C6 CONTROLLER

EN Functions description

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1. Start up

During start up (after start button was pressed) air damper outputs are activated. After 60 s. voltage to the fans and rotor heat exchanger is started. Independently from temperature conditions – heat exchanger are active for 3-15 minutes.

2. Rotor control

Each time when unit is started, rotor heat exchanger is forced start together with fans and runs for some time according the selected airflow: 100% - 3 min., 20% - 15 min. After the initial phase, temperature difference between outdoor (B3) and exhaust air (B2) is checked. If it is more than 1 degree, rotor is started if at leaset one of the conditions is met:

a. If heating is needed (supply temperature is lower than setpoint) and rotor can recover the heat (Exhaust temperature is higher than outdoor)
b. If cooling is needed (supply temperature is higher than setpoint) and rotor can recover cold (Exhaust temperature is lower than outdoor)

When conditions are not met – rotor is stopped with 90s. delay. Also rotor operation is blocked with 90s. delay in ECO mode if „Free cooling“ or „Free heating“ functions are active
From the temperature sensors B2, B3, B4, B14 readings, heat exchanger efficiency is calculated. If efficiency is dropped below 20% (configurable *„Lowest efficiency allowed“*), after 5 min. delay AHU operation is stopped and alarm F7 indicated.
Rotor operation signal is controlled according *PI* regulation, however it is converted to ON/OFF (0/230V) output. *PI* algorithm is programmed in case if in the future, rotor construction will be updated to be used with speed controlled motors.

2.1 Frost prevention

If AHU is OFF and any of the temperature sensors measure less than 5°C, rotor is started for 30s. with 30 min. intervals. Function indication: *C6-> status rotor_hx_antifreezecleaning_running = 1.*

2.2 Training function

If during AHU operation rotor is not running for more than 4 hours, it is started for 1 min. Function indication: *C6-> status rotor_hx_antifreezecleaning_running = 1.*

3. Plate exchanger by-pass control

By-pass damper is operated according the same algorithm as rotor exchanger. When there is no need for heat/cool recovery – by-pass damper opens, so outdoor air is allowed to pass around the exchanger. When AHU is OFF, by-pass is fully open and exchanger closed. When Heat recovery is needed, by-pass damper is closing, while airflow through the exchanger is opening.

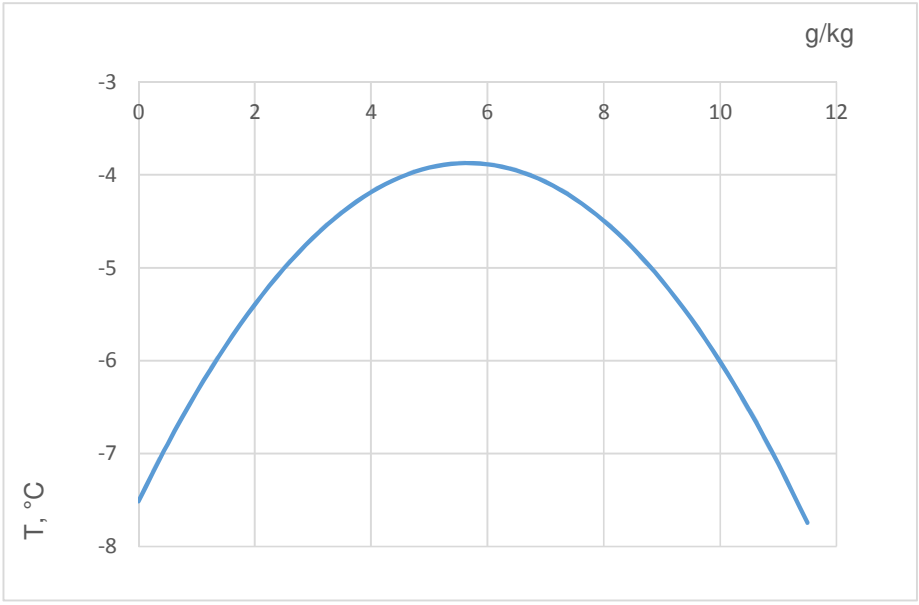
4. Plate exchanger frost prevention

AHU with counter flow plate exchangers (CF) has automatic frost prevention algorithm, which turns on electrical pre-heater when high indoor humidity and low outdoor temperatures may lead to freezing of the exchanger. Power of the pre-hearer is alternating according outdoor temperature, humidity amount in the room air (g/kg) and airflow intensity. Pre-heater operates on demand only as much as needed and as long as needed. When the inside humidity is low the heater may stay off even in the case of low outside temperatures.
Frost prevention:
• **On** – preset automatic protection with the integrated electric pre-heater.

• **Off** – the protection may be turned off however the ventilation device will operate only in the specific range of the outside temperatures. As soon as the outside temperatures drop below -4°C the device will turn off after 60 min. and will indicate F8 (Heat Exchanger Icing) alarm.
• **External heater** – this option allows activation of protection by external heater which is installed before the AHU in the outdoor air intake duct instead of integrated pre-heater. The control of the external pre-heater is provided via 0…10V signal from AUX terminals 9, 10 of main board.

Settings for the indoor humidity:
• **Auto** – indoor humidity is determined automatically according humidity sensor inside of the control panel or according to external humidity sensors. External sensors should be configured as type RH and connected to the main board contact terminals B8, B9. For the freezing prevention algorithm it will be used integrated or external humidity sensor, which gives highest actual value.
• **10...90%** - fixed indoor humidity value can be set, in cases if control panel is not used or mounted in the inappropriate place and there are no external humidity sensors. Humidity value must be set as close to the real value as possible, otherwise frost prevention may work incorrectly and CF exchanger may freeze.

According to the temperature and humidity in the room it is calculated relative humidity amount in the air (g/kg) and freezing point temperature is determined based on the curve:



Because of uneven pre-heater heat distribution over the surface of CF exchanger, temperature offset is added (configured for each type of the AHU) and in such a way temperature $T_{freezing}$ is determined, which is used as a set-point for the pre-heater. Pre-heater power needed to reach $T_{freezing}$ is calculated based on actual intake air from outside temperature and supply airflow. If with full pre-heater power it is still not possible to reach actual temperature higher then $T_{freezing}$, both fans is slowed down for 5% in 5 min. intervals.

5. Operation modes

Fan intensity for each operation mode (default settings):

Mode	Supply fan	Exhaust fan
Away	20%	20%
Normal	50%	50%
Intensive	70%	70%

Boost	100%	100%
Kitchen	80%	20%
Fireplace	60%	50%
Override	80%	80%
Holidays*	20% x 30min	20% x 30min

*premises will be ventilated for 30min. several times a day (can be configured up to 4 times)

From the control panel KITCHEN, FIREPLACE and OVERRIDE modes are set for time range from 1 to 300 min. In HOLIDAY mode, the time interval can be set from 1 day to 90 days, or a specific date can be selected. KITCHEN, FIREPLACE and OVERRIDE modes can be activated by external contacts connected to the main controller board. Mode activation by external contact has a priority over control panel selection. In KITCHEN, FIREPLACE, OVERRIDE and HOLIDAYS modes the unit will always operate only in the CAV mode, regardless of the selected flow control.

5.1 ECO mode

ECO – an energy-saving mode to minimize the power consumption of the air handling unit. The ECO mode has three-fold operation effects:

• Blocking the electric heater operation in the air handling unit, and blocking of all external air heating/cooling elements.

• Activation of the free cooling function, which at some point blocks the heat recovery process, if the outdoor coolness has to be used in an energy-efficient way. Cooling with the outdoor air automatically starts if the room air temperature is above a set value, and the outdoor air temperature at that time is lower than that in the room but not below the set min. value. Similarly, in the case of the opposite temperature conditions. Free heating is carried out.

• As the temperature control with heat recovery alone will not be ensured at all times, in the case of an extreme conditions, when the supply air temperature is below the specified minimum value (in winter) or exceeds the maximum value (in summer), the unit will try to maintain the temperature by decreasing the ventilation intensity. If the temperature does not reach the required min./max. limits over a long period of time, the air volume can be reduced to the lowest possible value (20%).

5.2 AUTO mode

AUTO – an automatic operation mode when the unit is operating and changing the ventilation intensity based on the chosen (pre-set) weekly operating schedule. If at least one air quality sensor is connected to the air handling unit, the AUTO key will activate the automatic air quality control function. Then, the ventilation intensity is adjusted, not according to the schedule, but according to the current air pollution in the room.

5.3 Air Quality

When the external air quality or humidity sensors are connected to the control terminals, automatically activates the air quality control, and the “Scheduling” menu item is replaced by “Air Quality”. In order for the unit to operate in the AUTO mode not according to the air quality, but according to the weekly schedule, this function can be deactivated.

Air quality control is provided with the several sensors. Their types are configured as follows:

CO2 – Carbon dioxide concentration sensor [0...2000 ppm];

VOC – Air quality sensor [0... 100%];

RH – relative humidity sensor [0... 100%].

The air quality control will automatically regulate ventilation intensity in the range of 20...70%. If necessary, the range may be adjusted.

If the minimum ventilation intensity is set to 0%, the air handling unit will be allowed to turn off when the air quality in the room meets the required value. However, the unit will turn on 20% speed for 15 min. periodically every 2 hours (configurable), to check the air quality in a room. If after checking, the air pollution does not exceed the set value, the air handling unit is switched off. However, if after checking the air quality is poor, the air handling unit will continue its operation until the room is ventilated. Fans speed will be changed automatically

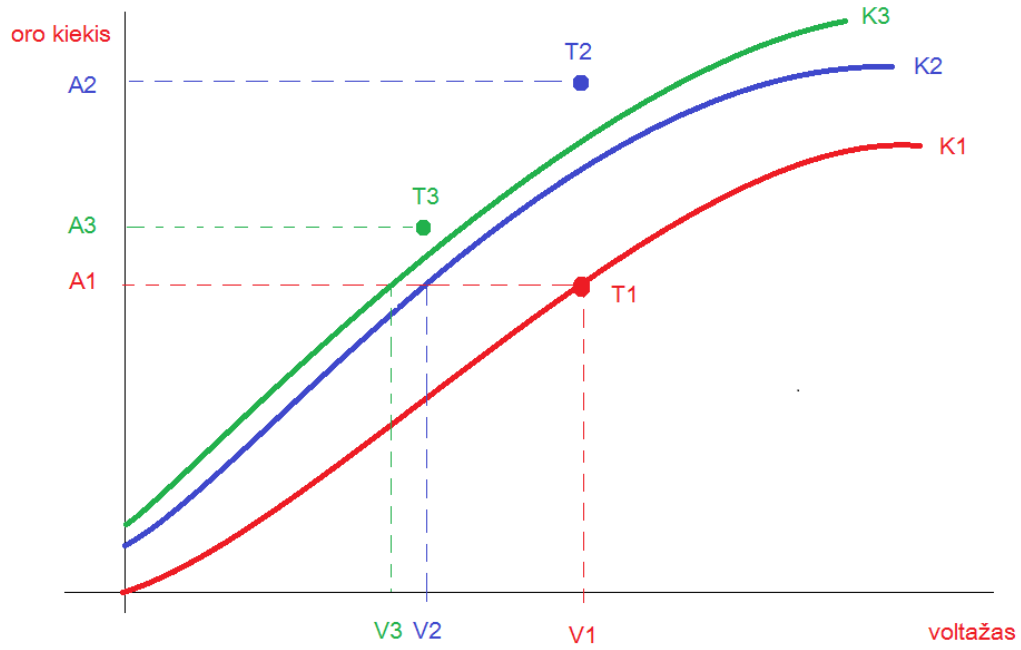
according *PI* regulation based on the air quality sensor reading, but will not exceed maximum limit – default 70% (configurable)

6. Fan control

By default unit operates without airflow control and fans run constant speed which was selected by the user. Fans are controlled by 0-10V signal, which corresponds to 0-100% of the user setting.

6.1 CAV

Constant air volume set by the user is supplied and extracted. During first start of the unit initial airflow calibration is done automatically. In the theoretical curve (tested in the laboratory for each unit type) K1, using user selected airflow A1 it is determined point T1, which allows to find initial fan voltage V1. Controller in 45s intervals is measuring airflow and out of the 5 measurements an average reading A2 is calculated. New point T2 is determined. Curve is moved closer to the T2 point (median value of previous curve and new point) and new curve K2 is generated. From K2 new fan voltage V2 is selected. All process is repeated until actual air volume will reach ±10% of the set airflow, so initial airflow calibration will be over and additional airflow related functions is allowed (for example “Airflow correction”). Airflow measurement is performed constantly in 45s. intervals, if CAV or DCV airflow control modes are selected.



If in 45 s. temperature changes more than 5°C (for example heater has started), CAV control is temporary disabled until temperature will stabilize.

If after initial calibration actual airflow do not correspond to the values shown on the control panel, there is an option to correct supply and exhaust airflows by +/-30% for CAV or DCV airflow maintenance modes. To apply airflow correction it is recommended that fan intensity is at least 50%.

6.2 VAV

Variable air volume control mode. The unit will supply and exhaust the air volume depending on the ventilation needs in different rooms, i.e., the constant pressure in the system will be maintained by the variable air volumes. After selecting the VAV flow control, the user will have to set the pressure maintained by the

ventilation system for each of the four modes. In VAV mode air quality function will be disabled and AUTO button will activate the weekly operation schedule

6.3 DCV

Directly Controlled Volume. The air handling unit will operate similarly as in the CAV mode, but air volumes will be maintained directly in accordance with the values of the B6 and B7 analog input signals. After giving the signal 0... 10 V to the appropriate input, it will be converted according to the current determined air volume, where 2V=20%, and 10V is user selected airflow for the actual mode. If calculated airflow will be in 15-20% limits, unit will run on 20%. If control signal will fall below 1,6V (if the unit just started) or 1,4V (if the unit was running) – corresponding fan will stop.

7. Temperature maintenance

The air handling unit has several temperature maintenance methods:
• Supply. The unit supplies the air at the user-defined temperature.
• Extract. The unit maintains extract air temperature, by regulating supplied air temperature automatically.
• Room. The unit control the ambient temperature, according to the temperature sensor in the panel.
• Balance. The temperature control value of the supply air is automatically set on the basis of the current extract air temperature, i.e. what the air will be removed from the premises, and the same will be returned back.

8. Electrical heater control

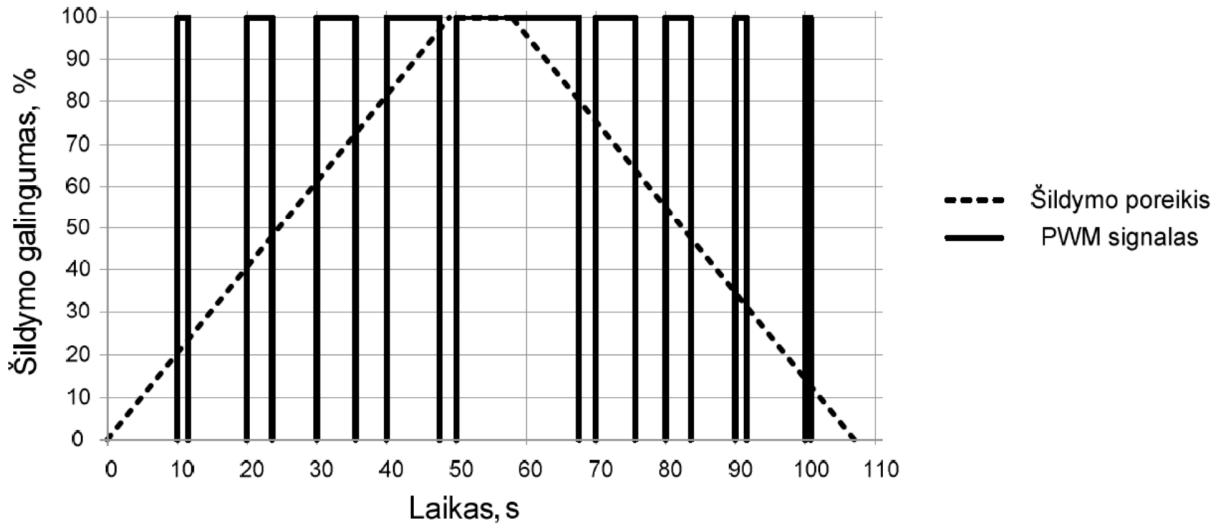
8.1 Pre-heater (CF units)

Needed power for the pre-heater is calculated according frost prevention algorithm. Pre-heater is controlled by PWM signal with period of 10s. After stopping the unit, pre-heater is cooled down with fans the same way as the main electrical heater. Constantly it is measured total power of pre-heater and fans and in case if power reading falls below 80% of the total pre-heater power (configured for each unit type), unit is stopped with an alarm F6 (Electric Heater Overheat).

8.2 Main heater

Electrical heater is controlled by PWM signal. When the unit is running, heater signal is regulated by *PI* regulation, depending on the heating demand of supply air, when the heat recovery is not enough.
If electrical heater works on 100% power and temperature difference between B10 and B1 sensor readings is less than 3°C, after 5 min. delay, unit is stopped with an alarm F6 (Electric Heater Overheat). Exception is R300V unit modification, where B10 is mounted after the main heater. On such construction unit temperature before the heater is calculated according outdoor temperature and rotor heat-exchanger efficiency. This calculated temperature is compared with actual B10 readings and if the difference is less than 3°C, after 5 min. delay, unit is stopped with an alarm F6 (Electric Heater Overheat).

Elektrinio šildytuvo PWM valdymo pavyzdys:



8.3 Electrical heater cool down

When unit is stopped during operation of main heater or pre-heater, 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.

9. Water heater control

For activation of external, duct mounted water heater control, in the user settings it is needed to select "External heater" and to set its type as "Hot water". Control signal 0-10V for water valve is given out of the TG1 output on the main board (terminals 3,4,5) according *PI* regulation. Return water sensor B5 must be installed, insulated and connected to the main board in order to get water coil frost protection.
Heating with hot water coil is activated when all conditions are met:

a. Supply airflow is above 20%
b. Supply temperature setpoint is not reached
c. Recuperation signal has reached maximum or recuperation is not active because of temperature conditions.
d. Earlier stage heating/cooling signal has reached

Water heater operation is blocked in ECO mode, when „Free heating" function is active (except coil frost protection).

9.1 Water heater frost protection

Water heater frost protection starts when temperature measured by B1 sensor (if B1 not used, other temperature sensor readings are checked) is lower than 8°C (fixed value) and if temperature before the water coil (measured or calculated) is equal or bellow „Min. protection temperature" (configurable). In case when frost possibility appears, 3-way valve is opening and according *PI* regulation following return water temperature (B5) is maintained:

- 20°C, when supply fan is working. Temperature can be changed in *service* level *„Protection temperature when AHU is ON"*
- 35°C, when supply fan is stopped or AHU is OFF. Temperature can be changed in *service* level *„Protection temperature when AHU is OFF"*

3-way valve control signal, needed to reach return water temperature is calculated according PI regulation with parameters *„freeze kp“* and *„freeze ki“*. After that two calculated signals are compared: valve opening signal needed to reach return water temperature and valve opening signal needed to reach air temperature setpoint. For 3-way valve control it is used higher signal.
If return water sensor (B5) measures temperature lower than 10°C (fixed value) – 3-way valve is opened 100%. If return water temperature drops below critical 8°C (configurable *„Alarm temperature“*), AHU is stopped without delays and F3 alarm indicated.
Watr heater frost protection can be deactivated by entering 0°C in the *service* level setting *„Alarm temperature“*.

9.2 Warning for insufficient coil temperature

When there is a heating demand and hot water heater starts additional conditions are checked:

a. Is return water temperature (B5) above air temperature after the heat exchanger (if there is no additional heaters installed or they are inactive)
b. Is return water temperature (B5) above air temperature before water coil (when earlier stage heaters are heating).

If conditions are not met, information warning W3 will appear with a 10 min. delay. Warning informs that water heater do not have a possibility to increase air temperature, because of too cold water in the coil, however water heater or AHU operation is not stopped.

10. Water cooler control

For activation of external, duct mounted water cooling control, in the user settings it is needed to select “External heater” and to set its type as “Cold water”. Control signal 0-10V for water valve is given out of the TG1 output on the main board (terminals 3,4,5). Control algorithm is analogical with water heater control.
Water cooler operation is blocked in ECO mode, when „Free cooling“ function is active.

11. Circulation pump control

Circulation pums are running on demand and starts when signal for water heating/cooling appears. Pumps are stopped with a 5 min. delay.
Circulation pump training function starts the pumps for 2 min. (Configurable *“Train time”*) if it was not running for 12 h. (configurable *“Train interval”*). After pump training is over, 3-way valves are also opened and closed for the same duration.

Hot water pump is started additionally if:
- Water coill frost protection is active
- Supply fan is working and outdoor temperature (B3) is below 0°C, pump is started for 2 min. (configurable „Train time“) each 30 min. (fixed value).

12. DX control

For activation of external, duct mounted DX unit control, in the user settings it is needed to select “External DX unit”. Control signal 0-10V for capacity is given out of the DX output on the main board (terminals 6,7) according *PI* regulation. DX unit switching between cooling and heating modes comes out of the digital outputs of the main board (terminals 17,18,19)
DX is started with a 1 min. delay, when all of the following conditions are met:
a. Supply airflow is above 20%
b. Supply temperature setpoint is not reached
c. Recuperation signal has reached maximum or recuperation is not active because of temperature conditions.
d. Earlier stage heating/cooling signal has reached
e. Outdoor temperature is above minimum temperature of -10°C (configurable *„Lowest outdoor temperature“*) allowed for DX operation.

DX operation is blocked in ECO mode, when „Free heating“ or „Free cooling“ functions are active.

13. Heater priorities

In the “Control sequence” advanced settings you can set up to 3 levels of control and set heater priorities. Only the default Stage 1 control is activated in the factory for an electric heater – but additionally it can be activated duct mounted water heater or DX unit and set their operating sequence. Also it is possible to completely turn off any of the heaters/coolers.

14. Alarms and messages :

Code	Message	When it appears
F1	Supply Flow Not Reached	If 20% of AHU maximum airflow is not reached. Delay 5 min.
F2	Exhaust Flow Not Reached	If 20% of AHU maximum airflow is not reached. Delay 5 min.
F3	Water Temp B5 To Low	If return water temperature <8C (configurable). No delay
F4	Low Supply Air Temperature	If supply air temperature <+5C (configurable). No delay
F5	High Supply Air Temperature	If supply air temperature >+45C (configurable). No delay
F6	Electric Heater Overheat	See description in 8.1 and 8.2
F7	Heat Exchanger Failure	Rotor efficiency is below 20% (configurable). Delay 5 min.
F8	Heat Exchanger Icing	Plate exchanger efficiency is below 20% (configurable). Delay 5 min
F9	Internal Fire	Temperature B1>70C, or B2 >50C.
F10	External Fire	
F11	Supply Air Temp B1 Short	
F12	Supply Air Temp B1 Not Connected	
F13	Extract Air Temp B2 Short	
F14	Extract Air Temp B2 Not Connected	
F15	Outdoor Air Temp B3 Short	
F16	Outdoor Air Temp B3 Not Connected	
F17	Exhaust Air Temp B4 Short	
F18	Exhaust Air Temp B4 Not Connected	
F19	Water Temp B5 Short	
F20	Water Temp B5 Not Connected	
F21	Supply Temp After Hx B10 Short	
F22	Supply Temp After Hx B10 Not Connected	
F23	Flash Fail	
F24	Too Low 24V Supply Voltage	Less than 23V
F25	Too High 24V Supply Voltage	More than 26V
F26	24V Supply Voltage Overloaded	More than 40W during start-up
F28	Room Temperature Sensor Fail	
F29	Room Humidity Sensor Fail	
W1	Change Air Filter	
W2	Service Mode	
W3	Water Temp B5 To Low (Warning)	Gives a warning when water heater cannot increase air temperature because of cold water. See 9.2.