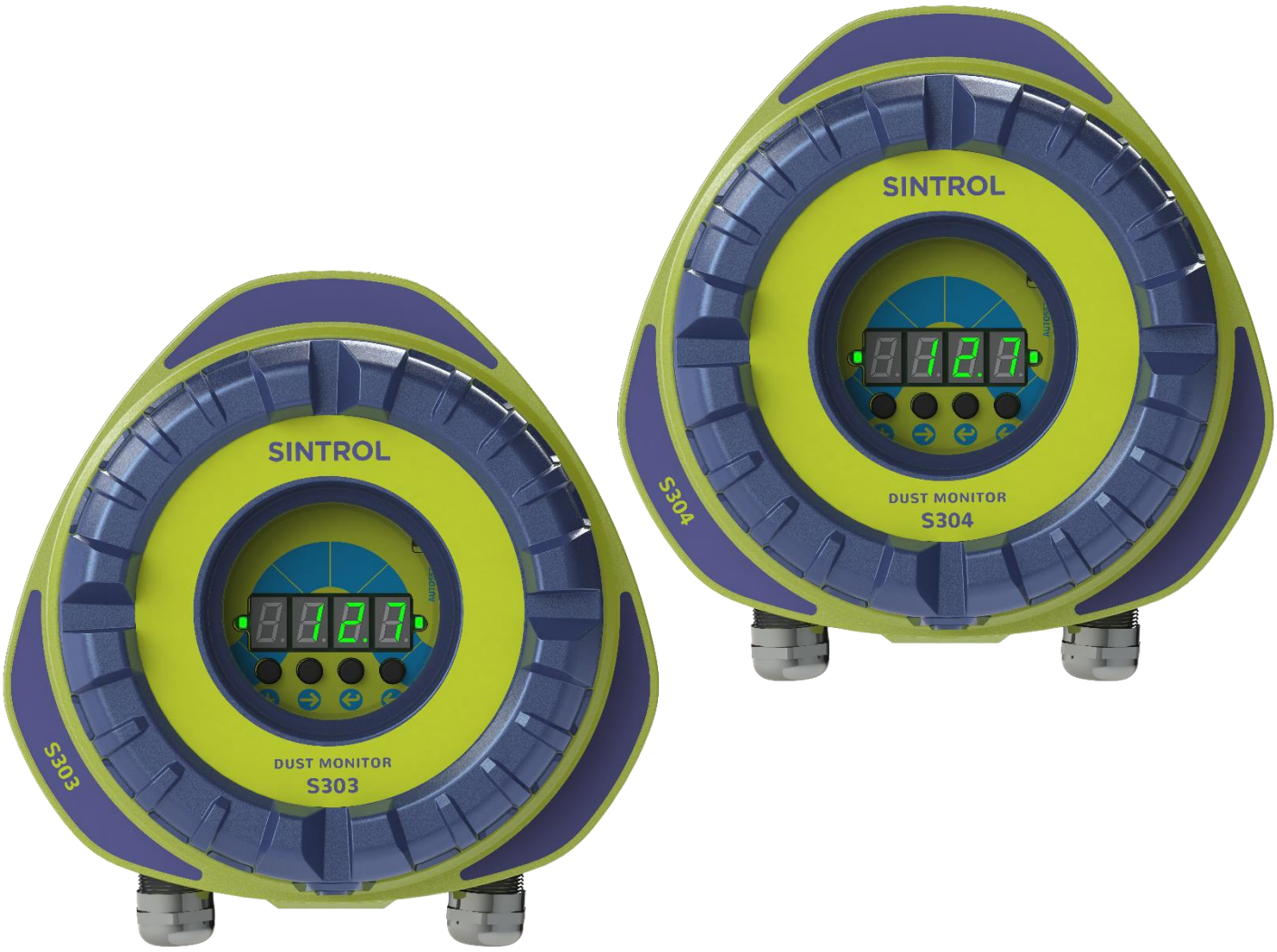
# User Manual

**IMPORTANT**

**READ CAREFULLY BEFORE USE**

**READ USER MANUAL FOR OPTIONAL PRODUCTS IF APPLICABLE**

**KEEP FOR FUTURE REFERENCE**




**S300 Series, comprising the models S303 and S304**

Date: 14th August 2019

Version: 2.6

# Table of Contents

# List of Figures

# 1 General Information

## 1.1 Reading and storing the user manual

This user manual accompanies the S303 and S304 dust measuring instruments and contains important information on installation, setup, calibration, and handling.

Before using the S303 or S304, 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 S303 or S304. This user manual must be accessible to those tasked with the installation and operation of the S303 or S304.

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 S303 or S304 and package contents

| NOTICE | **Risk of damage!**<br>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 S303 or S304 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 Filtration system is intact and production running (see chapter 8.2 Auto setup description)
- Change parameters and calibrate the instrument if necessary by using the local user interface or any of the Sintrol software (see chapter 8.4 Parameter table for the local display (S303 or S304) or 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 17.2 Disposal of the S300 Series)

## 1.4 Explanation of symbols

The following symbols and signal words are used in this user manual, on the S300 Series, 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:<br>IEC 60079-0:2017<br>EN 60079-11:2012, EN 60079-31:2014<br>EN 61010-1:2001 Safety, LVD<br>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 other model if required.
- This product is intended for skilled technicians and trained and certified operators. Make sure the S300 Series is only operated by qualified personnel.
- Electrical installation is only to be performed by qualified personnel.
- Children may not install, operate, or maintain the S300 Series. 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 S303 or S304 in any 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

S303 and S304 can be used in outdoor or indoor operations and is primarily meant to be used at non-condensing conditions inside the duct or pipe. (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 a variance in particle concentration in the process such as filter leak detection, process measurements or emissions monitoring in stacks. Sintrol S303 or S304 is the perfect instrument for monitoring the efficiency of this dust removal process.

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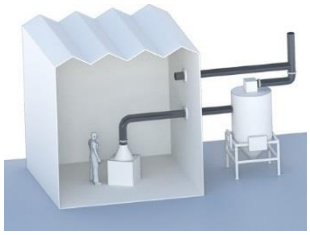
PURCHASER UNDERSTANDS AND AGREES THAT IT SHALL BE PURCHASER'S SOLE RESPONSIBILITY TO ENSURE THAT ALL PRODUCTS OBTAINED FROM SELLER SHALL ADHERE TO APPLICABLE LAWS, CODES AND STANDARDS WITHIN THE TERRITORY OF USE. PURCHASER ABSOLVES AND HOLDS SELLER HARMLESS FOR ANY ALLEGED VIOLATIONS OF SUCH LOCAL LAWS,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

## Fabric Filter Control

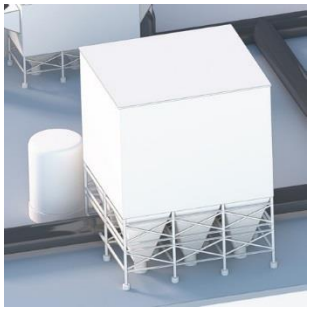
- Straightforward filter leak detection on an ALERT and ALARM signal base
- Filter performance monitoring and optimization on the mA output signal
- Minimize product loss by finding even the smallest leakages
- Identify broken solenoid valves
- Monitor pulse efficiency and reduce pulse rates
- Reduce consumption of compressed air
- Enable preventive maintenance
- Proactively reduce emergency downtime

## Extraction and Air Circulation Systems



- Help improve clean air working conditions
- Compliance with regulations by monitoring the return air
- According to EN12779 each wood shop which operates an air circulation system bigger than 10.000 m3/h needs to be continuously monitored
- Control of the weld fumes removal process
- Immediate alarm in case of filter malfunction

## Measuring in hot conditions such as Steel-, Cement-, Chemical Production or Power Plants



- Detect damage in coke oven walls to avoid exhaust gases from leaking into the flue gas
- Different probes and coatings allow the measuring of particulate matter in harsh industrial conditions to up to 700 0C and 6000 kPa
- Conductive and sticky dusts as in e.g. carbon black applications can be measured with teflon coated probes
- Abrasive dusts as in e.g. steel manufacturing processes can be measured by using diamond coated probes

## Continuous Particulate Stack Measurements

- Emissions monitoring in small and medium sized stacks
- Enables power plants <50 MW to be compliant with the EU directive 2010 / 75 / EU / IED, art 32
- US-EPA, OSHA or other local authorities often require continuous measurements parallel to periodic gravimetric samplings

**Typical applications for the S303 and S304 are:**

- Monitor for leaking or broken filters
- Optimize filter cleaning cycles
- Safeguard against unwanted dust
- Satisfy local environmental regulation
- Process control
- Provide real-time feedback from process
- Housekeeping applications
- HVAC applications
- Part of the explosion prevention system
- Welding fumes detection

**Typical industries in which the S303 and S304 are used:**

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

**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 to use the instrument only within the limits set forth in Chapter “5 Principle of operation, physical effects, and limitations”
- 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 S303 and S304 Overview

The instrument measures total suspended particles (TSP) in a conductive duct or pipe, based on a signal generated from moving particles. For parameterization and set up, S303 or S304 can be accessed via USB, RS485 or the optional wireless Radio Frequency (RF) communication with our DustTool software (available free of charge from our website 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. By performing the Auto setup feature the normal dust levels are determined and the two alarm levels are defined to factor 5 and factor 20 of normal dust concentration

The instrument has an isolated probe. Particles passing by crosswise this sensor rod cause a small electrical charge to pass between the particulate and the sensor. The small electric charges provide signals monitored by the electronics. The generated signals are proportional to the dust concentration.

The housing is made out of casted Aluminum. The measuring probe is made of stainless steel (316L) and the insulation material is made out of Ryton R-4 (a Polyphenylene sulfide), commonly used as a high-performance thermoplastic). For installation, it is equipped with a quick clamp between the instrument and the weld-on process connection.

## 4.1 Standard Scope of delivery

The standard scope of delivery of the S303 or S304 includes:

- One instrument
- One measurement probe, connected to the instrument enclosure
- One quick clamp
- One quick clamp gasket
- One weld-on quick-clamp process connection
- DustTool PC Software as a free download at *www.sintrolproducts.com*

| X Standard, oOptional, -blank- Not Available | S303 | S304 |
|---|---|---|
| Rugged IP65 rated Aluminum pressure casted enclosure | X | X |
| Quick clamp process connection for easy installation | X | X |
| Green, yellow and red LED for status indication | X | X |
| Auto Setup function for efficient commissioning | X | X |
| Two dry contact relays to indicate dust alert and dust alarm | X | X |
| 24 VDC and 80 to 230 VAC power supply options | 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 (1) to communicate with Modbus RTU to your control system | X | X |
| RS485 (2) to communicate with Sintrol protocol to your PC and DustTool | 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 (NAMUR) | X | X |
| Zero & span check with automatic drift compensation | X | X |
| Calibration possibility to read directly mg/m³ | | X |
| Flow speed compensation by the mA-output of a third party measurement device | | X |
| Wireless Network capability to avoid cabling cost and extensive installation | o | o |

## 4.2 Accessories, and options

According to the chosen Accessories and options, S303 or S304 comes in the respective configuration.

**Process Temperature (Deg. C)**

- (Standard) To be used in process temperatures below 200 Deg. C
- (Option) To be used in process temperatures below 300 Deg. C
- (Option) To be used in process temperatures below 700 Deg. C

**Process Pressure (bar)**

- (Standard) To be used in process pressure below 3 bar, (Option) Pressure below 6 bar

**Supply Voltages**

- 24VDC +-10%, Minimum 10W output power, Low output ripple, max 1% V p-p of output voltage
- Or 80 - 240 VAC, 47 – 63 Hz

**Air purge**

- (Standard) Without air purge. To be used in dry dust applications where dust build up and bridging is not an issue.
- (Option) Air purge is to be used in adhesive or conductive dust applications where dust build up and bridging may distort the measurement signal. We recommend to purge with approximately 50l/min. Our purge air adapter uses a ¼”R-thread.

**Probe length (mm)**

If the probe length is in comparison to the duct size very short, the measurement may be not representative. For explanation: In vertical ducts dust particle will center with increasing flow speeds towards the middle of the duct. In horizontal ducts large particles will concentrate on low flow speeds on the lower part of the duct. In order to capture this effect Sintrol recommends to use:

- For indicative measurements like for broken bag detection after dry filters a minimum probe length of one quarter (1/4) of the duct size.
- For more demanding and critical measurements in different flow speeds a probe size of a minimum one third (1/3) of the duct size.

| | |
|---|---|
|   | The probe shall not touch the opposing side of the duct. This would distort the measurement |

**Probe Coating**

- (Standard) No coating
- (Option) Teflon coating for wet processes under 250°C in non-hazardous areas
- (Option) Diamond coating for abrasive and dry processes
- (Option) Salocote coating for wet processes up to 700°C

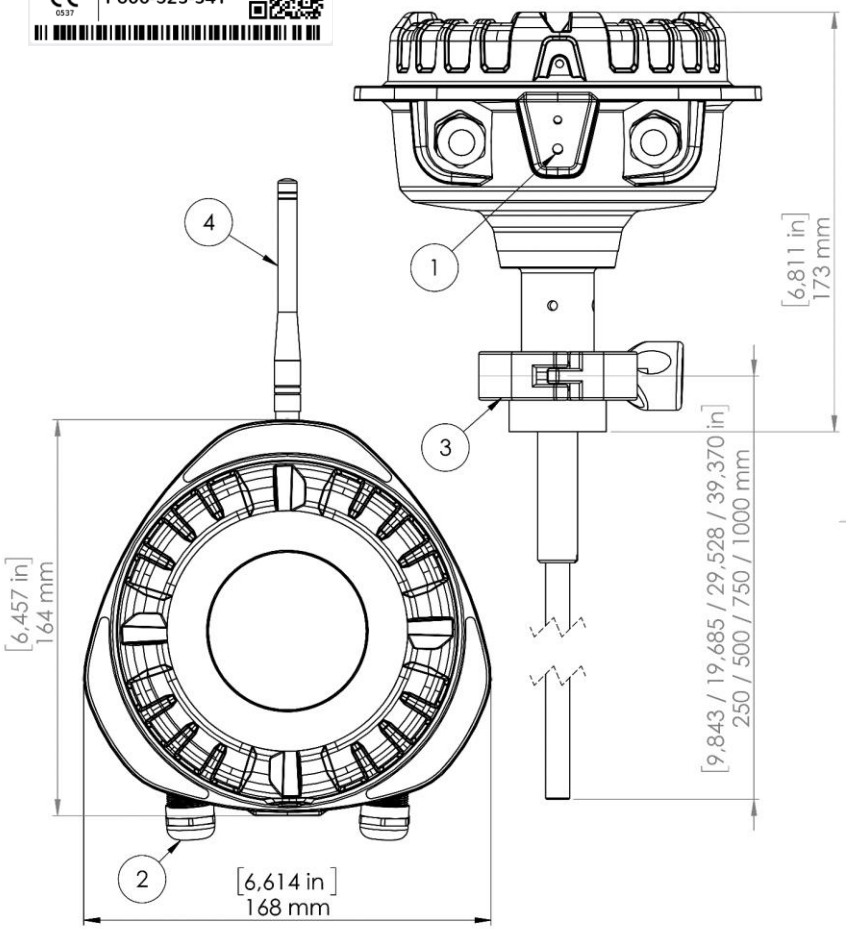
**Process Connection**

- (Standard) Quick Clamp, (Option) Flange

**Other Options**

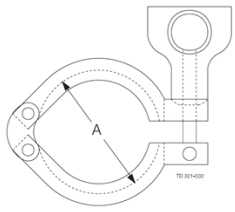
- RS485-to-USB converter
- Wireless communication option
- Network routers, wireless network routers and DustLog 8 reporting software. These supplies have their own manuals which need to be read and followed.

## 4.3 Illustrations of components and dimensions

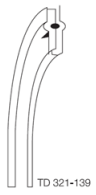




| No. | Desc. |
|---|---|
| 1 | Grouding terminal |
| 2 | PG11 Cable Gland |
| 3 | Quick-Clamp mount |
| 4 | Optional RF Antenna |

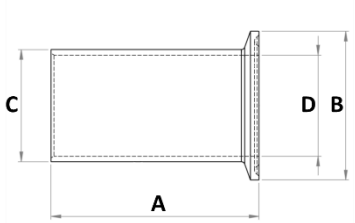
**Process connection components**



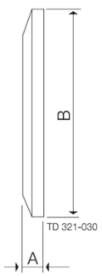

| Tri-Clamp | |
|---|---|
| Purchase-Code | MC900034 |
| Size DN/OD | 1" x 1½" / 25.4 x 38.1 |
| A | 2.13" / 54.0 |




| Sealing ring 1 ½" (Viton + Teflon) | |
|---|---|
| Purchase-Code | OC900007 |




| Process Connection (ANSI 316L) | |
|---|---|
| Purchase-Code | MC900229 |
| A | 70 |
| B | 50 |
| C | 37,7 |
| D | 34 |




| End Cap1 ½" (AISI 316L) | |
|---|---|
| Purchase-Code | MC900033 |
| A | 1,98" / 50,4 |
| B | 0,25" /6,4 |

# 5 Principle of operation, physical effects, and limitations

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.

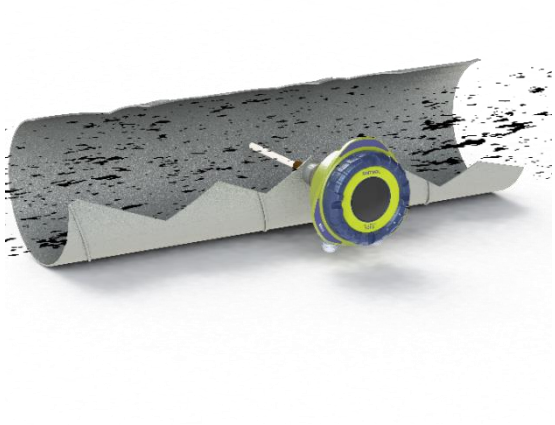


*Figure 1: Inductive Electrification Technology*

Classic triboelectric technology is based on the DC signal, which is caused by particles making contact with 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 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. 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, black dust will show less opacity than white dust.

## 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 S303 or S304 is able to detect is 0.3 µm.
- The best working range of the S303 or S304 is between 1 and 200 µm.

## 5.3 Linearity, maximum concentrations, and calibration

The measuring range and the behavior of the S303 and S304 depends on many factors, such as the dust 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 rang: from linear phase up to several g/m$^3$
- Saturation: after nonlinear range

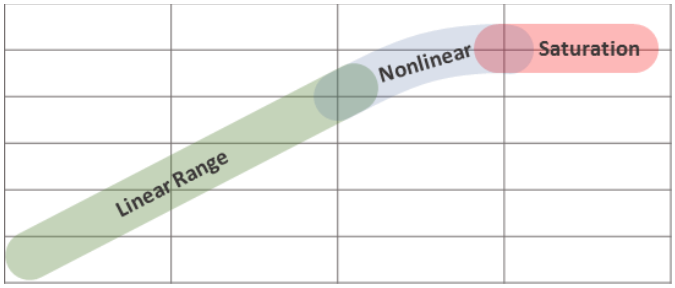



*Figure 2: Illustration of uncalibrated measuring behavior*

| | |
|---|---|
| INFORMATION | To measure higher concentrations than 200 mg/m$^3$ and it is critical to have a linear behaviour we recommend to perform 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 S300 Series, the variation of relative humidity in the measurement gas only has an insignificant effect on measurements **as long as there is no condensation**.

Should there be condensate in the gas, these droplets will be detected as dust particles and distort the measurement signal. No signal or a wrong (most likely too high) signal will be the consequence.

| | |
|---|---|
| INFORMATION | Make sure that the S303 or S304 is installed only in non-condensing conditions to mitigate the effect of droplets affecting the measurement. |

## 5.5 Influence of ambient temperature

Internal and external tests have shown that ambient temperature has very little effect on Sintrol's products using **Inductive Electrification Technology**.

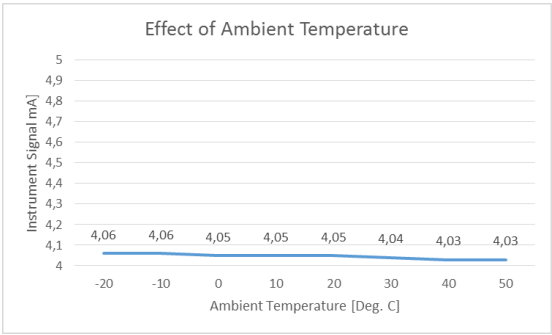



*Figure 3: Effect of Ambient Temperature*

## 5.6 Influence of flow velocity

As an indication and averaging of different internal and external tests Sintrol Instruments with **Inductive Electrification Technology** show the uncompensated Influence of flow velocity as follows:

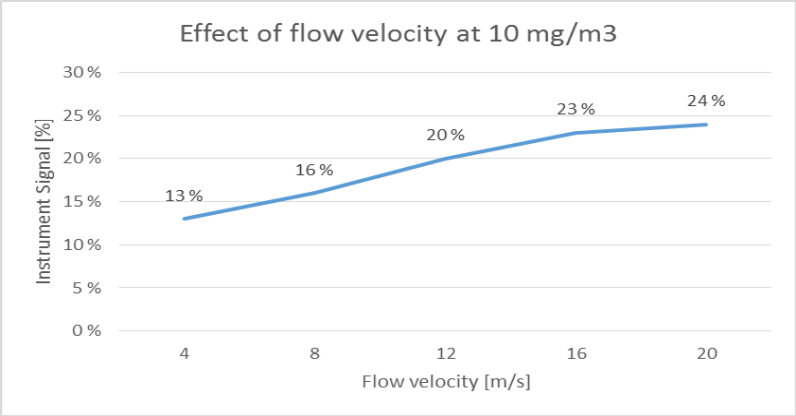
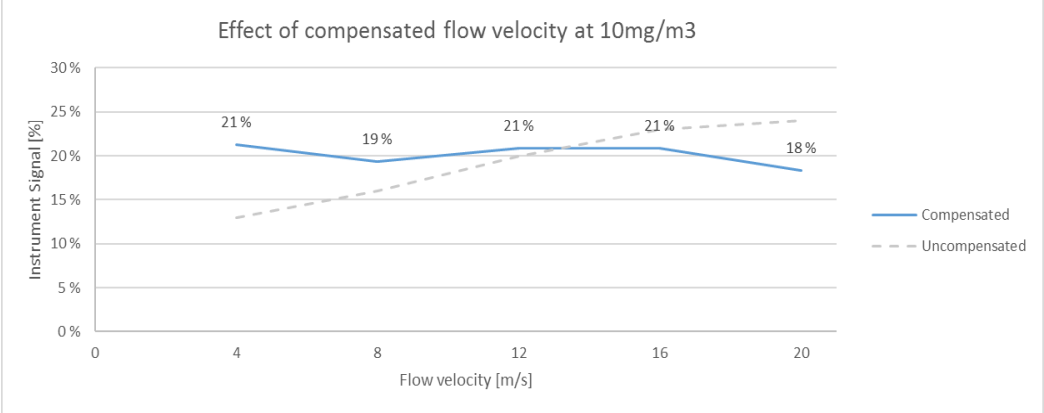



*Figure 4 Influence of Flow velocity*

On the S304 you have the possibility to connect the mA output signal of flow meter. This signal is used by the S304 for compensation. The influence of flow velocity is then as follows:




| | |
|---|---|
| INFORMATION | The flow behaviour may vary depending on the dust material, the particle size, the temperature and the installation location.<br>• The minimum flow velocity is recommended to be 3m/s<br>• Maximum tested flow velocity is 40m/s |

## 5.7 Special dusts

Sintrol Products with **Inductive Electrification Technology** react properly to almost all dust materials.

The only known exception is heavy metal dusts where the behavior is known to be challenging. For measuring such dusts, the S303 or S304 needs to be specially tested beforehand.

# 6 Mechanical Installation

| | |
|---|---|
| DANGER | **Poisonous and hot gas hazard**<br>When installing or removing the equipment, poisonous and hot gas may be released from the duct to the atmosphere. |
| • All applicable local and plant specific safety codes need to be studied and followed before loosening any flange or create any other opening to the duct<br>• Wear appropriate protective clothing, such as gas masks, gloves and follow any other additional safety measure stated in the local, plant specific code. | |

| | |
|---|---|
| WARNING | **Risk of burns due to hot components**<br>When installing or removing the equipment, the S305 and other connected components may be hot.. |
| • Wear appropriate heat protective gloves and follow any other additional safety measure stated in the local, plant specific code. | |

Install the S303 or S304 by using the Weld-on process connection socket, with a Quick Clamp connection in the desired location.

For installations with the RF version, make sure that all the S303 and S304 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.

| | |
|---|---|
| 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 careful functionality checks and if necessary approval by an expert consultant. |

## 6.1 Selecting the installation location

The best location for installation is in a section of duct where the particulate has an even distribution and the flow is as laminar as possible. This is to ensure that the sensor rod comes into contact with a representative flow of particles. The ideal position would be in a section of duct that has no bends, valves, dampers or other obstructions for a distance equal to at least three duct diameters downstream or upstream (preferable 5 x duct diameter).

In some applications, a compromise must be made and the sensor will have to be fitted in a position that satisfies the majority of above requirements. The S303 or S304 must be attached to conducive ductwork so that the device will be electrically shielded from interference and has good ground reference.

If installed downstream an electrostatic precipitator (**ESP**), the distance from the ESP should be at least 20 m.

Although the sensor (lengths less than 1m) is not affected by vibration, very high vibration levels should be avoided.

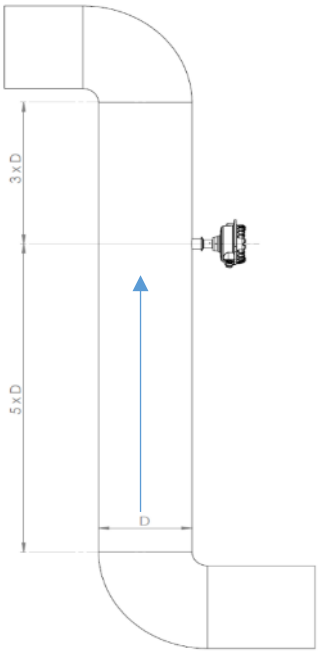
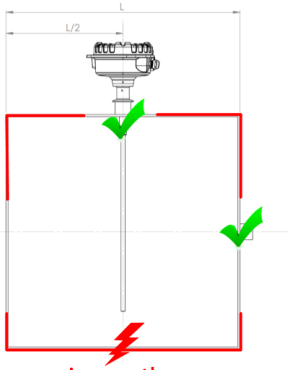



*Figure 5 Recommended distance to duct bends (D = Duct diameter)*

**Installation in a square duct**

**Correct!**
Install on top at the middle of the duct.
On the side, install 1/2...2/3 down from the top. At hot ambient temperatures, install on the side.

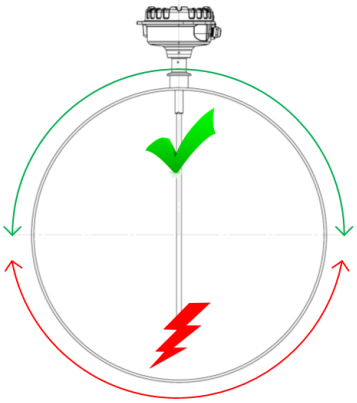


**Incorrect!**
Do **not** install at the corners or at the bottom of the duct

*Figure 6 Installation in a squared duct*

**Installation in a round duct**

**Correct!**
Install between 9 o'clock and 3 o'clock
At hot ambient temperatures, install **at** 9 o'clock or 3 o'clock



**Incorrect!**
Do **not** install at the bottom of the duct

*Figure 7 Installation in a round duct*

- The sensor must not contact the opposite wall or any other obstacle inside the duct. The only allowed interaction with the sensor are dust particles.
- The unit shall be installed in a position, where the gas flow passes the sensor rod at a 90° angle.
- Although the sensor is not affected by vibration, very high vibration levels should be avoided.
- If possible the unit shall be installed in a position where the duct pressure is negative.
- If installed downstream an electrostatic precipitator (ESP), the distance from the ESP should be at least 40 m.
- In case of occasional condensation conditions (droplets in the gas) it is recommended to install the sensor rod showing approximately 5 Deg. downward to avoid liquids cumulating at the S303 or S304 insulation.

## 6.2 Installing the sensor

Once the location of the unit has been selected, the mounting socket must be welded to the pipe or duct. To do this, first cut a hole in the duct slightly larger than the OD of the mounting socket, 35 mm. The socket must be perpendicular to the flow in the duct. Make sure the socket is in the right position and make an airtight welding

After welding the socket in position, insert the sensor.

The diameter of the hole must be minimum 35mm

*Figure 8 Wrong socket installation*

# 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 S303 or S304 when you are not using it, when you intend to clean it, or in the event of a malfunction.
- Only connect the S303 or S304 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 S303 or S304 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 S300-series 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

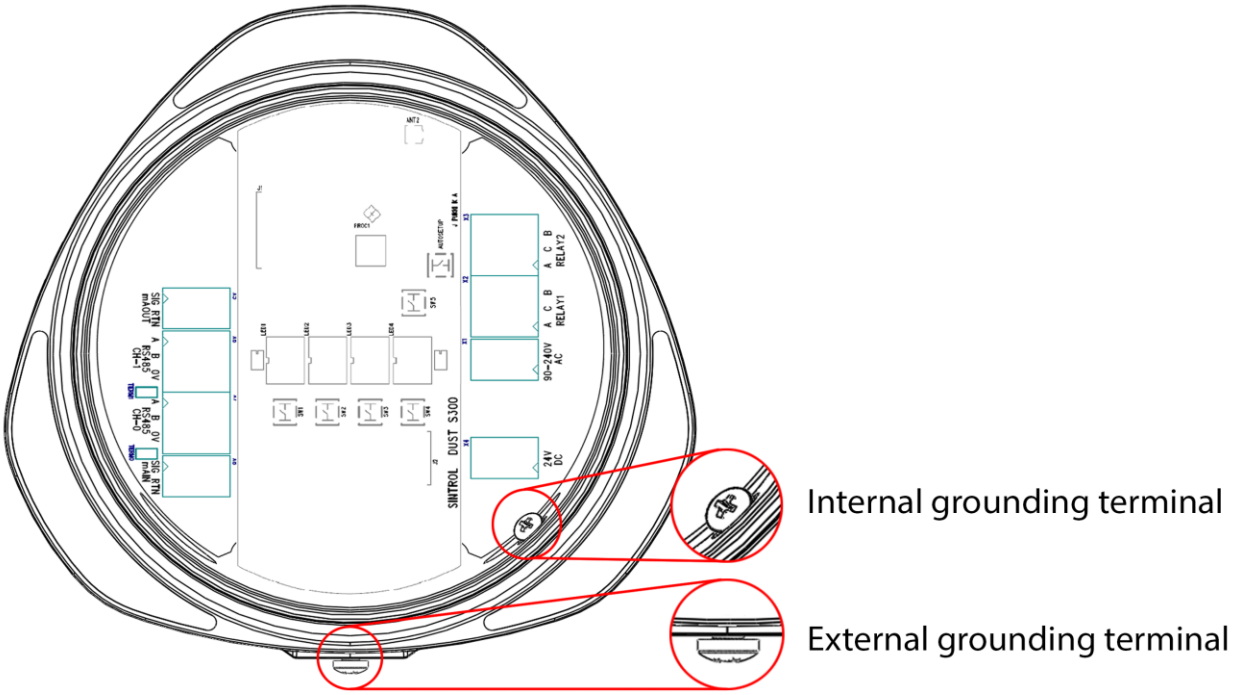
Conductor cross section solid min. 0.2 $mm^2$ / max. 4 $mm^2$

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

For proper operation of the S300 Series Dust Monitor, it is critical that the device is grounded properly. The enclosure is equipped with two grounding terminals, one on the inside of the enclosure and one on the outside. Depending on application either one of these can be used.




Connect the device to a stable ground potential, and make sure that the duct or stack where the S300 Series Dust Monitor is installed on is also grounded with a low-resistance connection.

| | |
|---|---|
| **WARNING** | **Risk of injury!**<br>If the S303 or S304 is not properly grounded, it may show false results, in the worst case resulting in severe health impacts to workers and/or a failure of the explosion prevention system. |
| • Connect the internal grounding terminal to the plants ground potential. Make sure that the ductwork the device is installed in is also connected to the same ground potential. Different ground potentials can cause false results in dust measurement or in worst case cause damage to the device or other connected devices.<br>• In case the ground potentials differ between the power feed location to the installation location, it is recommended to use the S303, S304 with a DC supply instead of AC, and ground the S300 series dust monitor from the external ground connection to the local ductwork instead. Make sure that the ducting is grounded properly.<br>• Make also sure that the power supply used to power the S303 or S304 is a Class 2 or equivalent power supply. | |

Signs of improper grounding are:

- Base values of over 3000 IEU (see Graph at DustTool) when the process is not running
- The S303, S304 should show a clear reaction when touching the probe
- The S303, S304 should show no reaction when touching the enclosure

Note that sub-par quality power sources might also induce such effects.

## 7.3 Connecting the voltage supply

The device can be connected to either a 24VDC voltage power supply or to a 100-240 VAC power supply. Make sure to connect only one power supply. The polarity is irrelevant with both AC and DC power inputs.

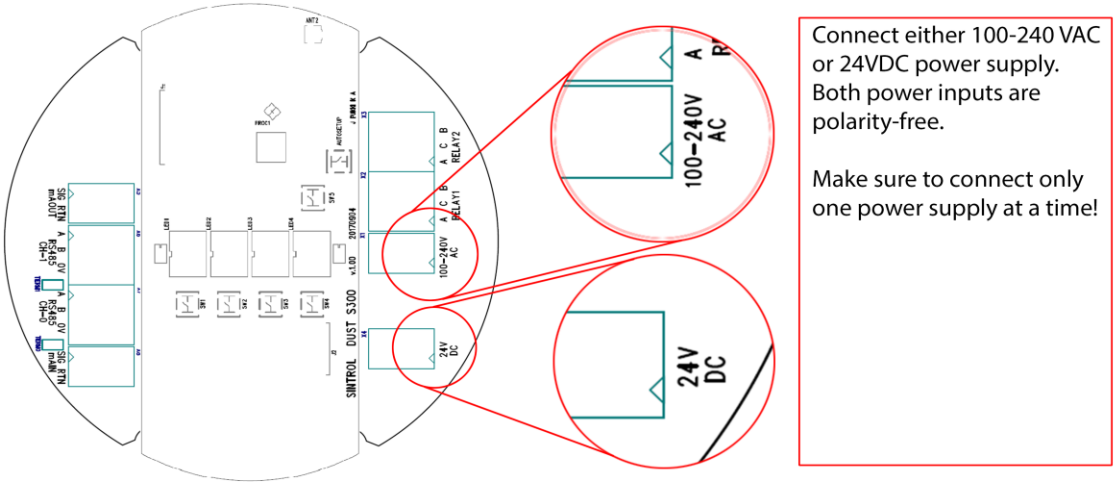



*Figure 9 Connecting power input*

When using AC input, connect the voltage input via a disconnect switch compliant with IEC 60947-1 and IEC 60947-3 – or locally accepted standards. Make sure that this switch is easily accessible and is clearly marked as a disconnect switch for this specific device.

## 7.4 Connecting Relays

S300 Series devices are equipped with two dry-contact SPDT (Single Pole Double Throw) relays. The contacts are labelled as A and B, and the common contact as C.

The relays can be used to power external loads up to 240VAC/5A or 30VDC/5A.

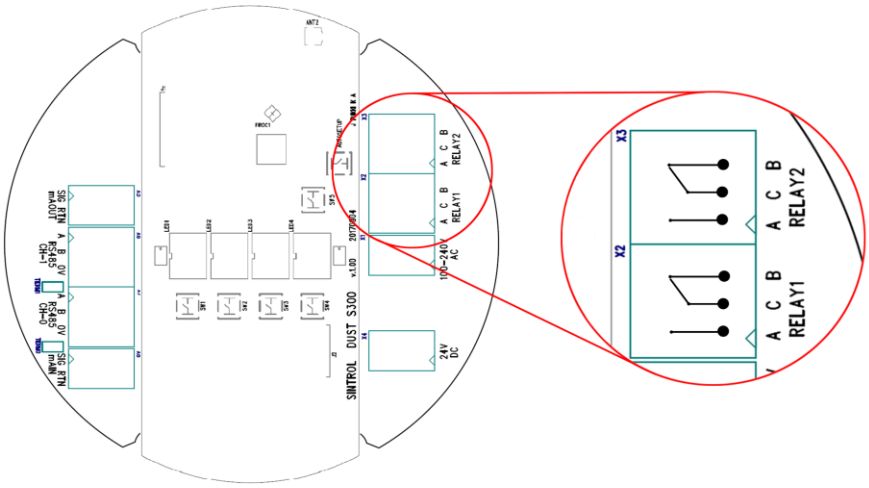



*Figure 10 Connecting Relays*

The relays can be used to connect any combination of AC or DC power.

## 7.5 Connecting via USB (Micro USB type B)

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, located on the bottom-right corner of the main board inside the enclosure.

| | |
|---|---|
| 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. The maximum wire length is 5m. |

## 7.6 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 24 mA | Failure, measurement grounded or device failure. Clean probe as instructed in Maintenance –section. |

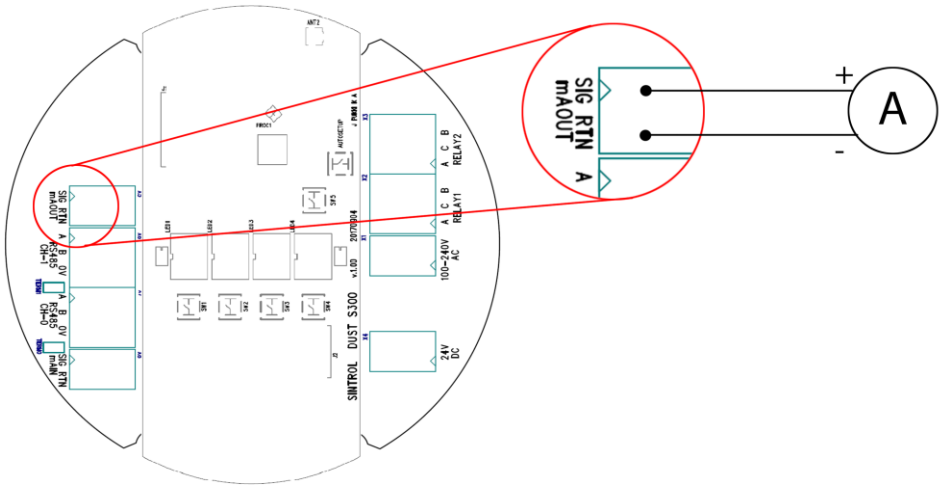



*Figure 11 mA loop connection*

## 7.7 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 S303 or S304 to the customers' own automation systems with the industry standard Modbus RTU protocol. This interface can be used to read data from the S303 or S304 as well as change measurement parameters.

The S303 and S304 have two isolated RS485 buses, one of which is reserved for Sintrol Network use, and the other for Modbus RTU protocol.

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

The S300 series devices have a built-in bus terminator which can be enabled with the jumper next to the connector. 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

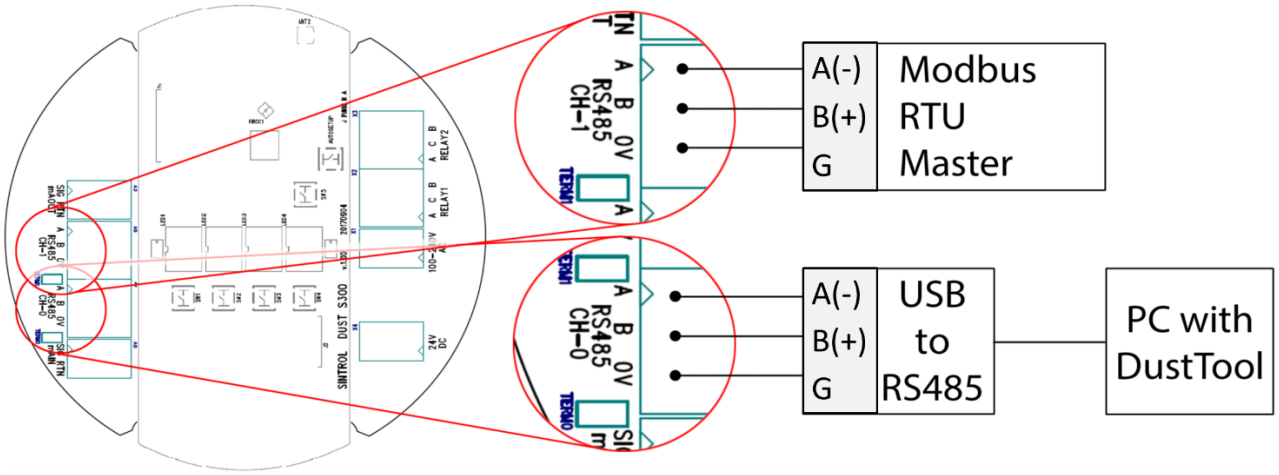



*Figure 12 RS485 connections*

## 7.8 Connecting a RS485 Network

Multiple S300 Series 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.

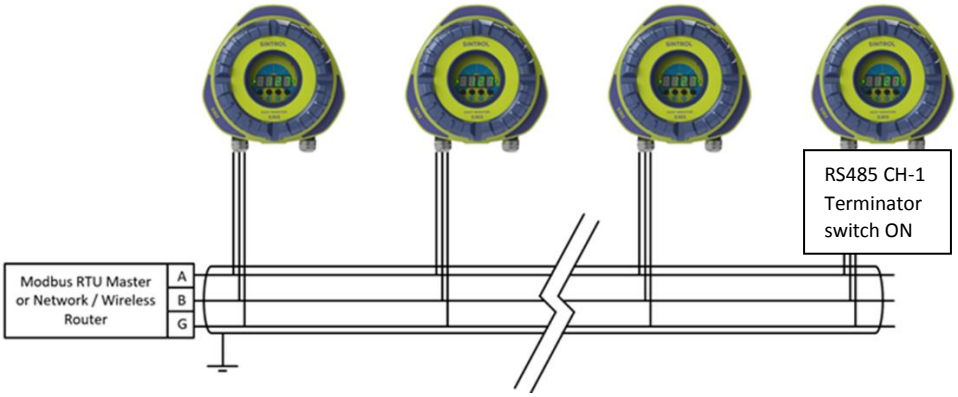



*Figure 13 Connecting a RS485 Network*

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. **(This is the default setting)**
- To use the device with DustLog and a router device, choose the Sintrol Slave option.

## 7.9 Connecting mA output of a flow speed meter (S304 only)

To enable flow compensation of dust measurement, connect the 4…20 mA output of a flow speed measurement instrument into the main terminal of the S304-device and set the compensation as described chapter 8.4.7 Parameter 7: Flow velocity in [m/s] at 4 [mA]  (S304 only)

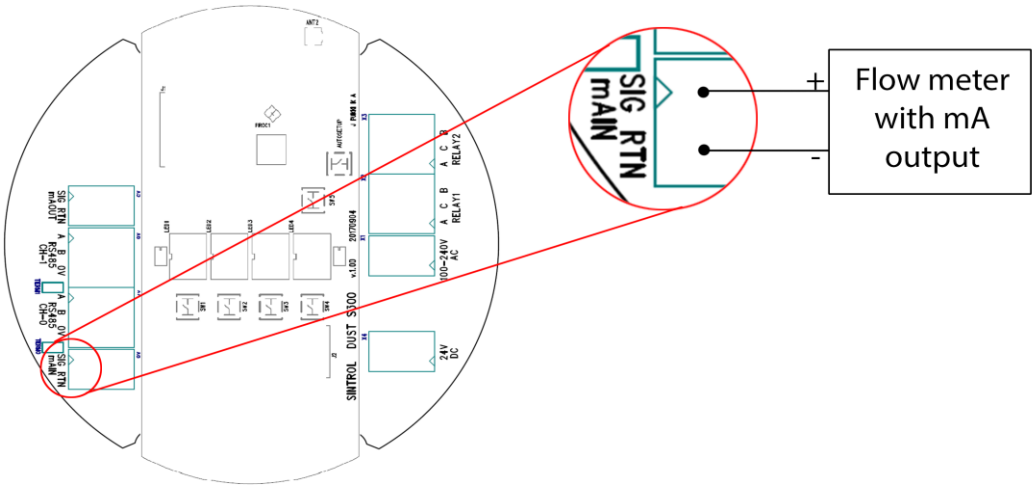



*Figure 14 Connecting mA output of a flow speed meter (S304 only)*

# 8 Parametrization and calibration

The S303 or S304 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 S303 or S304 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 local 4-Key user interface (S303 and S304)
- 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 (CH-1) to communicate under Modbus RTU to a control system or any Modbus master device
- RS485 (CH-0) to communicate under Sintrol Protocol via a commercial RS485 to USB converter to your Windows PC and Sintrol DustTool software
- RF wireless Network communication (optional)

## 8.1 Relay, LED and Display functional logic

The S303 or S304 has different operational statuses which are indicated to the user by changing the behavior of the LED, 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 1<br>Term. Block | RELAY 2 | RELAY 2<br>Term. Block | ANALOG<br>[mA] |
|---|---|---|---|---|---|
| **NORMAL DUST LEVEL AND OPERATION** | Energized | A-C: open<br>B-C: closed | Energized | A-C: open<br>B-C: closed | According to Dust level |
| **ALERT (A)** | Relaxed | A-C: closed<br>B-C: open | Energized | A-C: open<br>B-C: closed | According to Dust level |
| **ALARM (B)** | Relaxed | A-C: closed<br>B-C: open | Relaxed | A-C: closed<br>B-C: open | According to Dust level |
| **MAINTENANCE**<br>**AUTO SETUP**<br>**ZERO / SPAN CHECK** | Energized | | Relaxed | | >23 mA<br>>23 mA<br>4mA / ~16,6mA |
| **FAULT,** | Relaxed | | Relaxed | | >22 mA |

*Table 1: Relay functional logic*

- ENERGIZED relay is when power is applied to the coil
- RELAXED relay is when no power is applied to the coil
- ANALOG signal during fault condition is >23mA

**LED and Display functional logic**

| CONDITION | GREEN LED | RED LED | | DISPLAY<br>(S303, S304) |
|---|---|---|---|---|
| **NORMAL DUST LEVEL AND OPERATION** | on | off | | on, According to Dust level |
| **ALERT (A)** | on | on | (appears as orange) | on, According to Dust level |
| **ALARM (B)** | 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<br>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.

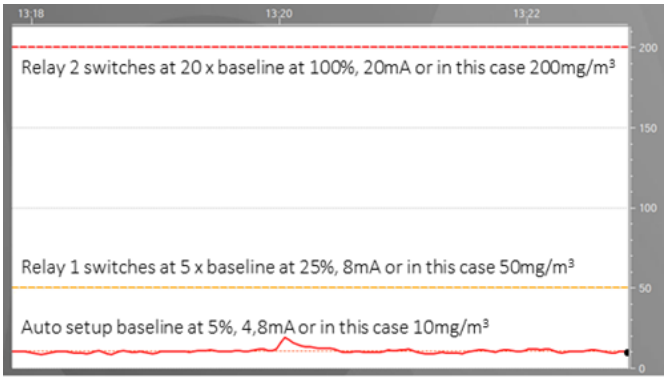


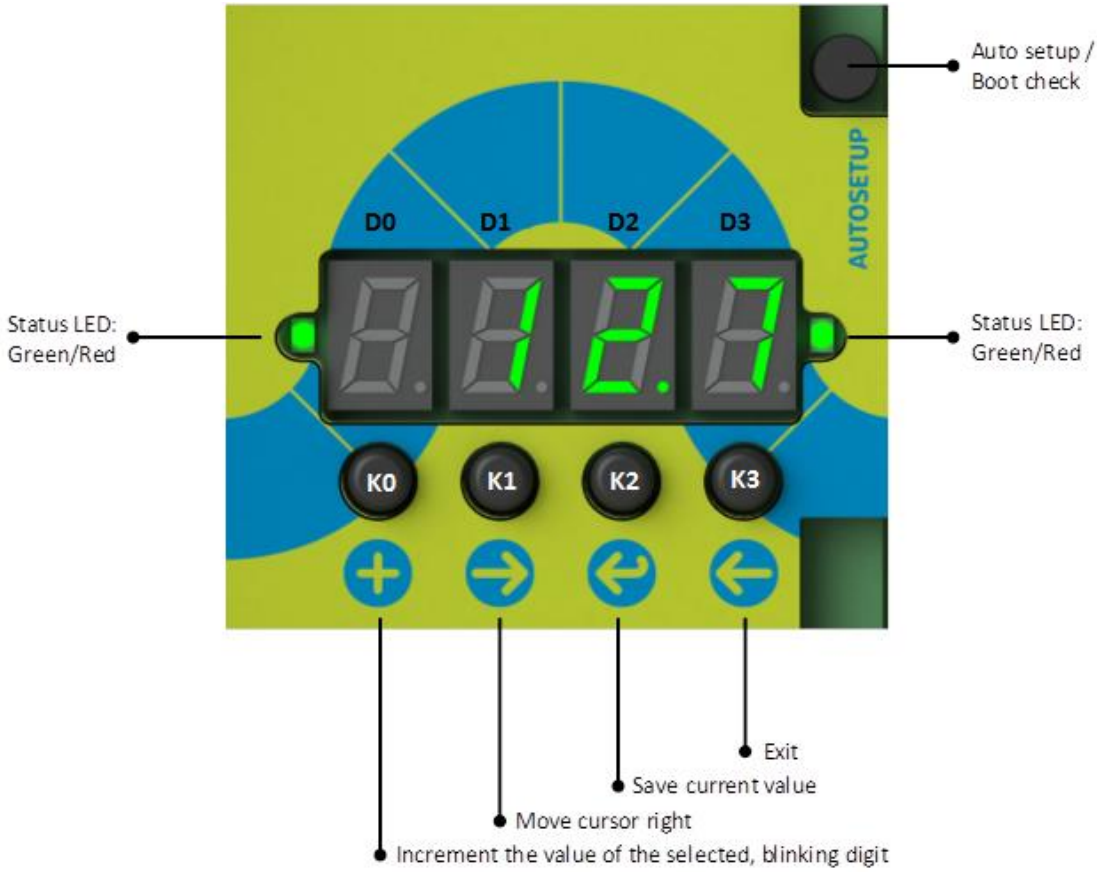

*Figure 15 Settings after Auto setup*

**To start Auto setup on the instrument** first press K0 (both LED will blink green) then press the AutoSetup key for 1 sec. The display shows the remaining time in seconds and count down to 0. Both 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 the AutoSetup key 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 (S303 and S304)

The S303 and S304 is equipped with a 4- Digit, 7- Segment display and 5 key buttons, placed on the top of the processing board, located between the connection areas.




- 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.

## 8.4 Parameter table for the local display (S303 or S304)

| No. | Description | Display | 303 | 304 |
|---|---|---|---|---|
| **1** | Display scale | D3 = 0 = 0.0...100.0 [%] of Range, default | x | x |
| | | D3 = 1 = [mA] | x | x |
| | | D3 = 2 = [mg/m$^3$], shows - - - - if mg/m$^3$ is disabled | | x |
| **2** | Averaging time [sec] | 000...300 [sec], default = 50 [sec] | x | x |
| **3** | 20 mA scaling (Range setting) | 000...999 [%], default 100%<br>determined by the value after Auto setup (20 times Baseline) | x | x |
| **4** | Alarm limit A [%] of Range | 000...100 [%] of Range, default = 25% of Range (8mA) | x | x |
| **5** | Alarm limit B [%] of Range | 000...100 [%] of Range, default = 100% of Range (20mA) | x | x |
| **6** | Alarm delay time [sec] | 000...180 [sec], default = 30 [sec] | x | x |
| **7** | Flow velocity in [m/s] at 4 [mA] | 000...99.9 [m/s], default = 0 [m/s] | | x |
| **8** | Flow velocity in [m/s] at 20 [mA] | 000...99.9 [m/s], default = 0 [m/s], no compensation | | x |
| **9** | Zero & Span check interval | 000...999 [hour], default = 0 [hour], no check | | x |
| **0** | Command parameter | 001 Reset to factory defaults | x | x |
| | | 002 Enable mg/m$^3$ calibration | | x |
| | | 003 Disable mg/m$^3$ calibration | | x |
| **1.** | Display Intercept **a** (Integer) to show [mg/m$^3$] | -99...099 [mg/m$^3$], default = 0 [mg/m$^3$] | | x |
| **2.** | Display Intercept **a** (Decimal) to show [mg/m$^3$] | 000...999 [mg/m$^3$], default = 0 [mg/m$^3$] | | x |
| **3.** | Display Slope **b** (Integer) to show [mg/m$^3$] | 000...999 [mg/m$^3$/mA], default = 0 [mg/m$^3$/mA] | | x |
| **4.** | Display Slope **b** (Decimal) to show [mg/m$^3$] | 000...999 [mg/m$^3$/mA], default = 0 [mg/m$^3$/mA] | | x |
| **5.** | 20 mA scaling in 000...999 [IEU] x 1 000 000 | 20 mA scaling in 000...999 [IEU] x 1 000 000 | | x |
| **6.** | 20 mA scaling in 000...999 [IEU] x 1 000 | 20 mA scaling in 000...999 [IEU] x 1 000 | | x |
| **7.** | Info: Firmware Version | Info: Firmware Version | x | x |

### 8.4.1 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.

### 8.4.2 Parameter 2: Averaging time [sec]:

S303 or S304 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).

### 8.4.3 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%


After performing a new mA scaling the instrument will run automatically a Zero / Span check**.**

### 8.4.4 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).

### 8.4.5 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).

### 8.4.6 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.

### 8.4.7 Parameter 7: Flow velocity in [m/s] at 4 [mA] (S304 only)

In case that your process is highly variating in the flow speed and you require the most accurate reading of the dust concentration, S304 offers the possibility to compensate the influencing effect of the flow speed variation.

To compensate the influence of variations in the flow speeds you need to connect the S304 to the mA output of a flow speed monitor (see 7.9 Connecting mA output of a flow speed meter).

Enter here the 4mA equivalent value, coming from the flow meter in 000...99.9 [m/s], default = 0 [m/s]

### 8.4.8 Parameter 8: Flow velocity in [m/s] at 20 [mA] (S304 only)

Enter here the 20 mA equivalent value, coming from the flow meter in 000...99.9 [m/s], default = 0 [m/s]


The default = 0 [m/s] means here that the compensation is not active.

### 8.4.9 Parameter 9: Zero & Span check interval (S304 only)

The reference value for the Zero & Span check will be automatically defined after setting the 4-20mA range or after the Auto setup.

- The span check will take place at 80% of range
- During the Zero & Span check Relay 1 will be energized and Relay 2 will be relaxed
- The mA output will follow the test values from 4mA to about 16,8mA
- The Zero and Span check function will correct the drift if it is >3% and < 10% of range
- If the drift is >10% of range the instrument will go to maintenance mode.

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


The Zero & Span check will be automatically performed each time you save the parameter by pressing K3 (even if the value is 0).

### 8.4.10 Parameter 10: Command parameter

**The command parameter has 3 functions:**

001 Reset to factory defaults

002 Enable mg/$m^3$ calibration (S304 only)

003 Disable mg/$m^3$ calibration (S304 only)

**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.

**(S304 only) 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/$m^3$

**(S304 only) 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/$m^3$

### 8.4.11 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 Sintrol S304) | **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

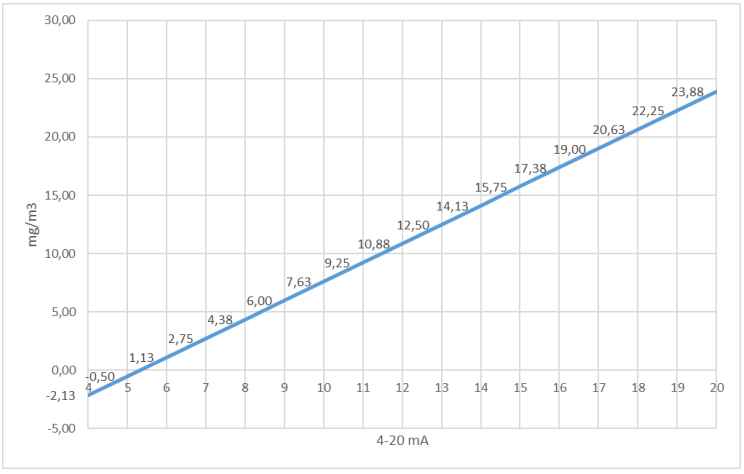



*Figure 16Example for display calibration*

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

### 8.4.12 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

### 8.4.13 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

### 8.4.14 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

### 8.4.15 Parameter 15: 20 mA scaling in 000…999 [IEU] x 1 000 000 (S304 only)

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 **5 Principle of operation, physical effects, and limitations**:


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 visa versa.

### 8.4.16 Parameter 16: 20 mA scaling in 000…999 [IEU] x 1 000 (S304 only)

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

### 8.4.17 Info: Firmware Version

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

# 9 Sintrol DustTool Software

Sintrol S303 and S304 are 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 visa versa, whatever comes last.

## 9.1 PARAMETERS tab

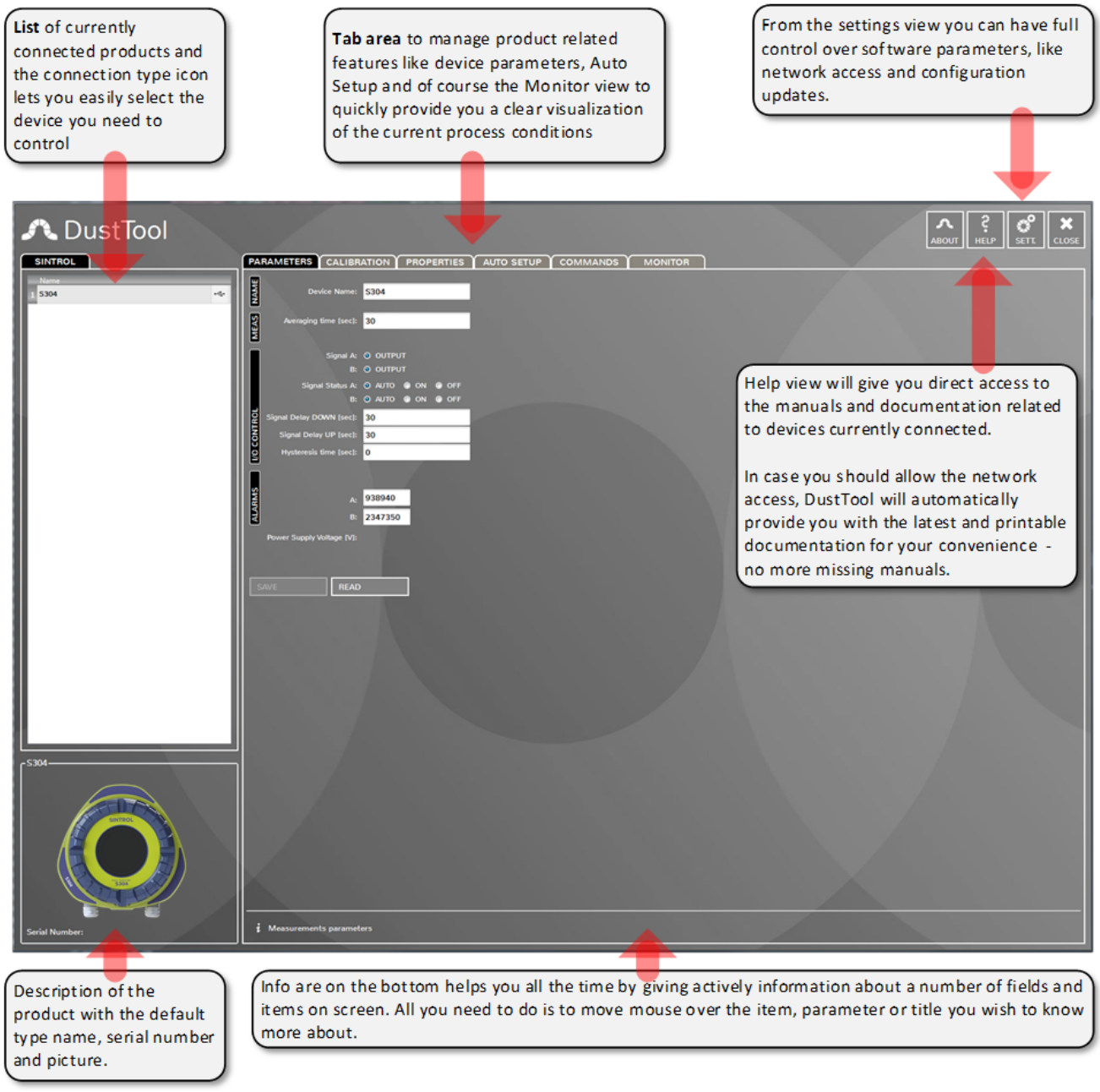



*Figure 17: DustTool main window*

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 S303 or S304 RF models

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 S303 or S304 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 S303 or S304 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 S303 or S304 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 is 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 18: 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 S300+ Series, almost all access to the S303 or S304 can be done remotely using the DustLog 8.


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

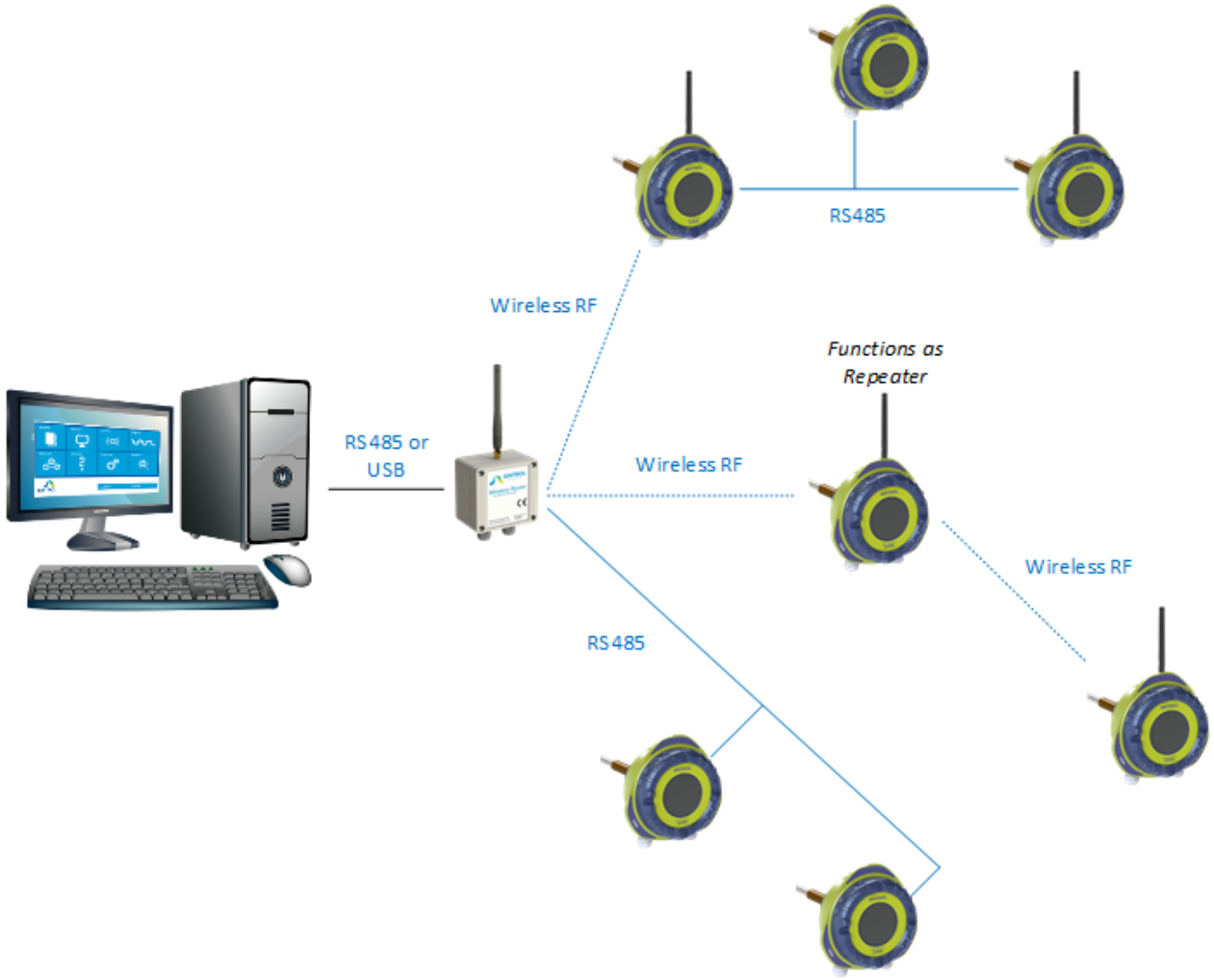



*Figure 18: Sintrol Network Example*

**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


**Poisonous and hot gas hazard**

When installing or removing the equipment, poisonous and hot gas may be released from the duct to the atmosphere.

- All applicable local and plant specific safety codes need to be studied and followed before loosening any flange or create any other opening to the duct
- Wear appropriate protective clothing, such as gas masks, gloves and follow any other additional safety measure stated in the local, plant specific code.


**Risk of burns due to hot components**

When installing or removing the equipment, the probe and other connected components may be hot..

- Wear appropriate heat protective gloves and follow any other additional safety measure stated in the local, plant specific code.


**Risk of electric shock!**

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

- Always disconnect power at the external circuit breaker to the S305 when you are not using it, when you intend to clean it, or in the event of a malfunction.
- Always work with another person in case an emergency should occur.
- Disconnect power before checking the S305 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.

**Inspection and maintenance interval:**

The cleaning and maintenance interval varies, 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.

For practical reasons we suggest now the following procedure:

- In the beginning we recommend a monthly maintenance interval
- If there is only modest dust build up to be noticed on the probe which is easy to be removed, the interval can be step by step prolonged
- However, an inspection of the functionality and a visual inspection of the device is recommended to be done monthly
- If you find unusual behavior, contact Sintrol or your local distributor and 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.

**Content of the inspection:**

- 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 lid, the quick clamp, the cable glands or conduits are closed and tight
- Check that the purge air supply is working and that hoses and pipes are tight (if applicable)
- Clean the cover and the window

**Content of the maintenance:**

- Removal of the S305 from the duct and clean the probe with a fabric or if necessary a brush.

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

# 12 Troubleshooting

## 12.1 No output signal

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

If the S303 or S304 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 S303 or S304 is not giving an output signal after these checks, contact your local distributor.

# 13 Technical Data

| | |
|---|---|
| Product name: | S303, S304 |
| Measurement objects: | Total Suspended Particles (TSP) |
| Measurement range: | Detection Limit 0,1 mg/m³<br>Maximum Range up to several g/m³, depending on conditions |
| Measurement principle: | Inductive Electrification |
| Protection category: | IP65 |
| Power supply: | 24 VDC, 100-240 VAC |
| Power consumption: | Up to 10 W, AC and DC |
| | |
| Output signals: | • Two independent SPDT dry contact Relays, max 5A@30VDC / 5A@240VAC<br>• Isolated 4 - 20 mA output loop |
| Communication interface: | • 2 x Serial communication RS-485<br>• USB<br>• Radio frequency (RF) (only on RF models) |
| Communication protocol: | • Modbus RTU (RS-485)<br>• Sintrol network (USB, RF and RS-485) |

**Ambient Conditions**

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

**Materials and Weight**

| | |
|---|---|
| Enclosure / casing: | Aluminum |
| Wetted parts: | Probe: Stainless steel 316L<br>Insulation material: Ryton R-4 (a Polyphenylene sulfide) |
| Weight: | 3,3 lbs (1,5 kg) |

**Process conditions**

| | |
|---|---|
| Temperature: | Max 200 °C default, optionally up to 700 °C |
| Pressure: | Max 3 bar default |

**Wireless Communication (only for RF models)**

| | |
|---|---|
| Frequency band: | 868 MHz, 15 channels<br>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 range (no line of sight): | 868 MHz Version<br>Up to 1000 m in urban environment<br>NOTE: The RF communication range is highly effected by the surrounding structures and other RF devices. |

# 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.

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Fax. +86 10 59002259
china@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

TRUST & QUALITY www.inspecta.com

## 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:<br><br>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<br>0: not used<br>1: not used<br>2: meas.ADC fails<br>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.<br><br>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.<br><br>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.<br><br>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)<br>signal 1 control source |
| | | <bit_value> | bit masks for enabling:<br>0x1 = alarm L (local)<br>0x2 = alarm A (local)<br>0x4 = alarm B (local)<br>0x8 = remote control |
| MB_REG_MEAS_SIGNAL_2_SRC | 0x1202 | | (R/W)<br>signal 2 control source |
| | | <bit_value> | bit masks for enabling:<br>0x1 = alarm L (local)<br>0x2 = alarm A (local)<br>0x4 = alarm B (local)<br>0x8 = remote control |
| MB_REG_MEAS_SIGNAL_3_SRC | 0x1203 | | (R/W)<br>signal 3 control source |
| | | <bit_value> | bit masks for enabling:<br>0x1 = alarm L (local)<br>0x2 = alarm A (local)<br>0x4 = alarm B (local)<br>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:<br>- alarm L: processed value < limit0<br>- alarm A: limit0 < processed value < limit1<br>- 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.<br><br>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.<br><br>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.<br><br>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:<br><br>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.<br><br>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.<br><br>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 Notes

# 17 Disposal

## 17.1 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.

## 17.2 Disposal of the S300 Series

Should the S303 or S304 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).

# 18 Acknowledgements


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