USER MANUAL

Dumo Series Ambient Dust Monitor
Model DumoPro

Document information

Revision	4
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Legal disclaimer

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Contents

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1 About this manual

This user manual contains the installation, commissioning, operating and maintenance instructions for Dumo series ambient dust monitor model DumoPro. Read this manual carefully before using the device. This manual is an important part of the product, and it must always be available for reference to all personnel installing, commissioning, operating or performing maintenance on the device. In case the manual is lost or damaged, request a new copy from the manufacturer or an authorized distributor.

1.1 Description of symbols

These symbols are used to alert you to any potential personal injury hazards, and to provide information on how to avoid them. Obey all safety messages that use these symbols to avoid possible injury or death. Symbols that provide additional information about using and handling the product are also described here.

Symbol	Description
	General warning symbol.
	Hot surface.
	Electric hazard.
	Toxic hazard.
	Explosion hazard.
	Important or useful information related to installing, maintaining or operating the device.
	Read the user manual before doing a procedure or operating the device.
	Wear protective gloves.

Symbol	Description
	Wear protective glasses.
	Wear protective overalls.
	Wear a welding mask.
	Wear respiratory protection.
CE	CE marking indicates that the device has been designed and manufactured to meet all applicable health, safety and environmental protection standards required for products sold in the European Union.
	Electronic devices that are marked with this symbol must not be disposed of with general waste. If a defective or broken-down device cannot be repaired, it must be recycled and disposed of in accordance with WEEE directive (2012/19/EU) or other applicable local regulations.
	This symbol indicates waste material that must be recycled.

1.2 Abbreviations

Abbreviation	Explanation
ID	Inside diameter
IEU	Inductive electrification unit
MB	Modbus
MEC	Minimum explosible concentration
OD	Outside diameter
RF	Radio frequency
RH	Relative humidity
SNT	Sintrol Network
SSR	Solid-state relay
TSP	Total suspended particles

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2 Safety

Read this chapter carefully before handling the device in any way.

In addition, read all safety notes before work steps and other instructions.

Only trained and qualified personnel can install, commission, operate and perform maintenance on the device. All personnel must read and understand this manual and follow its instructions accurately. Failure to follow the safety instructions and safety precautions can result in serious injury or death.

If you encounter any unexpected situations during the intended use of the device that are not described in this manual, contact the manufacturer or an authorized distributor.

In addition to the safety instructions described in this manual, the personnel using the device must follow all applicable country- and industry-specific safety standards and regulations.

2.1 Warnings

DANGER!

"DANGER" indicates a hazard with a high level of risk, which will result in death or serious injury if not avoided.

WARNING!

"WARNING" indicates a hazard with a medium level of risk, which can result in death or serious injury if not avoided.

CAUTION!

"CAUTION" indicates a hazard with a low level of risk, which can result in minor or moderate injury if not avoided.

NOTICE

"NOTICE" indicates a situation with a risk of equipment damage.

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2.2 Intended use

This device is designed for continuous measuring of total suspended particles (TSP) in ambient air. The intended use is as described in this user manual. Any other use is considered improper and can result in injury or equipment damage.

The manufacturer or distributor cannot be held liable for any damage, injury or financial loss resulting from improper use.

The device must not be modified or repaired in any way that is not specifically described in this manual. Do not perform any mechanical or electrical repairs without contacting the manufacturer or an authorized distributor. Only original Sintrol parts can be used for repairs. If third-party spare parts are used, the manufacturer cannot guarantee safe operation of the device.

Before installing and commissioning the device, carefully inspect it for any damage or defects. Do not use the device if it is damaged, or if the power supply is defective. Return damaged device to the manufacturer or an authorized distributor.

Non-compliance with any of these conditions immediately voids the warranty, and the manufacturer's responsibility no longer applies.

Wear appropriate protective gloves at all times when installing the device.

DANGER!

Explosion hazard

The device is not UL/CSA or IECEx/ATEX certified. Do not use the device in potentially explosive atmospheres.

WARNING!

Use in critical applications

Improper use in critical applications can lead to hazardous situations or have severe adverse health effects. Such critical applications include, but are not limited to:

- **Health protection**
- **Emission monitoring**
- **Process control**
- **Fire and explosion prevention**

Many factors can affect the operation of the dust monitoring system. These factors can include, for example, dust particle size, dust material, and operator error. Because of this, an industry specialist must evaluate and approve the suitability of Sintrol products for any given dust monitoring system. This is particularly true when the instruments are only a component in a larger monitoring system, or when they are used in critical applications.

2.3 Use in potentially explosive atmospheres

DANGER!
Explosion hazard **The device is not UL/CSA or IECEx/ATEX certified. Do not use the device in potentially explosive atmospheres.**

An ATEX-certified model of the device is available. Only ATEX-certified models can be used in potentially explosive atmospheres.

If you have ordered ATEX-certified device, read the supplementary ATEX safety instructions carefully before installing, commissioning, operating or performing maintenance on the device.

2.4 Conformity to standards and directives

This device has been designed and manufactured to comply with the requirements of ISO 9001:2015 standard related to quality management. See **Appendix A** for ISO 9001 certificate.

This device has been designed and manufactured to comply with the following standards and directives:

- EN 61326-1:2012
- UL 61010-1, 3rd edition, 19 July 2019
- CSA 22.2 NO 61010-1, 3rd edition, 2017
- ROHS Directive 2011/65/EU (RoHS II)

3 Product overview

3.1 Product description

This device is designed for continuous measuring of total suspended particles (TSP) in ambient air. It is an ideal solution for industrial applications where a disruption in normal operations can result in an increase in dust particle concentration in ambient air, which can cause further equipment malfunction or even pose a risk to worker health.

The operating principle is based on inductive electrification technology, where particles interacting with an isolated probe induce a signal that is transmitted to the monitoring system. The normal dust level is determined during commissioning, and the signal generated by the sensor is then scaled in proportion to this baseline level when the dust level fluctuates.

The device is intended for use in non-condensing environments. The sensor does not distinguish liquid droplets from dust particles. If the measured airflow contains liquid droplets, the measurement results are inaccurate.

The device has a local user interface with six keys and a 7-segment display with four digits for indicating measurement results and device status.

For detailed technical data, see chapter **Specifications**.

3.1.1 Key properties

Table 1: Key properties of a standard device

Enclosure:	Aluminum and stainless steel (316L)
Probe material:	Stainless steel (316L)
Insulation material:	Teflon
Output signal:	• 4 ... 20 mA • 2 × Independent solid-state relays
Communication protocol:	• Modbus RTU • Sintrol network
Ambient temperature	−40 ... 60 °C (−40 ... 140 °F)

3.1.2 Commissioning

Commissioning is easy with Auto Setup feature, which determines the baseline dust level and sets up two alarm thresholds that are proportional to the baseline. An alarm is triggered when the dust concentration exceeds a configured threshold.

3.1.3 Installation

The device is installed by simply securing it to the installation location with four screws through the built-in mounting feet. Mounting feet are suitable for standard wall, ceiling and tabletop installations.

Optionally, a mounting arm or mounting bracket is available for installing the device in alternative angles and orientations.

3.1.4 Settings and parameters

You can access and change the device settings and parameters with the local display that has six keys and a 7-segment display with four digits. Additionally, you can connect the device to a computer using USB, RS-485 bus or an optional radio frequency (RF) communication, and change the parameters using complementary DustTool software. You can download DustTool free of charge at https://sintrol.com/product/dusttool/.

3.2 Design drawings
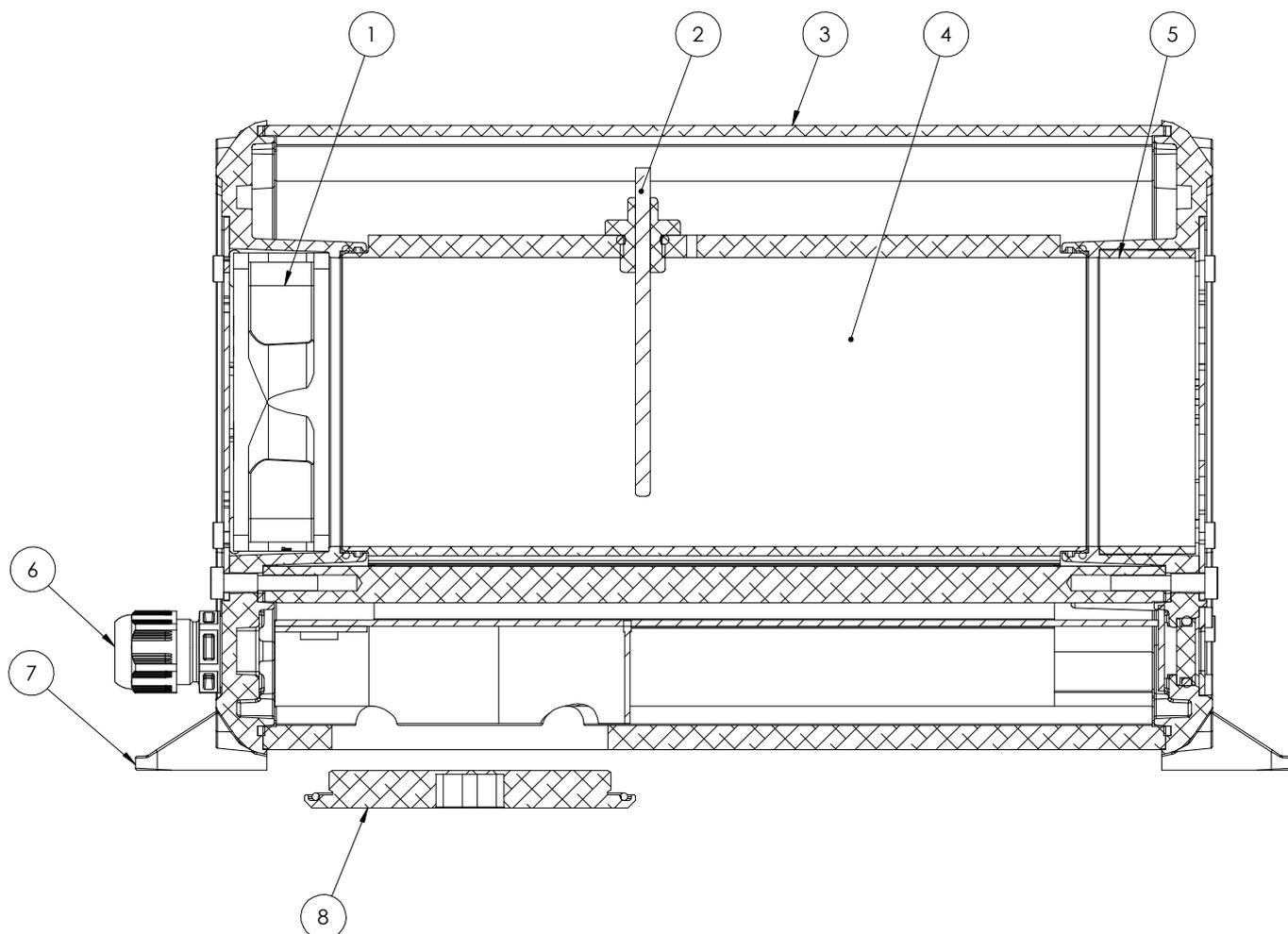
Figure 1: Side view of the dust monitor

①	Fan	⑤	Internal flow chamber extension
②	Sensor probe	⑥	M16 cable glands
③	Aluminum enclosure	⑦	Mounting feet
④	Internal flow chamber	⑧	Terminal cover
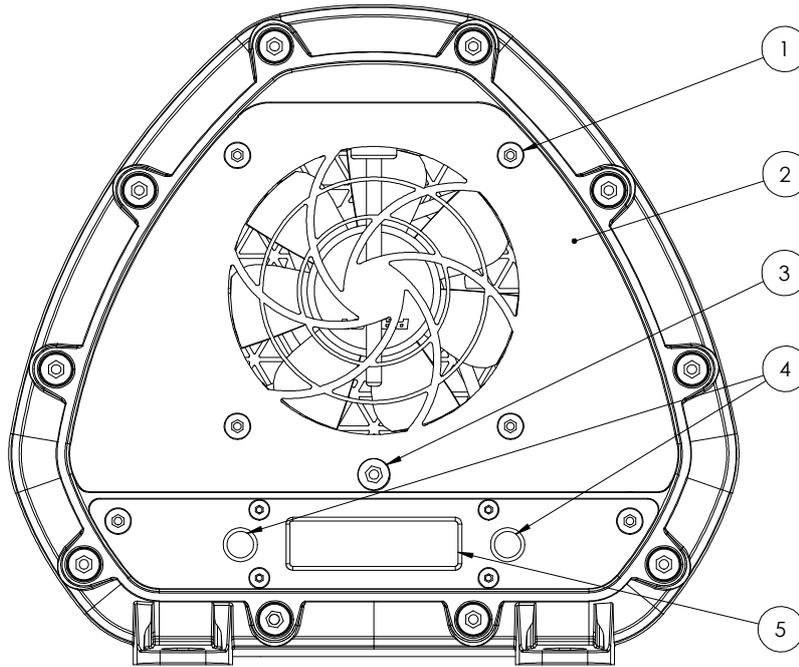
Figure 2: Front view of the dust monitor

①	Bolt, hex 4 mm	④	Status LEDs / magnetic switches
②	Front plate	⑤	7-segment display
③	Bolt, hex 5 mm		
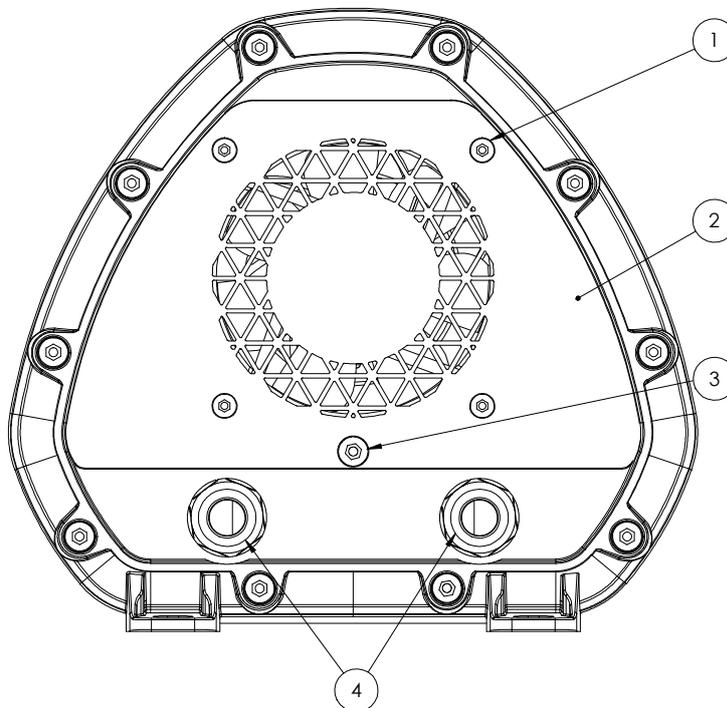
Figure 3: Rear view of the dust monitor

①	Bolt, hex 4 mm	③	Bolt, hex 5 mm
②	Rear plate	④	M16 cable glands

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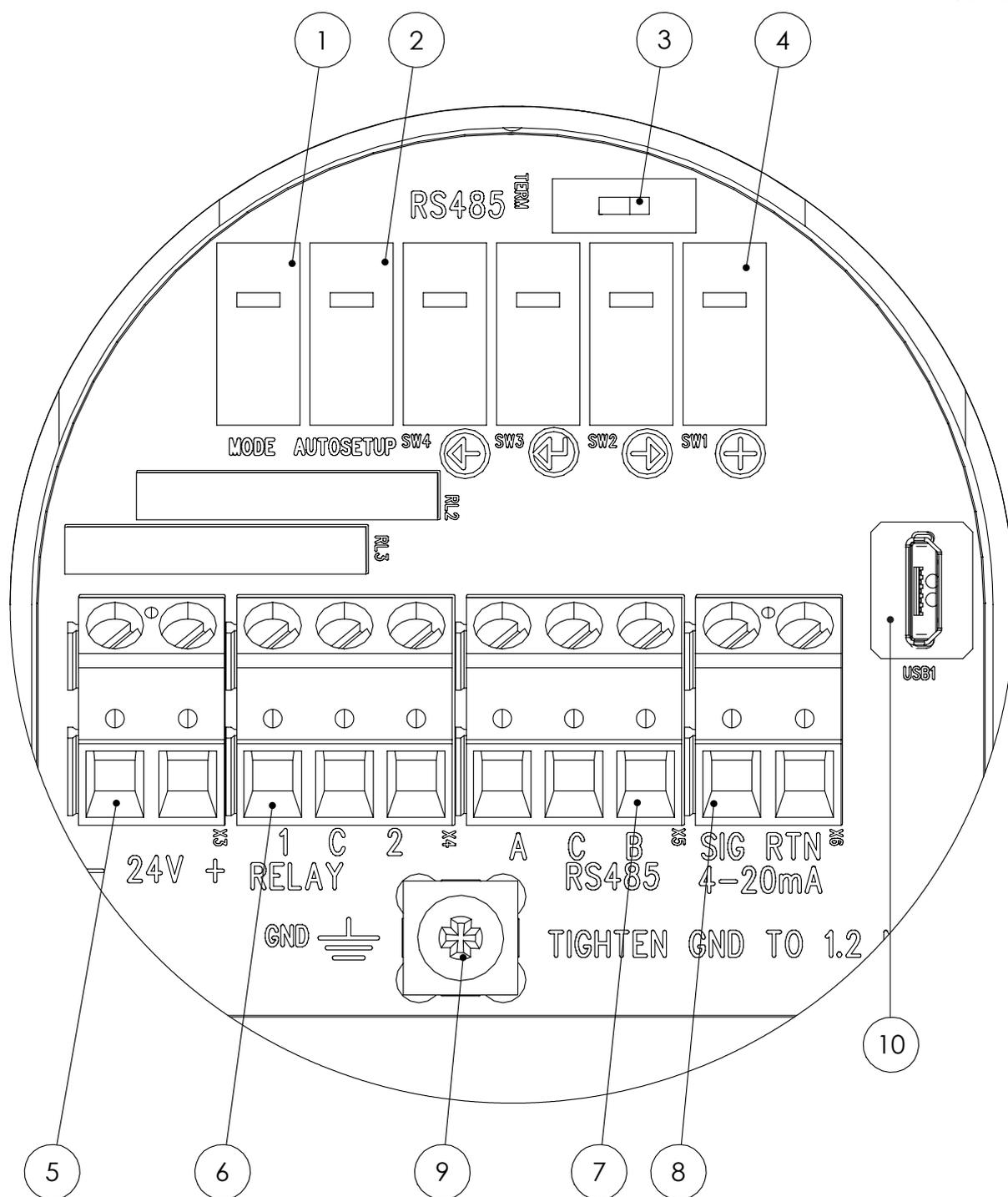
Figure 4: Electrical connections on the main board

①	Mode selector key	⑥	Solid-state relay terminal
②	AUTOSETUP key	⑦	RS-485 bus
③	RS-485 terminator switch	⑧	Analog mA output
④	Navigation keys	⑨	Ground connection
⑤	24 V DC power supply terminal	⑩	Micro-B USB port

3.2.1 Dimension drawings

Dust monitor side view

313.50 mm [123.43 in]

265.00 mm [10.43 in]

290.00 mm [11.42 in]
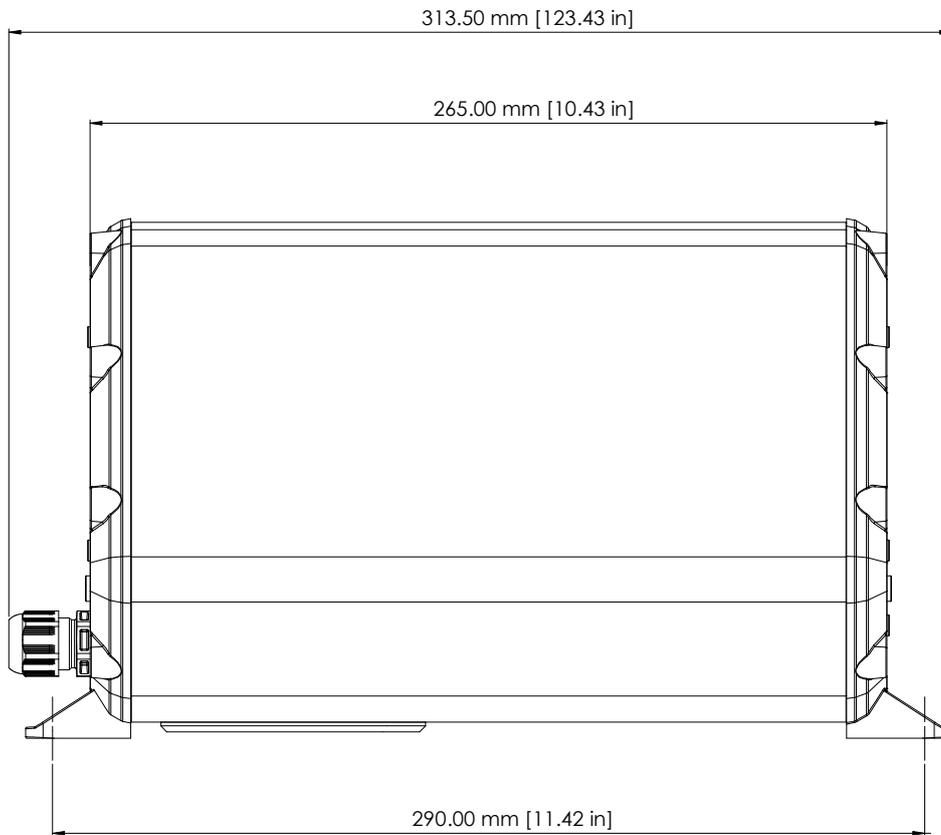
Figure 5: Side view dimensions of the enclosure

Dust monitor front view

174.00 [6.85 in]

100.00 [3.94 in]

191.00 [7.52 in]
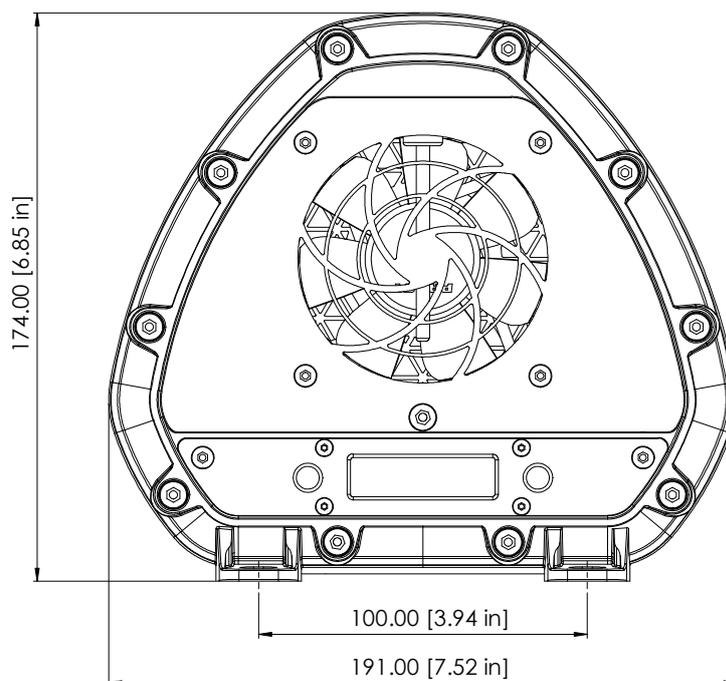
Figure 6: Front view dimensions of the enclosure

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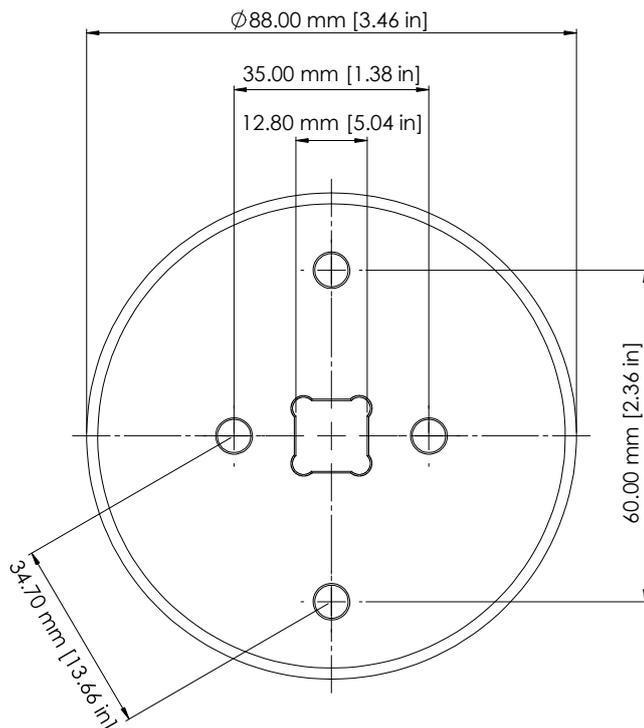
Terminal cover

Figure 7: Terminal cover dimensions

Mounting bracket
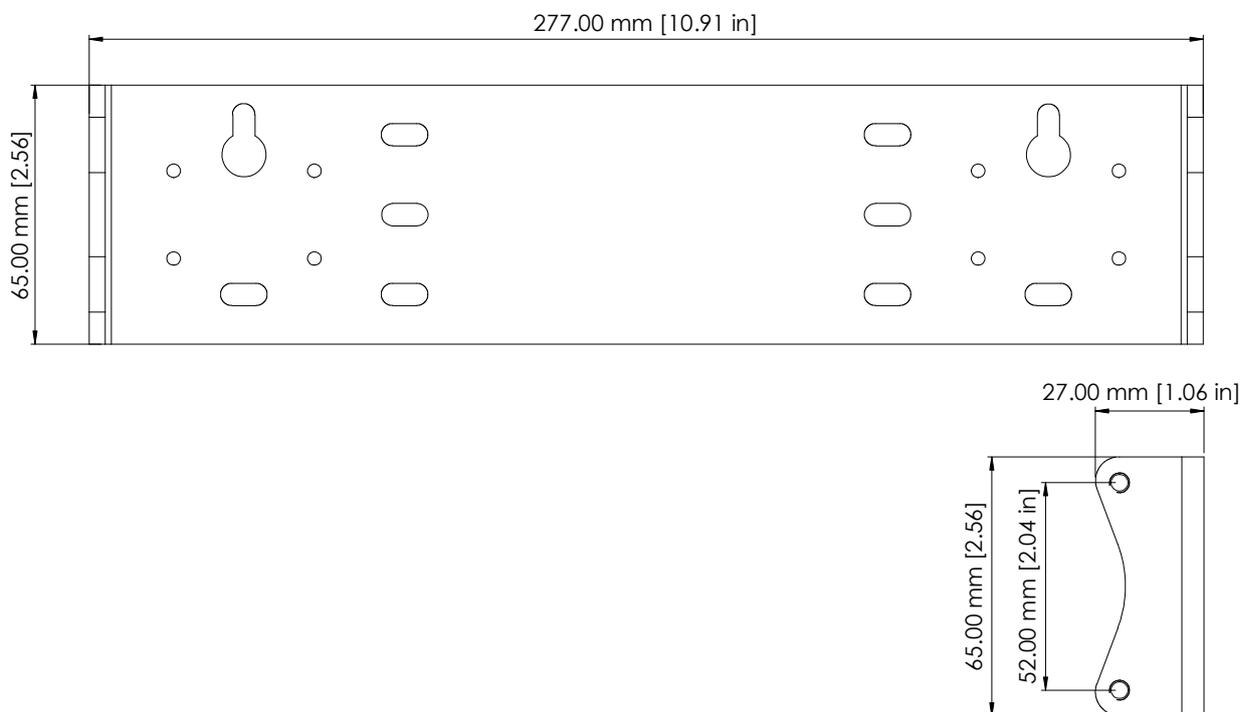
Figure 8: Mounting bracket dimensions

> **Mounting bracket is attached to the device using the 5mm hex bolts on the outer edge of the device enclosure. This enabled the device to be installed in various orientations.**

Mounting arm

![Figure 9: Mounting arm dimensions showing 256.00 mm [10.08 in] length and 32.00 mm [1.26 in] dimensions]
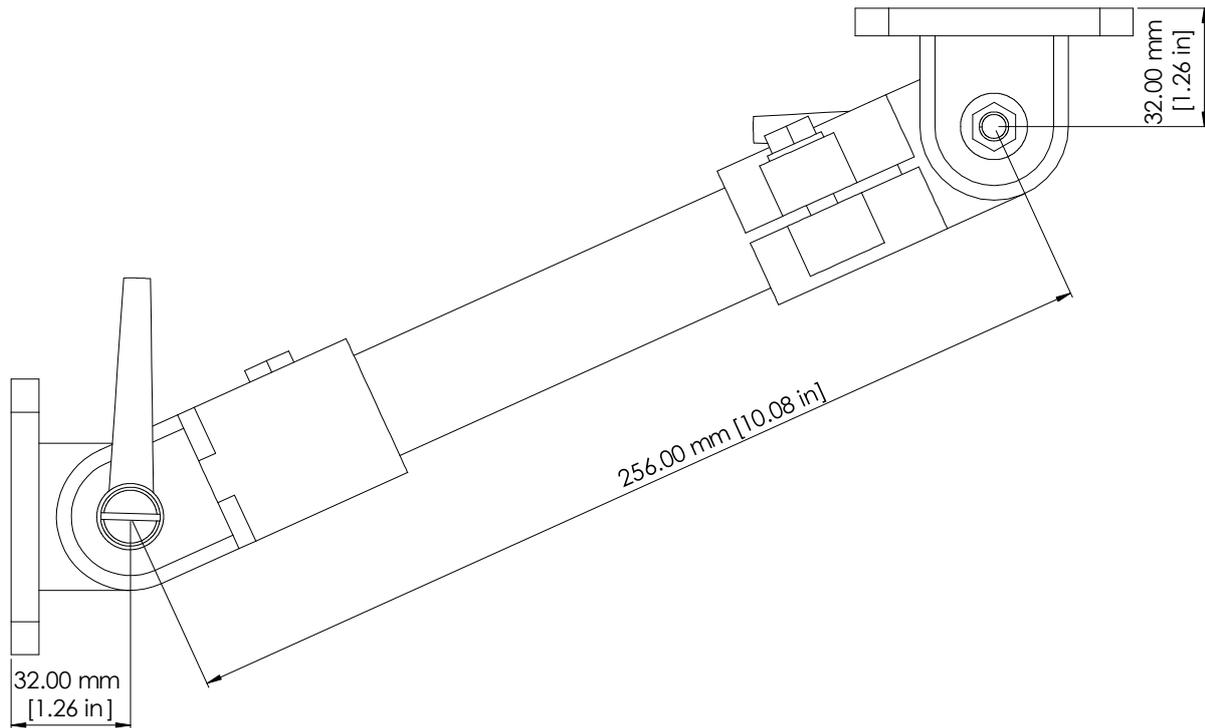
Figure 9: Mounting arm dimensions

3.2.2 Identification

Identification label is located on the bottom of the device.

![Figure 10: Identification label with callouts 1-7 pointing to different parts of the SINTROL DumoPro P700-678-790 label]
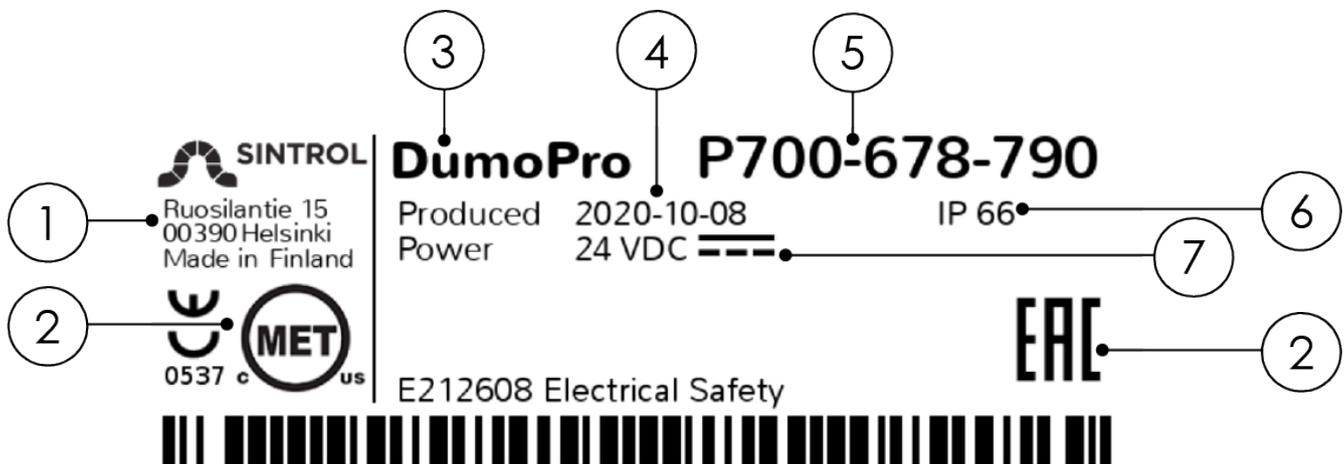
Figure 10: Identification label

①	Manufacturer details	⑤	Serial number
②	Approvals	⑥	IP rating
③	Device model	⑦	Power supply specifications
④	Production date		

3.3 Scope of delivery

A standard delivery includes one DumoPro ambient dust monitor and this user manual.
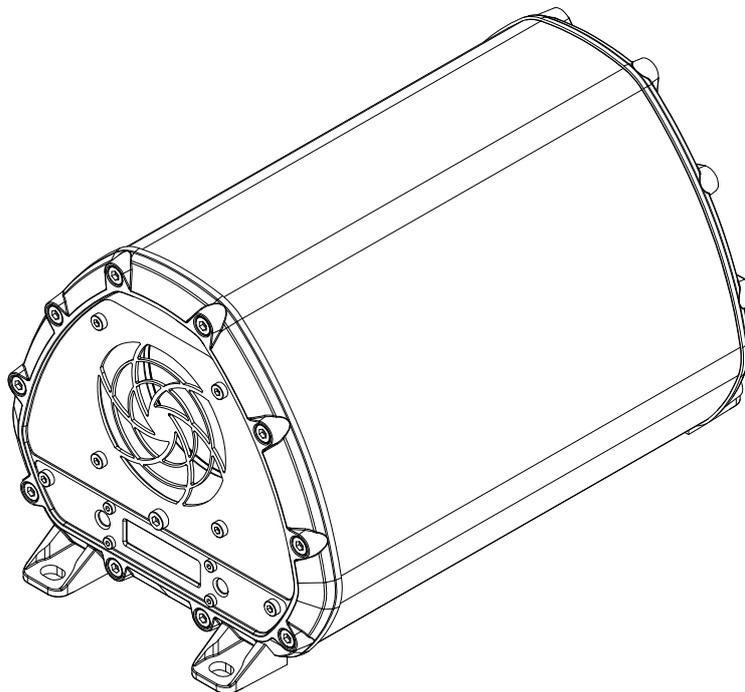
Figure 11: Standard delivery

3.4 Features and accessories

3.4.1 Standard features

A standard delivery includes the following features:

Table 2: Overview of standard features of DumoPro dust monitor

Feature	✓=Standard O=Optional
Rugged IP66-rated pressure-casted aluminum enclosure	✓
Bicolor (green and red) LEDs for status indication*	✓
Auto Setup function for easy commissioning	✓
Mode selector key with user-selectable FAST, MEDIUM and SLOW response modes	✓
Two independent solid-state relays to indicate dust alert and dust alarm	✓
USB interface	✓
DustTool software for easy calibration and setup	✓
RS-485 bus for integration into existing control systems using Modbus RTU, and for connecting multiple devices in parallel using Modbus RTU or Sintrol Network protocol	✓
Main interface with six keys and a 7-segment display with four digits for local measurement result and status indication	✓
Active and isolated 4 … 20 mA output in accordance with NAMUR NE43	✓

Feature	✓=Standard ○=Optional
Zero/span check with automatic drift compensation	✓
Possibility to program the display to show dust concentrations in mg/m^3	✓
Magnetic switches for easy Auto Setup and mode selection	○
Wireless network capability to reduce cabling costs**	○

* When green and red LEDs are ON at the same time, the color appears yellow or orange
** Requires radio frequency (RF) model. RF antenna cannot be retrofitted to non-RF models.

3.4.2 Optional features and accessories

The device can be customized to meet the specific requirements for various applications and process conditions.

Mounting bracket

The device can be installed in multiple angles and orientations with an optional mounting bracket that is attached to the device with screws located on the edges of the device enclosure. The bracket allows the device to be installed directly on a wall. Furthermore, the mounting bracket can be ordered with DIN rail holders.

The mounting bracket allows for more flexible installation configurations than the standard built-in mounting feet. For example, with the mounting bracket it is possible to mount the device on a ceiling so that the display is still in the correct orientation.
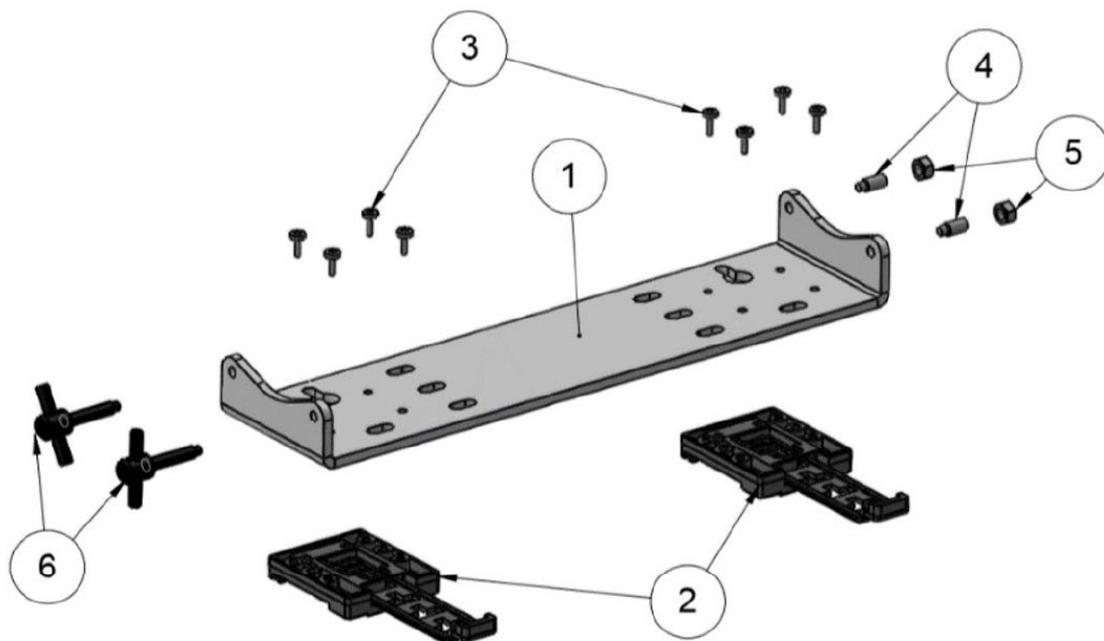
Figure 12: Mounting bracket

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①	Mounting bracket	④	2× Set screws, Dog Point M5
②	2× DIN rail holders (optional)	⑤	2× Hex nuts M5
③	8× Screws, ISO 7045 M3 (optional)	⑥	2× WDS Tommy Bar Screws

Mounting arm

Part number: MC901167

The flexible mounting arm allows the device to be installed in various angles and orientations. It also makes repositioning the device easy and leaves the terminal cover exposed, so it is possible to access the main board and make configuration changes locally.
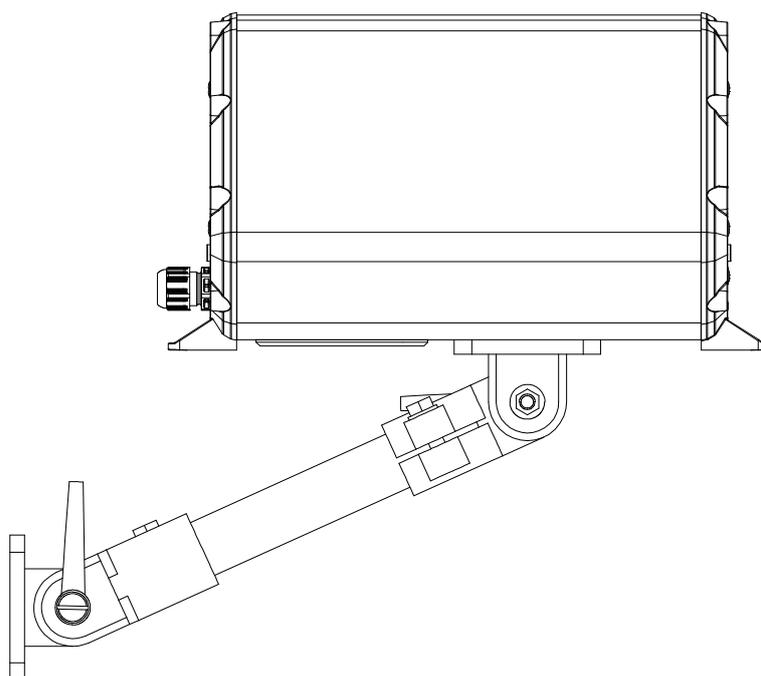
Figure 13: Mounting arm

The arm has two adjustable joints that can also be rotated around their center axis. The device enclosure has built-in holes on the bottom side, where the mounting arm can be attached in 90° steps.

Probe coating

The sensor probe can be equipped with a protective Teflon coating that is suitable for wet conditions in non-hazardous areas.

Magnetic switch

If magnetic switches are enabled on your device, you can use a magnetic key to initiate Auto Setup procedure or change the response mode of the device without having to access the main board.

Wireless communication

A standard device communicates with a monitoring system or PC with signals that are transmitted through physical wires. The device can be equipped with a radio frequency (RF) antenna to enable wireless communication.

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The device must be ordered with RF capability. Non-RF models cannot be retrofitted with the RF antenna after delivery.

Accessories

The device can be ordered with the following optional accessories:

RS-485 to USB converter for connecting the device to a computer using Sintrol Network protocol.

Part number: EC900041

Network Router for setting up device chains and networks.

Part number: PC900091

Wireless Router for setting up wireless device networks.

Part number: PC900090

DustLog 10 reporting software for additional data logging and reporting options.
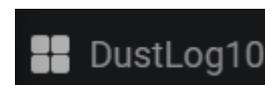
3.5 Operating principle

The device is designed for continuous measuring of total suspended particles (TSP) in ambient air. The instrument has a built-in fan that draws a constant flow of dust particles through the internal flow chamber. Dust particles flowing through the chamber interact with the internal sensor probe. This induces a signal, which is then transferred to a monitoring system, for example a computer running a monitoring software. The underlying technology is called "inductive electrification". This technology is

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very sensitive, and it minimizes the influence that sensor contamination, changes in process temperature and flow velocity have on the measurement results.

Inductive electrification technology enables a detection limit of as low as 0.01 mg/m^3.

3.5.1 Inductive Electrification Unit

The signal level generated by the device is measured in Inductive Electrification Units (IEU), and the IEU value is converted to mA output signal that the device uses to communicate the dust level to the monitoring system. The IEU value can be anything from a few hundred up to several million units, which allows the relation between the IEU value and mA signal to be set very accurately.

The relation between the IEU value and mA output signal is established automatically with the Auto Setup function. It is also possible to display the measurement results in mg/m^3. However, in this case the IEU value and output signal must be calibrated against a reference, for example the results of gravimetric analysis.

3.5.2 Potential influences on measurement results

With the inductive electrification technology, the signal level shows the following behavior over the measuring range:

- **Linear range**: Signal level increases linearly from the detection limit 0.01 mg/m^3 to several hundred mg/m^3.
- **Nonlinear range**: From linear range up to several g/m^3.
- **Saturation**: After non-linear range. The signal level reaches saturation and no longer increases.
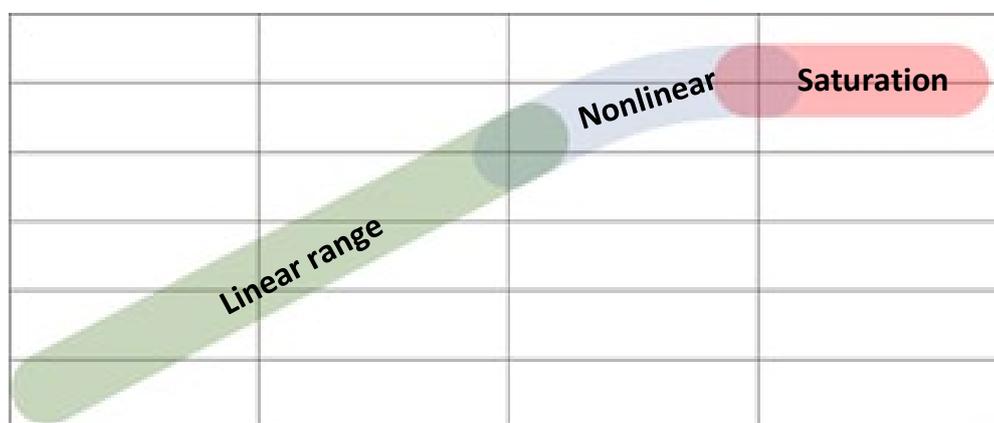
Figure 14: Uncalibrated measuring behavior

Many factors can affect the measuring range and behavior of the device. These factors include dust material, particle size, flow velocity and installation environment.

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(!) **If it is necessary to measure concentrations that are higher than 200 mg/m^3 and having linear behavior is critical, it is recommended to perform reference measurement at the desired concentration and to add additional calibration points using DustTool software.**

Particle material

Different materials can have different amounts of electrostatic charge. This means that the signals transmitted by dust particles can vary significantly from one material to another:

- Metals (inorganic, electroconductive) generate the lowest signals.
- Cement and minerals (inorganic, dielectric) generate average signals.
- Wood and flour (organic, dielectric) generate the highest signals.

As a result, different types of dust generate a different output signal at the same concentration.

(!) **Certain heavy metal dusts generate extremely low signals. For measuring such dusts, the device must be tested with a dust sample before delivery.**

Common dust particle materials include:

- Grains
- Sugar
- Coal
- Cosmetics
- Dyes

- Ceramics
- Textiles
- Wood and paper
- Soap
- Metals and metal oxides

- Minerals
- Ores
- Cement
- Plastics
- Chemicals

Particle size

The minimum particle size that the device can detect is 0.3 μm. The optimal detection range is from 1 to 200 μm.

Relative humidity

The device is intended for use in non-condensing environments in both indoor and outdoor applications.

The relative humidity (RH) has an insignificant effect on the measurement results. However, the sensor does not distinguish liquid droplets from dust particles. This means that the measured airflow must not contain condensation. If the measured airflow contains condensed liquid droplets, it is possible that the device does not produce output signal at all, or the output signal can be too high.

Ambient temperature

Ambient temperature only has a very minor effect on the output signal.
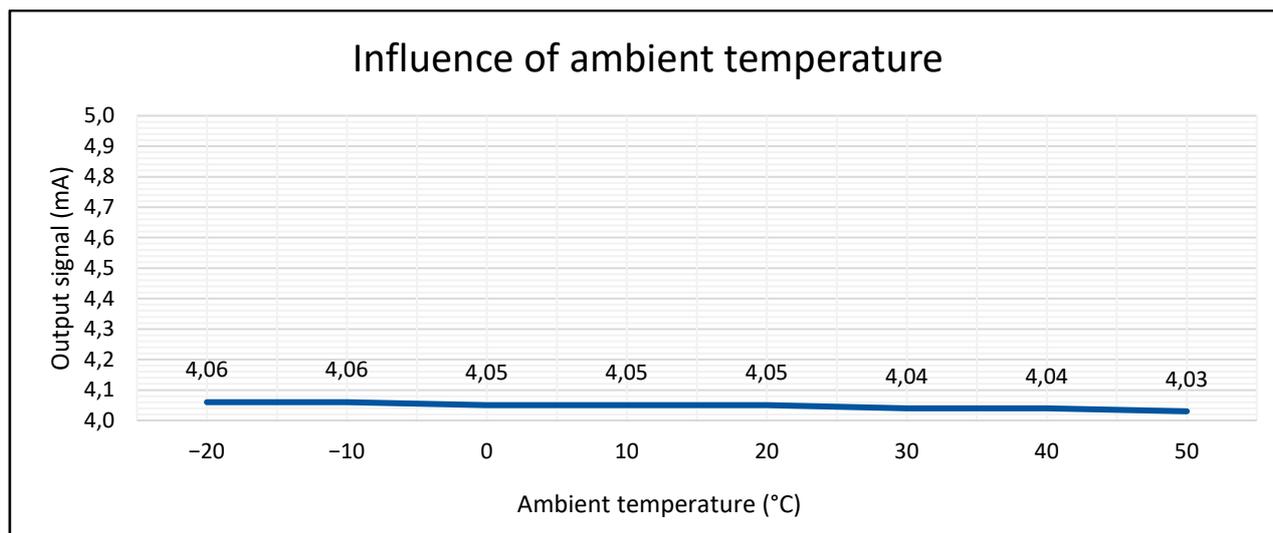
Figure 15: Influence of ambient temperature on the output signal

Flow velocity

The built-in fan draws dust particles through the internal flow chamber at a constant flow velocity. The device monitors the fan performance to ensure that the flow velocity remains stable.

If the surrounding airflow at the installation location is >5 m/s, it can affect the internal flow velocity of the device. This can decrease the accuracy of the measurement results.

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4 Storage

When storing the device:

- Select a dry, dust-free location.
- Store the device in its original packaging.
- Do not place any heavy objects on the device.
- Storage temperature must be within range −40 ... 60 °C (−40 ... 140 °F).

Retain the original packaging in case the device is ever transported or returned. For instructions on how to return a damaged or defective device for repair or replacement, see section **Returns** in chapter **Maintenance and inspection**.

5 Mechanical installation

Read chapter "Safety" carefully before installing the device.

5.1 Unpacking and inspection

5.1.1 Unpacking

NOTICE
Improper handling during unpacking can damage the equipment.

When unpacking the device:

- If you use a knife or scissors to open the package, be careful not to damage the device or its parts.
- Handle the device and its components with care when taking them out of the package.
- Do not drop the device or subject it to blows.

5.1.2 Inspection

After unpacking the device:

- Check that the device and all its standard and optional parts are included in the delivery.
- Inspect the device and its individual parts for any defects, or damage that may have occurred during delivery.

For instructions on how to return a damaged or defective device for repair or replacement, see section **Returns** in chapter **Maintenance and inspection**.

5.2 Selecting installation location

Any information given in this user manual regarding the installation location or suitability for a specific application does not replace careful functionality checks and necessary approvals from an industry specialist.

Do not install the device close to large motors, cables carrying high voltages, or other potential sources of interference. These can distort the measurement results.

5.2.1 Ambient environment

NOTICE

If there are any structures that radiate heat near the device, you must insulate the heat source. Very high temperatures will damage the device.

To minimize the effect that the environment has on the measurement results, install the device in a suitable location. Table 3 shows the suitable ambient conditions for the device.

Table 3: Ambient conditions of the installation location

Ambient temperature:	−40 ... 60 °C (−40 ... 140 °F)
Relative humidity:	Max. 95 % RH (non-condensing)

The device is intended for use in non-condensing environments. The sensor does not distinguish liquid droplets from dust particles. If the measured airflow contains liquid droplets, the measurement results are inaccurate.

If the device is installed in a location with occasional condensation, it is recommended to install the device in an upward position with the terminal cover and tip of the internal sensor probe pointing down. This helps prevent liquid from accumulating on the insulation.

5.2.2 Location

In ambient air, large airborne particles generally gather and settle close to the ground. Additionally, large particles represent most of the mass and volume of airborne particles. Because the device measures total suspended particles, it shows higher particle concentration close to the ground as compared to a higher installation location.

Select an installation location with a representative sample of dust particles as follows:

- To monitor specific machinery or area for possible dust emissions, install the device as close to the suspected dust source as possible.
- To monitor how much people in the working area are exposed to dust, install the device at an elevation that corresponds to the height at which an average person is breathing in the dust (Figure 16).

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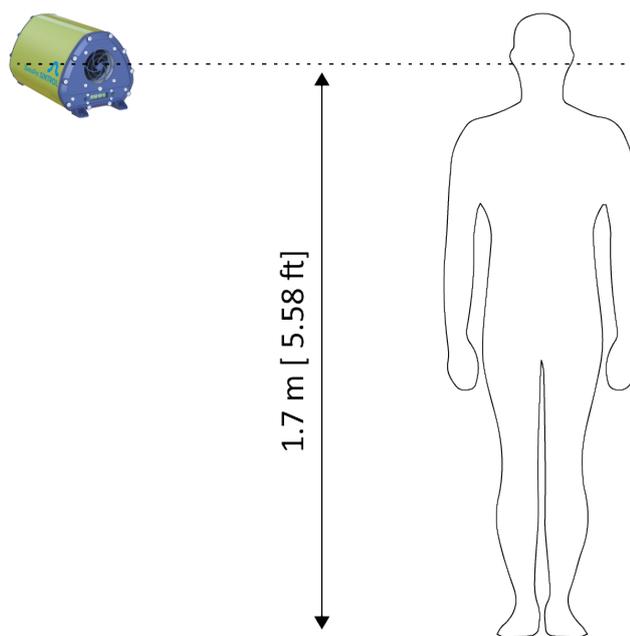
Figure 16: Installation height to monitor occupational dust exposure

For dust to reach the internal flow chamber of the device, an air current must carry it towards the device. The built-in fan pulls dust inside the flow chamber only once the dust is very close to the device. Figure 17 shows an incorrect installation location in relation to airflow direction, where the air current carries the dust particles away from the device.
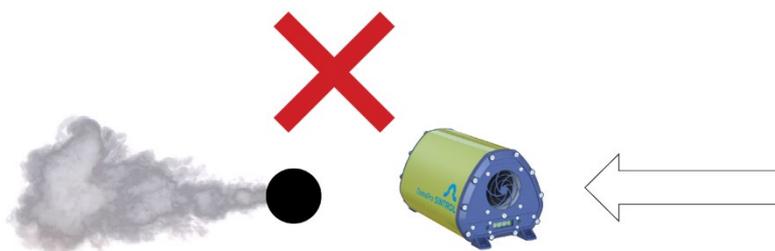
Figure 17: Incorrect installation location in relation to airflow direction

Figure 18 shows a correct installation location in relation to airflow direction, where the air current carries the dust particles towards the device.
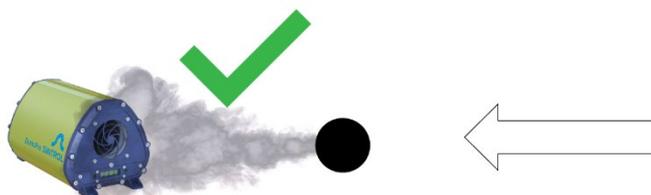
Figure 18: Correct installation location in relation to airflow direction

The built-in fan will only start to pull dust particles towards the internal flow chamber when the distance to the device is under 1 cm (0.39 in).

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5.2.3 Distance and grid layout

To accurately monitor the ambient dust concentration in a space, several devices must be arranged in a grid within an appropriate distance of the dust source.

Distance

The further away from the dust source the device is, the more diluted the dust concentration will be when the dust reaches the device.

> ### DANGER!
>
> **If the device is installed too far away from the dust source, the dust concentration at the source can reach minimum explosible concentration (MEC) even if the device indicates a dust concentration that is below the alarm limits. An explosion can result in a serious injury or death. If the device is part of an explosion preventing system, install the device sufficiently close to the dust source.**

The movement speed of a dust cloud slows down the further it gets from the source. This means that a longer distance between the dust source and measurement point also increases the time it takes for the device to react to an increase in ambient dust concentration.

Grid layout

To accurately capture the dust concentration in different locations in a space, multiple devices must be installed in a square grid layout (Figure 19).
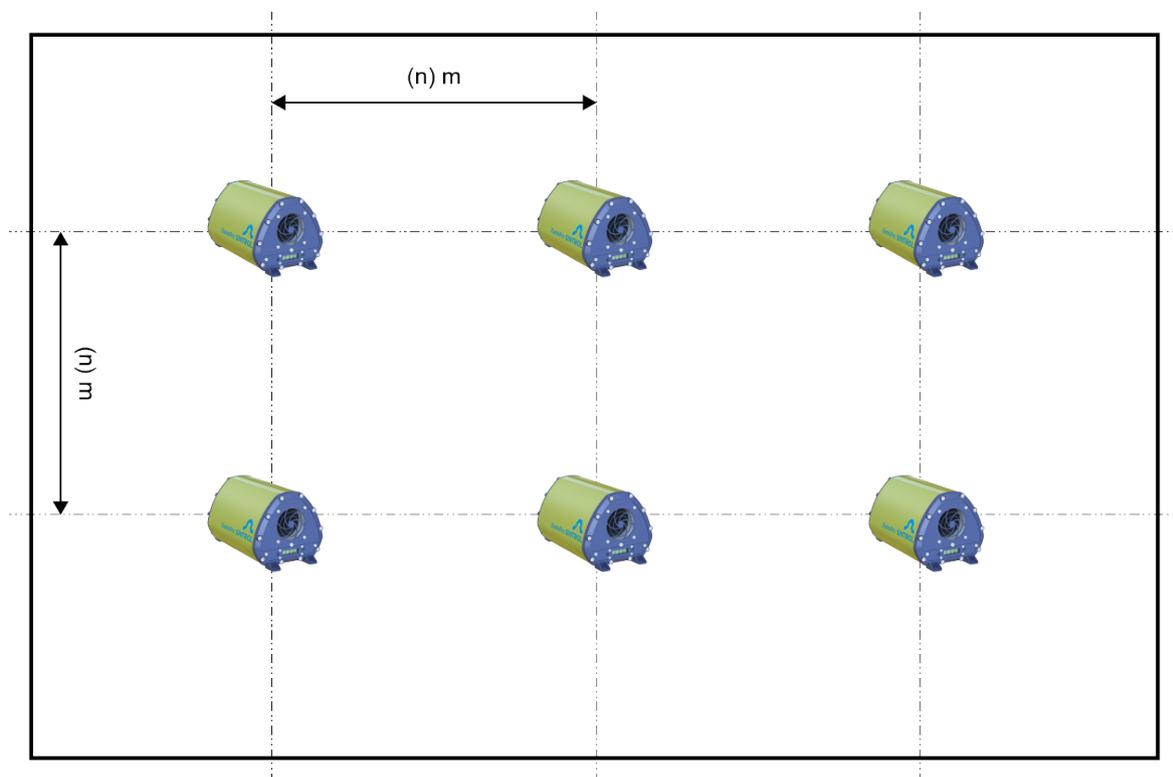
Figure 19: Installation grid

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- In non-critical installations where the dust is evenly distributed and has time to spread without reaching critical concentrations, we recommend a square side length of 20 m (65.6 ft).
- In critical installations that are used in applications related to worker health or explosion prevention, the grid should be narrower.

5.2.4 Orientation in wireless communication

If multiple devices are connected using a wireless RF connection, make sure that the devices are oriented the same way with RF antennas pointing in the same direction. This helps prevent polarization losses in the wireless communication.

5.3 Installing dust monitor

5.3.1 Safety precautions

WARNING!
Risk of burns due to hot components
When installing or removing equipment, the device or the installation surface can be hot.
Wear appropriate heat-resistant gloves and follow all applicable local and plant-specific safety codes before proceeding.

WARNING!
When installing the device, be aware of potential hazards related to the installation location, for example when installing the device in tight spaces or near running machinery. Make sure that there is room in the installation location for safe working.

NOTICE
Subjecting the device to any blows can damage it. Make sure that there is enough room in the installation location to fit the entire device and any mounting hardware, and do not subject the device to blows during installation or operation.

5.3.2 Installation

For mechanical installation, you need:

- An electric drill and suitable drill bit for the surface you intend to install the device on
- A tool for fastening screws
- Marker
- 4× fasteners, max. M6
- 4× wall anchors

![SINTROL logo]

When installing the device using built-in mounting feet, the main board becomes inaccessible. Make all necessary electrical connections before installing the device mechanically.

To install the device:

1. Position the device on the surface you want to install it on.
2. Mark the position of the mounting feet on the surface with a marker and remove the device from the installation area.
3. Drill holes on the installation surface on the spots you marked in the previous step. Use a drill bit that is suitable for the material that the installation surface is made of and that corresponds to the screw thread you are using.

NOTICE

Do not drill the holes on the installation surface through the mounting feet. Doing so can damage the mounting feet or the device enclosure.

4. Insert a wall anchor into each hole on the installation surface.
5. Position the device on the installation surface so that the holes align with the mounting feet.
6. Secure the device in place by tightening a fastener into each wall anchor through the mounting feet.
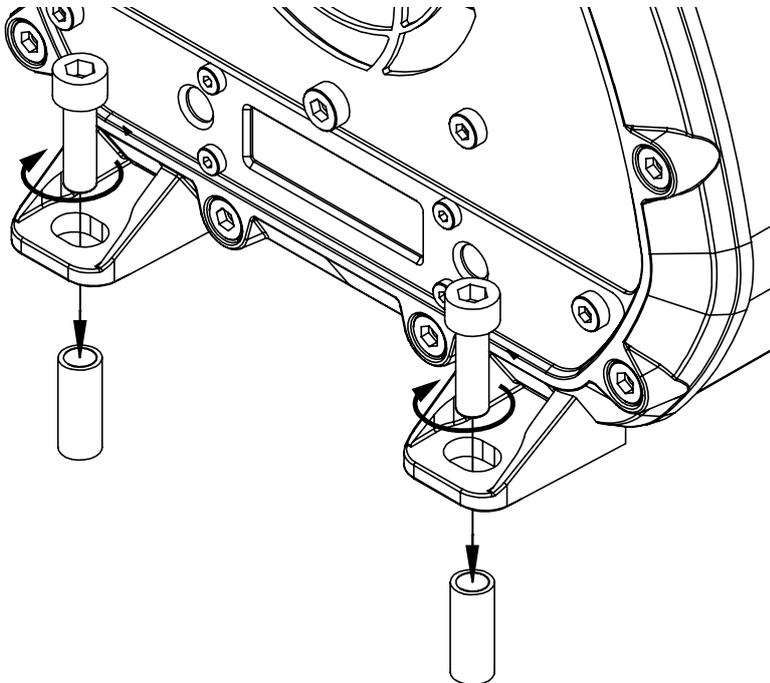
If you use screws that have a small head, place a washer between each screw and mounting foot.

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6 Electrical installation

Read chapter "Safety" carefully before making any electrical connections to the device.

6.1 Electrical safety

Wear protective glasses when making electrical connections on the device.

WARNING!
Electric shock hazard
Faulty electrical installations, too high line voltage or incorrect operation of the device can result in an electric shock. Only trained and qualified personnel can install, commission, operate and perform maintenance on the device.

To ensure safe installation of electrical connections:

- Power down the device when you are making electrical connections, when you intend to perform maintenance on it, or in the event of malfunction.
- Connect the device to line voltage only if the power supply specifications correspond to the data on the identification label of the device.
- Make sure that all equipment is properly grounded.
- Stand on an insulating pad and check components only with one hand.
- Never work alone on electrical connections.

When connecting cables, give them enough extra length. This allows the device to be removed from the mechanical installation for inspection and maintenance without disconnecting the cables.

Cables must be installed in accordance with all applicable local safety codes.

6.2 Cable types

Make sure that the cables are suitable for the environment and industrial application where the device is used. The cables must meet and be installed according to all applicable local safety standards.

When choosing cables, consider the following:

- Use a shielded cable if possible. Connect the cable shield to ground on one end only.
- Minimum required conductor size is 0.3 mm^2 or 22 AWG.
- The cables must withstand up to 75 °C (167 °F) continuous temperature.

The device uses screw-type wire-to-board terminal blocks for electrical connections. See Table 4 in section **Terminal blocks** for specifications.

Revision 4

6.3 Electrical connections

6.3.1 Main board
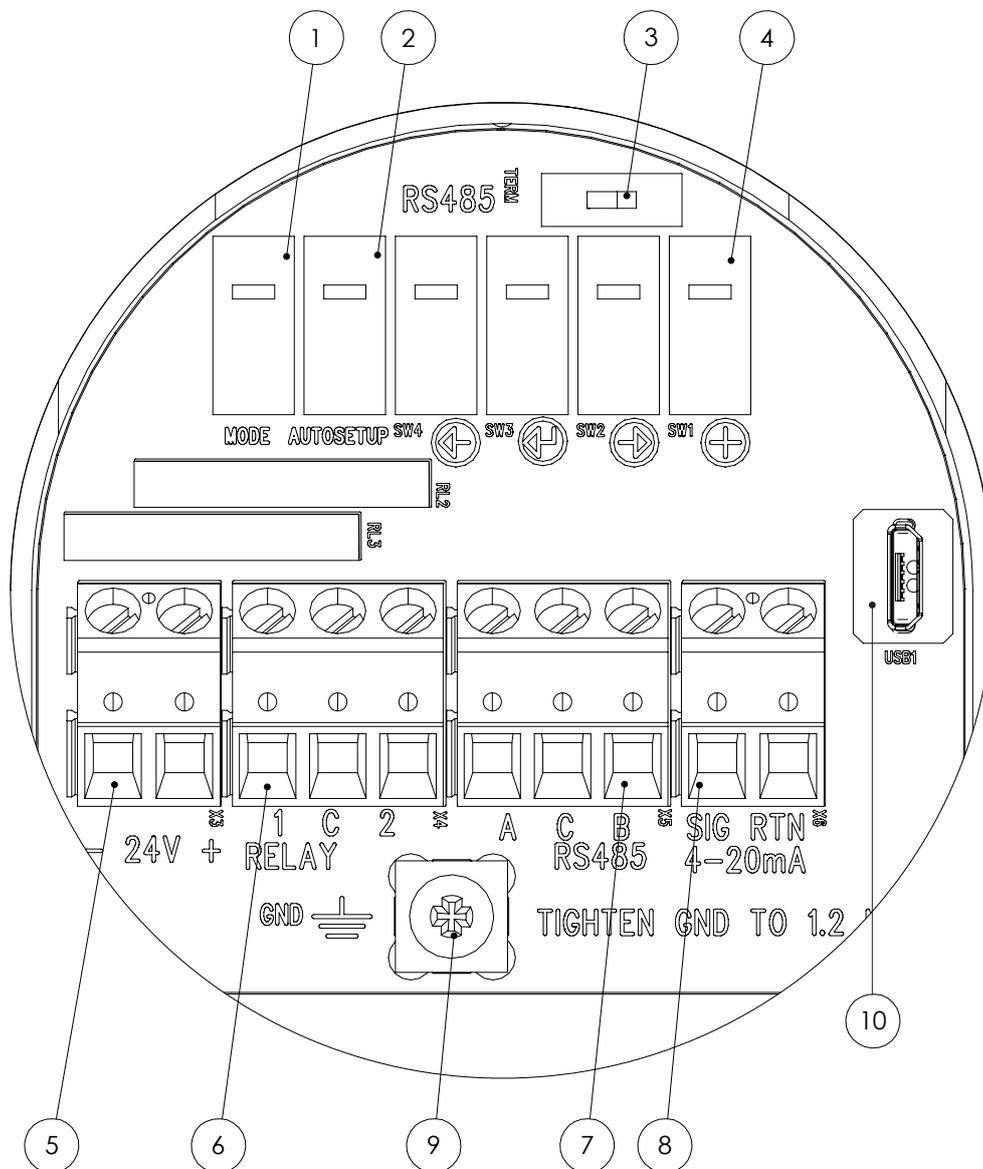
Figure 20: Main board and electrical connections of the dust monitor

①	Mode selector key	⑥	Solid-state relay terminal
②	AUTOSETUP key	⑦	RS-485 bus
③	RS-485 terminator switch	⑧	Analog mA output
④	Navigation keys	⑨	Ground connection
⑤	24 V DC power supply terminal	⑩	Micro-B USB port

Revision 4

6.3.2 Terminal blocks

The device uses screw-type wire-to-board terminal blocks for electrical connections. See Table 4 for specifications:

Table 4: Specifications of the terminal blocks

Connection method:	M3 slotted screw		
Tightening torque:	0.5 ... 0.6 Nm (4.425 ... 5.310 in-lb)		
Insulation stripping length:	8 mm (0.31 in)		
Pitch:	5.08 mm (0.20 in)		
Connection angle:	55°		
Conductor size:	Solid 0.2 ... 4 mm^2	Flexible 0.2 ... 2.5 mm^2	AWG 24 ... 12

> **Terminal blocks are compatible with smaller conductor sizes than the minimum conductor size that is recommended for the device. Do not use a conductor size that is smaller than 0.3 mm^2 / 22 AWG to make electrical connections on the device.**

6.3.3 Grounding

> **WARNING!**
>
> **Risk of injury**
>
> **If the dust monitor is not grounded properly, it can display false measurement results. In the worst case, this can result in severe health impacts to workers, or even a failure of an explosion prevention system.**

> **WARNING!**
>
> **Risk of malfunction**
>
> **Different ground potentials between the power supply and installation location can create ground current loops, which can result in false measurement results. Depending on the application, this can have severe implications on worker health and safety. Always make sure that the device is grounded properly.**

For proper and safe operation, it is critical that the device is properly connected to ground. The device is equipped with one ground connection on the main board.
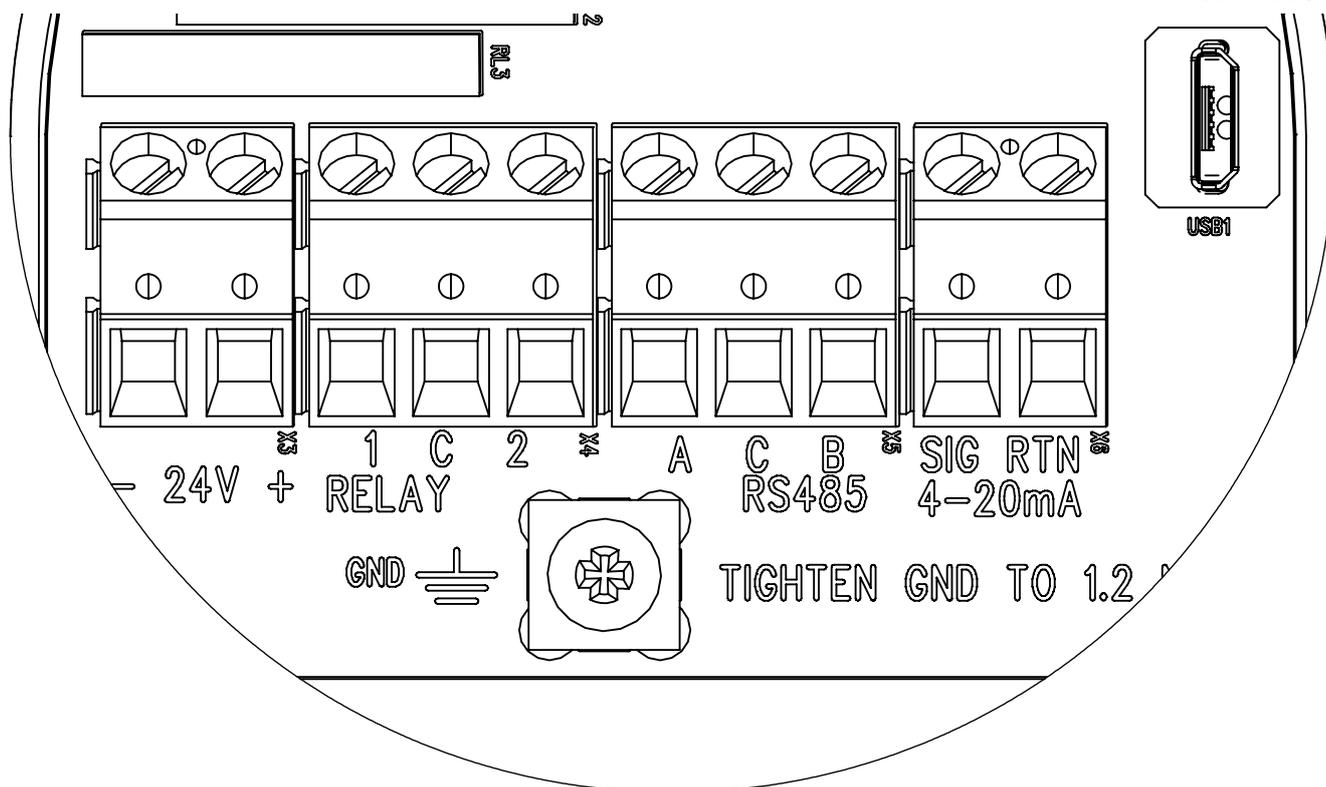
Figure 21: Ground connection on the main board

When the device is grounded properly, there is no change in the output signal level when you touch the enclosure.

Signs of improper grounding

If the device is not grounded properly, it can show the following behavior:

- Base value of the output signal is >3000 IEU when the process is not running.
- The output signal level changes when you touch the enclosure.
- The displays indicate "Err1" with the red status LEDs blinking. This means that the sensor probe is grounded.

> **Subpar power supply can cause behavior similar to improper grounding. Only use NEC Class 2 or equivalent power supply.**

Connecting ground wire

To connect the device to ground, you need:

- Protective gear for electric work
- Pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench
- Phillips-head screwdriver (M5)
- Wrench (20 mm [0.7874 in] or adjustable)
- Suitable ground wire

To connect the device to ground:

1. Make sure that the device is not connected to the power supply, or that the power supply is disconnected or isolated.

2. Turn the device on its side and remove the terminal cover located on the bottom of the device by turning it counterclockwise with a pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench.
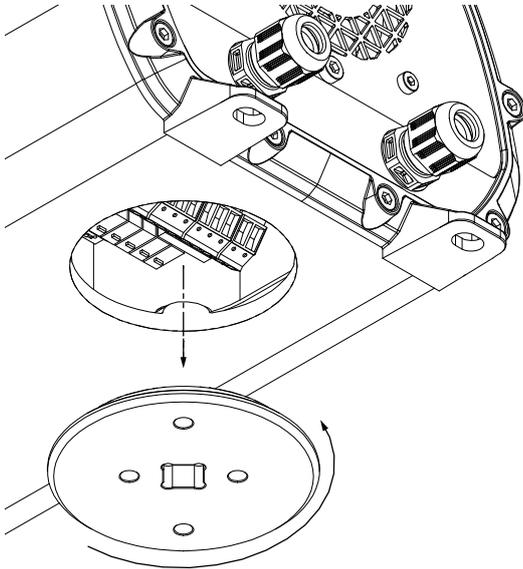
3. Remove either cable gland. Loosen the cable gland cap by turning it counterclockwise with a wrench.

Revision 4
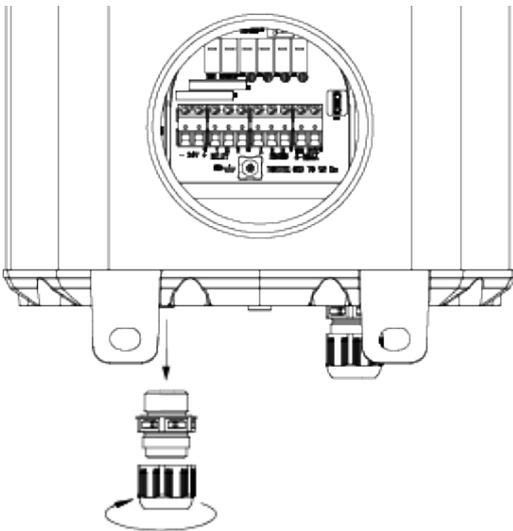
4. Slide the cable gland over the incoming ground wire.
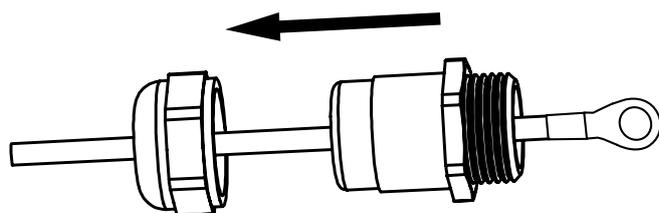
5. Insert the ground wire through the cable entry.
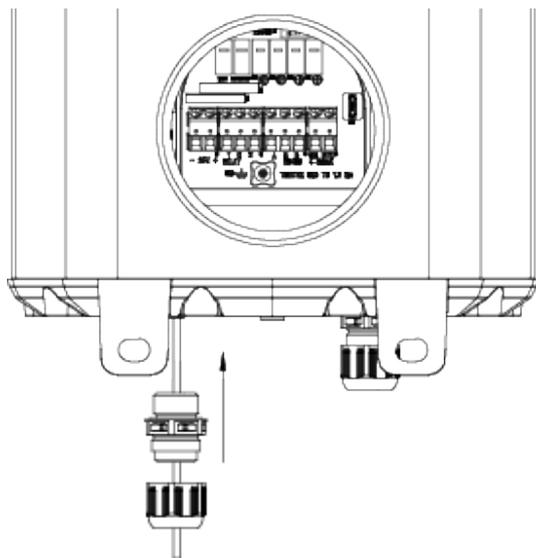
6. Loosen the screw on the ground connection with a screwdriver.

7. Place the ground wire under the screw head on the ground connection and tighten the screw.
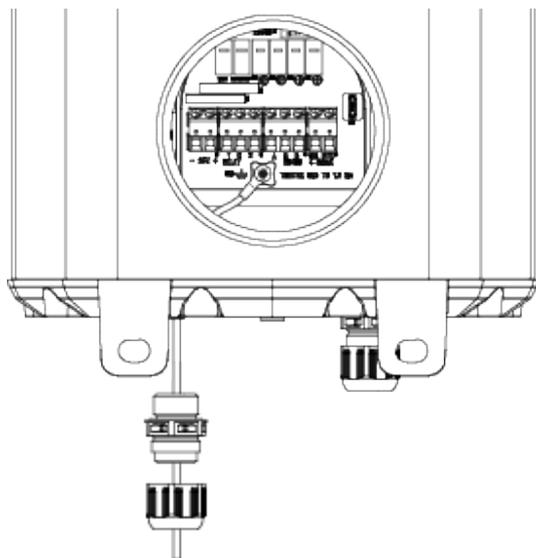
Revision 4

8. If you do not need to make any other electrical connections:

- Push the cable gland back inside the cable entry and tighten the cap with a wrench.
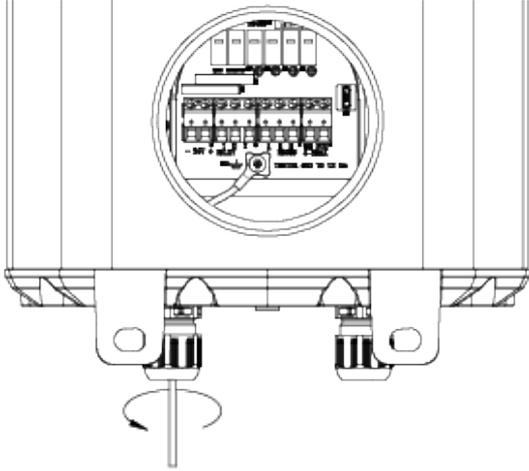
- Attach the terminal cover by tightening it clockwise with a pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench.
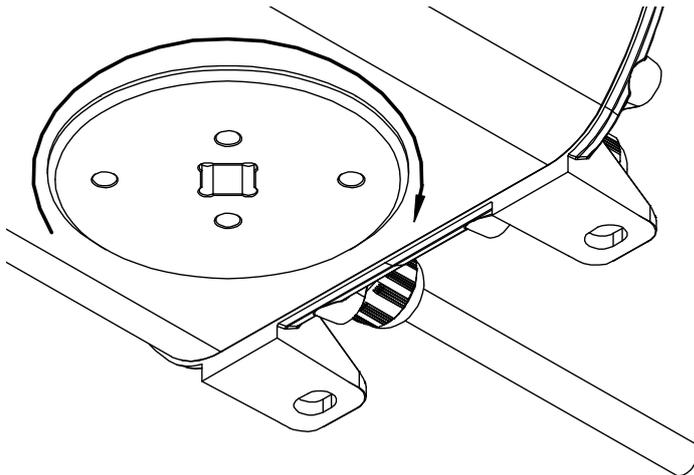
9. Connect the other end of the ground wire to a location with the same ground potential as the ductwork that the device is installed on.

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6.3.4 Power supply

<table>
<tr><td colspan="2" style="background-color:red; color:white">DANGER!</td></tr>
<tr>
<td>⚠️</td>
<td>
Electric shock hazard

Before connecting the device to a power supply, make sure that the power supply is isolated or disconnected. Electric shock from a connected power supply cable can result in serious injury or death.

When connecting the device to a power supply, wear protective glasses, protective clothing and insulating rubber gloves.

👓 🥼 🧤
</td>
</tr>
</table>

The device can be connected to a 24 V DC power supply. Note the polarity of the power input. Only use NEC Class 2 or equivalent power supply.

🛈 **If connected with incorrect polarity, the device does not start up. However, connecting the power supply with incorrect polarity does not damage the device.**

🛈 **Follow all applicable local regulations when selecting the circuit breakers that protect the cables.**
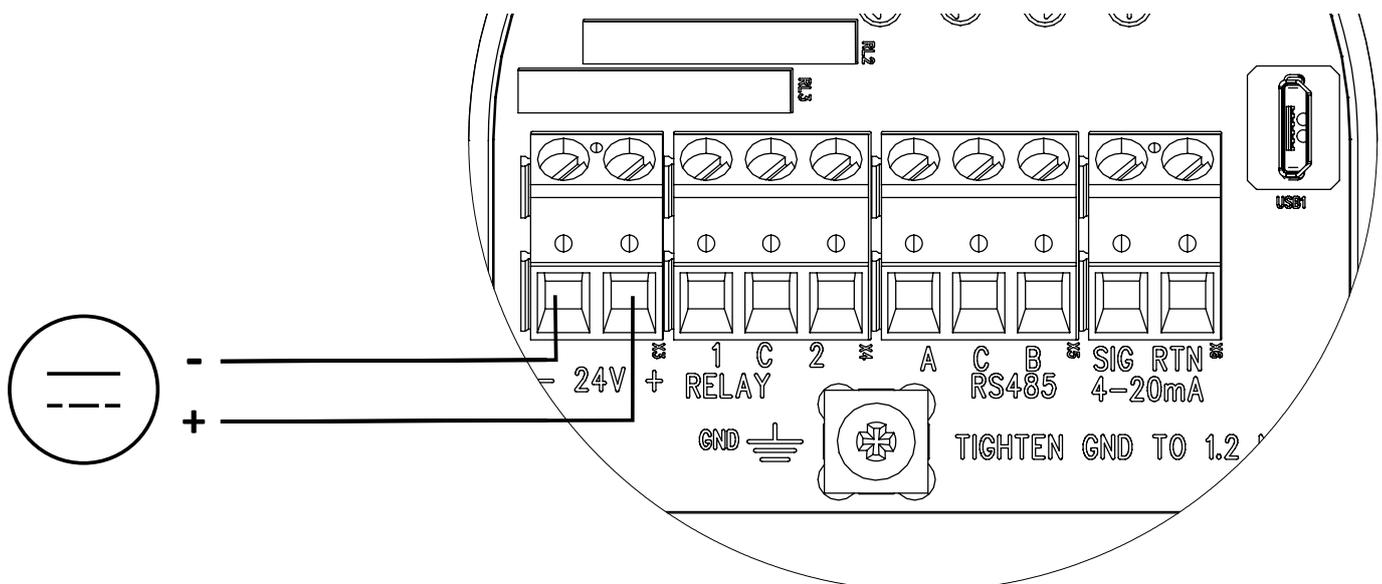
Figure 22: Power supply input on the main board

Revision 4

Connect the sheath of a shielded cable to ground only on one end. Connecting both ends to ground can create a ground loop.

To connect the power supply, you need:

- Protective gear for electric work
- Pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench
- Slotted-head screwdriver (M3)
- Wrench (20 mm [0.7874 in] or adjustable)
- Suitable power cable

To connect the device to power supply:

1. Make sure that the power supply is disconnected or isolated.
2. Turn the device on its side and remove the terminal cover located on the bottom of the device by turning it counterclockwise with a pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench.

Revision 4
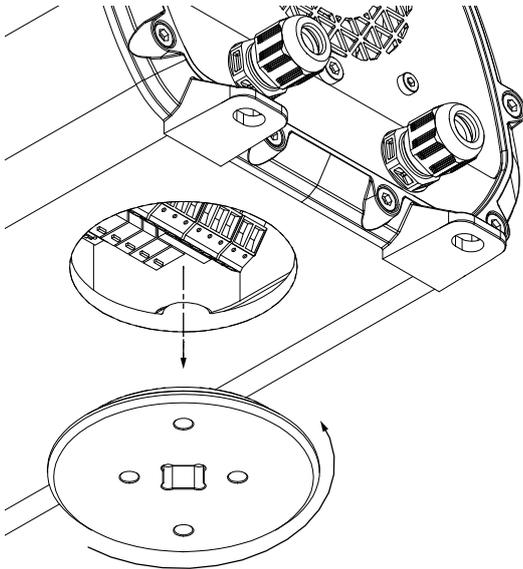
3. Remove the cable gland at the cable entry that is closer to the power supply terminal. Loosen the cable gland cap by turning it counterclockwise with a wrench.
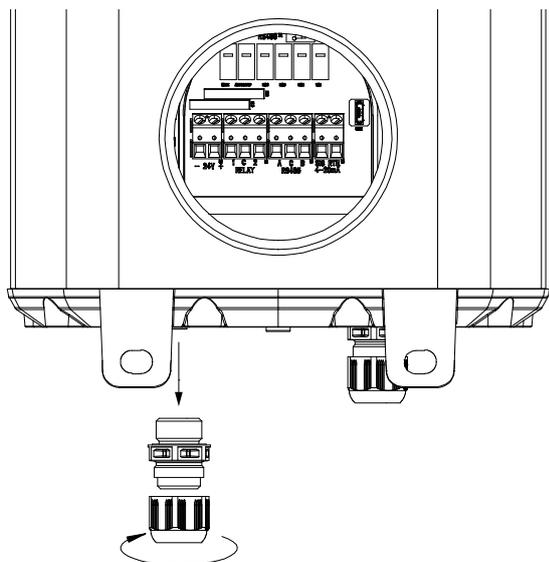
4. Slide the cable gland over the incoming power cable.
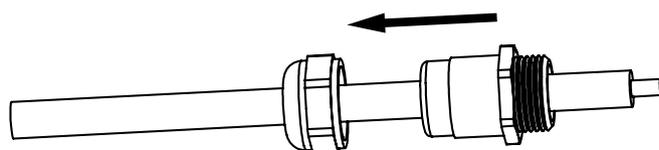
**5.** Insert the power cable through the cable entry.

Revision 4
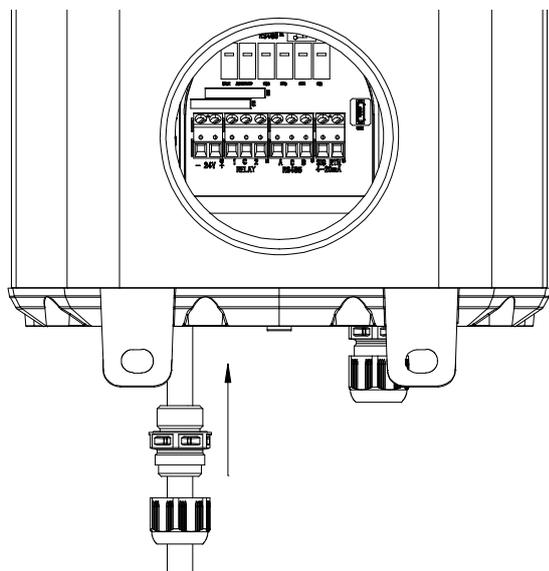
6. Connect the power cable to the 24 V DC power supply terminal.
Insert the wires to the terminal block and tighten the screws.
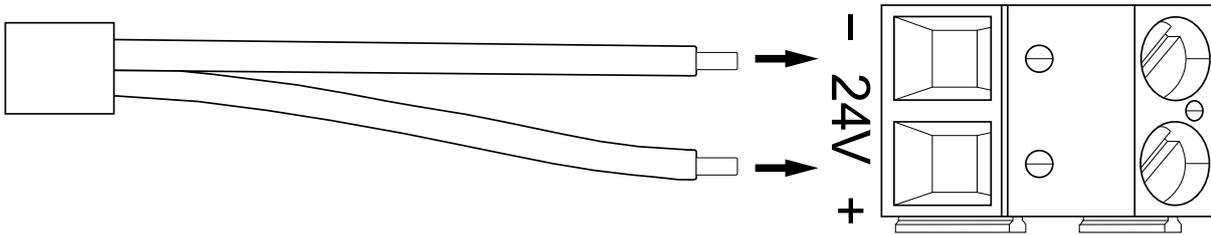
7. If you do not need to make any other electrical connections:

- Push the cable gland back inside the cable entry and tighten the cap with a wrench.

- Attach the terminal cover by tightening it clockwise with a pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench.

- Enable or connect the power supply, and power up the device.

Revision 4
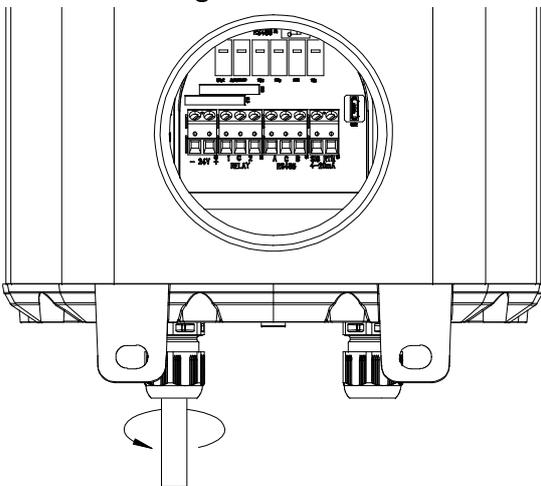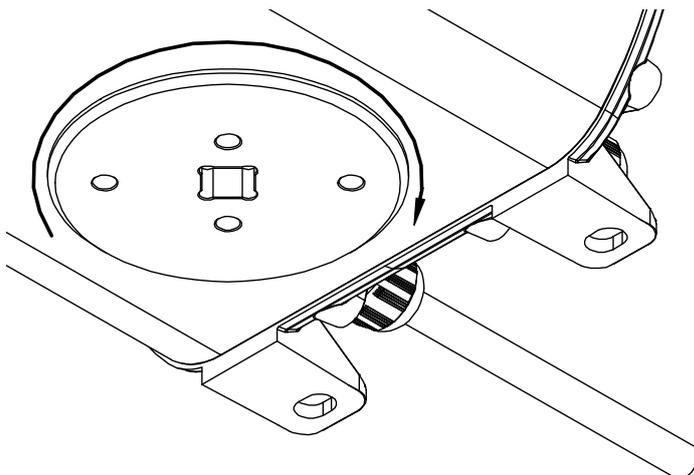
6.3.5 Relays

The device has two independent solid-state relays (SSR). The relays are used to indicate dust alarm statuses to a monitoring system. The contacts on the relay terminal block are labeled "1" and "2" for the individual relays. The common contact is labeled "C". The relays can be used to power external loads of up to 30 V DC / 1 A.

Figure 23: Relay connections on the main board

Connect the sheath of a shielded cable to ground only on one end. Connecting both ends to ground can create a ground loop.

To connect a relay, you need:

- Protective gear for electric work
- Pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench
- Slotted-head screwdriver (M3)
- Wrench (20 mm [0.7874 in] or adjustable)
- Suitable signal cable

To connect the relays:

1. Make sure that the device is not connected to the power supply, or that the power supply is disconnected or isolated.

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2. Turn the device on its side and remove the terminal cover located on the bottom of the device by turning it counterclockwise with a pin wrench or $^1\!/_2$-inch ratcheting socket wrench.
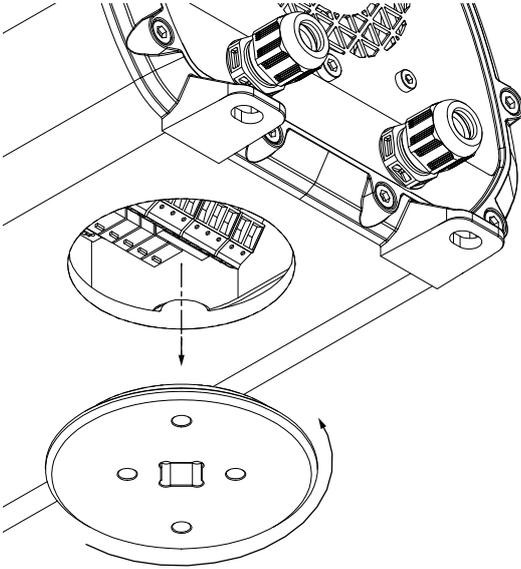
3. Remove the cable gland at the cable entry that is closer to the relay terminal. Loosen the cable gland cap by turning it counterclockwise with a wrench.
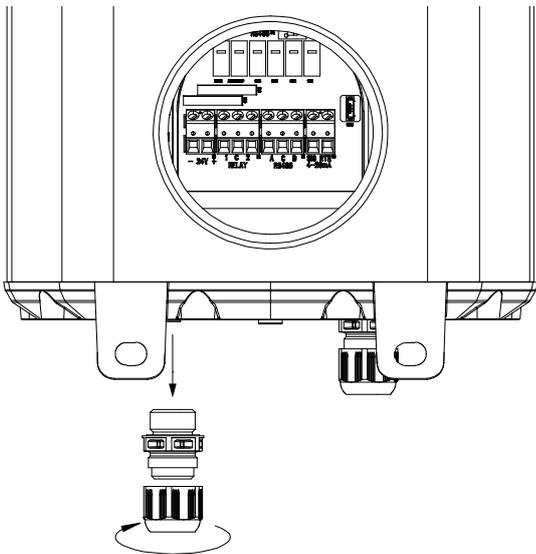
4. Slide the cable gland over the incoming signal cable.

Revision 4
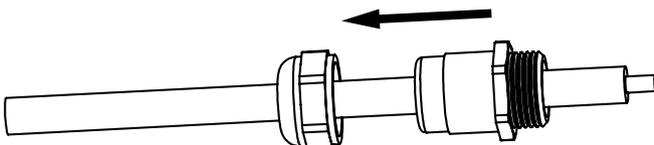
5. Insert the signal cable through the cable entry.
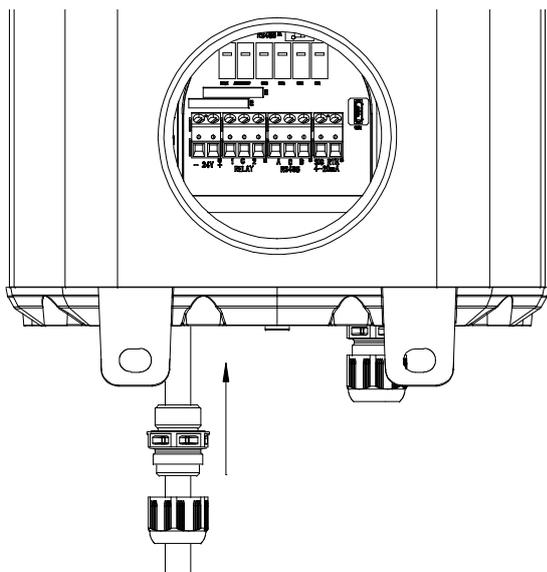
6. Connect the signal cable to contacts 1, 2 and C.
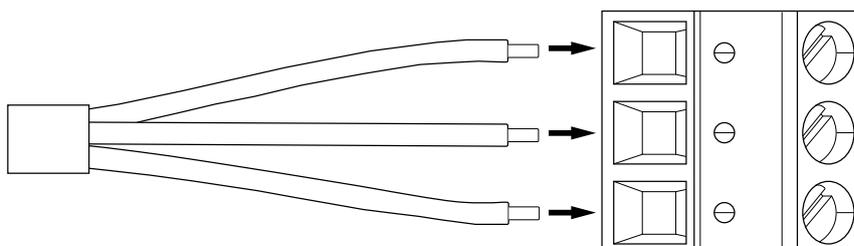
7. Connect the other end of each signal cable to the appropriate terminals on the application that you want to control with the relays.

8. If you do not need to make any other electrical connections:

- Push the cable gland back inside the cable entry and tighten the cap with a wrench.

Revision 4
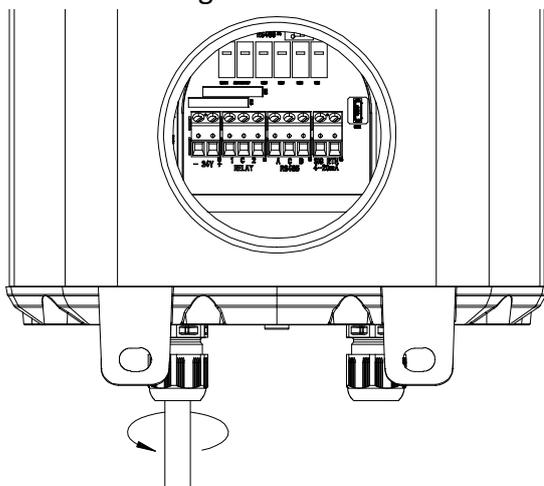
- Attach the terminal cover by tightening it clockwise with a pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench.
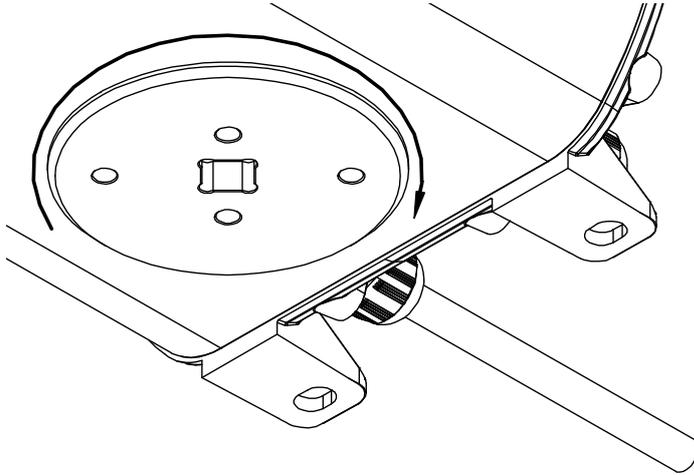
- Enable or connect the power supply, and power up the device.

When programming the external device to receive the signals from the relays, refer to Table 14 in section **Relay logic** in chapter **Operation**.

6.3.6 RS-485 bus

The device has an isolated RS-485 bus that can be used to integrate the device into existing automation systems, and to connect multiple devices in parallel to create a device network. The bus can be used to read data from the device, and to change device parameter. The device supports Modbus RTU and proprietary Sintrol Network communication protocols.

The default communication parameters for Modbus RTU are as follows:

Table 5: Modbus RTU communication parameters

Baud rate:	38400
Data bits:	8
Stop bits:	2
Parity:	None

For a quick reference of the register definitions of the Modbus RTU interface, see **Appendix B**.

For information about setting up device networks, see section **Setting up device network** in chapter **Commissioning and system setup**.

Polarity

Polarity of the RS-485 bus is indicated with labels A and B, where wire A is negative (−) and wire B is positive (+). Make sure to always connect wires A and B using correct polarity to the device that receives the signal.

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> ❗ **Markings that indicate polarity on the RS-485-to-USB converter supplied by Sintrol are inverted. When using RS-485-to-USB converter supplied by Sintrol, connect wire A to + and wire B to –.**

Some manufacturers have the RS-485 output signals inverted, and the way signal polarity is labeled can differ between manufacturers. For example, some manufacturers indicate negative polarity with TX–/RX– or D– instead of A, and positive polarity with TX+/RX+ or D+ instead of B.

> ❗ **If you are connecting the device into an existing Modbus RTU automation system or if you are using a third-party RS-485-to-USB converter or cable, read the related user documentation carefully before connecting the RS-485 output.**
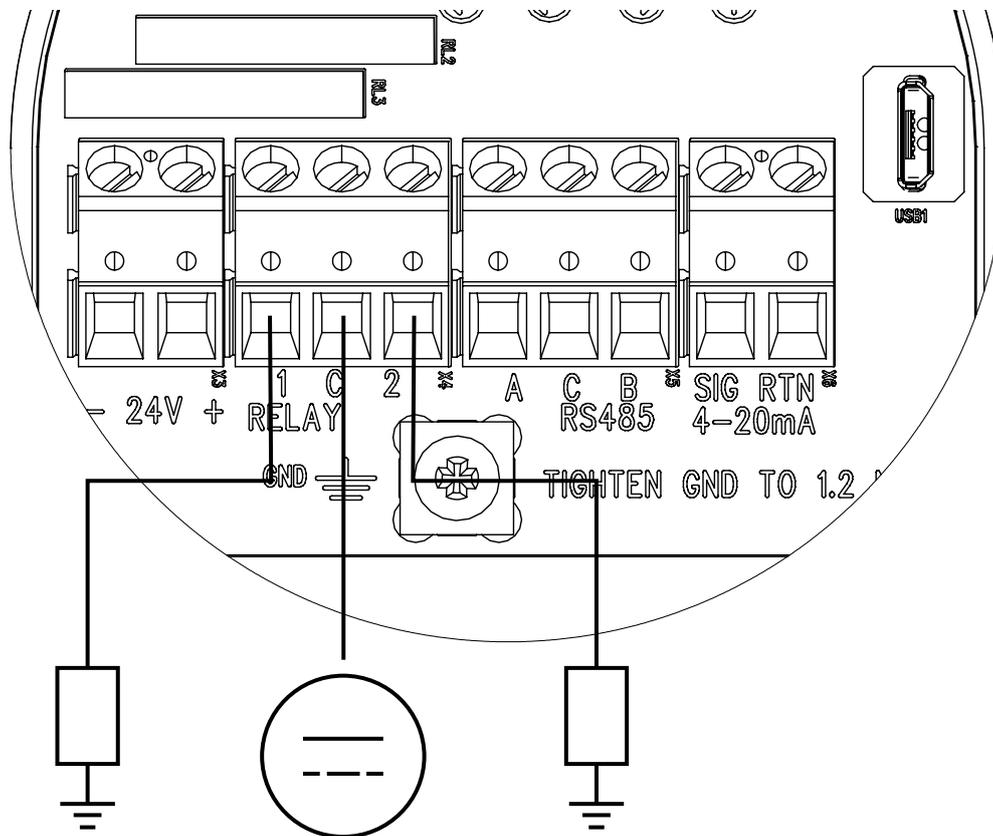
Connecting RS-485 bus
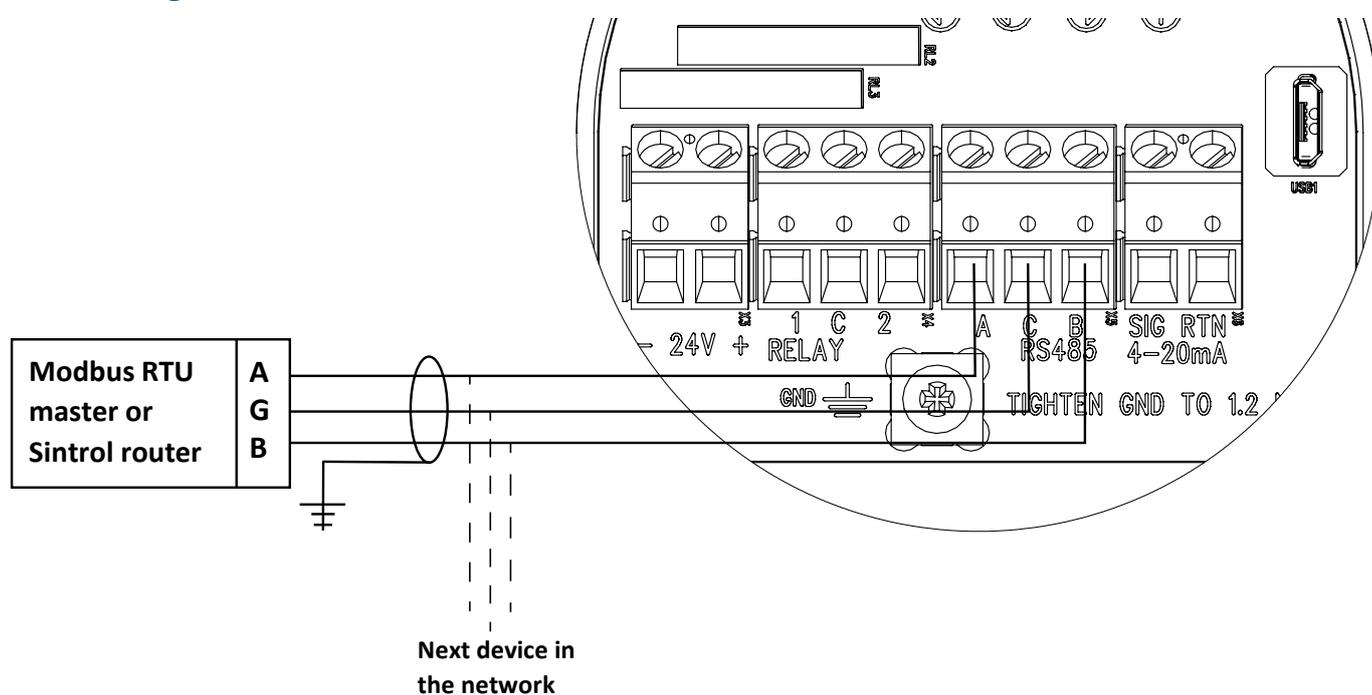
Figure 24: Modbus RTU bus on the main board

> ❗ **Connect the sheath of a shielded cable to ground only on one end. Connecting both ends to ground can create a ground loop.**

To connect a RS-485 bus, you need:

- Protective gear for electric work
- Pin wrench or ½-inch ratcheting socket wrench
- Slotted-head screwdriver (M3)
- Wrench (20 mm [0.7874 in] or adjustable)
- Suitable signal cable

To connect a RS-485 bus:

1. Make sure that the device is not connected to the power supply, or that the power supply is disconnected or isolated.

2. Turn the device on its side and remove the terminal cover located on the bottom of the device by turning it counterclockwise with a pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench.
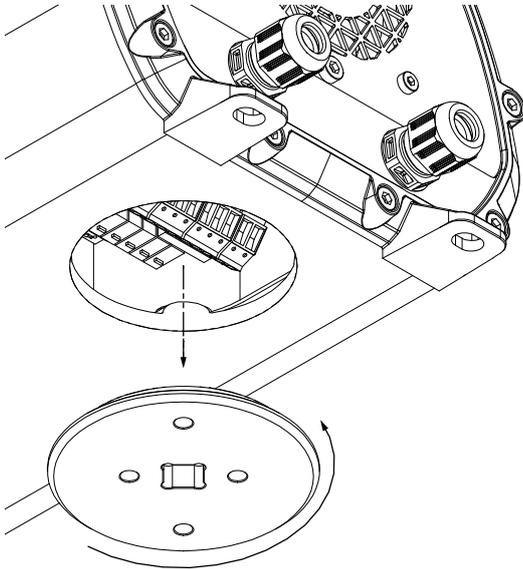
3. Remove the cable gland at the cable entry that is closer to the RS-485 bus. Loosen the cable gland cap by turning it counterclockwise with a wrench.
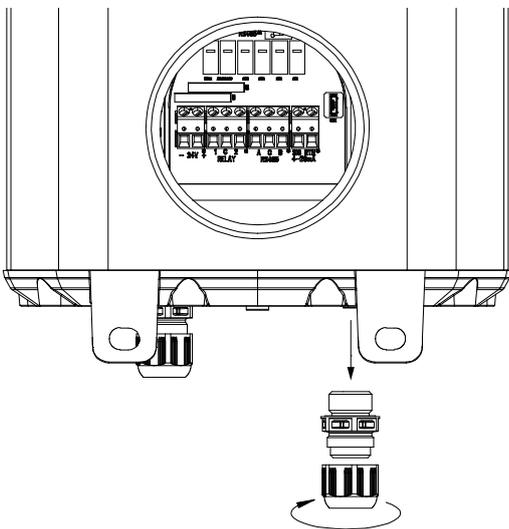
4. Slide the cable gland over the incoming signal cable.

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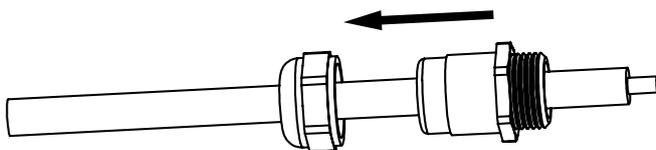
5. Insert the signal cable through the cable entry.
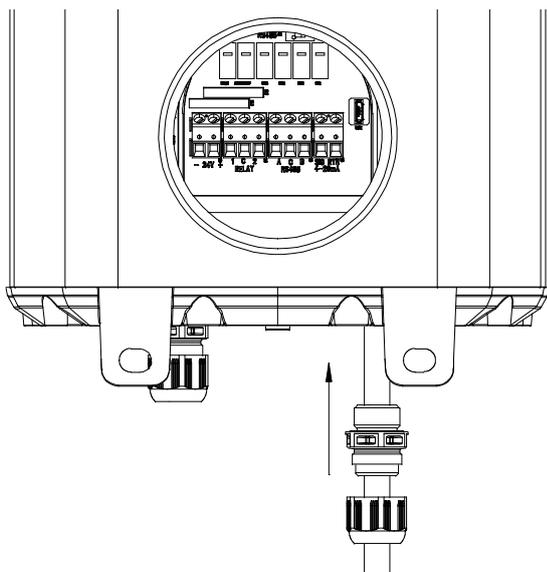
6. Connect the signal cable to the RS-485 output terminal block.
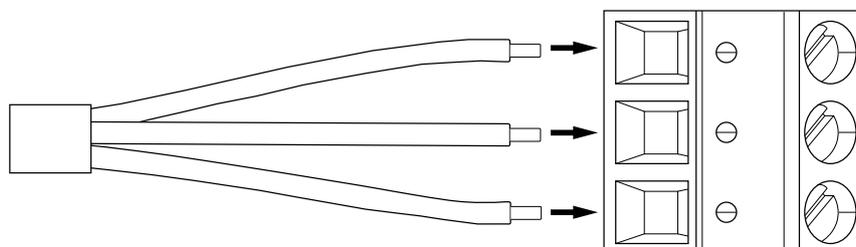
> **If you connect several devices in parallel with the RS-485 bus, you must adjust the settings for each device in DustTool according to instructions in section "Wired device network" in chapter "Commissioning and system setup".**

7. Connect the other end of the signal cable to the application that receives the RS-485 output.

8. If you do not need to make any other electrical connections:

- Push the cable gland back inside the cable entry and tighten the cap with a wrench.
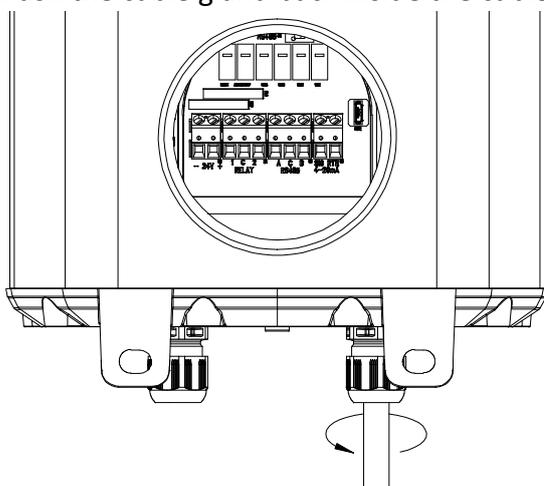
- Attach the terminal cover by tightening it clockwise with a pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench.
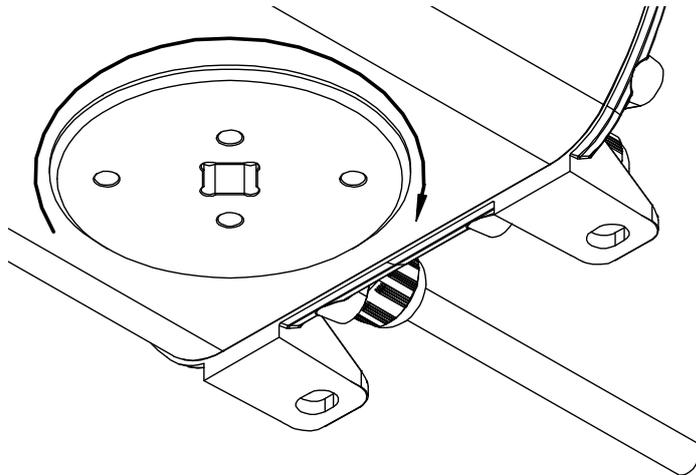
- Enable or connect the power supply, and power up the device.

Terminator switch

RS-485 bus allows multiple devices to be connected in parallel to create device chains and networks. The main board is equipped with a terminator switch that must be turned ON or OFF on each device based on their position in the chain. The switch must be in ON position only for the last device of the chain. On all other devices, the terminator switch must be in OFF position.

Table 6: Terminator switch configurations

Device position	Switch position	Note
Single device	ON [■] 1	A single connected device is always considered the last in a chain. If a single device is connected to the RS-485 bus, switch the terminator switch to ON position.
First or middle in chain	ON [■] 1	If the device is the first of a chain or in the middle of a chain, make sure that the terminator switch is in OFF position.
Last in chain	ON [■] 1	If the device is the last in a chain, switch the terminator switch to ON position.
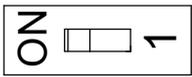
6.3.7 Analog mA output

The device has a single active and isolated mA output that uses industry standard 4 ... 20 mA signal range for indicating status and measurement value. Maximum resistance for the mA loop is 250 Ω. The mA output is intended to be used as a long-range analog data transfer in industrial applications.

After Auto Setup, the default output signal level is set to 5% of the scale (4.8 mA). This means that 20 mA output signal indicates a 20× increase in dust concentration. The scale of the mA output can also be customized according to the specific end-user application.

>22 mA signals are used to indicate sensor fault in accordance with NAMUR NE43.

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Table 7: Measurement values corresponding to device status

mA output	Status
4 ... 20 mA	Normal operation or zero/span self-test
>22 mA	Device failure, for example due to failure of the internal checks of the device

Connecting mA output
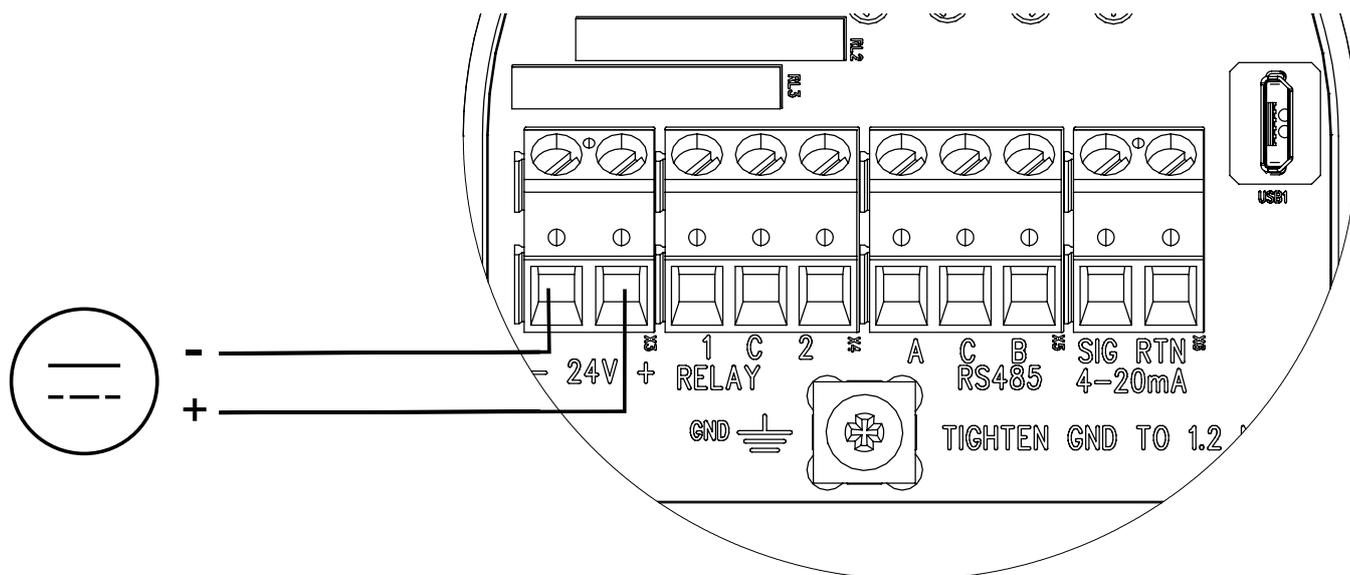
Figure 25: mA output on the main board

Connect the sheath of a shielded cable to ground only on one end. Connecting both ends to ground can create a ground loop.

To connect the mA output, you need:

- Protective gear for electric work
- Pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench
- Slotted-head screwdriver (M3)
- Wrench (20 mm [0.7874 in] or adjustable)
- Suitable signal cable

To connect the mA output of the device:

1. Make sure that the device is not connected to the power supply, or that the power supply is disconnected or isolated.

2. Turn the device on its side and remove the terminal cover located on the bottom of the device by turning it counterclockwise with a pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench.
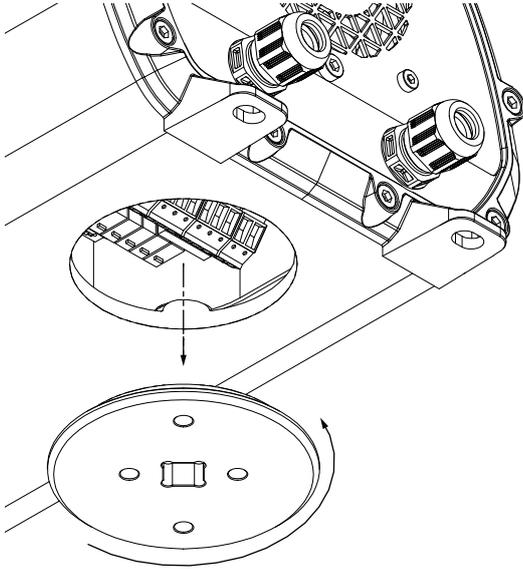
3. Remove the cable gland at the cable entry that is closer to the mA output terminal. Loosen the cable gland cap by turning it counterclockwise with a wrench.
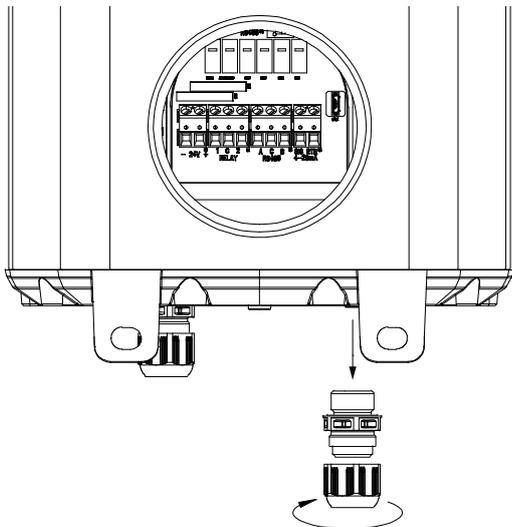
4. Slide the cable gland over the incoming signal cable.

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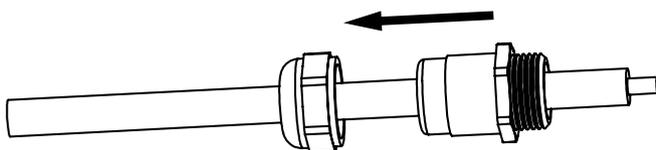
5. Insert the signal cable through the cable entry.
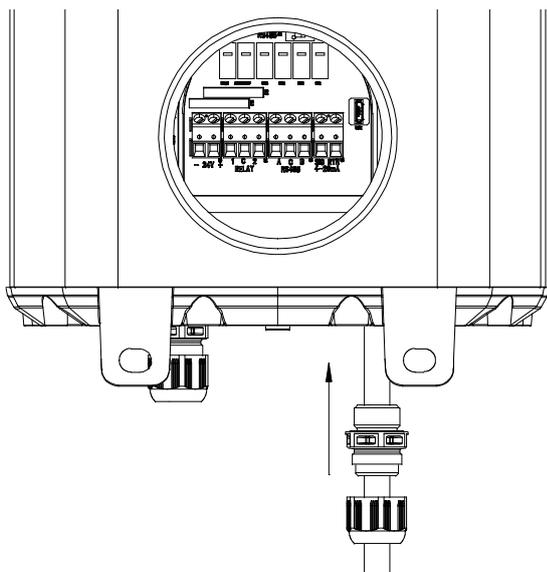
6. Connect the signal cable to mA output terminal block.
Insert the wires to the terminal block and tighten the screws.
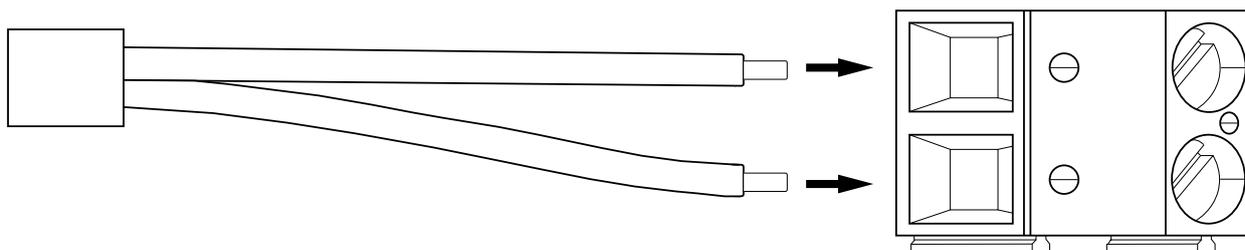
7. Connect the other end of the signal cable to the device that receives the mA output.

8. If you do not need to make any other electrical connections:

- Push the cable gland back inside the cable entry and tighten the cap with a wrench.

Revision 4
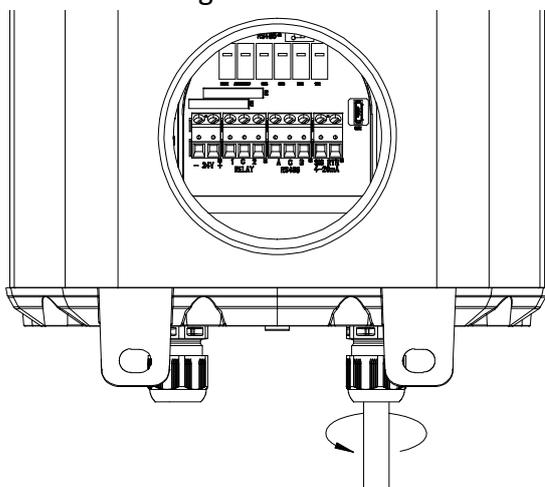
- Attach the terminal cover by tightening it clockwise with a pin wrench or $\frac{1}{2}$-inch ratcheting socket wrench.
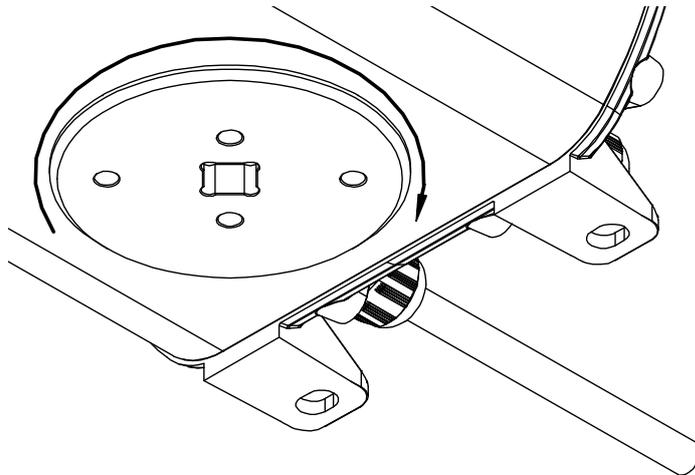
- Enable or connect the power supply, and power up the device.

6.3.8 Connecting with USB

You can connect the device directly to a computer with USB if the USB port of the host computer can supply enough power. However, when using USB power, the internal fan of the device does not rotate, and the device cannot measure dust concentration. This means that USB can only be used to change the parameters and settings of the device in DustTool.

Table 8: USB specifications

USB type:	Micro-B
Max. cable length:	5 m (16.4 ft)

The USB port is located on the main board inside the enclosure next to the 4 … 20 mA output.

> **You can use USB to configure the device, but it does not replace a dedicated industrial power supply. The USB connection cannot be used to supply power for the device in normal operation.**

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7 DustTool

7.1 Overview

DustTool is a complementary software that can be used to control the parameters and features of the device with a Windows computer. The device can be connected to a computer running DustTool directly with USB or using RS-485-to-USB converter, Sintrol Router or Wireless Router.

> **(!)** **To enable communication using RS-485 protocol, the device must have firmware version 3.0.2 or later, and the host computer must have DustTool version 1.2.1701101750 or later installed. You can check the firmware version in DustTool on PROPERTIES tab.**

> **(!)** **If you enable Lock Password feature in DustTool, it is no longer possible to run Auto Setup or change the device parameters. If you forget the password, you must contact Sintrol support to unlock the device with a device-specific master password.**

You can download DustTool free of charge at https://sintrol.com/product/dusttool/.

> **(!)** **DustTool is developed to set up and manage the device parameters and properties. If you need to save measurement data, create additional alarms, generate reports or access measurement history, monitoring software DustLog 10 is required.**

7.2 System requirements

DustTool is developed for Windows operating system. See Table 9 for system requirements.

Table 9: System requirements for DustTool

Minimum		Recommended	
Operating system:	Windows XP	**Operating system:**	Windows 10
Display:	1024×768	**Display:**	1920×1080
RAM:	512 MB	**RAM:**	4 GB

7.3 Main view

When you launch DustTool, it looks up any connected Sintrol devices. The software automatically detects the interface that is used for communication and connects to the device. Connected devices appear on the main view of the software, where you can manage them.

Figure 26 shows the main view that opens each time DustTool is launched.

Figure 26: DustTool main view

①	List of currently connected products. Connection type is displayed with a small icon next to the device name.
②	Description of the selected product with the model name, serial number and picture.
③	Tabs help navigate the software, and manage device features related to calibration, parameters, Auto Setup, and commands. Monitor view provides a visualization of the current process conditions.
④	Info area on the bottom of the window displays information about the fields and items on the screen when you hover the mouse cursor over them.
⑤	Help view provides direct access to documentation related to the connected devices. In order to access user documentation, network access must be enabled.
⑥	Settings give you full control over software properties, like updates and network access.

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8 Commissioning and system setup

The device requires minimal setup to establish regular operating condition. For basic trend monitoring applications, it is enough to only run the Auto Setup procedure. After commissioning and setting up the device, you can adjust parameter settings and alarm thresholds manually.

8.1 Auto setup

8.1.1 Overview

Parameters of the Auto Setup feature can be modified with DustTool software. This section only describes the default Auto Setup with factory settings.

In normal operation, the device continuously monitors the dust concentration in the airflow. During Auto Setup, the device analyzes the present measurement signal, determines an average signal level and establishes normal process conditions that are used as a baseline for future measurements.

Auto Setup also sets up two alarm thresholds (ALERT and ALARM) that are proportional to the normal dust level. An alarm is triggered when the dust concentration exceeds the configured dust level threshold.

Auto Setup is performed during normal operating conditions after the device is installed, and the process that the device monitors is running.

Make sure that Auto Setup is performed during normal operating conditions and usual dust levels. Performing Auto Setup during irregular conditions can result in false measurement results.

During Auto Setup, the device always uses the parameter values from MEDIUM response mode for signal averaging time (50 seconds) and alarm delay time (30 seconds). Signal averaging time determines the period from which the device calculates the average signal level, and alarm delay time determines how long the dust level must be above the configured ALERT or ALARM threshold before the relays switch position and trigger the alarms.

Auto Setup takes 500 seconds (approximately 8 minutes) to complete. After Auto Setup is completed or cancelled, signal averaging time and alarm delay time automatically revert to their user-set values.

8.1.2 Response modes

The device has user-selectable FAST, MEDIUM and SLOW response modes, which control how fast the device reacts to changes in dust levels. Additionally, each response mode has pre-programmed multipliers for the measurement baseline that are used to set the ALERT and ALARM thresholds. The baseline multipliers used in each response mode are described in Table 10.

Table 10: Alarm thresholds after Auto Setup

Response mode	ALERT threshold	ALARM threshold
FAST	3× baseline level	10× baseline level
MEDIUM	5× baseline level	20× baseline level
SLOW	5× baseline level	20× baseline level

The baseline of the previous Auto Setup is always stored in the device memory. When you change the response mode, the device applies the appropriate multipliers to the baseline, and adjusts the parameters for ALARM and ALERT thresholds automatically.

The response mode can be changed using a mode selector key on the main board, or an optional magnetic switch on the front panel. It is not possible to change the response mode in DustTool. Instead, you can use DustTool to change individual parameters.

Changing the response mode overwrites any previously made parameter changes.

For more detailed information about device parameters, see section **Parameters** in chapter **Operation**.

8.1.3 Operation statuses

Table 11 shows the default signal levels for each operation status after Auto Setup:

Table 11: Default signal levels after Auto Setup

Status	Output signal	Description
Normal:	4 ... 20 mA	Normal operation range
No dust present:	4 mA	Minimum value during normal operation
Measurement baseline:	4.8 mA	5% of signal range
ALERT:	≥8 mA	• 3× or 5× increase in dust concentration* • 25% of signal range • Relay 1 switches position
ALARM:	20 mA	• 10× or 20× increase in dust concentration* • 100% of signal range • Relay 2 switches position

* Multiplier is applied based on the selected response mode.

For further information on operation statuses and relay logic, see section **Relay, LED and display functional logic** in chapter **Operation**.

Figure 27 further illustrates the relation between Auto Setup baseline and the alarm thresholds:

Figure 27: Relation between the output signal baseline and alarm thresholds after Auto Setup

①	Average output signal. Dust concentration baseline in the example is 10 mg/m³. Output signal is around 4.8 mA, which represents 5% of measurement range.
②	Dust ALERT threshold at 25% of measurement range. ALERT is triggered when there is a 5× increase in dust level compared to the baseline. In the example this corresponds to an output signal of 8 mA and a dust concentration of 50 mg/m³.
③	Dust ALARM threshold at 100% of measurement range. ALARM is triggered when there is a 20× increase in dust level compared to the baseline. In the example this corresponds to an output signal of 20 mA and a dust concentration of 200 mg/m³.

The actual dust concentration at the baseline depends on the location of the measurement point.

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8.1.4 Performing Auto Setup

The easiest way to perform Auto Setup is to start it manually on the main interface of the device. Only two keys, K0 (+) and AUTOSETUP, are required to perform Auto Setup. The keys are highlighted in Figure 28.
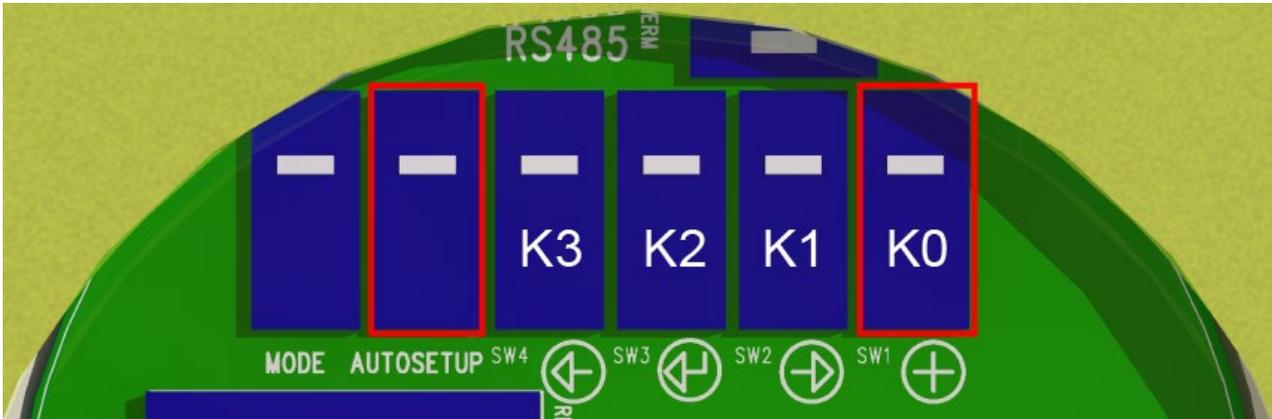
Figure 28: Main board of the device with AUTOSETUP and K0 (+) key highlighted

To perform Auto Setup:

1. Press K0 (+) key to enter MAINTENANCE mode. LEDs on both sides of the display on the front panel of the device start to blink, alternating between green and red.

2. Press AUTOSETUP key for 1 second. During Auto Setup:

    *   The display shows the remaining time in seconds.
    *   Both green LEDs continue to blink.

3. Auto Setup is completed when the counter reaches 0. The device resumes normal operation.

Auto Setup takes 500 seconds (approximately 8 minutes) to complete.

If you want to cancel Auto Setup, press AUTOSETUP key again for 1 second.

For a more detailed description of the main interface of the device, see section **Main interface** in chapter **Operation**.

8.2 Changing parameters

8.2.1 Main interface

You can change parameters manually with the main interface of the device. The main board of the device is equipped with six operation and navigation keys (Figure 29).

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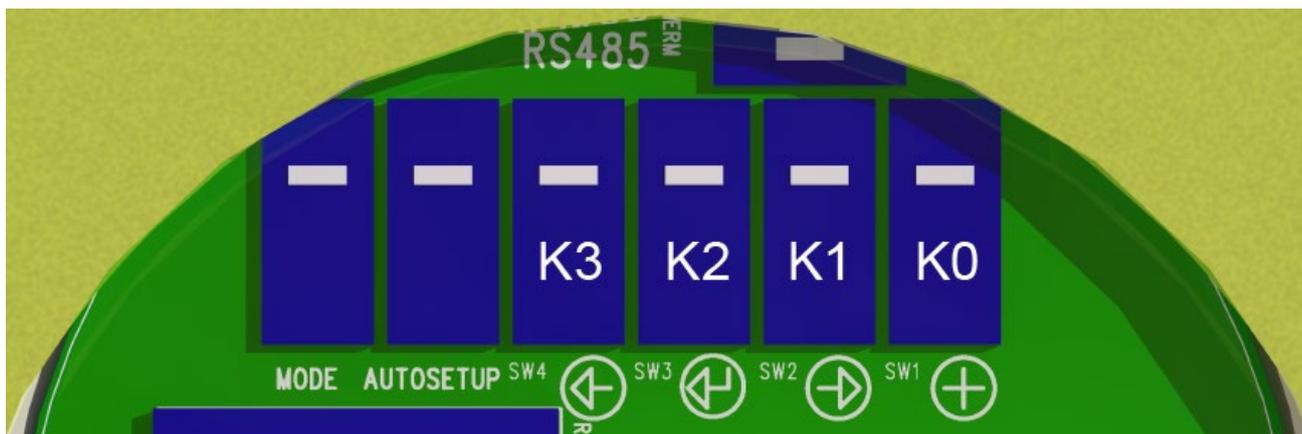
Figure 29: Operation and navigation keys on the main board of the device

The front panel of the device is equipped with a 7-segment display with four digits (Figure 30).

Figure 30: Display on the front panel of the device

To change a parameter with the main interface:

1. Press K0 (+) key to enter MAINTENANCE mode.

    - LEDs on both sides of the display on the front panel of the device start to blink, alternating between green and red.
    - The cursor position is indicated with a blinking digit.

2. Select the parameter you want to edit.

    - The selected parameter is displayed in display position D0.
    - Press K0 (+) key to select the next parameter.
    - Value of the selected parameter is displayed in positions D1 … D3.

3. Press K1 (→) key to select the value you want to change.

    - Pressing K1 (→) key moves the cursor one step to the right.
    - If the cursor reaches position D3 and you press the key again, the cursor returns to position D0.

4. Press K0 (+) key to increase the blinking value by 1. If the value reaches 9 and you press the key again, the value returns to 0.

5. Press K2 (↵) key to save the new parameter value. After saving, the new parameter value comes into effect immediately, and the cursor returns to position D0.

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6. Press SW4 (←) key to exit MAINTENANCE mode and return to normal operation.

> **If you do not press any key on the main interface for 10 seconds, Maintenance mode times out and the device returns to normal operation.**

For detailed information on the device parameters, see section **Parameters** in chapter **Operation**.

Setting negative values

Some parameters allow you to set negative values. To set a negative value, simply press K0 (+) key until a minus sign appears on the display. Minus sign is always set in display position D1, so for parameter value "–8" the displays D1 … D3 must indicate "– 0 8".

8.2.2 DustTool software

You can modify the operating parameters of the connected device in DustTool.

To change the device parameters in DustTool:

1. Launch DustTool.
2. Connect the device to a Windows computer with USB or RS-485 interface.
   - The software automatically detects the interface that is used for communication and connects to the device.
   - If multiple devices are connected to the same computer, you must select the device you want to control from the list on the left side of the main view.
   - When connecting with USB, no external power is needed. If you use RS-485, first connect the device to a power supply.
3. Find the parameter that you want to edit.
   - Parameter settings are located on tabs PARAMETERS, CALIBRATION and COMMANDS.
4. Edit the parameter value.
5. Click the SAVE button on the bottom of the screen to store the changes in the device memory.

> **If you do not click the SAVE button, the changes to the parameter values are lost when you close the program or disconnect the device.**

6. Click the READ button to view the parameter values that are currently stored in the device memory.

For a more detailed overview of the DustTool software, see chapter **DustTool**.

8.2.3 Modbus RTU and Sintrol Network protocol

You can edit the device parameters using the RS-485 bus.

Modbus RTU

You can use Modbus RTU protocol to control the device parameters with an automation control system or any Modbus master device. To enable communication through Modbus RTU, connect the device to the master device with the RS-485 bus.

For information on how to control slave devices, refer to the user documentation of your Modbus master device or control system.

For a quick reference of the register definitions of the Modbus RTU interface, see **Appendix B**.

For information on how to connect the RS-485 bus, see section **Connecting RS-485 bus** in chapter **Electrical installation**.

Sintrol Network

You can use Sintrol Network protocol to connect the device to a computer running DustTool software.

To control the device parameters using Sintrol Network:

1. Connect the device to a computer with the RS-485 bus.
2. Use DustTool software to change the device parameters.

For information on how to change the device parameters using DustTool, see section **DustTool software** in this chapter. For a more detailed overview of the DustTool software, see chapter **DustTool**.

For information on how to connect the RS-485 bus, see section **Connecting RS-485 bus** in chapter **Electrical installation**.

8.2.4 Wireless connection

If your device is equipped with the optional RF antenna, you can use DustTool to remotely control the settings and parameters of devices that are part of a wireless network.

For information on how to change the device parameters using DustTool, see section **DustTool software** in this chapter. For a more detailed overview of the DustTool software, see chapter **DustTool**.

For information on how to enable wireless communication for the device, see section **Establishing wireless communication** in this chapter.

8.3 Setting up device network

RS-485 bus allows multiple devices to be connected in parallel to create a device network. This makes it possible to communicate with several devices at the same time with minimum wiring. Wired connections can use either Modbus RTU or Sintrol Network protocol for communication. Wireless communication, and combination of wired and wireless connections require the use of Sintrol Network protocol.

A complete measurement system that is based on Sintrol Network protocol can consist of up to 254 devices connected to a single network. These can be connected either wirelessly, with the RS-485 bus, or with a combination of the two.

8.3.1 Naming devices

It is recommended to assign each device in the network a unique name before installation. Because the network is created automatically when Sintrol Network protocol is used, naming the individual devices makes it easier to identify them.

To assign a name to a device:

1. Launch DustTool.

2. Connect the device to a Windows computer with USB or RS-485 bus.

    - The software automatically detects the interface that is used for communication and connects to the device.
    - If multiple devices are connected to the same computer, select the device you want to assign a name to from the list on the left side of the main view.

> **When connecting with USB, no external power is needed.**
> **If you use RS-485, first connect the device to a power supply.**

3. Navigate to PARAMETERS tab and assign an individual name for the device in the Device Name field.

4. Click the SAVE button to store the new device name in the device memory.

5. Disconnect the device.

8.3.2 Wired device network

The device has an isolated RS-485 bus that is designed for connecting multiple devices into a single bus using either Modbus RTU or Sintrol Network protocol.

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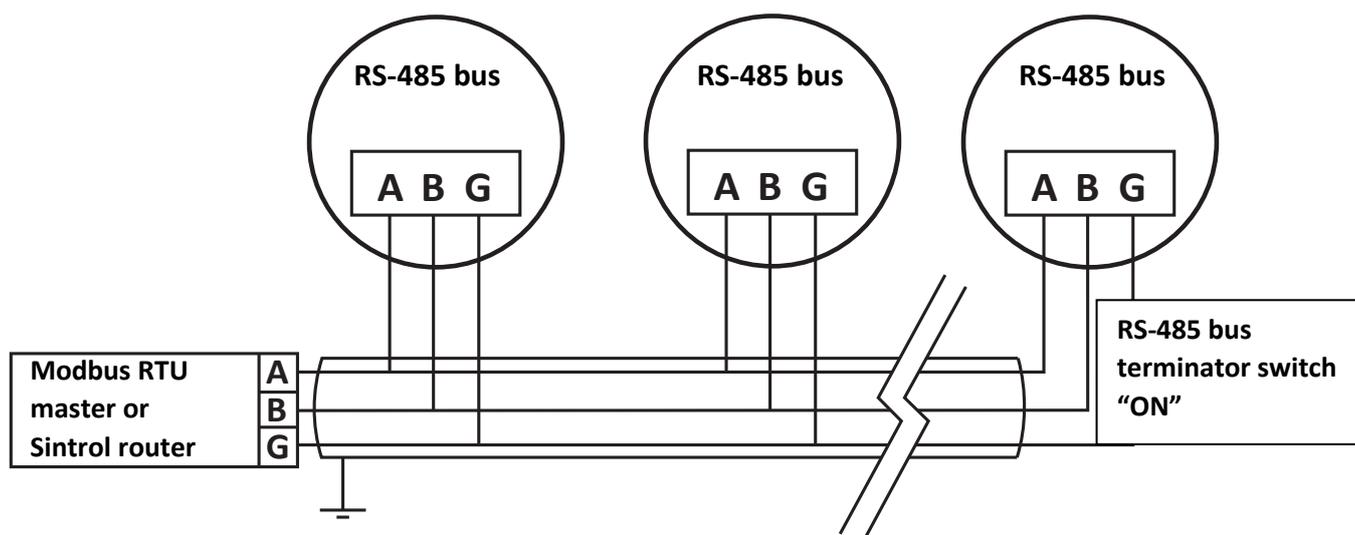
Figure 31: A device network created with RS-485 connections

To create a wired device network, you need:

- Communication base station
  - Modbus master device for Modbus RTU protocol
  - Network Router or Wireless Router for Sintrol Network protocol
- Suitable 3-wire shielded cable
- DustTool software

To set up a wired network, all devices in the chain must first be installed according to the instructions in chapters **Mechanical installation** and **Electrical installation**.

After the devices have been installed, the settings for each individual device must be adjusted in DustTool. To adjust the device settings in DustTool:

1. Connect the device to a computer with USB.

2. Launch DustTool and navigate to PROPERTIES tab.

3. Adjust the settings for the RS-485 protocol as necessary:

   - To use Modbus RTU protocol and to control the device network with Modbus master device, select the option "Modbus Slave" and assign an appropriate unique slave ID. "Modbus Slave" is selected by default.
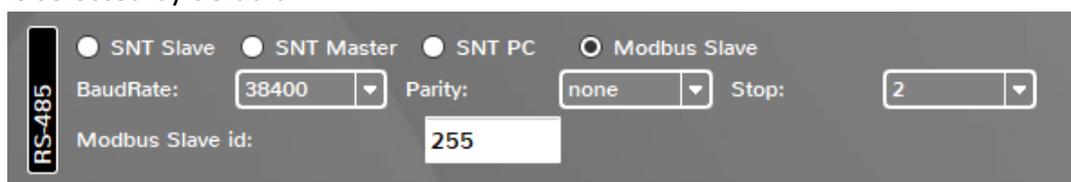
   - To use Sintrol Network protocol and to control the device network with DustTool software and Network Router or Wireless Router:
   - When "Modbus Slave" is selected, change "Stop" value to "1".
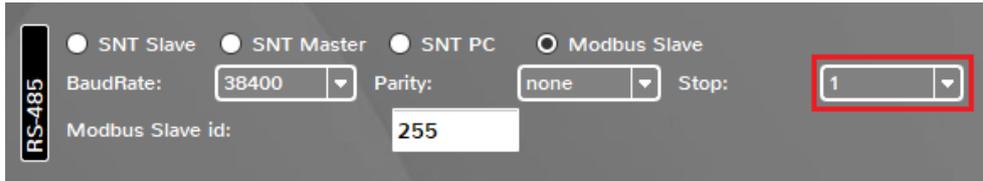
  - o Click the SAVE button to store the new value in the device memory.

  - o Select the option "SNT Slave".
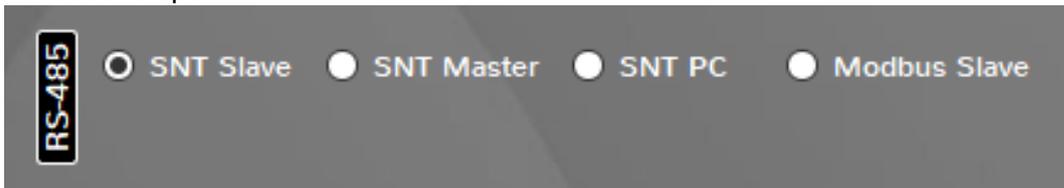
4. Click the SAVE button to store the new settings in the device memory.

5. Disconnect the device.

6. Repeat steps 1 to 5 for each individual device in the network.

After you have adjusted the settings for each individual device according to the selected communication protocol:

7. Switch the terminator switch to ON position on the last device of the chain.
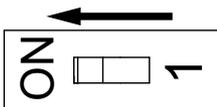
8. Connect the first device of the chain to the communication base station.

  - • If your device chain communicates through Modbus RTU protocol, the first device in the chain must be connected to a Modbus master device.
  - • If your device chain communicates through Sintrol Network protocol, the first device in the chain must be connected to Sintrol Router or Network Router. The router device in turn must be connected to a host computer.

The device network is now operational, and you can use the master device to control the devices.

8.3.3 Wireless device network

It is possible for multiple devices to communicate with each other using the optional radio frequency (RF) communication protocol. The wireless connection operates on the Sintrol Network protocol, which takes care of automatically forming the network. The measurement data is always transmitted using the strongest available connection.

 If you want to use the wireless connections, you must have a RF-enabled version of the device. RF antenna cannot be retrofitted to non-RF models.

The network operates within the ISM radio bands, which do not require any permits or licenses to use.

Table 12: ISM frequency bands that the device uses

Frequency band	Geographical availability
868 MHz	Europe
915 MHz	North and South America, Australia

 It is the responsibility of the end user to verify the available frequency bands and potential licensing needs in their area.

Sintrol Network protocol has a built-in support for wireless communication. This means that RF-enabled devices can operate seamlessly within the RS-485 network.

Establishing wireless communication

To establish a wireless connection, you need:

- A device equipped with the optional RF antenna
- Wireless Router
- DustTool software

To enable wireless connection:

1. Install the RF-enabled device as instructed in chapter **Mechanical installation**.
2. Install Wireless Router and connect it to the host computer as instructed in the related user manual.
3. Launch DustTool and select the router device from the list of connected devices.
4. Navigate to NETWORK tab.

5. NETWORK tab contains a graphical view of the device network. Right-click the icon of the router and select "Scan Network". The software automatically identifies the devices in the network and allows you to control their settings and parameters.

6. Close DustTool.

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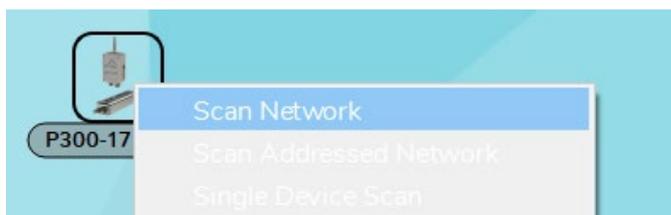
8.3.4 Combining wired and wireless connections in a network

Sintrol Network protocol supports communication using both the RS-485 bus and wireless RF connection. This means that it is possible to build a device network that uses both the wired and wireless connections.

To enable wireless communication in an existing device network that uses wired connections, at least one device in a device chain must be equipped with the RF capability. This device acts as a communication station that converts the physical signal from the other devices to radio frequencies. The communication station also converts radio frequencies from the host application to physical signals and passes them to the other devices in the network.

To manage the device network with a computer, connect a Wireless Router to a computer running DustTool. This router act as a base station for all communication between the control software and the device network. Figure 32 shows an example of a device network that uses both connection types:
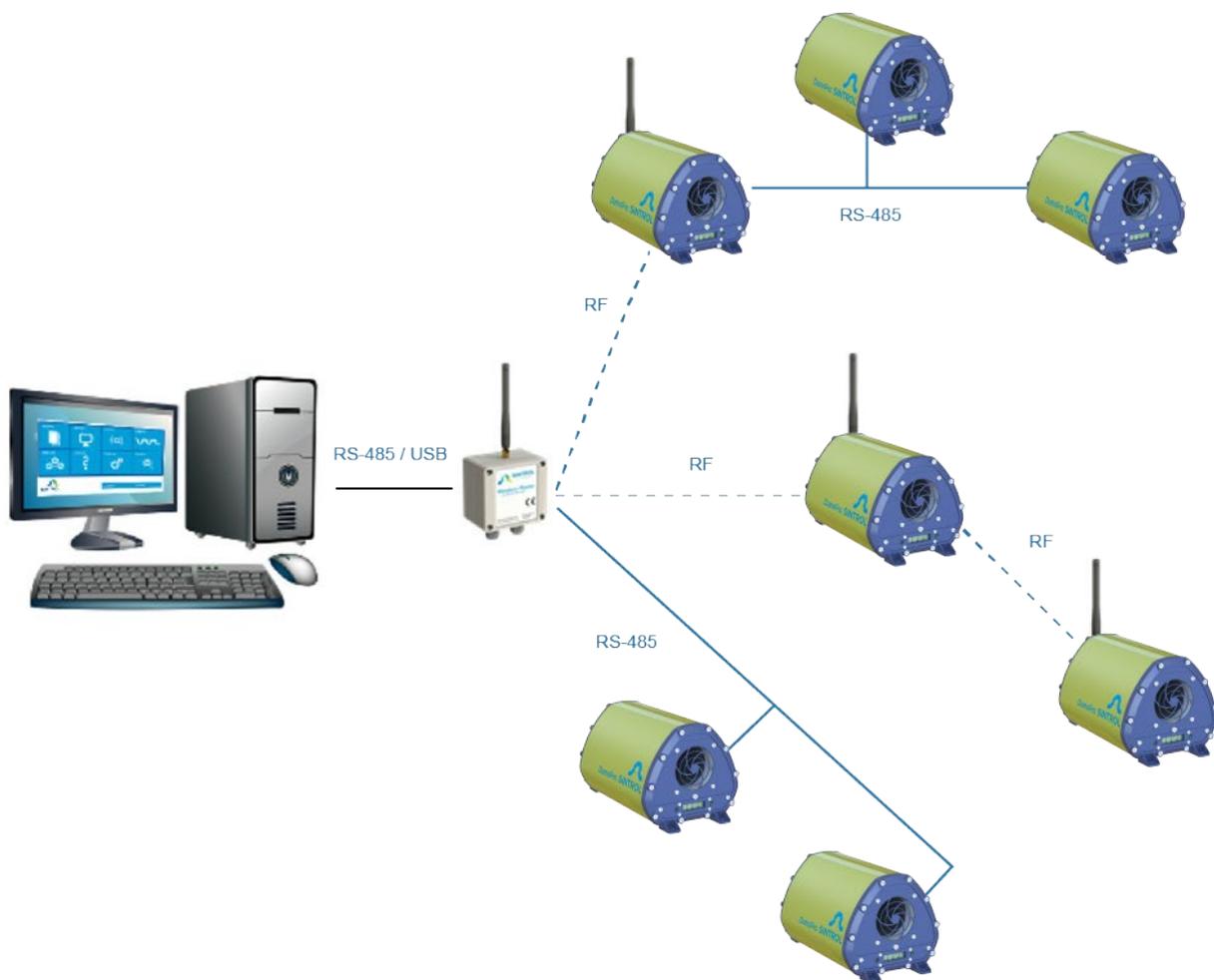
Figure 32: An example of a device network using Sintrol Network protocol with wired and wireless connections

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9 Operation

9.1 Main interface

The main board of the device is equipped with six operation and navigation keys (Figure 33).
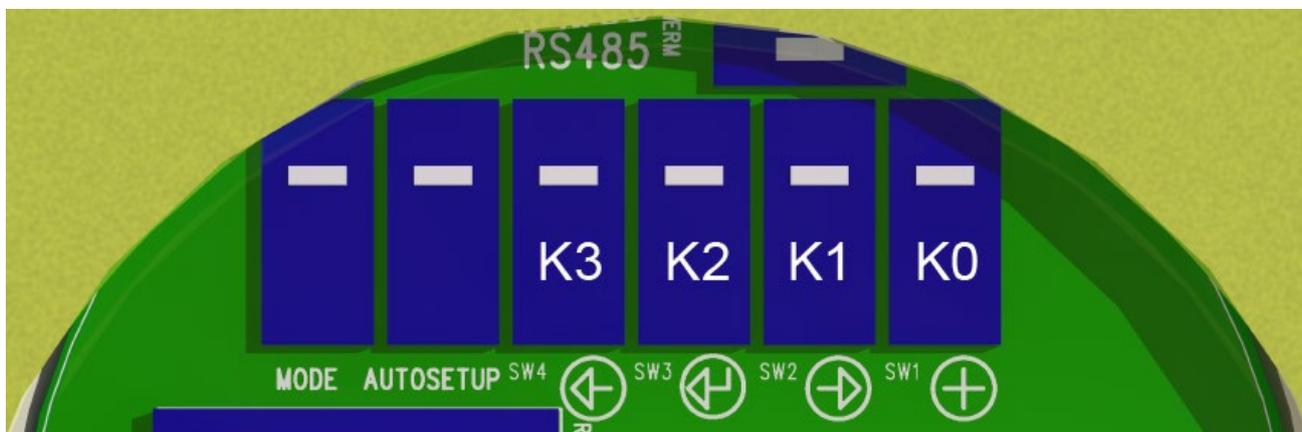
Figure 33: Operation and navigation keys on the main board of the device

See Table 13 for the description of each key.

Table 13: Description of operation and navigation keys

MODE	
AUTOSETUP	AUTOSETUP key. Performs Auto Setup.
K3 (←)	K3 key. Exits and returns the device to normal operation.
K2 (↵)	K2 key. Saves the active parameter value.
K1 (→)	K1 key. Moves the cursor one step to the right.
K0 (+)	K0 key. • Enters MAINTENANCE mode. • Increases the value of the selected, blinking digit by 1.

* Key labels K0 … K3 are included in this manual for reference purposes only. They are not printed on the device.

The front panel of the device is equipped with a 7-segment display with four digits (Figure 34). In normal operation, the display shows the measurement result as a percentage of total range (0 ... 100%) or as a measurement value in mA or mg/m^3.

You can change the display unit with **Parameter 1**. See section **Parameters** for more information.

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Figure 34: Display on the front panel of the device

See Table 14 for description of the front panel.

Table 14: Front panel of the device

①	7-segment display with four digits.*
	
	• In normal operation, indicates the measurement value.
	• In MAINTENANCE mode:
	    ○ Position D0 indicates the active parameter number.
	    ○ Positions D1 … D3 indicate the parameter value.

②	Status LEDs.

* Display position labels D0 … D3 are included in this manual for reference purposes only. They are not printed on the device.

9.2 Relay, LED and display functional logic

The device has various operation statuses that are indicated to the user with a combination of LEDs, two relays and a 7-segment display with four digits.

9.2.1 Operation statuses

The operation statuses are described in Table 15:

Table 15: Operation statuses and their descriptions

Device status	Description
NORMAL OPERATION	• The device operates normally according to the initial setup and generates a valid output signal. • The output signal is below the configured thresholds for ALERT and ALARM statuses.
ALERT	• The device operates normally according to the initial setup and generates a valid output signal. • The output signal is above the configured threshold for ALERT status. • The output signal is below the configured threshold for ALARM status.

Device status	Description
ALARM	• The device operates normally according to the initial setup and generates a valid output signal. • The output signal is above the configured threshold for ALARM status.
AUTO SETUP	• The device analyzes and establishes normal process conditions that are used as a baseline for future measurements. • The device does not generate a valid output signal.
MAINTENANCE	• The device has been manually set into MAINTENANCE mode. • The device does not generate a valid output signal.
ZERO/SPAN CHECK	• The device performs zero/span check automatically at a certain interval, when the measurement range settings are changed, and after each time Auto Setup is performed. • Measurement drift is automatically corrected if it is >3% but <10% of the measurement range. If the drift is >10% or if the device is unable to correct the drift, the device enters FAULT mode. • The device generates an output signal according to pre-determined test values.
FAULT	• The device has detected a fault in the operation. • The device does not generate a valid output signal.

9.2.2 Relay logic

The device has two independent solid-state relays (SSR). The relays are used to indicate dust alarm statuses to a monitoring system. The contacts on the relay terminal block are labeled "1" and "2" for the individual relays. The common contact is labeled "C". The relays can be used to power external loads of up to 30 V DC / 1 A.
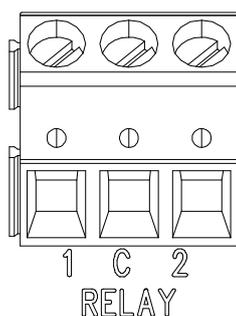
Figure 35: Relay terminal on the device main board

Both relays are energized during normal operation, which means that voltage is applied to the solid-state relay. When the dust level exceeds the configured alarm thresholds, the voltage is no longer supplied, and the relays are relaxed.

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Table 16: Relay statuses

Relay status	Relay contacts	Description
Relay 1: Energized Relay 2: Energized	C — 1, 2	The device operates normally, and dust concentration is below the configured ALERT and ALARM thresholds. Voltage is supplied to both relays.
Relay 1: Relaxed Relay 2: Energized	C — 1, 2	The dust concentration is above the ALERT threshold but below the ALARM threshold. Relay 1 switches status and triggers ALERT. Voltage is supplied to Relay 2.
Relay 1: Relaxed Relay 2: Relaxed	C — 1, 2	The dust concentration is above the configured ALARM threshold. Relay 2 switches status and triggers ALARM. Both relays are relaxed.
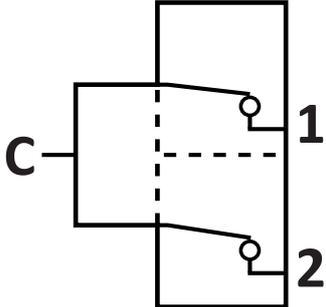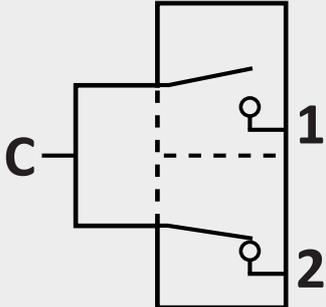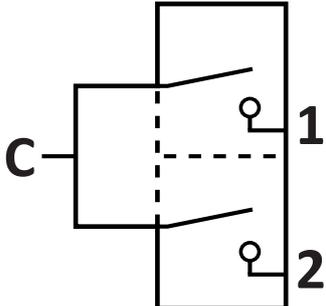
The operation logic of the relays is described in Table 17.

Table 17: Operation logic of the relays

Device status	Relay 1 status	Relay 2 status	Analog signal (mA)
NORMAL OPERATION	Energized	Energized	According to dust level
ALERT	Relaxed	Energized	According to dust level
ALARM	Relaxed	Relaxed	According to dust level
MAINTENANCE	Energized	Relaxed	According to dust level
AUTO SETUP	Energized	Relaxed	>22 mA
ZERO/SPAN CHECK	Energized	Relaxed	4 mA for Zero check, approx. 16.8 mA for Span check
FAULT	Relaxed	Relaxed	>22 mA

9.2.3 LED and display logic

The main interface of the device is equipped with a 7-segment display and red and green status LEDs. The LEDs are mirrored, and their function is the same regardless of their location on the main interface.

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The operation logic of the display and LEDs is described in Table 18:

Table 18: Operation logic of the LEDs and display

Device status	Green LED	Red LED	Display
NORMAL OPERATION	ON	OFF	Displays current dust level
ALERT	ON*	ON*	Displays current dust level
ALARM	OFF	ON	Displays current dust level
AUTO SETUP	Blinks	OFF	Countdown (sec)
MAINTENANCE	Blink between green and red with 500 ms interval	Blinks between red and green with 500 ms interval	Number and value of active parameter
ZERO/SPAN CHECK	Blinks between green and red with 500 ms interval	Blinks between red and green with 500 ms interval	Output signal
FAULT	OFF	Blinks between left and right with 500 ms interval	Error code

* With both red and green LEDs ON, the color appears orange.

To test that the display and LEDs are operating normally, press K0 (＋) and K3 (←) keys at the same time. All four displays are activated, displaying "8.8.8.8.", and status LEDs on each side of the display are illuminated. This indicates that the display and LEDs are operating as intended.

For descriptions of error codes, see section **Error codes in FAULT mode**.

9.3 Response modes

Figure 36: Mode selector key on the main board

The device has user-selectable FAST, MEDIUM and SLOW response modes, which determine how fast the device reacts to changes in dust levels. This is done by applying pre-programmed values to parameters that control signal averaging time and alarm delay time.

Signal averaging time determines the period from which the device calculates the average signal level. Alarm delay time determines how long the dust level must be above the configured ALERT or ALARM threshold before the relays switch position and activate the alarms. This is to avoid false alarms caused by naturally occurring peaks in dust levels in certain processes.

Response modes also affect the ALERT and ALARM thresholds that the device sets automatically during Auto Setup based on the measurement baseline. Each response mode has pre-programmed multipliers for the measurement baseline that are used to set the ALERT and ALARM thresholds.

The response modes are pre-programmed, and you can switch between them with a mode selector key that is located on the main board of the device, or with a magnetic key on the front panel if you have a device with magnetic switching feature enabled. When changing the response mode, the selected mode is indicated on the device display.

Settings used in each response mode are described in Table 19.

Table 19: Pre-programmed response modes

Response mode	Signal averaging time	Alarm delay time	Alarm thresholds after Auto Setup
FAST	10 second	10 seconds	ALERT: 3× baseline ALARM: 10× baseline
MEDIUM	50 seconds	30 seconds	ALERT: 5× baseline ALARM: 20× baseline
SLOW	100 seconds	60 seconds	ALERT: 5× baseline ALARM: 20× baseline

The baseline of the previous Auto Setup is always stored in the device memory. When you change the response mode, the device applies the appropriate multipliers to the baseline, and adjusts the parameters for ALARM and ALERT thresholds automatically.

In addition to the mode selector and navigation keys on the device main board, all device parameters can be manually adjusted in DustTool. For more detailed information about device parameters, see section **Parameters** in this chapter.

Using the mode selector key overwrites any previously made parameter changes.

9.4 Parameters

For instructions on how to change the device parameters, see section **Changing parameters** in chapter **Commissioning and system setup**.

9.4.1 Overview

You can control how the device operates and reacts to changes in dust levels by adjusting the device parameters. To change parameter values on the main display, press K0 (+) key to enter MAINTENANCE mode. The device indicates the parameter number on the display position D0, and parameter values on positions D1 ... D3.

Because only one display position is reserved for the parameter number, 2-digit parameters are indicated in an abbreviated form. Parameter 10 is indicated as 0, and parameters 11 to 17 as 1., 2., 3. and so on, with a single digit followed by a period.

See Table 20 for an overview of the user-adjustable parameters:

Table 20: The device parameters

No.	Parameter	Value
1	Display unit	000: Displays measurement range in %. Default value. 001: Displays output signal level in mA. 002: Displays dust concentration in mg/m^3. Displays - -.- - if mg/m^3 is disabled.
2	Signal averaging time (sec)	000 ... 300 Default = 50 sec
3	Measurement range (%)	000 ... 999 Default = 100% (20× the baseline value calibrated during Auto Setup)
4	ALERT threshold (% of range)	000 ... 100 Default = 25% (8 mA)
5	ALARM threshold (% of range)	000 ... 100 Default = 100% (20 mA)
6	Alarm delay time (sec)	000 ... 180 Default = 30 sec
7	*Flow velocity compensation at 4 mA (m/s)*	*Parameter not functional on this device.* *Displays "00.0" when selected.*
8	*Flow velocity compensation at 20 mA (m/s)*	*Parameter not functional on this device.* *Displays "00.0 " when selected.*
9	Zero/Span check interval (hours)	000 ... 999 Default = 0 hours (no check)
0 (10)	Command parameter	001: Reset to factory default 002: Enable mg/m^3 calibration 003: Disable mg/m^3 calibration
1. (11)	Integer part of x-intercept α	–99 ... 099 Default = 0 mg/m^3
2. (12)	Decimal part of x-intercept α	000 ... 999 Default = 0 mg/m^3
3. (13)	Integer part of slope β	000 ... 999 Default = 0 mg/m^3 per mA
4. (14)	Decimal part of slope β	000 ... 999 Default = 0 mg/m^3 per mA
5. (15)	20 mA scaling × 1 000 000 IEU	000 ... 999 Default = 004
6. (16)	20 mA scaling × 1000 IEU	000 ... 999 Default = 000

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No.	Parameter	Value
7. (17)	Firmware version	Displays current firmware version.

9.4.2 Parameter 1: Display unit

Parameter 1 is used to determine the unit that the device uses when it displays the measurement signal level. See Table 21 for descriptions of the parameter values:

Table 21: Parameter 1 values

Value	Description	Display
000	Displays measurement range in %. Default value.	0.0 ... 100.0 (%), fixed decimal point
001	Displays output signal level in mA.	04.00 ... 20.00 (mA), fixed decimal point
002	Displays dust concentration in mg/m^3.	00.01 ... 999.9 ... 9999 (mg/m^3), floating decimal point

If the mA output is not properly connected and parameter value 001 is selected, the display indicates "OL" for "Open Loop". This means that the 4 ... 20 mA loop is not closed.

The device indicates the currently selected measurement unit every 8 seconds by showing it on the display for 2 seconds. For parameter value 000 the device displays "%", for parameter value 001 it displays "mA" and for 002 it displays "mg".

9.4.3 Parameter 2: Signal averaging time

Signal averaging time refers to the period from which the device calculates the average signal level. For example, with the default value of 50, the displayed measurement result is the moving average of the past 50 seconds.

Signal averaging time cannot be changed with the local user interface. You must use DustTool to change parameter 2 value.

9.4.4 Parameter 3: Measurement range

Parameter 3 value controls the maximum measurement range in relation to the baseline value that is determined during Auto Setup. You can control the maximum dust concentration that the device can detect before reaching the maximum output signal of 20 mA by changing the parameter value. This scales the whole measurement range to the standard 4 ... 20 mA signal range.

If Auto Setup has not been performed, the display indicates "3 - - -" when this parameter is selected.

Table 22: Parameter 3 values

Value range (%)	Description	Default
000 ... 999	Increases or decreases the maximum dust concentration at 20 mA output signal.	100

With the default value, the device can detect a 20× increase in the dust level in relation to the baseline before reaching 20 mA signal level. This represents 100% of the default measurement range.

The maximum range determined with parameter 3 is always calculated from the baseline value. In practice, parameter 3 value sets a multiplier for how much the dust concentration can increase before the output signal reaches 20 mA.

See Table 23 for examples on how changing the parameter value affects the measurement range:

Table 23: Examples of adjusting the measurement range with parameter 3

Value (%)	Description	Dust level at 20 mA
050	Halves the measurement range	10× baseline
100	Default value	20× baseline
200	Doubles the measurement range	40× baseline

After adjusting the measurement range, the device automatically performs zero/span check.

Adjusting the measurement range does not change the dust concentrations required to trigger ALERT and ALARM statuses. Instead, it adjusts parameter 4 and 5 values in relation to the new maximum range. For example, doubling the measurement range with parameter 3 halves the values of parameters 4 and 5.

For detailed information on the default measurement range and signal levels, see section **Auto setup** in chapter **Commissioning and system setup**.

9.4.5 Parameter 4: ALERT threshold

Parameter 4 controls the relation between the maximum measurement range (adjusted with parameter 3) and the ALERT status threshold. Parameter value corresponds to the signal level required to trigger the ALERT status.

Table 24: Parameter 4 values

Value range (%)	Description	Default
000 ... 100	Increases or decreases the signal level required to trigger the ALERT status.	025

See Table 25 for examples on how the parameter value affects the signal level required to trigger the ALERT status.

Table 25: Examples of adjusting ALERT threshold with parameter 4

Value (%)	Description
012	Halves the default signal level. ALERT triggers at 12% of maximum range.
025	Default value. ALERT triggers at 25% of maximum range.
050	Doubles the default signal level. ALERT triggers at 50% of maximum range.

ALERT threshold is set in relation to maximum measurement range, which is determined with parameter 3. These two parameters are not linked and must be set independently. For example, if you double the maximum measurement range, the default parameter 4 value is decreased from 025 to 012 (25% to 12% of maximum measurement range).

9.4.6 Parameter 5: ALARM threshold

Parameter 5 controls the relation between the maximum measurement range (adjusted with parameter 3) and the ALARM status threshold. Parameter value corresponds to the signal level required to trigger the ALARM status.

Table 26: Parameter 5 values

Value range (%)	Description	Default
000 ... 100	Increases or decreases the signal level required to trigger the ALERT status.	100

See Table 27 for examples on how the parameter value affects the signal level required to trigger the ALARM status.

Table 27: Examples of adjusting ALARM threshold with parameter 5

Value (%)	Description
050	Halves the default signal level. ALARM triggers at 50% of maximum range.
100	Default value. ALARM triggers at 100% of maximum range.

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ALARM threshold is set in relation to maximum measurement range, which is determined with parameter 3. These two parameters are not linked and must be set independently. For example, if you double the maximum measurement range, the default parameter 5 value is decreased from 100 to 050 (100% to 50% of maximum measurement range).

9.4.7 Parameter 6: Alarm delay time

Parameter 6 determines how long the average dust level must be above the configured ALERT or ALARM threshold before an alarm is triggered. This is to avoid false alarms caused by naturally occurring peaks in dust levels in certain processes.

Parameter value corresponds to the alarm delay time in seconds.

Table 28: Parameter 6 values

Value range (sec)	Description	Default
000 ... 180	Sets the alarm delay time in seconds.	30

Parameter 6 applies a delay to all relay position switches when the device changes its operation status. However, in practice this only affects the operation of the device in relation to ALARM and ALERT statuses.

9.4.8 Parameter 9: Zero/Span check interval

Zero/span check is an automatic self-diagnostics procedure. During zero/span check, the device disconnects the sensor probe from the measurement chain and induces a computer-generated signal to the processing electronics. This is done to ensure that the measurement results match the factory-calibrated reference values. Parameter 9 controls how often the device performs zero/span check.

Parameter value corresponds to the zero/span check interval in hours.

Table 29: Parameter 9 values

Value range (h)	Description	Default
000 ... 999	Sets the zero/span check interval in hours.	000

Parameter value 000 means that the automatic zero/span check is disabled. The device performs zero/span check independently of the parameter 9 value each time you adjust the range setting with parameter 3, and each time Auto Setup is performed.

9.4.9 Parameter 10: Command parameter

Command parameter 10 can be used to reset the device to the default factory settings and to enable the device to display the measurement results in mg/m^3.

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See Table 30 for descriptions of the parameter values:

Table 30: Parameter 10 values

Value	Description
001	Reset all parameters to default factory values.
002	Enable mg/m^3 calibration.
003	Disable mg/m^3 calibration.

Reset to default factory values

To reset the device to the default factory settings:

1. Press K0 (+) key to enter MAINTENANCE mode.

2. Navigate to parameter 10.

3. Enter parameter value 001 and press K2 (↩) key to save the value.

4. Press K3 (←) key to exit and return to normal operation.

All device parameters are now overwritten with the default factory values.

Resetting the device to factory settings with command parameter 10 rewrites all parameter values, including the ones set with Auto Setup.

Enable mg/m^3 calibration

To enable displaying the measurement results in mg/m^3:

1. Press K0 (+) key to enter MAINTENANCE mode.

2. Enter the values α and β of the calibration equation $y_i = \alpha + \beta x_i$ to parameters 11, 12, 13 and 14. After setting the value for each parameter, press K2 (↩) key to save the new value.

   See section **Parameters 11 to 14: Displaying measurement results in mg/m^3** for information about the calibration equation and individual calibration parameters.

3. Navigate to parameter 10.

4. Enter parameter value 002 and press K2 (↩) key to save the value.

5. Navigate to parameter 1.

6. Enter parameter value 002 and press K2 (↩) key to save the value.

7. Press K3 (←) key to exit and return to normal operation.

The measurement results are now displayed in mg/m^3.

Disable mg/m³ calibration

To disable displaying the measurement results in mg/m³:

1. Press K0 (＋) key to enter MAINTENANCE mode.

2. Navigate to parameter 10.

3. Enter parameter value 003 and press K2 (↵) key to save the value.

4. Navigate to parameter 1.

   - Enter parameter value 000 to display the measurement range in %.
   - Enter parameter value 001 to display output signal level in mA.

> **If you do not set a new value for parameter 1, the device alternates between displaying "- -.- -" and "mg" in normal operation mode.**

5. Press K2 (↵) key to save the value.

6. Press K3 (←) key to exit and return to normal operation.

9.4.10 Parameters 11 to 14: Displaying measurement results in mg/m³

To enable the device to display the measurement results in mg/m³, the device must be calibrated by inserting values from a calibration equation to parameters 11, 12, 13 and 14. These values are calculated by utilizing a linear regression curve with an equation $y_i = \alpha + \beta x_i$. To determine the parameter values for parameters 11 to 14, you need to know the values for x-intercept α and slope β. The values are calculated from the results of a reference measurement. A commonly used method is gravimetric sampling.

> **This section describes how to perform the calibration using the local display. You can also use DustTool to calibrate the device to display measurement results in mg/m³.**

> **After setting values for parameters 11 to 14, enable mg/m³ calibration with parameter 10 and set the local display to show measurement results in mg/m³ with parameter 1.**

Example parameter values

For setting the parameters, values α and β are split into integer and decimal parts:

- Integer part of value α becomes the value for parameter 11.
- Decimal part of value α becomes the value for parameter 12.
- Integer part of value β becomes the value for parameter 13.
- Decimal part of value β becomes the value for parameter 14.

Table 31 uses example values to show how these values are used to set the parameter values for calibrating the device to display the measurement results in mg/m³:

Table 31: Example values for parameter 11 to 14

No.	Parameter	Calibration variable	Parameter value
1. (11)	Integer part of x-intercept α	$\alpha = -\mathbf{8}.625$	−08
2. (12)	Decimal part of x-intercept α	$\alpha = -8.\mathbf{625}$	625
3. (13)	Integer part of slope β	$\beta = \mathbf{1}.625$	001
4. (14)	Decimal part of slope β	$\beta = 1.\mathbf{625}$	625

Parameter 11: Integer part of x-intercept α

Parameter 11 is used to set the calibration value for the integer part of x-intercept α when the device is calibrated to display measurement results in mg/m^3.

Table 32: Parameter 11 values

Value range (mg/m^3)	Description	Default
−99 … 099	Value for the integer part of x-intercept α.	000

Parameter 12: Decimal part of x-intercept α

Parameter 12 is used to set the calibration value for the decimal part of x-intercept α when the device is calibrated to display measurement results in mg/m^3.

Table 33: Parameter 12 values

Value range (mg/m^3)	Description	Default
000 … 099	Value for the decimal part of x-intercept α.	000

Parameter 13: Integer part of slope β

Parameter 13 is used to set the calibration value for the integer part of slope β when the device is calibrated to display measurement results in mg/m^3.

Table 34: Parameter 13 values

Value range (mg/m^3/mA)	Description	Default
000 … 099	Value for the integer part of slope β.	000

Parameter 14: Decimal part of slope β

Parameter 14 is used to set the calibration value for the decimal part of slope β when the device is calibrated to display measurement results in mg/m^3.

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Value range (mg/m³/mA)	Description	Default
000 … 099	Value for the decimal part of slope β.	000

9.4.11 Parameters 15 and 16: IEU to 20 mA scaling

Parameters 15 and 16 control the maximum measurement range by setting an IEU value that corresponds to the 20 mA output signal. This allows you to set the measurement range more accurately than with parameter 3, which controls the measurement range by setting a multiplier in relation to the baseline value.

The IEU scale ranges from 0 to several million units. Because of this, setting the IEU value is done with two parameters. Parameter 15 sets the IEU value in millions, and parameter 16 in thousands.

Table 36: Parameter 15 and 16 functions

No.	Parameter	Description
5. (15)	IEU units in millions	Parameter value represents × million IEU units
6. (16)	IEU units in thousands	Parameter value represents × thousand IEU unit

This means that for setting 20 mA to correspond to, for example, 125 020 000 IEU, the parameter values would be as shown in Table 37:

Table 37: Example parameter values for 125 020 000 IEU

No.	Parameter	Parameter value
5. (15)	IEU units in millions	125
6. (16)	IEU units in thousands	020

Adjusting the measurement range with parameters 15 and 16 overrides the previous range settings done using parameter 3.

Parameter 15: IEU units in millions

Parameter 15 sets the million part of the IEU value that corresponds to 20 mA output signal. Parameter value represents × million IEU units.

Table 38: Parameter 15 values

Value range (million IEU)	Description	Default
000 … 999	Sets the million part of the IEU value	004

Parameter 16: IEU units in thousands

Parameter 16 sets the thousand part of the IEU value that corresponds to 20 mA output signal. Parameter value represents × thousand IEU units

Table 39: Parameter 16 values

Value range (thousand IEU)	Description	Default
000 … 999	Sets the thousand part of the IEU value	000

9.4.12 Parameter 17: Firmware version

Parameter 17 is a read-only parameter. Navigating to it returns the current firmware version.

The user cannot update the device firmware on-site.
To update firmware version, contact the manufacturer or an authorized distributor.

9.5 Troubleshooting

If performing the checks as instructed in this section does not solve your problem, contact the manufacturer or an authorized distributor.

9.5.1 Resetting RS-485 settings to factory defaults

In case you must reset the device RS-485 communication settings to factory defaults, you can manually initiate an internal boot check. During internal boot check the device performs self-checks that ensure that all the functions that are essential to its operation are working as intended.

During boot check the RS-485 settings are reverted to the default factory settings.

To initiate boot check:

1. Disconnect the power supply to power down the device.
2. Connect the power supply to power up the device again.
3. Press AUTOSETUP key within 6 seconds of the device booting up.

When performing the boot check this way outside production environment and without external test hardware, the boot check fails. After a failed boot check, the device enters FAULT mode and issues error code Err5.

4. Reboot the device again by disconnecting and connecting the power supply.

RS-485 settings are now reset to factory defaults.

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9.5.2 Error codes in FAULT mode

When the device enters FAULT mode, an error code is displayed on the local display. See below table for the error codes and their descriptions.

Table 40: Error codes

Error code	Description	Solution
Err1	Sensor probe grounded	Clean the probe.
Err2	Zero/span check failed	Check measurement response and return the device for repair.
Err3	*Flow compensation input failed*	*Not applicable to this device*
Err4	Auto Setup failed	Run Auto Setup again. If the issue persists, contact the manufacturer or an authorized distributor.
Err5	Boot check failed	Contact the manufacturer or an authorized distributor.
Err6	Internal fan malfunction	Replace the internal fan.

Err1: Sensor probe grounded

Error code "Err1" indicates that the sensor probe is grounded. In this case, power down the device and clean it with non-abrasive methods.

For more information about cleaning and inspecting the probe, see section **Cleaning flow chamber and sensor probe** in chapter **Maintenance and inspection**.

Err2: Zero/span check failed

Error code "Err2" indicates that zero/span check has failed. This happens when the device is unable to compensate for the drift, or when the drift is >10% after the first zero/span check. There are two possible causes for this:

- Measurement response is drifting due to faulty components, for example due to heat damage.
- Internal signal generator is damaged.

To determine the cause of zero/span check failure, you can use Reference Signal Generator to check if the measurement response is within the expected range.

- If the results of the check with Reference Signal Generator are within the expected range, the internal signal generator of the device is damaged. In this case the measurement results are most likely accurate, but the device is unable to confirm that there is no drift.
- If the check with Reference Signal Generator fails, the measurement response is drifting due to component failure. In this case the measurement response no longer corresponds to the actual dust concentration, and the measurement results are false.

In both cases, return the device to the manufacturer or an authorized distributor for maintenance and repair.

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Err4: Auto Setup failed

Error code "Err4" indicates that Auto Setup function has failed.

- Run Auto Setup again.
- If the problem persists, contact the manufacturer or an authorized distributor.

For more information about Auto Setup feature, see section **Auto setup** in chapter **Commissioning and system setup**.

Err5: Boot check failed

Error code "Err5" indicates that the device has failed to perform internal functions that are essential to its operation. In this case, contact the manufacturer or an authorized distributor.

Err6: Internal fan malfunction

Error code "Err6" indicates that the rotation speed of the internal fan has dropped below 1000 rpm. If the rotation speed drops below 1000 rpm or the fan fails completely, replace the internal fan according to instructions in section **Replacing malfunctioning fan** in chapter **Maintenance and inspection**.

9.5.3 Display indicates "- -.- -"

Four dashes (- -.- -) on the device display indicate that the parameters for displaying the measurement results are set improperly. The correct procedure to fix this depends which unit of measurement you want to display the measurement results with.

Displaying measurement results in mA or % of total range

If you want to display the measurement results in mA or as % of total range:

1. Press K0 (＋) key to enter MAINTENANCE mode.
2. Navigate to parameter 1.
   - Enter parameter value 000 to display the measurement result as % of total range.
     or
   - Enter parameter value 001 to display the output signal level in mA.
3. Press K2 (↵) key to save the value, and press K3 (←) key to exit and return to normal operation.

Displaying measurement results in mg/m³

If you want to display the measurement results in mg/m³:

1. Press K0 (＋) key to enter MAINTENANCE mode.
2. Enter the values α and β of the calibration equation $y_i = \alpha + \beta x_i$ to parameters 11, 12, 13 and 14. After setting the value for each parameter, press K2 (↵) key to save the new value.

   See section **Parameters 11 to 14: Displaying measurement results in mg/m³** for information about the calibration equation and individual calibration parameters.
3. Navigate to parameter 10.

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4. Enter parameter value 002 and press K2 (↵) key to save the value.

5. Navigate to parameter 1.

6. Enter parameter value 002 and press K2 (↵) key to save the value.

7. Press K3 (←) key to exit and return to normal operation.

9.5.4 Display indicates "[n] - - -"

When setting parameter values, the display can indicate "[n] - - -", where [n] is the parameter number and dashes have replaced the parameters values. This usually means that the device has not been properly commissioned to accept parameter values. For example, if you attempt to set parameter value for the measurement range (parameter 3) without running Auto Setup, the displays indicate "3 - - -".

Make sure that you have commissioned and set up the device according to instructions in chapter **Commissioning and system setup**.

9.5.5 No output signal

If the device does not generate a valid output signal during normal operation:

- Make sure that the device is connected to a power source and that all electrical connections are made correctly.
- Make sure that the power supply is ON.
- Make sure that normal processes are running.
- Perform Auto Setup.

9.5.6 No response after Auto Setup

If the device does not respond after you have performed Auto Setup:

- Make sure that the device is connected to a power source and that all electrical connections are done correctly.
- Make sure that the power supply is ON.
- Make sure that normal processes are running during Auto Setup.

10 Maintenance and inspection

10.1 Safety precautions

Read chapter "Safety" carefully before performing maintenance on the device.

The device must not be modified or repaired in any way that is not specifically described in this manual. Do not perform any mechanical or electrical repairs without contacting the manufacturer or an authorized distributor.

Only original Sintrol parts can be used for repairs. If third-party spare parts are used, the manufacturer cannot guarantee safe operation of the device. The manufacturer or distributor cannot be held liable for any damage, injury or financial loss resulting from improper use.

Wear protective glasses when working on electrical connections.

WARNING!

Risk of burns due to hot components

When installing or removing equipment, the device or the installation surface can be hot.

Wear appropriate heat-resistant gloves and follow all applicable local and plant-specific safety codes before proceeding.

WARNING!

When installing or removing the device, be aware of any potential hazards related to the installation location, for example when installing or removing the device in tight spaces or near running machinery.

WARNING!

Electric shock hazard

Faulty electrical installations, too high line voltage or incorrect operation of the device can result in an electric shock. Only trained and qualified personnel can install, commission, operate and perform maintenance on the device.

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To ensure that performing maintenance on the device is safe, keep the following points in mind:

- Power down the device when you are making electrical connections, when you intend to perform maintenance on it, or in the event of malfunction.
- Make sure that all equipment is properly grounded.
- Never perform maintenance on the device alone.

10.2 Maintenance and inspection interval

The recommended inspection and maintenance intervals depend on the operating conditions. The amount of dust and other possible substances in the measurement air affect how often the sensor must be inspected and cleaned.

During the first two weeks after installation, it is recommended to perform daily and weekly inspection and maintenance on the device.

Interval	Content
Daily	• Visually inspect the outer parts of the device, its accessories, and cables. Make sure that there is no obvious visible damage. • Make sure that the fan is rotating freely. • Check that the measurement results are within the expected range.
Weekly	• Make sure that the device lid, cable glands and cables are tightly secured. • Remove the front cover of the device and clean the probe using compressed air and a cloth. If necessary, use a soft brush. • Remove the rear cover of the device and clean the fan using compressed air. If necessary, use a soft brush.

After the first two weeks, if there is no noticeable dust build-up on the sensor probe and the probe is easy to clean, the maintenance interval can be increased step-by-step.

In non-critical applications it is the responsibility of the plant operator to decide what is the appropriate maintenance interval.

WARNING!

In critical installations, for example in applications that are related to worker health or functioning of an explosion prevention system, the recommended maintenance and inspection interval is one week.

If you notice that the device is not operating normally, contact the manufacturer or an authorized distributor. Make sure that an industry specialist inspects and approves the device for use in the

monitoring system that the device is part of, and ensures that its use complies with all local safety standards and regulations.

10.2.1 Cleaning supplies

Use a cloth or paper towel to clean the device enclosure and probe. If necessary, you can apply mild solvent or isopropyl alcohol to remove stuck-on dirt.

NOTICE
Do not use any abrasive material or corrosive substances to clean the device enclosure or sensor probe. They can damage the device or probe and influence the measurement results.

10.2.2 Maintenance of Teflon-coated probe

NOTICE
If you have a Teflon-coated probe, only use soft cloth to clean it. If you use other kinds of cleaning supplies, the Teflon coating can break. Always handle a Teflon-coated probe with care.

If the dust build-up on a Teflon-coated probe is impossible to clean or it is damaged, contact the manufacturer or an authorized distributor to have the probe replaced.

10.3 Cleaning flow chamber and sensor probe

The sensor probe can be cleaned with compressed air without disassembling the enclosure. However, if the dust buildup is stuck on the probe too tightly to remove with compressed air, you can remove the front plate of the device to access the internal flow chamber and the sensor probe.

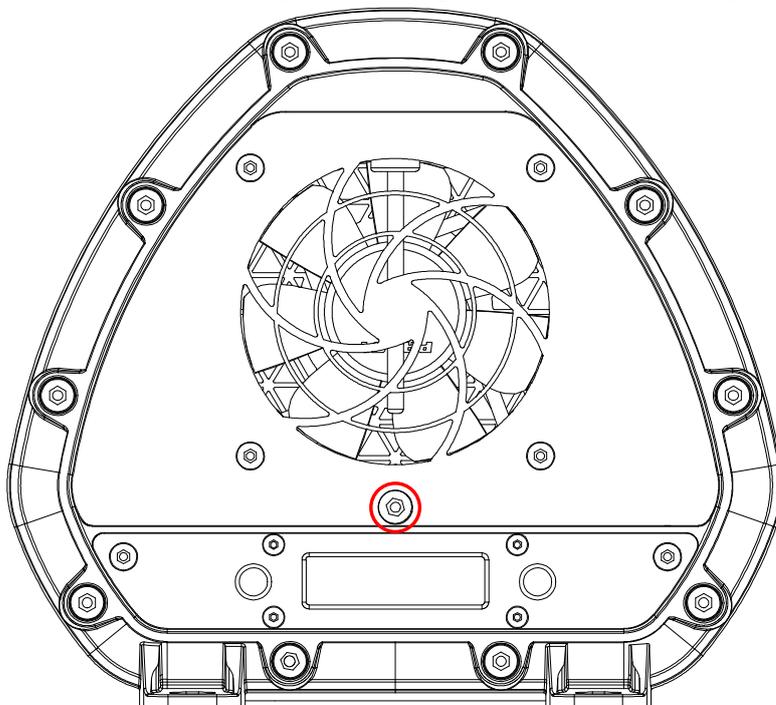To clean the internal flow chamber and sensor probe, you need:

- 4 mm hex key
- 5 mm hex key
- Cleaning supplies (soft cloth, brushes, mild solvent)

To clean the internal flow chamber and sensor probe:

1. Make sure that the device is not connected to the power supply, or that the power supply is disconnected or isolated.

2. Loosen the five bolts on the front panel using the hex keys.

   - Use the 4 mm hex key for the four small bolts located around the air inlet grating
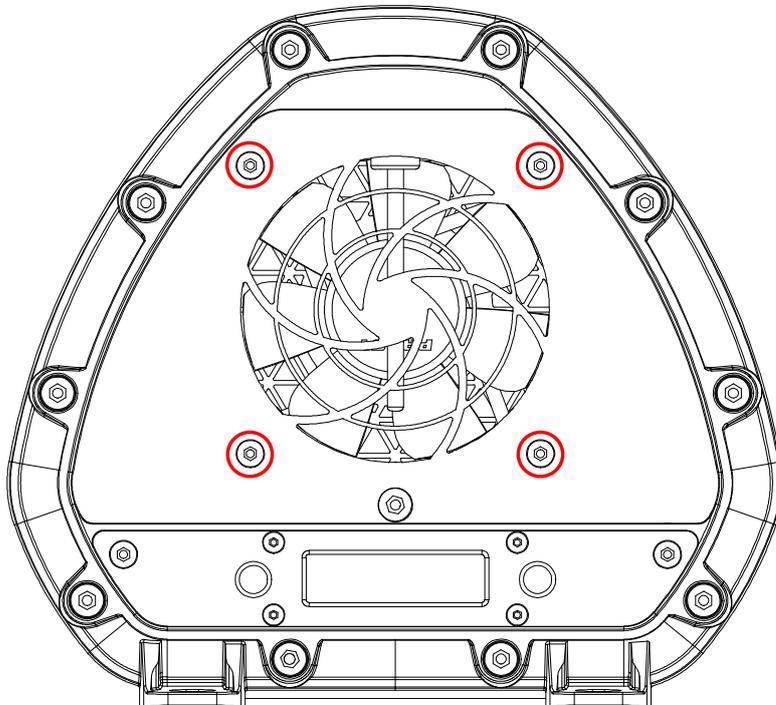
   - Use the 5 mm hex key for the single bolt located directly above the display.

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3. Remove the front panel and the internal flow chamber extension.
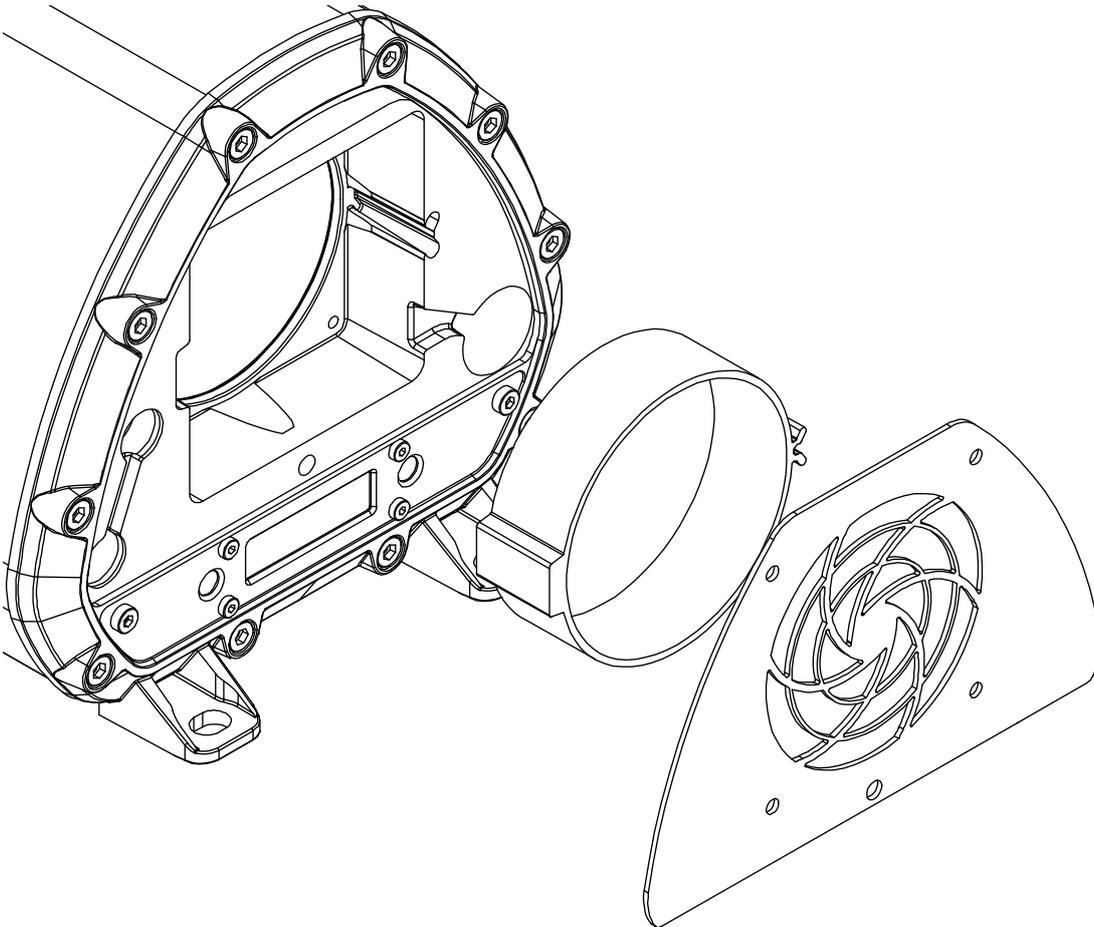
4. Clean the probe and internal flow chamber using soft cloth or brushes. If necessary, use a mild solvent to remove stuck-on dirt.

5. Place the flow chamber extension back inside the enclosure. Attach the front plate by securing it in place with the five bolts.

> **NOTICE**
>
> **Maximum tightening torque for the bolts is 7 Nm. To avoid equipment damage, do not secure the bolts tighter than the maximum tightening torque.**

10.4 Replacing malfunctioning fan

The device continuously monitors the rotation speed of the internal fan to ensure the flow velocity inside the flow chamber remains constant. If the rotation speed of the fan drops below 1000 rpm or the fan fails completely, the device enters FAULT mode and issues error code "Err6".

To replace a malfunctioning fan, you need:

- 4 mm hex key
- 5 mm hex key
- Needle-nose pliers

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To replace a malfunctioning fan:

1. Make sure that the device is not connected to the power supply, or that the power supply is disconnected or isolated.

2. Loosen the five bolts on the rear panel using the hex keys.

    - Use the 4 mm hex key for the four small bolts located around the fan grating. These four
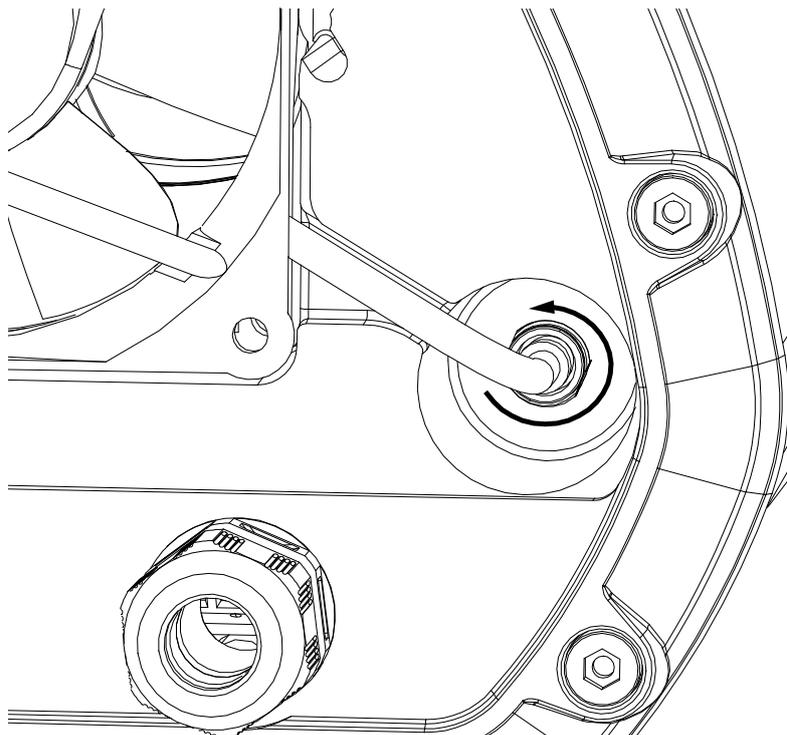   - bolts also secure the fan to the internal flow chamber.
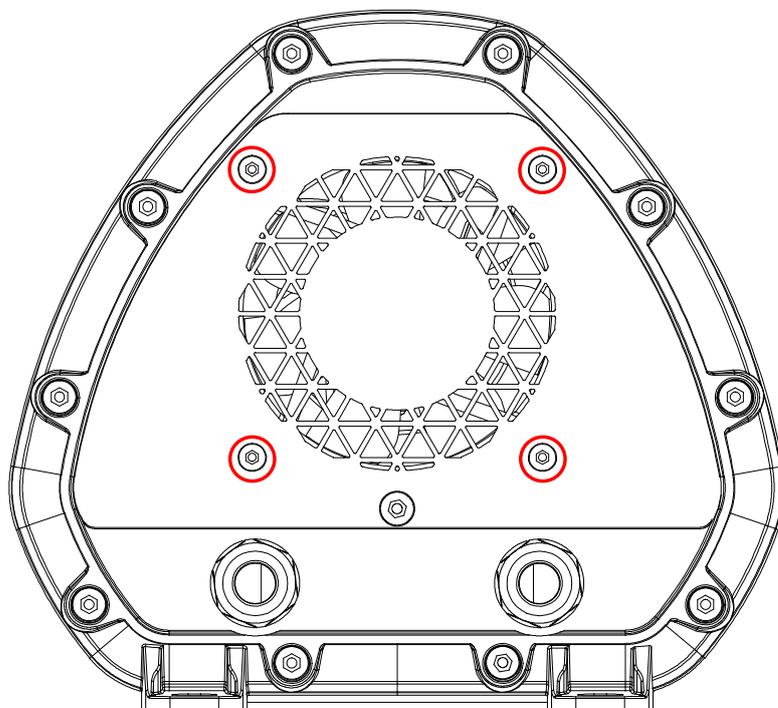
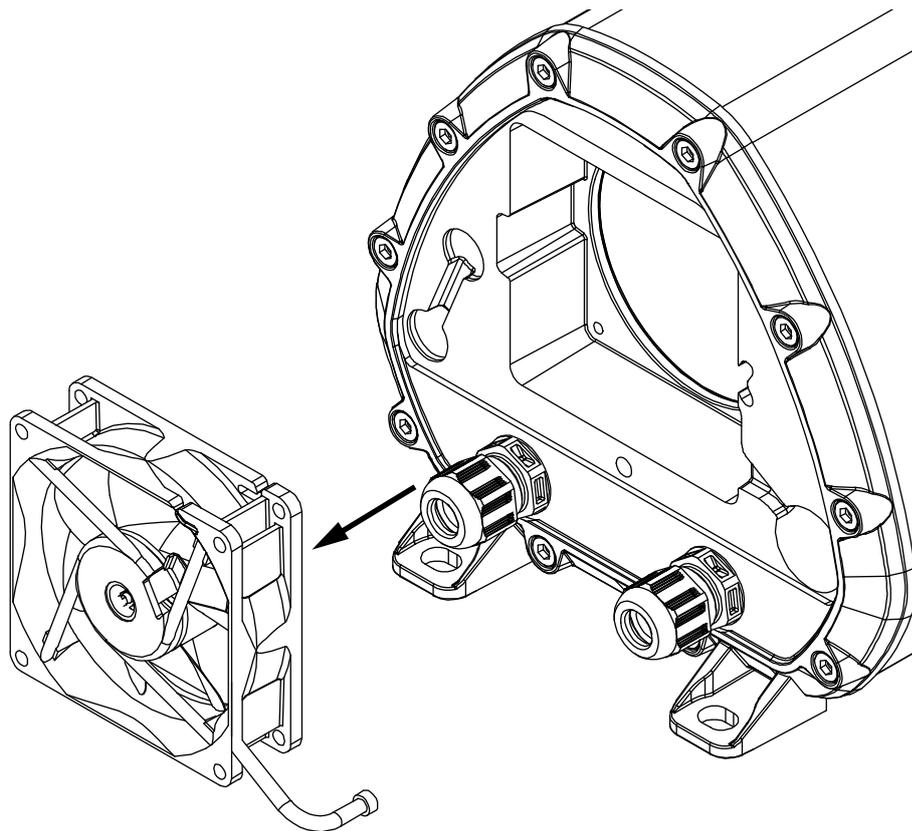   - Use the 5 mm hex key for the single bolt located between the cable glands.
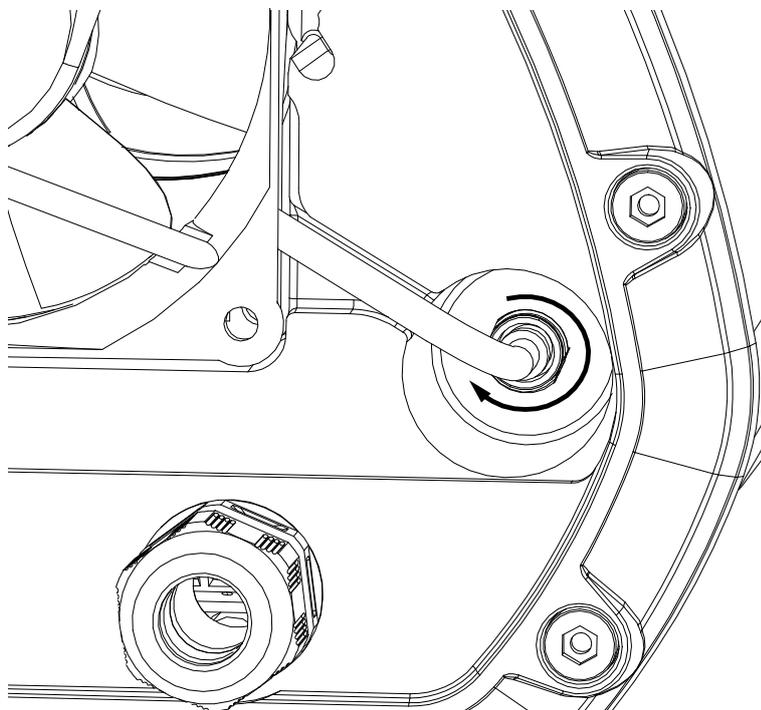
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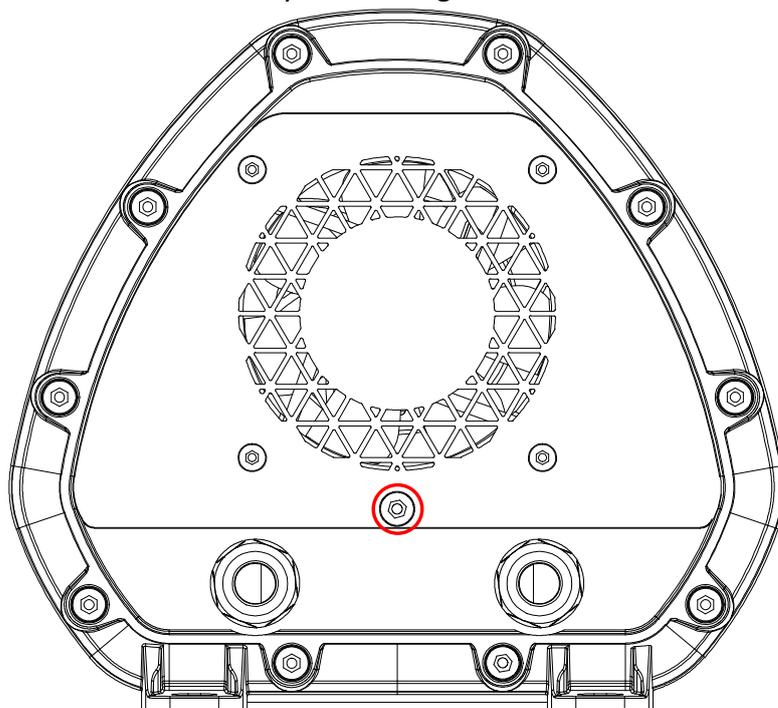
3. Remove the rear panel.
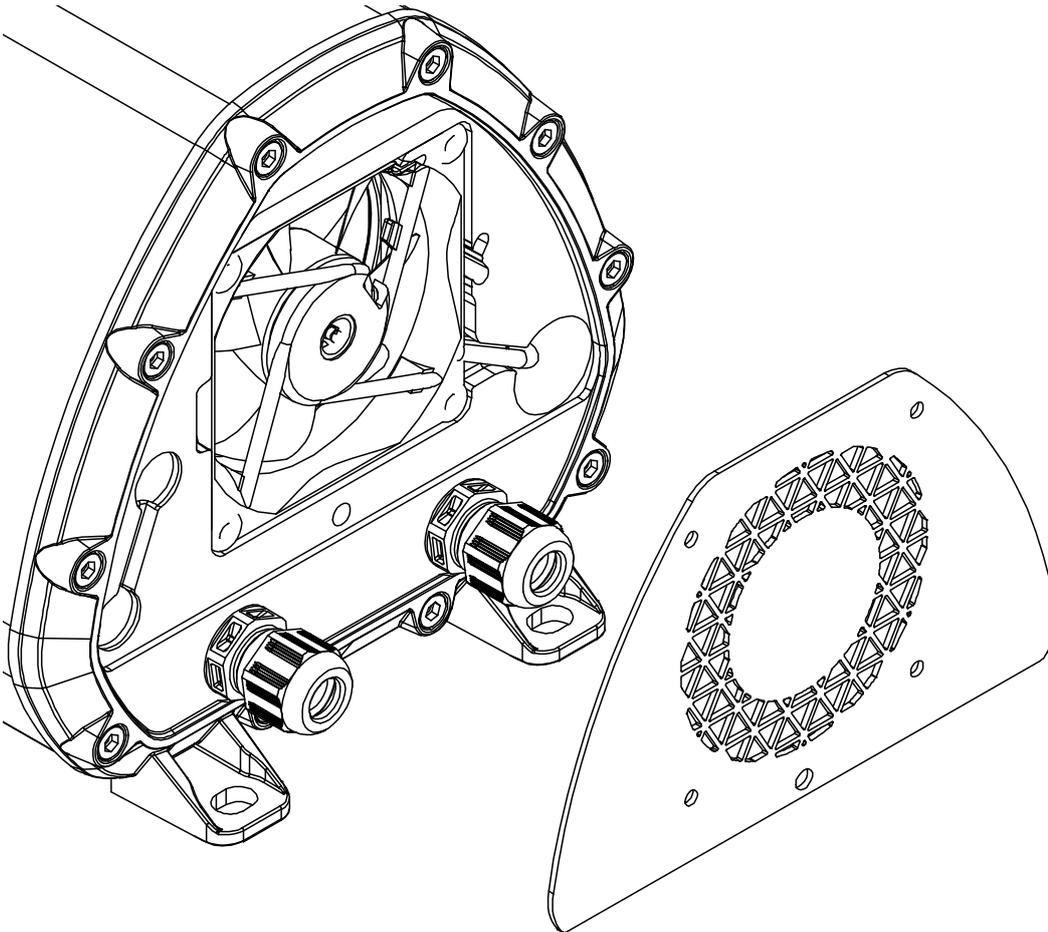
4. The fan cable uses a custom connector that is locked into place with a threaded locking ring. Disconnect the fan cable by turning it counterclockwise using needle-nose pliers.
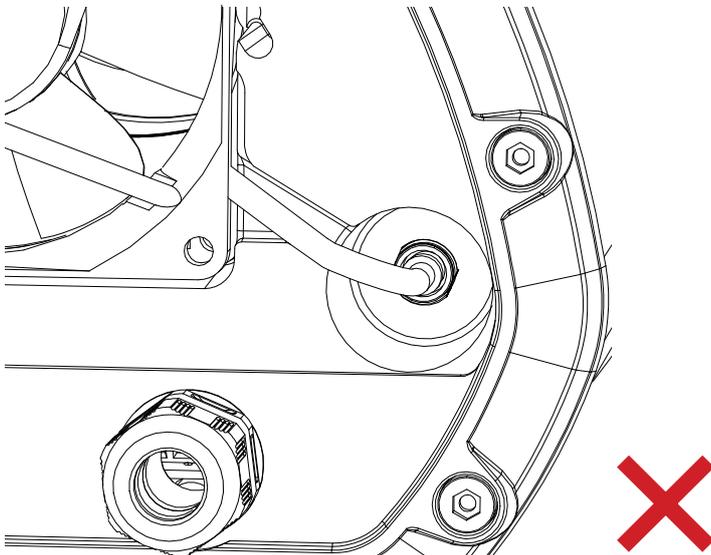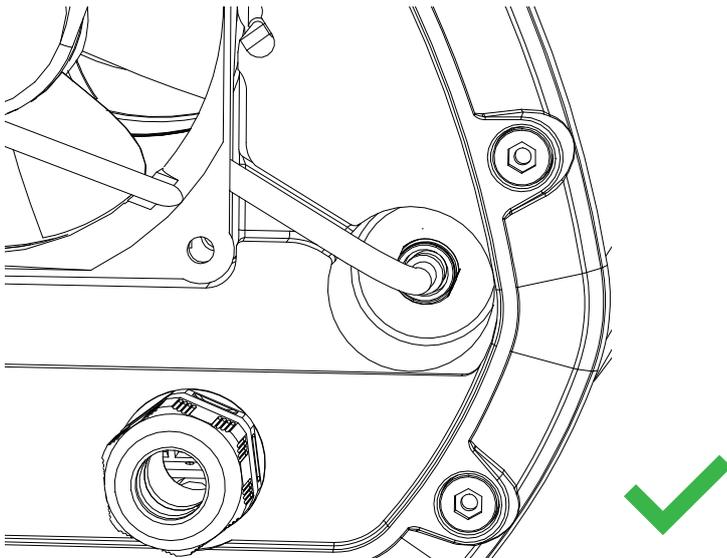
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5. Remove the fan from the enclosure.

6. Install a new fan and secure the fan cable by turning it clockwise using needle-nose pliers.

Make sure that the entire fan cable is in the designated groove and that it is not pinched between the enclosure body and rear plate.

7. Attach the rear plate by securing it in place with the five bolts.

> **NOTICE**
>
> **Maximum tightening torque for the bolts is 7 Nm. To avoid equipment damage, do not secure the bolts tighter than the maximum tightening torque.**

10.5 Returns

If you need to return a defective device for repair, replacement or disposal, contact the manufacturer or an authorized distributor. Return the device in its original packaging, or in a suitable secure container.

Contact details for the manufacturer's offices are available on the back cover of this user manual, and online at https://sintrol.com/contact/.

11 Recycling and disposal

11.1 Packaging

Recycle any paper, cardboard or plastic material used in the product packaging, and sort them in an appropriate recycling container.

Any non-recyclable packaging material must be disposed of with general waste.

11.2 Device

Electronic devices that are marked with this symbol must not be disposed of with general or household waste. If a defective or broken-down device cannot be repaired, it must be recycled and disposed of in accordance with WEEE directive (2012/19/EU) or other applicable local regulations.

12 Specifications

For dimensional drawings, see section **Dimension drawings** in chapter **Product overview**.

General information

Product name:	DumoPro
Measured objects:	Total suspended particles (TSP)
Measurement principle:	Inductive electrification
Measurement range:	Detection limit 0.01 mg/m^3 Max. range up to several g/m^3 depending on operating conditions
Ingress protection:	IP66
Power supply requirements:	24 V DC ±10%
Power consumption:	Up to 10 W
Output signals:	• 2 × Independent solid-state relays, max. 30 V DC / 1 A • Isolated active 4 … 20 mA output loop, max. loop resistance 250 Ω
Communication interface:	• Serial communication RS-485 • USB • Radio frequency*
Communication protocol:	• Modbus RTU (with RS-485) • Sintrol network (with USB, RF and RS-485)

Physical characteristics

Enclosure:	Aluminum and stainless steel (316L)
Wetted parts:	• Probe: Stainless steel (316L) • Insulation: Teflon
Weight:	4.20 kg (9.26 lb)

Ambient conditions

Temperature:	−40 … 60 °C (−40 … 140 °F)
Humidity:	Max. 95 % relative humidity (non-condensing)

* Requires optional RF antenna

Wireless communication*

Frequency bands:	• 868 MHz, 15 channels • 915 MHz (license-free ISM band)
Transmit power:	Up to +23 dBm, user-adjustable
Receiver sensitivity:	−110 dBm
Communication protocol:	Proprietary Sintrol Network protocol
Typical communication range (non-line of sight)	• 868 MHz version • Up to 1000 m (3280 ft) in urban environments**

* Requires optional RF antenna.
** Surrounding structures and other devices using radio frequencies can have significant effect on RF communication range.

Appendix A: ISO 9001 certificate

Certificate
No. 5236-05

kiwa

Inspecta Sertifiointi Oy has granted this certificate as proof that
the quality system of

Sintrol Oy
Helsinki

complies with the requirements of the standard

ISO 9001:2015

Certification covers

**Development, manufacturing, marketing, sales and maintenance services of
solutions demanding a high degree of knowledge for measuring, analyzing
and testing.**

The certificate is issued on 2021-02-03
(first issue 2009-02-06).
The certificate is valid until 2024-02-06.

Maija Vanttaja, Managing Director

The certificate is valid on condition that the quality system of the organization remains in compliance with
the aforementioned standard and the General Regulations ABC 200. The validity of the certificate can
be verified on the Internet at www.kiwa.com/fi.

Inspecta Sertifiointi Oy
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IQNet
MEMBER

kiwa
certified

ISO 9001
Inspecta Sertifiointi Oy

FINAS
Finnish Accreditation Service
S002 (EN ISO/IEC 17021-1)

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Appendix B: Modbus RTU registers

Full register definitions available from the manufacturer on request.

Default Modbus communication parameters

Baud rate:	38400
Data bits:	8
Stop bits:	2
Parity:	None

Supported function codes

Input registers (R – Read only)

- **4** – Read Input Registers

Holding registers (R/W – Read and Write)

- **3** – Read Holding Registers
- **6** – Write Single register

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Modbus RTU quick reference guide

Description	Register address	R or R/W	Data type	Notes
Unscaled measurement data [IEU] MSB	6	R	First 16 bits of a 32-bit integer	
Unscaled measurement data [IEU] LSB	7	R	Last 16 bits of a 32-bit integer	
Calibrated measurement data [mg/m3] MSB	8	R	First 16 bits of a 32-bit integer	Value must be divided by 100 to achieve the correct result. For example, value 125 = 1.25 mg/m^3.
Calibrated measurement data [mg/m3] LSB	9	R	Last 16 bits of a 32-bit integer	
Auto Setup remaining time	34	R	16-bit unsigned integer	Remaining Auto Setup time in seconds
Alarm status	50	R	16-bit Boolean values	Alarm status of the device: 00000000000000[bit1][bit0]: Bit 0 Bit 1 No alarm 1 1 ALERT 0 1 ALARM 0 0 Maintenance 1 0 Fault 0 0
Auto Setup command register	1536	W	16-bit integer	1 Start Auto Setup 2 Cancel Auto Setup
Signal averaging time	4096	R/W	16-bit unsigned integer	Measurement moving averaging time in seconds, divided by 10. For example, value 100 = 10.0 seconds.
Save measurement parameters	1538	W	16-bit integer	1 Save parameters

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Notes

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