User Manual

IMPORTANT

READ CAREFULLY BEFORE USE

READ USER MANUAL FOR OPTIONAL PRODUCTS IF APPLICABLE

KEEP FOR FUTURE REFERENCE

Dumo and Dumo RF

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Version: 2.0

ProDetec
Measure . Prevent . Protect . Control

ProDetec Pty.Ltd.
P. +61 (02) 9620 8700
F. +61 (02) 9620 8755
E. info@prodetec.com.au
A. 17/38 Powers Rd,
Seven Hills NSW 2147
www.prodetec.com.au

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1 General Information

1.1 Reading and storing the user manual

This user manual accompanies the Dumo and Dumo RF dust measuring instrument (hereafter referred to as the „Dumo"), and contains important information on installation, setup, calibration, handling and maintenance.

Before using the Dumo, read the user manual carefully. This particularly applies to the safety instructions. Failure to do so may result in personal injury or damage to the Dumo. This user manual must accessible to those tasked with the installation and operation of the Dumo.

Store the user manual for further use. Make sure to include this user manual when passing the instrument on to third parties.

1.2 Checking the Dumo and Dumo RF package contents

NOTICE	**Risk of damage!** If you are not cautious when opening the packaging with a sharp knife or other pointed object, you may quickly damage the instrument.
• Be careful when opening and removing the instrument from the packaging.	

1. Take the instrument out of the packaging.
2. Check to make sure that the delivery is complete (see 4.1 Standard Scope of delivery).
3. Check whether the Dumo or individual parts are damaged. If this is the case, do not use the instrument and contact the Sintrol Customer Service Department.

1.3 Overview of the life cycle operation

After unpacking the instrument, the whole life cycle operation shall be handled as follows:

- Choose the appropriate installation location (see chapter 6 Mechanical Installation)
- Install the instrument mechanically (see chapter 6 Mechanical Installation)
- Install the instrument electrically (see chapter 7 Electrical Installation and Wiring)
- **Run Auto setup** at normal conditions while production is running (see chapter 8.2 Auto setup description)
- Change parameters and calibrate the instrument if necessary by using
    - The selectable parameter sets (see chapter 8.4 Selectable parameter sets)
    - or the local user interface buttons (see chapter 8.5 Parameter table for the local display)
    - or any of the Sintrol software (see chapter 9 Sintrol DustTool Software)
- Use the instrument according to this manual
- Clean and maintain the instrument periodically (see chapter 11 Cleaning and Maintenance)
- If required do troubleshooting (see chapter 12 Troubleshooting)
- If you relocate the instrument repeat the whole installation, Auto setup and calibration procedure
- At the end of lifetime dispose the Instrument according to this manual (see chapter 16 Disposal)

1.4 Explanation of symbols

The following symbols and signal words are used in this user manual, on the Dumo, or on the packaging.

	This symbol indicates a hazard, a hazardous situation, a precaution to avoid a hazard, a result of not avoiding a hazard or a combination of them.
	This signal symbol/word designates a hazard with a high degree of risk, which will result in death or severe injury if not avoided.
	This signal symbol/word designates a hazard with moderate risk, which may result in death or severe injury if not avoided.
	This signal symbol/word designates a hazard with low risk, which may result in minor or moderate injury if not avoided.
	This signal word warns of possible damage to property.
	This symbol provides you with useful additional information on handling and use.
	Label for waste materials intended for recycling.
	Electrical products may not be disposed of with household or other garbage. Applicable in the European Union and other European countries with separate collection systems of recyclable materials.
	This instrument conforms to the following standards: IEC 60079-0:2017 EN 60079-11:2012, EN 60079-31:2014 EN 61010-1:2001 Safety, LVD EN 61326-1 A1 (1998) Electromagnetic Compatibility EMC
	RoHOS2: Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment Text with EEA relevance.

2 General safety instructions

Only use the instrument as described in this user manual. Any other use is considered improper and may result in damage to property or persons.

The manufacturer or vendor cannot be held liable for damages or injury or loss incurred through improper or incorrect use.

	• These models are **NOT** UL/CSA or IECEX/ATEX certified and **CANNOT** be used in explosion risk areas. Chose another model if required. • This product is intended for skilled technicians and trained and certified operators. Make sure the Dumo is only operated by qualified personnel. • Electrical installation is only to be performed by qualified personnel. • Children may not install, operate, or maintain the Dumo. Make sure that children do not play with the plastic wrapping. They may get caught in it when playing and suffocate. • Do not modify, alter, or remove parts of the Dumo in any unforeseen way, without prior written authorization from the Sintrol Customer Service Department. • Do not use the instrument if it is damaged or if the power cord or plug is defective. • For repairs always contact Sintrol authorized service partners. Do not perform any mechanical or electrical repairs without prior consultation of Sintrol authorized service partners • Only original Sintrol parts may be used for repairs. This device contains electrical and mechanical parts which are essential for providing protection against sources of danger.

3 Intended use

The Dumo is exclusively designed to continuously measure the concentration of total suspended particles (TSP) in ambient air under the conditions and limits outlined in this manual.

It is primarily meant for indoor operation in non-condensing conditions. (The instrument will recognize droplets as particles and therefore cannot distinguish between water droplets and dust).

It is ideal for applications where any disruption in normal operation may result in an increase in particle concentration in the workplace causing nuisance and harm to people or machinery. In areas requiring dust extraction systems to lower particulate levels in the environment, Sintrol Dumo is the ideal complement to monitor the efficiency of this dust removal process.

Only UL/CSA or IECEX/ATEX certified models, can be used in higher risk areas to detect abnormal levels of potentially explosive dust concentrations.

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PURCHASER UNDERSTANDS AND AGREES THAT IT SHALL BE PURCHASER'S SOLE RESPONSIBILITY TO ENSURE THAT ALL PRODUCTS OBTAINED FROM SELLER SHALL ADHERE TO APPLICABLE LAWS, CODES AND STANDARDS WITHIN THE TERRITORY OF USE. PURCHASER ABSOLVES AND HOLDS SELLER HARMLESS FOR ANY ALLEGED VIOLATIONS OF SUCH LOCAL LAWS, CODES, AND STANDARDS WITHIN THE TERRITORY OF USE.

Typical applications for the Dumo are:

- Housekeeping applications
- Control of unwanted dust accumulations and general dust control
- HVAC applications
- Equipment safety
- Employee hygiene,
- To helps prevent explosions
- To help the efficiency of dust removal systems
- Welding fumes detection
- Hazardous location monitoring

Typical industries in which the Dumo is used:

- Steel and aluminum industries, foundries, electroplating
- Agriculture, food Industry, sugar and grain mills, bakeries
- Chemical and petrochemical industries, fertilizer production, plastic production, color and ink
- Pulp and paper mills
- Public facilities, subways
- Mining, gravel pits, quarries
- Power plants
- Pharmaceutical industry
- Wood and textile industries, cotton processing
- Cement production, ceramic industry

Common dusts are:

- Grains
- Sugar
- Coal
- Cosmetics
- Dyes
- Ceramics
- Textiles
- Wood and paper
- Soaps
- Metals and metal oxides
- Minerals
- Ores
- Cement
- Plastics
- Chemicals

Improper usage in CRITICAL APPLICATIONS,

such as but not limited to:

- **Worker protection, Health and Hygiene**
- **Emissions monitoring**
- **Process control**
- **Explosions prevention**

may lead to dangerous and hazardous situations and severe consequential health impacts.

- There are many factors which may influence the functionality of a dust measurement system. These factors include but are not limited to the particle size of the dust, the dust material, design and maintenance of ductwork as well as worker procedure and error. Therefore, the statements made in Chapter3 Intended use, do not automatically imply the fitness of any of the Products for a particular installation or application. This applies in particular when the dust monitor is only a component of a whole system.
- Sintrol recommends that all dust control system designs and functionality in the above listed CRITICAL APPLICATIONS be reviewed and approved by an expert consultant who is responsible for the integrity of the system design and compliance with locally accepted codes and regulations.
- Sintrol recommends using the instrument only within the limits set forth in Chapter 5.
- Sintrol also recommends that proper maintenance procedures and work practices be followed to maintain any dust control system in safe operating condition.
- It is the responsibility of the customer to engage the services of qualified experts and certified consultants in determining the suitability and application of the Sintrol products for any intended use, in particular when the products are used as a part of systems used to monitor fire and explosion risks and health or pollution related uses.

4 Dumo Overview

The instrument measures total suspended particles (TSP) in ambient air based on a signal generated from moving particles. For parameterization and set up, Dumo can be accessed via USB with our DustTool software (available free of charge on our website at http://www.sintrolproducts.com).

The instrument has a standard 4–20 mA output, which can easily be integrated into existing systems such as a PLC in the control room. Dumo has “Alert” and “Alarm” signals which correspond to certain dust concentration levels above the normal levels. By performing the Auto setup feature the normal dust level is determined and the two “Alert” and “Alarm” levels are defined to factor five and factor 20 of that level. The instrument can also be calibrated to show mg/m^3 by performing a reference measurement.

The instrument has a built-in fan, which draws in a steady and constant flow of ambient air through the measuring chamber. Particulate flowing through the chamber will interact with the sensor rod causing a small electrical charge to pass between the particulate and sensor. The small electric charges provide signals monitored by the electronics. The generated signals are proportional to ambient dust levels.

The housing is made of aluminum. The measuring probe is stainless steel (316L) and the insulation material is PTFE, commonly used as a high-performance thermoplastic).

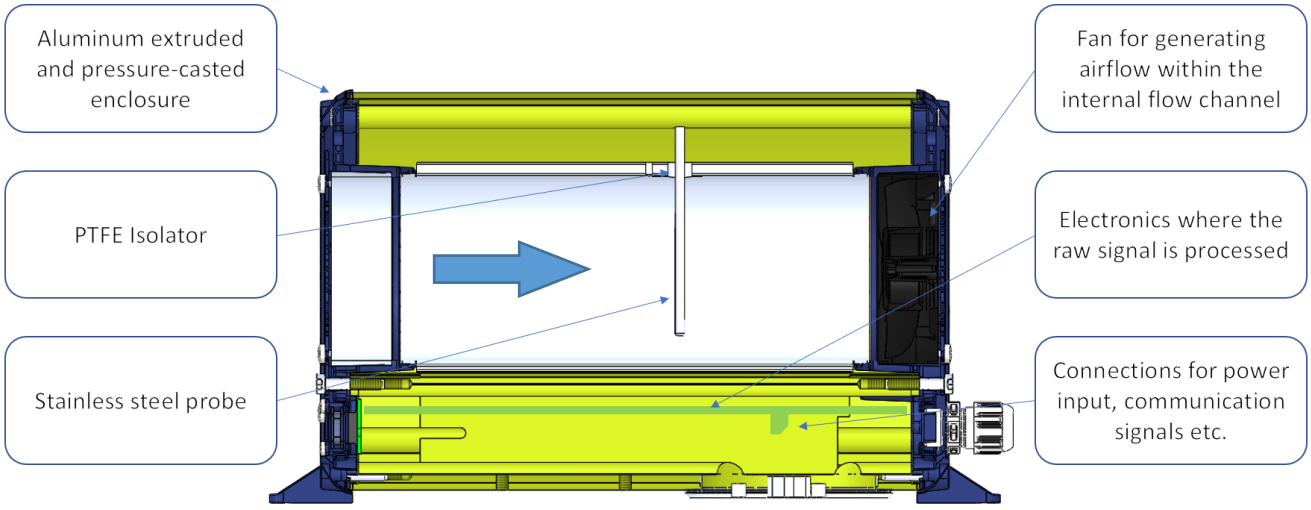


Figure 1 Dumo structure and main parts

4.1 Standard Scope of delivery

The standard scope of delivery of the Dumo includes:

- One instrument
- DustTool PC Software as a free download at *www.sintrolproducts.com*

X - Standard, O - Optional, -Blank- Not Available	Dumo	Dumo RF
Rugged IP 65 rated Aluminum enclosure	X	X
Wall/DIN-rail mount bracket for easy installation in multiple angles and positions	O	O
Green, and red LED for status indication	X	X
Auto Setup function for efficient commissioning	X	X
Two solid state relays (SSR) to indicate dust alert and dust alarm	X	X
24 VDC power supply	X	X
USB interface for convenient connection during commissioning	X	X
DustTool PC software for parametrization and setup	X	X
Normalized during production to ensure identical instruments and quality	X	X
Linearized during production to standard test dust (Arizona Road Dust)	X	X
RS485 to communicate with Modbus RTU to your control system or with Sintrol protocol to your PC and DustTool	X	X
All possibly contaminated parts are easy to clean	X	X
Bright green illuminated 4- digit display and buttons for local setup and status	X	X
Isolated and active mA-output, to indicate the status ≥21 mA or ≤3.6 mA is used	X	X
Zero & span check with automatic drift compensation	X	X
Correlation possibility to read directly mg/m3	X	X
Long life, voltage-controlled fan with malfunction detection and early warning	X	X
Wireless network capability to avoid cabling cost and extensive installation	O	X
DustTool and DustLog compatible	X	X
Magnetic Switch to initiate Auto setup and fast parametrization	O	O
Parameter set selection and Auto Setup activation via Magnets	O	O

4.2 Accessories and options

According to the chosen Accessories and options, Dumo comes in the respective configuration.

Communication Accessories

- RS485-to-USB converter
- Network routers, wireless network routers and DustLog 8 reporting software.

These supplies have their own manuals which need to be read and followed.

Probe Coating

- (Standard) No coating, stainless steel probe 316L
- (Option) Teflon coating for wet processes in non-hazardous, non ATEX areas

Installation options

- (Standard) Built-in mounting feet for wall, ceiling or tabletop mounting,
- (Option) Wall/DIN-rail mount bracket
- (Option) Adjustable installation arm

The standard, built-in mounting feet is the most suitable choice for installations with high vibrations.

Power supply

Sintrol has thoroughly tested and can recommend the following power supplies to be used:

- (Option) XP DNR120AS24 (DIN rail mount into cabinet)
- (Option) Cool power CPS-24037C6 (Tabletop model)

If you would like to use a different power supply, it should meet the following specifications:

- 24VDC +-10%
- Minimum 10W output power per Dumo which is connected to the power supply
- Low output ripple, max 1% V p-p of output voltage

4.3 Illustrations of components and dimensions: Dumo and Dumo RF

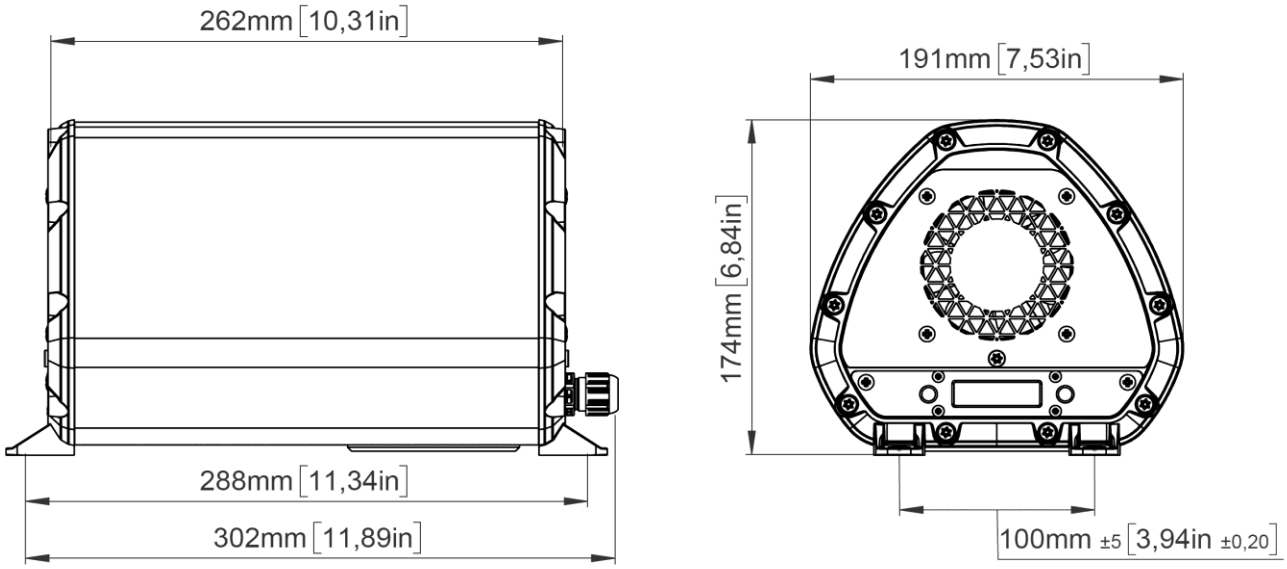


Figure 2 Dumo main dimensions

The built-in mounting feet can fit up to M6 fasteners.

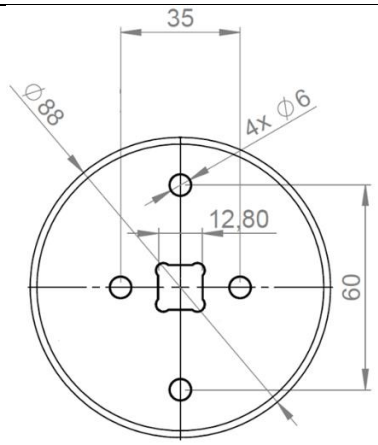
4.4 Cable gland specification

Dumo has two M16x1,5 mm cable glands, capable of accepting cable diameters between 4,5 and 10 mm.

4.5 Terminal cover on the underside of the Dumo

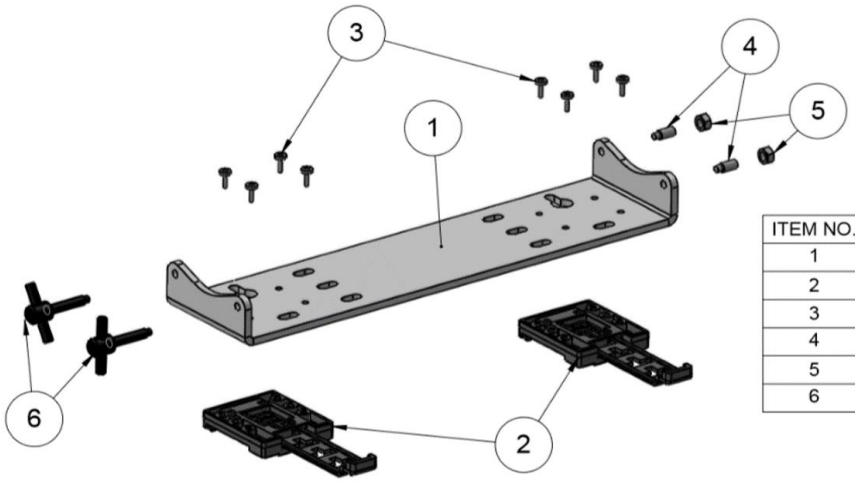
On the underside of the device is a terminal cover with an O-ring. This is used to secure the device electronics and the terminals.

The screw plug must be opened for electrical installation and should then be tightened and closed with **30Nm**.

Terminal cover	35 mm or 60 mm two-hole key	½" Ratchet handle
		

4.6 Illustrations of installation components

4.6.1 Wall/Din-rail mount bracket



ITEM NO.	DESCRIPTION	QTY.
1	Mounting Bracket	1
2	DIN rail holder	2
3	Screw ISO 7045 M3x8	8
4	Set screw, Dog Point M5	2
5	Hex. nut M5	2
6	WDS Tommy Bar Screw	2

Figure 3 Wall/Din-rail mounting bracket

The Dumo can be mounted onto a standard DIN-rail with the optional bracket. The bracket locks on to the Dumo on various orientations, making the mounting easier in tight areas. This bracket can also be used to mount the Dumo on to a ceiling with the display still being in the correct orientation.

4.6.2 Adjustable installation arm

The optional flexible installation arm allows the Dumo to be installed in a multitude of orientations and allows for easy repositioning of the device. This option also leaves room to access the internal connection area while the device is installed, making configuration changes easy and convenient. The arm has two adjustable joints and the rotation between the joints can be adjusted as well. The Dumo can also be mounted in different orientations in 90° steps.

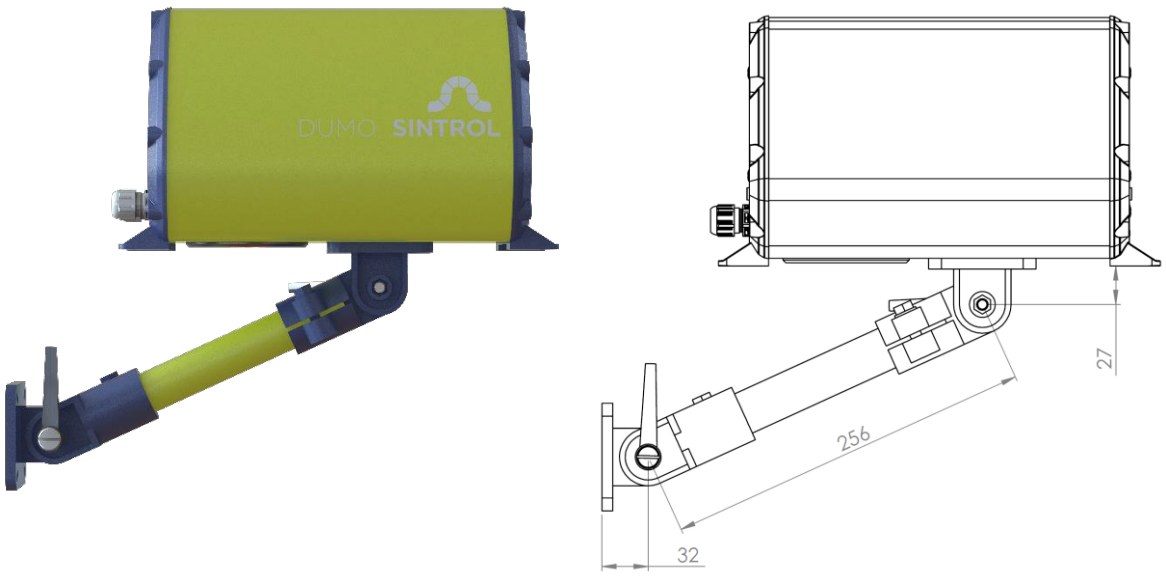


Figure 4 Adjustable installation arm

5 Principle of operation, physical effects, and limitations

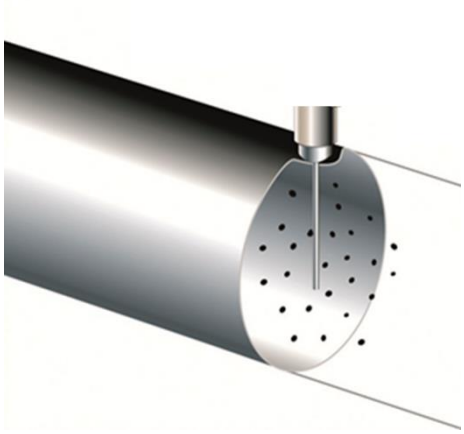


Figure 5 Inductive Electrification Technology

Sintrol dust monitors are based on a unique Inductive Electrification technology. The measurement is based on particles interacting with an isolated probe mounted into the duct or stack. When moving particles pass nearby or hit the probe a signal is induced. This signal is then processed through a series of Sintrol's advanced algorithms to filter out the noise and provide the most accurate dust measurement output.

Classic triboelectric technology is based on the DC signal, which is caused by particles contacting the sensor to transfer charges. Compared to DC based measurements, the Inductive Electrification technology is more sensitive and minimizes the influence of sensor contamination, temperature drift and velocity changes. By using the **Inductive Electrification Technology** it is possible to reach a detection limit as low as 0.01 mg/m3.

According to its position in the Triboelectric Table each material transfers a specific charge to the probe. Inorganic, electro-conductive materials (metals) create the lowest signals, Inorganic dielectric materials (cement, minerals) generate average signals, Organic dielectric materials (wood, flour) generate the highest Signals. This charge is captured by our sensor and its signal level is proportional to the particle concentration. As a unit for this signal level the **Inductive Electrification Unit (IEU)** is used.

The relation between **Inductive Electrification Unit (IEU)** and the mA output signal can be established by performing the Auto Setup function.

The relation between **Inductive Electrification Unit (IEU)** and the dust concentration in mg/m^3 can be done by calibrating the signal to a reference method e.g. to the results of a gravimetric sampling series.

5.1 Influence of particle material

The signals transmitted by different types of dust particles can vary greatly from one material to the other. For example:

- Inorganic electro-conductive materials (metals) create the lowest signals.
- Inorganic dielectric materials (cement, minerals) generate average signals.
- Organic dielectric materials (wood, flour) generate the highest signals.

This means that at the same concentration, different types of dusts generate different output signals. For example, this behavior can be compared to the behavior of opacity monitors, which show a different result depending on the color of the material: at the same concentration, white dust will show less opacity than black dust.

The initial measuring values transmitted by this measuring technology are relative measurements and the Dumo must not be relocated without a proper re-installation and setup.

5.2 Particle size

In terms of particle size, 425µm (40 mesh) is generally defined as the limiting size to classify a material as a "dust."

The minimum particle size which the Dumo is able to detect is 0.3 microns.

The best working range of the Dumo is between 1 and 200 microns.

5.3 Linearity, maximum concentrations, and calibration

The measuring range and the behavior of the Dumo depends on many factors, such as the dust material (as explained in chapter 5.1 Influence of particle material), particle size, flow speed and installation location.

As an indication and averaging of different internal and external tests, Sintrol Products with **Inductive Electrification Technology** show the following behavior over the measuring range:

- Detection limit: 0.01 mg/m^3
- Linear range: from detection limit to several hundred mg/m^3
- Nonlinear range: from linear phase, up to several g/m^3
- Saturation: after nonlinear range

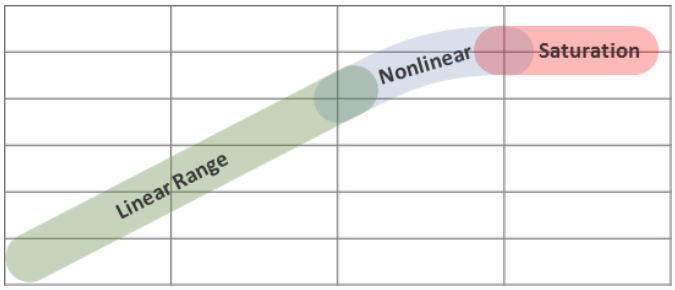


Figure 6: Illustration of un-calibrated measuring behavior

INFORMATION	To measure higher concentrations than 200 mg/m^3 and it is critical to have a linear behaviour we recommend performing reference measurements at the desired concentration and add additional calibration points by using Sintrol DustTool/calibration.

5.4 Influence of relative humidity RH %, condensation, and droplets in the measurement gas

Due to the working principle of the Dumo, the variation of relative humidity in the measurement gas only has an insignificant effect on measurements **as long as there is no condensation or droplets**.

Condensate or droplets will be seen as dust particles and distort the measurement signal. A wrong signal will be the consequence.

5.5 Influence of ambient temperature

As an indication and averaging of different internal and external tests, Sintrol Products with **Inductive Electrification Technology** show very low influence of ambient temperature:

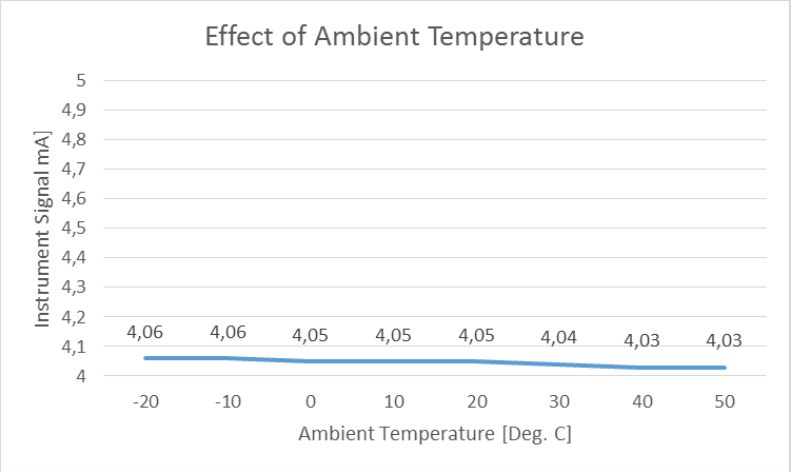


Figure 7: Effect of Ambient Temperature

5.6 Influence of flow velocity at the Dumo

Since the Dumo is equipped with an internal sampling fan which provides a constant flow speed. The fan is also monitored for changes in the performance to ensure a constant flow speed.

INFORMATION	In situations with high winds (>5m/s), the surrounding airflow may affect the internal flow speed of the Dumo and decrease the accuracy of the measurement.

6 Mechanical Installation

⚠	• Critical installations in health or explosion-prone areas, as well as use in all dust control systems, need to be reviewed and approved by an expert consultant who is responsible for the integrity of the system design and compliance with locally accepted codes. • Critical installations are considered to be such installations where a failure may directly or indirectly cause any damage to people or property.

INFORMATION	Any information given or implied by Sintrol in any way regarding installation points, the overall functionality of the system, or compatibility for a specific application are only suggestive and do not replace approval by an expert consultant.

- Install the Dumo to the desired location with the mounting feet. Use up to M6 bolts or similarly sized UNC/UNF fasteners. Optionally you can choose to buy the device with different mounting hardware, including Wall/Din-rail mount bracket or the adjustable wall connecting system.
- For installations with the RF version, make sure that all the Dumos are oriented in the same direction (antenna pointing in the same direction, vertical or horizontal) in order to avoid polarization losses in the wireless communication.

6.1 Height

INFORMATION	• In ambient air, larger airborne particles will generally collect and settle close to the ground. Larger particles also represent the majority of the mass and volume of airborne particles. • Because the Dumo measures **Total Suspended Particles (TSP)**, it is reasonable to say that it will show a higher signal closer to the ground as compared to an installation point at some elevation higher than ground level.

- To survey certain machinery or a specific area of suspected dust emissions, place the Dumo as close as possible to that location.
- To measure exposure to dust on humans, install the Dumo at a height relative to the respiratory tract (see Figure 6).

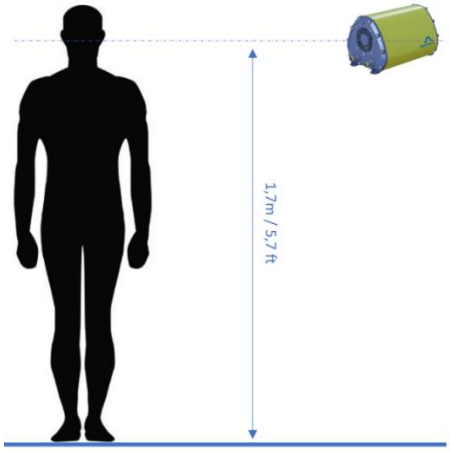


Figure 8: Installation height

6.2 Distances and grid layout

- Dust always needs to move in form of airflows, winds, or clouds actively towards the Dumo.
- Dumo's fan accelerates the gas towards the probe only once it is very close to the duct inside the Dumo. The fan will NOT actively pull dust particles towards it. The pulling effect of the fan is already negligible at less than ½ inch (1cm) from the Dumo.
- The further away from the source of dust the Dumo is, the more diluted the concentration of dust will be. This means that, while the dust concentration directly at the source point may have already reached the minimum explosible concentration (MEC), it may be well below this critical level further away.
- The time delay between the appearance of the dust at its source point and the measuring point will be longer, and the movement of the dust cloud slower, the further away the two points are from each other.

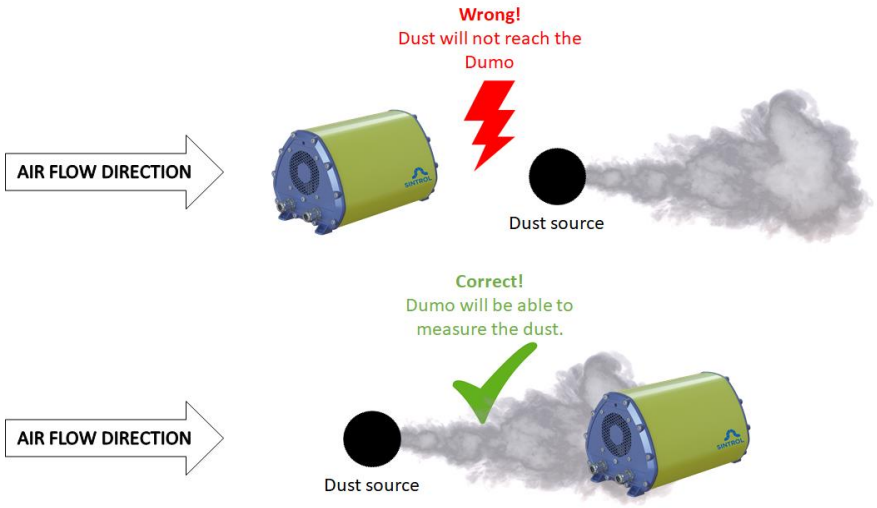


Figure 9: Installation Point in terms of air flow

- The more critical the installation is for worker safety, health, or explosion prevention, the narrower the grid should be.
- In case of an uncritical installation, where it can be assumed that the dust is fairly evenly distributed and has time to spread, a grid of approximately (n) ~ 20 m / 65 ft. is recommended.

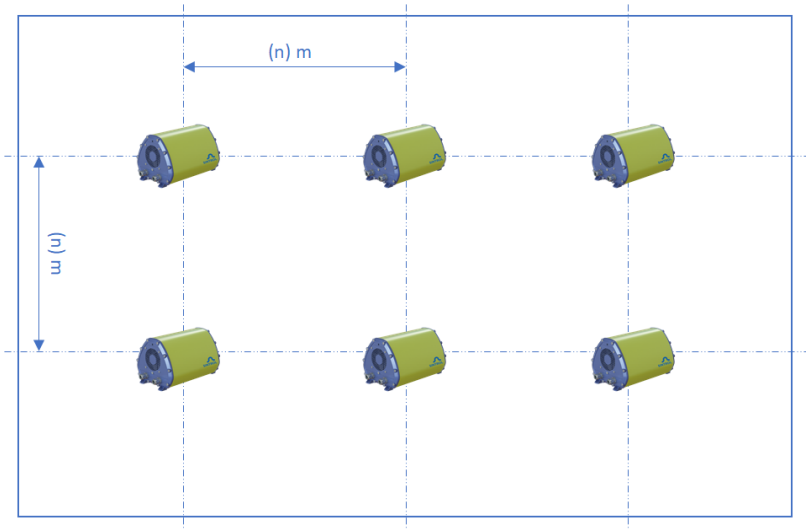


Figure 10: Installation Grid

7 Electrical Installation and Wiring

- Pay attention when choosing the cable. It must meet and be installed according to all locally applicable codes, and must be suitable for the environment it is going to be installed in.
- Always use a shielded cable when possible. Make sure to connect the shield to a protective earth potential at a single location.
- Use a minimum of 0,3 mm^2 or AWG 22 conductor size.
- When connecting the cabling make sure to leave enough slack to allow for the device to be removed from the process for cleaning without disconnecting the cables form the dust monitor.

Risk of electric shock!

A faulty electrical installation, excessive line voltage, or incorrect operation may result in an electric shock.

- Always turn off and unplug the Dumo when you are not using it, when you intend to clean it, or in the event of a malfunction.
- Only connect the Dumo if the line voltage of the socket corresponds to the data on the rating plate.
- Stand on an insulating pad and make it a habit to only use one hand when checking components.
- Always work with another person in case an emergency should occur.
- Disconnect power before checking the Dumo or performing maintenance.
- Make sure all equipment is properly grounded.
- Always wear safety glasses when working on the power supply.
- Read and understand User Manual before installation.

7.1 Wire-To-Board Terminal Block (Screw)

The Dumo uses Wire-To-Board Terminal Blocks with the following specification:

Connection method: Screw thread M3, Tightening torque, min 0.5 Nm / max 0.6 Nm

Pitch: 5.08 mm

Connection direction: 55 °

Stripping length 8 mm

Conductor cross section solid min. 0.2 mm^2 / max. 4 mm^2

Conductor cross section flexible min. 0.2 mm^2 max. 2.5 mm^2

Conductor cross section AWG min. 24 / AWG max. 12

7.2 Grounding and usage of grounded power supply

Risk of injury!

If the Dumo is not properly grounded, it may react to changes in the ground potential and show false results, resulting in severe health impacts to workers and/or a failure of the explosion prevention system.

- Connect the grounding terminal next to the cable gland to stable ground potential.
- The recommended grounding is where the Dumo external grounding terminal is connected to a nearby grounding strip.

Telltale signs of improper grounding include base values of over 3000 in clean office air or noticeable reaction to touching the Dumo series enclosure. Note that sub-par quality power sources might also induce such effects.

7.1 Connecting the voltage supply

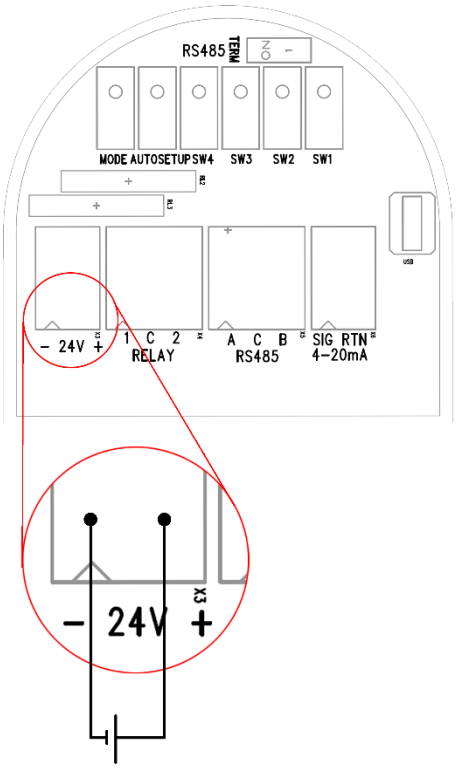


Figure 11: Connecting power input

Connect a 24 VDC power supply to the device in the internal connection area. Pay close attention to the polarity of the power input.

In case of wrong polarity, the devices will not start up, however the device will not be harmed or broken.

7.2 Connecting the solid-state relays (SSR)

Alarm signals can be transferred as digital I/O signals using two dedicated wires. Signal levels conform to the power source voltage (V+ (1 and 2) and V- (C)).

I/O signals are designed to be used as relatively short-range triggers for logic implementation or to drive external relays. Long distance connections are discouraged due to the uninsulated nature of the I/O signals, sourced from the local power supply of the Dumo.

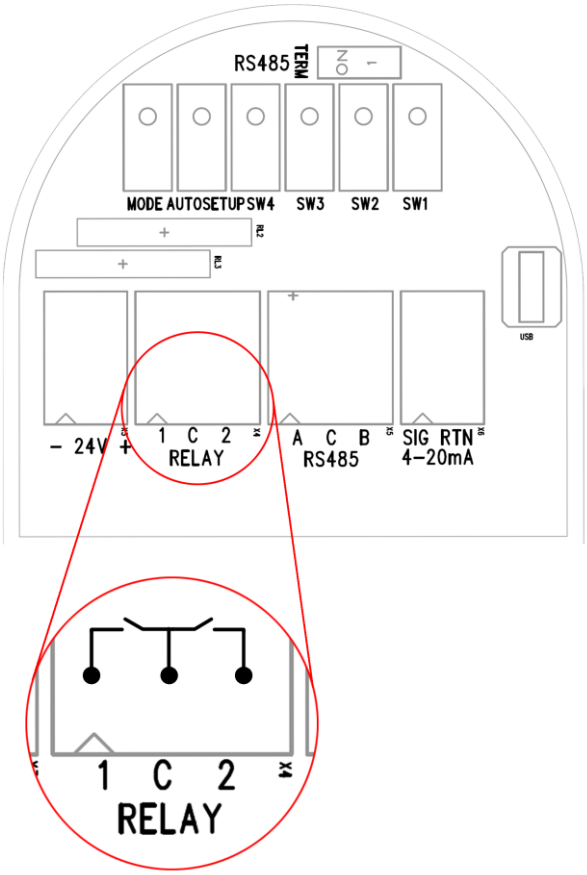


Figure 12: Connecting Relays

7.3 Connecting via USB

Direct USB connection on products makes it easy to connect to Sintrol Products without any additional equipment, provided that the USB-port has the capability to provide enough energy. The USB port is a Micro USB type B, inside of the enclosure in the connection area behind the threaded plug.

INFORMATION	USB is intended to be used for easy parameterization of Sintrol products with dedicated complementary DustTool software. However, the USB is not suitable to operate or substitute a dedicated industrial bus and it is not intended for extended use in an industrial environment during normal operation.

INFORMATION	**The maximum length of the USB cable can be 5m** USB is intended to be used for easy parameterization of Sintrol products with dedicated complementary DustTool software. However, the **USB is not suitable to operate or substitute a dedicated industrial bus** and it is not intended for extended use in an industrial environment during normal operation.

7.4 Connecting the mA-output

An active and isolated mA-output signal (mA+ and mA-) is used to transfer an analog 4-20 mA current signal that describes the measurement value.

After the default auto-setup procedure, the normal signal level is set to be 5% of the scale (i.e. 4.8 mA). Thus, a max signal level of 20 mA indicates a 20-fold increase in dust levels since auto-setup. The scale of mA-output can also be customized according to the end user application.

An mA-output loop is intended to be used as a long-range analog data transfer in industrial environments. The signal output is isolated to shield against local potential differences between the two end locations.

The device will also alarm on the mA output for device failures according to NAMUR NE 43.

mA output	**State**
4…20 mA	Normal measurement or Span/Zero self-test (relays indicating maintenance mode)
Over 22 mA	Failure, measurement grounded or device failure. Clean probe as instructed in Maintenance –section.

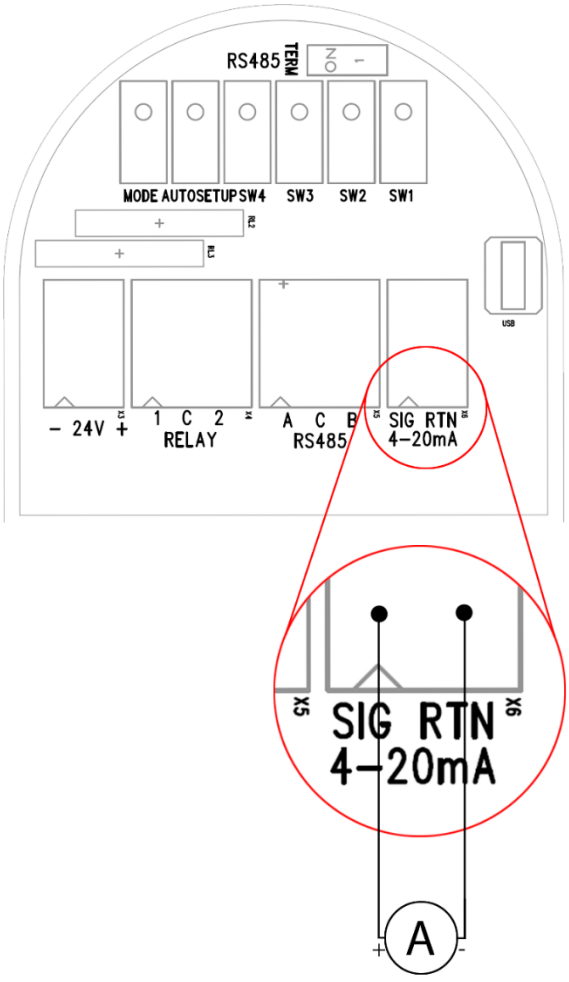


Figure 13: mA loop connection

7.5 Connecting the RS-485 bus

TIA-485-A, also known as ANSI/TIA/EIA-485, TIA/EIA-485, EIA-485 or RS-485, is a standard defining the electrical characteristics of drivers and receivers for use in balanced digital multipoint systems. The standard is jointly published by the Telecommunications Industry Association and Electronic Industries Alliance (TIA/EIA).

Digital communications networks implementing the EIA-485 standard can be used effectively over long distances and in electrically noisy environments. Multiple receivers may be connected to such a network in a linear, multi-drop configuration.

These characteristics make RS485 network useful in industrial environments and similar applications. Currently available communication protocols over the RS485 bus are Sintrol Network and Modbus RTU.

RS485 bus can be used to connect the Dumo to the customers' own automation systems with the industry standard Modbus RTU protocol. This interface can be used to read data from the Dumo as well as change measurement parameters.

Dumo has an isolated RS485 bus, which can be selected to operate in Sintrol Network protocol for connections to DustTool or DustLog software or within a Sintrol Network, or optionally Modbus RTU protocol. The selection can be made with our free-of-charge DustTool program via a USB-connection to the device.

The register definitions of the Modbus RTU interface are presented in section: 15.2 MODBUS RTU register map.

The Dumo has a built-in bus terminator which can be enabled with the jumper on top of the connection area. The terminator needs to be enabled at the last device of the bus.

INFORMATION

The default communications parameters for the Modbus RTU:

- Baud rate: 38400
- Data bits: 8
- Stop bits: 2
- Parity: none

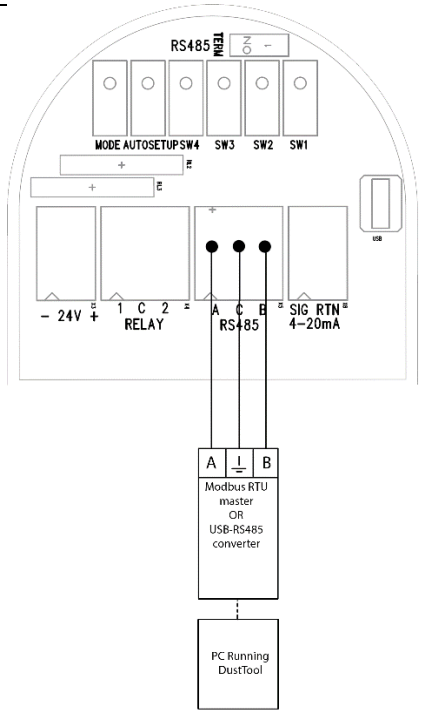


Figure 14: RS485 connections

7.6 Connecting a RS485 Network

Multiple Dumo dust monitors can be connected into a single network. This 'daisy chain' connection allows for several devices to be communicated with using only minimal wiring. Both Modbus RTU and Sintrol Network protocols are supported.

To use Modbus RTU protocol the RS485 bus needs to be connected to the CH-1 RS485 terminals according to the following schematics. Use suitable 3-wire or above shielded cabling, minimum 0,3 mm^2 or AWG 22 and make sure to ground the shield at a single location.

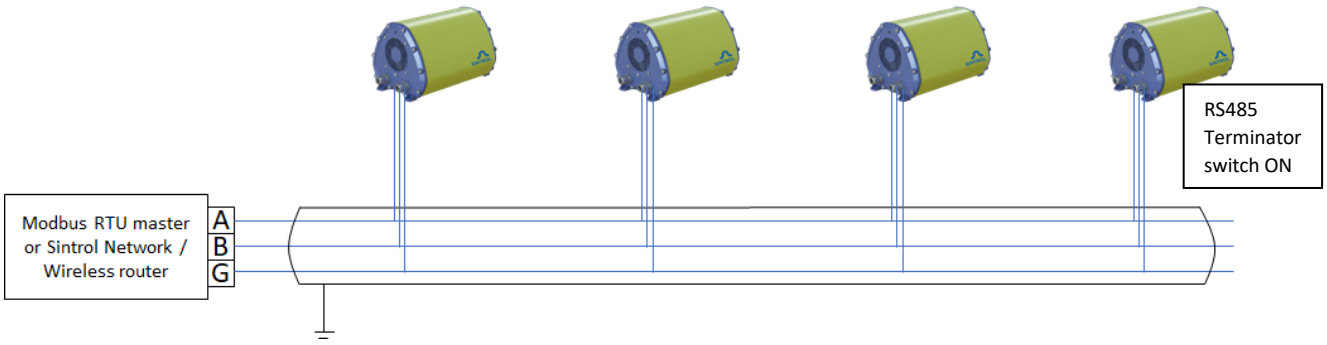


Figure 15: Connecting a RS485 Network

Make sure that the RS485 bus terminator resistor switch is enabled only on the last device in the bus.

Using DustTool, confirm on the properties-page that the RS485 protocol is set appropriately:

- To use the device with a Modbus RTU master, choose the Modbus Slave option and assign an appropriate slave ID.
- To use the device with DustLog and a router device, choose the Sintrol Slave option. **(This is the default setting)**

8 Parametrization and calibration

Dumo requires minimal set-up time to get to regular operating conditions. For trend monitoring applications, it is enough to run the auto-setup procedure. During regular operation, the Dumo continuously measures dust concentrations and sets an alarm signal according to the concentration and pre-set alarm levels.

The adjustment of the parameters can be done by using

- The selectable parameter sets SLOW, MEDIUM, FAST
- The local 4-Key user interface (located in the connection area)
- The USB interface and Sintrol protocol for direct connection to a Windows PC. DustTool PC-Software for parametrization and Setup comes with the instrument.
- RS485 bus for
    - SintrolNetwork protocol (default) to communicate with DustTool or DustLog software
    - Modbus RTU to communicate with any Modbus RTU master device
- RF wireless Network communication (optional) (only for SintrolNetwork protocol)

8.1 Relay, LED and Display functional logic

The Dumo has different operational statuses which are indicated to the user by changing the behavior of the LEDs, the display or the Relays. These operational statuses are defined as follows:

- NORMAL DUST LEVEL AND OPERATION: The instrument operates normally as it has been set up and gives a valid measurement signal. The measurement signal is below the configured trash hold for the ALERT or ALARM status.
- ALERT: The instrument operates normally as it has been stetted up and gives a valid measurement signal. The measurement signal is above the configured trash hold for the ALERT status (default 5 times the Auto setup dust level) but below the ALARM status.
- ALARM: The instrument operates normally as it has been stetted up and gives a valid measurement signal. The measurement signal is above the configured trash hold for the ALARM status (default 20 times the Auto setup dust level).
- AUTO SETUP: The instrument gives **NOT** a valid measurement signal. It collects dust level data of the present condition
- FAULT, SERVICE: The instrument gives NOT a valid measurement signal. It HAS BEEN SET MANUALLY INTO Maintenance mode or has detected a faulty behavior, detected by one of the calibration or self-check functions

Relay functional logic

CONDITION	RELAY 1	RELAY 2	ANALOG [mA]
NORMAL DUST LEVEL AND OPERATION	Energized	Energized	According to Dust level
ALERT	Relaxed	Energized	According to Dust level
ALARM	Relaxed	Relaxed	According to Dust level
AUTO SETUP	Relaxed	Relaxed	>22 mA
FAULT, MAINTENANCE	Relaxed	Relaxed	>22 mA

Table 1: Relay functional logic

- ENERGIZED relay is when Input voltage is present between relay contact (1 or 2) and C (Common)
- RELAXED relay is when no voltage is present on the relay output
- ANALOG signal during fault condition is >22mA

LED and Display functional logic

CONDITION	GREEN LED	RED LED		DISPLAY
NORMAL DUST LEVEL AND OPERATION	on	off		on, According to Dust level
ALERT	on	on	(appears as orange)	on, According to Dust level
ALARM	off	on		on, According to Dust level
AUTO SETUP	blink	off		count down [s]
MAINTENANCE	blink alternating with red (500ms)	blink alternating with green (500ms)		conditional to diagnostic code
FAULT INDICATION	off	blink alternating left and right with interval 500ms		conditional to diagnostic code or - - - -

Table 2 LED and Display functional logic

8.2 Auto setup description

The auto setup function is a unique Sintrol Dust Monitor feature, which allows for a simple, user-friendly setup. During the auto setup procedure, which is done in normal process conditions, the dust monitor will automatically adapt to the process conditions and set the measuring range and alarms accordingly.

The auto setup function analyzes the present measurement signal, determines the average value and establishes a normal operations baseline.

Ensure that Auto setup is performed during normal operation and usual dust levels.

Avoid unusual events that could provide false measurements during auto setup period.

By using the DustTool software the auto setup procedure can also be altered by the user, this section only describes the actions of the factory default auto setup.

After auto setup, the default alarm signals are set as follows:

- **Alert**: when dust concentration exceeds 5 times the dust level during auto setup.
- **Alarm**: when dust concentration exceeds 20 times the dust level during auto setup.

In addition, the following key parameters will also be affected:

- 4 mA equals no dust present.
- 20 mA is set to 20 times the dust level during auto setup.
- Dust signal averaging time is set to default (50 seconds).
- Signal delay times are set to default 30 seconds.

In other words:

- Baseline will be set to 5% of range, or [4,8mA]
- ALERT Relay 1 will switch at 25% of range or at [8mA]
- ALARM Relay 2 will switch at 100% of range or [20mA]
- 4mA equals no dust present.

In case the measuring point is before the filtration system the auto setup baseline could be several g/m3 and after the filtration system the auto setup baseline could be only a few of mg/m3. In both cases no manual range setup is required.

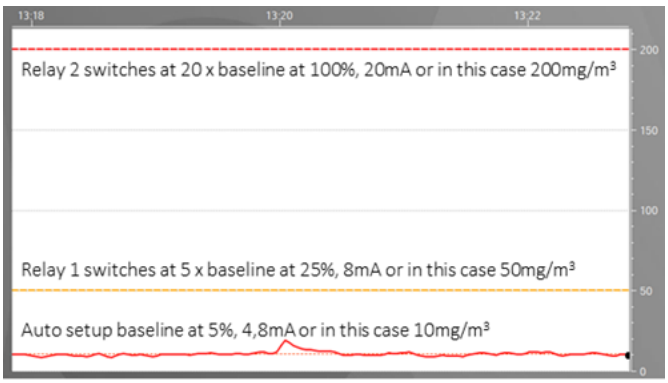


Figure 16: Settings after Auto setup

To start Auto setup on the instrument

- Either press key K4 for 1 sec. The display shows the remaining time in seconds and the green LED will be blinking. When the Auto setup procedure has finished the display goes back to normal operation mode. If you want to cancel Auto setup press K4 again for one second.

The auto setup procedure takes 10 times the signal averaging time to complete. For example, with the default parameters, this will be 500 seconds (approx. 8 min).

8.3 General usage of the Display and 4-Key user interface

The Dumo is equipped with a 4- Digit, 7- Segment display, 2 magnetic switched (option) and 6 key buttons. The optional magnetic switches are placed alongside the front-panel LED's whereas the push buttons are inside the connection area below the circular threaded plug.

Figure 17: Front view of display

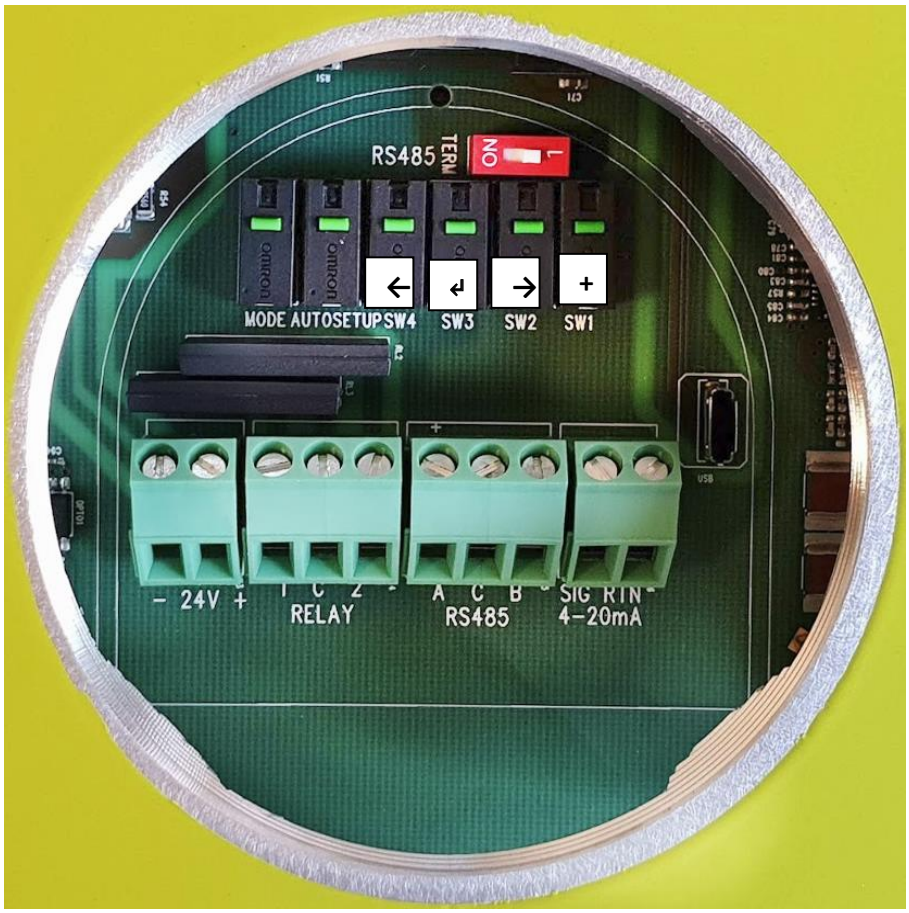


Figure 18: Bottom view of buttons

- In normal operation the instrument will show the measurement value.
- When **+** is pressed, the instrument goes to the parameter display/change mode.
- The cursor position is indicated with a blinking number.
- To increment the value of the blinking number press **+**
- To shift the cursor to the right press **→**
- To save the changed parameter press **↲**. After saving the changed parameter will come into effect and the cursor will go to D0
- To exit and return to show measurement values press **←** or wait for timeout
- To test the display and LED press in normal operation mode the keys **+** and **←** at the same time.

- To start Auto setup press key **Auto setup** for 1 sec. The display shows the remaining time in seconds and the green LED will be blinking. When the Auto setup procedure has finished the display goes back to normal operation mode. If you want to cancel Auto setup press **Auto setup** again for one second.
- To return the RS485 bus to the factory default setting (DustTool / DustLog connection) press the Auto setup button within 6 seconds of the device booting up. Note that this will initiate a self-check procedure during which the RS485 bus settings will be reset. When running outside of a production environment, the check will fail due to lack of external testing hardware and issue an alarm. When resetting the RS485 bus settings this way, make sure to reboot the device after the reset.

8.4 Selectable parameter sets SLOW, MEDIUM, FAST

The Dumo can be set to operate either with customer selectable parameters or in one of pre-determined modes. These modes change the behavior of the Dumo making the response either **SLOW, MEDIUM** or **FAST**.

The display shows periodically which of the parameter sets is in use, or 'CUST' if custom settings have been selected by modifying the parameters manually.

Parameter	SLOW	MEDIUM (default)	FAST
(Param.2) Averaging time: [sec]	100	50	10
(Param.6) Alarm delay time: [sec]	60	30	10
(see 8.2 Auto setup) Factor for Alarm A:	5	5	3
(see 8.2 Auto setup) Factor for Alarm B:	20	20	10
(see 8.2 Auto setup) Factor for 20 mA:	20	20	20
Display reading	SLO	MED	FAST

Table 3 Selectable mode parameters

The mode can be displayed by pressing the 'MODE' switch on the connection area for less than 1 second. Display will show the selected mode, and if the MODE button is pressed again within 10 seconds, the mode will change to the next option (FAST -> MEDIUM -> SLOW).

The parameters listed in the table above will be set and alarm limits and 20 mA scaling will be recalculated based on last Autos setup result.

8.5 Parameter table for the local display

No.	Description	Display
1	Display scale	D3 = 0 = 0.0...100.0 [%] of Range, default D3 = 1 = [mA] D3 = 2 = [mg/m^3], shows - - - - if mg/m^3 is disabled
2	Averaging time [sec]	000...300 [sec], default = 50 [sec]
3	20 mA scaling (Range setting)	000...999 [%], default 100% determined by the value after Auto setup (20 times Baseline)
4	Alarm limit A [%] of Range	000...100 [%] of Range, default = 25% of Range (8mA)
5	Alarm limit B [%] of Range	000...100 [%] of Range, default = 100% of Range (20mA)
6	Alarm delay time [sec]	000...180 [sec], default = 30 [sec]
7	Flow velocity in [m/s] at 4 [mA]	000...99.9 [m/s], default = 0 [m/s]
8	Flow velocity in [m/s] at 20 [mA]	000...99.9 [m/s], default = 0 [m/s], no compensation
9	Zero & Span check interval	000...999 [hour], default = 0 [hour], no check
0	Command parameter	001 Reset to factory defaults
		002 Enable mg/m^3 calibration
		003 Disable mg/m^3 calibration
1.	Display Intercept **a** (Integer) to show [mg/m^3]	-99...099 [mg/m^3], default = 0 [mg/m^3]
2.	Display Intercept **a** (Decimal) to show [mg/m^3]	000...999 [mg/m^3], default = 0 [mg/m^3]
3.	Display Slope **b** (Integer) to show [mg/m^3]	000...999 [mg/m^3/mA], default = 0 [mg/m^3/mA]
4.	Display Slope **b** (Decimal) to show [mg/m^3]	000...999 [mg/m^3/mA], default = 0 [mg/m^3/mA]
5.	20 mA scaling in 000...999 [IEU] x 1 000 000	20 mA scaling in 000...999 [IEU] x 1 000 000
6.	20 mA scaling in 000...999 [IEU] x 1 000	20 mA scaling in 000...999 [IEU] x 1 000
7.	Info: Firmware Version	Info: Firmware Version

Table 4: Parameter table

8.5.1 Parameter 1: Display scale

The instrument will show the measurement signal

- D3 = 0 in 000...100 [%] of Range with no decimal point (default)
- D3 = 1 in 04.00 … 20.00 [mA] with a fixed decimal point, 2 digits before and after the decimal point.

If the 4-20mA loop is electrically not properly connected and therefore not closed, the display will show **OL** (open Loop) to indicate this status.

- D3 = 2 in 99.99 … 9999 [mg/m3] with a floating decimal point 99.99[mg/m3] or 999.9[mg/m^3] or 9999[mg/m^3]

To change the display scale, follow the below procedure

- Navigate to Parameter 1
- Key the desired value (1, 2 or 3) into the instrument.
- Safe the result by pressing K3
- From now on the instrument will show the measurement result in the desired unit.

8.5.2 Parameter 2: Averaging time [sec]:

The averaging (running average) time has been adjusted to 50 seconds in the factory but can be adjusted freely between 0 and 6000 seconds (1 h 30 min).

8.5.3 Parameter 3: 20 mA scaling (Range setting)

After Auto setup the 20 mA signal has been adjusted to be 20 times the dust level present during the period automatic setup was running. This level represents 100%.

To manually double the range: Set Parameter 3 to be 200%

To manually halve the range: Set Parameter 3 to be 050%

8.5.4 Parameter 4: Alarm limit A [%] of Range

After Auto setup the alarm level A has been adjusted to be 5 times the dust level present during the period automatic setup was running. This level represents 25% of Range (8mA).

To manually double the Alarm limit A: Set Parameter 4 to be 050% of Range

To manually half the Alarm limit A: Set Parameter 4 to be 012% of Range

The parameters 3 and 4 are independent! If you double the Range with Parameter 3 the alarm limit A will stay at the same level and Parameter 4 will show half the value (12% of Range).

8.5.5 Parameter 5: Alarm limit B [%] of Range

After Auto setup the alarm level B has been adjusted to be 20 times the dust level present during the period automatic setup was running. This level represents 100% of Range (20mA).

To manually half the Alarm limit B: Set Parameter 5 to be 050% of Range

The parameters 3 and 5 are independent! If you double the Range with Parameter 3 the alarm limit B will stay at the same level and Parameter 5 will show half the value (50% of Range).

8.5.6 Parameter 6: Alarm delay time [sec]

To avoid false alarms, caused by short dust concentration peaks which may appear naturally in certain processes the alarm delay time can be set manually 000...180 [sec], default = 30 [sec]

The default of 30 [sec] means that the dust level needs to be uninterrupted for 30 [sec] above / below the Alarm limit A / B before the Relay switches either way.

8.5.7 Parameter 9: Zero & Span check interval

The internal Zero & Span check interval can be set between 000...999 [hour]. The default =0 (no check)

To change the Zero & Span check interval, follow the below procedure

- Navigate to Parameter 9 by pressing K1
- Key the desired interval in hours into the instrument.
- Safe the result by pressing K3
- From now on the instrument will perform Zero & Span check in the desired interval

8.5.8 Parameter 10: Command parameter

The command parameter has 3 functions:

001 Reset to factory defaults

002 Enable mg/m^3 calibration

003 Disable mg/m^3 calibration

To Reset to factory defaults, follow the below procedure:

- Navigate to Parameter 10 by pressing K1
- Key 001 into the instrument.
- Safe the result by pressing K3
- Now all parameters are set back to factory settings

This affects all parameters **including the result of the Auto setup procedure**. All previously done settings will be over written.

To show on the local display the measurement in mg/m^3, follow the below procedure:

- Enter the definition of the calibration function yi = a + b xi by changing the parameters 1., 2., 3., and 4.
- Navigate to Parameter 10 by pressing K1
- Key 002 into the instrument.
- Safe the result by pressing K3
- Navigate to Parameter 1 by pressing K1
- Key 002 into the instrument.
- Safe the result by pressing K3
- Now the measurement is displayed in mg/m^3

To disable the measurement in mg/m^3, follow the below procedure:

- Navigate to Parameter 10 by pressing K1
- Key 003 into the instrument.
- Safe the result by pressing K3
- Now the measurement will not anymore be displayed in mg/m^3

8.5.9 Parameter 11: Display Intercept “a” (Integer) -99...099 [mg/m3]

The instrument can be set to show mg/m^3 by utilizing a linear regression line which has an equation of the form **y = a + bx**.

> Parameter 11, 12, 13 and 14 will **NOT** change the actual mA-output signal.
>
> These parameters are used to show mg/m^3 on the local display according to the defined linear regression curve

The following glossary is based on the terminology used in the European stack testing regulations.

AMS	Automatic Measurement System (in this case Dumo)	**y**	Result of SRM [mg/m^3]
		a	The Intercept [mg/ m^3] (Par. 11,12)
SRM	Standard Reference Method (usually Gravimetric Sampling)	**b**	The Slope [mg/ m^3/mA] (Par. 13,14)
		x	Result of AMS [mA]

Example calculation:

	yi [mg/m3]	xi [mA]	Comment
Point 1	6,00	9,00	(In a simple one-point calibration 4 mA would equal 0 mg/m3)
Point 2	19,00	17,00	(Result of the gravimetric sampling)

1. Calculate the slope **b** by the two-point form of a straight line

   $\mathbf{b = y_2\text{-}y_1/x_2\text{-}x_1}$

   In our case: **b** = 19,00-6,00 / 17,00-9,00 = 1,625

2. Resolve the equation $\mathbf{y_i = a + b\ x_i}$ to the intercept a

   $\mathbf{a = y_i - b\ x_i}$

3. Calculate the intercept **a** by inserting **x** and **y** of either of the points

   $\mathbf{a = y_1 - bx_1}$ In our case: **a** = 6,00 – 1,625*9,00 = -8,625

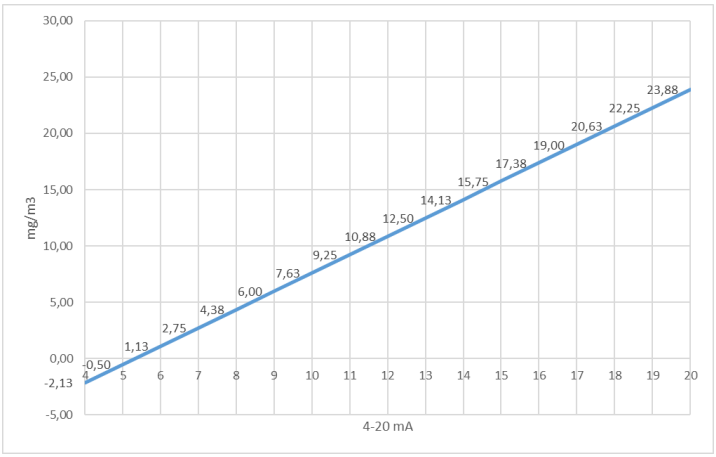


Figure 19: Example for display calibration

The values for the intercept **a** and the slope **b** are split into an integer and decimal part.

To change the integer part of the intercept **a**, follow the below procedure:

- Navigate to Parameter 11 by pressing K1
- Key the calculated value into the instrument -99...099 [mg/m3], default = 0 [mg/m3]
- Safe the result by pressing K3

8.5.10 Parameter 12: Display Intercept “a” (Decimal) 000...999 [mg/m3]

To change the decimal part of the intercept **a**, follow the same procedure as for Parameter 11

8.5.11 Parameter 13: Display Slope “b” (Integer) 000...999 [mg/m3/mA]

To change the integer part of the slope **b**, follow the same procedure as for Parameter 11

8.5.12 Parameter 14: Display Slope “b” (Decimal) 000...999 [mg/m3/mA]

To change the decimal part of the slope **b**, follow the same procedure as for Parameter 11

8.5.13 Parameter 15: 20 mA scaling in 000…999 [IEU] x 1 000 000

This parameter is used for a very fine and accurate scaling and correlation of the 20 mA scaling to the **Inductive Electrification Unit (IEU).**

IEU is described under chapter Error! Reference source not found. Error! Reference source not found.:

The reading of the **IEU** value at the Parameters 15 and 16 is the base for the Range setting on the **Sintrol Signal Generator**. The Signal Generator is used for the linearity checks in regulated applications.

As the **IEU** is a very fine scale with an open scale from 0 to several millions, the reading of this number is split into two parameters.

- Parameter 15: 20 mA scaling in 000…999 [IEU] x 1 000 000
- Parameter 16: 20 mA scaling in 000…999 [IEU] x 1 000

To change the [IEU] x 1 000 000 part of the number, follow the below procedure:

- Navigate to Parameter 15 by pressing K1
- Key the desired value into the instrument.
- Safe the result by pressing K3

Rescaling of the mA scale with the Parameters 15 and 16 will overwrite previous settings done by using Parameter3 and vice versa.

8.5.14 Parameter 16: 20 mA scaling in 000…999 [IEU] x 1 000

To change the [IEU] x 1 000 part of the number, follow the same procedure as for Parameter 15

8.5.15 Info: Firmware Version

This is a read only Parameter and returns the Firmware Version.

9 Sintrol DustTool Software

Sintrol Dumo is equipped with USB and RS485 interfaces for connecting to DustTool. Both interfaces are preconfigured to use Sintrol Network protocol from firmware version 3.0.2 onwards.

Connect a USB cable directly to a Windows PC or alternatively, use a generic USB-to-RS485 converter and connect to the device's RS485 bus.

DustTool will automatically detect the interface being used and connect to the device.

DustTool is complementary software to help you to easily control the parameters and features of your Sintrol products. The hardware requirements to run the software are:

- Windows XP, Vista, 7 or 10
- Screen resolution: 1024x768 pixels or higher
- Memory: at least 512 MB

The DustTool software can be connected directly to the dust measurement devices via USB. By using a converter, connections over RS 485 and RF are also supported.

If the lock password feature is used, auto setup is disabled and changing any device parameters will not be allowed.

If the lock password is forgotten, there is no way to unlock the device without contacting Sintrol for the device-specific master password.

When DustTool software opens, it first looks for USB-connected Sintrol products. If any are connected, they will appear within the software and can then be directly managed.

A DustTool version of 1.2.1701101750 or later is required for the RS485 communication to be available. You can download the latest version at ***https://secure.sintrol.com/?getupdates=DustTool**** The device needs to have a firmware of **3.0.2** or later for the RS485-to-DustTool communication to be enabled.

In order to save measurement data, create additional signals and alarms and/or generate reports and history, **DustLog 8** software is required.

Changes in the parameter settings, done by DustTool will overwrite the settings done by the local button interface and vice versa, whatever comes last.

More info, tutorials etc. can be found on our YouTube channel SintrolProducts at https://www.youtube.com/channel/UCP8edFkx8uA7LrSNBP9rIdQ/

9.1 PARAMETERS tab

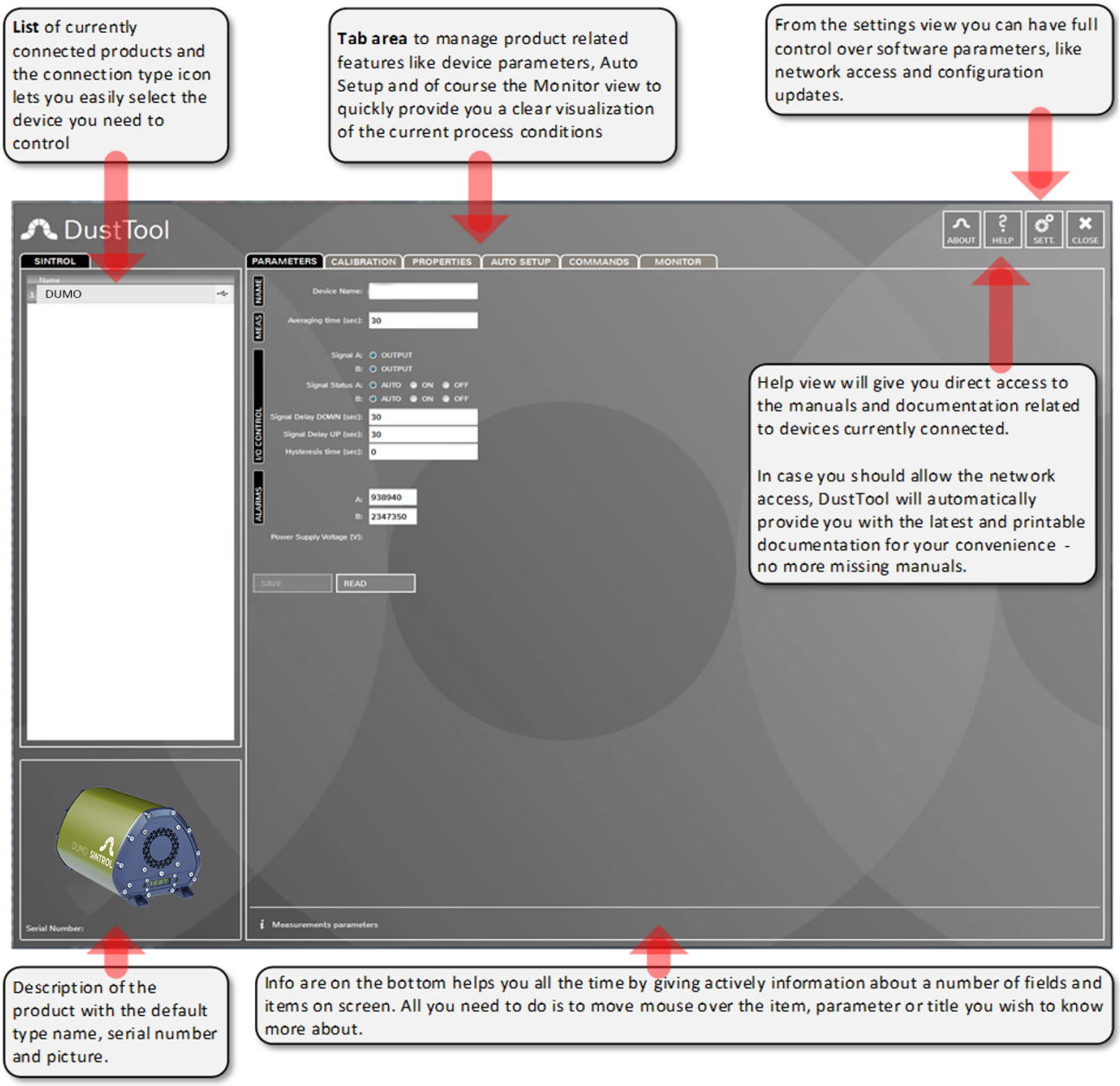


Figure 20: DustTool main window

In the PARAMETERSS tab, you can modify the operating parameters of the connected dust meter. The basic operating principle to change parameters is as follows:

1. Change parameter to the desired value
2. Press the “Save” button to save the changes into the memory of the instrument. If the “Save” button is not pressed, the changes will not be sent to the device and the values will be lost at program shut down or when the instrument is detached.
3. By pressing “Read,” the parameters which are currently saved in the instrument will be loaded from the device.

In the MONITOR tab of the DustTool software, it is possible to follow dust levels online. The MONITOR view is intended to help you in deciding which parameters to set up manually.

10 Wireless connectivity of DUMO

The wireless connection operates on the proprietary Sintrol Network communication protocol. The protocol stack takes care of automatically forming the network and routing data within the network via the strongest available connection possible.

It is recommended to name each Dumo in a wireless network before the installation. In this way, each device will be easily identified by the given name when the network is otherwise automatically created. Naming is quite simple:

1. Run Sintrol DustTool or DustLog 8 PC software on the computer.
2. Connect the Dumo to a PC with USB or RS485.
    a. Note, when using the USB, no external power is needed. If you wish to use RS485, please connect power first.

The Dumo will appear automatically in the software once it's connected.

3. Type the name you wish to use in the parameters tab and then press the save button.
4. Disconnect the device

Networking:

In combination with our network router and the DustLog 8 Software, it is also possible to set up wireless, RS485 networks, or combinations thereof. The wireless network works within the ISM bandwidth and therefore has no need for licenses or permits.

A complete Sintrol Network-based measurement system consists of up to 254 instruments on a single network connected either wirelessly or with an RS485 bus to the data collecting and reporting software, DustLog 8. The basic principle and topology are shown in the figure above.

Sintrol Wireless solution is part of the whole Sintrol Network system. For this reason, the wireless RF connection can operate transparently with the RS 485 network.

Figure 21: Sintrol Network Example presents one example of the working Sintrol Network. In this illustration, both wireless and wired connections are used to illustrate the seamless and extraordinarily flexible operation between both physical communication methods.

DustLog 8 (Optional):

DustLog 8 is Sintrol's data logging system and reporting tool that gives the user greater access to the monitoring process than ever before. Reports can be generated to see historical trends in the measurement with the ability to create monthly, daily, or hourly averages charted on meaningful graphs. Additionally, the easy user interface gives the user full control of the device's parameters so they can be read, sent, or configured directly from the control room. After installation of the Dumo, almost all access to the Dumo can be done remotely using the DustLog 8.

This software is not covered by this manual, please read and follow the respective manual.

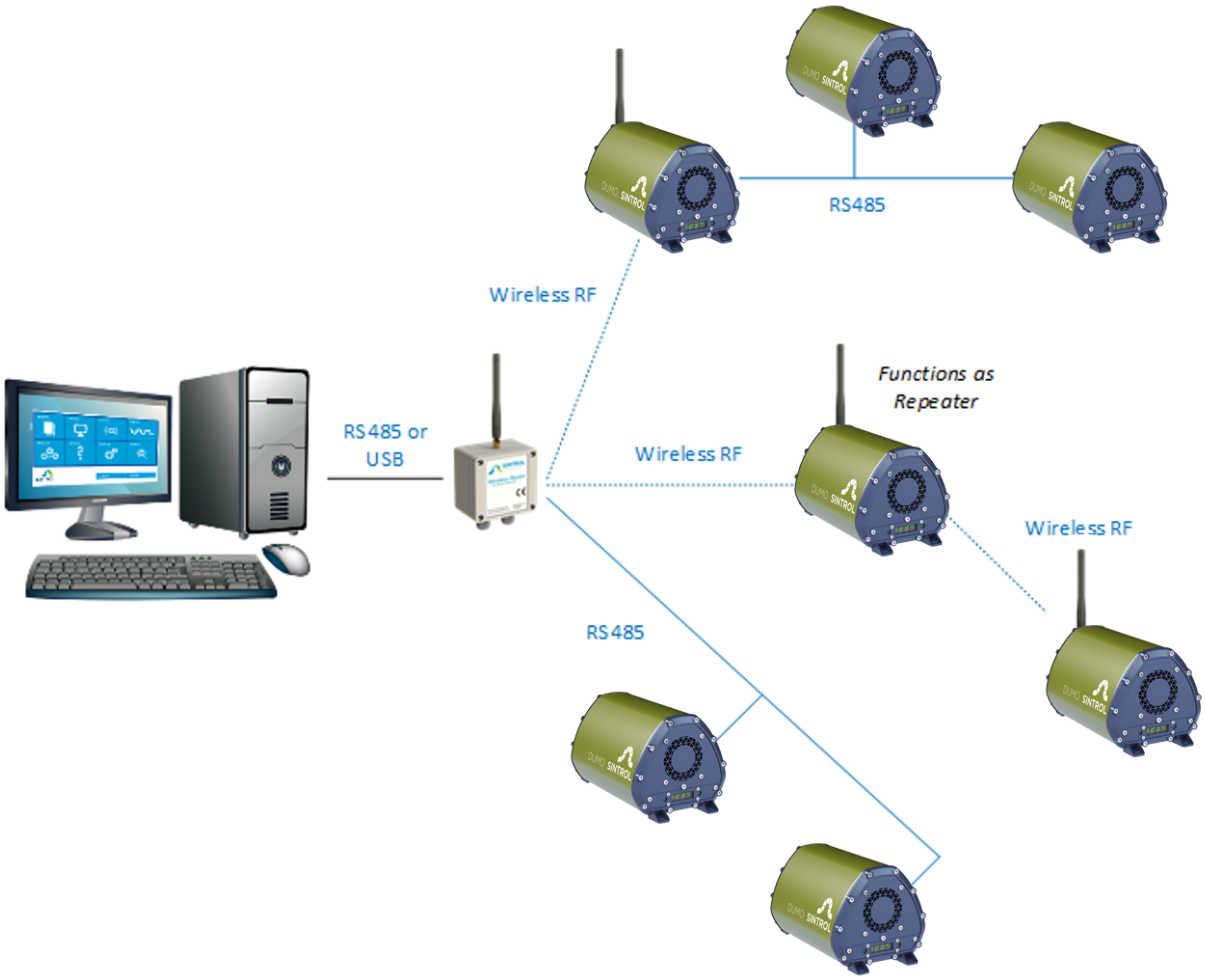


Figure 21: Sintrol Network Example

Wireless router (Optional):

To use a wireless network, at least one additional unit is needed. This unit is used as the communication base station which converts physical signals into the radio network and back. The base station can also be connected to a PC via USB, where it is then possible to run Sintrol DustLog 8 data collection software to manage and operate the network online.

INFORMATION	Sintrol Network products operate automatically as repeaters within the network; therefore, repeaters are rarely needed.

INFORMATION	This device is not covered by this manual, please read and follow the respective manual

11 Cleaning and Maintenance

Risk of electric shock!

A faulty electrical installation, excessive line voltage, or incorrect operation may result in an electric shock.

- Always turn off and unplug the Dumo when you are not using it, when you intend to clean it, or in the event of a malfunction.
- Stand on an insulating pad and make it a habit to only use one hand when checking components.
- Always work with another person in case an emergency should occur.
- Disconnect power before checking the Dumo or performing maintenance.
- Make sure all equipment is properly grounded.
- Always wear safety glasses when working on the power supply.
- Read and understand user manual before installation.

Interval during first month of operation	Content
Daily	• Visual inspection of the outer parts of the instrument, its accessories, media supplies and cables to assure that there are no obvious damages. • Check that the fan is rotating freely • Check that all operations are according to the initial intended condition.
Weekly	• Check that the lid, the cable glands or conduits are closed and tight • Remove the front cover of the Dumo and clean the probe with compressed air, a fabric or if necessary, a brush. • Remove the rear cover of the Dumo and clean the fan with compressed air, a fabric or if necessary, a brush • Perform a bump test by applying an unusual amount of dust to the sensor and observe that it will react

Risk of malfunction for **critical** installations where malfunctions may lead to dangerous and hazardous situations and severe consequential health impacts.

- If you find unusual behavior, contact Sintrol or your local distributor to make sure that the instrument is inspected and approved by an expert consultant who is responsible for the integrity of the system design and compliance with locally accepted codes.
- **Always follow the above specified cleaning and maintenance intervals and contents.**

For **uncritical** installations where malfunctions **DO NOT** lead to dangerous or hazardous situations or any consequential health impacts:

Interval after first month for uncritical installations	Content
Depending on condition	• The cleaning and maintenance interval vary, depending on monitoring conditions, dust concentrations and other substances in the measuring gas. It is subject of the plant operator to decide if longer or shorter intervals are necessary or appropriate.

11.1 Cleaning the probe

The probe of the Dumo can be cleaned with compressed air without any disassembly. Should the dust buildup on the probe be stuck on so hard that cleaning with air does not remove the build-up, the front cover of the Dumo can be removed allowing for proper access to the probe.

1) Disconnect power to the Dumo
2) Remove the 5 screws shown below:

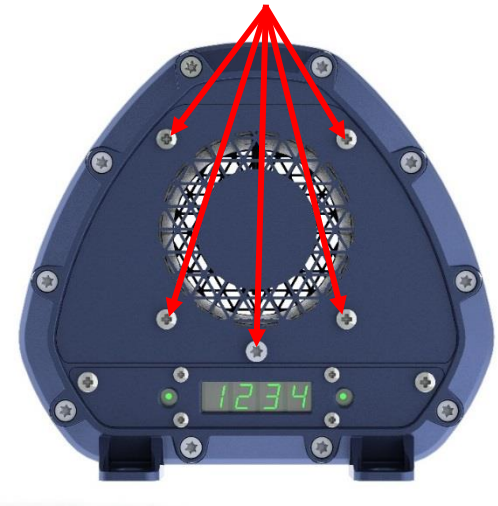


Figure 22 Remove bolts at the front cover

3) Remove the front cover

Figure 23: Cleaning the probe

4) The probe can now be cleaned with soft brushes and mild solvents should the dust be stuck on. If the Dumo is with the optional PTFE coated probe, do not use any abrasive cleaning methods.
5) Close the cover with the screws removed in section 1. Make sure that the short internal duct section does not fall of. Tighten the screws to max 7 Nm.

INFORMATION	If you have a Teflon coated probe avoid using any other tools than fabrics for cleaning. The Teflon coating may break. If the dust build up is impossible to remove, pull off the complete outer Teflon sleeve and replace it with a new Teflon sleeve. The black surface under the sleeve is a second layer of very fine Teflon, which represents the actual protection am may not be scratched.

11.2 Replacing the fan

If the fan of the Dumo should fail the device will indicate this by relaxing both alarm relays and outputting a constant mA signal of > 22 mA.

Confirm that the fan has stopped rotating or slowed down significantly.

Make sure that your replacement fan is an official Sintrol spare part. Using third party fans might affect the performance and accuracy of the Dumo and will void warranty.

1) Disconnect power to the Dumo
2) Remove the rear cover by removing these 5 screws:

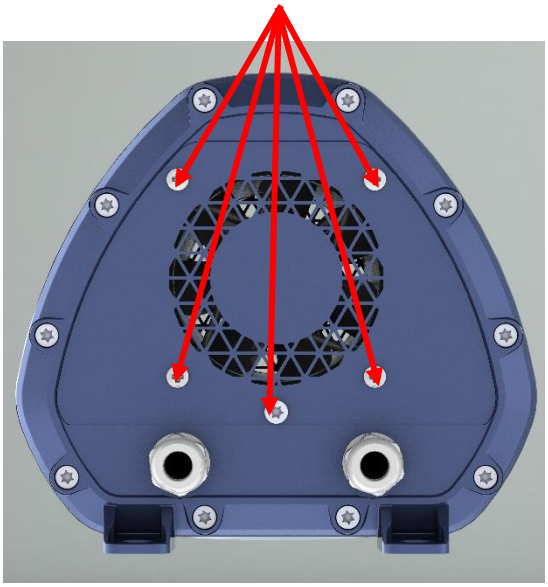


Figure 24: Removing the rear cover

3) Disconnect the fan cable. The connector is locked into place with a threaded locking ring which can be loosened by turning it counter-clockwise with needle-nose pliers.

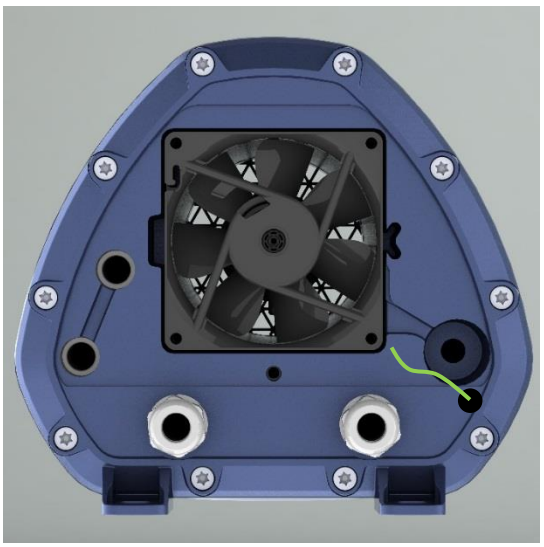


Figure 25: Replacing the fan

4) Install the new fan. Make sure to properly tighten the connector locking ring. Install the front cover with the 5 screws, tightening then to maximum 7 Nm. Pay attention that the fan cable is entirely in the designated groove and does not squish between the front plate and the Dumo body.

12 Troubleshooting

12.1 No output signals

- Check that the power and signal wiring are connected correctly.
- Check that there is power on.
- Run the auto setup.

If the Dumo is not giving an output signal after these checks, contact your local distributor.

12.2 No response after auto setup

- Make sure that normal processes are going on during auto setup.
- Check that the power and signal wiring are connected correctly.

If the Dumo is not giving an output signal after these checks, contact your local distributor.

13 Technical Data

Product name:	Dumo
Measurement objects:	Total Suspended Particles (TSP)
Measurement range:	Detection Limit 0,01 mg/m³, Maximum Range up to several g/m³
Measurement principle:	Inductive Electrification
Protection category:	IP65
Power supply:	24 VDC, Up to 10 W
Output signals:	• Two configurable alarm outputs (MAX 1A@30VDC) • Isolated 4 - 20 mA output loop, up to 250 Ω loop resistance, Namur NE43 compliant alarms
Communication interface:	• Serial communication RS-485 • USB • Radio frequency (RF) (option)
Cable connections:	• Internal screw terminals, up to: • 4 mm^2 for solid conductor, 2,5 mm^2 for solid stranded conductor
Communication protocol:	• Modbus RTU (RS-485) • Sintrol network (USB, RF and RS-485)
Alarm settings:	• Set by auto setup based on average measured ambient air dust level: 5 times and 20 times of reference dust level. • User adjustable
Signal averaging time:	• Default at factory: 100 s, Adjustable from 0 – 6000 s
Alarm delay time:	• Default at factory: 30 s, Adjustable from 0 – 60 000 s
Alarm hysteresis time:	• Default at factory: 0 s, Adjustable from 0 – 25 s

Ambient Conditions

Running temperature:	-40 °C to 60 °C (-40°F to +140 °F)
Humidity:	Max 95 % RH (non-condensing)

Materials and Dimensions

Enclosure / housing:	Aluminum enclosure, stainless steel cover plates and probe (AISI 316L).
Weight:	4,2 kg
Dimensions: [mm]	288(L)x191(W)x174(H)

Wireless Communication (only for RF models)

Frequency band:	868/915 MHz (license free ISM band), 15 channels
Transmit power:	Up to +23 dBm, user adjustable
Receiver sensitivity:	-110 dBm
Communication protocol:	Proprietary Sintrol Network protocol
Typical range (no line of sight):	***915 MHz Version for US*** Up to 800 m (2600 ft.) in urban environment ***868 MHz for EU and all others*** Up to 1000 m (3200 ft.) in urban environment NOTE: With directional antennas the range can be significantly extended. NOTE: The RF communication range is highly affected by the surrounding structures and other RF devices.

Table 5: Technical specifications

14 Authorized Distributor and Service Center Information

The contact details of our authorized distributor and service centers for the applicable countries can be found on our web page at:

http://www.sintrolproducts.com/contact/distributors

The maintenance and service of instruments sold in Finland, Russia, Ukraine, Kazakhstan, India, and China are managed by Sintrol's subsidiaries and representative offices. The contact details are found below.

The original language of this user manual is English (United States). It is the responsibility of Sintrol's local subsidiaries, representative offices, or distributers to provide a proper and correct translation when needed.

CONTACT US!

Sintrol Oy

Ruosilantie 15
00390 Helsinki
Finland

Tel. +358 9 5617 360
Fax +358 9 5617 3680

info@sintrolproducts.com

Sintrol China

Room 517, Building 1#
Section 2 Fengzhuyuan,
No.18 Jlaomen,
Fengtai District, P.R.China

Tel +86 10 59002256
Fax +86 10 59002259

china@sintrol.com

Sintrol India

A-2/78, Safdarjung Enclave
110029 New Delhi
India

Tel +91 9811676061

india@sintrol.com

Sintrol USA

Ruosilantie 15
00390 Helsinki
Finland

Tel. +358 50 463 5452

usa@sintrol.com

Sintrol Russia

Dunaysky Str 13,b.1
196158, St.Petersburg,
Russia

Tel. +7 812 4486083

spb@sintrol.com

Sintrol Ukraine

Rybalskaya street 2
Ukraine, 01011, Kiev city,
UKRAINE

Tel. +380 44 280 33 92

ua@sintrol.com

15 Appendix

15.1 ISO 9001 certificate

Certificate
No. 5236-03

Inspecta

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 9001:2008

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 2015-02-06
(first issue 2009-02-06).
The certificate is valid until 2018-02-06.

Tomi Kasurinen, 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 checked on the Internet at www.inspecta.fi

IQNet MEMBER

ORGANISATION CERTIFIED BY Inspecta
ISO 9001

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

Inspecta Sertifiointi Oy
P.O. Box 1000, Sörnäistenkatu 2
FI-00581 Helsinki, Finland
Tel. + 358 10 521 600

Group headquarters: Inspecta Group Oy, Helsinki, Finland

15.2 MODBUS RTU register map

MODBUS register map
Stand-alone MODBUS slave
1.0.0_EN_2014-06-12

Input registers (R).

(FC=0x04) Read Input Registers.

Holding registers (R/W) and values.

(FC=0x03) Read Holding Registers.
(FC=0x06) Write Single Register.

Relevant Information

MEASURING DATA

Dust measuring raw value RAW <int32_t>:			
Dust value after calculation of running average TC <int32_t>:			
MB_REG_DUSTRUNNINGAVERAGE_HIGH	0x0006		(R)
MB_REG_DUSTRUNNINGAVERAGE_LOW	0x0007		(R)
Dust value after calibration, concentration [mg/m3/100] CALIB <int32_t>:			
MB_REG_DUSTCALIBRATED_HIGH	0x0008		(R)
MB_REG_DUSTCALIBRATED_LOW	0x0009		(R)

MISCELLANEOUS

System state word 1 low: Note! Bit value masks may change according to FW-version. These values are valid for FW "v.1.1.2 dev".			
MB_REG_SYSTEM_STATE_WORD_1_LOW	0x002E		(R)
		<bit_value>	
		0x1	measuring starting
		0x2	measuring alarm L
		0x4	measuring alarm A
		0x8	measuring alarm B
Alarms:			
MB_REG_ALARMS_HIGH	0x0031		(R)
		<bit_value>	bit 0: not used 1: not used 2: meas.ADC fails 3…15: not used

COMMANDS

Auto-setup command:			
MB_REG_CMD_AUTOSETUP	0x0600		(W)
		1	start auto-setup
		2	cancel auto-setup

MEASUREMENT PARAMETERS (RAM)

Time constant used in running average calculation:			
MB_REG_MEAS_TC	0x1000		(R/W)
		<uint16_t>	[sec/10]
Measurement calibration enabled/ disabled:			
MB_REG_MEAS_CALIB_ENABLING	0x1001		(R/W)
		0	disabled
		1	enabled
Measurement calibration: Nbr of curve definition points. Note! Set this register value before sending corresponding curve points.			
MB_REG_MEAS_CALIB_POINTS	0x1002		(R/W)
		0…10	
Measurement calibration: X-coordinates of the curve definition points. Values has to be in ascending order. Note! Send always all register values X0…X9. Values are saved only after the last register is written. If nbr of curve definition points is less than 10, set register value =0 for the last unused points.			
MB_REG_MEAS_CALIB_X0_HIGH	0x1003		(R/W)
MB_REG_MEAS_CALIB_X0_LOW	0x1004		(R/W)
		<int32_t>	point0 [meas.value TC]
MB_REG_MEAS_CALIB_X1_HIGH	0x1005		(R/W)
MB_REG_MEAS_CALIB_X1_LOW	0x1006		(R/W)
		<int32_t>	point1 [meas.value TC]
MB_REG_MEAS_CALIB_X2_HIGH	0x1007		(R/W)
MB_REG_MEAS_CALIB_X2_LOW	0x1008		(R/W)
		<int32_t>	point2 [meas.value TC]
MB_REG_MEAS_CALIB_X3_HIGH	0x1009		(R/W)
MB_REG_MEAS_CALIB_X3_LOW	0x100A		(R/W)
		<int32_t>	point3 [meas.value TC]
MB_REG_MEAS_CALIB_X4_HIGH	0x100B		(R/W)
MB_REG_MEAS_CALIB_X4_LOW	0x100C		(R/W)
		<int32_t>	point4 [meas.value TC]
MB_REG_MEAS_CALIB_X5_HIGH	0x100D		(R/W)
MB_REG_MEAS_CALIB_X5_LOW	0x100E		(R/W)
		<int32_t>	point5 [meas.value TC]
MB_REG_MEAS_CALIB_X6_HIGH	0x100F		(R/W)
MB_REG_MEAS_CALIB_X6_LOW	0x1010		(R/W)
		<int32_t>	point6 [meas.value TC]
MB_REG_MEAS_CALIB_X7_HIGH	0x1011		(R/W)
MB_REG_MEAS_CALIB_X7_LOW	0x1012		(R/W)
		<int32_t>	point7 [meas.value TC]
MB_REG_MEAS_CALIB_X8_HIGH	0x1013		(R/W)
MB_REG_MEAS_CALIB_X8_LOW	0x1014		(R/W)
		<int32_t>	point8 [meas.value TC]
MB_REG_MEAS_CALIB_X9_HIGH	0x1015		(R/W)
MB_REG_MEAS_CALIB_X9_LOW	0x1016		(R/W)
		<int32_t>	point9 [meas.value TC]
Measurement calibration: Y-coordinates of the curve definition points (concentration). Values has to be in ascending order. Note! Send always all register values Y0…Y9. Values are saved only after the last register is written. Set register value =0 for unused points.			
MB_REG_MEAS_CALIB_Y0_HIGH	0x1017		(R/W)
MB_REG_MEAS_CALIB_Y0_LOW	0x1018		(R/W)
		<int32_t>	point0 [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_Y1_HIGH	0x1019		(R/W)
MB_REG_MEAS_CALIB_Y1_LOW	0x101A		(R/W)
		<int32_t>	point1 [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_Y2_HIGH	0x101B		(R/W)
MB_REG_MEAS_CALIB_Y2_LOW	0x101C		(R/W)
		<int32_t>	point2 [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_Y3_HIGH	0x101D		(R/W)
MB_REG_MEAS_CALIB_Y3_LOW	0x101E		(R/W)
		<int32_t>	point3 [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_Y4_HIGH	0x101F		(R/W)
MB_REG_MEAS_CALIB_Y4_LOW	0x1020		(R/W)
		<int32_t>	point4 [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_Y5_HIGH	0x1021		(R/W)
MB_REG_MEAS_CALIB_Y5_LOW	0x1022		(R/W)
		<int32_t>	point5 [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_Y6_HIGH	0x1023		(R/W)
MB_REG_MEAS_CALIB_Y6_LOW	0x1024		(R/W)
		<int32_t>	point6 [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_Y7_HIGH	0x1025		(R/W)
MB_REG_MEAS_CALIB_Y7_LOW	0x1026		(R/W)
		<int32_t>	point7 [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_Y8_HIGH	0x1027		(R/W)
MB_REG_MEAS_CALIB_Y8_LOW	0x1028		(R/W)
		<int32_t>	point8 [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_Y9_HIGH	0x1029		(R/W)
MB_REG_MEAS_CALIB_Y9_LOW	0x102A		(R/W)
		<int32_t>	point9 [mg/m³/100 CAL]
Signals:			
MB_REG_MEAS_SIGNAL_HOLD_TIME	0x1200		(R/W)
		0…255	signal hold time [sec/10]
MB_REG_MEAS_SIGNAL_1_SRC	0x1201		(R/W) signal 1 control source
		<bit_value>	bit masks for enabling: 0x1 = alarm L (local) 0x2 = alarm A (local) 0x4 = alarm B (local) 0x8 = remote control
MB_REG_MEAS_SIGNAL_2_SRC	0x1202		(R/W) signal 2 control source
		<bit_value>	bit masks for enabling: 0x1 = alarm L (local) 0x2 = alarm A (local) 0x4 = alarm B (local) 0x8 = remote control
MB_REG_MEAS_SIGNAL_3_SRC	0x1203		(R/W) signal 3 control source
		<bit_value>	bit masks for enabling: 0x1 = alarm L (local) 0x2 = alarm A (local) 0x4 = alarm B (local) 0x8 = remote control
Reject-% of max.raw values when diff.average of measurements is calculated:			
MB_REG_MEAS_DV	0x1204		(R/W)
		0…100	[%]
Dust levels (running average TC or concentration [mg/m³/100 CAL]) in order to generate alarms: - alarm L: processed value < limit0 - alarm A: limit0 < processed value < limit1 - alarm B: processed value > limit1			
MB_REG_MEAS_ALARM_LIMIT0_HIGH	0x1400		(R/W)
MB_REG_MEAS_ALARM_LIMIT0_LOW	0x1401		(R/W)
		<int32_t>	limit0

MB_REG_MEAS_ALARM_LIMIT1_HIGH	0x1402		(R/W)
MB_REG_MEAS_ALARM_LIMIT1_LOW	0x1403		(R/W)
		<int32_t>	limit1
mA calibration: Nbr of curve definition points. Note! Set this register value before sending corresponding curve points.			
MB_REG_MEAS_CALIB_MA_POINTS	0x1404		(R/W)
		0…10	
mA calibration: X-coordinates of the curve definition points (running average TC or concentration [mg/m³/100 CAL]). Values has to be in ascending order. Note! Send always all register values X0…X9. Values are saved only after the last register is written. If nbr of curve definition points is less than 10, set register value =0 for the last unused points.			
MB_REG_MEAS_CALIB_MA_X0_HIGH	0x1405		(R/W)
MB_REG_MEAS_CALIB_MA_X0_LOW	0x1406		(R/W)
		<int32_t>	point0 [meas.TC] / [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_MA_X1_HIGH	0x1407		(R/W)
MB_REG_MEAS_CALIB_MA_X1_LOW	0x1408		(R/W)
		<int32_t>	point1 [meas.TC] / [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_MA_X2_HIGH	0x1409		(R/W)
MB_REG_MEAS_CALIB_MA_X2_LOW	0x140A		(R/W)
		<int32_t>	point2 [meas.TC] / [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_MA_X3_HIGH	0x140B		(R/W)
MB_REG_MEAS_CALIB_MA_X3_LOW	0x140C		(R/W)
		<int32_t>	point3 [meas.TC] / [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_MA_X4_HIGH	0x140D		(R/W)
MB_REG_MEAS_CALIB_MA_X4_LOW	0x140E		(R/W)
		<int32_t>	point4 [meas.TC] / [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_MA_X5_HIGH	0x140F		(R/W)
MB_REG_MEAS_CALIB_MA_X5_LOW	0x1410		(R/W)
		<int32_t>	point5 [meas.TC] / [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_MA_X6_HIGH	0x1411		(R/W)
MB_REG_MEAS_CALIB_MA_X6_LOW	0x1412		(R/W)
		<int32_t>	point6 [meas.TC] / [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_MA_X7_HIGH	0x1413		(R/W)
MB_REG_MEAS_CALIB_MA_X7_LOW	0x1414		(R/W)
		<int32_t>	point7 [meas.TC] / [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_MA_X8_HIGH	0x1415		(R/W)
MB_REG_MEAS_CALIB_MA_X8_LOW	0x1416		(R/W)
		<int32_t>	point8 [meas.TC] / [mg/m³/100 CAL]
MB_REG_MEAS_CALIB_MA_X9_HIGH	0x1417		(R/W)
MB_REG_MEAS_CALIB_MA_X9_LOW	0x1418		(R/W)
		<int32_t>	point9 [meas.TC] / [mg/m³/100 CAL]
mA calibration: Y-coordinates of the curve definition points. Note! Send always all register values Y0…Y9. Values are saved only after the last register is written. Set register value =0 for unused points.			
MB_REG_MEAS_CALIB_MA_Y0_HIGH	0x1419		(R/W)
MB_REG_MEAS_CALIB_MA_Y0_LOW	0x141A		(R/W)
		<int32_t>	point0 [mA/100]
MB_REG_MEAS_CALIB_MA_Y1_HIGH	0x141B		(R/W)
MB_REG_MEAS_CALIB_MA_Y1_LOW	0x141C		(R/W)
		<int32_t>	point1 [mA/100]
MB_REG_MEAS_CALIB_MA_Y2_HIGH	0x141D		(R/W)
MB_REG_MEAS_CALIB_MA_Y2_LOW	0x141E		(R/W)
		<int32_t>	point2 [mA/100]
MB_REG_MEAS_CALIB_MA_Y3_HIGH	0x141F		(R/W)
MB_REG_MEAS_CALIB_MA_Y3_LOW	0x1420		(R/W)
		<int32_t>	point3 [mA/100]
MB_REG_MEAS_CALIB_MA_Y4_HIGH	0x1421		(R/W)
MB_REG_MEAS_CALIB_MA_Y4_LOW	0x1422		(R/W)
		<int32_t>	point4 [mA/100]
MB_REG_MEAS_CALIB_MA_Y5_HIGH	0x1423		(R/W)
MB_REG_MEAS_CALIB_MA_Y5_LOW	0x1424		(R/W)
		<int32_t>	point5 [mA/100]
MB_REG_MEAS_CALIB_MA_Y6_HIGH	0x1425		(R/W)
MB_REG_MEAS_CALIB_MA_Y6_LOW	0x1426		(R/W)
		<int32_t>	point6 [mA/100]
MB_REG_MEAS_CALIB_MA_Y7_HIGH	0x1427		(R/W)
MB_REG_MEAS_CALIB_MA_Y7_LOW	0x1428		(R/W)
		<int32_t>	point7 [mA/100]
MB_REG_MEAS_CALIB_MA_Y8_HIGH	0x1429		(R/W)
MB_REG_MEAS_CALIB_MA_Y8_LOW	0x142A		(R/W)
		<int32_t>	point8 [mA/100]
MB_REG_MEAS_CALIB_MA_Y9_HIGH	0x142B		(R/W)
MB_REG_MEAS_CALIB_MA_Y9_LOW	0x142C		(R/W)
		<int32_t>	point9 [mA/100]
Auto-setup result: Base dust level (average of running averages or concentration measures):			
MB_REG_MEAS_AS_RESULT_HIGH	0x142D		(R/W)
MB_REG_MEAS_AS_RESULT_LOW	0x142E		(R/W)
		<int32_t>	[meas.value TC] / [mg/m³/100 CAL]
Delay [sec] for alarm signal pin low -> high control:			
MB_REG_MEAS_SIGNAL_DELAY_LH	0x142F		(R/W)
		<uint16_t>	
Delay [sec] for alarm signal pin high -> low control:			
MB_REG_MEAS_SIGNAL_DELAY_HL	0x1430		(R/W)
		<uint16_t>	

DEVICE PARAMETERS (RAM)			
mA output linearization: Nbr of curve definitions points: Note! Set this register value before sending corresponding curve points.			
MB_REG_DEVI_LINEAR_MA_POINTS	0x2000		(R/W)
		0…10	
mA output linearization: X-coordinates of the curve definition points. Values has to be in ascending order. Note! Send always all register values X0…X9. Values are saved only after the last register is written. If nbr of curve definition points is less than 10, set register value =0 for the last unused points.			
MB_REG_DEVI_LINEAR_MA_X0_HIGH	0x2001		(R/W)
MB_REG_DEVI_LINEAR_MA_X0_LOW	0x2002		(R/W)
		<float>	point0 [mA-value]
MB_REG_DEVI_LINEAR_MA_X1_HIGH	0x2003		(R/W)
MB_REG_DEVI_LINEAR_MA_X1_LOW	0x2004		(R/W)
		<float>	point1 [mA-value]
MB_REG_DEVI_LINEAR_MA_X2_HIGH	0x2005		(R/W)
MB_REG_DEVI_LINEAR_MA_X2_LOW	0x2006		(R/W)
		<float>	point2 [mA-value]
MB_REG_DEVI_LINEAR_MA_X3_HIGH	0x2007		(R/W)
MB_REG_DEVI_LINEAR_MA_X3_LOW	0x2008		(R/W)
		<float>	point3 [mA-value]
MB_REG_DEVI_LINEAR_MA_X4_HIGH	0x2009		(R/W)
MB_REG_DEVI_LINEAR_MA_X4_LOW	0x200A		(R/W)
		<float>	point4 [mA-value]
MB_REG_DEVI_LINEAR_MA_X5_HIGH	0x200B		(R/W)
MB_REG_DEVI_LINEAR_MA_X5_LOW	0x200C		(R/W)
		<float>	point5 [mA-value]
MB_REG_DEVI_LINEAR_MA_X6_HIGH	0x200D		(R/W)
MB_REG_DEVI_LINEAR_MA_X6_LOW	0x200E		(R/W)
		<float>	point6 [mA-value]
MB_REG_DEVI_LINEAR_MA_X7_HIGH	0x200F		(R/W)
MB_REG_DEVI_LINEAR_MA_X7_LOW	0x2010		(R/W)
		<float>	point7 [mA-value]
MB_REG_DEVI_LINEAR_MA_X8_HIGH	0x2011		(R/W)
MB_REG_DEVI_LINEAR_MA_X8_LOW	0x2012		(R/W)
		<float>	point8 [mA-value]
MB_REG_DEVI_LINEAR_MA_X9_HIGH	0x2013		(R/W)
MB_REG_DEVI_LINEAR_MA_X9_LOW	0x2014		(R/W)
		<float>	point9 [mA-value]
mA output linearization: Y-coordinates of the curve definition points. Note! Send always all register values Y0…Y9. Values are saved only after the last register is written. Set register value =0 for unused points.			
MB_REG_DEVI_LINEAR_MA_Y0_HIGH	0x2015		(R/W)
MB_REG_DEVI_LINEAR_MA_Y0_LOW	0x2016		(R/W)
		<float>	point0 [PWM/DAC-value]
MB_REG_DEVI_LINEAR_MA_Y1_HIGH	0x2017		(R/W)
MB_REG_DEVI_LINEAR_MA_Y1_LOW	0x2018		(R/W)
		<float>	point1 [PWM/DAC-value]
MB_REG_DEVI_LINEAR_MA_Y2_HIGH	0x2019		(R/W)
MB_REG_DEVI_LINEAR_MA_Y2_LOW	0x201A		(R/W)
		<float>	point2 [PWM/DAC-value]
MB_REG_DEVI_LINEAR_MA_Y3_HIGH	0x201B		(R/W)
MB_REG_DEVI_LINEAR_MA_Y3_LOW	0x201C		(R/W)
		<float>	point3 [PWM/DAC-value]
MB_REG_DEVI_LINEAR_MA_Y4_HIGH	0x201D		(R/W)
MB_REG_DEVI_LINEAR_MA_Y4_LOW	0x201E		(R/W)
		<float>	point4 [PWM/DAC-value]
MB_REG_DEVI_LINEAR_MA_Y5_HIGH	0x201F		(R/W)
MB_REG_DEVI_LINEAR_MA_Y5_LOW	0x2020		(R/W)
		<float>	point5 [PWM/DAC-value]
MB_REG_DEVI_LINEAR_MA_Y6_HIGH	0x2021		(R/W)
MB_REG_DEVI_LINEAR_MA_Y6_LOW	0x2022		(R/W)
		<float>	point6 [PWM/DAC-value]
MB_REG_DEVI_LINEAR_MA_Y7_HIGH	0x2023		(R/W)
MB_REG_DEVI_LINEAR_MA_Y7_LOW	0x2024		(R/W)
		<float>	point7 [PWM/DAC-value]
MB_REG_DEVI_LINEAR_MA_Y8_HIGH	0x2025		(R/W)
MB_REG_DEVI_LINEAR_MA_Y8_LOW	0x2026		(R/W)
		<float>	point8 [PWM/DAC-value]
MB_REG_DEVI_LINEAR_MA_Y9_HIGH	0x2027		(R/W)
MB_REG_DEVI_LINEAR_MA_Y9_LOW	0x2028		(R/W)
		<float>	point9 [PWM/DAC-value]

AUTO-SETUP ETC. FLASH PARAMETERS			
Measurement params used in auto-setup:			
MB_REG_AS_USED_PROFILE	0x3000		(R/W)
		0	default RAM meas.params
		1…10	flash meas.params set
Coefficients in order to calculate alarm limits (auto-setup). Negative value means division:			
MB_REG_AS_CO_ALARM_LIMIT0_HIGH	0x3001		(R/W)
MB_REG_AS_CO_ALARM_LIMIT0_LOW	0x3002		(R/W)
		<float>	
MB_REG_AS_CO_ALARM_LIMIT1_HIGH	0x3003		(R/W)
MB_REG_AS_CO_ALARM_LIMIT1_LOW	0x3004		(R/W)
		<float>	
Coefficients in order to calculate mA calib line (auto-setup). Negative value means division:			
MB_REG_AS_CO_CALIB_MA_LINE0_HIGH	0x3005		(R/W)
MB_REG_AS_CO_CALIB_MA_LINE0_LOW	0x3006		(R/W)
		<float>	

MB_REG_AS_CO_CALIB_MA_LINE1_HIGH	0x3007		(R/W)
MB_REG_AS_CO_CALIB_MA_LINE1_LOW	0x3008		(R/W)
		<float>	
MODBUS address:			
MB_REG_MODBUS_ADDRESS	0x3009		(R/W)
		1…254	=
		255	= default (no address)

Supported function codes.

MODBUS data model:

```
            (Discrete input          == single bit, R)
            (Coil                    == single bit, R/W)
            Input register           == 16-bit word, R
            Holding register         == 16-bit word, R/W
```

Serial communication settings:

38400/ 8/ no parity/ 1 stop bit

READ HOLDING REGISTERS (FC=0x03):
READ INPUT REGISTERS (FC=0x04):

```
Request:
            FC                       0x03/ 0x04              (1 byte)
            Starting address         0x0...0xffff            (2 bytes)
            Quantity of registers(N) 1... 20 (spec.125)      (2 bytes)

Response:
            FC                       0x03/ 0x04              (1 byte)
            Byte count               2*N                     (1 byte)
            Register value           <register values>       (2*N bytes)

Error response:
            Error code               0x80+FC                 (1 byte)
            Exception code           1/2/3/4                 (1 byte)
```

WRITE SINGLE REGISTER (FC=0x06):

```
Request:    FC                       0x06                    (1 byte)
            Register address         0x0...0xffff            (2 bytes)
            Register value           0x0...0xffff            (2 bytes)

Response:   FC                       0x06                    (1 byte)
            Register address         0x0...0xffff            (2 bytes)
            Register value           0x0...0xffff            (2 bytes)

Error response:
            Error code               0x80+FC                 (1 byte)
            Exception code           1/2/3/4                 (1 byte)
```

Exception codes:

```
            EC_ILLEGAL_FUNCTION      =1
            EC_ILLEGAL_DATA_ADDRESS  =2
            EC_ILLEGAL_DATA_VALUE    =3
            EC_SLAVE_DEVICE_FAILURE  =4
```

If requested valid read or write operation fails, slave responds with exception EC_SLAVE_DEVICE_FAILURE.

Reading: Must read first HIGH and then LOW part of the 32-bit variable in order to get atomic value. If LOW part is read without preceding HIGH part, exception EC_ILLEGAL_DATA_ADDRESS is responded.

Writing: For the 32-bit variable send first HIGH and then LOW part. If LOW part is received without preceding HIGH part, exception EC_ILLEGAL_DATA_ADDRESS is responded. If register value is out of range, EC_ILLEGAL_DATA_VALUE or EC_SLAVE_DEVICE_FAILURE is responded.

16 Disposal

16.1 Disposal of packaging

Sort the packaging before you dispose of it. Dispose of paperboard and cardboard with the recycled paper service and wrappings with the appropriate collection service.

16.2 Disposal of the Dumo

Should the Dumo no longer be capable of being used at some point in time, dispose of it in accordance with the regulations in force in your city or state.

Please ensure your recycling information applies to local regulations and the EPA recommendations (www.epa.gov).

17 Notes

18 Acknowledgements

Sintrol Oy

Ruosilantie 15

FI-00390 Helsinki

Finland

VAT number: FI21439063

Registered domicile: Helsinki

ProDetec Measure . Prevent . Protect . Control

ProDetec Pty.Ltd.
P. +61 (02) 9620 8700
F. +61 (02) 9620 8755
E. info@prodetec.com.au
A. 17/38 Powers Rd,
Seven Hills NSW 2147
www.prodetec.com.au