
Functional description

Verhulst VKTrs v2.0*

Suitable for:

VKT Plus
Basic HR
Basic W

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*rs indicates control strategy

OC Verhulst is a trade name of Verhulst Klimaattechniek B.V., part of Orange Climate.

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1. Introduction

This document provides a functional description of the air handling unit control software. A brief explanation is given of how the unit is constructed, what the operating conditions are, what air conditions are required and how they are achieved. This description is based on the factory default settings. The software offers various additional possibilities for setting the controls and the control strategy. For further information on this, please refer to the Carel English manual for the software version mentioned.

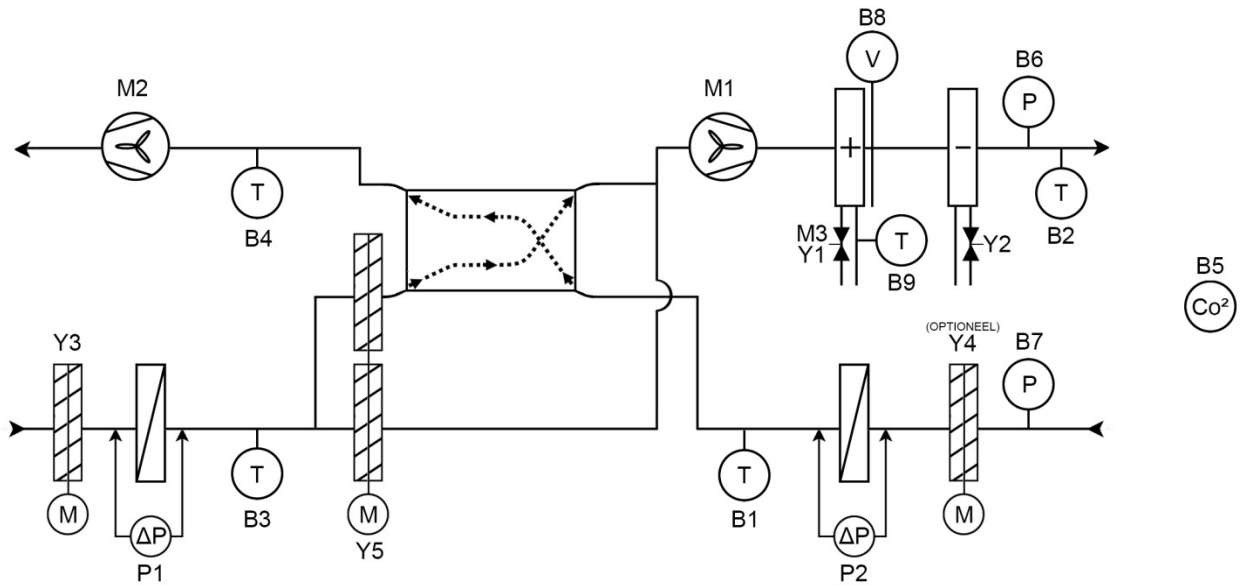
2. Verhulst VKTrs

The Verhulst VKTrs air handling unit controls are suitable for the following Verhulst unit types:

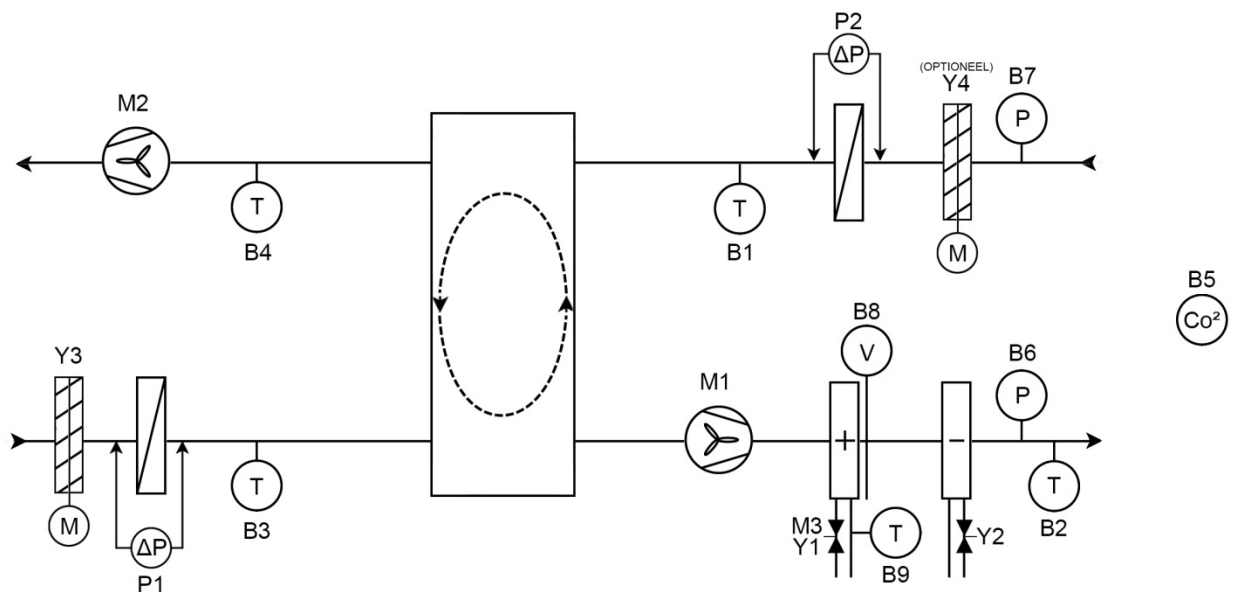
- VKTplus
- Basic HR
- Basic W

**If not type-specific, the description refers to a "VKT".

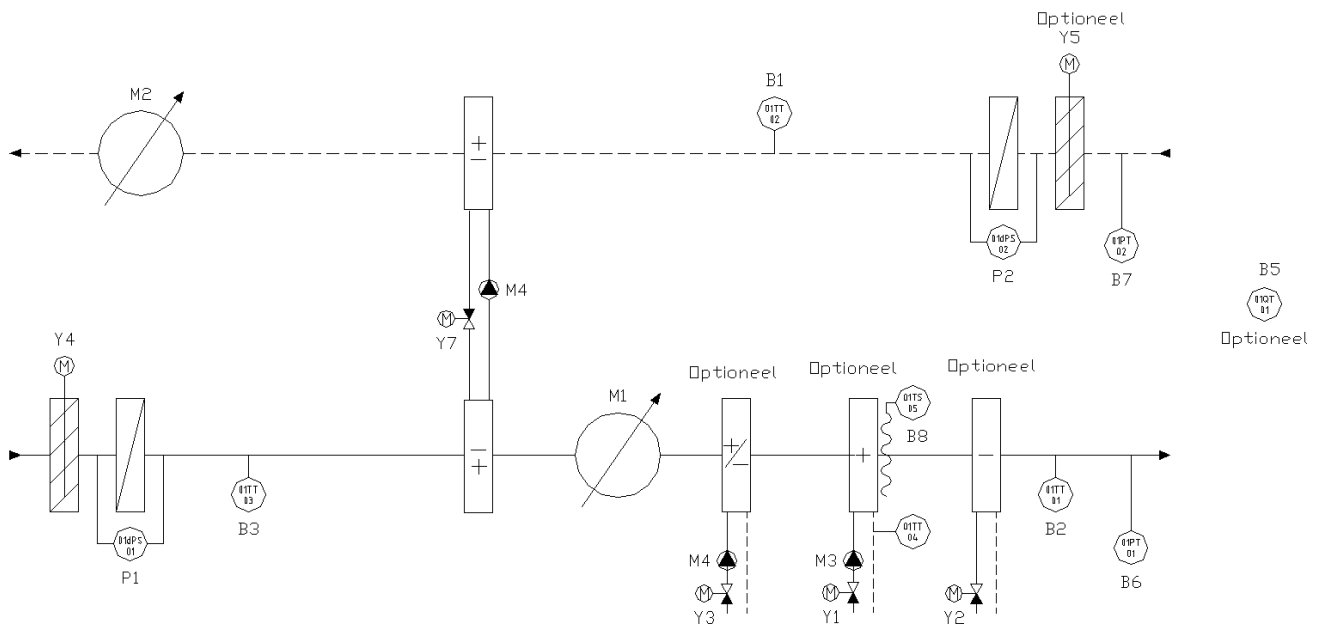
3. Construction of the air handling unit



1.1. HR counterflow plate exchanger version



1.2. Heat wheel version



- B1 - Exhaust air temperature sensor
- B2 - Supply air temperature sensor
- B3 - External air temperature sensor
- B4 - Temperature sensor plate heat exchanger/thermal wheel
- B5 - CO2 sensor (optional)
- B6 - Pressure sensor (optional)
- B7 - Pressure sensor (optional)
- B8 - Heater frost protection sensor
- P1 - Differential pressure gauge supply filter monitoring
- P2 - Differential pressure gauge return filter monitoring
- P3 - Differential pressure gauge heat plate exchanger (optional)
- Y1 - Three-way heating damper with servomotor
- Y2 - Three-way cooling damper with servomotor
- Y3 - Three-way change-over damper with servomotor
- Y4 - External air suction damper
- Y5 - Return air suction damper (optional)
- Y6 - Modulating damper for plate heat exchanger bypass (Basic HR)
- M1 - Supply air fan
- M2 - Return air fan
- M3 - Heating pump release
- M4 - Change-over pump release

The following is included in the control system for the units above:

- Switch-on commands;
- Status notifications;
- Fault messages;
- Temperature control circuits;
- Flow / pressure control circuits.

4. Functional description of the Verhulst VKTrs

The parts are described in the order of the direction of airflow. The order may be different for a VKTplus.

4.1. External air suction damper

The air flow is cut off when the VKT is out of operation by means of an air damper, fitted with a servo drive, in the suction part of the VKT. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Control open/closed air damper, (this is combined with a return air damper in the Basic model)

Strategies / Controls:

- When the VKT is started, the external air damper opens first. Only then is the supply air fan started.

4.2. External air suction filter

The suction air is filtered through a filter section in the suction part of the VKT. A pressure differential switch across the filter signals when the filters have reached their terminal resistance. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Dirty filter notification, pressure differential switch across filter. (With the Basic model, this is combined with a return air filter);

Strategies / Controls:

- If the pressure difference exceeds the set "dirt filter" value (default 250 Pa), the pressure differential switch signals this to the controller and a non-urgent fault is generated.

4.3. Heat recovery

4.3.2. HR counterflow exchanger

A High Efficiency countercurrent plate heat exchanger enables the energy present in the exhaust air to be used to heat or cool the supply air. Heat recovery capacity control is included in the sequence control. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Exhaust temperature sensor.

Strategies / Controls:

- The control signal for the control unit is PI controlled based on the deviation from the calculated intake temperature;
- The heating / cooling function is determined according to the measured return and intake temperature, this is also known as supply / demand control;
- When cooling or heating is active, heat recovery at 0% or 100% is used according to the measured return and intake temperatures.
For example:
If, in "cooling" mode, the return temperature is lower than the intake temperature, the capacity of the heat recovery system is fully used (100%). An adjustable hysteresis (default + / - 2K) with adjustable time delay (default 1:00 min) is taken into account;
- The exhaust temperature prevents the heat exchanger from freezing. This is done by opening the bypass damper if the exhaust temperature falls below the setting by -1°C. If there is no heater, the above has an effect on the supply air temperature.

General:

- **If the anti-freeze protection is active and no heater is included in the AHU, cold external outside air is blown in for some time.**

4.3.3. Heat recovery bypass damper section

A full face bypass damper section is included to control the heat recovery capacity. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Servomotor control volume control damper 0-10V, for heat recovery capacity control.

Strategies / Controls:

- The control signal for the control unit is an analogue one based on the deviation from the calculated intake temperature (see also WTW unit description);
- At 0% (control signal 10V) required capacity, the heat exchanger is fully utilised and the damper section of the bypass part is fully closed;
- At 100% (control signal 0V) required capacity, the heat exchanger is fully closed and the bypass part is fully open.

4.3.4. Thermal wheel

The energy and moisture present in the exhaust air is used to heat, cool or humidify the supply air using a thermal wheel. The heat recovery capacity control is included in the sequence control and is temperature-controlled. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Thermal wheel motor control, 0-10V;
- Thermal wheel fault;
- Return air temperature sensor;
- External air intake temperature sensor.

Strategies / Controls:

- The control signal for the control unit is PI controlled based on the deviation from the calculated intake temperature;
- The heating / cooling function is determined according to the measured return and intake temperature, this is also known as supply / demand control;

4.4. Supply air fan

The supply air volume is controlled with a regulated fan. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Regulated fan control 0-10V or ModBus; (ModBus only for EC fans in the Basic model);
- Fan fault.
- Measurement of air flow rate across the supply fan (optional) or measurement of supply duct pressure (optional);
- Air quality measurement (CO₂) (optional).

Strategies / Controls:

- The control signal for the control unit can be set to a fixed control or it can be PI controlled based on the deviation from the required flow rate, the deviation from the required duct pressure (optional) or air quality (optional);
- The actual flow is calculated using the pressure measured across this fan (if flow control is active) as a reference.

4.4.2. Supply air fan flow monitoring (if pressure sensor is present)

Belt breakage/flow monitoring according to the pressure measurement over the fan or in the supply duct. If the pressure does not exceed a set value (default 25Pa) after activation of the fan, the unit is switched off due to the delayed message "Flow monitoring" (default 1:00 min).

4.5. Hot water heater (optional)

A hot water battery is included in the supply air flow for (re)heating the intake air. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Control unit 0-10V, for heater capacity control;
- Circulation pump release;
- Circulation pump fault;
- Return water temperature measurement.
- Pump group maximum current 2A for the VKTplus. (not available for the Basic)

Strategies / Controls:

- The control signal for the control unit is PI controlled based on the deviation from the calculated intake temperature;
- To prevent frost-related issues, a minimum position for the control signal is maintained according to a heating curve;
- The pump control is switched on when there is heat demand from the control;
- Periodic pumping: To prevent jamming, the circulation pump control is switched on for 30 seconds if the pump has been off for 7 consecutive days;
- If the external air intake temperature falls below the set frost limit (default 5°C), the control for the pump will always be switched on;

-
- When the frost thermostat is triggered (if present), the fans are switched off, the ambient dampers close and the control signals for the pump and control damper for the hot water circuit are forced to 10V. The control damper of the cooler is directed to 50%. The fault is locked by the software until a reset has been performed. This is reported as an urgent fault.

4.6. Electric heater (optional)

The unit can be fitted with an electric heater to reheat the supply air. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Capacity control 0-10V;
- Electric heater fault;
- Release via a switched-mode power supply for the circuit board in the electric heater. (only with the VKTplus)

Strategies / Controls:

- The control signal for the control unit is PI controlled based on the deviation from the calculated intake temperature;
- A contact fault has been registered. If this protection is triggered, an urgent fault is generated, the control signal is switched off and the "heater" control is blocked;
- Release from the VKTplus controller via a switched-mode power supply (230V) for the circuit board in the electric heater.

General:

- The main power supply for the electric heater is not provided. These facilities must be installed by a third party.

4.7. Cold water cooling (optional)

A cold water battery is included in the supply air flow to cool the supply air. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Control unit 0-10V, for the cooler capacity control;
- Circulation pump \ refrigeration unit release;
- Circulation pump \ refrigeration unit fault;

Strategies / Controls:

- The control signal for the control unit is PI controlled based on the deviation from the calculated intake temperature;
- The pump control is switched on if there is a cooling demand from the control;
- Periodic pumping: To prevent jamming, the circulation pump control is switched on for 30 seconds if the pump has been off for 7 consecutive days;
- If the external air intake temperature falls below the set frost limit (default 5°C), the control for the pump will always be switched on;
- When the frost thermostat (for the hot water battery) is triggered, the fans are switched off, the ambient dampers are closed, the pumps are started and the control signal for the cold water circuit damper is forced to 50% (5V). This is reported as an urgent fault. If no heater is included, the frost thermostat is not present and so the cooler is not protected against freezing.

4.8. DirectExpansion cooling (optional)

To cool the supply air, a DX cooling battery is included in the supply air flow. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Control unit 0-10V, for the cooler capacity control;
- DX cooling machine release;
- DX cooling machine fault.

Strategies / Controls:

- The control signal for the control unit is PI controlled based on the deviation from the calculated intake temperature;
- The DX cooling machine control is switched on if there is a cooling demand from the control.

4.9. Change-over battery function (optional)

This makes it possible to cool or heat with a single battery. The control then works according to the heating or cooling control strategy. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Open/close control for a hydraulic change-over damper.
 - Heating (open) / Cooling (closed) signal
- Control unit 0-10V, for the cooler capacity control;
- Release;
- Fault.

Strategies / Controls:

- A bandwidth between switching heating and cooling demand;
- If heat is required, the heater control strategy is activated. For further description, see the section "Hot water heater";
- If cooling is required, the cooling control strategy is activated. For further description see section "Cold water cooling".

CAUTION

OC Verhulst is not responsible for the correct functioning of the water cooling and heating facilities.

4.10. Humidification (optionally available for the VKTplus only)

A humidification section is included in the supply air flow to further humidify the intake air. There are various types of humidifiers to choose from: steam humidifiers, adiabatic humidifiers, high-pressure humidifiers etc. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

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- Control unit 0-10V, for the humidifier capacity control;
 - RH sensors in the return, intake and external air streams;
 - Humidifier release;
 - Humidifier fault.

Strategies / Controls:

- The control signal for the control unit is PI controlled according to the deviation from the calculated intake air humidity;
- The humidifier is switched on if there is humidity demand from the control.

General:

- The main power supply for the humidifier is not provided. These facilities must be installed by a third party.

4.11. Recirculation damper (optionally available for the VKTplus only)

A recirculation damper can be used to further improve energy efficiency. This is a control damper between the return and supply air directly for heat recovery, seen from the return. The control responds to cooling or heating demand and proportionally controls the recirculation damper and the external air suction damper. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Control unit 0-10V, for controlling the recirculation damper and the external air suction damper.

Strategies / Controls:

- The control signal for the control unit is PI controlled based on the deviation from the calculated intake temperature.

General:

- This option is also possible in combination with a thermal wheel.

4.12. Heating damper (optionally available only for the VKTplus)

In order to heat the building quickly, a so-called heating damper can be used. The damper is placed between the return and the supply. The control signal fully opens the heating damper and fully closes the external air suction where necessary. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Control unit open/closed, for controlling the heating damper and the ambient dampers.

Strategies / Controls:

- The control signal for the controller is regulated according to the desired room temperature (return temperature).

4.13. Return air damper / exhaust air damper (optional)

A damper section fitted with a servo drive in the return section of the Verhulst Basic closes off the air flow. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Open/closed air damper control, (with the Basic this is combined with an external air suction damper)

Strategies / Controls:

- When the return fan is about to start, there is a delay between the air damper opening and the fan starting.

4.14. Return air filter

A filter section in the return section of the VKT filters the return air. A pressure differential switch signals when these filters have reached their terminal resistance. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Dirty filter notification, pressure differential switch across filter. (with the Basic this is combined with the supply air filter)
- across the filter (optional for VKT plus). Not available with the Basic model

Strategies / Controls:

- If the pressure difference exceeds the set "dirt filter" value (default 200Pa), the pressure differential switch signals this to the controller and a fault is generated.

4.15. Return fan

The supply air volume is controlled with a regulated fan. The following controls, strategies, operation and fault signals are included in the controller for this purpose:

Inputs / outputs:

- Fan control 0-10V;
- Fan fault, combined with supply fan;
- Measurement of pressure difference across the return fan (optional) or measurement of pressure at the return duct (optional);
- Air quality measurement (CO₂) (optional).

Strategies / Controls:

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- The control signal for the controller can be set to a fixed control or it can be PI controlled based on the deviation from the desired flow (optional), the deviation from the desired duct pressure (optional) or air quality (optional);
 - The actual flow is calculated using the pressure measured across this fan (if flow control is active) as a reference.

4.15.2. Return air fan flow monitoring (if pressure sensor is present)

Belt breakage/flow monitoring by measuring the pressure across the fan. If the pressure does not exceed a set value (standard setting 25Pa) after the fan is activated, the unit switches off due to the delayed message "Flow monitoring" (standard setting 1:00 min).

5. Control strategy for the Verhulst VKTrs

5.1. Temperature control

The standard temperature control is based on a calculated inflow temperature determined by the desired return temperature. The set point for the supply air temperature is calculated with a PI controller based on the deviation from the required return temperature. The set point for the return temperature can be compensated for based on the outside temperature. The temperature control is released in connection with the fan operation message.

5.2. Flow control

5.2.2. Constant fan speed (standard)

The standard flow control is based on fixed fan speeds (nominal factory speed setting).

5.2.3. Constant flow (optional)

The flow control is based on the pressure difference across the fan. By keeping the pressure differential across the fan constant, the flow will remain constant regardless of changing system pressure or filter contamination. The desired air flow is entered via the display panel.

5.2.4. Constant pressure (optional)

Flow control takes place with constant pressure in the duct system. By automatically changing the air flow, the pressure in the duct system will remain constant, regardless of changing system conditions or filter contamination. The desired pressure is entered via the display panel.

5.2.5. Air quality (optional)

Flow control is based on air quality. An air quality sensor integrated in the room or return duct regulates the controller so that the correct amount of fresh air is always supplied.

5.3. Sequence control

The cooling or heating command is determined according to the deviation between the desired and measured supply air values. The cooling or heating command, along with the sequence control, determines the control of various components. When cooling is required, the heat recovery control and the cooler control are released in sequence. When heat is required, the heat recovery and the hot water battery or electric heater are released in sequence. See figure 3.

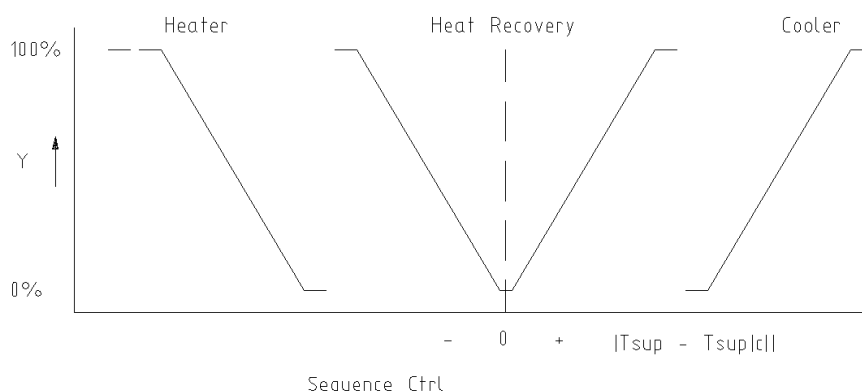


Figure 3

5.4. Start-up procedure

Starting up

1. Ambient dampers are opened;
2. HR plate heat exchanger bypass closes if not already closed;
3. After 45 seconds, the return fan starts up;
4. After 90 seconds, the supply fan starts up.

Switching off

1. The fans switch off;
2. The ambient dampers close with a 1-minute delay;
3. The HR plate heat exchanger bypass closes if not already closed.

5.5. Summer night ventilation

If summer night ventilation is switched on, the building can be cooled at night using outside air.

Adjustable start between 01:00 and 06:00

Outside air temp > default 14°C (adjustable) < Indoor air temp

Indoor air > default 18°C (adjustable)

The next day is a working day.

If the unit is off at the beginning of the summer night ventilation period, the fans will start up to blow air across the temperature sensors. If the conditions are met then summer night ventilation will start. After the night ventilation period, the unit switches off again.

If the operating mode is comfort, pre-comfort or economy at the beginning of the summer night ventilation period, ventilation starts immediately if the conditions are met. After the summer night ventilation period, the unit returns to its status prior to the summer night ventilation period or goes to its timer programme.

5.6. Timer programmes

Two timer programmes (two switching blocks which can also be used for switching between high / low) enable the ventilation system to be switched on when it is configured as "stand-alone". Holiday programmes (5 switching blocks) can be set via the controller.

5.7. Overtime timer (optional)

1 input is included for external release of the unit. This input can also be used to set an overtime timer.

6. General

6.1. Faults

Faults are collected. The contact fault is presented on the controller. All faults are locked, i.e. all fault messages remain provided that no reset has taken place.

Urgent faults

The unit stops in the event of urgent faults.

1. Belt breakage
2. Frozen heat exchanger
3. Fan error message
4. etc.

Non-urgent faults

The unit continues to function in the event of non-urgent faults.

1. Dirty filter.
2. Illogical sensor value.
3. etc.

6.2. Circuit fire

Basic

A circuit fire input is included in case of a circuit fire. In the event of a fire alarm, the fans switch to a preset flow rate.

VKT Plus

A circuit fire input is included in case of a circuit fire. In the event of a fire alarm notification via the digital input, the fans switch off or to a preset speed.

6.3. Release unit

1. Via the GBS.
2. Via the unit's own timer programme.
3. Via an external release, e.g. an overtime timer.
4. Via the display