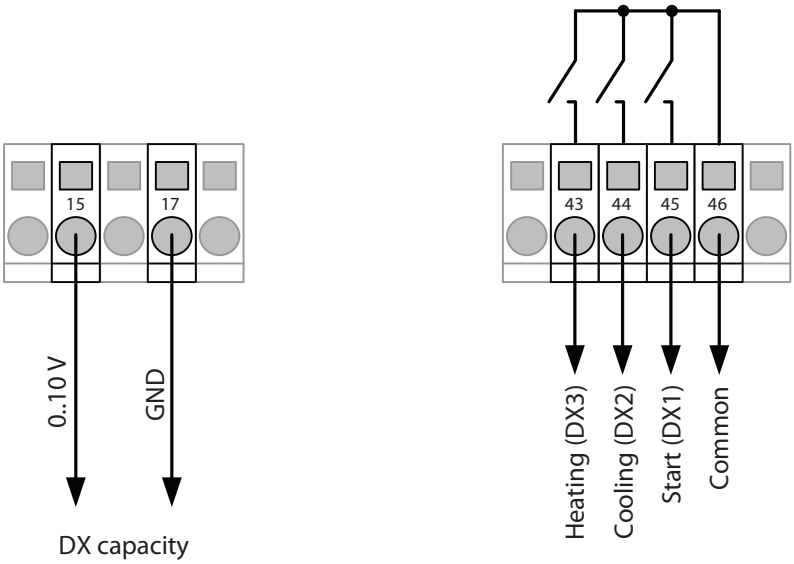


By default stepping DX control mode is used only for cooling. In cases when connected DX units (On/OFF type) has also a possibility to heat "Stepping changeover heating" should be activated:

It is only possible to control two changeover DX units (Stepping count → 2 steps) since DX3 relay output will be used to reverse DX units between cooling and heating.

13.2. Modulating type DX

Modulating type DX units controlled by 0..10 V signal (TG2 terminals on the C5 board). Additionally digital outputs DX1, DX2 and DX3 are activated and can be used for DX unit start/cooling/heating signal if needed.



If water cooling and DX are used at the same time, then DX capacity 0..10 V signal will be provided out of TG3 analog output terminals (13-14). Such options is not available in cases when external humidifier is used.

Capacity by 0..10 V signal can be controlled in the following ways:

Modulating signal type	0..10V ∨
	0..5..10V
	Temperature

Universal PI regulation **(Modulating signal type → 0..10V):**

Capacity is controlled according PI regulation comparing actual supply temperature with supply temperature setpoint (set or calculated). 0..10 V signal is equal to the requested heating/cooling demand, where 0V is 0% and 10V is 100% requested DX capacity. Additionally control signal voltage can be limited or inverted (then 0V will be equal to 100% capacity).

Modulating signal type	0..10V ∨
Min. voltage	0.0 V
Max. voltage	10.0 V
Invert signal	☐

Regulation according temperature difference **(Modulating signal type → 0..5..10V):**

Such regulation is used for some of the Daikin DX units. Control signal is regulated according difference between requested and actual temperatures. If difference is positive (capacity should increase), 5..10 V signal is provided. If difference is negative (capacity should decrease), 0..5 V signal is provided. If requested temperature meets actual and DX capacity should be kept at the same level, then 5V signal is provided.

Direct DX temperature output control **(Modulating signal type → Temperature):**

Some DX units are controlled not by the capacity regulation, but by temperature setpoint. 0..10 V control signal (Ain) is sent to DX unit, which interprets it as temperature setpoint. Following A and B coefficients are used for temperature setpoint calculation, according the formula:

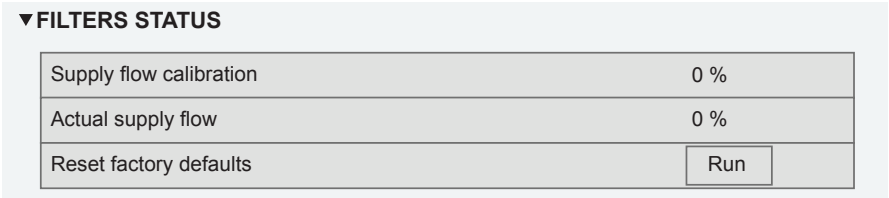
$$T_{set} = A \times A_{in} + B$$

Temperature curve coefficient A	2.5
Temperature curve coefficient B	5.0

A and B coefficients should be provided by DX unit manufacturer.

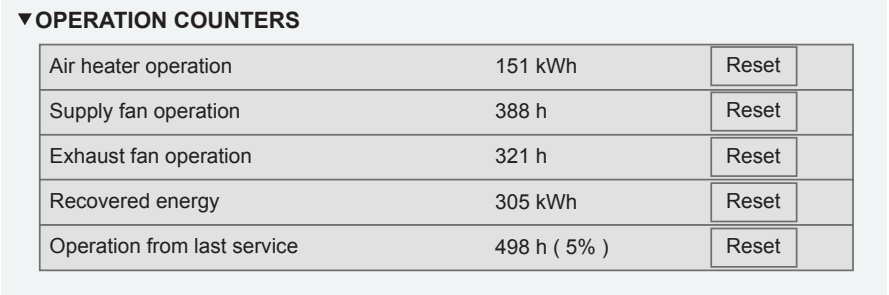
14. FILTER IMPURITY INDICATION

In VERSO PRO and RHP PRO units, there are pressure sensors measuring pressure drop over the filters. Pressure sensors are integrated into the VM module electronic board or on the C5 board (VERSO-S units). Filter impurity is calculated in percent according clean filter pressure drop, which is preprogrammed in the factory (according AHU specification) or measured during "Clean filter calibration". During calibration, AHU runs on maximum designed intensity for 3 minutes and pressure drop over clean filter is measured. From the measured value, theoretical dirty filter pressure drop is calculated and percentage counter starts to indicate filter impurity level.



In VERSO Standard units, there are pressure relays (pressostats) which is set to trigger at specific pressure drop over the filter. Pressure drop setting depends on the unit size and filter type. Relay provides normally open (NO) signal and closes when pressure drop over filter exceeds limit, thus dirty filter message will be indicated. If unit is running on low fan intensity (less than 95% of designed maximum airflow), it will be forced to it's maximum airflow after 30 days of operation, to check pressure drop over the filters (test duration 3 minutes). If maximum airflow cannot be reached, filter test interval is reduced and will be checked in every 15 days.

15. OPERATION COUNTERS



Air heaters and heat exchanger operation is calculated in kWh (actual power multiplied by working time).

Fan operation is calculated in hours of 100% control signal. If for example fans run on 50% intensity, 2 hours of operation will be counted as 1 h. Since fans is usually running not on the exactly the same intensities, it's calculated operation hours also will be different.

Operation since last service calculates hours and percentage since last reset of the service timer. This timer calculates 1 year of continuous AHU operation, meaning that if the AHU operates only during the day, the timer takes 2 years to get to 100%. When 100% is reached – "Service time" message will be shown. By deleting the message, service timer is automatically restarted. If service is performed earlier, timer can be restarted by pressing "Reset" button in the "Service" level.

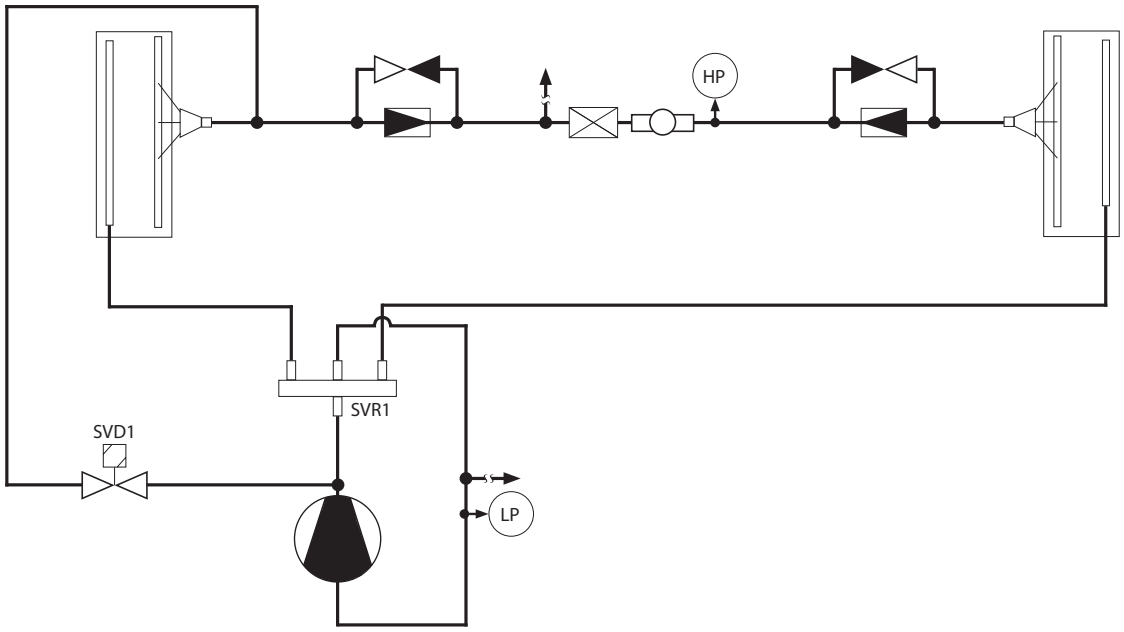
16. HEAT PUMP CONTROL

AHU's with integrated heat-pump module is divided in two groups: RHP Standard and RHP Pro. Construction of the heat-pump and its control is different for both groups.

16.1. RHP Standard units (C5 firmware version 2.230 or later) with mechanical thermo regulation valves (TRV)

Heat-pump main components are:

- ON/OFF type compressor
- Two mechanical thermal expansion valves (TRV) – one for heating and one for cooling mode.
- 4-way valve (SVR) for reversing between heating and cooling modes.
- Hot gas by-pass solenoid (SVD) used for defrosting of the evaporator coil
- Two reversible coils – both can be used as evaporator or condenser depending on the operating mode.
- Low pressure (LP) and high pressure (HP) protection pressure switches.



SVR moves to heating or cooling position depending on what mode is needed to reach temperature setpoint.

Heat-pump control signal starts in case when heat exchanger and/or previous heating/cooling steps was not enough to reach setpoint. When request signal has reached >65 %, SVD valve opens to equalize refrigerant pressure in the system. After 60 s delay compressor starts and after additional 5 s SVD closes. Compressor runs until heating/cooling request drops <65 %.

The drip pan under refrigerant coil in the extract side of the unit has tray heating cable installed, which do not allow condensate to freeze blocking the drain. Tray heating turns ON/OFF when exhaust temperature (B4) is 2±0,5°C.

16.1.1. Evaporator defrosting

If exhaust air temperature (B4) falls below <4 °C, frost protection of evaporator coil algorithm starts. Pressure drop over evaporator coil is monitored (sensor B13) and compared to theoretical "clean" evaporator coil pressure drop (P_{clean}) curves. If actual pressure increases to defrost pressure limit (configurable in the "factory" level, default is 2.5x), defrosting starts by opening SVD and supplying hot gas out of the compressor directly to the evaporator. Since SVR stays in heating position, some of the hot gas is still used for heating of supply air. If this is not enough to reach setpoint, additional heating devices is started. Defrost is done no longer than 5 min and is treated as successful if after defrost pressure drop over evaporator is less than:

$$P_{clean} + (0{,}5 \times ((P_{clean} \text{ x Defrost pressure limit}) - P_{clean})).$$

If defrost was unsuccessful after 5 min it is repeated. After 3 unsuccessful defrosting attempts, heat-pump will be stopped and alarm message "15B Evaporator icing" generated.

Additionally, besides pressure drop measurement, forced defrost is done each 300 min (timer starts from the last defrost sequence) if temperature conditions is met. If pressure drop sensor measures less than 1% (assuming there is some problems with pressure sensor), forced defrost is done each 75 min.

During defrost tray heating is activated despite temperature conditions and is kept ON additional 10 min after defrost is over.

16.1.2. Protections and limitations

From the start of the compressor refrigerant pressure switches are ignored for:

- 180 s – LP switch
- 30 s – HP switch

When delays are over in case of triggering any of the pressure switches, compressor will be stopped immediately (minimum compressor ON time is ignored). HP and LP pressure switches has automatic reset. Pressure alarms will be generated after 3 consecutive pressure switch triggering if it appears during minimum ON time of the compressor.

Other limitations:

- Temperature hysteresis for heat-pump operation is ±2°C from the setpoint.
- Minimum compressor ON time 300 s (except LP or HP triggering)
- Minimum compressor OFF time 300 s
- Maximum outdoor temperature when heating 15°C (can be changed in "factory" level).
- Minimum outdoor temperature when cooling 20°C (can be changed in "factory" level).
- LP triggering pressure 0,5 bar, reset pressure 1,5 bar.
- HP triggering pressure 18 bar, reset pressure 13 bar.
- Minimum needed airflow for the heat pump to start (if airflow is lower, heat pump will not start even if needed):

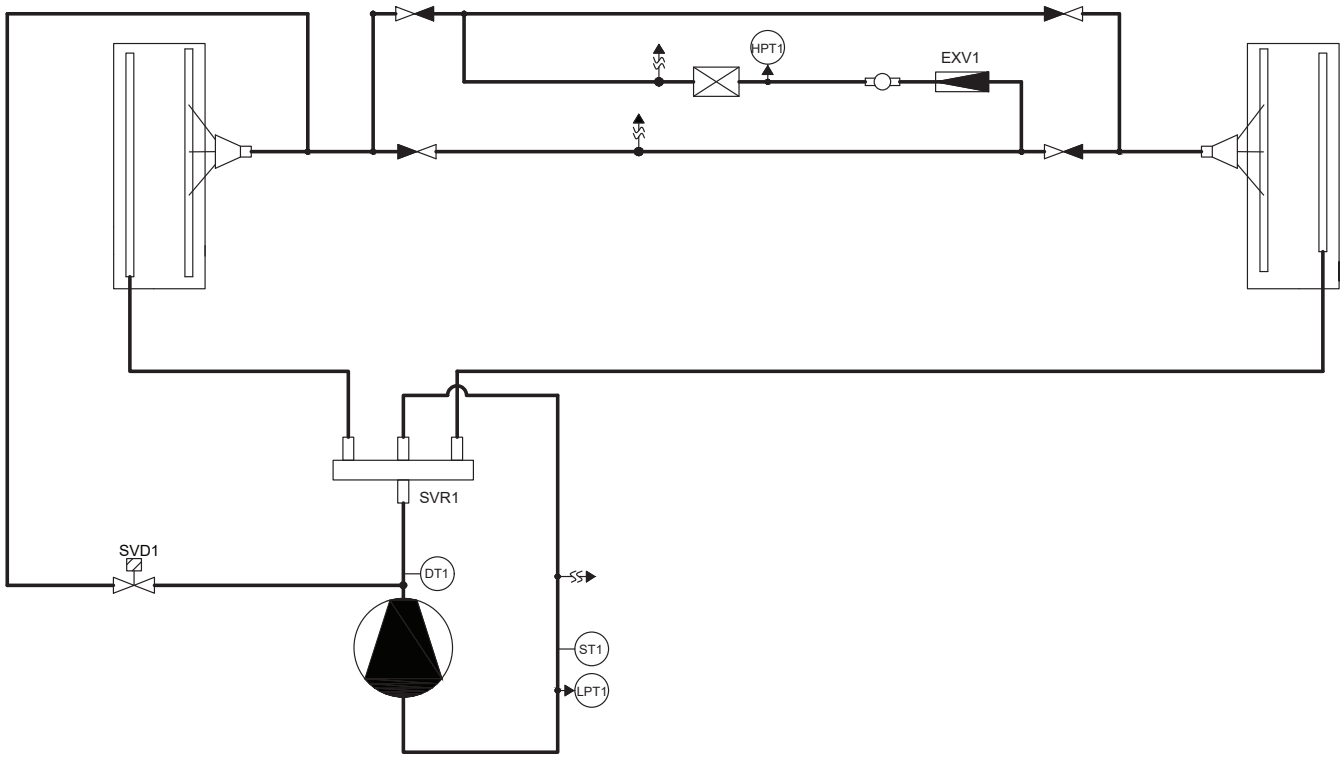
AHU model	Minimum airflow to start heat-pump, m^3/h
RHP 400 V-2.2/1.4	150
RHP 400 V-2.8/2.4	250
RHP 600 U-3.7/3	300
RHP 600 U-4.4/3.8	400
RHP 800 U-5.3/4.7	400
RHP 800 U-6.1/5.8	600
RHP 1300 U-8.1/6.6	600
RHP 1300 U-9.2/7.6	800
RHP 1500 U-9.6/7.8	800

16.2. RHP Standard units (C5 firmware version 2.400 or later) with electronic expansion valve (EXV)

From January of 2021 in the RHP400 and RHP600 AHU's construction of heat-pump was redesigned by installing EXV and other related electronics for the heap-pump control.

Heat-pump main components are:

- ON/OFF type compressor
- Electronic expansion valve (EXV)
- 4-way valve (SVR) for reversing between heating and cooling modes.
- Hot gas by-pass solenoid (SVD) used for defrosting of the evaporator coil
- Two reversible coils – both can be used as evaporator or condenser depending on the operating mode.
- Analog pressure sensors for high (HPT) and low (LPT) refrigerant pressure.
- Suction temperature (ST) and discharge pressure (DT) sensors.
- Electronic TRV-K1 board.



SVR moves to heating or cooling position depending on what mode is needed to reach air temperature setpoint. Heat-pump control signal starts in case when heat exchanger and/or previous heating/cooling steps was not enough to reach setpoint. When request signal has reached >65 %, heat pump starts in the following order:

Outdoor temperature B3 ≥ -5°C	Outdoor temperature B3 < -5°C
EXV valve opens to 100%	EXV valve opens to 100%
Compressor starts after EXV is fully open	Rotary heat exchanger speed is limited to 50%
60s delay	Compressor starts after EXV is fully open
EXV starts regulating to maintain super heat (SH) value of 6K	60s delay
	EXV starts regulating to maintain super heat (SH) value of 6K
	Heat exchanger speed is restored to the previous request

All the time during heat pump operation EXV is constantly regulated:

- To maintain SH value of 6K. If SH is within the set range of 6+1K (configurable in factory level), current EXV position is locked and temporarily will not be adjusted until SH will stay in the range.
- To avoid critical high/low refrigerant pressure limits. EXV opens 100%, when refrigerant pressure reach set values. After pressures stabilize, EXV regulation slowly goes back to SH maintenance

Compressor runs until heating/cooling request drops <65 %.

The drip pan under refrigerant coil in the extract side of the unit has tray heating cable installed, which do not allow condensate to freeze blocking the drain. Tray heating turns ON/OFF when exhaust temperature (B4) is 2±0,5°C.

16.2.1. Evaporator defrosting

If exhaust air temperature (B4) falls below <4 °C, frost protection of evaporator coil algorithm starts. Pressure drop over evaporator coil is monitored (sensor B13) and compared to theoretical "clean" evaporator coil pressure drop (P_{clean}) curves. If actual pressure increases to defrost pressure limit (configurable in the "factory" level, default is 2.5x), defrosting starts:

- Supply airflow is reduced to 20% of the unit designed maximum flow.
- Heat exchanger is stopped.
- EXV is regulated to maintain low refrigerant pressure at 1.1 bar (configurable in factory level), thus discharge temperature (from DT sensor) will increase.
- By-pass solenoid (SVD) opens injecting hot gas in to the evaporator immediately when **DT ≥ +40 °C** or after 10 min. if **DT < +40 °C**.
- SVD closes immediately when **DT ≤ (B2 + 6 °C)**, or after 10 min. if **DT > (B2 + 6 °C)**, where B2 is extract air temperature.

Defrosting is treated as successful if measured pressure drop over evaporator is less than:

$$P_{clean} + (0{,}5 \times ((P_{clean} \text{ x Defrost pressure limit}) - P_{clean}))$$

If pressure drop is still too high – defrost procedure is repeated. After 3 unsuccessful defrosting attempts, heat-pump will be stopped and alarm message "15B Evaporator icing" generated.

During defrost tray heating is activated despite temperature conditions and is kept ON additional 10 min after defrost is over.

After successful defrost cycle:

- EXV opens to 100%.
- Supply airflow is returned to previous value.
- Heat exchanger speed is restored to the previous request.
- After 60s delay EXV starts regulating again to maintain SH value and heat pump operates normaly.

16.2.2. Protections and limitations

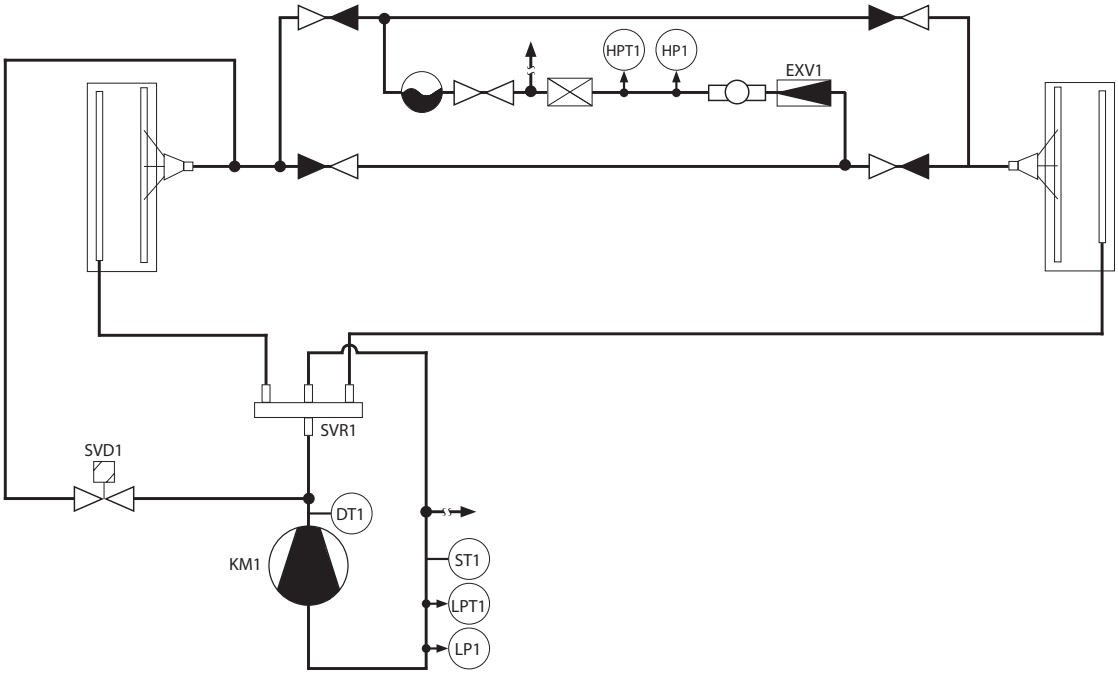
- Temperature hysteresis for heat-pump operation is ±2°C from the setpoint.
- Minimum compressor ON time 300 s (except LPT or HPT triggering).
- Minimum compressor OFF time 300 s.
- Maximum outdoor temperature when heating 15°C (can be changed in "factory" level).
- Minimum outdoor temperature when cooling 20°C (can be changed in "factory" level).
- LPT triggering pressure 0,5 bar, reset pressure >0,8 bar.
- HPT triggering pressure 20 bar, reset pressure <18 bar.
- Minimum needed airflow for the heat pump to start (if airflow is lower, heat pump will not start even if needed):

AHU model	Minimum airflow to start heat-pump, m^3/h
RHP 400 V-2.8/2.4	250
RHP 600 U-3.7/3	300
RHP 600 U-4.4/3.8	400

16.3. RHP Pro units (C5 firmware version 2.230 or later)

Heat-pump main components are:

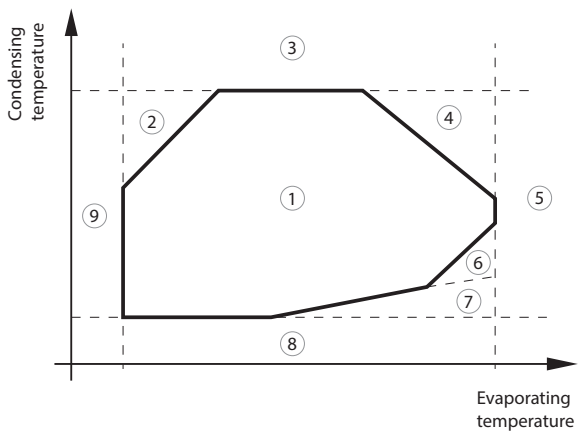
- Inverter type compressor
- Electronic expansion valve (EXV)
- 4-way valve (SVR) for reversing between heating and cooling modes.
- Hot gas by-pass solenoid (SVD) used for defrosting of the evaporator coil.
- Two reversible coils – both can be used as evaporator or condenser depending on the operating mode.
- Analog pressure sensors for high (HPT) and low (LPT) refrigerant pressure.
- Suction temperature (ST) and discharge temperature (DT) sensors.
- Low pressure (LP) and high pressure (HP) protection pressure switches.
- Carel controller board for regulating compressor and EXV position.



Depending on the unit size, heat-pump can consist of one, two or three independent hydraulic circuits. If heat-pump has more than one circuit, only first compressor will be inverter type and second and third will be ON/OFF. All other hydraulic components will be the same. Each circuit is completely independent and do not interconnect with each other.

In heat-pump stand-by EXV is open at 30% and SVR moves to heating or cooling position depending on what mode is needed to reach temperature setpoint. Heat-pump control signal starts in case when heat exchanger and/or previous heating/cooling steps was not enough to reach setpoint. When request signal has reached >20 %, EXV opens to 50% and compressor starts. Depending on the needed capacity compressor will start on 60 rps or higher to ensure good lubrication. If needed capacity is lower, compressor will run on 60 rps for 60 s and after that speed will be decreased to the requested. If needed capacity is higher, compressor will go directly to the requested speed. EXV is regulated to keep super-heat (SH) at 6K.

Compressor envelope zones



Compressor speed and EXV position can be also adjusted to keep the compressor inside of the envelope operation limits (Zone 1):

1. Zone inside the operating limits – normal working zone of the compressor
2. Max compression ratio – discharge temperature is controlled by slowing down compressors power increase and if not enough, starts power reducing.
3. Max condensation pressure – decreasing speed and capacity of compressor
4. Max motor current – decreasing speed and capacity of compressor, EXV closing to increase evaporator temperature.
5. Max evaporation pressure – increasing compressor speed, regulating EXV to maintain evaporation pressure
6. Min compression ratio – increasing compressor speed and capacity, regulating EXV.
7. Min differential pressure – increasing compressor speed and capacity, regulating EXV.
8. Min condensation pressure – increasing compressor speed and capacity.
9. Min evaporation pressure – decreasing speed and capacity of compressor.

Additionally compressor speed can be limited by electrical current limit.

16.3.1. Evaporator defrosting

If exhaust air temperature (B4) falls below <4 °C, frost protection of evaporator coil algorithm starts. Pressure drop over evaporator coil is monitored (sensor B13) and compared to theoretical "clean" evaporator coil pressure drop (P_{clean}) curves. If actual pressure increases to defrost pressure limit (configurable in the "factory" level, default is 2.5x), defrosting starts by opening SVD and supplying hot gas out of the compressor directly to the evaporator. Since SVR stays in heating position, some of the hot gas is still used for heating of supply air. If this is not enough to reach setpoint, additional heating devices is started. EXV moves to 30% position and compressor runs on fixed speed. Defrost is done in three cycles with maximum duration of 10 min., 15 min and 20min. Defrost duration can be shorter if pressure drop over evaporator coil has reached P_{clean}. If after maximum defrost time pressure drop has not decreased to $<P_{clean} \times 1,3$, defrost is repeated after 5 min. with different maximum duration. If after defrost pressure drop is lower than theoretical it is used as new P_{clean} in the future. During defrost cycles rotary wheel is slowed down to maintain 8°C air temperature between heat exchanger and evaporator coil (sensor B11). After 3 unsuccessful defrosting attempts (if pressure drop is $> P_{clean} \times 1,3$), heat-pump will be stopped and alarm message "15B Evaporator icing" generated.

Additionally, besides pressure drop measurement, forced defrost is done each 300 min (timer starts from the last defrost sequence) if temperature conditions is met. If pressure drop sensor measures less than 1% (assuming there is some problems with pressure sensor), forced defrost is done each 75 min.

During defrost tray heating is activated despite temperature conditions and is kept ON additional 10 min after defrost is over.

After defrost is over, EXV moves to 80% and after 60 s delay is starts regulate SH normally.

16.3.2. Protections and limitations

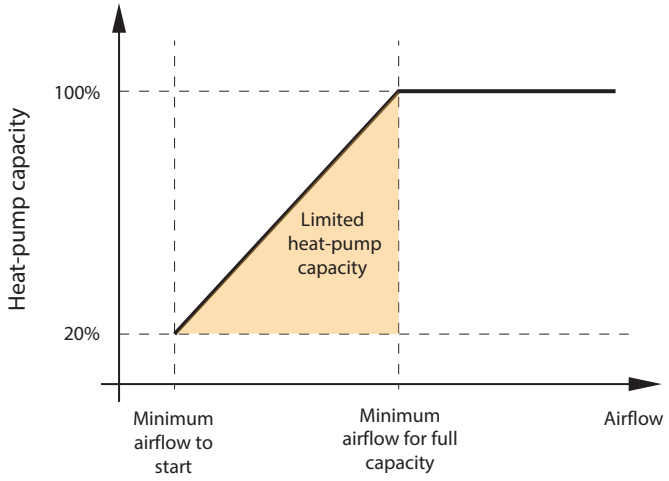
All alarm messages from Carel controller board has auto-reset in 30 s intervals. If same alarm appears 3 times consecutively or if alarm do not reset – heat-pump is stopped and alarm message generated on C5. Ventilation unit operation is not stopped in case of heat-pump alarms.

Other limitations:

- Minimum compressor ON time 300 s (can be changed in "factory" level), except critical alarms.
- Minimum compressor OFF time 300 s (can be changed in "factory" level).
- Maximum outdoor temperature when heating 15°C (can be changed in "factory" level).
- Minimum outdoor temperature when cooling 20°C (can be changed in "factory" level).
- LP triggering pressure 1,7 bar, reset pressure 2,7 bar.
- HP triggering pressure 42 bar, reset pressure 33 bar.
- Critical temperature between heat exchanger and evaporator (sensor B11) in heating mode <-10°C
- Heat-pumps on RHP PRO units has two airflow limits:

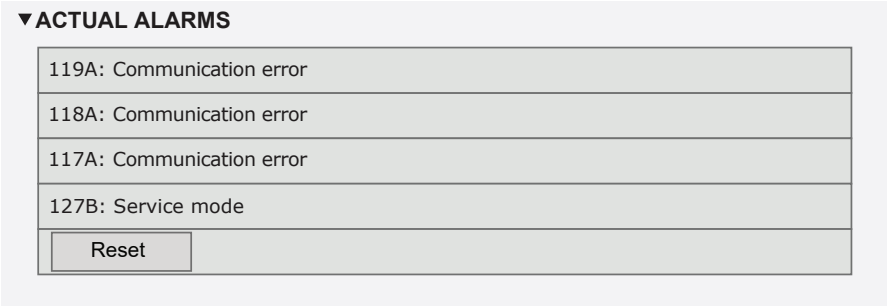
RHP PRO SIZE	Minimum airflow and hysteresis to start heat-pump, m^3/h	Minimum airflow to allow full capacity, m^3/h
10	900 ± 30	1200
20	1800 ± 60	2400
30	2700 ± 90	3600
40	3600 ± 120	4800
50	5000 ± 175	7000
60	7000 ± 225	9000
70	9000 ± 300	12000
80	10000 ± 350	14000
90	13000 ± 400	16000

Heat-pump capacity will be limited in between above stated airflow range as follows:



17. ALARM LIST AND TROUBLESHOOTING

When alarms are generated, besides of the alarm message there is a code of alarm, which may lead to more information about the problem. Alarm codes marked with letter A is critical and will stop the AHU. Alarms marked with letter B is informational messages and ventilation is not stopped.



When cause of the alarm is removed and alarm deleted – AHU will restart automatically on the previous operation mode.

In the following table, there is a list of possible alarms and some troubleshooting tips.

Code		Alarm text	Comment	Troubleshooting tips
Text	Hex			
1B	1	Low supply air flow	Supply flow not reaching 80% of setpoint in normal mode or 95% of setpoint while calibrating VAV	1. Too high pressure in the duct system (wrong size ducts, closed diffusers, blocked intake grills, stuck dampers) 2. Dirty filters 3. Disconnected, clogged, bent pressure tubes.
2B	2	Low extract air flow	Extract flow not reaching 80% of setpoint in normal mode or 95% of setpoint while calibrating VAV	1. Too high pressure in the duct system (wrong size ducts, closed diffusers, blocked intake grills, stuck dampers) 2. Dirty filters 3. Disconnected, clogged, bent pressure tubes.
3B	3	VAV calibration fail	Both VAV sensors values are out of allowed range (3..9V)	VAV sensor not connected, broken or wrong measuring range selected.
4B	4	Change outdoor air filter	Outdoor air filter impurity level reached 100%	Message can also appear after unsuccessful filter calibration
5B	5	Change extract air filter	Extract air filter impurity level reached 100%	Message can also appear after unsuccessful filter calibration
6B	6	Electric heater off	Heater overheat (TK70)	Thermostat 70°C
7B	7		Heater radiator overheat (TK60)	On the units where TRIAC's has separate overheating thermostat 60°C on the radiator.
8B	8		Heater(Zone1) overheat (TK70)	Additional zone with electrical heater. Thermostat 70°C
9B	9		Heater(Zone1) radiator overheat (TK60)	
10B	A		Heater(Zone2) overheat (TK70)	Additional zone with electrical heater. Thermostat 70°C
11B	B		Heater(Zone2) radiator overheat (TK60)	
12B	C	High pressure on compressor		Reached maximum allowed pressure (18 bar), by presostat (RHP Standard). Resets at 13 bar.
13B	D	Low pressure on compressor		Reached minimum allowed pressure (0,5 bar), by presostat (RHP Standard). Resets at 1,5 bar.
14B	E	Service time		One year of continuous operation has passed.
15B	F	Evaporator icing	Heat pump evaporator icing and can't be defrosted	After three defrost cycles, pressure drop over evaporator have not increased above limit
16B	10	Compressor failure	Compressor 1	DIN 17-18 on PM board
17B	11		Compressor 2	Not used
18B	12		Compressor 3	Not used

Code		Alarm text	Comment	Troubleshooting tips
Text	Hex			
19B	13	Compressor off	Heatpump can't start due to too low air flow	Minimum airflow needed for the heat pump to start not reached. Increase airflow setpoint.
20B	14		Heatpump can't start due to too low air temperature	Outdoor temperature is between max. temperature allowed for heating and min. temperature allowed for cooling (default is 15 and 20C)
21B	15			
22B	16			
23B	17	Compressor failure	Defrost procedure stop for max time	Not used
24B	18		Probe U3 broken or disconnected	Analog low pressure sensor (LPT1)
25B	19		Probe U4 broken or disconnected	Suction temperature sensor (ST1)
26B	1A		Probe U5 broken or disconnected	Analog high pressure sensor (HPT1)
27B	1B		Probe U6 broken or disconnected	Discharge temperature sensor (DT1)
28B	1C		Probe U8 broken or disconnected	Phase sequence relay (circuit 2 or circuit 3)
29B	1D		Low SH alarm circ.1	SH<4K, more than 360 s
30B	1E		LOP alarm circuit 1	Too low condensation pressure
31B	1F		MOP alarm circuit 1	Too high disscharge pressure
32B	20		Low suction temp. circuit 1	Suction temperature < -20 °C for more than 180 s, or < -25 °C
33B	21		High discharge press. circuit 1	Measured by analog high pressure sensor (HPT1) >33 bar, for more than 180s
34B	22		Low suction pressure circuit 1	Measured by analog low pressure sensor (LPT1) <4 bar, for more than 180s, or <3,3 bar
35B	23		Low pressure circ.1 by pressostat	Pressostat LP1 <1,7 bar (auto reset at 2,7 bar)
36B	24		High pressure circ.1 by pressostat	Pressostat HP1 >42 bar (auto reset at 33 bar)
37B	25		Maintenance request compressor 1 circuit 1	Not used
38B	26		Pump down end for max time circuit 1	Not used
39B	27		Error BLDC management circuit 1	Compressor can not start because of electrical limitations (voltage, current, etc.). Can also appear of compressor type or settings missmatch.
40B	28		High discharge temp. circuit 1	>105°C for more than 180 s, or imediately if >115°C
41B	29		Alarm delta pressure circuit 1	Pressure difference is <0,5 bar after 15 s since compressor start. Possible refrigerant leackage, stuck SVR or EVD, broken compressor.
42B	2A		Start failure BLDC circuit 1	Compressor can not reach specified speed during start-up. Can appear because of compressor type/settings mismatch.
43B	2B		Envelope alarm circuit 1	Compressor was working outside envelope zone for longer than 180 s. Needed to verify in what zone compressor was running, to find possible reasons.
44B	2C		Offline Power+ circuit 1	No communication with Carel frequency inverter. Possible reasons: no power, broken cable, wrong settings.
45B	2D		Alarm Power+ circuit 1	Alarm generated by Carel frequency inverter. Actual alarm message needed to be checked in /_hp.html screen or on the Carel control panel.
46B	2E		Probe S1 EVD circ.2 broken or disconnected	Analog low pressure sensor (LPT2)
47B	2F		Probe S2 EVD circ.2 broken or disconnected	Suction temperature sensor (ST2)
48B	30		Probe S3 EVD circ.2 broken or disconnected	Analog high pressure sensor (HPT2)
49B	31		Probe S4 EVD circ.2 broken or disconnected	Discharge temperature sensor (DT2)
50B	32		Low SH alarm circ.2	SH<4K, more than 360 s
51B	33		LOP alarm circuit 2	Too low condensation pressure

Code		Alarm text	Comment	Troubleshooting tips
Text	Hex			
52B	34	Compressor failure	MOP alarm circuit 2	Too high disscharge pressure
53B	35		ExV motor alarm circuit 2	
54B	36		Low suction temp. circuit 2	Suction temperature -20 °C for more than 180 s
55B	37		Battery alarm EVD circuit 2	
56B	38		EEPROM EVD alarm circuit 2	
57B	39		Firmware EVD circ.2 not ok	
58B	3A		Configuration error EVD circuit 2	
59B	3B		Offline EVD circ.2	
60B	3C		High discharge press. circuit 2	Measured by analog high pressure sensor (HPT2)
61B	3D		Low suction pressure circuit 2	Measured by analog low pressure sensor (LPT2)
62B	3E		Low pressure circ.2 by pressostat	Pressostat LP2
63B	3F		High pressure circ.2 by pressostat	Pressostat HP2
64B	40		Maintenance request compressor 1 circuit 2	Not used
65B	41		Pump down end for max time circuit 2	Not used
66B	42		Compressor Starter overcurrent circuit 2	
67B	43		Mains power phases mismatched	Check voltage and phase sequence
68B	44		Alarm delta pressure circuit 2	Pressure difference is <0,5 bar after 15 s since compressor start. Possible refrigerant leackage, stuck SVR or EVD, broken compressor.
69B	45		Envelope alarm circuit 2	Compressor was working outside envelope zone for longer than 360 s. Needed to verify in what zone compressor was running, to find possible reasons.
70B	46		Probe S1 EVD circ.3 broken or disconnected	Analog low pressure sensor (LPT3)
71B	47		Probe S2 EVD circ.3 broken or disconnected	Suction temperature sensor (ST3)
72B	48		Probe S3 EVD circ.3 broken or disconnected	Analog high pressure sensor (HPT3)
73B	49		Probe S4 EVD circ.3 broken or disconnected	Discharge temperature sensor (DT3)
74B	4A		Low SH alarm circ.3	SH<4K, more than 360 s
75B	4B		LOP alarm circuit 3	Too low condensation pressure
76B	4C		MOP alarm circuit 3	Too high disscharge pressure
77B	4D		ExV motor alarm circuit 3	
78B	4E		Low suction temp. circuit 3	Suction temperature -20 °C for more than 180 s
79B	4F		Battery alarm EVD circuit 3	
80B	50		EEPROM EVD alarm circuit 3	
81B	51		Firmware EVD circ.3 not ok	
82B	52		Configuration error EVD circuit 3	
83B	53		Offline EVD circ.3	
84B	54		High discharge press. circuit 3	Measured by analog high pressure sensor (HPT2)
85B	55		Low suction pressure circuit 3	Measured by analog low pressure sensor (LPT2)
86B	56		Low pressure circ.3 by pressostat	Pressostat LP2
87B	57		High pressure circ.3 by pressostat	Pressostat HP2
88B	58		Maintenance request compressor 1 circuit 2	Not used
89B	59		Pump down end for max time circuit 3	Not used
90B	5A		Compressor Starter overcurrent circuit 3	
91B	5B		High discharge temp. circuit 3	
92B	5C		Alarm delta pressure circuit 3	Pressure difference is <0,5 bar after 15 s since compressor start. Possible refrigerant leackage, stuck SVR or EVD, broken compressor.

Code		Alarm text	Comment	Troubleshooting tips
Text	Hex			
93B	5D	Compressor failure	Envelope alarm circuit 3	Compressor was working outside envelope zone for longer than 360 s. Needed to verify in what zone compressor was running, to find possible reasons.
94B	5E		Carel module configuration sequence was not completed	
95B		Low heat exchanger efficiency	Rotor efficiency is lower than warning setting (Factory level → Configuration → Rotary heat exchanger → Low efficiency warning), when outdoor temperature is below -5°C.	1. Low efficiency because of the temperature/ humidity conditions or too high efficiency warning limit. 2. Air temperature sensors measuring incorrectly, so calculated efficiency is incorrect. 3. Air leakage between extract and supply airflows (missing gaskets, not fully closed door)
96B	60	Compressor failure	TRV module configuration sequence was not completed	Alarm generated by Simna TRV control board
97B	61		TRV circuit 1 module configuration sequence was not completed	Alarm generated by Simna TRV control board
98B	62		TRV circuit 2 module configuration sequence was not completed	Alarm generated by Simna TRV control board
99B	63		TRV circuit 3 module configuration sequence was not completed	Alarm generated by Simna TRV control board
100B	64		TRV drive failure circuit 1	Alarm generated by Simna TRV control board
101B	65		TRV motor failure circuit 1	Alarm generated by Simna TRV control board
102B	66		TRV drive overload circuit 1	Alarm generated by Simna TRV control board
103B	67		TRV motor overload circuit 1	Alarm generated by Simna TRV control board
104B	68		TRV drive failure circuit 2	Alarm generated by Simna TRV control board
105B	69		TRV motor failure circuit 2	Alarm generated by Simna TRV control board
106B	6A		TRV drive overload circuit 2	Alarm generated by Simna TRV control board
107B	6B		TRV motor overload circuit 2	Alarm generated by Simna TRV control board
108B	6C		TRV drive failure circuit 3	Alarm generated by Simna TRV control board
109B	6D		TRV motor failure circuit 3	Alarm generated by Simna TRV control board
110B	6E		TRV drive overload circuit 3	Alarm generated by Simna TRV control board
111B	6F		TRV motor overload circuit 3	Alarm generated by Simna TRV control board
112B	70	Water pump/coil alarm	Open contacts 47-48 when water pump is in operation	1. Disconected protection relay cables or relay failure. 2. No water flow, because of broken pump, stuck valve, missing water. 3. Wrong settings for pump protection relay.
113B	71	CF exchanger not calibrated	CF exchanger calibration not performed and there is no default pressure curve coefficients available	Upload .cfg file with theoretical CF pressure curve coefficients or perform CF exchanger calibration.
114B	72	CF exchanger not calibrated	CF exchanger calibration failed or canceled	1. Air leakage between extract and supply airflows (missing gaskets, not fully closed door) 2. CF pressure drop sensor range incorrect, sensor failure, pressure tube not connected or blocked. 3. In VAV mode, duct pressure changed significantly during calibration (some dampers in the system was opened/closed)
127B	7F	Service mode	I/O override or pressure lock function is active	By deleting alarm all override inputs/outputs will be restored to automatic.
1A	80	Supply air temp. sensor failure	B1 Open circuit	
2A	81		B1 Short circuit	
3A	82	Extract air temp. sensor failure	B2 Open circuit	
4A	83		B2 Short circuit	
5A	84	Outdoor air temp. sensor failure	B3 Open circuit	
6A	85		B3 Short circuit	

Code		Alarm text	Comment	Troubleshooting tips
Text	Hex			
7A	86	Exhaust air temp. sensor failure	B4 Open circuit	
8A	87		B4 Short circuit	
9A	88	Water temp. sensor failure	B5 Open circuit	
10A	89		B5 Short circuit	
11A	8A	Return water temp. low	Bellow set alarm temperature (default +8C)	
12A	8B	Internal fire alarm	Supply air temp. exceeding +70C or extract air temp. exceeding +50C	
13A	8C	External fire alarm	External fire system	
14A	8D	External stop	External alarm input	
15A	8E	Heat exchanger failure	Heat exchanger efficiency is too low	1. Rotary heat exchanger not rotating (broken belt, motor, control board). 2. CF heat exchanger by-pass failure (damper stuck, broken actuator, actuator not connected). 3. Air temperature sensors measuring incorrectly, so calculated efficiency is incorrect. 4. Air leakage between extract and supply airflows (missing gaskets, not fully closed door).
16A	8F	Heat exchanger icing		1.After three cycles of defrosting, pressure drop over exchanger has not increased above critical limit. 2.After three cycles of defrosting, exchanger efficiency has not increased above critical limit.
17A	90	Low supply air temperature	Supply air temp drops bellow +5C	
18A	91	High supply air temperature	Supply air temp. exceeding +45C (10min)	
19A	92	Low supply air flow	Supply flow not reaching 30% of setpoint	1. Disconnected, clogged, bent pressure tubes. 2. Air dampers stuck or not open. 3. Fan turning in wrong direction (AC fans). 4. Wrong fan settings (k-factor, VM module microswitches, wrong max. airflow setting). 5. Control voltage not reaching the fan (broken cable, electronic board). 6. Broken fan or frequency inverter.
20A	93	Low extract air flow	Extract flow not reaching 30% of setpoint	1. Disconnected, clogged, bent pressure tubes. 2. Air dampers stuck or not open. 3. Fan turning in wrong direction (AC fans). 4. Wrong fan settings (k-factor, VM module microswitches, wrong max. airflow setting). 5. Control voltage not reaching the fan (broken cable, electronic board). 6. Broken fan or frequency inverter.
21A	94	Electric heater overheat	Heater TK100	
22A	95		Heater(Zone1) TK100	
23A	96		Heater(Zone2) TK100	
24A	97	Evaporator air temp. sensor failure	B11 Open circuit	
25A	98		B11 Short circuit	
26A	99	Evaporator coil temp. sensor failure	B12 Open circuit	
27A	9A		B12 Short circuit	
28A	9B	Compressor failure	Compressor 1	
29A	9C		Compressor 2	
30A	9D		Compressor 3	
31A	9E	Supply air temp. sensor failure	Open circuit (Zone1)	
32A	9F		Short circuit (Zone1)	
33A	A0		Open circuit (Zone2)	
34A	A1		Short circuit (Zone2)	

Code		Alarm text	Comment	Troubleshooting tips
Text	Hex			
35A	A2	Water temp. sensor failure	Open circuit (Zone1)	
36A	A3		Short circuit (Zone1)	
37A	A4		Open circuit (Zone2)	
38A	A5		Short circuit (Zone2)	
39A	A6	Return water temp. low	Zone1	
40A	A7		Zone2	
41A	A8	Supply air temp. sensor failure	B14 Open circuit	
42A	A9		B14 Short circuit	
43A	AA	External stop	Zone1	
44A	AB		Zone2	
45A	AC	Water pump/coil alarm	Open contacts 47-48 when water pump is in operation	1. Disconected protection relay cables or relay failure. 2. No water flow, because of broken pump, stuck valve, missing water. 3. Wrong settings for pump protection relay.
46A	AD	CF exchanger not calibrated	Automatic CF calibration failed three times consecutively and there is a risk of exchanger to freeze.	1. Air leakage between extract and supply air-flows (missing gaskets, not fully closed door) 2. CF pressure drop sensor range incorrect, sensor failure, pressure tube not connected or blocked. 3. Too low extract airflow through exchanger (fan problems, inverted dampers, wrong airflow settings). 4. In VAV mode, duct pressure changed significantly during calibration (some dampers in the system was opened/closed) 5. Frozen or blocked CF exchanger
83A	D2	Controller failure	Mixed C5 board power connection	18V and 24V from transformer is mixed at the connector for C5 board power, or transformer failure
84A	D3	Communication error	TRV main module	Cable, settings or electronics fault
85A	D4		TRV inverter 1	Cable, settings or electronics fault
86A	D5		TRV inverter 2	Cable, settings or electronics fault
87A	D6		TRV inverter 3	Cable, settings or electronics fault
88A	D7		C5_CF module	PM board for 3+1 damper actuator control. Cable, settings or electronics fault
89A	D8		Carel module not responding to modbus requests	No communication with Carel main board. Possible reasons: no power, broken cable, wrong settings.
90A	D9	Service mode	C5 board is locked	Can be unlocked only by Komfovent service department connected to the AHU.
91A	DA	Controller failure	Too low 24V supply voltage	
92A	DB		Too high 24V supply voltage	
93A	DC		Supply fan C5_VM module	
94A	DD		Exhaust fan C5_VM module	
95A	DE		El. Heater C5_PM module	
96A	DF		Heat pump C5_PM module	
97A	E0		Zone1 C5_PM module	
98A	E1		Zone2 C5_PM module	
99A	E2	Supply fan drive failure		Alarm generated by fan frequency inverter
100A	E3	Supply fan drive overload	(Lenze: F_AF)	Alarm generated by fan frequency inverter
101A	E4	Supply fan motor failure	(Lenze: F_rF, F_OF1)	Alarm generated by fan frequency inverter
102A	E5	Supply fan motor overload	(Lenze: F_EF), Overheat	Alarm generated by fan frequency inverter
103A	E6		(Lenze: F_PF, F_OF), Overcurrent	Alarm generated by fan frequency inverter
104A	E7	Exhaust fan drive failure		Alarm generated by fan frequency inverter
105A	E8	Exhaust fan drive oveload	(Lenze: F_AF)	Alarm generated by fan frequency inverter
106A	E9	Exhaust fan motor failure	(Lenze: F_rF, F_OF1)	Alarm generated by fan frequency inverter

Code		Alarm text	Comment	Troubleshooting tips
Text	Hex			
107A	EA	Exhaust fan motor overload	(Lenze: F_EF), Overheat	Alarm generated by fan frequency inverter
108A	EB		(Lenze: F_PF, F_OF), Overcurrent	Alarm generated by fan frequency inverter
109A	EC	Rotor drive failure		Alarm generated by rotor motor frequency inverter
110A	ED	Rotor drive overload		Alarm generated by rotor motor frequency inverter
111A	EE	Rotor motor failure		Alarm generated by rotor motor frequency inverter
112A	EF	Rotor motor overload		Alarm generated by rotor motor frequency inverter
113A	F0			Alarm generated by rotor motor frequency inverter
114A	F1	Communication error	Supply fan C5_VM module	Cable, settings or electronics fault
115A	F2		Exhaust fan C5_VM module	Cable, settings or electronics fault
116A	F3		El. Heater C5_PM module	Cable, settings or electronics fault
117A	F4		Heat pump C5_PM module	Cable, settings or electronics fault
118A	F5		Zone1 C5_PM module	Cable, settings or electronics fault
119A	F6		Zone2 C5_PM module	Cable, settings or electronics fault
120A	F7		Supply drive (Lenze modbus)	Cable, settings or electronics fault
121A	F8		Exhaust drive (Lenze modbus)	Cable, settings or electronics fault
122A	F9		Supply drive2 (Lenze modbus)	Cable, settings or electronics fault
123A	FA		Exhaust drive2 (Lenze modbus)	Cable, settings or electronics fault
124A	FB		Rotor drive	Cable, settings or electronics fault
125A	FC	Controller failure	Internal pressure sensors (C5_DP)	
126A	FD		C5 Analog circuit (auto-calibration, multiplexer)	Short circuit on the C5 board external terminals (incorrect wiring, broken external components)
127A	FE		C5 Digital circuit (EEPROM, flash)	

18. CONNECTION TERMINALS OF THE C5 MAIN BOARD

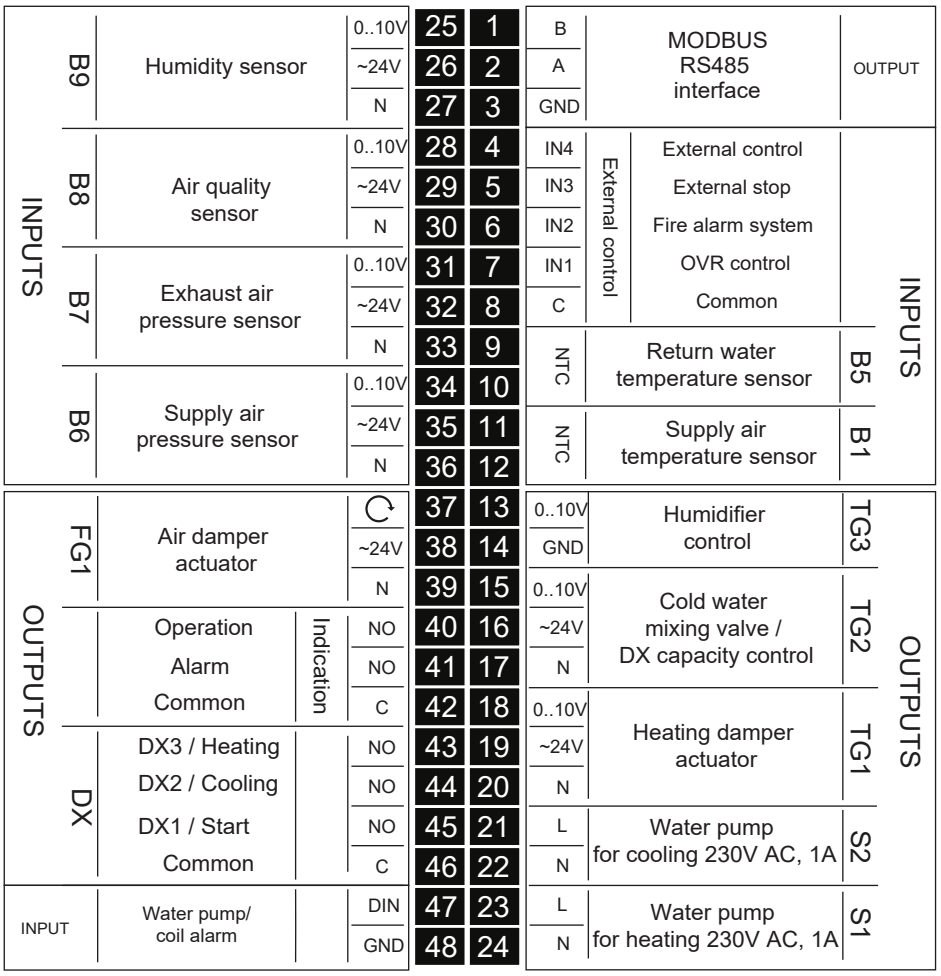


Fig. 1. Connection terminals for external components on the C5 main board

Total power of all external devices with 24 V supply voltage shall not exceed 25 W.

LITHUANIA

UAB KOMFOVENT

TECHNINĖS PRIEŽIŪROS SKYRIUS / SERVICE AND SUPPORT
Phone: +370 5 200 8000
Email: service@komfovent.com
www.komfovent.com

RUSSIA

ООО «КОМФОВЕНТ»
Ул. Выборгская д. 16, стр. 1,
2 этаж, 206 офис, Москва, Россия
Тел. +7 499 673 22 73
info.ru@komfovent.com
www.komfovent.ru

ООО «КОМФОВЕНТ»
Ряжское шоссе, 20 литера Е, пом Н6
390017 г. Рязань, Россия
Тел.: +7 491 255 95 71
info.ru@komfovent.com
www.komfovent.ru

BELARUS

ИООО «Комфовент»
ул. Уручская 21 – 423,
220125 г. Минск, Беларусь
Тел. +375 17 266 5297, 266 6327
info.by@komfovent.com
www.komfovent.by

SWEDEN

Komfovent AB
Ögärdesvägen 12B
433 30 Partille, Sverige
Tel. +46 31 487 752
info_se@komfovent.com
www.komfovent.se

FINLAND

Komfovent Oy
Muuntotie 1 C1
FI-01 510 Vantaa, Finland
Tel. +358 0 408 263 500
info_fi@komfovent.com
www.komfovent.com

PARTNERS

AT	J. PICHLER Gesellschaft m. b. H.	www.pichlerluft.at
BE	Ventilair group	www.ventilairgroup.com
	ACB Airconditioning	www.acbairco.be
CZ	REKUVENT s.r.o.	www.rekuvent.cz
CH	WESCO AG	www.wesco.ch
	SUDCLIMATAIR SA	www.sudclimatair.ch
	CLIMAIR GmbH	www.climair.ch
DK	Øland A/S	www.oeland.dk
EE	BVT Partners	www.bvtpartners.ee
FR	AERIA	www.aeria-france.fr
HR	Microclima	www.microclima.hr
HU	AIRVENT Légtechnikai Zrt.	www.airvent.hu
	Gevent Magyarország Kft.	www.gevent.hu
	Merkapt	www.merkapt.hu
IR	Fantech Ventilation Ltd	www.fantech.ie
IS	Blikk & Tækniþjónustan ehf	www.bogt.is
	Hitataekni ehf	www.hitataekni.is
IT	Icaria srl	www.icariavmc.it
NL	Ventilair group	www.ventilairgroup.com
	DECIPOL-Vortvent	www.vortvent.nl
	CLIMA DIRECT BV	www.climadirect.com
NO	Ventistål AS	www.ventistal.no
	Ventistål AS	www.ventistal.no
	Thermo Control AS	www.thermocontrol.no
PL	Ventia Sp. z o.o.	www.ventia.pl
SE	Nordisk Ventilator AB	www.nordiskventilator.se
SI	Agregat d.o.o	www.agregat.si
SK	TZB produkt, s.r.o.	www.tzbprodukt.sk

GERMANY

Komfovent GmbH
Konrad-Zuse-Str. 2a,
42551 Velbert, Deutschland
Tel. +49 0 2051 6051180
info@komfovent.de
www.komfovent.de

LATVIA

SIA Komfovent
Bukaišu iela 1, LV-1004 Riga, Latvia
Tel. +371 24 66 4433
info@komfovent.lv
www.komfovent.lv

Vidzemes filiāle
Alejas iela 12A, LV-4219 Valmiermuiža,
Valmieras pagasts, Burtnieku novads
Tel. +371 29 358 145
kristaps.zaicevs@komfovent.com
www.komfovent.lv

komfovent®