Functional Description:

AHU equipped with AHC-3000 Controller

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AHU equipped with OJ-Air2 Controller

Revision	Initials	Date	Item	Changes/Updates
01	JBA	24-06-2020	All	First version

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1. Introduction to AHC-3000

1.1. A pre-programmed and configurable AHU control solution

The AHC-3000 system is a complete control solution for an Air Handling Unit (AHU), pre-programmed and configurable. A range of standard operation modes and configurations are supported and ready for use. Available features in a specific AHU depends on the installed components and actual configuration.

1.2. This documents scope

The goal for this document is to provide a short high-level description of the most frequently used functions in a standard AHU. The descriptions can be used as basis for:

- Text for tenders.
- Functional description in sales documentation.
- Technical information to Sales support.
- Technical information for Commissioning engineers.
- Technical information for Service crews.

1.3. Other documents

Detailed information for each standard component in the AHC-3000 system are available in the corresponding instructions and documentation at https://www.ojelectronics.com. Further detailed information is available at OJ Electronics Customer log-in.

1.4. Selection of applicable text

Since an AHU can be designed with different hardware and options, great care shall be taken when selecting applicable texts for a specific AHU. It is strongly recommended to perform a review by the Engineering department before publishing any extracts from this document.

2. Functional Description

2.1. Fan control loops

Depending on the installed hardware the AHU fans are controlled on/off by relays or by variable speed drives. The variable speed drives are controlled by either 0-10V signal or Modbus RS485.
Some fan control loops requires pressure transmitters in the ventilation ducts and at the fan inlet cones.

2.1.1. Constant Pressure

The Supply and Extract fan speeds are individually controlled to maintain duct air pressure according to the setpoints (Pa). The duct pressure is maintained even in case of Variable Air Volume (VAV) dampers in ducts.

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

Setpoint range: 20 - 3.000 Pa depending on Pressure transmitter type.

2.1.2. Constant airflow

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

- The Inlet cone pressure in the fans shall be measured by pressure transmitters.

Setpoint range: 5 - 100.000 m3/h depending on Max. Airflow settings.

2.1.3. Extract air slave (Air volume)

The Extract fan speed are controlled to maintain the same Extract air volume as measured in the Supply air duct with an optional offsett up to +/-50%. Balanced ventilation is maintained even in case of Variable Air Volume (VAV) dampers in the supply duct and none in the extract duct.

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

2.1.4. Extract air slave (Fan speed)

The Extract fan speed are controlled to maintain the same fan speed as the Supply air fan speed with an optional offsett up to +/-50%. Duct pressure and air volume are unregulated and depends on actual loads and internal pressure drops e.g. in filters.

- No sensors required.

2.1.5. Supply air slave (Air volume)

The Supply fan speed are controlled to maintain the same Supply air volume as measured in the Extract air duct with an optional offset up to +/-50%. Balanced ventilation is maintained even in case of Variable Air Volume (VAV) dampers in the extract duct and none in the supply duct.

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

2.1.6. Supply air slave (Fan speed)

The Supply fan speed are controlled to maintain the same fan speed as the Extract air fan speed with an optional offset up to +/-50%. Duct pressure and air volume are unregulated and depends on actual loads and internal pressure drops e.g. in filters.

- No sensors required.

2.1.7. Constant VOC/CO_2

The Extract fan speed is controlled to maintain Extract air quality according to the setpoint (ppm). The air volume decreases to the Min. airflow setpoint in case of low VOC/CO_2

- The Extract duct or room Air Quality shall be measured by a VOC or CO_2 transmitter.
- The Supply fan shall be set to Slave operation in order to get balanced ventilation.

Setpoint range: 0 - 10.000 ppm depending on used transmitter.

2.1.8. Constant VOC/CO_2 (Supply air unit)

The Supply fan speed is controlled to maintain room air quality according to the setpoint (ppm). The air volume decreases to the Min. airflow setpoint in case of low VOC/CO_2

- The room Air Quality shall be measured by a VOC or CO_2 transmitter.

Setpoint range: 0 - 10.000 ppm depending on used transmitter.

2.1.9. GreenZone

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

- The OJ ZoneMaster is a part of an OJ Electronics GreenZone system.
- Fan setpoints are communicated by Modbus RS485 between AHC-3000 and OJ-ZoneMaster.

2.1.10. Constant motor speed %

The Supply and Extract fan speeds are individually controlled by fixed setpoints.
Duct pressure and air volume are unregulated and depends on actual loads and internal pressure drops e.g. in filters.

- No sensors required.

Setpoint range: 0 – 100 %.

2.1.11. Constant Humidity

The Extract fan speed is controlled to maintain Extract air humidity according to the setpoint (RH%). The air volume decreases to the Min. airflow setpoint in case of low humidity.

- The Extract or room Air humidity shall be measured by a Relative humidity transmitter.
- The Supply fan shall be set to Slave operation in order to get balanced ventilation.

Setpoint range: 0 - 100 %RH.

2.1.12. Constant Humidity (Supply air unit)

The Supply fan speed is controlled to maintain room air humidity according to the setpoint (RH%). The air volume decreases to the Min. airflow setpoint in case of low humidity.

- The room Air humidity shall be measured by a Relative humidity transmitter.

Setpoint range: 0 - 100 %RH.

2.2. Temperature control loops

Depending on the installed hardware a range of different coils and heat recovery devices can be used for heating. Some temperature control loops requires additional temperature sensors.

2.2.1. Constant Supply air

The available heating sources are controlled to maintain the Supply air temperature at the set-point (ºC, ºF). This control loop is used when the AHU shall supply ventilation air.
Other systems shall control the temperature in the building.

- The Supply air temperature shall be measured by a duct temperature sensor (PT-1000/NTC 12K).

Setpoint range: 5 – 40 ºC.

2.2.2. Constant Extract air

The available heating sources are controlled to maintain the Extract air temperature at the set-point (ºC, ºF). The Supply air temperature is kept within minimum and maximum limit setpoints. This control loop is used when the AHU shall control the average temperature in a building.

- The Supply and Extract air temperature shall be measured by duct temperature sensors (PT-1000/NTC 12K).

Setpoint range: 5 – 40 ºC.
Supply air Min. limit setpoint 0 - 30ºC, Supply air Max. limit setpoint 8 – 50 ºC.

2.2.3. Constant Room

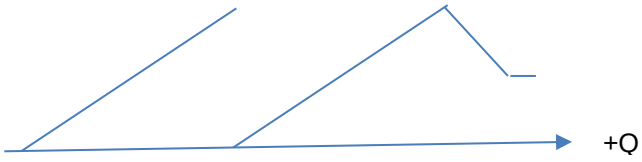
The available heating sources are controlled to maintain the Room air temperature at the setpoint (ºC, ºF). The Supply air temperature is kept within minimum and maximum limit setpoints. This control loop is used when the AHU shall control the temperature in a specific room.

- The Supply air temperature shall be measured by a duct temperature sensors (PT-1000/NTC 12K).
- The room temperature shall be measured by a room temperature sensor (0-10V = 0 to +50 ºC, OJ-Air2-HMI-20T, TTH-6040-W).

Setpoint range: 5 – 40 ºC.
Supply air Min. limit setpoint 0 - 30ºC, Supply air Max. limit setpoint 8 – 50 ºC.

2.2.4. Control sequence Heating

The heating control sequence uses the installed heating sources in this sequence.
Sources not installed in the AHU are skipped by the control loop.



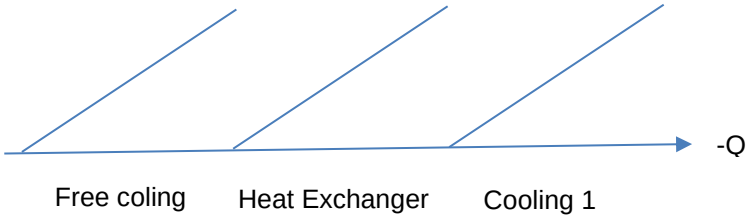
Heat Exchanger Heater 1 Fan speed

Mixing dampers can replace the Heat Exchanger.

2.2.5. Control sequence Cooling

The Cooling control sequence uses the installed Cooling sources in this sequence.

Sources not installed in the AHU are skipped by the control loop.



Mixing dampers can replace the Heat Exchanger.

2.3. Heat recovery

Depending on the installed hardware Heat recovery are controlled on/off by relays or by a modulating actuator. Modulating actuators are controlled by 0-10V signals.
Some frost and ice protection control loops requires a temperature sensor or pressure transmitters.

2.3.1. Cross flow heat exchanger (Plate Exchanger)

The heat recovery is controlled by a set of modulating by-pass dampers splitting the freshair between the Cross flow heat exchanger and the by-pass duct to the supply air.

- Outdoor Air, Supply Air and Extract Air temperatures shall be measured by duct temperature sensors (PT-1000/NTC 12K).

Ice protection
The principle for protection against ice build-up in the Exhaust channel depends on the installed hardware.

A. **Exhaust temperature**
If the Exhaust temperature drops below the ice protection setpoint, then the by-pass damper is overridden to increase the by-passed air volume.

- The Exhaust temperature shall be measured by a duct temperature sensor (PT-1000/ NTC 12K).

B. **Dynamic Pressure drop**
If the heat exchanger pressure drop from Extract to Exhaust increases above a flow dependent ice protection setpoint, then the by-pass damper is overridden to max. by-passed air volume during a de-icing cycle. This principle increases the heat recovered at low temperatures if the Extract air humidity is low and the air volume is variable.

- The Heat Exchanger pressure drop shall be measured by a pressure transmitter.
- The Inlet cone pressure in both fans shall be measured by pressure transmitters.

Setpoint range: +30 to +100 % deviation from reference pressure drop.

2.3.2. Rotary heat exchanger (Energy wheel)

The heat recovery is controlled by adjusting the rotation speed of the heat recovery wheel.

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

Rotation speed

The principle for controlling the rotation speed depends on the installed hardware.

A. **Fixed speed**. The heat recovery are controlled On/Off. This might be OK in a large room having high ceilings where the supply air temperature not is important.
   - The rotor shall be controlled by a motor having fixed speed.

B. **Variable speed**
   The supply temperature are controlled precisely at low outdoor temperatures and operate On/Off at medium outdoor temperatures. In a building having low ceilings there can be some complaints due to fluctuations in the supply temperature, which inhibits the Coanda effect and occasionally results in cold draft.
   - The rotor shall be controlled by at variable speed drive with 1:10 speed ratio.

C. **Variable speed Stepper motor**
   The supply temperature are controlled precisely at all outdoor temperatures.
   This is the correct solution for buildings having low ceilings.
   - The rotor shall be controlled by at variable speed drive and a stepper motor with 1:100 speed ratio. E.g. the DRHX rotor drive.

2.3.3. Counter flow heat exchanger

See section 2.3.1 Cross flow heat exchanger.

2.4. Heating coils

Depending on the installed hardware heating is controlled on/off by relays or by a modulating valve actuator. The modulating valve is controlled by a 0-10V signal. Some heating coils requires an additional temperature sensor for frost protection.

2.4.1. Electric heating coils

The principle for controlling the Electrical heating depends on the installed hardware.

A. 0-10V: The electrical heating power is modulated.
   - The 0-10V output signal shall be used to modulate the output from e.g. a triac power controller.

B. 1 step: The electrical heating power is controlled in two steps.
   - Heating coil section 1 shall be turned on at heating demand.
   - Heating coil section 2 shall be turned on at heating demand above 50 %.

Min. Airflow (Air volume)

The electrical heater coils is protected against overheating by a flow dependent output power limit. Overheating is prevented even if the supply duct is blocked or the supply fan fails.

- The Inlet cone pressure in the supply fan shall be measured by a pressure transmitter.

Min. Airflow (Fan speed)

The electrical heater coils is protected against overheating by a Fan speed dependent output power limit.

- No sensors required.

2.4.2. Water heating coil

The water heating coil is controlled by a modulating heating valve controlling the hot water flow.

Frost protection
The modulating valve is overridden to increase the heat if the heating coil return water temperature drops below the frost protection setpoint.

- Heating coil return water temperature shall be measured by a pipe/water temperature sensor (PT-1000/NCT 12K).

Standby heating
The modulating valve is controlled to maintain return water temperature according to the Standby heating setpoint when the AHU is stopped.

- Heating coil return water temperature shall be measured by a pipe/water temperature sensor (PT-1000/NCT 12K).

Circulator pump
The circulator pump is On when the outdoor temperature is below 12ºC or there is a heating demand.

- The pump shall be controlled by a digital output.
- Outdoor air temperature shall be measured by a duct temperature sensor (PT-1000/NTC 12K) or an Outdoor temperature sensor (TTH-6040-O).

2.5. Cooling recovery

2.5.1. Cross flow heat exchanger (Plate Exchanger)

The cooling recovery is controlled by a set of modulating by-pass dampers splitting the freshair between the Cross flow heat exchanger and the by-pass duct to the supply air.

- Outdoor Air, Supply Air and Extract Air temperatures shall be measured by duct temperature sensors (PT-1000/NTC 12K).

2.5.2. Rotary heat exchanger (Energy wheel)

The cooling recovery is controlled by adjusting the rotation speed of the heat recovery wheel.

- Outdoor Air, Supply Air and Extract Air temperatures shall be measured by duct temperature sensors (PT-1000/ NTC 12K).

2.5.3. Counter flow heat exchanger

See section 2.5.1 Cross flow heat exchanger.

2.6. Free cooling

Basic Free cooling requires only temperature sensors. If Mixing dampers are installed please see section “Dampers”.

2.6.1. Free cooling

Cold outside air is utilised for energy effective cooling.

- Outdoor Air and Supply Air temperatures shall be measured by duct temperature sensors (PT-1000/NTC 12K).

2.7. Summer night cooling

The Summer night cooling functionality depends on the installed temperature sensors.

2.7.1. Summer night cooling: Standard sensors

Cold outside air during the night is utilised for energy effective cooling and increased comfort.
Summer night cooling starts a 10 minutes temperature test run once every night if the other conditions are met.

- Outdoor Air, Supply Air and Extract Air temperatures shall be measured by duct temperature sensors (PT-1000/NTC 12K).

2.7.2. Summer night cooling: Additional sensors

Cold outside air during the night is utilised for energy effective cooling and increased comfort.
Summer night cooling starts and restarts anytime during the night if the conditions are met.

- Supply Air temperatures shall be measured by duct temperature sensors (PT-1000/NTC 12K).
- Outdoor Air shall be measured by a dedicated Outdoor temperature sensor outside the ducts. (TTH-6040-O).
- Room temperature shall be measured by a dedicated room temperature sensor outside the ducts. (0-10V room sensor, TTH-6040-W or OJ-Air2-HMI-20T).

2.7.3. Summer night cooling: Conditions

The Summer night cooling only starts when:

- Operation mode is set to “Low speed” or operation mode is set to “Scheduler” and the AHU is in status ”Stop” or “Low speed”.
- There was less than 60 minutes heating demand between 12.00 noon and 23.59, during the latest operation period.
- The room temperature is above the set “Start room temperature”.
- The Outdoor temperature is min. 2 ºC below the Room/Extract temperature.
- The Outdoor temperature is above the set “ Outdoor temperature stop”
- The set “Start time” has been passed.

The Summer night cooling will stop when:

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

2.8. Cooling coil

Depending on the installed hardware cooling is controlled by a modulating valve actuator.
The modulating valve are controlled by a 0-10V signal.

2.8.1. Water cooling coil

The water cooling coil is controlled by a modulating cooling valve controlling the chilled water flow.

Circulator pump
The circulator pump is On when there is a cooling demand.

- The pump shall be controlled by a digital output.

2.8.2. Combi coil

The Combi coil is controlled by a modulating valve controlling the water or refrigirant flow.
The valve opens at heat demand if heating is available and opens at cooling demand if cooling is available.

Central Heating/cooling production
Digital input “Summer/Winter” shall be used to signal heating or cooling is available for the Combi coil.

- Summer operation and Cold water available. Summer/Winter input Closed.
- Winter operation and Hot water available. Summer/Winter input open.

Local Heating/cooling production
Digital outputs shall be used to start production of either heating or cooling for the Combi coil.

Standby heating
The modulating valve is controlled to maintain return water temperature according to the Standby heating setpoint when the AHU is stopped.

Circulator pump
The circulator pump is On when the outdoor temperature is below 12ºC or there is a heating/cooling demand.

- The pump shall be controlled by a digital output.
- Outdoor air temperature shall be measured by a duct temperature sensor (PT-1000/NTC 12K) or an Outdoor temperature sensor (TTH-6040-O).

2.9. Filters

Depending on the installed hardware are the Outdoor air filter and Extract air filter monitored by different methods.

2.9.1. Filter clogging: Timer.

The filter is monitored by a timer. An alarm is released when it expires and the filter needs replacement.
OBS: Only allowed in dedicated domestic ventilation units up to 1000m3/h according to EU 1253

Setpoint range: 367 days.

2.9.2. Filter clogging: Pressure switch

An alarm is released when the filter pressure drop reach the switching setpoint and the filter needs replacement. The current filter status OK/NOK is displayed in the Touch panel.

- Filter pressure drop shall be measured by a Pressure switch.

Setpoint range: Depends on installed Pressure switch.

2.9.3. Filter clogging: Static Pressure drop

An alarm is released when the filter pressure drop reach the alarm setpoint and the filter needs replacement. The current filter pressure drop is displayed in the Touch panel.

- Filter pressure drop shall be measured by a Pressure transmitter.

Setpoint range: 0 – 500 Pa.

2.9.4. Filter clogging: Dynamic Pressure drop

An alarm is released when the filter pressure drop reach the dynamic alarm setpoint and the filter needs replacement. The dynamic alarm setpoint is flow corrected and detects filter clogging even when the AHU not is operating at max. airvolume. The current filter pressure drop is displayed in the Touch panel.

- Filter pressure drop shall be measured by a Pressure transmitter.
- The Inlet cone pressure in the corresponding fan shall be measured by a pressure transmitter.

Setpoint range: +0 to +100 % deviation from reference pressure drop.

2.10. Dampers

Depending on the installed hardware dampers are controlled on/off by relays or by a modulating damper actuator. Modulating dampers are controlled by 0-10V signal.

2.10.1. OA, SA, RA, EA dampers

The Outdoor Air damper, Supply Air damper, Room Air damper and Exhaust Air damper are closed when the AHU operation stops. This protects the ductwork against bad weather conditions.

2.10.2. Mixing dampers: temperature

The Mixing dampers recirculates some of the extract air in order to save heating/cooling energy. The damper positions are controlled to min. fresh air if the current outdoor temperature not can be used for heating/cooling.

- Outdoor Air, Supply Air and Extract Air temperatures shall be measured by duct temperature sensors (PT-1000/NTC 12K).
- The Recircualtion Air, Outdoor Air and Exhaust Air damper shall be modulated.

Min. Fresh air mixing setpoint range: 0 - 100%.

2.11. Scheduler and Calendar

The built-in scheduler can automatically change the fan set point 6 times a day with individual settings each day of the week. Exceptions like e.g. vacation periods and holidays are set in the calendar function, which can handle 10 different time periods or repetitions.

2.12. PIR input (Boost speed)

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

- A PIR sensor shall be connected to a digital input.

2.13. Start input

The AHU can be started manually with a switch.

- A switch shall be connected to a digital input.

2.14. Smoke

The fans can be stopped by a smoke detector in the duct system.

- A Smoke detector shall be connected to a digital input.

2.15. Fire

The fans are individually controlled to a pre-installed set point in case of fire.

- A Fire detector shall be connected to a digital input.

2.16. Frost protection

The AHU operation is stopped if a frost thermostat detects low temperature in the supply air duct.

- A frost thermostat (e.g. capillary tube temperature switch) shall be connected to a digital input.

2.17. Connectivity

2.17.1. Modbus TCP/IP

A modbus TCP/IP server is included in the AHU controller for easy BMS integration using TCP/IP.

2.17.2. Modbus RTU

A Modbus RTU server is included in the AHU controller for easy BMS integration using RS485.

2.17.3. Cloud

A secure cloud connection is included the AHU controller for easy connection to OJ Air Cloud. The OJ Air Cloud service offers easy visualization, operation and maintenance.

- The AHU controller shall have access to the internet through the TCP/IP connector.
- The client shall create an account in the OJ Air Cloud

2.17.4. BasicBMS

A BasicBMS network is included in the AHU controller enabling low cost system integration of multiple decentralized ventilation units. All the connected AHU's can be monitored from a common 3,5" Touch panel for easy visualization, operation and maintenance.

- The AHC-3000 AHU controllers shall be connected into a BasicBMS network by cables suitable for Modbus RS485 communication.
- One BasicBMS network can handle up to 25 rooms.
- Each room can support up to 14 satellite AHU's located in the same room if multiple AHU's is required to operate in parallel due to ventilation / heating / cooling capacity or design requirements due to architecture.