Installation and configuration manual GB/en

Single room control system

FSL-CONTROL II

Read the instructions prior to performing any task!

TROX® TECHNIK

The art of handling air

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General information

About this manual

This manual enables personnel to correctly install and configure FSL-CONTROL II for the control of TROX decentralised ventilation units.

This manual is intended for use by network administrators, properly trained persons, and qualified electricians or air conditioning technicians.

It is essential that these individuals read and fully understand this manual before starting any work. The basic prerequisite for safe working is to comply with the safety notes and all instructions in this manual.

The local regulations for health and safety at work and the general safety regulations for the area of application of the ventilation unit also apply.

This manual must be given to the system owner when handing over the system. The system owner must include the manual with the system documentation. The manual must be kept in a place that is accessible at all times.

Illustrations in this manual are mainly for information and may differ from the actual design.

Other applicable documentation

- Operating and installation manual for the decentralised ventilation unit
- Project-specific documents (if any)

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TROX Technical Service

To ensure that your request is processed as quickly as possible, please keep the following information ready:

- Product name
- TROX order number
- Delivery date
- Brief description of the fault

Online	*www.troxtechnik.com*
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Limitation of liability

The information in this manual has been compiled with reference to the applicable standards and guidelines, the state of the art, and our expertise and experience of many years.

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- Incorrect use
- Operation or handling by untrained individuals
- Unauthorised modifications
- Technical changes
- Use of non-approved replacement parts

The actual scope of delivery may differ from the information in this manual for bespoke constructions, additional order options or as a result of recent technical changes.

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Table of contents

1 Safety

1.1 Symbols used in this manual

Safety notes

Symbols are used in this manual to alert readers to areas of potential hazard. Signal words express the degree of the hazard.

Comply with all safety instructions and proceed carefully to avoid accidents, injuries and damage to property.

DANGER!
Imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING!
Potentially hazardous situation which, if not avoided, may result in death or serious injury.

CAUTION!
Potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE!
Potentially hazardous situation which, if not avoided, may result in property damage.

ENVIRONMENT!
Environmental pollution hazard.

Safety notes as part of instructions

Safety notes may refer to individual instructions. In this case, safety notes will be included in the instructions and hence facilitate following the instructions. The above listed signal words will be used.

Example:

1. ▸ Untighten the screw.
2. ▸

   CAUTION!
   Danger of finger entrapment when closing the lid.

   Be careful when closing the lid.
3. ▸ Tighten the screw.

Tips and recommendations

Useful tips and recommendations as well as information for efficient and fault-free operation.

Additional markers

In order to highlight instructions, results, lists, references and other elements, the following markers are used in this manual:

Marker	Explanation
1., 2., 3. ...	Step-by-step instructions
⇨	Results of actions
	References to sections in this manual and to other applicable documents
■	Lists without a defined sequence
[Switch]	Operating elements (e.g. push buttons, switches), display elements (e.g. LEDs)
'Display'	Screen elements (e.g. buttons or menus)

1.2 Correct use

The FSL-CONTROL II controller is designed exclusively for the control of TROX decentralised ventilation units.

Correct use also involves complying with all the information provided in this manual.

Any use that goes beyond the correct use or any different use of the unit is regarded as incorrect use.

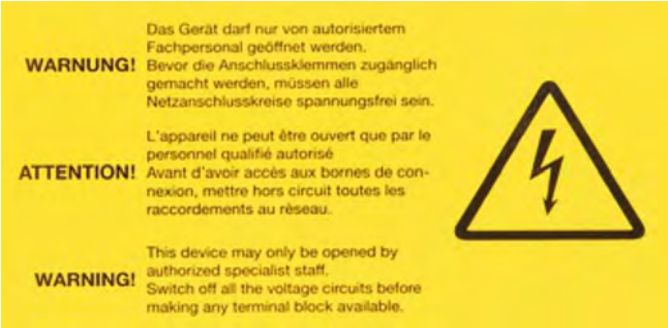
1.3 Safety signs

The following symbols and signs are found on the unit. They apply to the very location where they are found.

Electrical voltage

Hazardous electrical voltage that is present in the ventilation unit. Only skilled qualified electricians are allowed to work on parts of the ventilation unit marked with this symbol. Such work must be carried out only by skilled qualified electricians or the technical service.

Controls access panel



Only skilled qualified electricians are allowed to open the controls access panel. Ensure that no voltage is present on any mains circuit before you open the cover to access the terminal connections.

1.4 Electric shock hazard

Electric current

⚠ DANGER!

Danger of death due to electric current!

Danger of electric shock! Do not touch any live components! Damaged insulation or damaged parts are a life threatening hazard.

- Only a skilled qualified electrician must work on the electrical systems.
- If the insulation is damaged, disconnect the power supply immediately and have the insulation repaired.
- Switch off the power supply before you carry out maintenance or cleaning.
- Ensure that live parts do not come into contact with moisture. Moisture can cause a short circuit.

1.5 Qualified staff

Qualification

The work described in this manual has to be carried out by individuals with the qualification, training, knowledge and experience described below:

Network administrator
Network administrators design, install, configure and maintain the IT infrastructure in companies or organisations.

Skilled qualified electrician
Skilled qualified electricians are individuals who have sufficient professional or technical training, knowledge and actual experience to enable them to work on electrical systems, understand any potential hazards related to the work under consideration, and recognise and avoid any risks involved.

Any work has to be carried out by individuals who can be expected to carry out their assigned duties reliably. Individuals whose reaction time is delayed due to alcohol, drugs or other medication must not carry out any work.

2 Making electrical connections

⚠ DANGER!

Electric shock hazard! Electrical equipment carries a dangerous electrical voltage!

– Only skilled qualified electricians are allowed to work on the electrical system and to connect the unit to the mains.
– Disconnect the cable from the mains (all phases) and secure the unit against being switched on accidentally.
– Ensure that no voltage is present.
– Carry out assembly or connection jobs only as long as no voltage is present.

Notes on the electrical installation

Use only cables that are designed for the supply voltage for which they will be used. The length and cross section as well as any contact resistance may increase voltage losses. The power rating of each unit must also be considered. A skilled qualified electrician has to select the correct cable types and sizes. This job must only be carried out by specialist electrical companies.

- For the electrical connection comply with any applicable regulations and follow the code of good practice. Be sure to comply with the applicable guidelines for working on electrical and electronic equipment as well as with any applicabe local regulations.
- The connection data can be found on the rating plate or in the wiring diagrams.
- Protect any connections from physical damage.
- Feed cables through the cable glands on the ventilation unit.
- Ensure that the unit can be de-energised (all phases) for maintenance such that no voltage is present. This requires separators (e.g. fuses or RCBOs); the distance between contacts should be at least 3 mm.
- For units without integral controls from TROX follow the instructions of the controls provider.

Notes on control panels

Select an installation location where the control panel is not affected by disturbances. Avoid solar gain and draughts.

Seal the end of the conduit in the junction box as otherwise a draught could occur in the conduit and affect the measurement results.

2.1 Wiring

Personnel:

- Skilled qualified electrician

▸ Connect the ventilation unit according to the wiring diagram.
  - Stand-alone operation ↬ *8*
  - Integration with the central BMS ↬ *11*

2.1.1 Stand-alone operation

Wiring diagram, unit with digital control panel

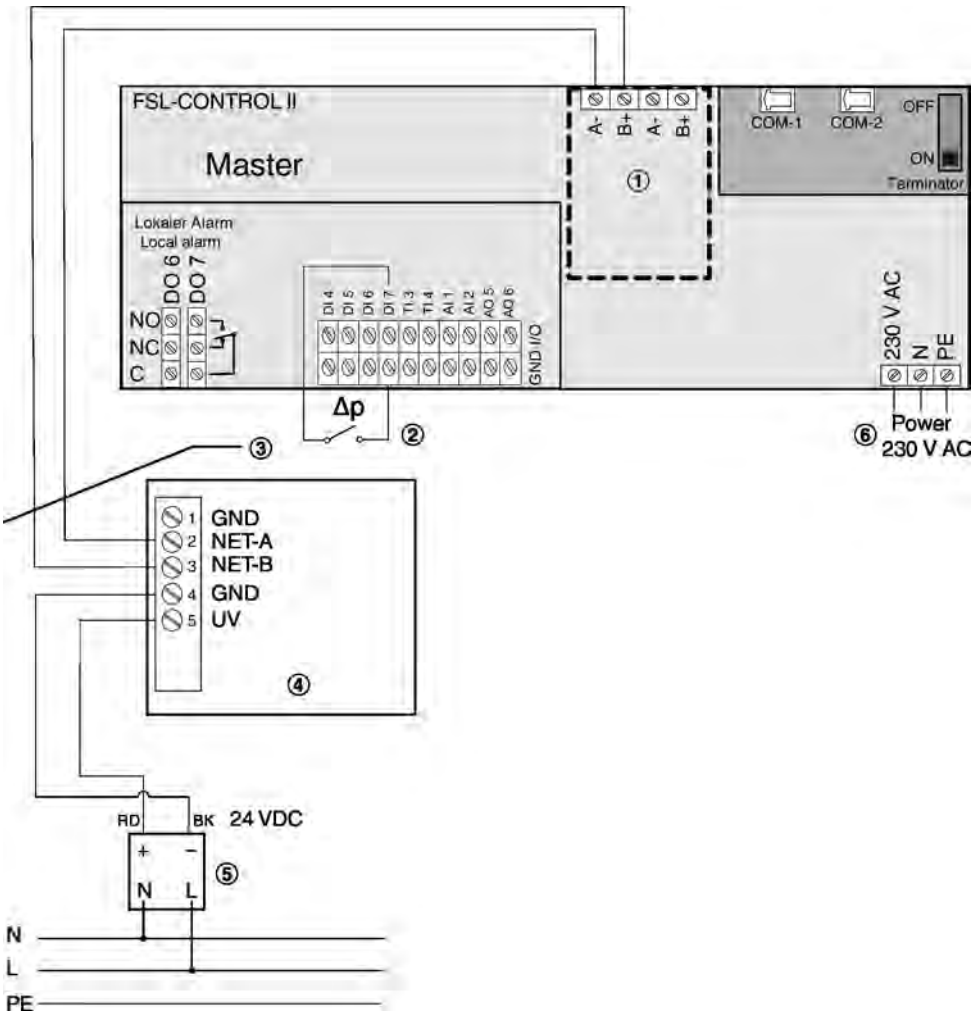


Fig. 1: Wiring diagram, stand-alone operation (without central BMS)

① LonWorks (FTT10) interface, ↳ *14*
② Outdoor air filter differential pressure monitoring, unit variants *-HE, *-HV
③ JY(St)Y 2 × 2 × 0.8, 10 m max. (use only twisted pair for LON-A and LON-B)
④ Digital control panel
⑤ Power supply unit, 24 V DC (optional or provided by others)
Connecting cable 3 × 0.75 mm² (L, N, PE)

Important note:

The digital control panel is a dedicated device to be used with the ventilation unit (master). Both carry the same serial number, which is found on the rating plate (ventilation unit) or on the packaging (control panel).

Use any control panel only for a ventilation unit with the same serial number.

Digital control panel

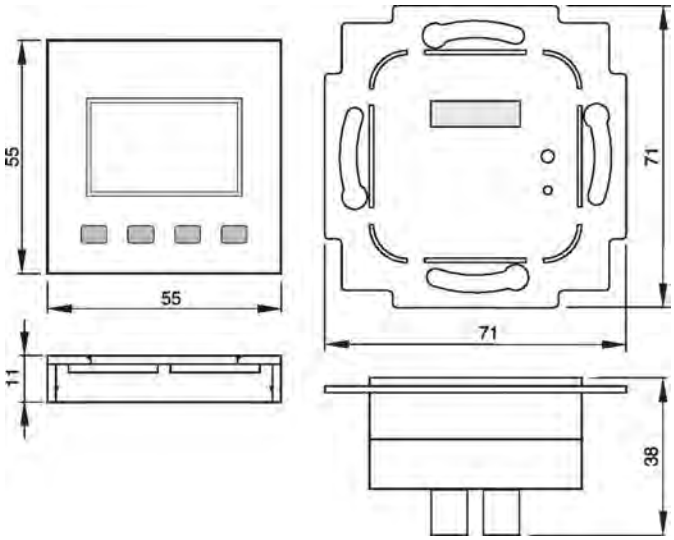


Fig. 2: Dimensions

Note: The overall dimensions depend on the frame that has been selected for the switch.

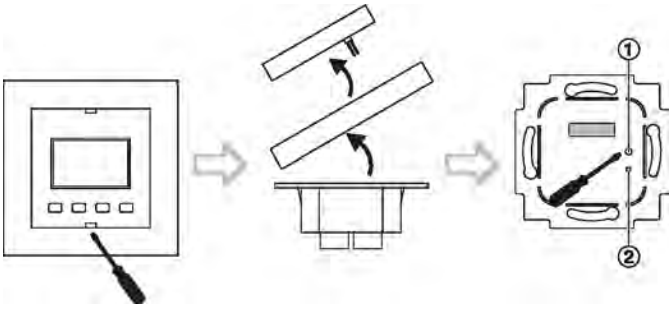


Fig. 3

1 Service push button
2 Service LED

Notes on installation

The control panel is suitable for installation on a junction box. You can connect the bus cable to the control panel with a screw terminal. For pre-wiring you can remove the screw terminal from the panel.

We recommend using deep junction boxes as they provide more space for cables.

Attach the LON interface card to the screws (by others) in the junction box; max. torque for the screws is 0.8 Nm. Place the mounting ring of the LON interface card flat on the face of the wall; do not cover it with paint or wallpaper.

Technical data

Supply voltage	15...24 V= (±10%) or 24 V~ (±10%)
Power consumption	1.3 W / 1.5 VA
Interface	FTT, free topology
Measuring range	0...+50 °C
Accuracy (21 °C)	±0.5 K
Response time	Time constant t_{63} 15 minutes
Screw terminals	1.5 mm² max.
Protection level	IP 30 to EN 60529
Ambient temperature	0...50 °C
Transport	-10...50 °C / max. 85% rh, no condensation

Wiring diagram, unit with analogue control panel

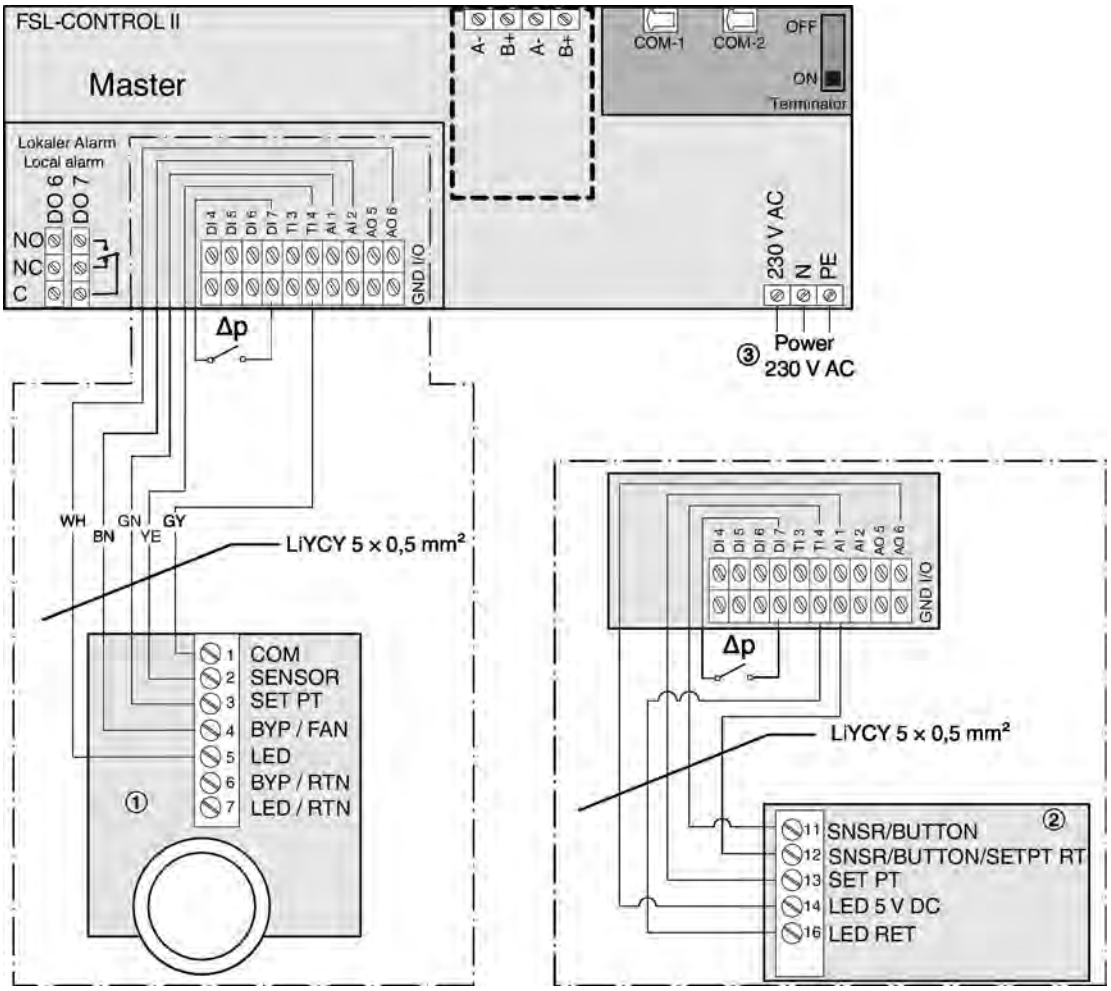


Fig. 4: Wiring diagram for analogue control panels

① Control panel with 0-1-2-3-AUTO selector switch
② Control panel without selector switch
③ Connecting cable 3 × 0.75 mm² (L, N, PE)

2.1.2 Integration with a central BMS

Wiring example for three interconnected FSL-CONTROL II controllers in a control zone

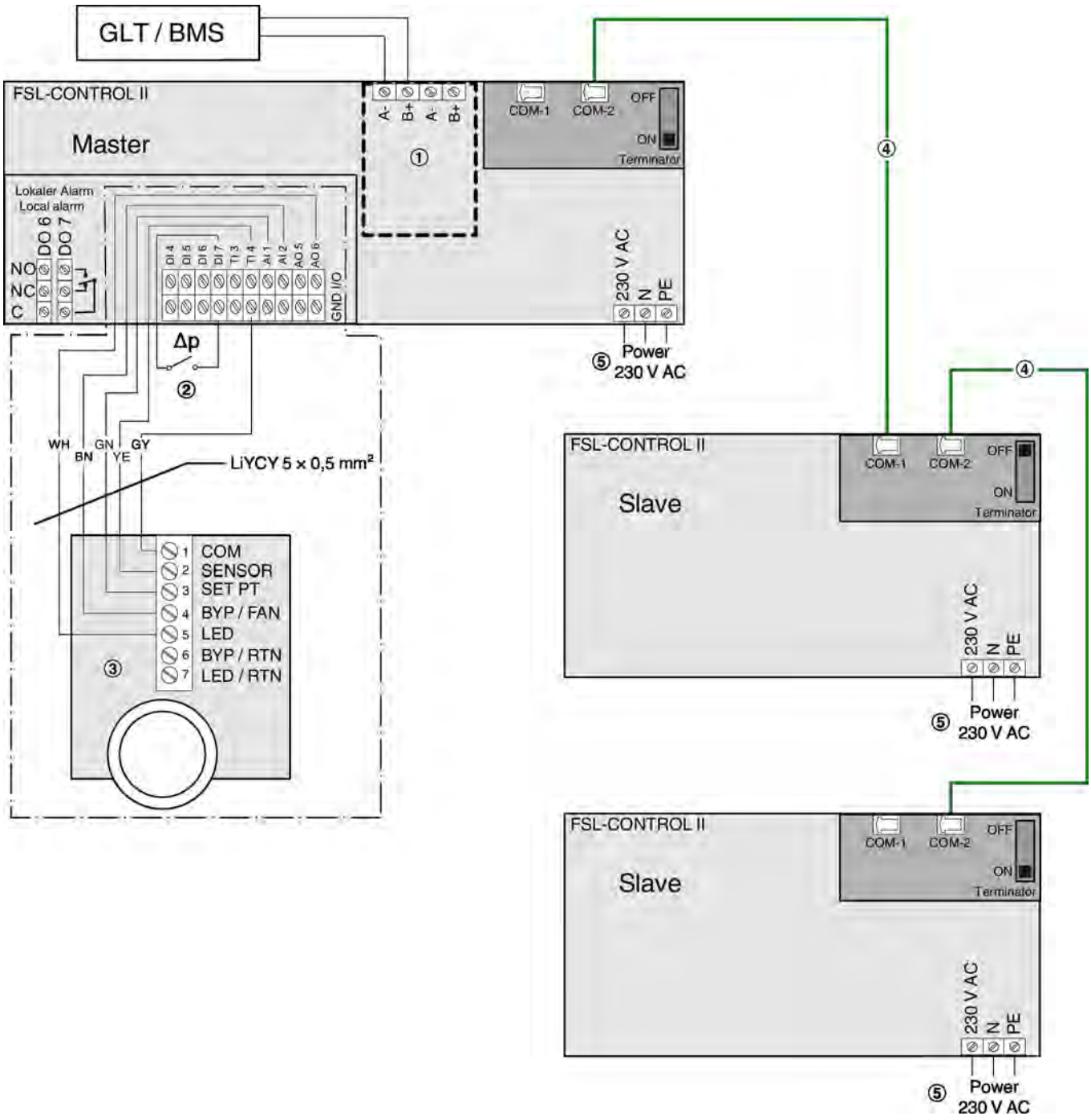


Fig. 5: Wiring diagram: Interconnected FSL-CONTROL II controllers

① LonWorks (FTT10) interface or BACnet MS/TP or Modbus RTU interface (optional) ↳ *13*
② Outdoor air filter differential pressure monitoring, unit variants *-HE, *-HV
③ Analogue control panel with or without selector switch (a digital control panel can be used only for stand-alone operation of the ventilation unit)
④ Patch cable (by others, at least cat. 5)
⑤ Connecting cable 3 × 0.75 mm² (L, N, PE)

2.2 FSL-CONTROL II communication

2.2.1 Several controllers in a control zone

Connect FSL-CONTROL II controllers (master-slave) within a control zone with a standard network cable (RJ45, to be provided by others).

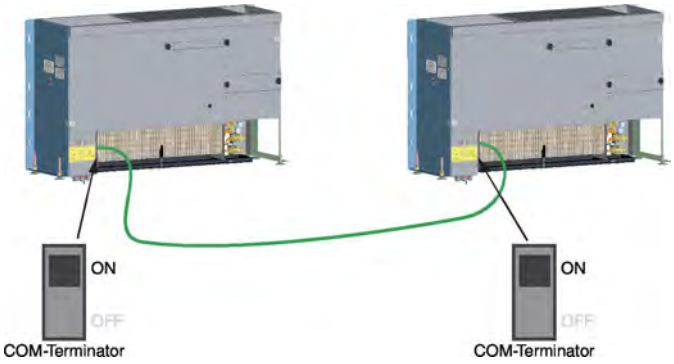


Fig. 6: FSL-CONTROL II communication of 2 units

Fig. 7: FSL-CONTROL II communication of 3 units

- Up to 15 FSL-CONTROL II controllers for a control zone (1 × master, 14 × slave)
- Up to 300 m network cable for each control zone
- Network cable type SF-UTP (braided and with foil), to ISO IEC 11801 (2002), as a patch cable with RJ45 plugs on both ends, or from a roll, at least cat. 5
- Activate terminal resistors on the first and last controllers on the communication cable

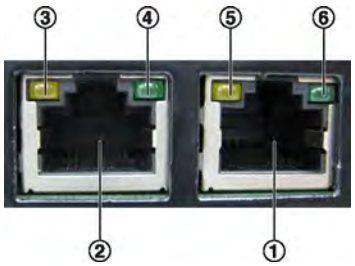


Fig. 8: Sockets and LEDs

① Port COM-1
② Port COM-2
③ LED for communication cable termination
④ Not used
⑤ LED - Data reception
⑥ LED - Heartbeat

LEDs

Termination (yellow)

ON - Cable termination is enabled

OFF - Cable termination is disabled

Data reception (yellow)

ON (blinking) - Data reception in progress

OFF - No data reception

Heartbeat (green)

ON (blinking) - Normal controller operation

OFF - Device not ready

Terminal resistor / termination

Fault-free data exchange between the controllers requires that both ends of the communication cable are terminated.

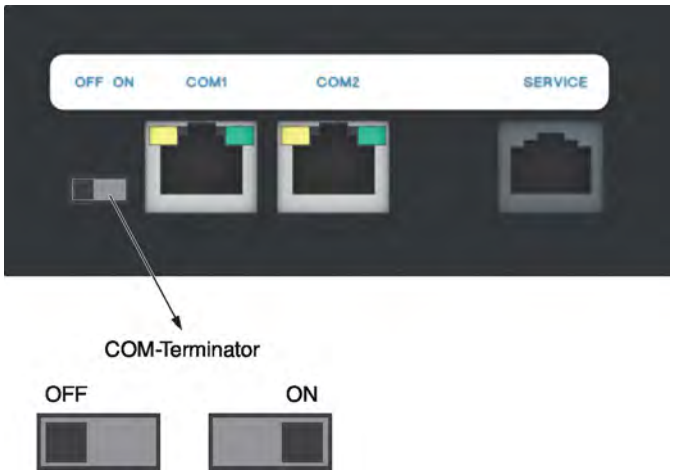


Fig. 9: COM terminal resistor

COM terminal resistor

OFF - Cable termination is disabled

ON - Cable termination is enabled

2.2.2 Network with several control zones

Building a network

You may interconnect control zones by making use of a standard network protocol such as LON FTT10, BACnet MS/TP or Modbus RTU. This requires a bus interface card to be connected to the FSL-CONTROL II master controller.

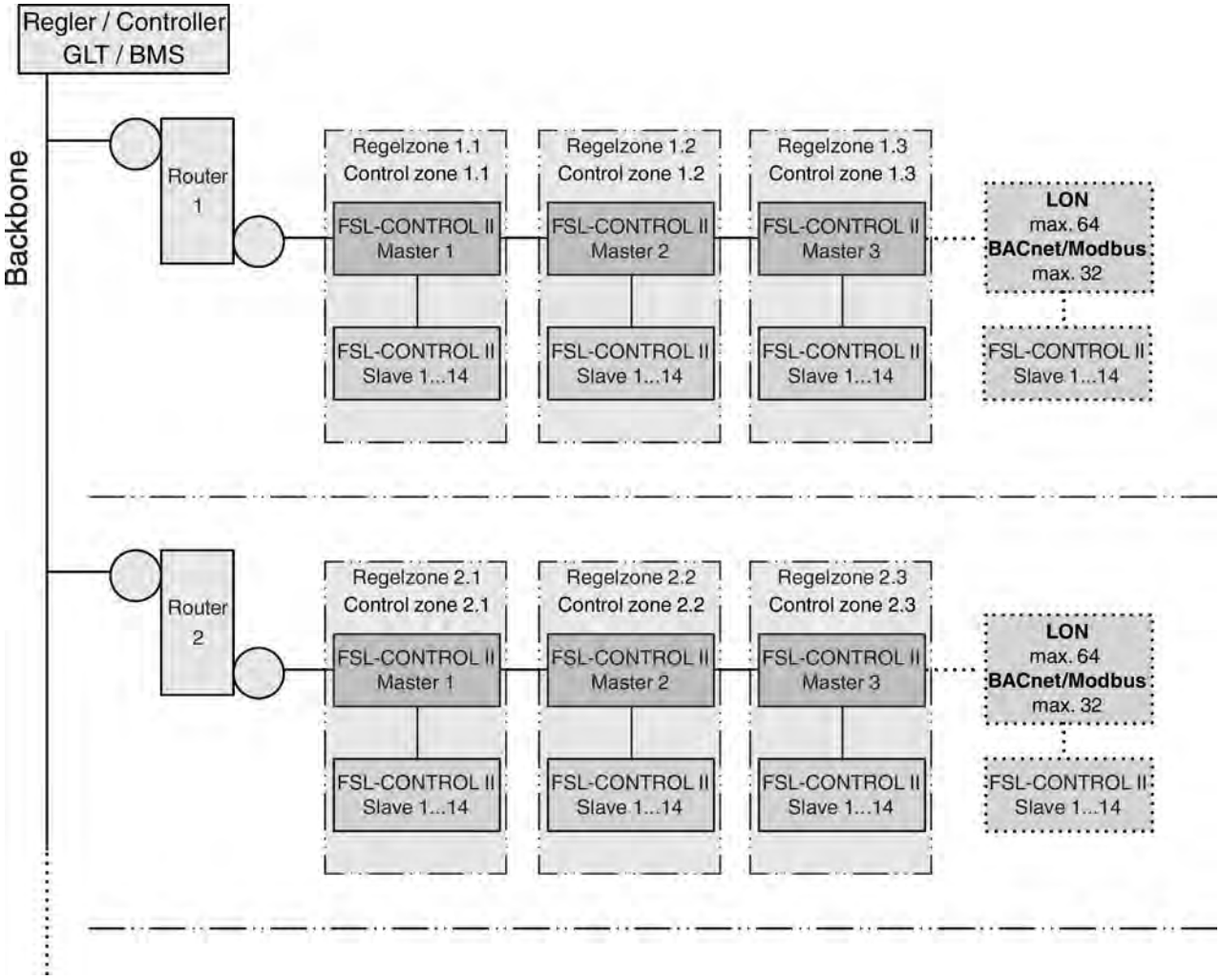


Fig. 10: FSL-CONTROL II, building a network

If the master controller is integrated with a central BMS (by others), it acts as a slave within the bus network, but as a master within the FSL-CONTROL II system.

2.2.2.1 Integration with a bus communication system provided by others

2.2.2.1.1 LonWorks LON-FTT10 interface module

Connecting data cables

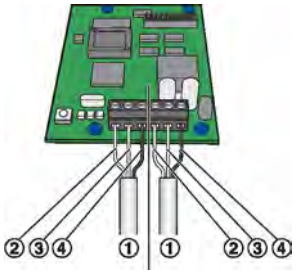


Fig. 11: Wiring the LonWorks interface card

① Bus cable
② LON A
③ LON B
④ SH (shield)

The LonWorks interface card has terminals for two bus cables of a LonWorks network. Depending on the network topology, controllers at the end of a chain may be connected to one bus, controllers at other positions in the chain may be connected to two buses.

1. ▸ Strip the insulation from the bus cable (at least two wires), insert the bare wires into the terminals and tighten the screws by hand.
2. ▸ Fix the bus cables to the casing using the wire clamping bracket.
3. ▸ Connect the shield to the SH terminals.

   Note: Within a chain (channel) connect the shield only at one point to the earth. Earthing the shield at every controller will lead to voltage disturbances.
4. ▸ To avoid reflections at the end of a chain (channel), use a terminal resistor.

Recommended bus cables

Bus cables to TIA 568A, category 5

- Belden 8471 or 85102
- Cables to DOCSIS specification level IV
- JY(St)Y 2×2×0.8 (use only twisted pair for LON-A and LON-B)

Commissioning

Personnel:

- Network administrator

Materials:

- Software, e.g. Echelon or LonMaker
- Application software, download from *www.troxtechnik.com*

1. ▸ **Commissioning:** Press the service pin push button and download the application software for the LonWorks node.
2. ▸ **Binding:** Create the logical bindings for the network variables to be transferred by the LonWorks interface card (expansion module). As an alternative, use polling.
3. ▸ **Configuration:** If necessary, adjust the configuration.
4. ▸ Configure data points

2.2.2.1.2 BACnet MS/TP or Modbus RTU interface card

Connecting data cables

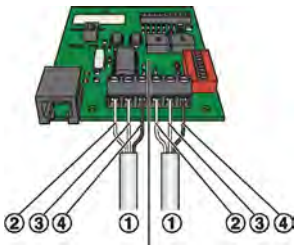


Fig. 12: Wiring the BACnet MS/TP or Modbus RTU interface card

① Bus cable
② B+ (EIA-485)
③ A- (EIA-485)
④ SH (shield)

The interface card has terminals for two cables of an EIA-485 network. A maximum of 32 units can be operated on one network segment.

1. Strip the insulation from the bus cable (at least two wires), insert the bare wires into the terminals and tighten the screws by hand.

   Make sure that the polarity of the conductor pairs is correct. Incorrect polarity will result in inverted data signals and hence communication errors.
2. Fix the bus cables to the casing using the wire clamping bracket.
3. Connect the shield to the SH terminals.

   Note: Within a chain (channel) connect the shield only at one point to the earth. Earthing the shield at every controller will lead to voltage disturbances.
4. To avoid cable reflections, network segments must be terminated at both ends with 120 Ω bus terminal resistors. Alternatively, the terminal resistors can be enabled or disabled on the PCB.

Recommended bus cables

Twisted Pair, e.g. JY(St)Y 2 × 2 × 0.8 (use only twisted pair for B+ and A-)

Hardware configuration

Before you use a BACnet MS/TP or Modbus RTU interface card, you have to configure it to the actual application. To do so, use the switches on the interface card.

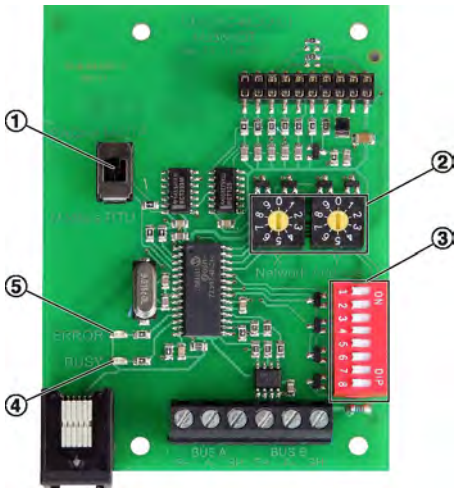


Fig. 13: BACnet MS/TP or Modbus RTU interface card

① Slide switch for setting the protocol type
② Rotary switch for setting the network address
③ DIP switch for setting the communication parameters
④ BUSY-LED (green): On = supply voltage OK, blinking = communication in progress
⑤ ERROR-LED (red): On = communication error

Setting the protocol type

Use the slide switch (Fig. 13/1) to set the BACnet MS/TP or Modbus RTU protocol.

Setting the network address

Use the two address code switches X and Y (Fig. 13/2) to set a network address (01 to 99). Address 00 is reserved for broadcast mode. A maximum of 32 controllers (network addresses) can be operated on one network segment. Each device requires a different network address.

Transmission speed (EIA-485)

BACnet	Modbus	S2	S3
9600 Bd	9600 Bd	Off	Off
19200 Bd	19200 Bd	On	Off
38400 Bd	38400 Bd	Off	On
76800 Bd	57600 Bd	On	On

Parity

Parity	S5	S6
None	Off	Off
None	On	Off
Odd	Off	On
Even	On	On

Terminal resistor for EIA-485 network

Terminal resistor	S8
Disabled	Off
Enabled	On

Commissioning

Personnel:

- Network administrator

  - Configuration of data points depending on protocol type

    BACnet - *Chapter 5.2 'BACnet MS/TP interface' on page 57*

    Modbus RTU - *Chapter 5.3 ' Modbus RTU interface' on page 65*

3 Control of ventilation units

3.1 FSL-CONTROL II

System overview

FSL-CONTROL II is a dedicated single room control system for decentralised TROX ventilation systems.

FSL-CONTROL II can be used to combine the following control strategies:

- Room temperature or extract air temperature control
- Room air quality control (optional)

3.1.1 Control components

The modular design of the hardware allows for adding optional equipment to expand the functions of FSL-CONTROL II.

Fig. 14: Main PCB, valve with thermoelectric actuator

Basic equipment

- Main PCB (control module)
- Heating and/or cooling valves including thermo-electic actuators and lockshields
- Supply air temperature sensor

Optional equipment

- Master PCB (room module)
  - Control panel including setpoint value adjuster and room temperature sensor
  - Outdoor air temperature sensor
  - VOC sensor
  - RTC module (real time clock)
  - LonWorks LON-FTT10 interface module
  - BACnet MS/TP interface card
  - Modbus RTU interface
- Valve actuators
- Pressure-independent control valve
- Modulating actuator for the bypass damper

FSL-CONTROL II with several interconnected controllers

A group of FSL-CONTROL II controllers must include at least 1 master. This group may include up to 14 slaves.

A plug-in communication cable (plug and play) is used for the communication between master and slave devices (at least cat. 5; the cable is not included in the supply package).

3.1.2 Functional description

3.1.2.1 General

FSL-CONTROL II is used to control various parameters for single rooms.

It is primarily used to control the room temperature, i.e. to maintain the set parameters and a comfortable room climate. With an air quality sensor (optional) it is possible to control the outdoor air flow rate based on the VOC value.

FSL-CONNECT software

The FSL-CONNECT software for personal computers is used to configure the control parameters. The software is available for download from www.troxtechnik.com.

For more information on how to use the software *Chapter 3.2 'FSL-CONNECT software' on page 23.*

3.1.2.2 Room temperature control

FSL-CONTROL II ensures that the comfort temperature range for each operating mode is maintained.

Cascade control ensures that the comfort temperature range is quickly achieved. The supply air temperature is controlled within the set range and with internal and external loads being accounted for. This is how the comfort requirements are met.

Room temperature control requires that the following values are measured:

- Room temperature, e.g. from an optional control panel or from the central BMS
- Outdoor air temperature, e.g. from the central BMS or from an optional temperature sensor in the outdoor air intake of the master unit
- Supply air temperature

Room temperature control works best when the room temperature is measured at a carefully selected point. The control panel is ideally installed about 1.5 m above the floor. Select an installation location where the control equipment is not affected by disturbances (e.g. solar gain or draughts). We recommend adjusting the flow temperature based on the outdoor temperature in heating and in cooling mode.

Factory settings for room temperature (example)

Operating mode	Room temperature setpoint values		
	Heating	Comfort range	Cooling
Occupied	< 21 °C	21...23 °C	> 23 °C
Standby	< 19 °C	19...25 °C	> 25 °C
Unoccupied	< 16 °C	16...28 °C	> 28 °C

To prevent the system from constantly changing between heating and cooling mode, the room temperature is controlled not to a fixed value, but within a comfort temperature range.

The effective room temperature setpoint value depends on:

- Heating mode (room temperature < room temperature limit for heating)
- Cooling mode (room temperature > room temperature limit for cooling)

In heating mode, the room temperature limit for heating is the room temperature setpoint to be achieved; in cooling mode, it is the room temperature limit for cooling. As soon as the room temperature has reached the comfort range, the supply air temperature is controlled to a previously set value (cascade basic value). If the room temperature setpoint value is changed, e.g. by your entering +2 K on a room control panel, both room temperature limits and hence the comfort temperature range are also changed by +2 K as a consequence. Recommended: Comfort temperature range 2 K.

Factory settings for supply air temperature limits

Operating mode	Supply air temperature limits	
	Heating	Cooling
Occupied	45 °C	18 °C
Standby	45 °C	16 °C
Unoccupied	45 °C	15 °C

For a comfortable room climate the supply air temperature in 'Occupied' mode should be at least 18 °C. In heating mode a comfortable room climate can be achieved with supply air temperatures of up to 45 °C.

These factory settings have been selected for their energy efficiency but can be changed for each project using the software.

3.1.2.3 Bypass on the heat recovery unit

The ventilation units are fitted with a bypass with an open/close actuator. The bypass is controlled automatically. The bypass is used in combination with the following functions: *'Night purge'*, *'Free heating'* and *'Free cooling'*.

Alternatively, a modulating actuator can be used. The volume flow to be heated by the heat recovery unit depends on the position of the bypass damper.

If, for example, the outdoor temperature is low, yet an internal space has to be cooled anyway, use of the cooling coil can be reduced to the minimum since only a small portion or even no portion of the air has to pass the heat recovery unit.

3.1.2.4 Fan stages

FSL-CONTROL II automatically selects the correct fan stage based on temperature control or air quality (optional). The fan stage can also be preset by the central BMS (by others) or from a control panel.

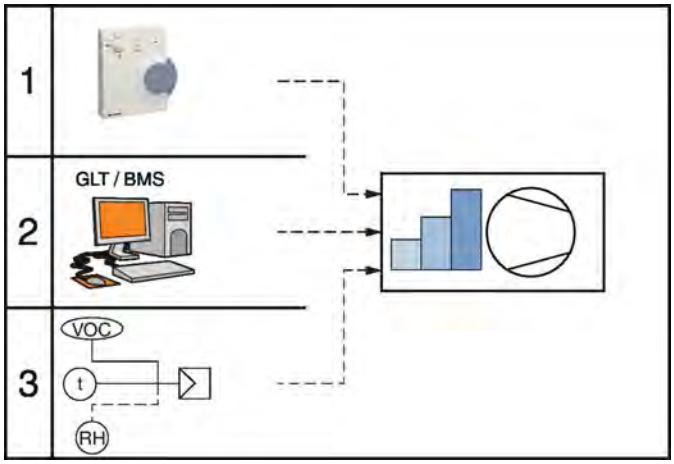


Fig. 15: Fan stages – priority

3.1.2.5 Air quality control

Air quality control means that the outdoor air flow rate is controlled based on the room air quality.

This type of control is only possible with an air quality sensor (optional equipment or by others). The optional VOC sensor captures various VOC emissions that are linked to the CO_2 content of the room air.

Air quality control is always active in 'Occupied' mode. It can additionally be activated in 'Standby' mode.

Air quality control – factory settings

VOC value [ppm]	Fan stage
< 600	Secondary air operation
600 – 800	1
800 – 1000	2
> 1000	3

The system owner can adjust the air quality values
↳ *Chapter 3.2.2.2 'Fan stage adjustment based on air quality' on page 27*.

Secondary air and outdoor air modes

FSL-CONTROL II ensures that units with secondary air function start in secondary air mode, which is energy efficient. As soon as the VOC value for fan stage 1 is exceeded, the unit automatically switches to outdoor air mode. Preset minimum periods of time ensure that not too many quick changes between the fan stages occur.

3.1.2.6 Operating modes

FSL-CONTROL II can be used for the following operating modes:

- Occupied
- Standby
- Unoccupied
- Boost

You can define different comfort temperature ranges for these operating modes.

You can define daily schedules and enter a start time for each operating mode. Using the optional real time clock (RTC) allows for defining 5 switching points per day. If no RTC is used, operating modes must be changed by the central BMS.

The comfort temperature range for all operating modes can be changed from the central BMS or using the control panel.

Occupied

The 'Occupied' mode is used for occupied rooms.

The following parameters can be set:

- Comfort temperature range
- Supply air temperature limits for heating/cooling

Standby

The 'Standby' mode is used to raise the temperature of a room before it is actually occupied.

The following parameters can be set:

- Comfort temperature range
- Supply air temperature limits for heating/cooling

Recommended:

– *Use this operating mode in the early morning (e.g. from 6 to 7 am).*
– *Note the operating times of the heating and cooling systems.*

Unoccupied

The 'Unoccupied' mode is used for unoccupied rooms.

The following parameters can be set:

- Comfort temperature range
- Supply air temperature limits for heating/cooling

Unoccupied

– *This operating mode is used to protect the building; it is required for night purge.*
– *Air quality control is not possible with this operating mode.*

Boost

The 'Boost' mode is used for the quick ventilation of rooms. This mode can be used, for example, to ventilate a classroom during breaks.

The following parameters can be set:

- Fan stage

The same comfort temperature range and supply air temperature limits as for the 'Occupied' mode are used.

You can enable 'Boost' mode using the room control panel.

3.1.2.7 Functions

The following functions of FSL-CONTROL II are factory set, based on the project-specific requirements. If necessary, the TROX Technical Service can change the factory settings at a later stage.

3.1.2.7.1 Summer and winter compensation

With summer compensation and winter compensation the comfort temperature range is automatically adjusted based on the outdoor air temperature.

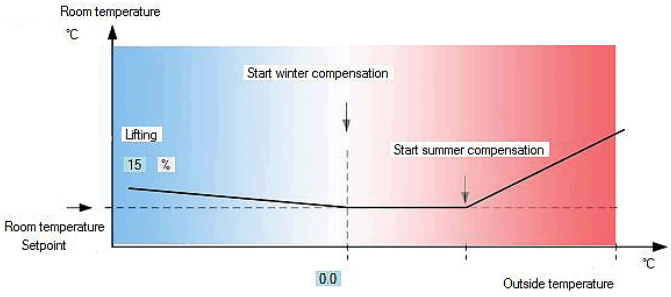


Fig. 16: Summer/winter compensation, example

Recommended

Winter compensation enabled, summer compensation disabled

3.1.2.7.2 Minimum fan stages

Setting minimum fan stages allows for enforced ventilation in all operating modes. The software can be used to select the minimum fan stage (0 to 5, if any).

Recommended

– *Occupied – fan stage 1*
– *Standby – fan stage 0*
– *Unoccupied – fan stage 0*

3.1.2.7.3 Secondary air function

If the room air quality is good, FSL-CONTROL II X-AIR-CONTROL switches to secondary air mode, which is more energy efficient. The shut-off dampers are closed and the supply air fan remains switched on.

The control system compares the room air quality limit value to the ACTUAL values measured by the VOC sensor and switches automatically between outdoor air and secondary air mode. The ventilation unit starts always in secondary air mode.

Secondary air mode is an option and only possible with air quality measurement (integral function or central BMS). The secondary air function is not available for all unit variants.

Recommended

Limit value: 600 ppm

3.1.2.7.4 Frost protection

Room temperature frost protection

FSL-CONTROL II provides frost protection for the controlled rooms. Room temperature frost protection depends on the measured room temperature. If the room temperature falls below a set limit, the frost protection function is activated. This means that the heating valve opens completely, the fans are switched off, and the dampers close. The module will not return to its previous configuration until the room temperature has increased to at least 1 K (can be configured) above the room temperature frost protection limit.

Recommended

Room temperature limit: 8 °C

Supply air temperature frost protection

To prevent the heat exchanger from freezing and becoming damaged as a consequence, the supply air temperature is measured immediately after the heat exchanger (when viewed in airflow direction). If the temperature falls below a set limit, the heating valve opens, the fans are switched off, and the damper closes. The control system will not return to its previous configuration until the room temperature has increased to at least 1 K (can be configured) above the temperature limit.

Recommended

Supply air temperature limit: 8 °C

Frost protection

If the outdoor temperature is ≤ -20 °C (can be configured) or if there is no outdoor temperature signal, the unit is switched off; this is to protect it if operating temperatures are too low.

Heat recovery frost protection

If the outdoor temperature is very low, the airflow through the heat recovery unit on the extract air side may become impaired or even impossible due to the freezing of the condensate; to prevent this from happening, the control system opens a motorised bypass damper. The bypass remains open until the outdoor air temperature has risen to at least 2 K (can be configured) above the limit.

Recommended

Limit value: -6 °C

Frost protection of the heat recovery unit can be signalled with an alarm relay on DO6/DO7.

As an alternative, the heat recovery unit can be used as standard. After 180 minutes (configurable) the unit is set to secondary air operation for 20 minutes (configurable) such that ice build-up is avoided and the extract air duct is de-iced if necessary.

After the set time has elapsed, the previous operating mode is resumed.

This function can be used all year round and helps to reduce the water heating energy required.

A condensate drain is required when you use this function.

3.1.2.7.5 Start-up delay

If the outdoor air temperature is below 3 °C (can be configured), the start-up of the fans is delayed if one of the following is true:

- The ventilation unit is restarted
- The frost protection function ends
- The fan stage is changed from 0 to 1

Start-up delay means that the heating valve opens and the heating coil is preheated for 300 s (can be configured). After the preheating time has elapsed, the control system starts the operating mode valid for this time.

3.1.2.7.6 Free cooling

Free cooling means that outdoor air is supplied directly to the room, without passing through the heat recovery unit.

Requirements:

- Room temperature > comfort temperature range
- Outdoor air temperature < comfort range upper limit
- ∆t Room temperature to outdoor temperature >5 K (can be configured) for at least 10 minutes
- The supply air temperature for the operating mode must not fall below the set limit

If the room temperature to outdoor air temperature difference falls below 1 K (can be configured) or if the room temperature reaches the comfort temperature range, free cooling is disabled. The unit resumes the original operating mode.

Recommended

Select free cooling for the following operating modes:

- *Unoccupied*
- *Standby*
- *Occupied*

3.1.2.7.7 Free heating

Free heating means that outdoor air is supplied directly to the room, without passing through the heat recovery unit.

Requirements:

- Room temperature < comfort temperature range
- Outdoor air temperature > comfort range lower limit
- ∆t Room temperature to outdoor temperature >2 K (can be configured) for at least 10 minutes
- The supply air temperature for the operating mode must not exceed the set temperature limit

If the outdoor air temperature to room air temperature difference falls below 1 K (can be configured) or if the room temperature reaches the comfort range, free heating is disabled.

Recommended

Select free heating for the following operating modes:

– *Unoccupied*
– *Standby*
– *Occupied*

3.1.2.7.8 Night purge

In the summer months (can be configured; factory setting: May to September), the night purge function allows for the building to be cooled during the nights, which is energy efficient. This function requires that the optional real time clock (RTC) is used. If no RTC is used, operating modes must be changed by the central BMS.

Saving energy

Night purge provides a high energy savings potential since rooms can be 'pre-cooled' at night without using a cooling coil.

Recommended

Highest fan stage

3.1.2.7.9 Filter change alert

The *'Monitoring filter replacement interval'* function (i.e. filter change alert) alerts users in each of the following cases that a filter change is due:

- The number of operating hours exceeds the preset value (factory set to 2500 h, adjustable)
- The differential pressure at the outdoor air filter exceeds the preset value (only for unit variants *-HE and *-HV)

Type of alarm:

Analogue control panel	-	LED double blinking
Digital control panel	-	⚠ symbol
FSL-CONNECT	-	'Next filter replacement in 0 h' message

Note: If the differential pressure at the outdoor air filter exceeds the maximum pressure, the 'Next filter change' counter is reset to 0 h.

Differential pressure monitoring

The ventilation units (master) variants *-HE and *-HV come with a differential pressure monitoring function. This function monitors the differential pressure of the outdoor air filter up to the nominal air volume (usually stage 3) If the differential pressure exceeds the preset value for at least 30 minutes, the filter change alert is activated (see above).

Differential pressure monitoring is not active in operating modes 'boost' and 'night purge' in order to avoid unnecessary filter changes.

Filter checks

Differential pressure monitoring is not supposed to replace any regular checks of the outdoor air filter or checks due to hygiene reasons.

Resetting the filter change alert

You have to reset the number of operating hours after each filter change. To do so, either keep the occupancy push button on the room control panel pressed for at least 10 s or use the FSL-CONNECT software (☞ *33*).

3.1.2.7.10 Enforced fan activation

Fan activation is enforced by a signal sent to a digital input. Outdoor air flow rate and exhaust flow rate can be configured separately.

Fume hoods or fume cupboards can extract high air volumes in classrooms and similar rooms. Enforced fan activation can help to achieve balanced volume flow rates.

3.1.2.8 Interfaces

FSL-CONTROL II masters provide 3 digital inputs and 3 digital outputs. You can use these for the following or for other functions:

- Inputs
  - **Frost protection hardware:** Additional frost protection sensor, e.g. capillary tube sensor with a digital output, as an additional means of switching units safely off if there is a risk of freezing.
  - **Window contact:** As soon as a window is opened, the master and slave devices in the room (connected via a communication cable) will be switched off.
  - **Changeover function:** Allows for changing from heating to cooling and vice versa in 2-pipe heat exchangers.
  - **Fire protection:** Master and slave devices are switched off if a signal is received at the corresponding input.
  - **PIR:** 'Occupied' mode can be manually enabled.
- Outputs (all contacts can be configured as NO or NC contacts).
  - **Alarm relay:** Frost protection
  - **Activation relay:** Signal regarding a heating or cooling request in changeover operation.
  - **Analogue output:** No power

Digital inputs

Factory setting: not configured

Digital outputs:

Max. contact load of relays: 230 VAC, 2 A

3.2 FSL-CONNECT software

The FSL-CONNECT software can be used to adjust the preset control parameters. It can also be used for maintenance. The software is available for download from the TROX website. Using the software requires an activation code, which you will receive by e-mail once you have registered. Enter the licence code when you start the software for the very first time.

You need a connecting cable to connect a PC to FSL-CONTROL II.

Fig. 17: Adapter and connecting cable

① USB-RS485 adapter with driver software (replacement part no. M536ED7)
② Connecting cable with RJ45 and 9-pole DSUB socket (replacement part no. M516SM3)

For more information on how to connect the control system to a PC and on how to install the software see Chapter 3.2.5 'Installing and connecting FSL-CONTROL II' on page 35

3.2.1 Starting screen

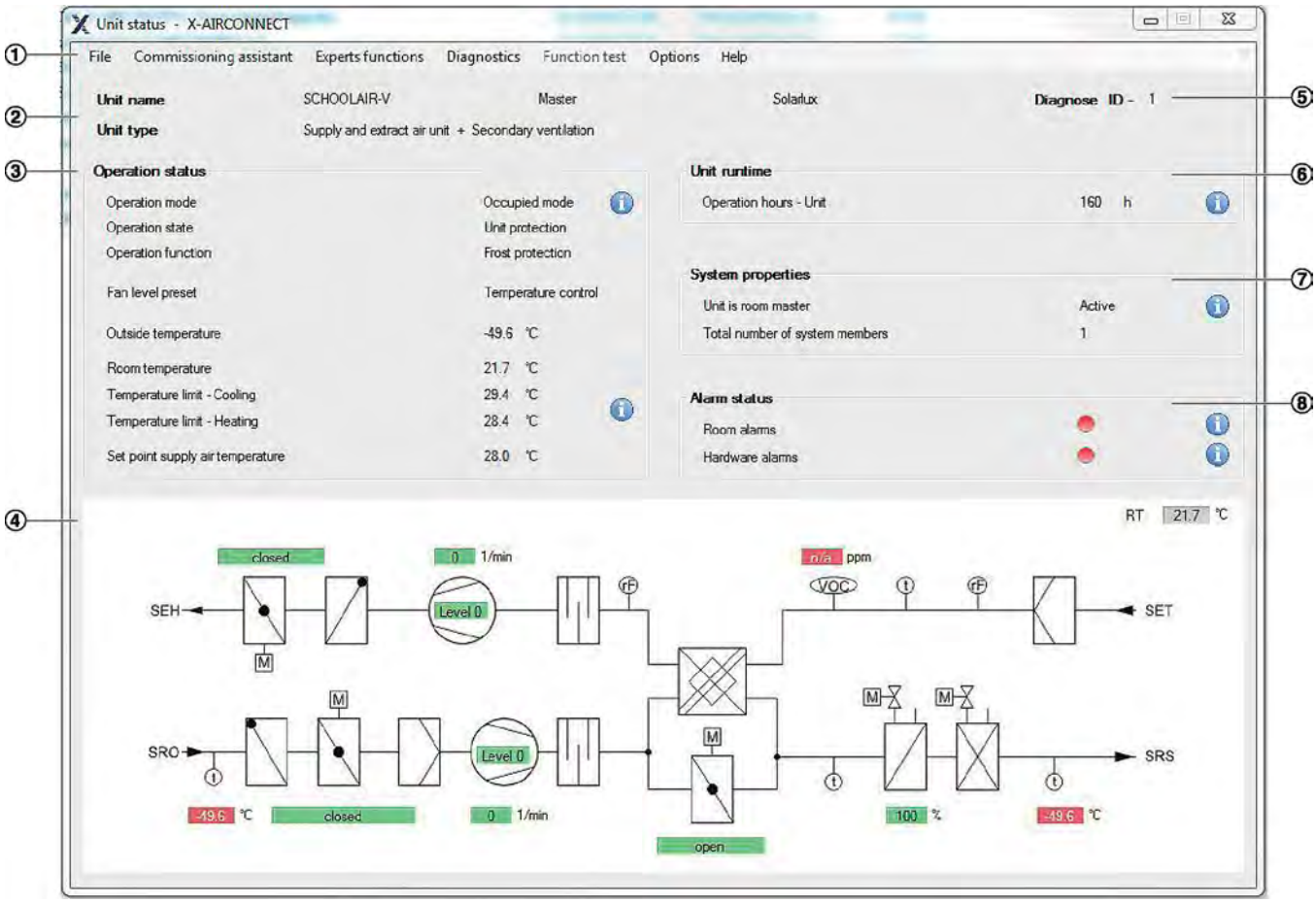
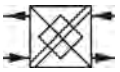


Fig. 18: FSL-CONNECT

① Main menu
② Unit name and unit type
③ Current operating modes and temperatures
④ Schematic illustration (example) with status displays
⑤ Diagnosis ID to identify the unit in a group of interconnected units
⑥ No. of total operating hours
⑦ System properties
⑧ Alarm status

Symbols

Symbol	Meaning
	Shut-off damper with the damper blade position shown
	Fan including fan stage and speed
	Heating coil and valve setting (percentage)
	Filter

Symbol	Meaning
	Cooling coil and valve setting (percentage)
	Recuperative heat exchanger
	Non-return damper (depends on unit type)
	Sound attenuator
	Volume flow rate limiter (depends on unit type)

Symbol	Meaning
	Volume flow controller with Compact controller (depends on unit type)
	Temperature sensor
	Humidity sensor (optional)
	Air quality sensor (optional)
SEH	Single room exhaust air
SET	Single room extract air
SRO	Single room outdoor air
SRS	Single room supply air
SEC	Secondary air

Colour codes

green - Function OK

red - Function not OK

3.2.2 Setting control temperatures and operating times (commissioning wizard, or 'assistant')

To set control temperatures and operating times, go to the main menu and select *'Commissioning assistant'*.

On the *'Temperature control'* page you can set the control parameters for cooling (Fig. 19/1) and heating (Fig. 19/6).

After setting the parameters, select *'Next'* to go to the next page.

3.2.2.1 Control temperatures

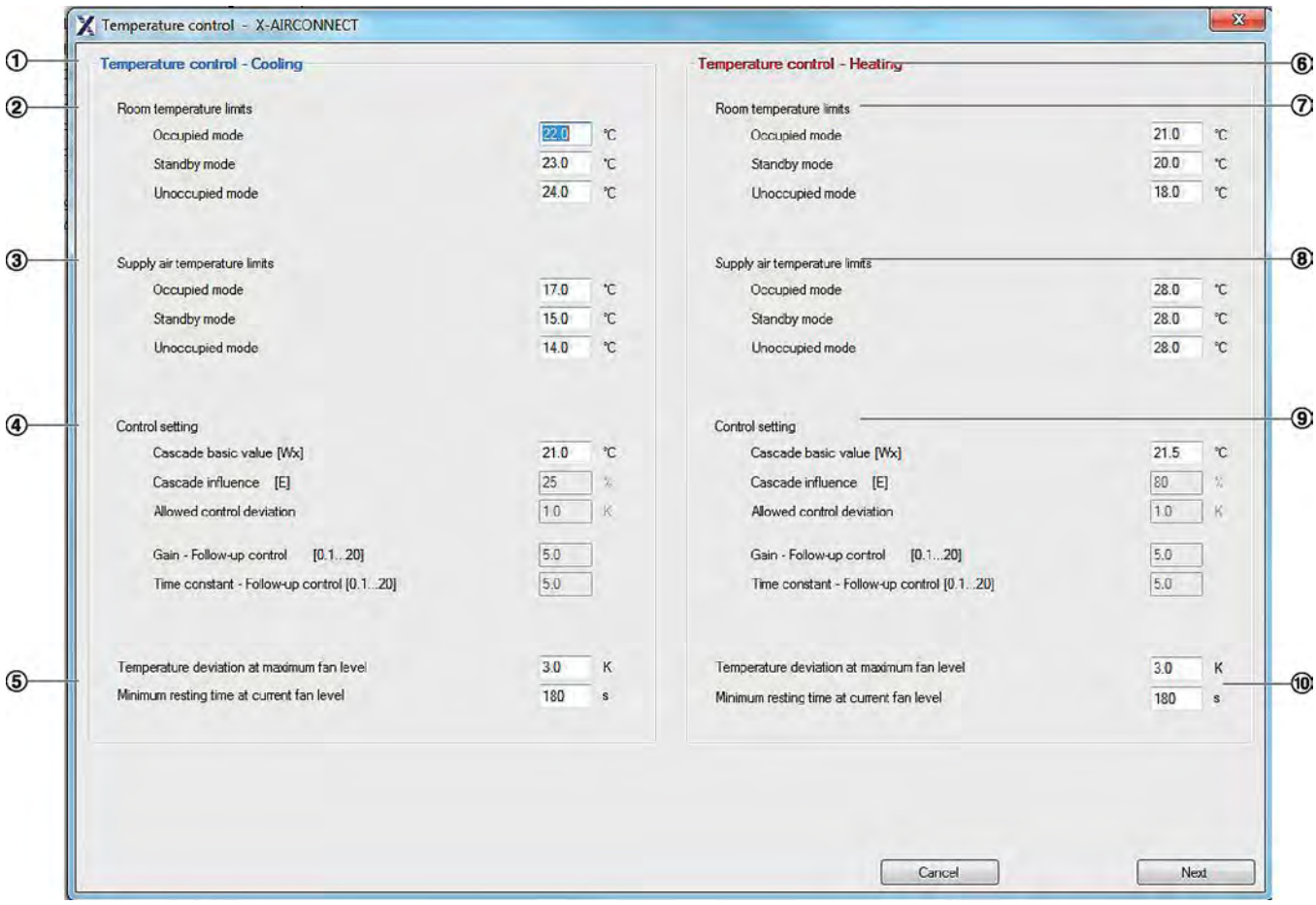


Fig. 19: Temperature control

3.2.2.1.1 Cooling

Room temperature limits (Fig. 19/2)

In cooling mode the room temperature is cooled down to the comfort range upper limit for the operating mode. If the room temperature is above the comfort range, the unit starts to cool the room air. If the room temperature is within the comfort temperature range, the supply air is provided to the room with the set cascade basic value for cooling.

You can set the upper limit of the comfort range for each operating mode independently.

Recommended:

- *Occupied: 23 °C*
- *Standby: 24 °C*
- *Unoccupied: 25 °C*

Supply air temperature limits Fig. 19/3)

In *[Occupied]* mode, the supply air temperature should be at least 18 °C to ensure good comfort levels.

You can set the lower limit of the comfort range for each operating mode independently.

Recommended:

- *Occupied: 18 °C*
- *Standby: 15 °C*
- *Unoccupied: 12 °C*

Control parameters (Fig. 19/4)

Cascade basic value - This is the supply air temperature setpoint to be maintained when the room temperature reaches and remains within the comfort range; factory setting: 22 °C

Only the TROX Technical Service can change the following parameters:

Cascade influence	- This parameter influences the calculation of the supply air setpoint temperature. The higher the cascade influence, the smaller the deviation of the supply air temperature from the cascade basic value; factory setting: 40 %
Allowed control deviation	- Range for which the supply air temperature is not corrected; factory setting: 0.5 K
Gain - Follow-up control	- The higher the 'Gain - Follow-up control' value, the larger the valve stroke change; factory setting: 4.0
Time constant - Follow-up control	- The higher the 'Time constant - Follow-up control' value, the more often the valve stroke is adapted; valve setting: 5.0

Fan stage (Fig. 19/5)

Temperature deviation at maximum fan stage	- When the set T_{set} to T_{actual} deviation is reached, the fan is automatically set to the highest stage; factory setting: 3.0 K
Minimum resting time at current fan stage	- Period of time for which the current fan stage remains set; factory setting: 180 s.

3.2.2.1.2 Heating

Room temperature limits (Fig. 19/7)

In heating mode the room temperature is heated to the comfort range lower limit for the operating mode. If the room temperature is below the comfort range, the unit starts to heat the room air. If the room temperature is within the comfort range, the supply air is provided to the room with the set cascade basic value for heating.

You can set the lower limit of the comfort range for each operating mode independently.

Recommended:

- *Occupied: 21 °C*
- *Standby: 21 °C*
- *Unoccupied: 19 °C*

Supply air temperature limits (Fig. 19/8)

For a comfortable room climate the supply air temperature should not exceed 45 °C.

You can set the upper limit of the comfort range for each operating mode independently.

Recommended:

- *Occupied: 45 °C*
- *Standby: 45 °C*
- *Unoccupied: 45 °C*

Control parameters (Fig. 19/9)

Cascade basic value	- Cascade control setpoint value; factory setting: 22 °C
Cascade influence	- Factory setting: 40 %
Allowed control deviation	- Same as cooling
Gain - Follow-up control	- Same as cooling
Time constant - Follow-up control	- Same as cooling

Only the TROX Technical Service can change grey parameters.

Fan stage (Fig. 19/10)

Temperature deviation at maximum fan stage	- When the set T_{set} to T_{actual} deviation is reached, the fan is automatically set to the highest stage; factory setting: 3.0 K
Minimum resting time at current fan stage	- Period of time for which the current fan stage remains set; factory setting: 180 s.

3.2.2.2 Fan stage adjustment based on air quality

To set air quality control, go to the main menu and select *'Commissioning assistant'* (commissioning wizard).

The *'Air quality control'* screen allows you to set parameters for fan stage adjustment ('fan level adjustment') based on air quality.

After setting the parameters, select *'Next'* to go to the next page.

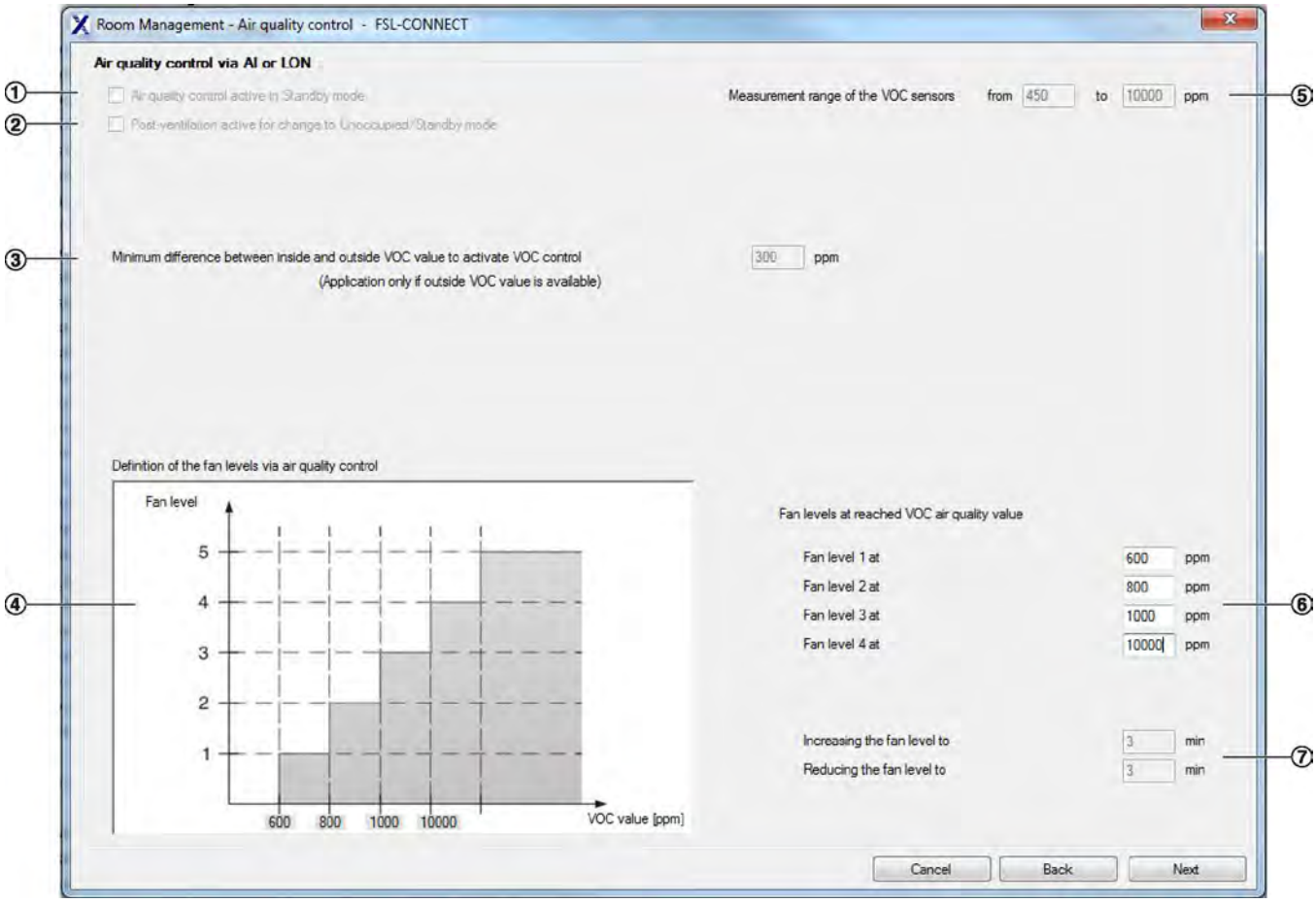


Fig. 20: Fan stage adjustment based on air quality

1 - Activate air quality control for 'Standby' mode.

2 - If the operating mode changes from 'Occupied' to 'Standby' or 'Unoccupied', room ventilation remains active. The set fan stages ('fan levels') are used (see item 6). The fan is switched off if the value falls below fan level 1.

3 - Minimum difference to activate VOC control.

Example 1: Difference: 300 ppm, outside: 350 ppm, inside: 600 ppm; air quality control is off

Example 2: Difference: 300 ppm, outside: 250 ppm, inside: 600 ppm; air quality control is on, fan stage ('fan level') 1

4 - Graphical depiction of air quality control

5 - Measurement range for the air quality sensors

6 - Fields to enter the fan stage ('fan level') limits.

Example: If limit value 600 ppm is exceeded, the system changes from secondary air mode to outdoor air mode. If the actual value falls below the limit, the system resumes secondary air mode.

7 - Fields to enter switching point delays. This prevents the system from constantly being switched on and off (cycling) near the limit values.

3.2.2.3 Operating hours

To set operating times, select *'Commissioning assistant'*.

On the *'Temperature control'* page you can set the control parameters for cooling and heating, ↳ 25. After setting the control parameters select *'Next'* to go to the *'Room Management'* page.

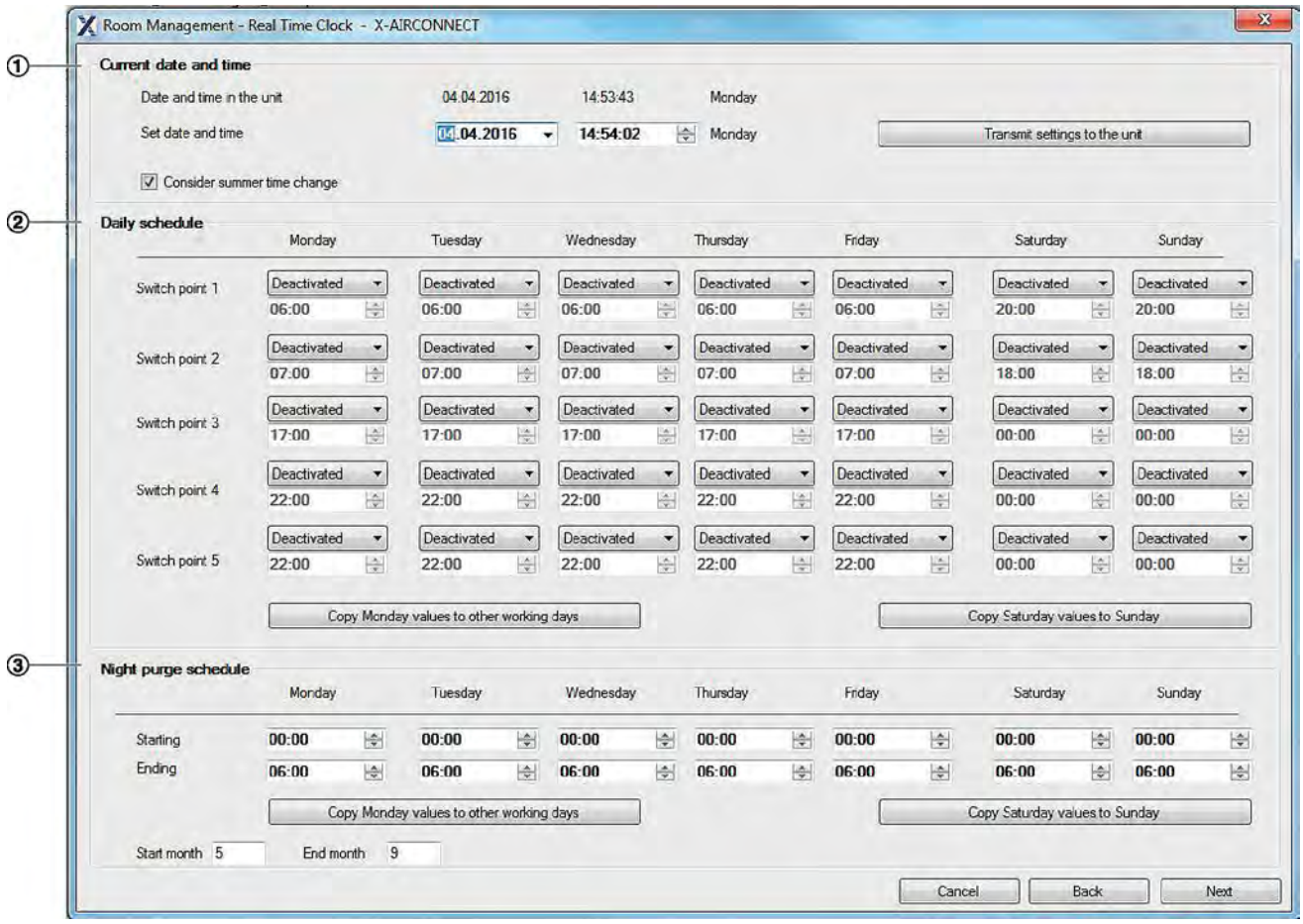


Fig. 21: Room management

3.2.2.3.1 Date and time

Use the fields under *'Current date and time'* to display and set operating dates and times for the unit. If you want to send any settings to the ventilation unit, select *'Transmit settings to the unit'*.

3.2.2.3.2 Daily schedule

You can define daily schedules and enter a start time for each operating mode. Using the optional real time clock (RTC) allows for defining 5 switching points per day.

Operating modes

Occupied	-	The system runs with the preset parameters.
Standby	-	Standby mode, which can be used to preheat a room for occupancy.
Unoccupied	-	Frost protection for the building is enabled, night purge may be enabled.
Boost	-	Used for short-time ventilation, e.g. during breaks; has to be configured using the software
Disabled	-	This switching point is not used.

Example: office hours from 8:00 to 17:00

6:00 - Standby	-	1 hour before work starts, the unit switches to *[Standby]*
7:00 - Occupied	-	15 minutes before work starts, the unit switches to *[Occupied]*
12:00 - Boost	-	During breaks the unit switches to *[Boost]*
12:30 - Occupied	-	After breaks the unit switches to *[Occupied]*
17:00 - Unoccupied	-	After breaks the unit switches to *[Unoccupied]*

Night purge

In the summer months (can be configured; factory setting: May to September), the night purge function allows for the building to be cooled during the nights, which is energy efficient. The room temperature will then have reached a comfortable level by the time the building is occupied. The night purge function must be initiated by a higher-level system (RTC, central BMS or DI); night purge is only possible in 'Unoccupied' mode. If the room temperature exceeds the cooling setpoint value and if the outdoor air temperature is at least 2 K (can be configured) below the cooling setpoint value, the heat recovery will be bypassed and the room will be ventilated by the fan (fan stage can be configured; factory setting: maximum fan speed).

Saving energy

Night purge provides a high energy savings potential since rooms can be 'pre-cooled' at night without using a cooling unit.

3.2.2.3.3 Transferring configuration parameters

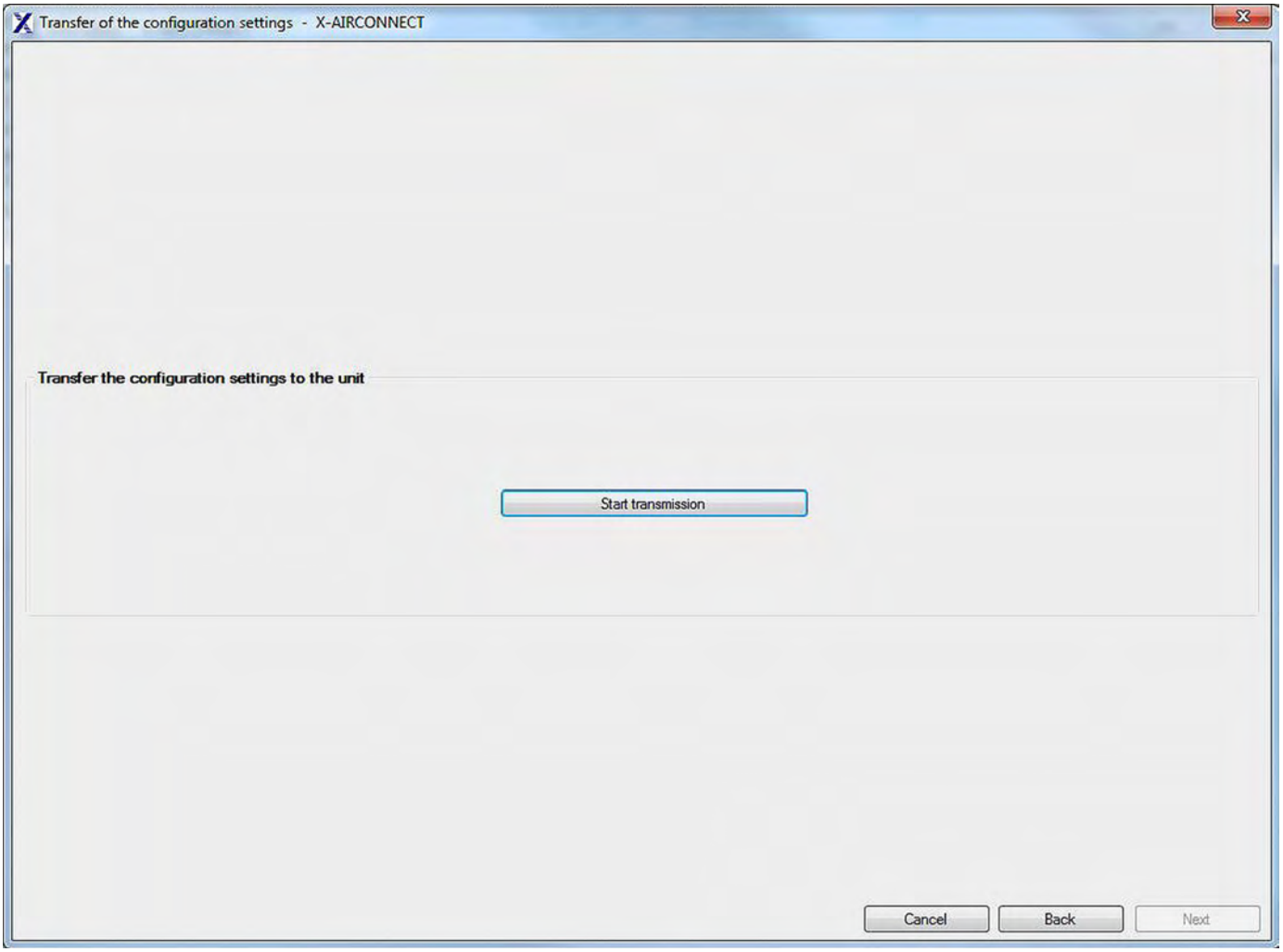


Fig. 22: Transferring configuration parameters

After setting control temperatures ↳ *Chapter 3.2.2.1 'Control temperatures' on page 26* and operating times ↳ *Chapter 3.2.2.3 'Operating hours ' on page 29*, select *'Start transmission'* to send the parameters to the ventilation unit.

After the parameters have been sent, the ventilation unit has to be restarted. To restart the unit, go to the *'Expert functions'* menu and select *'Restart unit'*.

Documentation of configuration settings

You may save the configuration settings as PDF. To do so, go the 'File' menu and select 'Save configuration settings in PDF format'.

3.2.3 Diagnosis

To open the diagnosis functions, go to the main menu and select *'Diagnostics'*.

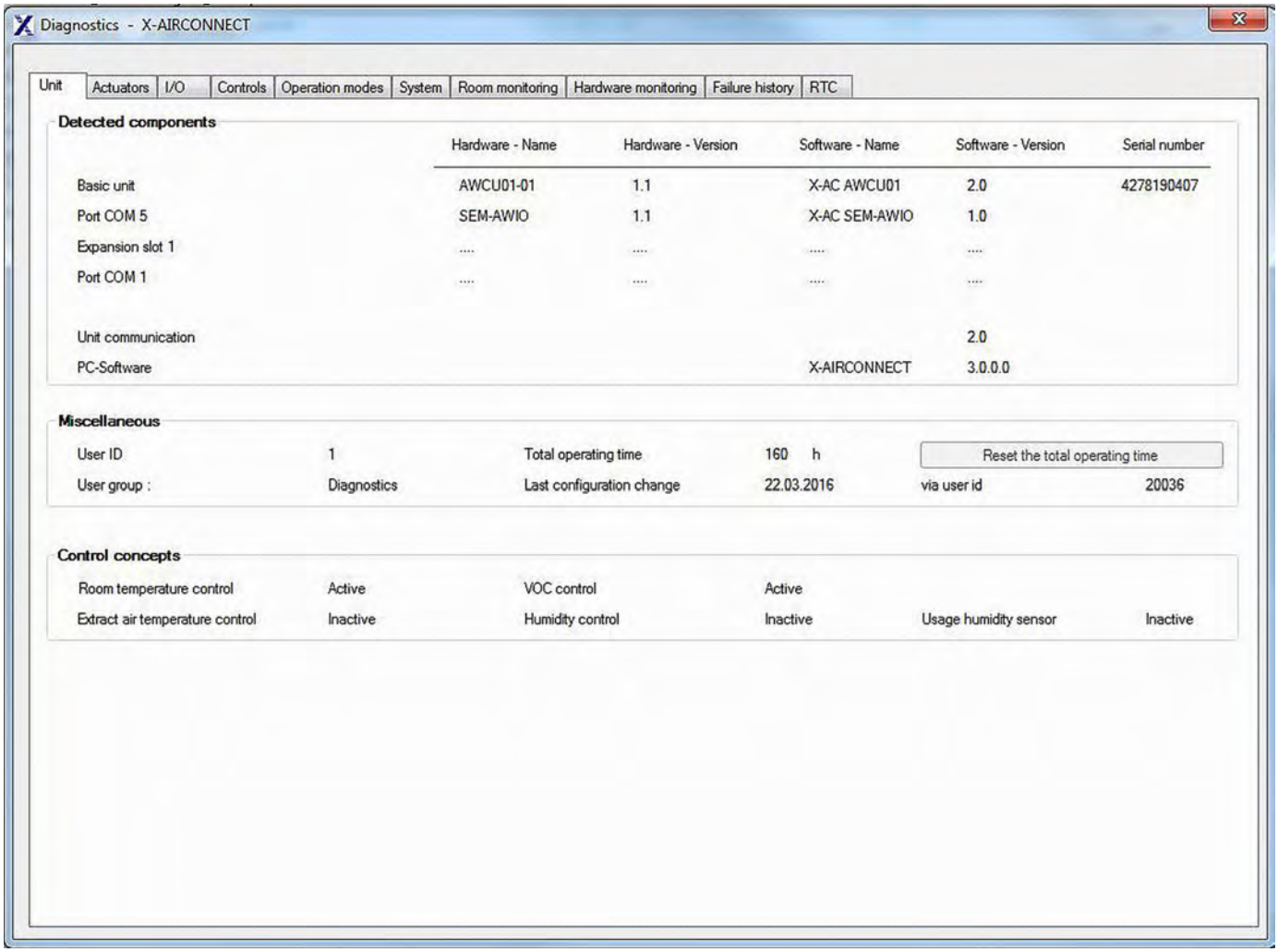


Fig. 23: Diagnosis

The *'Diagnostics'* page allows you to use other functions by selecting the corresponding tabs.

3.2.3.1 Resetting the filter operating hours counter

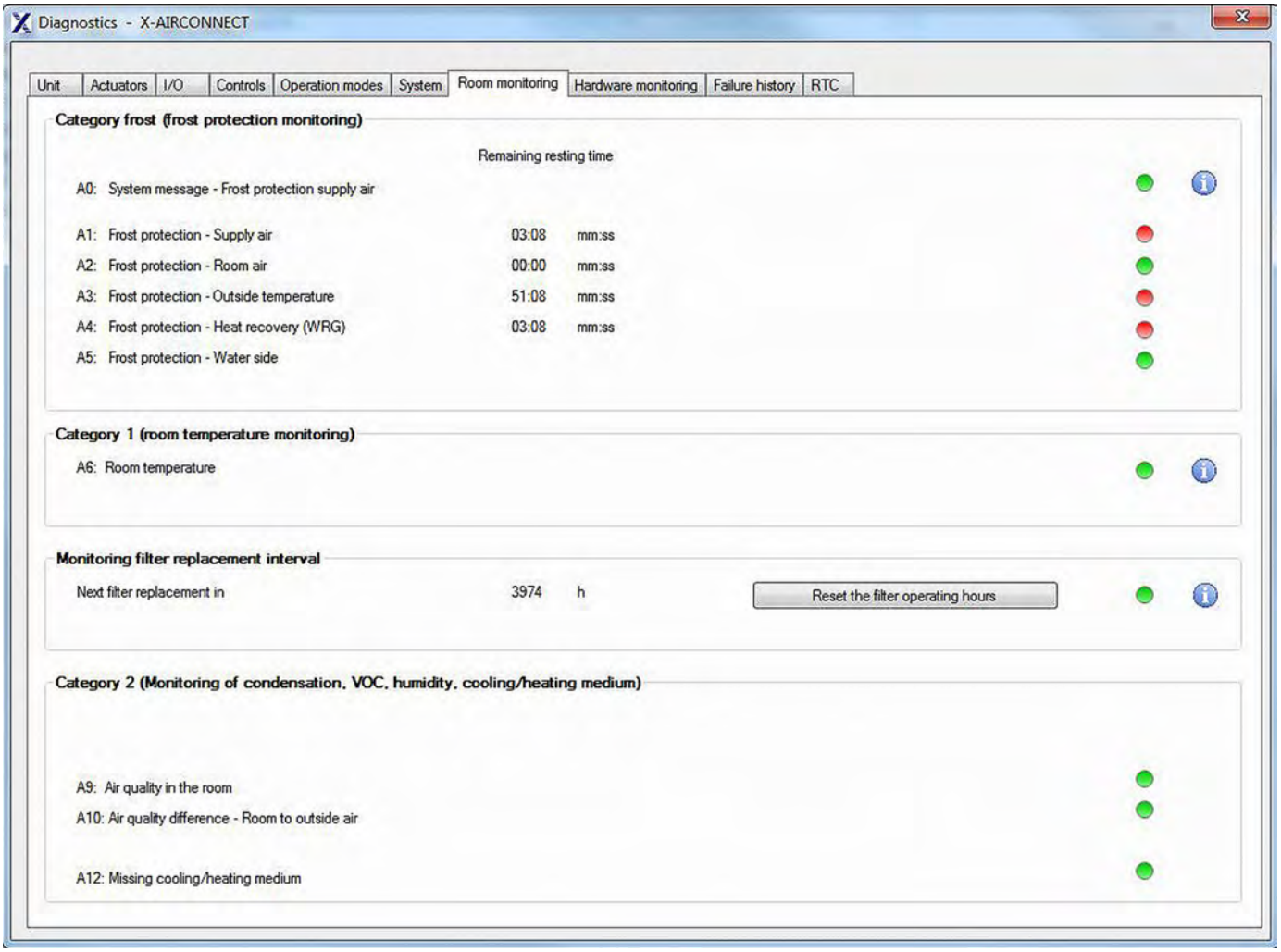


Fig. 24: Diagnosis - Room monitoring

After a filter on the ventilation unit has been changed, the filter operating hours counter should be reset. To do so, go to the *'Diagnostics'* menu and select the *'Room monitoring'* tab; on the page that opens select *'Reset filter operating hours'*.

3.2.4 Basic settings

Changing the language

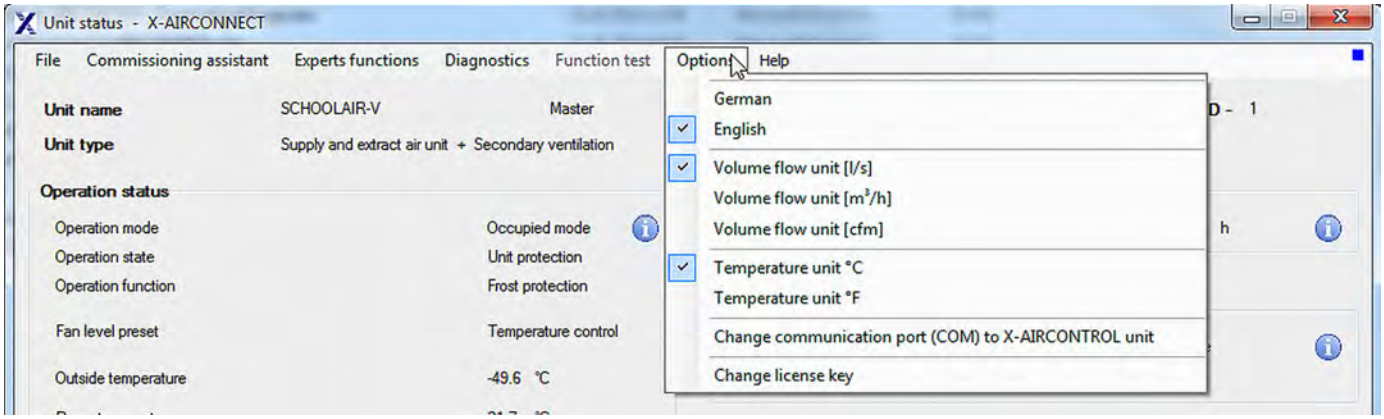


Fig. 25: FSL-CONNECT main menu, 'Options'

To set the dialogue language go to the *'Options'* menu and select *'German'* or *'English'*.

Changing units of measure

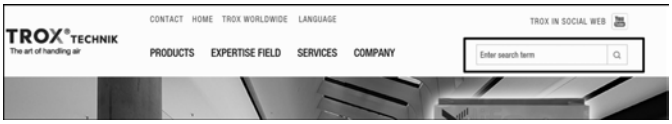
To set or change the unit of measure for volume flow rate or temperature, go to the *'Options'* menu and select the unit of measure you want to set or change.

Changing the licence key

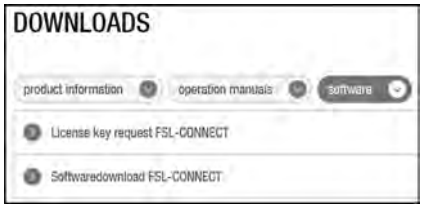
To enter the licence key, go to the *'Options'* menu and select *'Change licence key'*. Then enter the licence key and accept it.

3.2.5 Installing and connecting FSL-CONTROL II

Step 1: Download the FSL-CONNECT software



1. On the TROX website *http://www.trox.de* find the search field, enter *'FSL-CONTROL'* and open the respective product page.



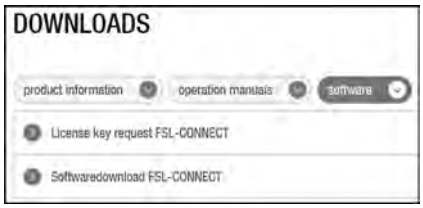
2. On the product page select *'DOWNLOADS -> Software -> Configuration software FSL-CONNECT'*.

3. Enter your contact data into the form and click *'Send'*.

   ⇨ You will then receive an e-mail with the link to download the software.

> *If you do not receive an e-mail with the link, check your spam filter settings.*

Step 2: Requesting the licence key



1. Select *'DOWNLOADS -> Software -> Licence key request FSL-CONNECT'*.

2. Enter your contact data into the form and click *'Send'*.

   ⇨ You will then receive an e-mail with your personal activation code.

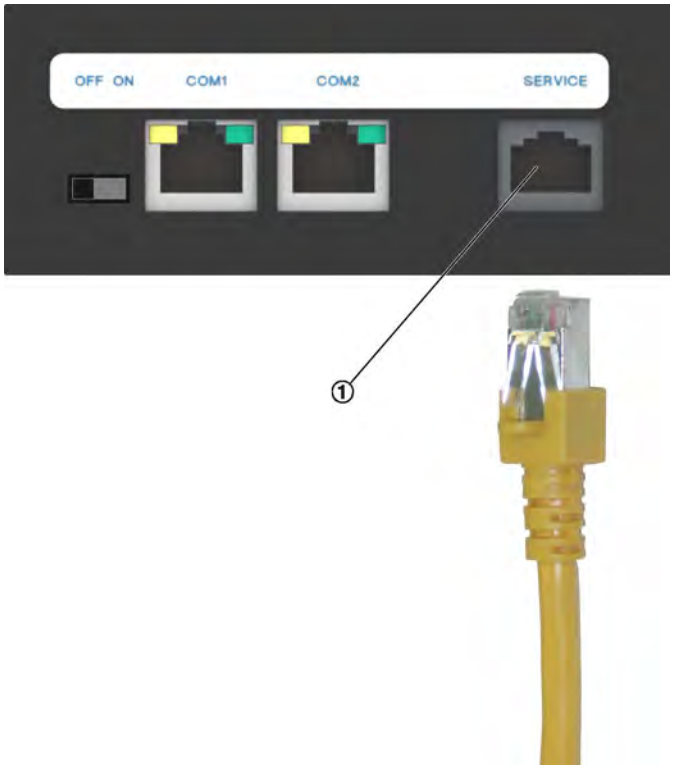
> *If you do not receive an e-mail with the link, check your spam filter settings.*

Step 3: Installing the software

- Unzip the ZIP archive you have just downloaded and install the software.

Step 4: Connecting your personal computer to FSL-CONTROL II – Starting the software

1. Connect the connecting cable to the USB-RS485 plug, and plug the adapter into the USB port of your personal computer or notebook.



① Service socket

2. Plug the communication cable into the service socket ① of the FSL-CONTROL II controller.
3. Start the FSL-CONNECT software and enter the licence key (only required when you start the software for the very first time).

4 Control panel settings

4.1 Analogue control panel

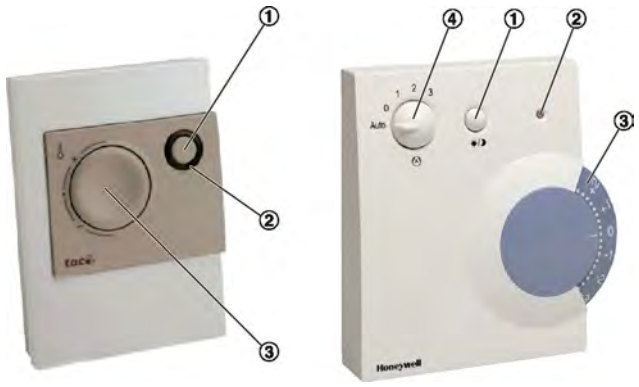


Fig. 26: Control panels

① Occupancy push button
② LED
③ Setpoint value adjuster
④ Fan stage selector

Function	Description	LED
Occupied/ Unoccupied [1]	If you want to change the operating mode from *'Occupied'* to *'Standby'* or vice versa, press the Occupancy push button briefly. This allows you, for example, to manually switch to *'Standby'* mode when the room is not occupied. Start-up delay: 1 to 2 minutes in summer, 6 to 7 minutes in winter.	Standby: LED off Occupied: LED on
Boost	If you want to activate or deactivate rapid ventilation of the room, keep the Occupancy push button pressed for some time.	LED blinks slowly
Overtime [1]	If you want to manually switch on the Overtime function while the system is in *'Standby'* or *'Unoccupied'* mode, press the Occupancy push button briefly. This allows you to set the ventilation unit to *'Occupied'* mode for a previously set period of time if, for example, overtime is required after regular office hours. The overtime period can be configured. After the set period the unit resumes the previous operating mode (RTC/central BMS).	Standby: LED off Overtime: LED on
Filter change	Double blinking of the LED indicates that a filter change is required (the number of operating hours can be configured; factory setting: after 2500 h). Units with differential pressure sensor: Activated if the preset maximum differential pressure or the preset number of operating hours is reached. To reset the number of operating hours, either keep the occupancy push button pressed for at least 10 s or use the FSL-CONNECT software.	LED double blinking This function overrides all other LED signals.
Alarm	Frost alarm and hardware alarm.	LED blinks rapidly

1) The room control panel is factory set to either the *'Occupied/Unoccupied'* function or the *'Overtime'* function. If you need to change this setting, contact the TROX Technical Service.

4.2 Digital control panel

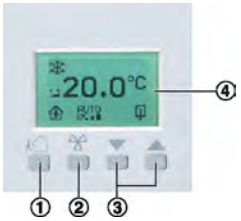


Fig. 27: Digital control panel

Push button Function	Settings	Display ④	Description	
① Operating mode	Occupied		The *'Occupied'* mode is used for occupied rooms.	If you want to change the operating mode between *'Occupied'*, *'Unoccupied'* and *'Boost'*, press this button briefly. Start-up time: ■ Summer: 1-2 minutes ■ Winter 6-7 minutes
	Unoccu-pied		The *'Unoccupied'* mode is used for unoccupied rooms.	
	Boost		*'Boost'* is used to increase ventilation, e.g. during breaks.	
② Ventilation	Automatic	AUTO	Automatic ventilation control.	
	Off		Ventilation off.	
	Stage 1		Manual ventilation control at the lowest level.	
	Stage 2		Manual ventilation control at a medium level.	
	Stage 3		Manual ventilation control at the highest level.	
③ Tempera-ture	▲		Used to increase the set-point temperature.	You can change the setpoint temperature in increments of 0.5 °C. You can change the default setpoint temperature from -3 °C ... +3 °C. Example: ■ Default setpoint temperature: 21 °C ■ Minimum temperature you can set: 18 °C ■ Maximum temperature you can set: 24 °C
	▼		Used to reduce the setpoint temperature.	
Room tem-perature	–	20.0 °C	Displays the actual room temperature.	
Frost pro-tection	–		Indicates that the frost protection function is active, i.e. that the ventilation unit is protected from frost damage at low temperatures.	

Push button Function	Settings	Display ④	Description
Filter	–		Indicates that a filter change is due; the number of operating hours after which a filter should be changed can be configured (the factory setting is 2500 h). Units with differential pressure sensor: Activated if the preset maximum differential pressure or the preset number of operating hours is reached. Use the FSL-CONNECT software to reset the counter after a filter change.
Window	–		Indicates that a window is open. The corresponding window contact signal has been received. The ventilation unit is automatically switched off as a consequence.

5 Configuring interfaces to the central BMS

5.1 List of data points

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List of X-AIRCONTROL data points (valid from V 1.14)

	Data point description, input values	LON		BACnet			Modbus (no. of registers = 1)
		Variable	Data type	Instance	Object type	Note	Register address
1	Operating mode default setting	nviApplicMode	SNVT_hvac_mode	2	Multistate value	2 states	0
2	Operating mode default setting by central BMS	nviMode	SNVT_occupancy	4	Multistate value	5 states	1
3	Operating mode default setting by PIR sensor	nviOccSensor	SNVT_occupancy	6	Multistate value	5 states	2
4	Outdoor air temperature default setting by central BMS	nviOutsideTemp	SNVT_temp_p	1	Analogue value	Temperature	3
6	Default setting of room temperature setpoint (relative)	nviTempOffset	SNVT_temp_p	5	Analogue value	Temperature	5
7	Default setting of room temperature	nviRoomTemp	SNVT_temp_p	6	Analogue value	Temperature	6
8	Default setting of relative air humidity	nviRelHumid	SNVT_lev_percent	8	Analogue value	Percentage	7
10	Default setting of room VOC value	nviVOC_Room	SNVT_ppm	10	Analogue value	VOC value	9
11	Default setting of outdoor air VOC value	nviVOC_Outside	SNVT_ppm	12	Analogue value	VOC value	10
12	Emergency switch-off of fire protection	nviFire	SNVT_hvac_emerg	2	Binary value	2 states	11
13	Switch-off based on window contact	nviWindow	SNVT_switch	3	Binary value	2 states	12
14	Extension of operating time	nviExtraTime	SNVT_switch	4	Binary value	2 states	13
15	Changeover between heating and cooling	nviChangeOver	SNVT_switch	7	Multistate value	3 states	14
16	Default setting of fan stage	nviFanSpeed	SNVT_switch	8	Multistate value	7 states	15

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nviApplicMode

SNVT_hvac_mode
Function: Operating mode default setting

LON Identifier	BACnet	Modbus (Register 0)	Description
HVAC_NUL	1	255	Invalid = inactive
HVAC_NIGHT_PURGE	6	4	Night purge activation

nviMode

SNVT_occupancy
Function: Operating mode default setting by central BMS

LON value	Identifier	BACnet value	Modbus value (Register 1)	Description
0	OC_OCCUPIED	1	0	Occupied
1	OC_UNOCCUPIED	2	1	Unoccupied
2	OC_BYPASS	3	2	Boost
3	OC_STANDBY	4	3	Standby
255	OC_NUL	5	255	invalid

nviOccSensor

SNVT_occupancy
Function: Operating mode default setting by a PIR sensor (by others)

LON value	Identifier	BACnet value	Modbus value (Register 2)	Description
0	OC_ OCCUPIED	1	0	Occupied
1	OC_ UNOCCUPIED	2	1	Unoccupied
2	OC_ BYPASS	3	2	Boost
3	OC_STANDBY	4	3	Standby
255	OC_ NUL	5	255	invalid

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nviOutsideTemp

SNVT_temp_p
Function: Default setting of outdoor air temperature by central BMS

LON value	BACnet value	Modbus value (Register 3)
Enter with 2 decimal places, e.g. -12 °C →-12.00	Enter with 2 decimal places, e.g. -12 °C →-12.00	Enter without decimal places, multiply with 100, e.g. -12.00 °C → -1200
Invalid: 327,67	Invalid: 327,67	Invalid: 327,67

nviTempOffset

SNVT_temp_p
Function: Default setting of room temperature setpoint (relative)

LON value	BACnet value	Modbus value (Register 5)
e.g. 3K →3	e.g. 3K →3	Enter without decimal places, multiply with 100, e.g. 3K → 300
Invalid: 327,67	Invalid: 327,67	Invalid: 327,67

nviRoomTemp

SNVT_temp_p
Function: Default setting of room temperature

LON value	BACnet value	Modbus value (Register 6)
Enter with 2 decimal places, e.g. 25 °C →25.00	Enter with 2 decimal places, e.g. 25 °C →25.00	Enter without decimal places, multiply with 100, e.g. 25.00 °C → 2500
Invalid: 327,67	Invalid: 327,67	Invalid: 327,67

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nviRelHumid

SNVT_lev_percent
Function: Default setting of relative room air humidity

LON value	BACnet value	Modbus value (Register 7)
-163.840….+163.830	0….100%	0….100%
Invalid: +163,830	Invalid: 65535	Invalid: 65535

nviVOC_Room

SNVT_ppm
Function: Default setting of room VOC value

LON value	BACnet value	Modbus value (Register 9)
0….65535	0….65535	0….65535
Invalid: 65535	Invalid: 65535	Invalid: 65535

nviVOC_Outside

SNVT_ppm
Function: Default setting of outdoor air VOC value

LON value	BACnet value	Modbus value (Register 10)
0….65535	0….65535	0….65535
Invalid: 65535	Invalid: 65535	Invalid: 65535

nviFire

SNVT_hvac_emerg
Function: Emergency switch-off of fire protection

LON value	Identifier	BACnet value	Modbus value (Register 11)	Description
0	emerg_normal	0	0	No switch-off
5	emerg_fire	1	1	Switch-off

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nviWindow

SNVT_switch
Function: Switch-off based on window contact

LON		BACnet	Modbus (Register 12)	Description
state	**value**			
0	XXX	0	0	Window contact disabled
1	XXX	1	1	Window contact enabled

nviExtraTime

SNVT_switch
Function: Extension of 'Occupied' or 'Boost' operating mode (time can be defined for the X-AIRCONTROL controller)

LON		BACnet	Modbus (Register 13)	Description
state	**value**			
0	XXX	0	0	Operating time is extended in case of change from 0 to 1
1	XXX	1	1	

nviChangeOver

SNVT_switch
Function: Information to the X-AIRCONTROL controller about the available operating fluid (heating/cooling, for 2-pipe system)

LON		BACnet	Modbus (Register 14)	Description
state	**value**			
-1	XXX	1	0	No changeover
1	XXX	2	1	Cooling fluid
0	XXX	3	2	Heating fluid

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nviFanSpeed

SNVT_switch
Function: Default setting of fan stage (fan speed)

LON		BACnet	Modbus (Register 15)	Description
state	value			
1	0	1	1	Fan stage OFF
1	20	2	10241	Fan stage 1
1	40	3	20481	Fan stage 2
1	60	4	30721	Fan stage 3
1	80	5	40961	Fan stage 4
1	100	6	51201	Fan stage 5
0	XXX	7	0	Automatic mode

Modbus: e.g. 20*2 = 40 => 28Hex + State 01 => 2801 Hex => 10241

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	Description of data points, Output values	LON		BACnet			Modbus (no. of registers = 1)
		Variable	Data type	Instance	Object type	Note	Register address
17	Output of supply air actual temperature	nvoSupplyAirTemp	SNVT_temp_p	13	Analogue value	Temperature	16
18	Actual operating mode	nvoMode	SNVT_occupancy	5	Multistate value	5 states	17
19	Feedback whether operating time extension has been enabled	nvoExtraTime	SNVT_switch	5	Binary value	2 states	18
20	Effective room temperature setpoint value	nvoEffectSetPt	SNVT_temp_p	14	Analogue value	Temperature	19
21	Feedback – window contact	nvoWindow	SNVT_switch	6	Binary value	2 states	20
22	Feedback – actual fan stage	nvoFanSpeed	SNVT_switch	9	Multistate value	12 states	21
23	Feedback – actual operating state	nvoApplicMode	SNVT_hvac_mode	3	Multistate value	15 states	22
24	Feedback – outdoor air actual temperature	nvoOutsideTemp	SNVT_temp_p	2	Analogue value	Temperature	23
25	Feedback – temperature offset	nvoSetPtOffset	SNVT_ temp_p	4	Analogue value	Temperature	24
26	Feedback – room air actual temperature	nvoRoomTemp	SNVT_ temp_p	7	Analogue value	Temperature	25
27	Feedback – relative humidity	nvoRelHumid	SNVT_lev_percent	9	Analogue value	Percentage	26
28	Feedback – VOC actual value	nvoVOCRoom	SNVT_ppm	11	Analogue value	VOC value	27
29	Alarm – frost protection	nvoFrostAlarm	SNVT_switch	7	Binary value	2 states	28
30	Alarm/error messages	nvoAlarm1	SNVT_switch	8	Binary value	2 states	29
33	Hardware messages	nvoHWStatus	SNVT_state	11-17	Binary value	2 states each	32
34	Return temperature	nvoReturnTemp	SNVT_temp_p	15	Analogue value	Temperature	33
35	Output of total supply air flow rate	nvoSumSup	SNVT_vol	16	Analogue value	Volume flow rate	34
36	Output of total extract air flow rate	nvoSumExh	SNVT_vol	17	Analogue	Volume flow	35

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					value	rate	
37	No. of devices within the system	nvoSystemDevices	SNVT_switch	18	Analogue value	1….16	36
38	Feedback – emergency switch-off	nvoFire	SNVT_switch	18	Binary value	3 states	37

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nvoSupplyAirTemp

SNVT_temp_p

Function: Output of the supply air actual temperature to the central BMS

LON value	BACnet value	Modbus value (Register 16)
Enter with 2 decimal places, e.g. 23 °C →23.00	Enter with 2 decimal places, e.g. 23 °C →23.00	Enter without decimal places, multiply with 100, e.g. 23.00 °C → 2300
Invalid: 327,67	Invalid: 327,67	Invalid: 327,67

nvoMode / ActMode

SNVT_occupancy

Function: Output of the actual operating mode to the central BMS

LON value	Identifier	BACnet value	Modbus value (Register 17)	Description
0	OC_OCCUPIED	1	0	Occupied
1	OC_UNOCCUPIED	2	1	Unoccupied
2	OC_BYPASS	3	2	Boost
3	OC_STANDBY	4	3	Standby
255	OC_NUL	5	255	invalid

nvoExtraTime / ActExtraTime

SNVT_switch

Feedback to the central BMS whether operating time extension has been enabled

LON		BACnet	Modbus (Register 18)	Description
state	value			
0	XXX	0	0	1 = operating time extension has been enabled
1	XXX	1	1	

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nvoEffectSetPt

SNVT_temp_p

Function: Feedback of the effective room temperature setpoint value to the central BMS

LON value	BACnet value	Modbus value (Register 19)
Enter with 2 decimal places, e.g. 26 °C →26.00	Enter with 2 decimal places, e.g. 26 °C →26.00	Enter without decimal places, multiply with 100, e.g. 26.00 °C → 2600
Invalid: 327,67	Invalid: 327,67	Invalid: 327,67

nvoWindow / ActWindow

SNVT_switch

Function: Feedback whether a window contact has been enabled

LON		BACnet	Modbus (Register 20)	Description
state	value			
0	XXX	0	0	Window contact disabled
1	XXX	1	1	Window contact enabled

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nvoFanSpeed / ActFanSpeed

SNVT_switch

Function: Feedback of the fan stage (fan speed) to the central BMS

LON		BACnet	Modbus (Register 21)	Description
state	value			
1	0	1	1	Fan stage OFF, manually
1	20	2	10241	Fan stage 1, manually
1	40	3	20481	Fan stage 2, manually
1	60	4	30721	Fan stage 3, manually
1	80	5	40961	Fan stage 4, manually
1	100	6	51201	Fan stage 5, manually
0	0	7	0	Fan OFF, automatic operation
0	20	8	10240	Fan stage 1, automatic operation
0	40	9	20480	Fan stage 2, automatic operation
0	60	10	30720	Fan stage 3, automatic operation
0	80	11	40960	Fan stage 4, automatic operation
0	100	12	51200	Fan stage 5, automatic operation

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nvoApplicMode / ActApplicMode

SNVT_hvac_mode
Function: Feedback of the actual operating state to the central BMS

LON value	Identifier	BACnet value	Modbus value (Register 22)	Description
-1 (0xFF)	HVAC_NUL	1	255	No function
0	HVAC_AUTO	2	0	Automatic mode
1	HVAC_HEAT	3	1	Heating
3	HVAC_COOL	5	3	Cooling
4	HVAC_NIGHT_PURGE	6	4	Night purge
6	HVAC_OFF	8	6	No ventilation
8	HVAC_EMERG_HEAT	10	8	Frost protection
9	HVAC_FAN_ONLY	11	9	Only ventilation
10	HVAC_FREE_COOL	12	10	Free cooling
12	HVAC_MAX_HEAT	13	12	Start-up delay
1	HVAC_ECONOMY	3	1	Free heating

nvoOutsideTemp / ActOutsideTemp

SNVT_temp_p
Function: Feedback of the outdoor air actual temperature to the central BMS

LON value	BACnet value	Modbus value (Register 23)
Enter with 2 decimal places, e.g. -12 °C →-12.00	Enter with 2 decimal places, e.g. -12 °C →-12.00	Enter without decimal places, multiply with 100, e.g. -12.00 °C → -1200
Invalid: 327,67	Invalid: 327,67	Invalid: 327,67

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nvoSetPtOffset

SNVT_temp_p
Function: Feedback of a temperature offset to the central BMS

LON value	BACnet value	Modbus value (Register 24)
Enter as follows 3K →3	Enter as follows 3K →3	Enter without decimal places, multiply with 100, e.g. 3K → 3
Invalid: 327,67	Invalid: 327,67	Invalid: 327,67

nvoRoomTemp / ActRoomTemp

SNVT_temp_p
Function: Feedback of the room air actual temperature to the central BMS

LON value	BACnet value	Modbus value (Register 25)
Enter with 2 decimal places, e.g. 23 °C →23.00	Enter with 2 decimal places, e.g. 23 °C →23.00	Enter without decimal places, multiply with 100, e.g. 23.00 °C → 2300
Invalid: 327,67	Invalid: 327,67	Invalid: 327,67

nvoRelHumid / ActRelHumid

SNVT_lev_percent
Function: Feedback of the actual relative humidity in the room to the central BMS (additional hardware required, or default setting by the central BMS)

LON value	BACnet value	Modbus value (Register 26)
-163.840….+163.830	0….100%	0….100%
Invalid: +163,830	Invalid: 65535	Invalid: 65535

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nvoVOC_Room / ActVOC_Room

SNVT_ppm
Function: Feedback of the room VOC actual value to the central BMS (additional hardware required, or default setting by the central BMS)

LON value	BACnet value	Modbus value (Register 27)
0….65535	0….65535	0….65535
Invalid: 65535	Invalid: 65535	Invalid: 65535

nvoFrostAlarm

SNVT_switch
Function: Frost alarm

LON		BACnet	Modbus (Register 28)	Description
state	value			
0	XXX	0	0	Frost alarm disabled
1	XXX	1	1	Frost alarm enabled

nvoAlarm1

SNVT_switch
Function: Consolidated alarm, category 1 (voltage monitoring and temperature sensor failure)

LON		BACnet	Modbus (Register 29)	Description
state	value			
0	XXX	0	0	Alarm disabled
1	XXX	1	1	Alarm enabled

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nvoHWStatus

SNVT_state
Function: Hardware messages, 16-bit string
The following list applies to LON and Modbus (register 32)

- Bit 0: XXX
- Bit 1: XXX
- Bit 2: Fan blocked
- Bit 3: XXX
- Bit 4: Filter alarm
- Bit 5: XXX
- Bit 6: XXX
- Bit 7 to bit 15 XXX

The following list applies to BACnet:

- Instance 11: Power supply
- Instance 12: Master module SEM-AWIO
- Instance 13: Fan blocked
- Instance 14: Sensor error
- Instance 15: Filter alarm
- Instances 16 and 17 are not used

nvoReturnTemp

SNVT_temp_p
Function: Feedback of the actual return temperature to the central BMS (additional hardware required)

LON value	BACnet value	Modbus value (Register 33)
Enter with 2 decimal places, e.g. 23 °C →23.00	Enter with 2 decimal places, e.g. 23 °C →23.00	Enter without decimal places, multiply with 100, e.g. 23.00 °C → 2300
Invalid: 327,67	Invalid: 327,67	Invalid: 327,67

nvoSumSup

SNVT_vol
Function: Feedback of the supply air total volume flow rate for all devices (masters and slaves) in this control circuit. The output is a number and it is identical for LON, BACnet and Modbus; the unit of measure is [l/s].

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nvoSumExh

SNVT_vol
Function: Feedback of the extract air total volume flow rate for all devices (masters and slaves) in this control circuit. The output is a number and it is identical for LON, BACnet and Modbus; the unit of measure is [l/s].

nvoSystemDevices

SNVT_switch
Function: Sum of all X-AIRCONTROL controllers (masters and slaves) in this circuit. The output is a number and it is identical for LON, BACnet and Modbus.

nvoFire / ActFire

SNVT_switch
Function: Feedback of an emergency switch-off to the central BMS.

LON		BACnet value	Modbus value (Register 37)	Description
state	**value**			No switch-off
0	XXX	0	0	
1	XXX	1	1	Switch-off

5.2 BACnet MS/TP interface

BACnet Protocol Implementation Conformance Statement

Date:	23.09.2013
Vendor Name:	TROX GmbH
Product Name:	EM-BAC-MOD-01 XAC
Product Model Number:	A00000020207
Application Software Version:	1.0
Firmware Revision:	1.0
BACnet Protocol Revision:	12

Product Description:

Expansion module for X-AIRCONTROL controllers providing a BACnet MS/TP Interface.

BACnet Standardized Device Profile (Annex L):

☐ **BACnet Operator Workstation (B-OWS)**
☐ **BACnet Advanced Operator Workstation (B-AWS)**
☐ **BACnet Operator Display (B-OD)**
☐ **BACnet Building Controller (B-BC)**
☐ **BACnet Advanced Application Controller (B-AAC)**
☒ **BACnet Application Specific Controller (B-ASC)**
☐ **BACnet Smart Sensor (B-SS)**
☐ **BACnet Smart Actuator (B-SA)**

List all BACnet Interoperability Building Blocks Supported (Annex K):

Data Sharing-ReadProperty-B (DS-RP-B)
Data Sharing-WriteProperty-B (DS-WP-B)
Data Sharing-COV-Unsolicited-B (DS-COVU-B)
Device Management-Dynamic Device Binding-B (DM-DDB-B)
Device Management-Dynamic Object Binding-B (DM-DOB-B)
Device Management-DeviceCommunicationControl-B (DM-DCC-B)
Device Management-ReinitializeDevice-B (DM-RD-B)

Segmentation Capability:

☐ Able to transmit segmented messages Window Size _____
☐ Able to receive segmented messages Window Size _____

Standard Object Types Supported:

An object type is supported if it may be present in the device. For each standard Object Type supported provide the following data:

1) Whether objects of this type are dynamically creatable using the CreateObject service
2) Whether objects of this type are dynamically deletable using the DeleteObject service
3) List of the optional properties supported
4) List of all properties that are writable where not otherwise required by this standard
5) List of all properties that are conditionally writable where not otherwise required by this standard
6) List of proprietary properties and for each its property identifier, datatype, and meaning
7) List of any property range restrictions

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Data Link Layer Options:

☐ BACnet IP, (Annex J)
☐ BACnet IP, (Annex J), Foreign Device
☐ ISO 8802-3, Ethernet (Clause 7)
☐ ATA 878.1, 2.5 Mb. ARCNET (Clause 8)
☐ ATA 878.1, EIA-485 ARCNET (Clause 8), baud rate(s) _____
☒ MS/TP master (Clause 9), baud rate(s): 9600, 19200, 38400, 76800
☐ MS/TP slave (Clause 9), baud rate(s): _____
☐ Point-To-Point, EIA 232 (Clause 10), baud rate(s):_____
☐ Point-To-Point, modem, (Clause 10), baud rate(s): _____
☐ LonTalk, (Clause 11), medium: _____
☐ BACnet/ZigBee (ANNEX O)
☐ Other: _____

Device Address Binding:

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) ☐ Yes ☒ No

Networking Options:

☐ Router, Clause 6 - List all routing configurations, e.g., ARCNET-Ethernet, Ethernet-MS/TP, etc.
☐ Annex H, BACnet Tunneling Router over IP
☐ BACnet/IP Broadcast Management Device (BBMD)
Does the BBMD support registrations by Foreign Devices? ☐ Yes ☐ No
Does the BBMD support network address translation? ☐ Yes ☐ No

Network Security Options:

☒ Non-secure Device - is capable of operating without BACnet Network Security
☐ Secure Device - is capable of using BACnet Network Security (NS-SD BIBB)
☐ Multiple Application-Specific Keys:
☐ Supports encryption (NS-ED BIBB)
☐ Key Server (NS-KS BIBB)

Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☒ ISO 10646 (UTF-8)	☐ IBM™/Microsoft™ DBCS	☐ ISO 8859-1
☐ ISO 10646 (UCS-2)	☐ ISO 10646 (UCS-4)	☐ JIS X 0208

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:

_____
_____
_____

Configuration Switches

Hexadecimal Switches X, Y	Network-Address

DIP Switch 2 DIP Switch 3	OFF OFF	ON OFF	OFF ON	ON ON
Baudrate	9600	19200	38400	76800

Device Object

Property	Remark / Value	RW
Object_Identifier	device, default instance: 32900 + Address Switch	RW-E
Object_Name	max. 50 Bytes, default “EM-BACnet”	RW-E
Object_Type	DEVICE (8)	R
System_Status	OPERATIONAL (0)	R
Vendor_Name	“TROX GmbH”	R
Vendor_Identifier	329	R
Model_Name	“EM-BAC-MOD-01 XAC”	R
Firmware_Revision	“1.0”	R
Application_Software_Version	“1.0”	R
Protocol_Version	1	R
Protocol_Revision	12	R
Protocol_Services_Supported	read-property, write-property, device-communication-control, reinitialize-device, who-has, who-is	R
Protocol_Object_Types_Supported	DEVICE, ANALOG_VALUE, BINARY_VALUE, MULTISTATE_VALUE	R
Object_List	device, analog-value 1…18, binary-value 1…20, multistate-value 1…9	R
Max_APDU_Length_Accepted	480	R
Segmentation_Supported	NO_SEGMENTATION (3)	R
APDU_Timeout	3000	R
Number_Of_APDU_Retries	0	R
Device_Address_Binding	-	R
Database_Revision	0	R
Description	Controller Type “X-AIRCONTROL”	R
Max_Master	default 127	RW-E
Max_Info_Frames	default 1	RW-E
R: Read Property, W: Write Property, -E: Storage in EEPROM		

Analog Value Objects

Property	Remark / Value	RW
Object_Identifier	analog-value, instance 1 … 18	R
Object_Name		R
Object_Type	ANALOG_VALUE (2)	R
Present_Value		
Status_Flags	IN_ALARM: 0 FAULT: 0 OVERRIDDEN: 0 OUT_OF_SERVICE: 0	R
Event_State	NORMAL (0)	R
Out_Of_Service	FALSE (0)	R
Units		R
R: Read Property, W: Write Property		

Instance	Object_Name	Units	Initial Present_Value	Present_Value
1	“OutsideTemp”	degrees-Celsius (62)	327.67	RW
2	“ActOutsideTemp”	degrees-Celsius (62)	327.67	R
3	“RoomTemp_Set”	degrees-Celsius (62)	327.67	RW
4	“SetptOffset”	degrees-Celsius (62)	327.67	R
5	“TempOffset”	degrees-Celsius (62)	327.67	RW
6	“RoomTemp”	degrees-Celsius (62)	327.67	RW
7	“ActRoomTemp”	degrees-Celsius (62)	327.67	R
8	“RelHumid”	percent-relative-humidity (29)	0	RW
9	“ActRelHumid”	percent-relative-humidity (29)	0	R
10	“VOC_Room”	parts-per-million (96)	0	RW
11	“ActVOC_Room”	parts-per-million (96)	0	R
12	“VOC_Outside”	parts-per-million (96)	0	RW
13	“DischAirTemp”	degrees-Celsius (62)	327.67	R
14	“EffectSetpt”	degrees-Celsius (62)	327.67	R
15	“RTemp”	degrees-Celsius (62)	327.67	R
16	“Sum_Sup”	liters-per-second (87)	0	R
17	“Sum_Exh”	liters-per-second (87)	0	R
18	“SystemDevices”	no-units (95)	0	R

Binary Value Objects

Property	Remark / Value	RW
Object_Identifier	binary-value, instance 1 … 20	R
Object_Name		R
Object_Type	BINARY_VALUE (5)	R
Present_Value	INACTIVE (0, Initial) / ACTIVE (1)	
Status_Flags	IN_ALARM: 0 FAULT: 0 OVERRIDDEN: 0 OUT_OF_SERVICE: 0	R
Event_State	NORMAL (0)	R
Out_Of_Service	FALSE (0)	R
Inactive_Text		R
Active_Text		R
R: Read Property, W: Write Property, COVU: Unsolicited Change of Value Notification		

Instance	Object_Name	Inactive_Text	Active_Text	Present_Value
1	“StartPCM”	“Off”	“On”	RW
2	“Fire”	“Normal”	“Fire”	RW
3	“Window”	“Close”	“Open”	RW
4	“ExtraTime”	“Inactive”	“Active”	RW
5	“ActExtraTime”	“Inactive”	“Active”	R
6	“ActWindow”	“Close”	“Open”	R
7	“FAlarm”	“Normal”	“Frostalarm”	R COVU
8	“Alarm1”	“Normal”	“Alarm1”	R COVU
9	“Alarm2”	“Normal”	“Alarm2”	R COVU
10	“Release”	“Off”	“On”	R
11	“Status_PowerSupply”	“Normal”	“LowPower”	R COVU
12	“Status_EMFSLIO”	“Normal”	“ComFail”	R COVU
13	“Status_Fan”	“Normal”	“FanBlocked”	R COVU
14	“Status_Sensor”	“Normal”	“SensorFail”	R COVU
15	“Status_Filter”	“Normal”	“FilterAlarm”	R COVU
16	“Status_FlowControl”	“Normal”	“FlowAlarm”	R COVU
17	“Status_Damper”	“Normal”	“CalibrationFail”	R COVU
18	“ActFire”	“Normal”	“Fire”	R
19	“FanForce”	“Inactive”	“Active”	RW
20	“ActFanForce”	“Inactive”	“Active”	R

Multistate Value Objects

Property	Remark / Value	RW
Object_Identifier	multistate-value, instance 1 … 9	R
Object_Name		R
Object_Type	MULTISTATE_VALUE (19)	R
Present_Value	State	
Status_Flags	IN_ALARM: 0 FAULT: 0 OVERRIDDEN: 0 OUT_OF_SERVICE: 0	R
Event_State	NORMAL (0)	R
Out_Of_Service	FALSE (0)	R
Number_Of_States		R
State_Text		R
R: Read Property, W: Write Property, -E: Storage in EEPROM		

Instance	Number_ Of_States	Object_Name	State	State_Text	Present_Value
1	3	“COV-Mode”	1 2 3 (initial)	“Disabled” “Local Broadcast” “Global Broadcast”	RW-E
2	15	“ApplicMode”	1 (initial) 2 3 4 5 6 7 8 9 10 11 12 13 14 15	“HVAC_NUL” “HVAC_AUTO” “HVAC_HEAT” “HVAC_MRNG_WRMUP” “HVAC_COOL” “HVAC_NIGHT_PURGE” “HVAC_PRE_COOL” “HVAC_OFF” “HVAC_TEST” “HVAC_EMERG_HEAT” “HVAC_FAN_ONLY” “HVAC_FREE_COOL” “HVAC_MAXHEAT” “HVAC_ECONOMY” “HVAC_DEHUMID”	RW
3	15	“ActApplicMode”	1 (initial) 2 3 4 5 6 7 8 9 10 11 12 13 14 15	“HVAC_NUL” “HVAC_AUTO” “HVAC_HEAT” “HVAC_MRNG_WRMUP” “HVAC_COOL” “HVAC_NIGHT_PURGE” “HVAC_PRE_COOL” “HVAC_OFF” “HVAC_TEST” “HVAC_EMERG_HEAT” “HVAC_FAN_ONLY” “HVAC_FREE_COOL” “HVAC_MAXHEAT” “HVAC_ECONOMY” “HVAC_DEHUMID”	R

Instance	Number_ Of_States	Object_Name	State	State_Text	Present_Value
4	5	“Mode”	1 2 3 4 5 (initial)	“OCCUPIED” “UNOCCUPIED” “BOOST” “STANDBY” “NUL”	RW
5	5	“ActMode”	1 2 3 4 5 (initial)	“OCCUPIED” “UNOCCUPIED” “BOOST” “STANDBY” “NUL”	R
6	4	“OccSensor”	1 2 3 4 5 (initial)	“OCCUPIED” “UNOCCUPIED” “BOOST” “STANDBY” “NUL”	RW
7	3	“ChangeOver”	1 (initial) 2 3	“Off” “COOLING” “HEATING”	RW
8	7	“FanSpeed”	1 2 3 4 5 6 7 (initial)	“Off” “LEVEL1” “LEVEL2” “LEVEL3” “LEVEL4” “LEVEL5” “AUTO”	RW
9	12	“ActFanSpeed”	1 2 3 4 5 6 7 (initial) 8 9 10 11 12	“Off” Hand “LEVEL1” “LEVEL2” “LEVEL3” “LEVEL4” “LEVEL5” “Off” Auto “LEVEL1” “LEVEL2” “LEVEL3” “LEVEL4” “LEVEL5”	R

5.3 Modbus RTU interface

Expansion module EM-BAC-MOD-01 XAC

When used in the X-AIRCONTROL base device

Communication via Modbus RTU

Switches and status LEDs

```
Green LED, illuminated: Power is being supplied to the device.
Green LED, blinking: Data is being received via Modbus.

Red LED, flashes: Modbus transmission error.

Slide switch: Used to switch between Modbus and BACnet.

Rotary switches: Used to set device addresses (Modbus slave address).
Valid addresses are 01-99; devices with one of these addresses can communicate
via Modbus. Address 00 is reserved for broadcast; a device with this address can
receive, but not send data.

The dip switch is used to set the operating mode:

Switch 2          OFF    ON    OFF    ON
Switch 3          OFF    OFF    ON    ON
Baud rate         9600  19200  38400  57600

Switch 5          OFF    ON    OFF    ON
Switch 6          OFF    OFF    ON    ON
Parity            none   none   odd    even

Switches 1,4,7 and 8 have no function.

If you change a switch setting, the device will be reset after about 1 s and
restarted with the new setting.
```

Frame timing with Modbus RTU

```
Modbus frames are separated by gaps, or intervals. The following intervals apply
to rates of up to 19200 Bd; values for higher Baud rates are given in brackets:

- Send process: A maximum of 1.5 character times (750µs) is considered an
interval between 2 characters of a frame.

- Send process: An interval between 2 frames must be at least 3.5 character
times (1750µs).

- The range between these values is considered a tolerance range by the
recipient.
  If this interval is exceeded during a send process, the frame ends.

This module sends messages (characters) continuously, i.e. without intervals.
There is a silent interval of >= 3.6 character times (1800µs) before the send
process starts.
A receive process ends after an interval of about 2.5 character times (1250µs).
```

1

Modbus functions

The device includes the following functions:

Function 1 (0x01) Read Coils
Function 3 (0x03) Read Holding Registers
Function 4 (0x04) Read Input Registers
Function 5 (0x05) Write Single Coil
Function 6 (0x06) Write Single Register
Function 8 (0x08) Diagnostics
Function 16 (0x10) Write Multiple Registers
Function 43/14 (0x02B/0x0E) Read Device Identification

The encoding for the corresponding Modbus RTU frames is shown below (shown without CRC). For data with 2 bytes the High-Byte comes first.

Meaning of exception codes:

1	Illegal function code	Unknown code for this function or subfunction.
2	Illegal Data Address	Invalid register address.
3	Illegal Data Value	Inconsistent encoding in the number of registers, number of bytes, data value.

Modbus function 3 (0x03) Read Holding Registers

Modbus function 4 (0x04) Read Input Registers

These functions are used to read several consecutive registers. Both functions are identical.

Request:

Byte 0	Slave Address	Rotary switch 1-99
Byte 1	Function Code	0x03 / 0x04
Byte 2-3	Register Address	First register
Byte 4-5	Register Quantity	No. of registers

Response:

Byte 0	Slave Address	Rotary switch 1-99
Byte 1	Function Code	0x03 / 0x04
Byte 2	Byte Count	2 bytes per register
Byte 3-4	Register Value	0x0000-0xFFFF
Byte ...	Register Value	0x0000-0xFFFF

Error:

Byte 0	Slave Address	Rotary switch 1-99
Byte 1	Error Code	0x83 / 0x84
Byte 2	Exception Code	0x02,0x03

Modbus function 06 (0x06) Write Single Register

This function is used to write to a single register.

```
Request:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Function Code         0x06
    Byte 2-3    Register Address      Address of the register
    Byte 4-5    Register Value        0x0000-0xFFFF

Response:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Function Code         0x06
    Byte 2-3    Register Address      Address of the register
    Byte 4-5    Register Value        0x0000-0xFFFF

Error:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Error Code            0x86
    Byte 2      Exception Code        0x02,0x03
```

Modbus function 16 (0x10) Write Multiple Registers

This function is used to write to several consecutive registers.

```
Request:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Function Code         0x10
    Byte 2-3    Register Address      First register
    Byte 4-5    Register Quantity     No. of registers
    Byte 6      Byte Count            2 bytes per register
    Byte 7-8    Register Value        0x0000-0xFFFF
    Byte ...    Register Value        0x0000-0xFFFF

Response:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Function Code         0x10
    Byte 2-3    Register Address      First register
    Byte 4-5    Register Quantity     No. of registers

Error:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Error Code            0x90
    Byte 2      Exception Code        0x02,0x03
```

Modbus function 1 (0x01) Read Coils

```
This function is used to read the state of several bits.

Request:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Function Code         0x01
    Byte 2-3    Starting Address      Number of the first bit
    Byte 4-5    Quantity of Coils     Number of bits
Response:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Function Code         0x01
    Byte 2      Byte Count            Number of bytes
    Byte 3      Coil Status           Bit values
    Byte ...    Coil Status           Bit values

Error:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Error Code            0x81
    Byte 2      Exception Code        0x02,0x03
```

Modbus function 5 (0x05) Write Single Coil

```
This function is used to write to a single bit.

Request:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Function Code         0x05
    Byte 2-3    Output Address        Bit number
    Byte 4-5    Output Value          0x0000 (false), 0xFF00 (true)

Response:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Function Code         0x05
    Byte 2-3    Output Address        Bit number
    Byte 4-5    Output Value          0x0000 (false), 0xFF00 (true)

Error:
    Byte 0      Slave Address         Rotary switch 1-99
    Byte 1      Error Code            0x85
    Byte 2      Exception Code        0x02,0x03
```

Modbus function 8 (0x08) Diagnostics

This function is used to check the Modbus communication.

Request:

Byte 0	Slave Address	Rotary switch 1-99
Byte 1	Function Code	0x08
Byte 2-3	Subfunction	see below
Byte 4-5	Data	see below

Response:

Byte 0	Slave Address	Rotary switch 1-99
Byte 1	Function Code	0x08
Byte 2-3	Subfunction	see below
Byte 4-5	Data	see below

Error:

Byte 0	Slave Address	Rotary switch 1-99
Byte 1	Error Code	0x88
Byte 2	Exception Code	0x01,0x03

Sub-func.	Data Requ.	Data Resp.	Name / Meaning
0	*	*	Return Query Data The whole frame (100 bytes max.) is sent back.
1	x	x	Restart Communications Option Modbus communication restarts after the response, Listen Only Mode ends.
4	0	-	Force Listen Only Mode No response is sent. Listen Only Mode starts immediately. The device reacts only to the Diagnostics function, Restart Communications Option subfunction.
10	0	0	Clear Counters All 5 diagnosis counters are deleted.
11	0	Count	Return Bus Message Count Request the number of error-free messages received.
12	0	Count	Return Bus Communication Error Count Number of messages with a CRC error, length < 3, request parity error or framing error
13	0	Count	Return Slave Exception Error Count Request number of error messages.
14	0	Count	Return Slave Message Count Request number of messages for this device.
15	0	Count	Return Slave No Response Count Request number of broadcast messages.

Modbus function 43/14 (0x02B/0x0E) Read Device Identification

This function is used to read data required for identifying the device.

Request:		
Byte 0	Slave Address	Rotary switch 1-99
Byte 1	Function Code	0x2B
Byte 2	MEI-Type	0x0E
Byte 3	Read Device ID Code	0x01
Byte 4	Object ID	0x00
Response:		
Byte 0	Slave Address	Rotary switch 1-99
Byte 1	Function Code	0x2B
Byte 2	MEI-Type	0x0E
Byte 3	Read Device ID Code	0x01
Byte 4	Conformity Level	0x01
Byte 5	More Follows	0x00
Byte 6	Next Object ID	0x00
Byte 7	Number of Objects	0x03
Byte 8	ID: VendorName	0x00
Byte 9	Obj-Length	9
Byte 10-18	Obj-Value	"TROX GmbH"
Byte 19	ID: ProductCode	0x01
Byte 20	Obj-Length	17
Byte 21-37	Obj-Value	"EM-BAC-MOD-01 XAC"
Byte 38	ID: MajMinRevision	0x02
Byte 39	Obj-Length	4
Byte 40-43	Obj-Value	"V1.0"
Error:		
Byte 0	Slave Address	1-99
Byte 1	Error Code	0xAB
Byte 2	Exception Code	0x01-0x03

Modbus register

The SPI interface protocol defines commands for sending and for receiving useful data. Each of these SPI commands is assigned a Modbus register. The SPI interface reads certain registers and writes to others, depending on the command. It is, however, possible to read all Modbus registers and to write to all Modbus registers.

The sequence of the registers is the same as the sequence of the commands of the SPI interface. Each Modbus register is 2 bytes.

The contents of the registers is the same as the useful data of the SPI interface. In the only re-encoding step, the high byte and the low byte of the SPI interface are distributed to different Modbus registers as required; see the SPI byte column.

List of registers for X-AIRCONTROL

Direction column: EM = expansion module, GG = base device

Modbus values column:
- uint16 = integer without prefix
- sint16 = integer with prefix
- 0 - 100 = value with unit of measure %
- 0 - 1 = binary values
- 0 - 2... = Selection of operating modes

SPI bytes column
- High, Low Both bytes are identical for Modbus and SPI
- Low, (High=0) Only the Low byte is valid, the High byte is deleted

Register address	Useful data name	Direction EM / GG	Modbus values	Modbus default	SPI bytes	Encoding / Unit / Resolution
0	ApplicMode	EM -> GG	255, 0 – 10, 12 – 14	255	Low, (High=0)	255 = HVAC_NUL 0 = HVAC_AUTO 1 = HVAC_HEAT 2 = HVAC_MRNG_WRMUP 3 = HVAC_COOL 4 = HVAC_NIGHT_PURGE 5 = HVAC_PRE_COOL 6 = HVAC_OFF 7 = HVAC_TEST 8 = HVAC_EMERG_HEAT 9 = HVAC_FAN_ONLY 10 = HVAC_FREE_COOL 12 = HVAC_MAXHEAT 13 = HVAC_ECONOMY 14 = HVAC_DEHUMID
1	Mode	EM -> GG	255, 0, 1, 2, 3	255	Low, (High=0)	255 = Nul 0 = Occupied 1 = Unoccupied 2 = Boost 3 = Standby
2	OCCSensor	EM -> GG	255, 0, 1, 2, 3	255	Low, (High=0)	255 = Nul 0 = Occupied 1 = Unoccupied 2 = Boost 3 = Standby
3	OutsideTemp	EM -> GG	sint16	0x7FFF	High, Low	Unit 0.01°C
4	RoomTemp_Set	EM -> GG	sint16	0x7FFF	High, Low	Unit 0.01°C
5	TempOffset	EM -> GG	sint16	0x7FFF	High, Low	Unit 0.01°C
6	RoomTemp	EM -> GG	sint16	0x7FFF	High, Low	Unit 0.01°C

Register address	Useful data name	Direction EM / GG	Modbus values	Modbus default	SPI bytes	Encoding / Unit / Resolution
7	RelHumid	EM -> GG	0 - 100	0	Low, (High=0)	Unit %
8	StartPCM	EM -> GG	0 - 1	0	Low, (High=0)	
9	VOC_Room	EM -> GG	uint16	0	High, Low	Unit ppm
10	VOC_Outside	EM -> GG	uint16	0	High, Low	Unit ppm
11	Fire	EM -> GG	0 - 1	0	Low, (High=0)	
12	Window	EM -> GG	0 - 1	0	Low, (High=0)	
13	ExtraTime	EM -> GG	0 - 1	0	Low, (High=0)	
14	ChangeOver	EM -> GG	0 - 2	0	Low, (High=0)	0 = off 1 = cooling 2 = heating
15	FanSpeed	EM -> GG	see Encoding	0; 0	High, Low	High-Byte: Value, Low-Byte: 0 Auto, 1 Hand 0x0001 = 0; 1 = Off 0x2801 = 40; 1 = Level 1 0x5001 = 80; 1 = Level 2 0x7801 = 120; 1 = Level 3 0xA001 = 160; 1 = Level 4 0xC801 = 200; 1 = Level 5 0x0000 = 0; 0 = Auto
16	DischAirTemp	GG -> EM	sint16	0x7FFF	High, Low	Unit 0.01°C
17	ActMode	GG -> EM	255, 0, 1, 2, 3	255	Low, (High=0)	255 = Nul 0 = Occupied 1 = Unoccupied 2 = Boost 3 = Standby
18	ActExtraTime	GG -> EM	0 - 1	0	Low, (High=0)	
19	EffectSetpt	GG -> EM	sint16	0x7FFF	High, Low	Unit 0.01°C
20	ActWindow	GG -> EM	0 - 1	0	Low, (High=0)	
21	ActFanSpeed	GG -> EM	see Encoding	0; 0	High, Low	High-Byte: Value, Low-Byte: 0 Auto, 1 Hand 0x0001 = 0; 1 = Off, Hand 0x2801 = 40; 1 = Level 1 0x5001 = 80; 1 = Level 2 0x7801 = 120; 1 = Level 3 0xA001 = 160; 1 = Level 4 0xC801 = 200; 1 = Level 5 0x0000 = 0; 0 = Off, Auto 0x2800 = 40; 0 = Level 1 0x5000 = 80; 0 = Level 2 0x7800 = 120; 0 = Level 3 0xA000 = 160; 0 = Level 4 0xC800 = 200; 0 = Level 5
22	ActApplicMode	GG -> EM	255, 0 – 10, 12 – 14	255	Low, (High=0)	255 = HVAC_NUL 0 = HVAC_AUTO 1 = HVAC_HEAT 2 = HVAC_MRNG_WRMUP 3 = HVAC_COOL 4 = HVAC_NIGHT_PURGE 5 = HVAC_PRE_COOL 6 = HVAC_OFF 7 = HVAC_TEST 8 = HVAC_EMERG_HEAT 9 = HVAC_FAN_ONLY 10 = HVAC_FREE_COOL 12 = HVAC_MAXHEAT 13 = HVAC_ECONOMY 14 = HVAC_DEHUMID
23	ActOutsideTemp	GG -> EM	sint16	0x7FFF	High, Low	Unit 0.01°C
24	SetptOffset	GG -> EM	sint16	0x7FFF	High, Low	Unit 0.01°C
25	ActRoomTemp	GG -> EM	sint16	0x7FFF	High, Low	Unit 0.01°C
26	ActRelHumid	GG -> EM	0 - 100	0	Low, (High=0)	Unit %
27	ActVOC_Room	GG -> EM	uint16	0	High, Low	Unit ppm
28	FAlarm	GG -> EM	0 - 1	0	Low, (High=0)	
29	Alarm1	GG -> EM	0 - 1	0	Low, (High=0)	

Register address	Useful data name	Direction EM / GG	Modbus values	Modbus default	SPI bytes	Encoding / Unit / Resolution
30	Alarm2	GG -> EM	0 - 1	0	Low, (High=0)	
31	Release	GG -> EM	0 - 1	0	Low, (High=0)	
32	Status	GG -> EM	uint16	0	High, Low	
33	RTemp	GG -> EM	sint16	0x7FFF	High, Low	Unit 0.01°C
34	Sum_Sup	GG -> EM	uint16	0	High, Low	Unit l/s
35	Sum_Exh	GG -> EM	uint16	0	High, Low	Unit l/s
36	SystemDevices	GG -> EM	uint16	0	High, Low	no unit
37	ActFire	GG -> EM	0 - 1	0	Low, (High=0)	
38	FanForce	EM -> GG	0 - 1	0	Low, (High=0)	
39	ActFanForce	GG -> EM	0 – 1	0	Low, (High=0)	

Bit list for X-AIRCONTROL

The Read Coils and Write Single Coil functions are used to access binary data; this is in addition to the above register accesses.

The Write Single Coil function encodes the binary value by (false -> 0x0000, true -> 0x0001) and writes the result to the register.

For bit addresses 0-15 the Read Coils function reads the registers and re-encodes to bit values by using bit 0 of the register values.

Bit addresses 16-22 are copies of the Status register (address 32).

Direction column:
  EM -> GG Reading and writing of bits
  GG -> EM Reading of bits

Bit address	Useful data register name	Direction EM / GG
	Bits from several registers	
0	StartPCM	EM -> GG
1	Fire	EM -> GG
2	Window	EM -> GG
3	ExtraTime	EM -> GG
4	FanForce	EM -> GG
8	ActFanForce	GG -> EM
9	ActFire	GG -> EM
10	ActWindow	GG -> EM
11	ActExtraTime	GG -> EM
12	Falarm	GG -> EM
13	Alarm1	GG -> EM
14	Alarm2	GG -> EM
15	Release	GG -> EM
	Bits from Status register	
16	Powersupply	GG -> EM
17	EMFSLIO	GG -> EM
18	FanBlocked	GG -> EM
19	SensorError	GG -> EM
20	FilterAlarm	GG -> EM
21	FlowControl	GG -> EM
22	DamperCalibration	GG -> EM

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TROX® TECHNIK

The art of handling air

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