Control component Compact XM0 • XS0

for VAV terminal unit TVE

TROX® TECHNIK

The art of handling air

General information

Information about installation and commissioning instructions

These installation and commissioning instructions enable the safe and efficient handling of the *Compact XM0 • XS0* type control components and the associated VAV terminal unit. Also referred to as control component or compact controller in the following document.

The manual must be kept near the unit to be available for use at all times.

The personnel performing work on the device must read and understand this manual carefully before starting any work. The basic prerequisite for safe working is to comply with the safety notes and all instructions in this manual.

In addition, the local health and safety regulations and general safety regulations apply to the area of application of the device.

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

Other applicable documentation

In addition to these instructions, the following documents must be observed:

- Installation and commissioning instructions of the VAV terminal unit
- Product data sheets
- Project-specific wiring documents of the system planner if any

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*
Phone	+49 2845 202-400

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.

Tips and recommendations

ℹ

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

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. ▶ Loosen the screw.

2. ▶

> ⚠ **CAUTION!**
>
> **Danger of finger entrapment when closing the lid.**

  Be careful when closing the lid.

3. ▶ Tighten the screw.

Specific safety notes

The following symbols are used in safety notes to alert you to specific hazards:

Warning signs	Type of danger
⚡	Warning – high-voltage.
⚠	Warning – danger zone.

TROX® TECHNIK

1   Safety

1.1   Correct use

The electronic control component type Compact XM0 • XS0 is used in combination with a TROX VAV terminal unit TVE for constant volume flow control in ventilation and air conditioning systems.

The control component is designed for use in internal spaces.

Supply air area of application

Conditions for use	Control component
The usual conditioning in ventilation and air conditioning systems allows use in the supply air without additional dust protection measures.	■ XM0

Extract air area of application

Conditions for use	Control component
Extract air with a low content of dust or lint (e. g. office) without additional dust protection measures.	■ XM0 ■ XS0
For dry extract air with higher dust or lint content, without additional dust protection measures.	■ XS0
For extract air with a high proportion of dust, lint or sticky components or for exhaust air with aggressive media without additional dust protection measures.	■ XS0
In unspecified applications or in combination of contaminated air (e. g. dust) with humidity.	■ XS0

Do not use VAV terminal units in extract air systems in commercial kitchens unless the extract air has been cleaned as much as possible with high-efficiency aerosol separators; see VDI 2052.

Incorrect use

> ⚠ **WARNING!**
>
> **Danger of injury or risk of damage to property due to incorrect use!**
>
> Misuse of the control component can lead to dangerous situations.
>
> Never use the control component/device:
>
> – in explosion-proof areas
> – in aircraft
> – outdoors without sufficient protection against the effects of weather
> – for areas of application that are not described in this manual

Modifying the unit or using replacement parts that have not been approved by TROX is not permitted.

1.2   Safety signs

The following symbols and signs are usually found in the work area. They apply to the very location where they are found.

> ⚠ **WARNING!**
>
> **Danger due to illegible signage!**
>
> Over time, stickers and signs may fade or become otherwise illegible, meaning that hazards cannot be identified and necessary operating instructions cannot be followed. There is then a risk of injury.
>
> – Ensure that all of the safety, warning and operating information is clearly legible.
> – Replace illegible signs or stickers immediately.

Electrical voltage

Only skilled qualified electricians are allowed to work in areas marked as having electrical voltage.

Unauthorised people must not enter areas, open cabinets or work on components where an electrical voltage is present and which are hence marked with this symbol.

1.3 Residual risks

The VAV terminal unit is state of the art and designed in accordance with current safety requirements. Residual risks cannot be excluded, however, and you should proceed with caution. This section describes the residual risks that have been identified in a risk assessment.

Always follow the safety notes in this manual to reduce health hazards and prevent any hazardous situations.

1.3.1 Electric shock hazards

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.
>
> – Have work on the electrical system carried out only by skilled qualified electricians.
> – If the insulation is damaged, switch off the supply voltage immediately and have the insulation repaired.
> – Before you start working on electric systems and equipment, switch off the supply voltage and secure it against being switched on accidentally. Comply with the following safety rules:
>   – Switch off the power supply.
>   – Secure it against being switched on accidentally.
>   – Ensure that no voltage is present.
>   – Connect to the earth; short circuit connection.
> – Do not bypass or disable any circuit breakers. Be sure to maintain the correct current rating when you replace a circuit breaker.
> – Ensure that live parts do not come into contact with moisture. Moisture can cause a short circuit.

1.4 System owner's responsibility

System owner

The system owner is a natural or legal person who for commercial or business purposes owns or manages the ventilation system or component or allows third parties to use or operate it, but continues to bear legal responsibility for the safety of users, staff or third parties while the product is in use.

System owner's obligations

The unit is intended for commercial use. The system owner is therefore subject to the legal obligations of occupational health and safety regulations.

In addition to the safety notes in this manual, the applicable regulations for safety, accident prevention and environmental protection must also be complied with.

In particular:

- The system owner must be aware of the applicable occupational health and safety regulations and carry out a risk assessment to determine any additional hazards that may exist or result from the specific working conditions at the installation location. The system owner has to create operating instructions for the unit that reflect the results of this risk assessment.
- The system owner has to ensure, throughout the entire operating period of the unit, that these operating instructions conform to applicable standards and guidelines; in case of any deviation, the system owner has to adapt the instructions.
- The system owner must secure the unit to prevent access by unauthorised individuals.
- The system owner must clearly define the responsibilities for operation, maintenance, cleaning, troubleshooting and removal.
- The system owner has to ensure that all individuals who handle or use the unit have read and understood this manual.
- The system owner must provide the employees with the required personal protective equipment.
- The system owner must observe the local fire regulations.

Hygiene requirements

The system owner has to comply with the local regulations and harmonised standards for hygiene requirements. These include, among other things, compliance with the corresponding maintenance and test intervals.

1.5 Staff

Qualification

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

HVAC technician
HVAC technicians are individuals who have sufficient professional or technical training in the field they are working in to enable them to carry out their assigned duties at the level of responsibility allocated to them and in compliance with the relevant guidelines, safety regulations and instructions. HVAC technicians are individuals who have in-depth knowledge and skills related to HVAC systems; they are also responsible for the professional completion of the work under consideration.

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

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.

1.6 Personal protective equipment

Personal protective equipment is equipment that protects the user against health or safety risks at work.

Personal protective equipment must be worn for various types of work; the protective equipment required is listed in this manual together with the description of each type of work.

Description of personal protective equipment

Industrial safety helmet

Industrial safety helmets protect the head from falling objects, suspended loads, and the effects of striking the head against stationary objects.

Protective gloves

Protective gloves protect hands from friction, abrasions, punctures, deep cuts, and direct contact with hot surfaces.

Safety shoes

Safety shoes protect the feet from crushing, falling parts and prevent slipping on a slippery floor.

1.7 General safety measures

> **! NOTICE!**
>
> **Risk of damage to property due to large temperature differences**
>
> If any electronic components have been kept in an unheated area, condensation may form and damage the electronic components beyond repair.
>
> – Before you start commissioning, make sure that all devices have warmed up to the ambient temperature. Only after about 2 hours will the system have reached ambient temperature.

Foreign matter and liquids

> **! NOTICE!**
>
> **Risk of damage to property due to foreign matter and liquids!**
>
> Foreign matter and liquids that get into the unit may damage the electronic parts.
>
> – Do not use any liquids for cleaning.
> – Remove foreign matter, if any.
> – If the device emits a smell or smoke, have it checked by the manufacturer.
> – If liquid gets into the module, let the module completely dry before commissioning.

1.8 Repair and replacement parts

Only qualified personnel can repair the devices, and only genuine replacement parts are allowed to be used. This applies to work on the electrical equipment. Therefore, for safety reasons, have defective devices repaired by TROX Technical Service, ⮡ *'TROX Technical Service' on page 3* .

2 Transport, storage and packaging

Sharp edges and sheet metal parts

> ⚠️ **CAUTION!**
>
> **Danger of injury from sharp edges and sheet metal parts.**
> – Always wear protective gloves when handling the unit.

Damage to the VAV terminal unit

> ❗ **NOTICE!**
>
> **Risk of damage to the VAV terminal unit!**
> – Handle the unit with care.
> – Do not lift the VAV terminal unit by its control components, the damper blade or differential pressure sensor.
> – Lift the unit only by lifting the entire casing.

2.1 Delivery check

Check delivered items immediately after arrival for transport damage and completeness. In case of any damage or an incomplete shipment, contact the shipping company and your supplier immediately.

The product is typically delivered mounted on a VAV terminal unit.

Check the following items on delivery:

- Control component Compact XM0 • XS0
  - Mounted on the VAV terminal unit and fixed with anti-rotation lock
  - Adjustment sticker on the VAV terminal unit ⚒ *'Adjustment sticker' on page 29*
  - Rubber cap for terminal cover present

2.2 Transport on site

- If possible, transport the VAV terminal unit to the installation location in the shipping container.
- Do not remove the protective wrapping until just before installation.

2.3 Bearing

If the product must be stored:

- Moisture and lack of ventilation can lead to oxidation, even on galvanised components. Remove any plastic wrapping in order to avoid oxidation.
- Protect the product from dust and contamination.
- Store the product in a dry place and away from direct sunlight.
- Do not store the product below -10 °C or above +50 °C.
- After storage and prior to installation, first allow the unit to acclimatise to the installation temperatures for at least 2 hours.

2.4 Packaging

Properly dispose of packaging material.

3 Structure and functional description

3.1 Product overview
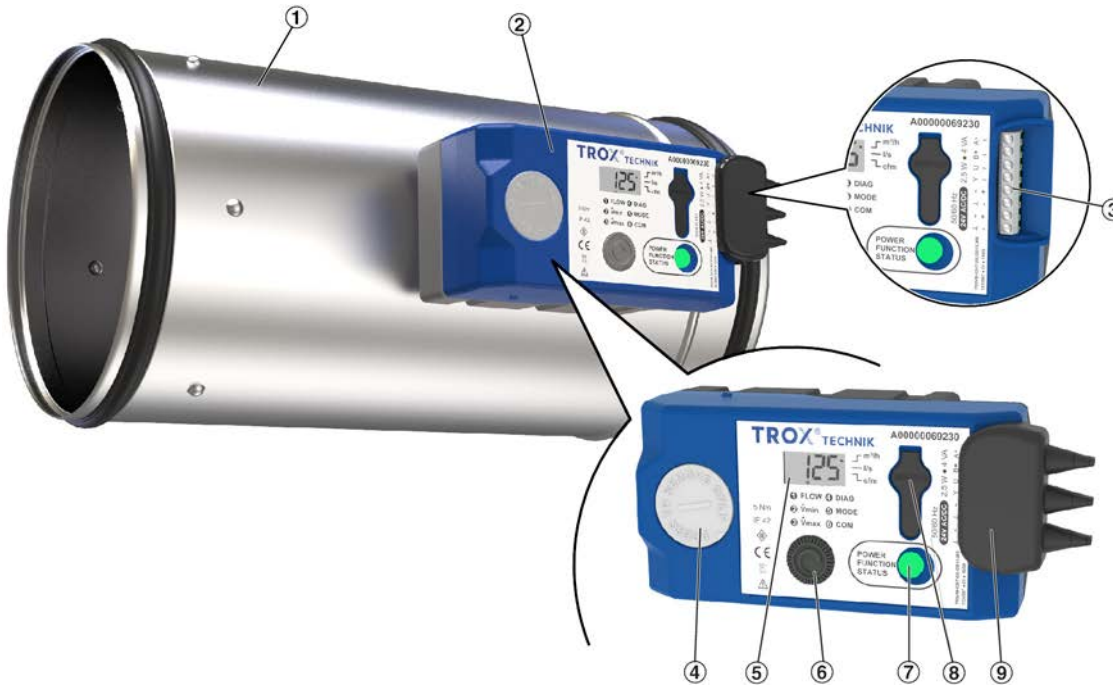
Fig. 1: Compact controller attached to terminal unit

1   VAV terminal unit TVE
2   Compact controller XM0/XS0
3   Terminal
4   Release button
5   Display

6   Control element - selection of options/setting values
7   LED / control element - selection of menu item, ✣
    7 'Operation and status of the control component' on page 25
8   Service socket
9   Terminal cover with cable penetration (part of the supply package)

ℹ️ **For more information on the operation of the control component**

✣ Chapter 7 *'Operation and status of the control component' on page 25*

3.2 Position of the damper blade

VAV terminal unit TVE

The position of the damper blade corresponds to the mark on the unlocking button and is therefore recognisable from the outside.
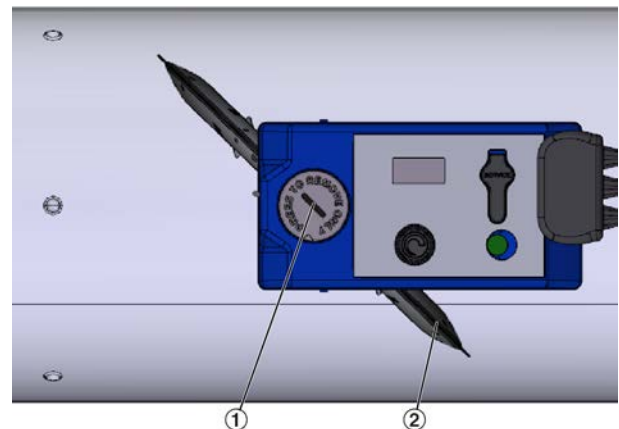
Fig. 2: Position indicator of the damper blade

1   Unlocking button with marking for position indication
2   Damper blade

3.3 Function description

Basic function

The electronic control component is used for variable and constant volume flow control for the TROX VAV terminal unit type TVE. Its functional units consist of a dynamic (XM0) or static (XS0) differential pressure transducer, the controller electronics and the actuator.

Closed control circuit

The control component operates in closed loop, i.e. to measure – compare – control.

Fig. 3: Principle of operation

1   Differential pressure transducer
2   Actuator
3   Volume flow controller
4   Setpoint value via Modbus or analogue signal
5   Shaft with effective pressure channel

The determination of the current volume flow rate takes place by measuring a differential pressure (effective pressure) directly on the damper blade. The effective pressure is 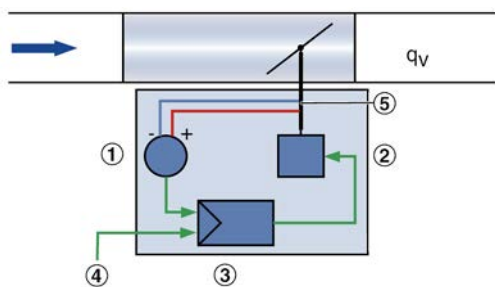forwarded through the damper blade shaft to the differential pressure transducer (1) integrated in the control component and converted here into a voltage signal.

The volume flow rate actual value is thus the internal control loop as well as an external use, e.g. central BMS or master-slave sequential circuit, available either as an analogue voltage signal 0 – 10 V DC / 2 – 10 V DC or as digital Modbus information.

In regular operation, the integrated actuator (2) is controlled by permanent evaluation of the offset (setpoint value-actual) in the volume flow controller (3) that adjusts the damper blade of the VAV terminal unit via the axle mounting and thus regulates the volume flow rate to the setpoint value.

Due to the factory adjustment, the maximum starting value 10 V DC always corresponds to the nominal volume flow rate (q_{vnom}) indicated on the adjustment sticker on the VAV terminal unit. The factory-set q_{vmin} and q_{vmax} values can also be found on the adjustment sticker or the order code. The q_{vmin} and q_{vmax} values can be set individually on the display.

Setpoint value control independent of the duct pressure
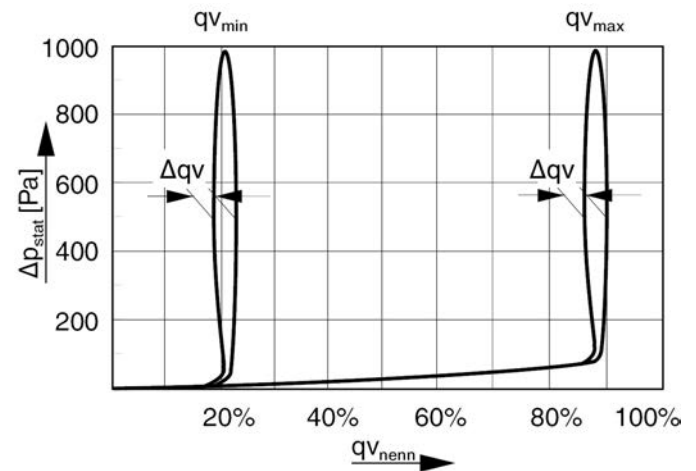
Fig. 4: Pressure independent control characteristics

The controller detects and corrects changes of the duct pressure that may occur, for example, due to volume flow rate changes from other units. The Compact controller thus operates independently of the duct pressure, and pressure fluctuations cause no lasting changes to the volume flow rate.

In order to prevent the volume flow control from becoming unstable, the controller maintains a dead band (hysteresis) within which the damper blade is not moved. This dead band and the tolerances of the measurement lead to a volume flow rate deviation Δq_v in accordance with the product data sheets of the VAV terminal units. If the conditions specified in the product data sheets (e.g., minimum differential pressure, upstream conditions) are not met, the controller will no longer function correctly or more significant system deviations can be expected.

Diagnostic options

- Status of the control component ✋ *'Status and error messages' on page 27*
- Functional test ✋ *8.4 'Functional test' on page 30*
- Setting the control component, ✋ *8.5 'Setting of the control component' on page 30*.
- Troubleshooting ✋ *9 'Troubleshooting' on page 36*

3.4 Operating modes

The operating mode of the control component (analogue 0(2) – 10 V or Modbus) is set at the factory and specified by the order code. The operating mode can be changed on the control component itself or on Modbus register 122.

Setpoint and actual value signals

Setpoint and actual values are transmitted via the Modbus communication interface or by an analogue voltage signal.

Oper-ating mode	Signal		Order code	Menu configu-ration (mode)
	Setpoint value	Actual value		
Analogue	Analogue 0 – 10 V		V or F	CA0
Analogue	Analogue 2 – 10 V		V or F	CA2
Modbus	Register 0	Register 6 or 7 or Analogue 2-10 VDC	M	CB2

V = variable operation

F = constant value operation

A special configuration of the Modbus register (register 122) interface operation enables the configuration of a mixture of Modbus and analogue operation. In this way, when controlled locally with an analogue signal from a higher-level building management system (central BMS), additional operating values can be transmitted via the Modbus interface e. g. Read out the actual volume flow rate value and damper position or even trigger central override controls ⬩ *'Detailed information on register 122 (communication interface setpoint/actual value - Interface Mode)' on page 34* .

3.4.1 Operation with constant volume flow rate setpoint value

3.4.1.1 Operation with a fixed setpoint value
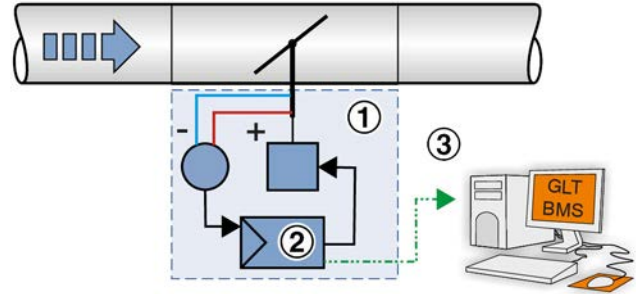
Fig. 5: Constant control

1 Compact controller
2 Volume flow rate setpoint value set at the factory (q_{vmin})
3 Volume flow rate actual value as analogue voltage signal or digitally via Modbus e. g. to central BMS or slave controller

In the simplest case, the control component is operated with a constant volume flow rate setpoint value. The constant setpoint value ($q_{vconst} = q_{vmin}$) is already set by the factory default. Adaptation of the factory-set constant values, ⬩ *8.5   'Setting of the control component' on page 30* .

A control signal at terminal Y must not be switched in this case.

3.4.1.2 Operation with two fixed setpoint values (min./max. switching)
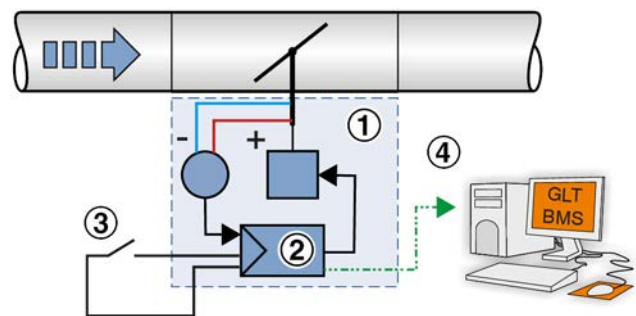
Fig. 6: Min./max. switching

1 Compact controller
2 Factory-set volume flow rate setpoint values (q_{vmin} and q_{vmax})
3 Volt-free switch contact for switching between q_{vmin} and q_{vmax}
4 Volume flow rate actual value as analogue voltage signal or digitally via Modbus e. g. to the central BMS

The factory-set constant values (q_{vmin} and q_{vmax}) can be alternatively activated by volt-free switch contact, e. g. day/night switching, ↳ *on page 20* .

Adaptation of the factory-set constant values: ↳ *8.5 'Setting of the control component' on page 30*

3.4.2 Operation with variable volume flow rate setpoint value
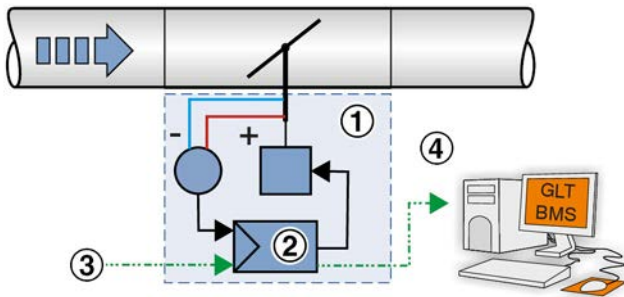
Fig. 7: Variable volume flow control

1 Compact controller
2 Factory-set volume flow rate operating range (q_{vmin} – q_{vmax})
3 Control signal as an analogue voltage signal or digitally via Modbus as setpoint value default setting, e. g. from room temperature controller, DDC outstation or similar.
4 Volume flow rate actual value as analogue voltage signal or digitally via Modbus e. g. to the central BMS

For the use of variable volume flow rate setpoint values, the specification of an electrical control signal must be made by a higher-level controller (e.g. room temperature controller, air quality controller, central building management system, etc.). If the input signal is changed, the controller adjusts the volume flow rate to the new setpoint. The variable volume flow rate is limited to a minimum and maximum volume flow rate value, ↳ *Chapter 3.5 'Characteristics' on page 15* . Adaptation of the factory-set constant values, ↳ *8.5 'Setting of the control component' on page 30*

3.4.3 Override control

The constant or variable control can be disabled by override controls, e.g., when the sash is open, a window switch stops ventilation of the room by closing the damper blade.

Further application examples:

- Circuits for intensive ventilation (boost / q_{vmax})
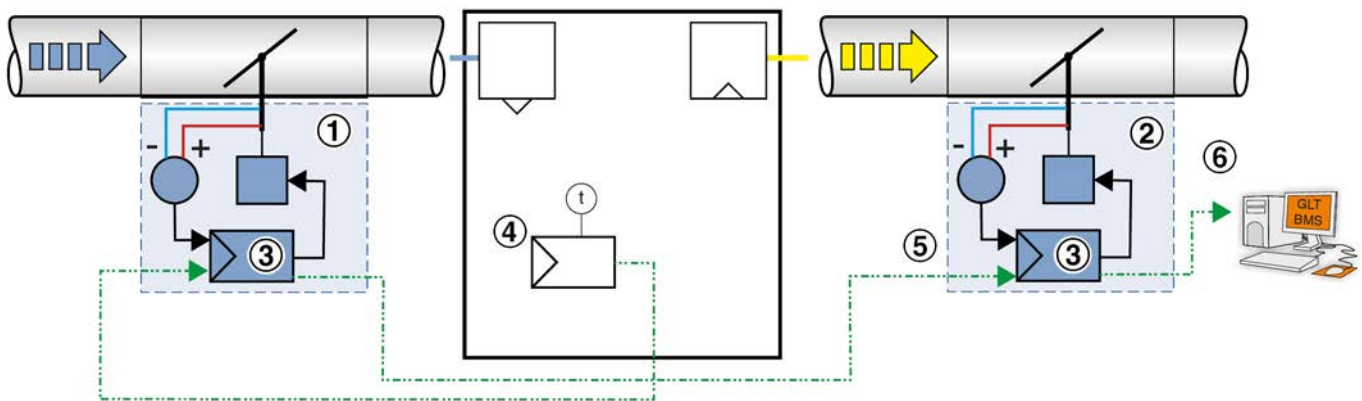- Opening the damper blade

3.4.4 Supply/extract air tracking control

Fig. 8: Supply/extract air tracking control

1	Supply air controller (master), compact controller
2	Extract air controller (slave), compact controller
3	Volume flow rate operating range (q_{vmin} and q_{vmax})

4	Room temperature controller (control signal for supply air controller)
5	Volume flow rate actual value for the supply air controller
6	Volume flow rate actual value for the extract air controller

In individual rooms and closed-off office areas, where the balance between supply and extract air flow rate has to be maintained. Otherwise, annoying whistling noises can occur at door gaps, and the doors can be difficult to open. For this reason, the extract air should also have variable control in a VAV system.

The control signal from the room temperature controller is switched to the supply air controller in this example. The actual value signal of the supply air controller is then connected to the extract air controller (slave controller) as a setpoint value signal. The actual volume flow rate of the supply air controller (master) is thus used as the reference value for the extract air controller (slave). The connection can be made as an analogue signal or digitally via the Modbus. As a consequence, the extract air always follows the supply air.

Setting for the slave controller in the simplest case (same VAV terminal units and dimensions):

- $q_{vmin} = 0$ m³/h
- $q_{vmax} = q_{vnom}$
  ⇨ q_{vnom} is specified on the adjustment sticker.

When using different VAV terminal unit types or dimensions for tracking control, special setting instructions for q_{vmin} and q_{vmax} of the slave controller must be observed due to the different nominal volume flow rates.

Alternatively, the control signal of the room temperature controller can also be connected in parallel to the supply air and the extract air controller. The limitation due to the technical data of the controller outputs (current) and the controller inputs (input resistances) must be observed.

3.5 Characteristics

Setpoint value signal

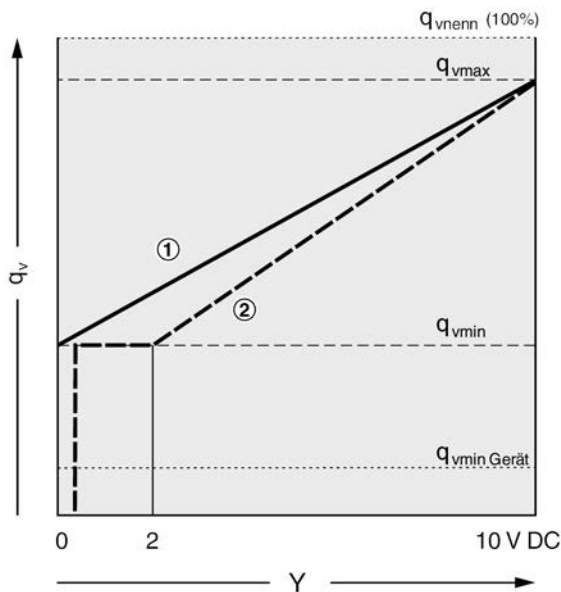*Fig. 9: Characteristic of the setpoint value signal*

1   Characteristic for signal voltage range 0 – 10 V DC
2   Characteristic for signal voltage range 2 – 10 V DC
q_v Volume flow rate
Y   Setpoint value input

The volume flow rate setpoint value must be specified as follows, depending on the operating mode:

- **In analogue operation:** At terminal Y, a voltage signal 0 – 10 V DC or 2 – 10 V DC, 0(2) V = q_{vmin}, 10 V = q_{vmax}

- **In digital operation:** The setpoint value is specified in Modbus register 0 as a percentage value. [0 – 100%], 0% = q_{vmin}, 100% = q_{vmax}

The relationship between the volume flow rate set value and the associated voltage signal can be calculated from the formula below. The setting for q_{vmin} and q_{vmax} must be taken into account.

0 – 10 V DC

$$q_{vsoll} = \frac{Y}{10\ V} \times (q_{vmax} - q_{vmin}) + q_{vmin}$$

2 – 10 V DC

$$q_{vsoll} = \frac{Y - 2}{(10\ V - 2\ V)} \times (q_{vmax} - q_{vmin}) + q_{vmin}$$

> ℹ️ *Sample calculations*
> ↳ *9.3.2 'Sample calculations' on page 37*

Actual value signal
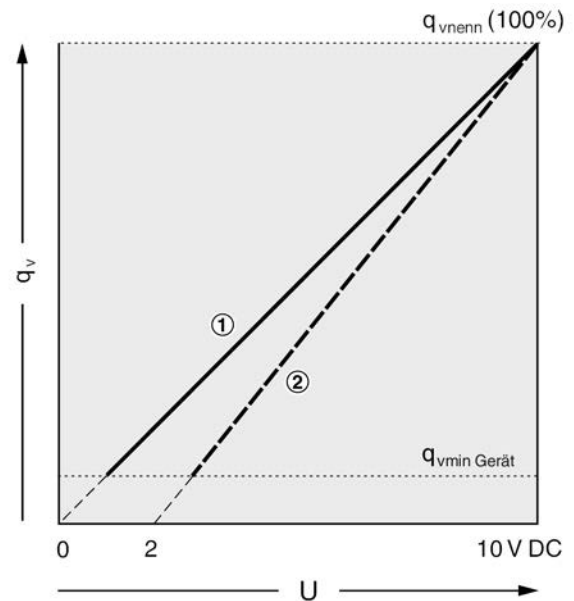
Fig. 10: Characteristic of the actual value signal

1   Characteristic for signal voltage range 0 – 10 V DC
2   Characteristic for signal voltage range 2 – 10 V DC
q_v Volume flow rate
U   Actual value signal

The volume flow rate actual value can be tapped as a voltage signal at the terminal (U). The measuring range is factory-adjusted to the size of the VAV terminal unit, so that the respectively device nominal volume flow rate (q_{vnom}) always corresponds to an actual value signal of 10 V DC. In digital and hybrid operation, the actual value in Modbus register 6 can be read out as a percentage value of q_{vnom}.

The current volume flow rate actual value can be calculated from the measured voltage at the output (U) using the formula below.

0 – 10 V DC

$$q_{vist} = \frac{U}{10\ V} \times q_{vnenn}$$

2 – 10 V DC

$$q_{vist} = \frac{U - 2}{(10\ V - 2\ V)} \times q_{vnenn}$$

Activation of override control CLOSED via a characteristic

Characteristic 0 – 10 V			Characteristic 2 – 0 V		
Setpoint value signal Y	$q_{vmin} = 0$	$q_{vmin} > 0$	Setpoint value signal Y	$q_{vmin} = 0$	$q_{vmin} > 0$
≤ 0.3 V	Damper CLOSED	Operation	≤ 0.8 V	Damper CLOSED	Operation
> 0.3 V	Operation	Operation	> 0.8 V	Operation	Operation

4 Installation

Personnel:
- HVAC technician

Protective equipment:
- Protective gloves
- Safety shoes
- Industrial safety helmet

Only specialist personnel are allowed to perform the described work on the VAV terminal unit.

Only skilled qualified electricians are allowed to work on the electrical system.

> ⚠ **CAUTION!**
>
> **Danger of injury from sharp edges and sheet metal parts.**
> – Always wear protective gloves when handling the unit.

The control component is delivered mounted on the VAV terminal unit so that the work is limited to the electrical wiring ⬦ *5 'Wiring' on page 18* and to the setting of the control component ⬦ *8.5 'Setting of the control component' on page 30* .

When installing the VAV terminal unit, take particular note of the following points:

- Upstream section
  - A special upstream flow length is not required for the TVE terminal unit.
- Direction of airflow
  - For TVE terminal units with control component XS0, the direction airflow is clearly specified (airflow direction arrow).
  - For TVE terminal units with control component XM0, a preferred airflow direction is specified (acoustic), alternative installation is possible.
- Fixing/suspension
- Accessibility for service work

Information on this can be found in the VAV terminal unit installation and commissioning instructions.

Installation orientation

Any installation orientation of the VAV terminal unit is possible for both the XM0 (transducer with dynamic measuring principle) and the XS0 (transducer with static measuring principle). The terminal unit may be mounted in such a way that the position of the control component is above, below or to the side of the duct.

5 Wiring

Safety instructions

> ⚠ **DANGER!**
>
> Danger of electric shock! Do not touch any live com-
> ponents! Electrical equipment carries a dangerous
> electrical voltage.
>
> – Only skilled qualified electricians are allowed to
>   work on the electrical system.
> – Switch off the power supply before working on
>   any electrical equipment.

5.1 Installation instructions

The VAV terminal unit was manufactured and configured
on a project-specific basis. The control components are
factory-mounted and balanced. For installation, the
supply voltage and, if necessary, signal lines, must be
connected for electrical control components.

The connection is established based on the information
specified on the control components or connection dia-
grams in this manual. The voltage ranges and the ter-
minal connections specified on the control components
must be observed!

Personnel:

- Skilled qualified electrician

Please observe the following during installation:

- Legal and official regulations, in particular VDE
  guidelines.
- Consideration of the technical connection rules
  (TCR) of the local network operators.
- Wiring work for supply voltage and signal lines on
  site.
- The rating and manufacture of customer-side con-
  nections and wiring must be carried out in accord-
  ance with the recognised rules of electrical engi-
  neering.
- Observe the wiring guidelines and the customer's
  project-specific connection diagrams of the control
  component.
- The electrical connection to the terminal unit may
  only be established if the installation has been car-
  ried out correctly.
- The 24 V supply voltage may only be supplied with
  a safety power supply unit.
- If several control components are connected to a
  24 V mains supply, it must be ensured that a
  common zero or ground line is defined and not inter-
  changed.

- The control component contains no parts that can
  be replaced or repaired by the user and may only be
  opened by the manufacturer.
- Lay connecting cables in such a way that they
  cannot be accidentally damaged by mechanical
  impact or by heat.

The following must be observed when using the
Modbus RTU interface:

- The relevant RS485 guidelines must be observed
  for the wiring.
- Do not galvanically isolate the supply voltage and
  communication.
- Connect the grounds of the Modbus participants to
  one another.
- Further information and wiring examples for the
  Modbus RTU, ⬏ *Chapter 6 'Digital operating mode
  (Modbus RTU)' on page 22*

Electrical safety

The control component complies with all relevant stand-
ards and guidelines, see declaration of conformity.

Open terminals

According to the electro-technical regulations, contact
protection insulation is only required for active parts.

Because Compactregler controllers are operated with
protective extra-low voltage (PELV), the screw terminals
are not considered to be active parts.

To protect the terminals, fit the terminal cover included
in the supply package.

Wire clamping bracket

Devices that are permanently installed in buildings are
stationary electrical equipment for which no strain relief
on the connecting cables is required.

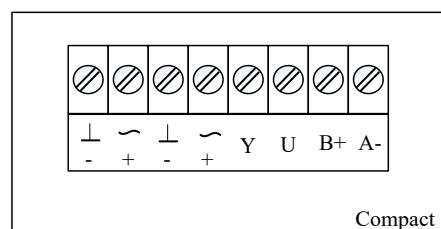## 5.2 Connection diagrams

5.2.1 Terminals

Fig. 11: Terminals

Terminal	Function
⊥ -	Ground, neutral
∼ +	24 V AC / DC supply voltage
Y	Setpoint value signal (Y) 0 – 10 V DC and/or 2 – 10 V DC override control
U	Actual value signal (U) 0 – 10 V DC or 2 – 10 V DC
B+ A-	Modbus RTU

The terminals for the supply voltage are doubled for easy rewiring. **Attention:** To protect against overload of the terminals and tracks, the supply voltage may be wired through for a maximum of three control components. Terminals for 0.5 to 1.5 mm² cables, rigid and flexible.

5.2.2 Control variable volume flow rate q_{vmin}···q_{vmax}
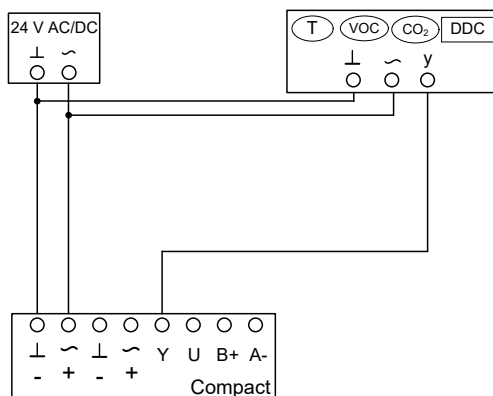
$q_{vmin} \cdots q_{vmax}$

Fig. 12: Variable volume flow control

If the volume flow rate must be specified by a higher-level controller (e. g. for room temperature, air quality or a DDC outstation), its 0 – 10 (2–10) V DC output must be connected as a control signal to terminal Y on the control component in accordance with the connection diagram. In case of a common 24 V supply voltage for the control components and control signal, please note that a common ground is used.

5.2.2.1 Parallel connection
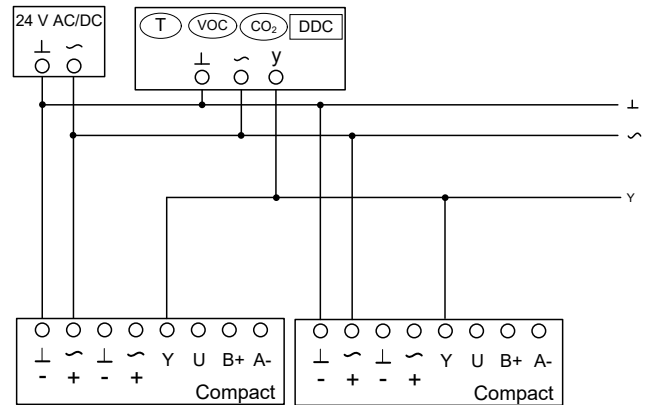
Fig. 13: Parallel connection

If several control components are to be controlled simultaneously, this is possible in the constant variation (Fig. 16 , Fig. 17 , Fig. 18) and in the variable (Fig. 13). For this purpose, the control signal is duplicated and simultaneously applied to terminal Y of the control component.

5.2.2.2 Sequential control
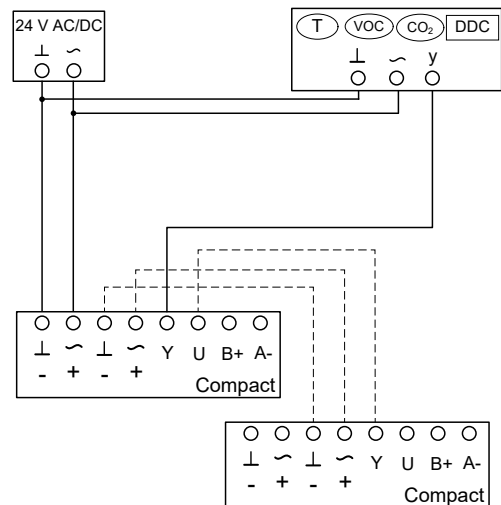
Fig. 14: Variable volume flow control (master and slave control component)

If the volume flow balance between two control components should always be the same, e. g., supply and extract air in a closed room, this is achieved via a sequential circuit. In this case, the control signal from the room temperature controller is switched to the supply air controller, for example. The actual value signal of the supply air controller is then connected to the extract air controller. Additional information: ⚡ *on page 14*

5.2.3 Control constant volume flow rate q_{vmin}
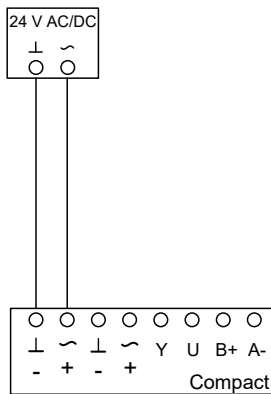
Fig. 15: Constant volume flow rate q_{vmin}

After applying the 24 V supply voltage, the control component performs a synchronisation and then throttles the volume flow rate to q_{vmin} (factory setting). A setpoint value signal is not required. The volume flow rate actual value can be tapped at the terminal (U).

5.2.4 Control constant volume flow rate q_{vmin} or q_{vmax} (switching)
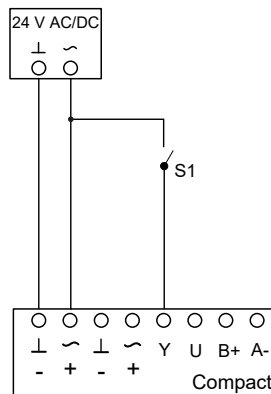
Fig. 16: Switching between volume flow rates q_{vmin} and q_{vmax}

If the volume flow rate is to be switchable between two fixed values (e. g., day/night changeover), a volt-free switch contact provided by the customer can be used to switch between the volume flow rate setpoint values q_{vmin} and q_{vmax} (factory setting).

Switch S1 open   - q_{vmin}

Switch S1 closed - q_{vmax}

5.2.5 Control variable operation / override controls

If the volume flow rate is to be switchable between several fixed values (e. g., day/night changeover / CLOSED / OPEN), volt-free switch contacts provided by the customer can be used to switch between four or five different fixed operating states. The switches must be interlocked to avoid short circuits. A service tool is required to adjust volume flow rate setpoint values, ⅏ *Chapter 8.2 'Service tools functional overview' on page 29* .
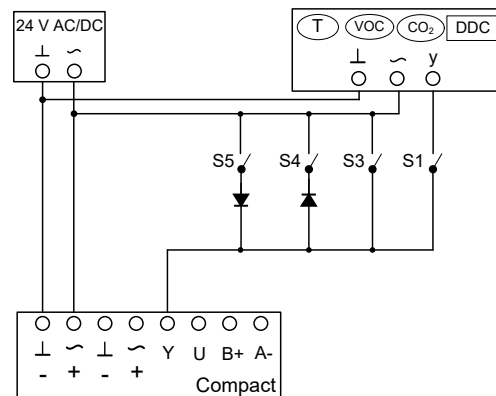
Fig. 17: Step operation 0 – 10 V DC
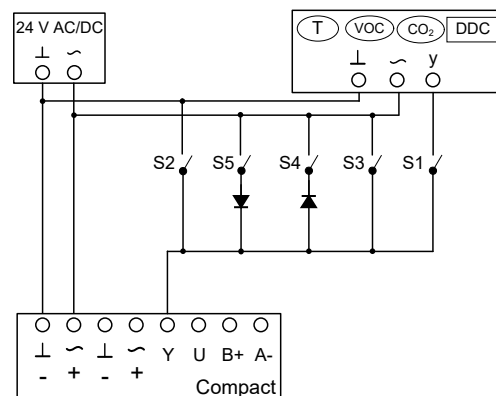
Fig. 18: Step operation 2 – 10 V DC

T   Temperature sensor
VOC   Room air quality sensor
CO_2 Carbon dioxide sensor
DDC   Office automation

- The functions shown in the table below refer to the respective operated switch.
- The switches must be interlocked.
- Never operate more than one switch.

Override controls CLOSED / q_{vmin} / q_{vmax} / OPEN

Switch	Control input signal	
	0 – 10 V	**2 – 10 V**
All open	Minimum volume flow rate q_{vmin}	
S1 closed	Room temperature control	
S2 closed	Not used	OPEN
S3 closed	Maximum volume flow rate q_{vmax}	
S4 closed*	Damper blade CLOSED	
S5 closed*	Damper blade OPEN	

* Only applies to 24 V AC supply voltage; the S4 and S5 functions are not available for the DC supply.

<div align="right">TROX® TECHNIK</div>

6 Digital operating mode (Modbus RTU)

6.1 Basic principles for Modbus RTU

The Modbus RTU is a master-slave bus system. It enables simple wiring of up to 32 control components (slaves) which can be parameterised, written to and read out centrally via a Modbus master (e.g., switch cabinet). This makes it easy to check the function of up to 32 volume flow controllers.

Fig. 19: Example: Modbus segment with one master and 5 slaves

M   Master
S   Slave

Modbus allows a line structure (daisy chain) as a bus structure. Due to circumstances on site, signal feedback can occur at the end of a Modbus line. To filter this feedback, a 120 Ω terminal resistor is necessary at the end of the bus line. The communication of the bus participants is based on a serial two-wire line (twisted-pai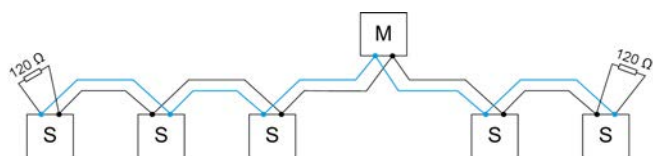r) following an EIA/TIA RS485 standard with master/slave configuration. All Modbus participants must be given a unique Modbus address (1 - 32) for system affiliation. Slaves can also be third-party products.

6.2 Modbus RTU for XM0/XS0

In Modbus operation, no analogue control signal is required. The setpoint value is transmitted digitally to the control component via the Modbus. If connected, the analogue setpoint value signal is ignored in this case. For smooth data exchange in the on-site Modbus RTU network, the communication parameters and user address must be set for the Modbus interface. The service tools GUIV3-M adjustment device, WINVAV2 PC software or the internal display enable simple addressing of the control components ⮤ *Chapter 8.2 'Service tools functional overview' on page 29* .

Various standardised Modbus registers are available for setpoint value specification, actual value feedback or status messages. Therefore, for example, the volume flow rate setpoint value is specified with the Modbus address by transferring the new setpoint value to Modbus register 0. The volume flow rate actual value is queried for each control component with the Modbus address by reading out Modbus register 6. Further Modbus registers: ⮤ *Chapter 8.6 'Configuring the Modbus interface' on page 32*

> ℹ️ **Observe the installation instructions!**
> ⮤ *Chapter 5 'Wiring' on page 18*

6.3 Modbus operation
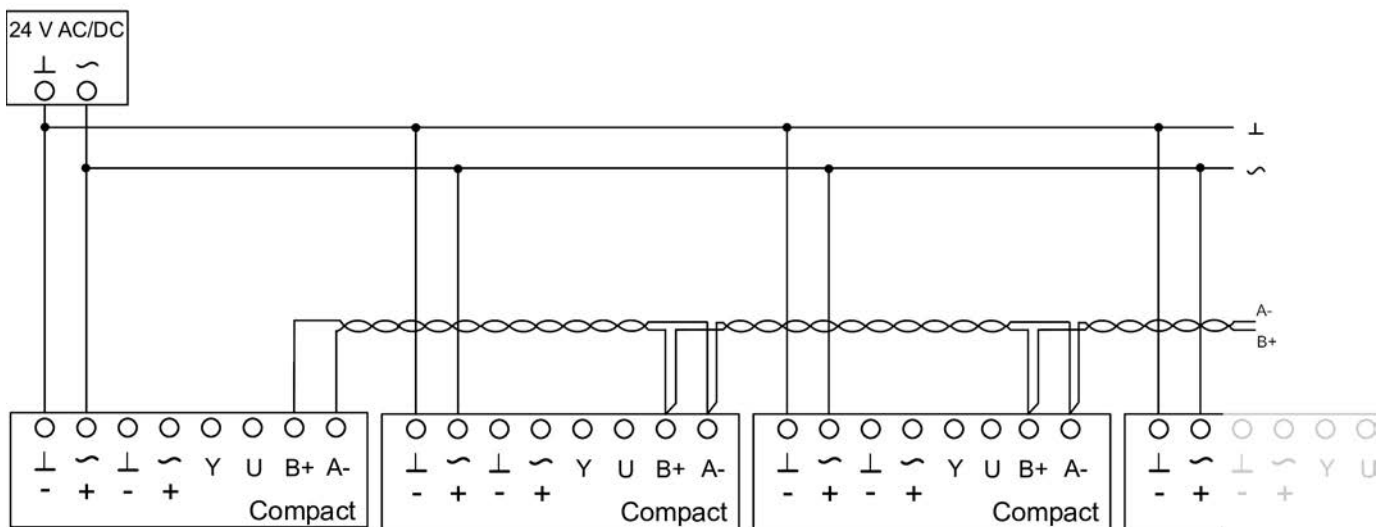
Fig. 20: Modbus operation with a supply voltage
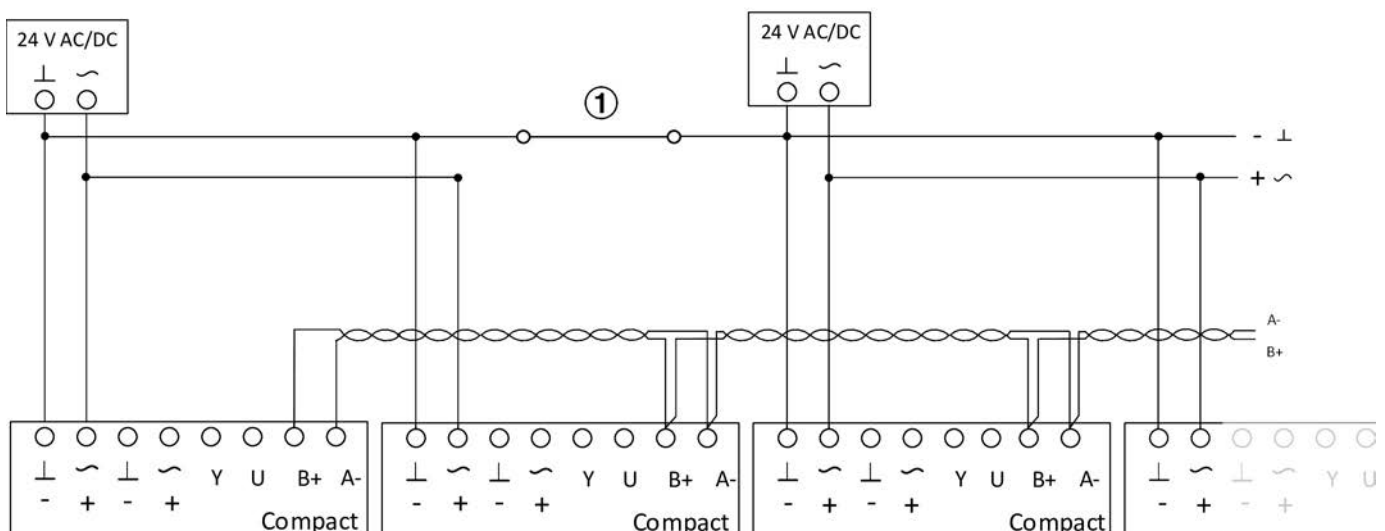
Fig. 21: Modbus operation with multiple supply voltages

1   If there are several supply voltages, connect the grounds of the Modbus participants to one another.

No analogue control signal is required for Modbus operation. The setpoint value is transmitted digitally to the control component via the Modbus. If the control component is set to Modbus operation, the analogue setpoint value signal is ignored.

The transmission of setpoint values and actual values, as well as override controls, is carried out either for all control components in parallel or independently and individually by means of digital communication in the common Modbus network.

- ■ The volume flow rate setpoint value is specified for each control component by specifying the Modbus address and transferring the new setpoint value to Modbus register 0.
- ■ The volume flow rate actual value is queried for each control component by reading Modbus register 6 and specifying the Modbus address.

6.4 Hybrid operation (analogue operation with Modbus feedback)
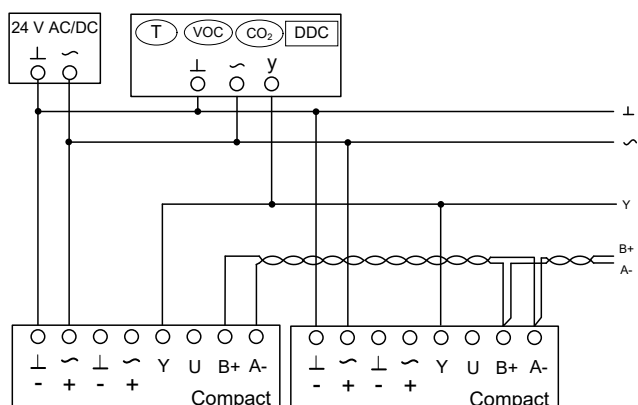
Fig. 22: Analogue operation with Modbus feedback

In hybrid operation, an analogue control signal is provided to the control component. Actual value signals from several control components can be called up in parallel via the Modbus. In hybrid operation, no control signal can be specified via the Modbus. In this case, the Modbus is only used for feedback and display of the actual values of the control components.

7   Operation and status of the control component

Display and control elements

At the control component, current operating values can be read, operating parameters can be set and the controller status can be queried for diagnosis.

Fig. 23: Display and control elements of the XM0 / XS0 control component

1   Display of actual values and operating states
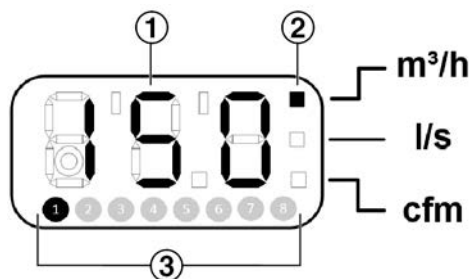2   Rotary selector switch
3   LED push button

Display description

Fig. 24: Display

1   Display area
2   Display of volume flow unit
3   Display of the menu level
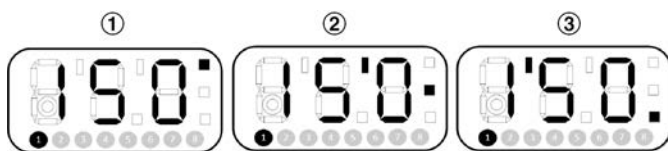
Fig. 25: Display examples of volume flow rate values

1   150 m³/h
2   15 l/s
3   1.5 cfm

Decimal point values are indicated by an apostrophe.

Menu selection
Pressing the LED button briefly (<3 s) switches to the next menu item ❶ - ❻; see the table below for a description of the menus.

Editing mode
Pressing the LED button for a long time (>3 s) switches to editing mode.

Value change
Value change with rotary selector switch
Save by briefly pressing the LED button (<3 s).

After 60 seconds without an entry, the system switches back to menu item ❶.

Menu description
❶ Flow Display of set volume flow rate [m³/h] – [l/s] – [cfm]
❷ V$_{min}$ Display and setting of q_{vmin}
❸ V$_{max}$ Display and setting of q_{vmax}
❹ Diagnosis Displays the control signal and feedback signal alternately in [V] Activation of override controls for test and diagnostic purposes: ▪ tst = test run ▪ oP = damper OPEN / cL = damper CLOSED ▪ Lo = q_{vmin} / Hi = q_{vmax} ▪ St = motor stop ▪ oFF = override control OFF ▪ 000 = display firmware version
❺ Mode Selection of the operating mode: ▪ cA0 = setpoint value default setting and actual value return via analogue interface (0 – 10 V) ▪ cA2 = setpoint value default setting and actual value return via analogue interface (2 – 10 V) ▪ cb2 = setpoint value setting and actual value return via Modbus, additional actual value return via (2 – 10 V)
❻ COM DIP switch to set communication parameters ▪ Address: 1 – 247 ▪ Baud rate, parity and stop bits, (b1 – b32)   ↳ *'Detailed information on register 568 (Modbus communication parameters)' on page 35*

Menu navigation

Fig. 26: Menu navigation

Status and error messages
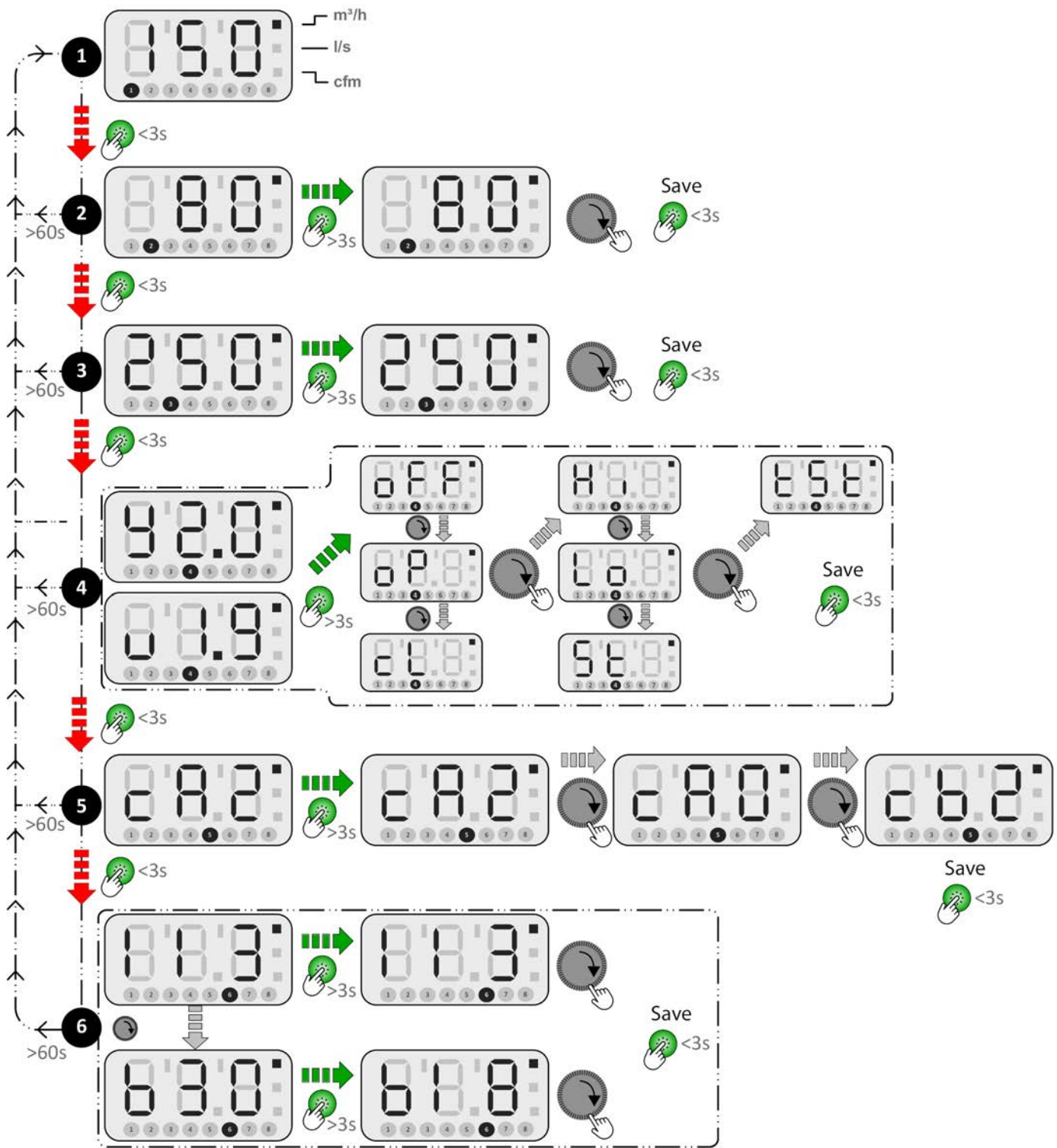
Display	Flashing signal of LED button	Status
OFF	OFF	No power
E C	(LED signal pattern)	Inform TROX Service
b L c	(LED signal pattern)	Overload of the actuator ■ Check for mechanical blockage!
r E F		Synchronisation after voltage recovery ■ Wait for automatic end position detection (open position).
t 5 t	(LED signal pattern)	Test mode activated ■ End position OPEN is approached, ■ End position CLOSED is approached, ■ then back to the normal position
○ (display)	(LED signal pattern)	Positive pressure detected on sensor: ■ XS0 – static transducer: $\Delta p \geq 1000$ Pa ■ XM0 – dynamic transducer: $\Delta p \geq 1500$ Pa
H i	(LED signal pattern)	Forced control q_{vmax} activated but not yet reached Display switches between Hi and actual volume flow rate value
	(LED signal pattern)	Override control q_{vmax} reached Display switches between Hi and actual volume flow rate value
L o	(LED signal pattern)	Forced control q_{vmin} activated, but not yet reached Display switches between Lo and actual volume flow rate value
	(LED signal pattern)	Override control q_{vmin} reached Display switches between Lo and actual volume flow rate value
o P	(LED signal pattern)	Override control **OPEN** activated, but not yet reached Display switches between op and volume flow rate actual value
	(LED signal pattern)	Override control **OPEN** reached Display switches between op and volume flow rate actual value
c L	(LED signal pattern)	Override control **CLOSED** activated, but not yet reached Display switches between cl and volume flow rate actual value
	(LED signal pattern)	Override control **CLOSED** reached. Display switches between cl and volume flow rate actual value
5 8 0	(LED signal pattern)	Setpoint value or override control position not yet reached. Display switches between e. g. Hi and volume flow rate actual value
	(LED signal pattern)	Regulated. Is signalled as long as the actuator does not rotate to readjust the setpoint value.

The flashing signal appears every 2 seconds.
1 = LED is illuminated, 0 = LED is not illuminated

8 Commissioning and operation

Safety instructions

> ⚠️ **DANGER!**
>
> Danger of electric shock! Do not touch any live components! Electrical equipment carries a dangerous electrical voltage.
>
> – Only skilled qualified electricians are allowed to work on the electrical system.
> – Switch off the power supply before working on any electrical equipment.

Before initial commissioning and switching of the supply voltage, check for proper wiring.

The green illuminated LED button signals correct wiring after switching on the supply voltage.

When the supply voltage is switched on, the control component performs a synchronisation and the damper blade is moved to the OPEN position. The damper then returns to its original position. This can take up to three minutes; the status is shown on the display and the LED, ⬦ *Chapter 3.1 'Product overview' on page 10* .

8.1 Factory settings:

The volume flow controller is adjusted at the factory and set to the operating mode and operating parameters specified in the order code. Due to the factory-set volume flow rates, always ensure that the terminal units are only installed in the specified locations

The factory-set operating parameters can be taken from the adjustment sticker on the terminal unit. (Fig. 27 /5)

Modbus (M)

Factory set operating parameters:

q_{vmin} [m³/h]; [l/s] - Lower limit of the operating range for the VAV terminal unit

q_{vmax} [m³/h]; [l/s] - Upper limit of the operating range for the VAV terminal unit

Additional commissioning steps required ⬦ *Chapter 8.6 'Configuring the Modbus interface' on page 32*

Analogue (0 – 10 V / 2 – 10 V) – variable operation (V)

Factory set operating parameters:

q_{vmin} [m³/h]; [l/s] - Lower limit of the operating range for the VAV terminal unit

q_{vmax} [m³/h]; [l/s] - Upper limit of the operating range for the VAV terminal unit

Analogue (0 – 10 V / 2 – 10 V) – constant value mode (F)

Factory set operating parameters:

q_{vmin} [m³/h]; [l/s] - The volume flow rate constant value q_{vconst} is set in parameter q_{vmin}.

q_{vmax} [m³/h]; [l/s] - The parameter q_{vmax} is set to q_{vnom}.

For constant value operation, no control signal may be specified at terminal Y.

During commissioning, the settings can be adjusted on the display of the control component or with the service tool according to the requirements, ⬦ *8.5 'Setting of the control component' on page 30* .

`Cb2` - Modbus

`CA0` - Analogue 0 – 10 V – variable operation (V) or constant value operation (F)

`CA2` - Analogue 2 – 10 V – variable operation (V) or constant value operation (F)

Supplementary use of the Modbus interface in analogue operation (hybrid operation)

In analogue operation, only the setpoint value settings of the control component are analysed at the analogue input. A setpoint value setting via the Modbus interface (register 0) is not possible. Any write attempts are acknowledged with an error response.
Regardless of the selected interface configuration, however, the other Modbus registers can be used. In analogue mode with analogue setpoint value specification, various operating values, such as the volume flow rate actual value and damper position, can therefore be read out from a higher-level building management system (central BMS) via the Modbus interface, or central override controls can also be triggered.
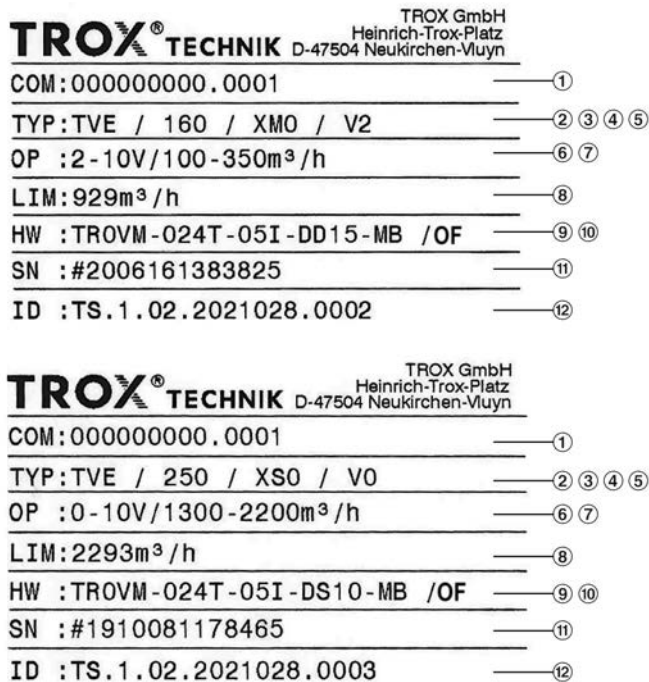
Adjustment sticker

Fig. 27: Adjustment sticker XM0 and XS0

① Commission number. Order number
② Type designation of terminal unit
③ Nominal size
④ Control component
⑤ Operating mode
   M ⇨ Modbus
   F ⇨ constant value
   V ⇨ variable
   0 or 2 ⇨ characteristic type
⑥ Characteristics 0 – 10 V or 2 – 10 V
⑦ Volume flow rate ranges q_{vmin} – q_{vmax} or constant value
⑧ Nominal volume flow rate q_{vnom}
⑨ Hardware type designation
⑩ Control components:
   OF ⇨ equipped at the factory
   SP ⇨ replacement part
⑪ Serial number
⑫ Test ID number

8.2 Service tools functional overview

Functions	Display	Adjustment device	PC software
Actual value display	✔	✔	✔
Changes from q_{vmin} and q_{vmax}	✔	✔	✔
Mode setting (0…10 V / 2…10 V / Modbus)	✔	✔	✔
Record running times (operating time, running time, ratio)	✖	✖	✔
Perform test run function	✔	✔	✔
Setpoint value signal in Y [V]	✔	✔	✔
Actual value return U [V]	✔	✔	✔
Assign bus address	✔	✔	✔
Set Modbus parameter sets	✔	✔	✔

8.2.1 Display XM0 / XS0

Current values can be read, operating parameters can be set and the status can be read from the control component.
After applying the supply voltage, various functions are available.

Additional information:

- ⟳ Chapter 7 *'Operation and status of the control component' on page 25*
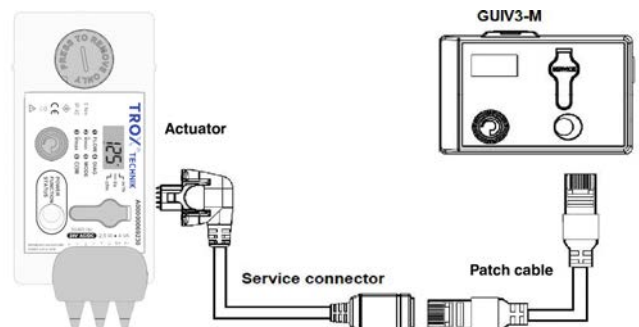
8.2.2 Adjustment device GUIV3-M

Fig. 28: GUIV3-M is connected to the control component by means of the cable provided in the supply package.

The GUIV3-M adjustment device offers the same range of functions as the internal display of the control component, setting via this display is useful if the control component is difficult to access due to an unfavourable installation orientation. Connecting and patch cables allow for easy commissioning. All illustrated connecting cables, software and operating instructions are included in the supply package of the adjustment device, rechargeable battery 2.4V (2x AA Ni-Mh) not included. To ensure proper operation of the adjustment device, use the cables included in the supply package.
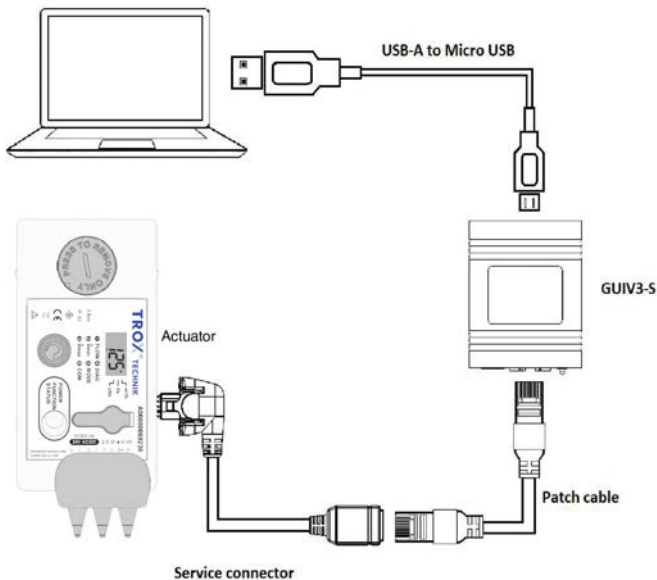
8.3   PC software WINVAV2

Fig. 29: Connection to the PC with interface adapter GUIV3-S

With the WINVAV2 software, actual values can be read and parameterised and time diagrams can be created. The software is installed on a customer PC.

The control component is connected to the GUIV3-S interface adapter with a service plug and patch cable. The USB cable is then used to connect the PC and GUIV3-S. The software comes with the GUIV3-S interface adapter, all the connecting cables shown, and the operating instructions. To ensure proper function, the cables in the supply package must be used.

8.4   Functional test

Personnel:
- Skilled qualified electrician
- HVAC technician

For commissioning, we recommend creating commissioning documentation in which the function of the terminal unit is checked and documented.

The function test of the terminal unit can be carried out in various ways, ↻ *Chapter 8.2   'Service tools functional overview' on page 29* .

The internal display is sufficient for most function tests, ↻ *7   'Operation and status of the control component' on page 25*

To check the function of the VAV terminal unit, check the position of the damper blade on the damper blade shaft (marked), ↻ *3.2   'Position of the damper blade' on page 10* .

Preparation:

- Switch on the supply voltage; the green LED indicates that the supply voltage is properly connected.
- Wait until the synchronisation run has been completed.
- Switch on air conditioning system.
  Note: The system pressure at the volume flow controller must be sufficient for a proper function test.

1. ▶ Perform the test function:
   For this purpose, select menu item `tst` on display menu ❹ *'Diagnosis'* , ↻ *on page 25* .

   ⇨ The test function is started and the LED flashes once briefly at 2-second intervals.

      - Actuator moves the damper blade to the OPEN position.
      - Actuator moves the damper blade to the CLOSED position.
      - Actuator moves the damper blade back to the control position.

2. ▶ Activate the override control q_{vmin}
   For this purpose, select menu item `Lo` on display menu ❹ *'Diagnosis'* , ↻ *on page 25* .

   ⇨ Measure actual value signal with the voltmeter and log the volume flow rate actual value

3. ▶ Activate the override control q_{vmax}
   For this purpose, select menu item `Hi` on display menu ❹ *'Diagnosis'* , ↻ *on page 25* .

   ⇨ Measure the actual value signal with a voltmeter, read the volume flow rate actual value on the display and log it.

8.5   Setting of the control component

8.5.1   Setting constant value operation (F)

If the factory-set value qv_{vconst} is to be changed, or an ordered variable volumetric flow controller is to be converted to a constant volumetric flow controller, this can be adjusted on the internal display or via the service tools described. Here, the constant value is set to q_{vmin}. Since q_{vmin}= q_{vconst} with constant control. In this case, the q_{vmax} value has no relevance and no further setting is required.

For constant value operation, no control signal may be specified at terminal Y.

TROX ®TECHNIK

Commissioning and operation

Setting of the control component > Change of the control input signals analogue 0...

8.5.2 Setting variable operation (V)

The factory-set values for q_{vmin} and q_{vmax} can be adjusted on the internal display or using the service tools described.
q_{vmin} to q_{vmax} is the variable-limited volume flow rate operating range, which is controlled by the control signal at terminal Y.

The following points should be noted for the control input signal:

- Usable control range of the VAV terminal unit 4%–100%

- The settings q_{vmin} und q_{vmax} define the controllable operating range of the control component, ↳ *3.5 'Characteristics' on page 15*

- In order to achieve a higher resolution of the assignment voltage signals to the volume flow rate setpoint values, the operating range can be restricted by q_{vmin} und q_{vmax}.

8.5.2.1 Setting the entire control range for the control input signal of the central building management system

If the volume flow rate is to be specified by the central BMS across the entire control range, q_{vmin} must be set to 0 m³/h and q_{vmax} to q_{vnom}.

The following points should be noted for the control input signal:

- Observe the usable control range
  For example, with a signal voltage range of 0 – 10 V DC and settings of q_{vmin} = 0 m³/h and q_{vmax} = q_{vnom}, the control range is only reached from a control signal of 0.4 V DC.

- If the control signal drops below 0.3 V DC with a control input signal of 0 – 10 V and q_{vmin} = 0, the damper blade moves to the CLOSED position.

! NOTICE!

Safe shut-off function

Compliance with a control signal $\leq$ 0.3 V DC is not always given due to interference voltages on the supply lines. Therefore, the positive circuit should always be preferred for a safe shut-off,
↳ *on page 20*

8.5.3 Change of the control input signals analogue 0 – 10 V, 2 – 10 V, Modbus

In menu item ❺, the control input signal of the control component can be adjusted as follows. ↳ *7 'Operation and status of the control component' on page 25*

`Cb2` - Modbus

`CA0` - Analogue 0 – 10 V – variable operation (V) or constant value operation (F)

`CA2` - Analogue 2 – 10 V – variable operation (V) or constant value operation (F)

8.6 Configuring the Modbus interface

The Modbus parameters can be set on the internal display, the service tools ⇗ *Chapter 8.2 'Service tools functional overview' on page 29* or an external Modbus software.
The following table lists all Modbus registers and their meaning.

Explanation of the access right / storage:
R = Register can be read
R, W = Register can be read and written
RAM = Register value temporary
EEPROM = Register value not temporary, but saved permanently (max. 1 million write processes)

Register	Meaning	Access right	Storage
0	Volume flow rate setpoint value [%] ▪ Reference: Vmin – Vmax (q_{vmin} – q_{vmax}) ▪ Resolution: 0 – 10000 ▪ Volume flow rate setpoint value: 0.00 – 100.00%	R, W	RAM
1	Activation of an override control ▪ 0 = None ▪ 1 = OPEN position ▪ 2 = CLOSED position, shut-off CLOSED ▪ 3 = q_{vmin} ▪ 4 = q_{vmax}	R, W	RAM
2	Command triggering ▪ 0 = None ▪ 1 = Synchronisation ▪ 2 = Test run ▪ 4 = Controller reset	R, W	RAM
4	Current damper blade position [%] ▪ Resolution: 0 – 10000 ▪ Damper blade position: 0.00 – 100.00%	R	RAM
5	Current damper blade position [°] ▪ Reference: without decimal places	R	RAM
6	Volume flow rate actual value [%] ▪ Reference: q_{vnom} ▪ Resolution: 0 – 10000 ▪ Volume flow rate actual value: 0.00 – 100.00%	R	RAM
7	Current volume flow rate actual value in volume flow unit according to the setting in register 201 [m³/h], [l/ s], [cfm]	R	RAM
8	Voltage value at analogue input setpoint value Y [mV]	R	RAM
103	Firmware version	R	Flash
104	Status information ▪ Bit 5 = Mechanical overload ▪ Bit 8 = Internal activity, e. g., test run, synchronisation ▪ Bit 10 - Bus timeout monitoring triggered **Note:** All other bits for internal purposes only	R	RAM

Register	Meaning	Access right	Storage
105	Lower limitation of work area: • Operating parameter Vmin (q_{vmin}) [%] • Reference: q_{vnom} (see adjustment sticker) • Resolution: 0 – 10000 • Vmin: 0.00 – 100.00% **Note:** Modbus registers 105 and 120 influence each other mutually; the last setpoint value default setting is valid.	R, W	EEPROM
106	Upper limitation of work area: • Operating parameter Vmax (q_{vmax}) [%] • Reference: q_{vnom} • Resolution: 0 – 10000 Vmax: 0.00 – 100.00% **Note:** Modbus registers 106 and 121 influence each other mutually; the last setpoint value default setting is valid.	R, W	EEPROM
108	Behaviour on bus timeout • 0 = Control of the last setpoint value • 1 = OPEN position • 2 = CLOSED position, shut-off CLOSED • 3 = q_{vmin} • 5 = q_{vmax}	R, W	EEPROM
109	Definition bus timeout [s]	R, W	EEPROM
120	Lower determination of work area: Operating parameter q_{vmin} in the volume flow unit [m³/h], [l/ s], [cfm] according to the setting in register 201 **Note:** Modbus registers 120 and 105 influence each other mutually; the last setpoint value default setting is valid.	R, W	EEPROM
121	Upper determination of work area: Operating parameter q_{vmax} in the volume flow unit [m³/h], [l/s], [cfm] according to the setting in register 201 **Note:** Modbus registers 121 and 106 influence each other mutually; the last setpoint value default setting is valid.	R, W	EEPROM
122	Interface definition (interface mode); for assignment see separate table	R, W	EEPROM
130	Modbus address (participant address), factory setting: Modbus address 1	R, W	EEPROM
201	Volume flow unit • 0 = l/s • 1 = m³/h • 6 = cfm	R, W	EEPROM

TROX® TECHNIK

Register	Meaning	Access right	Storage

231	Determination of signal voltage range (mode):
	
	■ Bit 0 defines the characteristic selection of the analogue interface.
	  – Bit 0 = 0 characteristic: 0 – 10 V
	  – Bit 0 = 1 characteristic: 2 – 10 V
	■ Bit 4 defines the actual value signal as volume flow rate actual value or damper blade position.
	  – Bit 4 = 0 Volume flow rate actual value
	  – Bit 4 = 1 Damper blade position
	■ All other bits must not be changed.
		R, W	EEPROM

568	Modbus parameter set, communication settings: ■ Baud rate ■ Parity ■ Stop bits For the assignment, see the separate table	R, W	EEPROM
569	Modbus communication settings: Modbus response time = 10 ms + delay With delay = 3 ms × register value 0 – 255	R, W	EEPROM
572	Setting of switching threshold for override control CLOSED via control signal for signal voltage range 2 – 10 V: ■ Setting range 0.5 V – 1.8 V ■ Default value 0.8V (register value = 20) ■ Resolution: 1 setting unit = 40 mV	R, W	EEPROM

Detailed information on register 122 (communication interface setpoint/actual value - Interface Mode)

Register value	Setpoint value default setting	Actual value
0	Analogue input at terminal Y; signal voltage range 0(2) – 10 V according to register 231	Analogue signal at terminal U; signal voltage range 0(2) – 10 V according to register 231
1	Modbus via Register 0	(0)2 – 10 V
2	Modbus via Register 0	Modbus register 10
3	Analogue input at terminal Y; signal voltage range 0(2) – 10 V according to register 231	Modbus register 10

Detailed information on register 568 (Modbus communication parameters)

Setting value		Baud rate	Parity	Stop bits
Modbus register	Display			
0	1	1200	None	2
1	2	1200	Straight	1
2	3	1200	Uneven	1
3	4	2400	None	2
4	5	2400	Straight	1
5	6	2400	Uneven	1
6	7	4800	None	2
7	8	4800	Straight	1
8	9	4800	Uneven	1
9	10	9600	None	2
10	11	9600	Straight	1
11	12	9600	Uneven	1
12	13	19200	None	2
13	14	19200	Straight	1
14	15	19200	Uneven	1
Factory setting ⇒ 15	**16**	**38400**	**None**	**2**
16	17	38400	Straight	1
17	18	38400	Uneven	1
18	19	1200	None	1
19	20	2400	None	1
20	21	4800	None	1
21	22	9600	None	1
22	23	19200	None	1
23	24	38400	None	1
24	25	76800	None	1
25	26	115200	None	1
26	27	76800	None	2
27	28	76800	Straight	1
28	29	76800	Uneven	1
29	30	115200	None	2
30	31	115200	Straight	1
31	32	115200	Uneven	1

9 Troubleshooting

TROX air terminal units and control components are tested technically before delivery. The factory-set operating parameters are documented on the adjustment sticker and must be checked during commissioning ⭲ *'Adjustment sticker' on page 29* .

If faults occur after commissioning, they can usually be remedied yourself using the following descriptions.

If a fault cannot be remedied on its own, TROX Service will be happy to assist you with troubleshooting, simply contact ⭲ *'TROX Technical Service' on page 3*

For this, the following information is needed:

- Order number and item or serial number (see order code)
- Type and nominal size of VAV terminal unit (see adjustment sticker):
- q_{vmin} / q_{vmax} settings
- Control input signal

9.1 Common mistakes

9.1.1 Incorrect wiring

In many cases wiring errors are the cause of faults. For this reason, only the 24 V supply voltage should initially be connected when troubleshooting a control component.

1. ▶ If present, disconnect the connecting cables at the setpoint value input (terminal Y) and the actual value output (terminal U). This switches off all external circuit influences.

2. ▶ Check if the 24 V supply voltage is switched on and is within the permitted tolerance zone.

    ⇨ When the supply voltage is switched on and there is an adequate minimum differential pressure in the duct, the control component attempts to adjust the volume flow rate to the setpoint value q_{vmin}.

3. ▶ Check whether the volume flow controller has reached the setpoint value.

    Reading out with service tool or voltage signal ⭲ *9.3.1 'Use of voltmeters to control setpoint values and feedback signals' on page 37* .

    ⇨ If the setpoint value is reached, the volume flow controller will work properly.

4. ▶ The test can be repeated for different setpoint values by adjusting the V_{min} value.

9.1.2 System pressure too low

The aim of the volume flow control is to regulate the volume flow rate actual value to the specified setpoint value. However, this requires a sufficient fan output so that the terminal unit can regulate (restrict) the desired volume flow rate setpoint value. If the required minimum differential pressure is not reached due to an inadequate fan output, the setpoint value of the terminal unit cannot be reached either.

If the system pressure is too low, the volume flow controller will attempt to open the damper blade further to reach the desired volume flow rate setpoint value. This can be detected on the damper blade shaft of the VAV terminal unit ⭲ *3.2 'Position of the damper blade' on page 10* .

If the damper blade is still in the OPEN position with the setpoint signal present, instead of in a control position (throttle position), the volume flow rate is not high enough to set the setpoint value.

Remedy:

- Check fan output,
- Check if the duct section is blocked, e.g., fire damper closed
- ⭲ *A 'Systematic troubleshooting' on page 46*

9.1.3 Use outside the control range

If the unit-specific control range is left with the q_{vmin}- / q_{vmax} setting, the setpoint values cannot be reached. The actual value reached by the volume flow controller is undefined.

Adapt the settings for q_{vmin} and q_{vmax} with the specific control ranges of the terminal unit.

Additional information:

- Useful control range 4% – 100% of q_{vnom} (see adjustment sticker)
- ⭲ *3.5 'Characteristics' on page 15*

9.1.4 Deviation between setpoint value and actual value signal

Frequently, in the regulated condition, the same signal voltage is expected at the setpoint value input and the actual value output of the control component. However, this only applies if q_{vmin} is set to 0 m³/h and q_{vmax} is set to q_{vnom}, since the same characteristic curve vertices are used for the setpoint value input and the actual value output.

Furthermore, in the controlled state, due to the permissible control tolerance, small deviations between the signal voltages of the setpoint value and actual value can always be expected.

TROX® TECHNIK

If the q_{vmin} and q_{vmax} settings restrict the usable control range, this changes the characteristic profile of the setpoint value signal. Since the signal voltage of the actual value is always assigned to the characteristic profile of q_{vnom}, this results in a restriction of the usable control range in a different characteristic profile of the signal voltages for setpoint and actual values.

In this case, a direct inference due to different signal voltages at the setpoint value input or actual value output without (rollover) calculation is not possible.

9.2 Systematic troubleshooting

In case of malfunctions of the VAV terminal unit, we recommend systematic troubleshooting based on our flow chart, ⮮ A *'Systematic troubleshooting' on page 46* .

9.3 Further diagnostic options

9.3.1 Use of voltmeters to control setpoint values and feedback signals

In analogue mode, a voltmeter can be used to electrically measure both the setpoint value signal Y (terminal Y to earth) and the actual value signal U (terminal U to earth). Using the following formulas, the associated volume flow rate setpoint values and actual value scan be calculated and thereby checked:

Voltage signal 0 – 10 V

$$q_{vsoll} = \frac{Y}{10\ V} \times (q_{vmax} - q_{vmin}) + q_{vmin}$$

$$q_{vist} = \frac{U}{10\ V} \times q_{vnenn}$$

Voltage signal 2 – 10 V

$$q_{vsoll} = \frac{Y - 2}{(10\ V - 2\ V)} \times (q_{vmax} - q_{vmin}) + q_{vmin}$$

$$q_{vist} = \frac{U - 2}{(10\ V - 2\ V)} \times q_{vnenn}$$

Note: Depending on the selected setting of the q_{vmin}- / q_{vmax} values, the setpoint value signal voltage and actual value voltage can be different even in the correctly controlled state, ⮮ *9.1.4 'Deviation between setpoint value and actual value signal' on page 36* .

9.3.2 Sample calculations

Example 1:

Calculation of the volume flow rates by means of setpoint and actual value signal voltage

Terminal unit nominal volume flow rate q_{vnom}	- 1828 m³/h
Set q_{vmin}	- 600 m³/h
Set q_{vmax}	- 1000 m³/h
Characteristic setting	- 0 – 10 V
Voltage (Y)	- 8.24 V
Voltage (U)	- 5.4 V

$$q_{vsoll} = \frac{Y}{10\ V} \times (q_{vmax} - q_{vmin}) + q_{vmin}$$

Billing solution:

q_{vset} = (8.24 V / 10 V) × (1000 m³/h – 600 m³/h) + 600 m³/h

q_{vset} = <u>929.6 m³/h</u>

$$q_{vist} = \frac{U}{10\ V} \times q_{vnenn}$$

q_{vist} = 5.4 V / 10 V × 1828 m³/h

q_{vist} = <u>987.12 m³/h</u>

Deviation = 987.12 m³/h – 929.6 m³/h

Deviation = <u>57.52 m³/h</u>

$$\Delta q_v = 1 - \frac{q_{vsoll}}{q_{vist}} \times 100\%$$

Δq_v = 1 – (929.6 m³/h / 987.12 m³/h) × 100

$\Delta q_v \approx$ <u>6%</u>

Example 2:

Calculation of the setpoint value voltage (Y) for desired volume flow rate

Terminal unit nominal volume flow rate q_{vnom}	-	2293 m³/h
Set q_{vmin}	-	500 m³/h
Set q_{vmax}	-	2000 m³/h
Characteristic setting	-	0 – 10 V
Desired volume flow rate q_{vset}	-	1500 m³/h

$$Y = \frac{q_{vsoll} - q_{vmin}}{\left(\frac{q_{vmax} - q_{vmin}}{10\ V}\right)}$$

Billing solution:

Y = 1500 m³/h – 500 m³/h / (2000 m³/h – 500 m³/h / 10 V)

Y = 0.66 V

Example 3:

Calculation of the setpoint value voltage (Y) for desired volume flow rate

Terminal unit nominal volume flow rate q_{vnom}	-	1513 m³/h
Set q_{vmin}	-	250 m³/h
Set q_{vmax}	-	800 m³/h
Characteristic setting	-	2 – 10 V
Desired volume flow rate q_{vset}	-	650 m³/h

$$Y = \frac{q_{vsoll} - q_{vmin}}{\left(\frac{q_{vmax} - q_{vmin}}{(10V - 2V)}\right)} + 2V$$

Billing solution:

Y = 650 m³/h – 250 m³/h / (800 m³/h – 250 m³/h / (10 V– 2 V)) + 2 V

Y = 7.81 V

10 Replacement parts

10.1 Order of replacement control components

The unit type, nominal size/dimensions as well as operating mode, signal voltage ranges, operating values (q_{vmin}, q_{vmax}) and the nominal flow rate are required for ordering replacement parts. Additional details such as the order number make it easier to identify the delivery status of the VAV terminal unit.

> ℹ️
>
> *The adjustment sticker on the VAV terminal unit provides all the information required for ordering replacement parts for a control component, which can be sent as a photo when ordering replacement parts, for example.*

10.2 Assembly of replacement control components

Fig. 30: Plug the control component onto the basic unit

> ❗ **NOTICE!**
>
> Observe correct assembly!

1. ▶ Align the markings with each other.

2. ▶ Attach the controller without force

3. ▶ Engage the controller – done!

11 Disposal

Have the VAV terminal unit with control component disposed of by an authorised company following its final decommissioning. The device contains electrical and electronic components and must not be disposed of as domestic waste. When disposed of, local up to date regulations must be complied with.

12 Technical data

General operating conditions of the control components

Ambient temperature	10–50 °C
Ambient humidity	5-90% rF

Fig. 31: XM0 / XS0

	Compact controller XM0 TROVM-024T-05I-DD15-MB	Compact controller XS0 TR0VM-024T-05I-DS10-MB
Supply voltage (AC voltage)	24 V AC ± 20%, 50/60 Hz	
Supply voltage (DC voltage)	24 V DC ± 20%%	
Power rating (AC voltage)	Nominal width 100 – 200: max. 4 VA Nominal width 250 – 400: max. 7 VA	
Power rating (DC voltage)	Nominal width 100 – 200: max. 2.5 W Nominal width 250 – 400: max. 4 W	
Power consumption (when running/ when idle)	1 W	
Transducer	Dynamic (XM0)	Static (XS0)
Run time for 90°	Approx. 100 s	
Setpoint value signal input (analogue optional)	0 – 10 V DC, Ra > 100 kΩ or 2 - 10V DC Ra> 50 kΩ	
Actual value signal output	0 – 10 V DC or 2 – 10 V DC, max. 5 mA	
IEC protection class	III (protective extra-low voltage)	
Protection level	IP 42 (with the terminal cover attached)	
EC conformity	EMC to 2014/30/EU	
Bus connection	Modbus RTU, RS485	
Number of nodes	128	
Adjustable communication parameters	1200 – 115,200 Bd Start bit: 1 Data bits: 8 stop bits: 1 or 2 Parity: None, Even, Odd	
Setpoint / actual value interface (Modbus)	via Modbus register list	
Cable termination	externally required	

13   Declaration of conformity

We hereby declare that the control component complies with all relevant provisions of the following EC guide-lines:

- Richtlinie 2014/30/EU
- Richtlinie 2014/35/EU
- Richtlinie 2011/65/EU

The individual CE certificates can be found at _www.trox.de_ .

14 Index

Index

Appendix

A   Systematic troubleshooting

Troubleshooting VAV terminal units with Compact controller XM0 and XS0	Status 04.03.2021

Start troubleshooting

Supply voltage within the tolerance specifications? — No → Check wiring, transformer

Yes

Take note of display ASCII code! See Chapter 6.4

bLc — No → **rEF** — No → **tSt** — No → **circle** — No → **Hi, Lo, oP, cL** — No → **E C** — No

bLc — Yes → Check mechanical block of the actuator and repair if necessary.

rEF — Yes → Wait for synchronisation.

tSt — Yes → Test mode activated. Deactivate test mode or wait for test to be completed.

circle — Yes → Overpressure of sensor. Reduce system pressure.

Hi, Lo, oP, cL — Yes → Override control active. Deactivate override control.

E C — Yes

Initiate function test (run test function) Via DIAG menu 4
Damper blade first moves to positions OPEN and then to the control position.
(takes a few minutes; monitor process) Display shows tSt for the entire process.

Damper blade reaches the "OPEN" position first? — No →

Mechanische Überprüfung

- Check that the control component is seated corrected on the basic device
- Remove the control component from the basic device. See Fig. 29

Yes

Damper blade reaches control position? — No → Damper blade position? — Open →

Check system pressure

Minimum differential pressure maintained? Duct section shut off/fire damper closed?

- Sensor openings dirty (damper blade)
- Check setpoint value setting (Bus/analogue)

Closed →

Check q_{vmin}

Check q_{vmin} setting und setpoint value setting and correct if necessary

Yes

Actual value consistent with setpoint value setting? — No →

- Tolerance observation controller vs. Measuring tolerance
- Check control ranges
- Check wiring
- Check airflow direction (only for XS0)
- Check for dirt

→ Call TROX service technician

Yes

Controller OK