BÜHLER
TECHNOLOGIES

BDA 15

Fine Dust Monitor

Fine dust monitor

BDA 15

Installation and Operation Instructions

Original instructions

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Read this instruction carefully prior to installation and/or use. Pay attention particularly to all advises and safety instructions to prevent injuries. Bühler Technologies can not be held responsible for misusing the product or unreliable function due to unauthorised modifications.

1 Introduction

1.1 Intended Use

The fine dust monitor is an optical sensor to continuously measure and monitor fine dust concentrations. It can be integrated in various applications.

The product outlined in this manual was developed, manufactured, inspected and documented in compliance with the relevant safety standards. When observing the handling instructions and safety information outlined for planning, installation, specified normal operation and service the device therefore normally poses no dangers with respect to property damage or to the personal health.

Proper and safe operation of this device further requires extremely appropriate transport, proper storage, set-up and installation, as well as careful operation and service.

To keep the device in good condition and ensure proper and safe operation it may only be used as described by the manufacturer. Any use not described in these operating instructions is considered improper use and may result in personal injury or property damage.

Improper use will void the warranty.

1.2 Scope of delivery

The respective scope of delivery according to the purchase agreement is specified in the shipping documents included with delivery. Verify the shipment is complete and intact. Keep the packaging material in the event of a return shipment.

Scope of delivery:

– 1 x fine dust monitor
– 1 x product documentation

The technical design may vary depending on the configuration ordered.

1.3 Product description

1.3.1 Function

The fine dust monitor is an optical sensor to continuously measure and monitor fine dust concentrations. It can be integrated in various applications.

The fine dust monitor determines the dust content based on the principle of light-scattering measurement. It is factory calibrated and can be used for a measuring range of up to 1500 µg/m^3 . The device has two conditioned scattered light sensors for improved stability. The incoming air is preheated to 50 °C (122 °F). A built-in fan ensures a forced flow (2 L/min). The sample gas is set to a speed which allows representative particle detection.

The fine dust monitor periodically analyses and corrects the zero point and reference point. Analysis of the internal measurement signals ensures high zero point stability.

A pre-separator for analysing alveolar particle fractions (PM$_{2.5}$) and an electrostatic filter for zeroing in highly contaminated environments can optionally be built into the device.

In addition to the standard Modbus interface, an optional 4...20 mA current loop or integrated WiFi module can be used for communication.

1.3.2 Layout

The BDA 15 fine dust monitor has a compact aluminium housing for all the necessary components. At the core of the device are two infrared scattered light sensors. The housing also holds a regulated heater, a fan, analysis display electronics and the power supply.
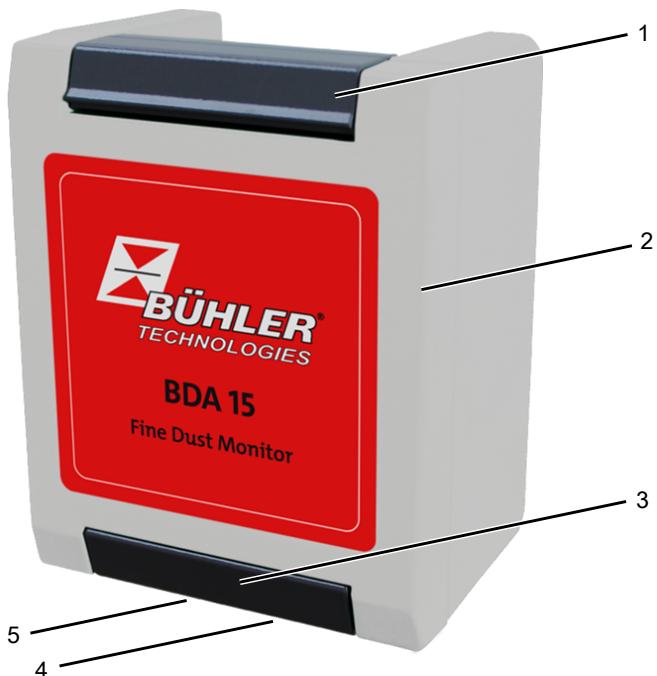

Fig. 1: Layout

1	Locking clamp	4	Air outlet
2	Housing cover	5	Sample gas inlet
3	Housing cover bracket		
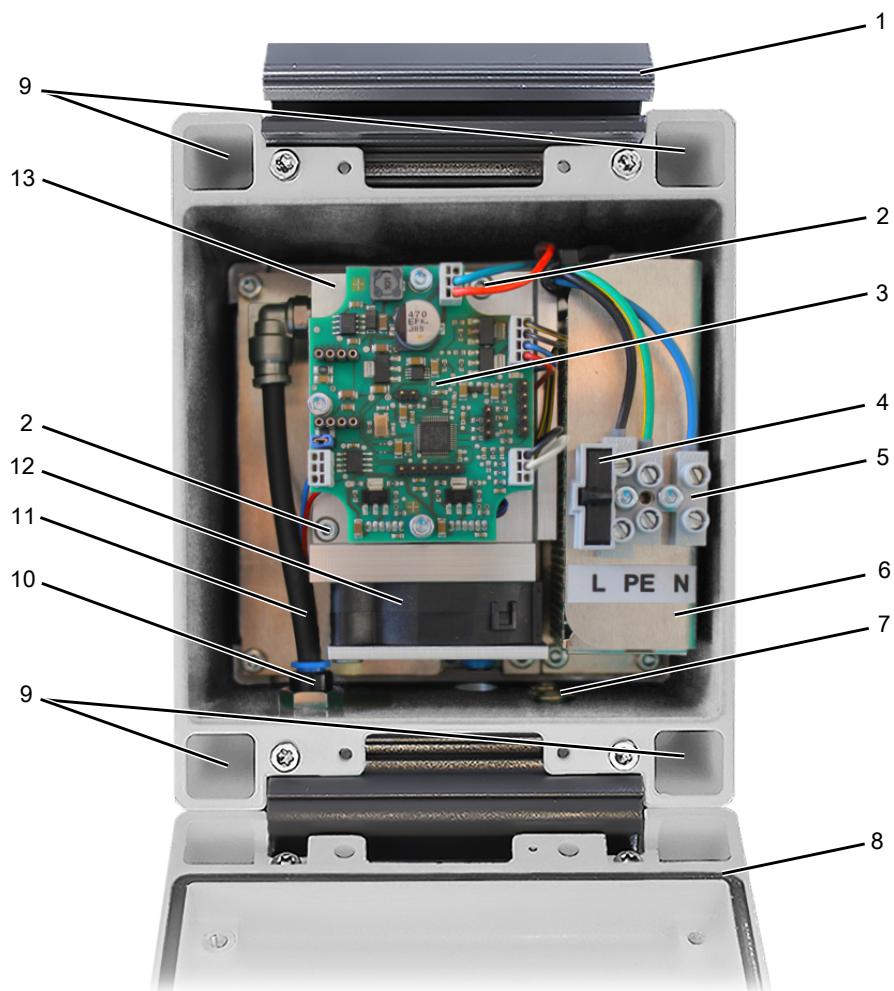
Fig. 2: Internal layout (standard)

1	Locking clamp	8	Housing cover open
2	Screws for mounting the sensor module inside the housing (2x)	9	Wall mounting screws (4x)
3	Analysis electronics	10	Sample gas inlet
4	Fuse 5 A / 240 V	11	Sample gas hose
5	Power connection 240 V AC	12	Fan
6	Power supply	13	Sensor module with regulated heater along with measuring and reference sensor (behind the analysis electronics)
7	Cable guides		

1.3.2.1 Options

1.3.2.1.1 Built-in pre-separator

Alveolar particle fractions ($PM_{2.5}$) are analysed by built-in pre-separator.
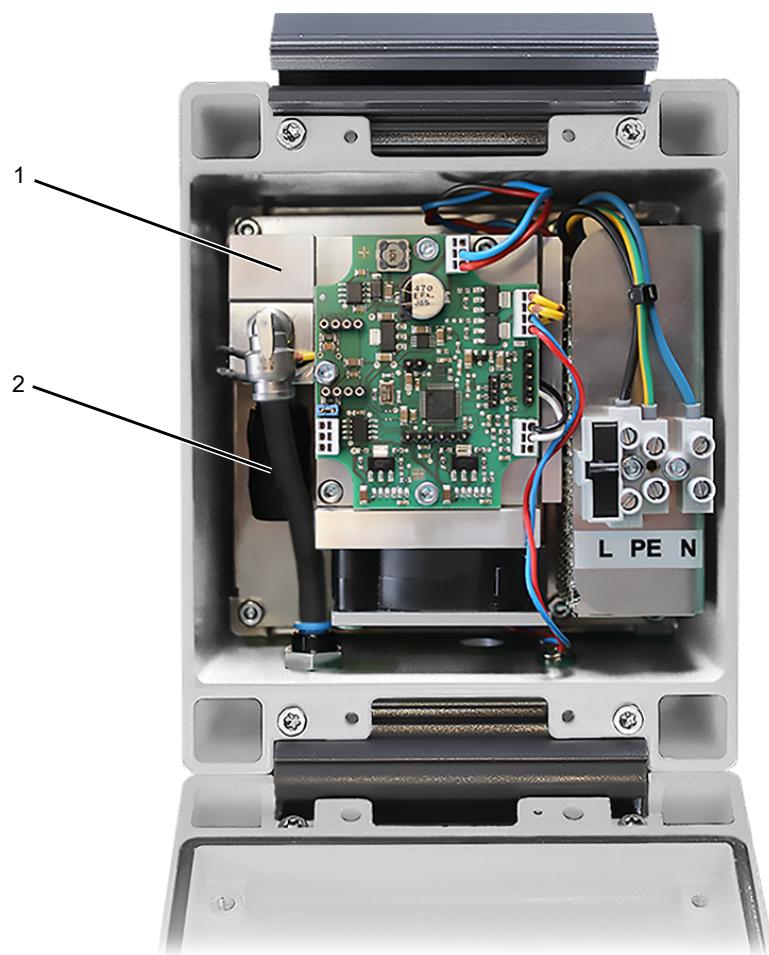
Fig. 3: Internal layout with pre-separator (optional)

1	Pre-separator with regulated heater	2	Residual dust bin

1.3.2.1.2 Electrostatic filter

The unit is designed for electrostatic filter with built-in high-voltage module for setting a zero point in heavily contaminated environments.

| DANGER	**Electric voltage**
⚡	Risk of electric shock
	a) Parts of the device may be under high voltage.
	b) Always disconnect the unit from the mains before working on it.
	c) Any work on the device must be performed by trained professionals.

Fig. 4: Internal layout with electrostatic filter (optional)

1	Electrostatic filter		

2 Safety instructions

2.1 Important notices

Operation of the device is only valid if:

- the product is used under the conditions described in the installation- and operation instruction, the intended application according to the type plate and the intended use. In case of unauthorized modifications done by the user Bühler Technologies GmbH can not be held responsible for any damage,
- when complying with the specifications and markings on the nameplates.
- the performance limits given in the datasheets and in the installation- and operation instruction are obeyed,
- monitoring devices and safety devices are installed properly,
- service and repair is carried out by Bühler Technologies GmbH,
- only original spare parts are used.

This manual is part of the equipment. The manufacturer keeps the right to modify specifications without advanced notice. Keep this manual for later use.

Signal words for warnings

DANGER	Signal word for an imminent danger with high risk, resulting in severe injuries or death if not avoided.
WARNING	Signal word for a hazardous situation with medium risk, possibly resulting in severe injuries or death if not avoided.
CAUTION	Signal word for a hazardous situation with low risk, resulting in damaged to the device or the property or minor or medium injuries if not avoided.
NOTICE	Signal word for important information to the product.

Warning signs

These instructions use the following warning signs:

⚠	Warns of a general hazard	❗	General information
⚠	Warns of hot surfaces	👷	Wear respiratory equipment
⚠	Warns of corrosive liquids	🧑	Wear a safety mask
EX	Warns of explosive areas	🧤	Wear gloves
⚡	Voltage warning		

2.2 General hazard warnings

The equipment must be installed by a professional familiar with the safety requirements and risks.

Be sure to observe the safety regulations and generally applicable rules of technology relevant for the installation site. Prevent malfunctions and avoid personal injuries and property damage.

The operator of the system must ensure:

– Safety notices and operating instructions are available and observed,
– The respective national accident prevention regulations are observed,
– The permissible data and operational conditions are maintained,
– Safety guards are used and mandatory maintenance is performed,
– Legal regulations are observed during disposal.

Maintenance, Repair

Please note during maintenance and repairs:

– Repairs to the unit must be performed by Bühler authorised personnel.
– Only perform conversion-, maintenance or installation work described in these operating and installation instructions.
– Always use genuine spare parts.

Always observe the applicable safety and operating regulations in the respective country of use when performing any type of maintenance.

DANGER	Electrical voltage
	Electrocution hazard.
	a) Disconnect the device from power supply.
	b) Make sure that the equipment cannot be reconnected to mains unintentionally.
	c) The device must be opened by trained staff only.
	d) Regard correct mains voltage.

DANGER	Use in explosive areas
	The equipment is **not** suitable for use in explosive areas.

DANGER	Toxic, corrosive gasses
	Toxic or corrosive gases can result in serious health damage or death. Irritation of the eyes, skin or respiratory system may occur.
	a) Take all necessary safety precautions (e.g. personal protective equipment) to ensure safe handling near flue gas systems.
	b) If contact with the skin or eyes occur, clean the affected area immediately!
	c) Thoroughly clean objects which have come into contact with irritating or corrosive gases or substances.
	d) If necessary, ensure safe gas discharge.

CAUTION	Hot surface
	Some device components may become very hot. Burns may result! Wear protective gloves to prevent potential injuries.

2.3 Additional notices

Assemblies

The device and the individual assemblies may only be operated in the original state. Always replace parts with OEM parts. Assemblies are configured specific to the device and are therefore not interchangeable between the different devices.

Electronic components

Electrostatic discharge can damage electronic components. Take the following precautions:

– Electronic components must be stored in their original packaging until ready to use.
– Touch electronic components by the housing. Do not touch contacts.
– Keep electronic components and boards away from static surfaces (PVC plastic, plastic bags, etc.).
– Wear a special ESD wrist strap or use an earthed, anti-static worktop.

Configuration settings

Modifying the configuration may affect the safety and functionality of the device. Configuration settings may only be modified by an authorised service technician or the manufacturer's factory staff.

3 Transport and storage

Only transport the product inside the original packaging.

The device comes in a special transport crate. This is generally protected against mild shock during transport.

CAUTION	Transport
⚠	Significant shock during transport (e.g. falling) can damage delicate components. Choose suitable transportation.

− Check the device and the packaging for transport damage.
− Document any damage.

Ambient conditions for proper device storage:

− Ambient temperature: 0 ... +50 °C (32...122 °F),
− Relative humidity: max. 90 % (non-condensing),
− Out of direct sunlight,
− Store indoors (outdoor storage prohibited),
− Protect from moisture.

4 Installation and connection

4.1 Installation site requirements

DANGER	**Use in explosive areas**
EX	The equipment is **not** suitable for use in explosive areas.

Ambient conditions for proper device operation:

– Ambient temperature: -20...+50 °C (-4 ...122 °F),
– Relative humidity: 0...100 %,
– Location with representative dust loads,
– Protected from drafts,
– Out of direct sunlight,
– Vibration-free location.

NOTICE	
!	An additional heater may be installed in lower ambient temperatures. Please contact us for a custom solution.

4.2 Installation
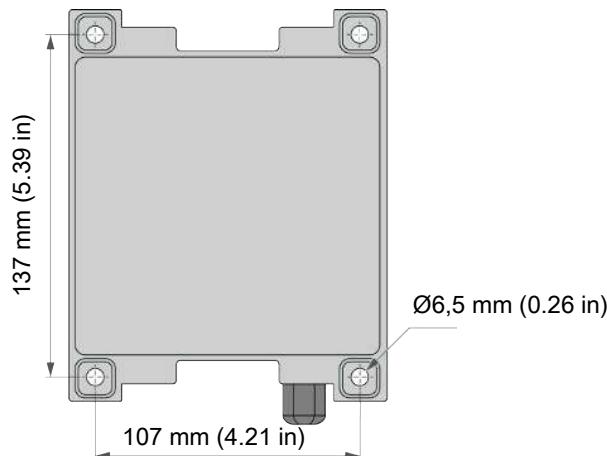
Fig. 5: Bore size for wall mounting, in mm (inch)

– Select a suitable location for wall-mounting and place the bores per the drawing.

NOTICE	
!	The device must be mounted upright. The gas inlet and outlet along with the cable guides must face downward. To ensure correct mounting the device will automatically check the installation position. The service message "**Alignment Error**" will appear when mounted incorrectly.

– Open the housing cover. Loosen the locking clamp at the top of the device for this purpose.
– Secure the fine dust sensor using the four screws inside the housing.
– Use the cable guides to feed all necessary cables into the device.
– Connect the cables for the external power supply to the power supply connection on the power supply.
– Pin assignment see chapter Connections on the power supply connection of the power supply (100-240 VAC supply, standard) [> page 14].
– Make any other connections depending on the device version.
– Tighten the cable guides until all cables are fixed and secure.
– Close the housing cover and secure with the locking clamp.

4.3 Electrical connections

4.3.1 Power supply information

DANGER	**Electric voltage**
	Risk of electric shock
	a) Parts of the device may be under high voltage.
	b) Always disconnect the unit from the mains before working on it.
	c) Any work on the device must be performed by trained professionals.

- The power supply must be installed and fused in accordance with the relevant safety laws and regulations.
- Use a prefuse of at least 5 A.
- Only connect the device to the supply voltage specified in the type plate.
- This device was manufactured to ensure protective separation of primary and secondary circuits. Connected extra-low voltages must also be generated through protective separation.

Earth contact

- The device must always be earthed. Only operate using a power supply with earth contact.
- Never cut or disconnect the earth conductor inside the device or of the mains supply.
- Do not use an extension cord without earth conductor, eliminating the protection. Any disconnection in the earth conductor inside or outside the device is dangerous and prohibited.
- If inadequately earthed or the earth conductor is damaged, remove the device from service and secure against improper or accidental use.

Fuses

- Only replace fuses with the same type and rating as the old fuses.
- Never substitute fuses.
- Never short-circuit fuse holders.
- Route cables to prevent accident hazards due to tripping or getting caught.

Covers

- Never operate the device if covers or other parts have been removed due to exposed live components during operation.
- Unless expressly specified, never work on internal components.
- Always use the prefuse to switch off power before opening the device.
- Any work required with the device open (adjustments, service, etc.) must be performed by trained personnel familiar with dangerous areas and how to avoid hazards with suitable safeguards.

Electrical safety

If the electrical safety of the device is no longer guaranteed, it must be removed from service and secured against improper or accidental use.

The device is no longer electrically safe if:

- External damage is visible,
- It is not working correctly,
- It was stored in improper or unfavourable conditions for extended periods,
- It was exposed to improper loads during transport.

4.3.2 Pin assignment

The device comes standard with analysis electronics located directly behind the housing cover. It requires an external 100-240 VAC voltage supplied via the built-in power supply. An optional 12-24 VDC power supply is also available.

4.3.3 Connections on the power supply connection of the power supply (100-240 VAC supply, standard)

The external power supply connects to the power supply connection on the power supply. It has a 5 A fuse.

Pin assignment

Description	Type
N	External power supply (100-240 V AC, 0.7 A, 50-60 Hz)
PE	External power supply (100-240 V AC, 0.7 A, 50-60 Hz)
L	External power supply (100-240 V AC, 0.7 A, 50-60 Hz)

Tab. 1: Connections on the power supply connection of the power supply – pin-assignment

4.3.4 Analysis electronics connections
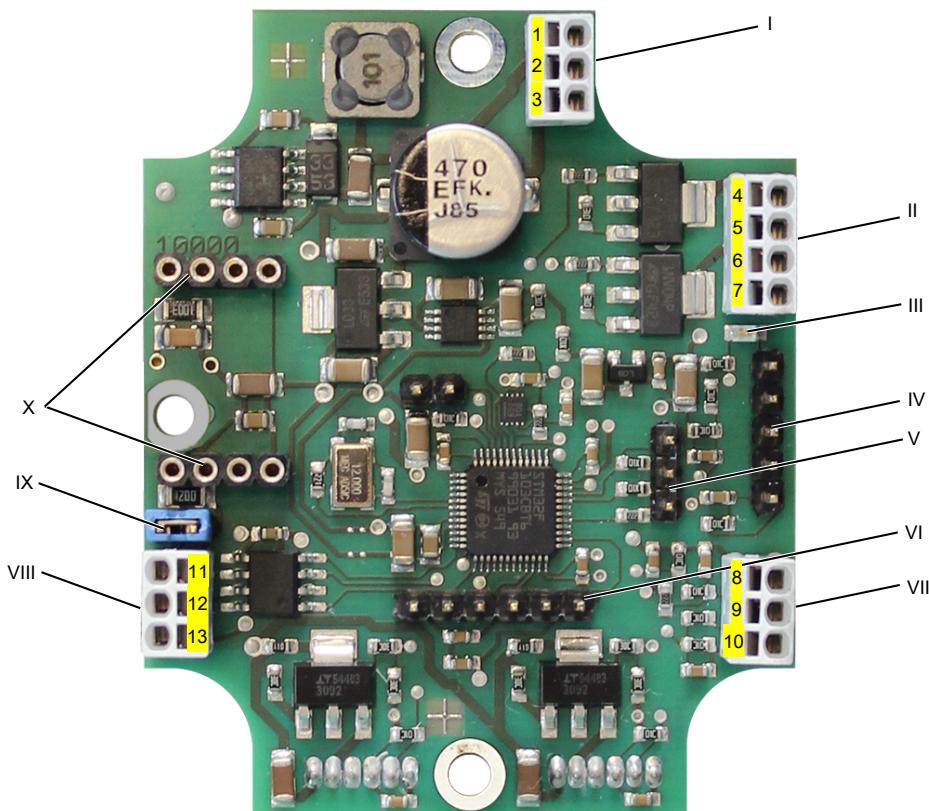
Fig. 6: Analysis electronics connections

I	Power supply connection (12 VDC supply)	VI	Expansion port (e.g. for version with mA out)
II	Supply connection for heating resistor and fan	VII	Temperature sensor connection
III	Status indicator LED	VIII	RS485 port (Modbus interface)
IV	Service Port 1	IX	RS485 load resistor (jumper)
V	Service Port 2	X	WiFi port (for version with WiFi module)

NOTE! The operating status LED (III) will flash during normal operation.

Depending on the device version the analysis electronics will have an expansion module with additional connections (e.g. for mA out) and/or WiFi module.

Pin assignment

Description		Type
1	PE	Housing earth
2	GND	Power supply (1.8 A)
3	+	Power supply (12 V DC)
4	−	Heating resistor power supply
5	+	Heating resistor power supply
6	−	Fan power supply
7	+	Fan power supply
8	GND_A	Temperature sensor analogue earth
9	+	Temperature sensor analogue input
10	+	*Analogue input (not allocated)*
11	A	RS485 (Modbus)
12	B	RS485 (Modbus)
13	GND_M	RS485 (Modbus), shield

Tab. 2: Analysis electronics connections – pin assignment

5 Operation and control

5.1 Initial operation

DANGER	Electric voltage
⚡	Risk of electric shock a) Parts of the device may be under high voltage. b) Always disconnect the unit from the mains before working on it. c) Any work on the device must be performed by trained professionals.

– Connect the external power supply.
  – The LED on the analysis electronics will flash.
  – The fan will start.
  – The sensor is being heated.
– Wait until the sensor is heated up and the device is ready for use (10-30 min depending on ambient temperature).

NOTICE! By default the device will automatically zero. In some cases a zero point reset will be required.

CAUTION	Dust load
⚠	The dust load must not exceed 50 µg/m during the zeroing process (approx. 1 h or longer)[3] (for option with electrostatic filter max. 500 µg/m³).

– Wait for automatic zeroing to complete.
– Check the plausibility of measurements.

NOTICE	Dust signal output:
ⓘ	- Measurement during normal operation: Value ≥ 2 µg/m³ - Sensors initialising: Value = 1 µg/m³ - Service required: Value ≥ 2 µg/m³ (measurements unstable) - Fault: Value = 0 µg/m³ (measurements invalid)

5.2 Operation

The device is not designed for direct operation. The fine dust monitor is factory configured to ensure proper operation. If necessary, the settings of select parameters can be modified externally via Modbus interface (see chapter Digital interface - Modbus [> page 33]) or optional WiFi module.

CAUTION	Improper operation
⚠	Improper operation can result in false measurements, malfunctions during the measuring process or device damage. Detailed knowledge of the device function is required for safe operation. The device must be operated by trained staff.

Diagnostics

The LED's on the analysis electronics, the plausibility of the dust signal, temperature regulator and messages output via Modbus interface must be checked for diagnostics purposes.

Calibration

The device is factory calibrated under predefined conditions. It can be adjusted to dust conditions on site using calibration constants A and D (defaults: A = 1.0; D = 0.0).

$$St.sig. = A \cdot St.sig.´ + D$$

St.sig.	Dust signal output by the device [µg/m³]
A	Calibration constant
D	Calibration constant [µg/m³]
St.sig.´	Factory calibrated dust signal [µg/m³]

5.2.1 Zero point reset

The zero point reset will delete the current zero point and automatically set a new zero point.

The zero point must be set:

– During initial startup (device delivered with zero point > device not at status "Initialising Sensors", dust signal = 1 µg/m^3).
– After modifying the device.
– After being stored for extended periods.

NOTICE	Deleting the zero point
ⓘ	The zero point can be deleted by connecting a jumper to Service Port 2 and restarting the device. The zero point will then automatically be reset. The jumper must be disconnected for normal operation.

CAUTION	Dust load
⚠	The dust load must not exceed 50 µg/m during the zeroing process (approx. 1 h or longer)^3 (for option with electrostatic filter max. 500 µg/m^3).
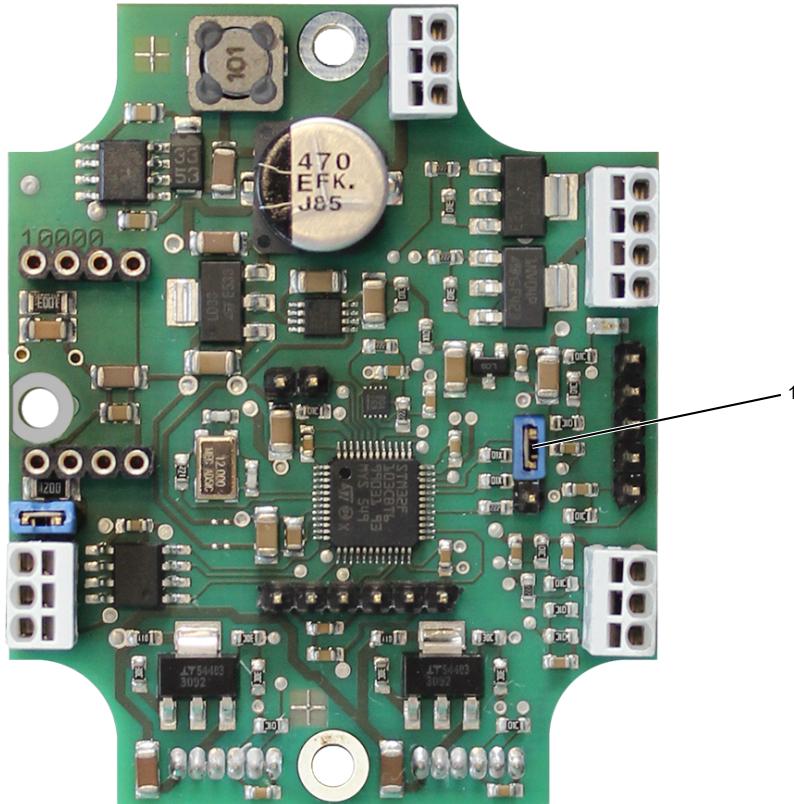
Fig. 7: Analysis electronics jumper connected to Service Port 2

1	Service Port 2 with jumper connected		

5.2.2 Modbus RTU (standard version)

Modbus settings see chapter Digital interface - Modbus [> page 33].

Connections

‒ Connect the Modbus transfer cable to the RS485 port (VIII, Fig. Analysis electronics connections [> page 14]).

> **NOTICE**
>
> The BDA 15 is configured as Modbus slave. The load resistor must be set as the last device in the RS485 string. Otherwise it needs to be removed.

‒ If necessary, disconnect the RS485 Load resistor (IX).

Address

On device versions with Modbus RTU (RS485, 2-wire) the device comes standard with a Modbus address defined by the last two digits in the serial number of the device.

> **NOTICE** **Unknown Modbus address**
>
> If the Modbus address is unknown, it can be reset using a jumper on the top two pins at Service Port 1 and restarting the device. This will set the Modbus address to "10" (19200 Baud 8N1) and can then be reconfigured.
> The jumper must be disconnected for normal operation.

> **CAUTION** **Equipment damage**
>
> Connecting the jumper incorrectly will damage the analysis electronics beyond repair. Only connect the jumper to the top two pins on Service Port 1. The respective pins must be free for this purpose. Assigned Service Port 1 pins must be disconnected.
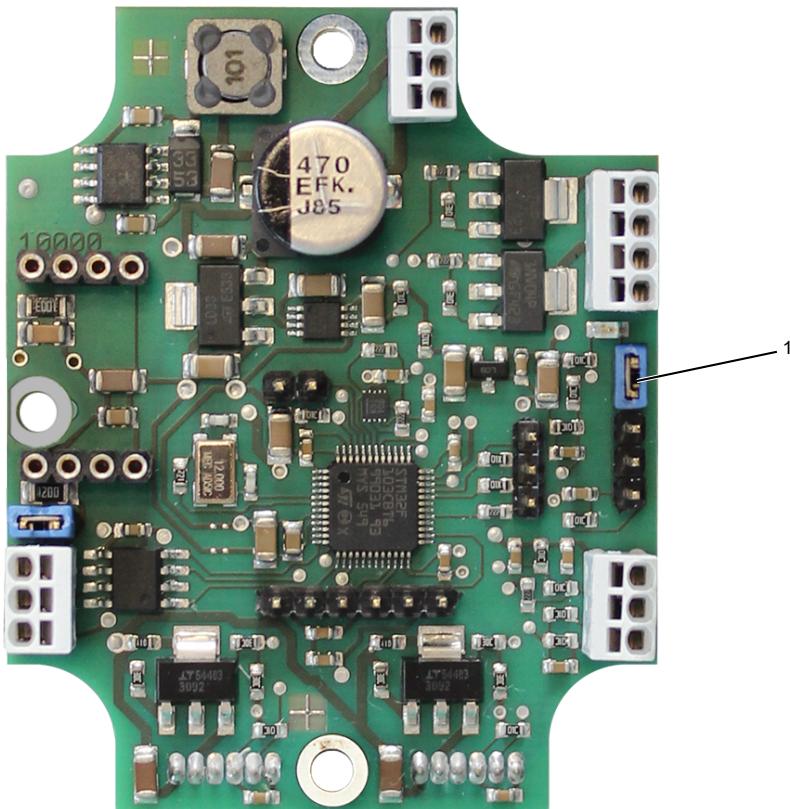
Fig. 8: Analysis electronics with jumper connected to Service Port 1

1	Service Port 1 with jumper connected		

5.2.3 4...20 mA current loop

On versions with 4...20 mA current loop the analysis electronics are equipped with an add-on board for active mA output (galvanically isolated):
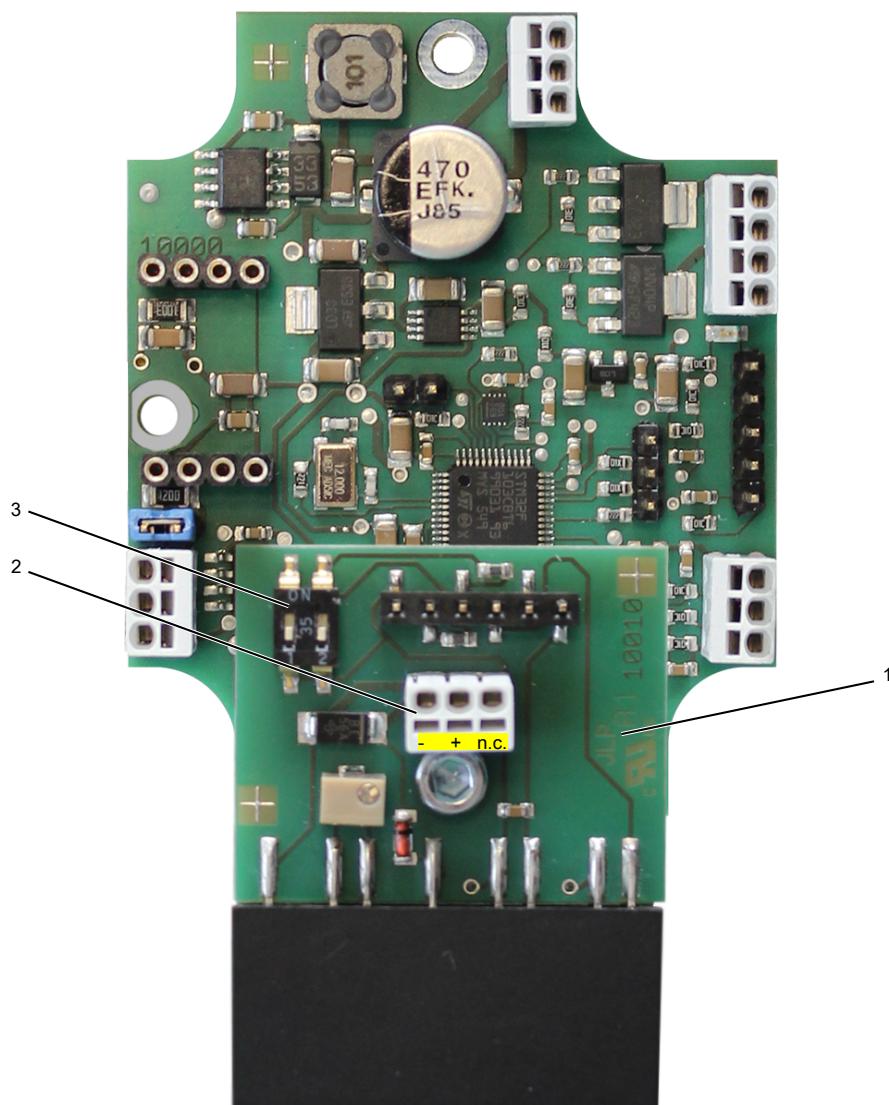
Fig. 9: Analysis electronics with add-on board

1	Add-on board	3	Switch for setting the measuring range
2	Current output 4...20 mA (max. load 450 Ω)		

Setting the measuring range

The measuring range for the 4...20 mA output can be set using the two switches (3) on the add-on board:

Measuring range [µg/m³]	Setting switch 1	Setting switch 2
100	OFF	OFF
300	OFF	ON
1000	ON	OFF
3000	ON	ON

Tab. 3: Setting the measuring range for the 4...20 mA output

5.2.4 WiFi module (optional)

On versions with WiFi module you can use the integrated web-server to view and export all necessary measurements with a PC, laptop, smartphone, etc.
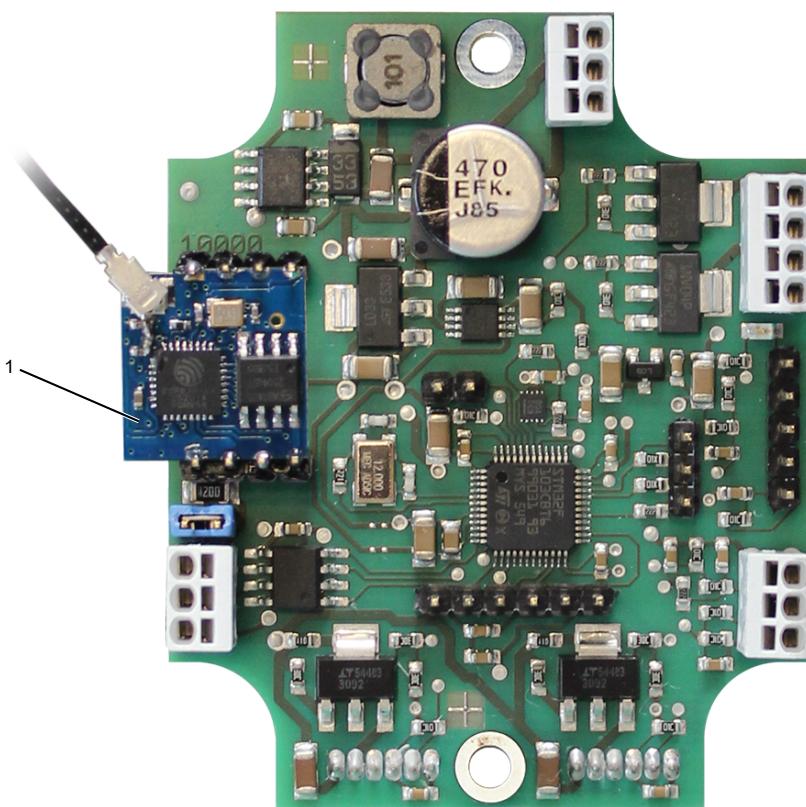
Fig. 10: Analysis electronics with WiFi module

1	WiFi module		

The IP address of the device varies depending on the WiFi mode:

– Used as access point (AP) / BDA 15 serves as wireless access point (default):
   The default IP address is always **192.168.15.1**.

– Used as station (ST) / BDA 15 connects to existing wireless access point:
   The device receives the IP address from the wireless access point. It must be determined using an IP scanner.

NOTICE	**Password entry**
ⓘ	Access to parameter settings is password protected: **WiFi password = 12345678 (default)** The password can be changed in the respective box in the setup screen.

After dialing the necessary data will appear in the browser and the main screen of the device will open. The title of the window is the device name (defined by the respective serial number).

Changing the WiFi mode

On initial start-up or after a reset the unit will by default dial in using the IP address **192.168.15.1** as the access point.

NOTICE! With the device set as access point it cannot be used to access other WiFi devices.

You can change the WiFi mode in the setup screen. When using the device as a station, you can configure a WiFi name and password.

NOTICE	Resetting the WiFi module
ⓘ	The WiFi module can be reset by connecting a jumper to the top two pins of Service Port 1 and restarting the device. This will set the WiFi mode to access point (*IP address 192.168.15.1*) and can then be reconfigured. The jumper must be disconnected for normal operation.

CAUTION	Equipment damage
⚠	Connecting the jumper incorrectly will damage the analysis electronics beyond repair. Only connect the jumper to the top two pins on Service Port 1. The respective pins must be free for this purpose. Assigned Service Port 1 pins must be disconnected.

5.2.4.1 Main screen
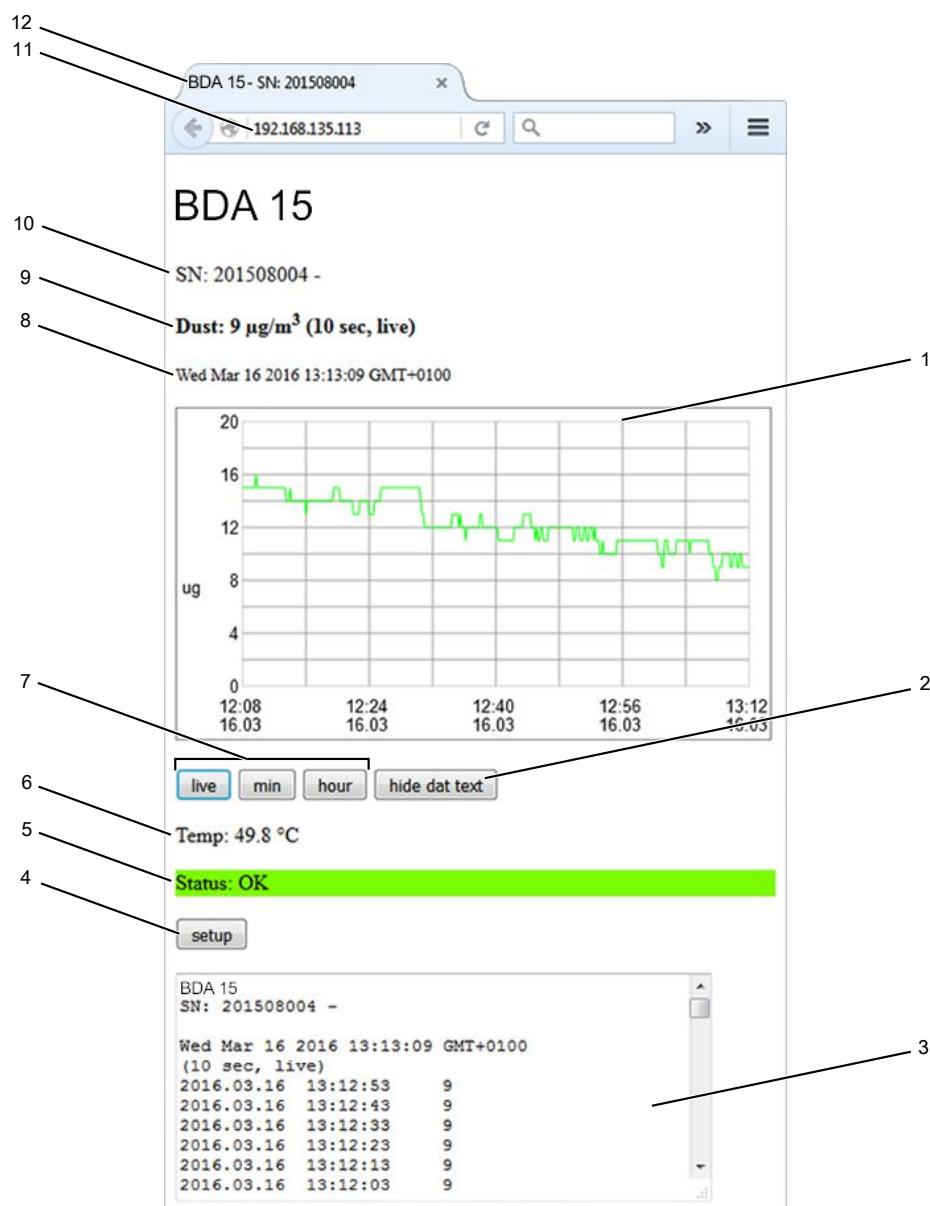
Fig. 11: Data output in browser - main screen

1	Dust values chart	7	Buttons for selecting the display range for the chart and table
2	Button to show/hide spreadsheet values	8	Date and time of the last data export
3	Table of values	9	Dust value from the last data export
4	Setup button	10	Serial number and manufacturer information
5	Status display	11	Device IP address
6	Sensor temperature display (if applicable, additional values will be shown)	12	Device name

The Chart (1) shows the trend of the last 385 averages. The output is based on the 5 min sliding average of the dust value (output interval 2 s). The values can be averaged over defined intervals. The respective buttons (7) below the chart are used to select the display range:

- "live" button:
  Pressing this button will show the chart as 10 s averages. It will show the last 64 min. The chart will automatically refresh.
- Button "min":
  Pressing this button will show the chart as 5 min averages. It will show the last 32 h. The chart needs to be refreshed manually.
- Button "hour":
  Pressing this button shows the chart as 30 min averages. It will show the last 8 days. The chart needs to be refreshed manually.

The measurements can also be output as a table of values (3). Pressing the "Show/Hide dat text" (2) button will show or hide the table of values. Here you can copy measurements for further processing (e.g. to past into a spreadsheet).

NOTICE	
ⓘ	The BDA 15 does not have an internal clock. The browser time is used as the reference time. When switching the device off all values are lost. After powering on any uncalculated averages will be zero.

5.2.4.2 Setup screen

Device settings can be configured in the setup screen. Press the setup button to open the setup screen.

NOTICE	Password entry
ⓘ	The setup screen is password protected: **Setup password = 12345678 (default)** The password can be changed in the respective box in the setup screen.

After entering the password the respective setup screen will open:
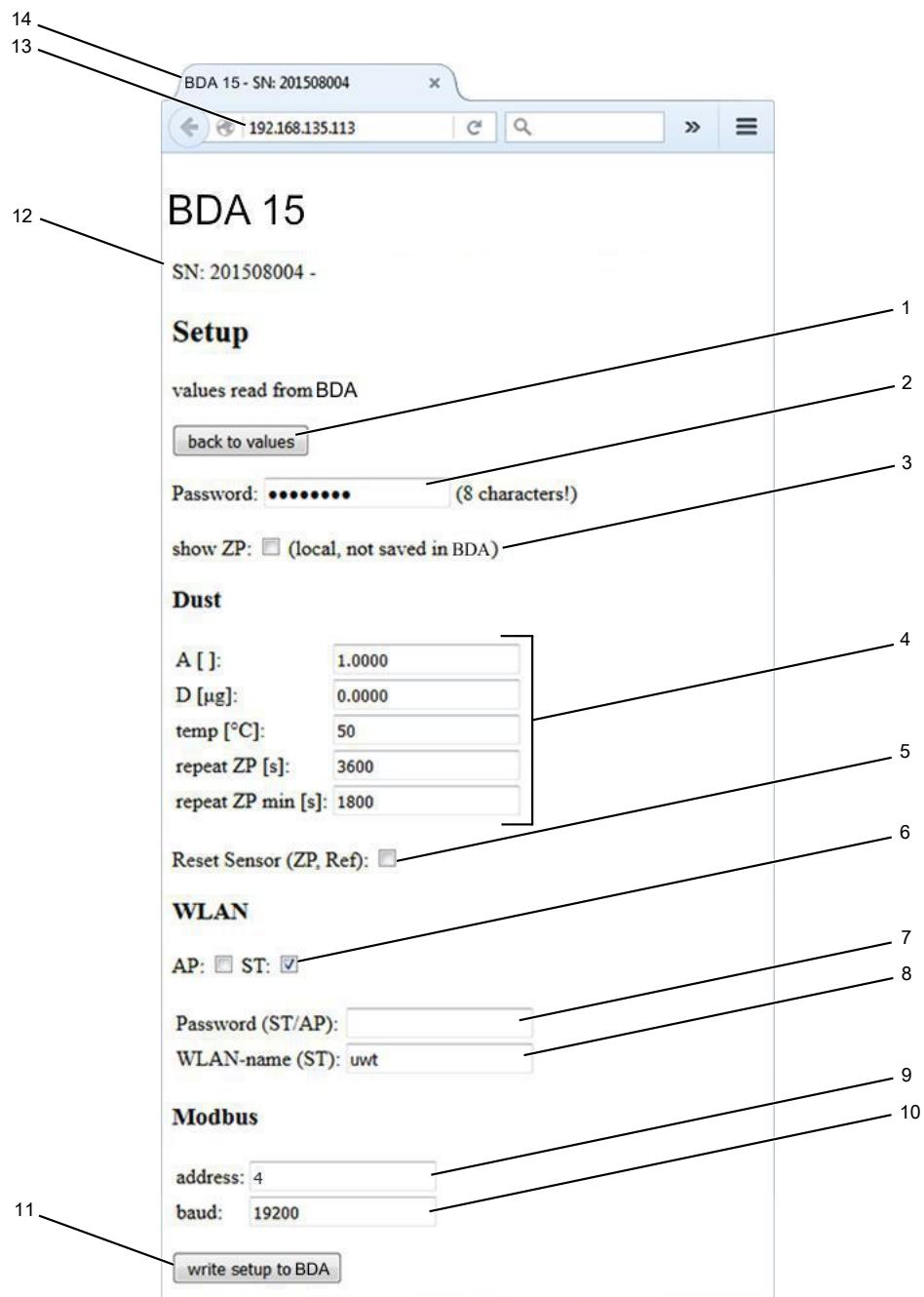
Fig. 12: Output data to browser - setup screen

1	Button to return to main screen (without saving changes)	8	Box for entering the WiFi name for the station
2	Box for the setup password	9	Box for the Modbus address
3	Tick box for showing additional values	10	Modbus speed box
4	Fine dust measurement parameter box	11	Button for writing the setup configuration to the device
5	Zero point reset tick box	12	Serial number and manufacturer information
6	WiFi mode tick box	13	Device IP address
7	WiFi password box (current password will not be shown)	14	Device name

Tick box for showing additional values

When selecting "Show ZP" (3) the main screen will also show the current zero points in increments.

Fine dust measurement parameter box

Different parameters for determining the fine dust concentration can be entered in the various boxes (4).

- "A [ ]": Calibration constant A
- "D [μg]": Calibration constant D
- "temp [°C]": Device target temperature
- "repeat ZP [s]": regular zero point interval
- "repeat ZP min [s]": min. Zero point interval for repeated zeroing (if the last zeroing failed)
- Zero point reset tick box

Selecting "Reset Sensor (ZP, Ref)" (5) will reset the zero point. The last zero point will then be deleted and automatically reset. After writing the device will enter status "Initialising sensors".

NOTICE! Please contact Bühler Technologies GmbH before ticking the box (5).

WiFi settings

WiFi mode tick box

Selecting the respective tick box (6) will set the device to the respective WiFi mode:

AP: Use as Access Point (AP) / BDA 15 serves as wireless access point

ST: Use as station (ST) / BDA 15 connects to an existing wireless access point

WiFi password

Use the box (7) to set the access password for the access point (mode "AP") or the password for the available wireless access point (mode "ST").

Box for entering the WiFi name for the station

When using the device as a station (option "ST") you can configure the desired WiFi name in the box (8).

NOTICE! When using the device as access point the WiFi name is always "BDA_serial number".

Modbus settings

The two boxes (9, 10) are used to configure the Modbus address and the respective baud rate.

NOTICE! By default the device will have a Modbus address defined by the last two digits in the device serial number.

Button for writing the setup configuration to the device

Pressing the "write setup to BDA" button (11) will write all settings to the BDA 15.

NOTICE! Do not disconnect the WiFi connection during the write process.

5.3 Shut-down

DANGER	Electric voltage
	Risk of electric shock
	a) Parts of the device may be under high voltage.
	b) Always disconnect the unit from the mains before working on it.
	c) Any work on the device must be performed by trained professionals.

Disconnect the device from the external power supply.

5.3.1 Disassembly

CAUTION	Hot surface
⚠	Some device components may become very hot. Burns may result! Wear protective gloves to prevent potential injuries.

- Open the housing cover. Loosen the locking clamp at the top of the device for this purpose.
- Loosen the cable guide fitting.
- Disconnect the Modbus transfer cable from the RS485 port.
- Disconnect the cables for the external power supply from the power supply connection on the power supply.
- Remove all cables from the cable guides on the device.
- Remove the fine dust sensor from the wall. Loosen the four screws inside the housing to do so.
- Close the housing cover and secure with the locking clamp.
- Store all cables in a safe location and properly store the fine dust sensor.

6 Service

During maintenance, remember:

- The equipment must be maintained by a professional familiar with the safety requirements and risks.
- Only perform maintenance work described in these operating and installation instructions.
- When performing maintenance of any type, observe the respective safety and operation regulations.
- Service must be performed as instructed to have the device repaired under warranty.

The goal of service is:

- Maintaining the measuring accuracy of the device
- Ensuring safe operation
- Extending the life of the measuring device

6.1 Service

Required maintenance/service:

Assembly	Action	Service interval
General	Functional test	1 year/as needed
Residual dust bin	Empty	1 year/as needed

Tab. 4: Maintenance/service

6.1.1 Check LED and fan functionality

- Verify the LED on the analysis electronics is flashing.
  - If the LED is not flashing, check the power supply.
- Acoustically check the fan is functional (you can hear it running).

NOTICE	
①	The fan regularly shuts off. The fan will stop approx. every 8 h. It will start again after approx. 5 min. Please contact service if the fan is defective.

6.1.2 Empty residual dust bin

NOTICE	**Empty residual dust bin**
①	Regularly empty the residual dust bin. Depending on the type of dust and the dust load it may need to be emptied more than once a year.

- Open the housing cover. Loosen the locking clamp at the top of the device for this purpose.
- Disconnect the sample gas hose, if applicable including optional electrostatic filter.
- Pull the residual dust bin down and remove.
- Empty and clean the residual dust bin (e.g. with a cotton swab).
- Reinstall the residual dust bin in the designated location on the housing.
- Reattach the Sample gas hose, if applicable including optional electrostatic filter.
- Close the housing cover and secure with the locking clamp.

7 Service and repair

This chapter contains information on troubleshooting and correction should an error occur during operation.

Repairs to the unit must be performed by Bühler authorised personnel.

Please contact our Service Department with any questions:

Tel.: +49-(0)2102-498955 or your agent

If the equipment is not functioning properly after correcting any malfunctions and switching on the power, it must be inspected by the manufacturer. Please send the equipment inside suitable packaging to:

Bühler Technologies GmbH

- Reparatur/Service -

Harkortstraße 29

40880 Ratingen

Germany

Please also attached the completed and signed RMA decontamination statement to the packaging. We will otherwise be unable to process your repair order.

You will find the form in the appendix of these instructions, or simply request it by e-mail:

service@buehler-technologies.com.

7.1 Troubleshooting

DANGER	**Electric voltage**
	Risk of electric shock
	a) Parts of the device may be under high voltage.
	b) Always disconnect the unit from the mains before working on it.
	c) Any work on the device must be performed by trained professionals.

CAUTION	**Hot surface**
	Some device components may become very hot. Burns may result! Wear protective gloves to prevent potential injuries.

– New messages are output via the Modbus interface or via WiFi/web server and can be displayed on the connected output device.

– When using the 4...20 mA current loop it will only output 0 µg (= fault) or 1 µg (= initialising sensors).

– Check all messages displayed on the output device or output via Modbus interface or WiFi.

– Please see the chart in section Error and status messages [> page 29]for the respective messages.

– Troubleshoot the respective message as indicated.

– If necessary, take additional measures for troubleshooting.

– Now briefly disconnect the power supply from the device to reset the device.

– If the error/malfunction has been corrected, the output device connected to the Modbus port will no longer show the error message.

– Verify the error message no longer appears.

NOTICE! Please contact us for any errors or malfunctions you are unable to resolve.

7.1.1 Error and status messages

Message	Cause	Action
Alignment Error	Device mounted incorrectly	– Verify the device is mounted upright.
Temperature error	Sensor temperature error	– The device will be ready 10-30 min after connecting the power supply. – Check the location and verify it matches the ambient conditions specified for the device.
Initialising sensors (status message)	Resetting zero point (dust signal = 1 µg/m³)	– Wait for initialisation to complete.
Internal error	Internal sensor error, analysis electronics defective	– Replace the analysis electronics. Note: You can alternatively send the device to Bühler Technologies GmbH for repair.
No zero point	Automatic zero point check failed, not set; invalid measuring range; misalignment	– Check the location and verify it matches the ambient conditions specified for the device. – Verify the device is mounted upright. – Please contact Bühler Technologies GmbH.
Zero point too high	Automatic zero point check failed, zero point too high; invalid measuring range; misalignment	– Check the location and verify it matches the ambient conditions specified for the device. – Verify the device is mounted upright. – Please contact Bühler Technologies GmbH.
No reference point	Automatic reference point check failed, not set; invalid measuring range; misalignment	– Check the location and verify it matches the ambient conditions specified for the device. – Verify the device is mounted upright. – Please contact Bühler Technologies GmbH.
Replace sensors	one or more sensors defective	– Please contact Bühler Technologies GmbH.
Sensor test + zero point (status message)	Resetting valid zero and reference point active (last dust signal will be maintained)	– Wait for the zero and reference point to be set.
Malfunction (status message)	New error message (dust signal = 0 µg/m³, measurements invalid) [for 4...20 mA current loop (optional): Output = 20 mA]	– Check all other messages.
Measuring range invalid	faulty or incorrect sensors installed; dust load too high; Sensors dirty	– Check the location and verify it matches the ambient conditions specified for the device. – Please contact Bühler Technologies GmbH.
Incorrect sensors	Incorrect sensors installed	– Please contact Bühler Technologies GmbH.
Service required (status message)	New service message (measurements unstable)	– Check all other messages.

Tab. 5: Error and status messages

7.1.2 Additional troubleshooting

7.1.2.1 Checking the power supply

– Verify the LED on the analysis electronics is flashing.
  – The LED will flash during normal operation.
– Check all power supply connections are tight.
– Check all cables of the power supply for kinks and tears/breaks.
– Replace any damaged cables.

7.1.2.2 Checking the fan

CAUTION ⚠	**Incorrect ventilation**
	Incorrect ventilation can result in measurement errors. Verify the fan inside the device housing is operating correctly.

Acoustically check the fan is functional (you can hear it running).

NOTICE ①	
	The fan regularly shuts off. The fan will stop approx. every 8 h. It will start again after approx. 5 min. Please contact service if the fan is defective.

7.1.2.3 Checking communication

Modbus

– Verify all RS485 connections are tight.
– Check all RS485 cables for kinks and tears/breaks.
– Replace any damaged cables.
– Check if the RS485 load resistor is set/removed.
– Check the Modbus transfer settings (see section Digital interface - Modbus [> page 33]).

NOTICE ①	
	The BDA 15 is configured as Modbus slave. The load resistor must be set as the last device in the RS485 string. Otherwise it needs to be removed. If the Modbus address is unknown it can be reset via jumper.

– Check if the RS485 load resistor is set/removed.
– Check the Modbus transfer settings.

WiFi

– Verify WiFi transmission is enabled on the receiver.
– Check the signal strength.

NOTICE! The WiFi module can be reset via jumper.

Please refer to the information in section WiFi module (optional) [> page 20].

7.1.2.4 Check the automatic zero and reference point check

The zero and reference point checks are automatic processes and performed at set intervals. In the case of a zero or reference point malfunction:

– Verify the device is mounted upright.

NOTICE ①	
	To ensure correct mounting the device will automatically check the installation position. The service message "**Alignment Error**" will appear when mounted incorrectly.

– Check the temperature in the data output via Modbus interface or displayed in the WiFi menu.
– Verify the two sensors are working correctly. To do so, check the output device for the Modbus interface for the message "Replace sensors".
    – Please contact us if the message "**Replace sensors**" appears.

8 Disposal

The applicable national laws must be observed when disposing of the products. Disposal must not result in a danger to health and environment.

The crossed out wheelie bin symbol on Bühler Technologies GmbH electrical and electronic products indicates special disposal notices within the European Union (EU).

The crossed out wheelie bin symbol indicates the electric and electronic products bearing the symbol must be disposed of separate from household waste. They must be properly disposed of as waste electrical and electronic equipment.

Bühler Technologies GmbH will gladly dispose of your device bearing this mark. Please send your device to the address below for this purpose.

We are obligated by law to protect our employees from hazards posed by contaminated devices. Therefore please understand that we can only dispose of your waste equipment if the device is free from any aggressive, corrosive or other operating fluids dangerous to health or environment. **Please complete the "RMA Form and Decontamination Statement", available on our website, for every waste electrical and electronic equipment. The form must be applied to the packaging so it is visible from the outside.**

Please return waste electrical and electronic equipment to the following address:

Bühler Technologies GmbH
WEEE
Harkortstr. 29
40880 Ratingen
Germany

Please also observe data protection regulations and remember you are personally responsible for the returned waste equipment not bearing any personal data. Therefore please be sure to delete your personal data before returning your waste equipment.

9 Appendices

9.1 Technical Data

Technical Data

Housing:	compact aluminium sensor housing
Dimensions:	130 mm x 160 mm x 90 mm (W x H x D)
Weight:	approx. 2 kg
Degree of protection:	IP 33
Voltage:	100-240 V AC, 0.7 A, 50-60 Hz (optional 12 V DC, 2.1 A); prefuse min. 5 A
Ambient temperature:	-20...+50 °C
Relative humidity:	0...95 %
Measuring principle:	Light-scattering measurement
Sensors:	2 x optical sensor; separate control and signal analysis
Volume flow:	2 L/min
Port:	RS485 (modbus), WLAN
Clip contacts:	max. 0.5 mm; Voltage supply connection: max. 2.5 mm
Fan:	for forced flow
Heater:	for sample gas conditioning (maintaining the dew point difference)
Average dust contents:	up to 200 µg/m³ (with electrostatic filter 500 µg)
Detection limit:	3 µg/m³
Outlet:	4...20 mA current loop
Optional:	- Pre-separator with regulated heater (aerosols)
	- Electrostatic filter (for zero point control in high fine dust pollution)
	- Built-in pre-separator for measuring fine particles ($PM_{2.5}$)

9.2 Dimensions
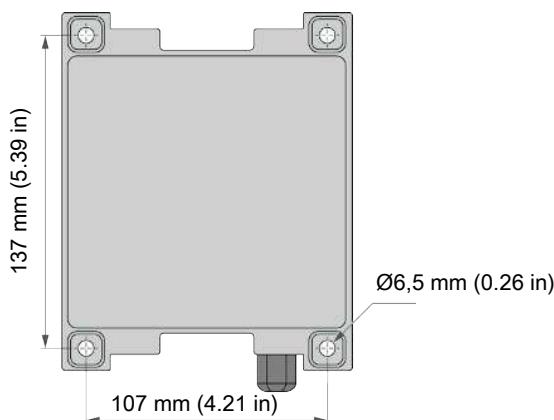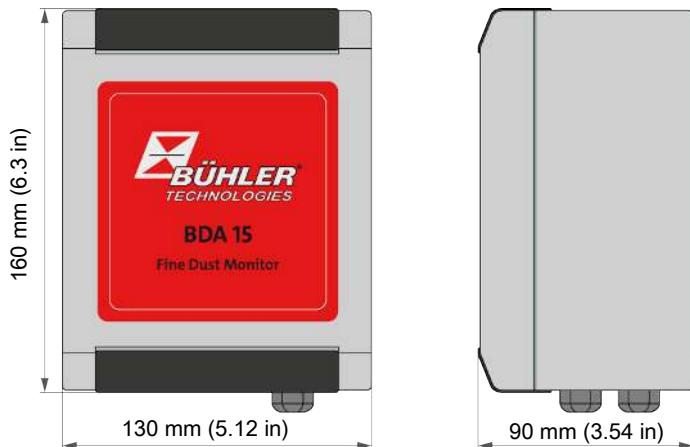
9.3 Digital interface - Modbus

Terminals 11 and 12 on the analysis electronics (see VIII, Fig. Analysis electronics connections [> page 14]) are used to connect to a Modbus interface. Modbus data is analysed with standardised Modbus hardware (writer), SPS or a PC with the respective software and an RS485 adapter.

9.3.1 Communication settings

The following chart shows the general communication settings for data transfer:

Description	Info
Baud rate	19200
Parity	Even
Stop bits	1
Data bits	8
Mode	RTU
Modbus address (preset)	*- the lasttwo digits in the serial number -*

Tab. 6: Modbus transfer communication settings

9.3.2 Measurement display

The measurement to be transferred is generated as a binary floating-point number per IEEE 754 using a sign bit, an 8 bit exponent and a 23 bit significand in big-endian format as MSW-LSW (Most Significant Word - Least Significant Word).

9.3.3 Log

9.3.3.1 Overview

The following chart lists all supported function codes:

Function code	Description
01h Read Coil Status	Read out statuses/bit strings
03h Read Holding Register	Read single or multiple registers
06h Write Single Register	Write single register
10h Write Multiple Registers	Write multiple registers

Tab. 7: Function codes overview

9.3.3.2 Addresses

Description	Modbus number		Type	Read	Write		
	hex	dec		3 h	10 h	6 h	
Serial number Part 1 Part 2	 0x00 0x02	 0 2	Unsigned 16-bit integer	X	–	–	
Software version	0x04	4	Float	X	–	–	
Dust signal [µg/m³]	0x06	6	Float	X	–	–	
Current heating temperature [°C]	0x08	8	Float	X	–	–	
Heating temperature preset [°C] (0...60), default 50.0	0x0A	10	Float	X	X	X	
A calibration constant rise, default = 1.0	0x0C	12	Float	X	X	X	
D calibration constant [µg/m³], Default = 0.0	0x0E	14	Float	X	X	X	
Modbus address, 1...247	0x10	16	Unsigned 16-bit integer	X	X	X	
Modbus speed (valid baud rates: 9600, 14400, 19200, 38400, 57600)	0x12	18	Unsigned 16-bit integer	X	X	X	
Sensors replaced (initialising sensors)	0x14	20	Float	–	X	X	
					(value = 1234)		
Status	0x16	22	Unsigned 16-bit integer	X	–	–	

Tab. 8: Modbus protocol

NOTICE	**Dust signal output:**
ⓘ	- Measurement during normal operation: Value ≥ 2 µg/m³ - Sensors initialising: Value = 1 µg/m³ - Service required: Value ≥ 2 µg/m³ (measurements unstable) - Fault: Value = 0 µg/m³ (measurements invalid)

NOTICE	
ⓘ	Writing the Modbus settings (address, speed) will end Modbus communication. It must be reconfigured with the new settings.

Description	Modbus number		Type	Read	Write
	hex	dec		1 h	
Sensor test + zero point	0x00	0	Bit	X	–
Service required	0x01	1	Bit	X	–
Malfunction	0x02	2	Bit	X	–
Initialising sensors	0x03	3	Bit	X	–
Temperature error (service required)	0x04	4	Bit	X	–
Alignment Error (failure)	0x05	5	Bit	X	–
Measuring range invalid (failure)	0x06	6	Bit	X	–
Replace sensors (service required, failure)	0x07	7	Bit	X	–
No reference point (service required, failure)	0x08	8	Bit	X	–
No zero point (service required, failure)	0x09	9	Bit	X	–
Zero point too high (service required, failure)	0x0A	10	Bit	X	–
Internal error (failure)	0x0B	11	Bit	X	–
Incorrect sensors (failure)	0x0C	12	Bit	X	–
free	0x0D	13	Bit	X	–
free	0x0E	14	Bit	X	–
free	0x0F	15	Bit	X	–

Tab. 9: Device status Modbus log

10 Attached documents

– Declaration of Conformity KX08F004
– RMA - Decontamination Statement

EU-Konformitätserklärung
EU-declaration of conformity

Hiermit erklärt Bühler Technologies GmbH, dass die nachfolgenden Produkte den wesentlichen Anforderungen der Richtlinie

Herewith declares Bühler Technologies GmbH that the following products correspond to the essential requirements of Directive

2014/35/EU
(Niederspannungsrichtlinie / *low voltage directive*)

in ihrer aktuellen Fassung entsprechen.

in its actual version.

Folgende Richtlinie wurde berücksichtigt:

The following directive was regarded:

2014/30/EU (EMV/EMC)

Produkt / products: Feinstaubmonitor / *Fine dust monitor*
Typ / type: BDA 15

Das Betriebsmittel dient zur kontinuierlichen Messung und Überwachung von Feinstaubkonzentrationen.
This equipment is intended to continuously measure and monitor dust concentrations.

Das oben beschriebene Produkt der Erklärung erfüllt die einschlägigen Harmonisierungsrechtsvorschriften der Union:
The object of the declaration described above is in conformity with the relevant Union harmonisation legislation:

EN 61326-1:2013	EN 61010-1:2010/A1:2019/AC:2019-04	EN 55011:2011

Zusätzlich wurden berücksichtigt:
In addition, the following standards have been used:

EN 61000-3-2:2014	EN 61000-4-3:2011	EN 61000-4-6:2014
EN 61000-3-3:2013	EN 61000-4-4:2013	EN 61000-4-11:2005
EN 61000-4-2:2009	EN 61000-4-5:2015	EN 61000-6-2:2005

Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller.
This declaration of conformity is issued under the sole responsibility of the manufacturer.

Dokumentationsverantwortlicher für diese Konformitätserklärung ist Herr Stefan Eschweiler mit Anschrift am Firmensitz.
The person authorized to compile the technical file is Mr. Stefan Eschweiler located at the company's address.

Ratingen, den 17.02.2023

Stefan Eschweiler
Geschäftsführer – *Managing Director*

Frank Pospiech
Geschäftsführer – *Managing Director*

KX 08 F004

Bühler Technologies GmbH, Harkortstr. 29, D-40880 Ratingen,
Tel. +49 (0) 21 02 / 49 89-0, Fax. +49 (0) 21 02 / 49 89-20
Internet: www.buehler-technologies.com

UK Declaration of Conformity

The manufacturer Bühler Technologies GmbH declares, under the sole responsibility, that the product complies with the requirements of the following UK legislation:

Electrical Equipment Safety Regulations 2016

The following legislation were regarded:

Electromagnetic Compatibility Regulations 2016

Product: Fine dust monitor
Type: BDA 15

This equipment is intended to continuously measure and monitor dust concentrations.

The object of the declaration described above is in conformity with the relevant designated standards:

EN 61010-1:2010/A1:2019/AC:2019-04   **EN 61326-1:2013**
EN 55011:2011

In addition, the following standards have been used:

EN 61000-3-2:2014   **EN 61000-4-3:2011**
EN 61000-4-6:2014   **EN 61000-3-3:2013**
EN 61000-4-4:2013   **EN 61000-4-11:2005**
EN 61000-4-2:2009   **EN 61000-4-5:2015**
EN 61000-6-2:2005

Ratingen in Germany, 17.02.2023

Stefan Eschweiler
Managing Director

Frank Pospiech
Managing Director

RMA-Formular und Erklärung über Dekontaminierung
RMA-Form and explanation for decontamination

BÜHLER TECHNOLOGIES

RMA-Nr./ RMA-No. [   ]

Die RMA-Nr. bekommen Sie von Ihrem Ansprechpartner im Vertrieb oder Service. Bei Rücksendung eines Altgeräts zur Entsorgung tragen Sie bitte in das Feld der RMA-Nr. "WEEE" ein./ You may obtain the RMA number from your sales or service representative. When returning an old appliance for disposal, please enter "WEEE" in the RMA number box.

Zu diesem Rücksendeschein gehört eine Dekontaminierungserklärung. Die gesetzlichen Vorschriften schreiben vor, dass Sie uns diese Dekontaminierungserklärung ausgefüllt und unterschrieben zurücksenden müssen. Bitte füllen Sie auch diese im Sinne der Gesundheit unserer Mitarbeiter vollständig aus./ This return form includes a decontamination statement. The law requires you to submit this completed and signed decontamination statement to us. Please complete the entire form, also in the interest of our employee health.

Firma/ Company

Firma/ Company	[ ]
Straße/ Street	[ ]
PLZ, Ort/ Zip, City	[ ]
Land/ Country	[ ]

Gerät/ Device	[ ]
Anzahl/ Quantity	[ ]
Auftragsnr./ Order No.	[ ]

Ansprechpartner/ Person in charge

Name/ Name	[ ]
Abt./ Dept.	[ ]
Tel./ Phone	[ ]
E-Mail	[ ]

Serien-Nr./ Serial No.	[ ]
Artikel-Nr./ Item No.	[ ]

Grund der Rücksendung/ Reason for return

☐ Kalibrierung/ Calibration ☐ Modifikation/ Modification
☐ Reklamation/ Claim ☐ Reparatur/ Repair
☐ Elektroaltgerät/ Waste Electrical & Electronic Equipment (WEEE)
☐ andere/ other

bitte spezifizieren/ please specify

[   ]

Ist das Gerät möglicherweise kontaminiert?/ Could the equipment be contaminated?

☐ Nein, da das Gerät nicht mit gesundheitsgefährdenden Stoffen betrieben wurde./ No, because the device was not operated with hazardous substances.

☐ Nein, da das Gerät ordnungsgemäß gereinigt und dekontaminiert wurde./ No, because the device has been properly cleaned and decontaminated.

☐ Ja, kontaminiert mit:/ Yes, contaminated with: [   ]

☐	☐	☐	☐	☐	☐	☐	☐	☐
explosiv/ explosive	entzündlich/ flammable	brandfördernd/ oxidizing	komprimierte Gase/ compressed gases	ätzend/ caustic	giftig, Lebensgefahr/ poisonous, risk of death	gesundheitsgefährdend/ harmful to health	gesundheitsschädlich/ health hazard	umweltgefährdend/ environmental hazard

Bitte Sicherheitsdatenblatt beilegen!/ Please enclose safety data sheet!

Das Gerät wurde gespült mit:/ The equipment was purged with: [   ]

Diese Erklärung wurde korrekt und vollständig ausgefüllt und von einer dazu befugten Person unterschrieben. Der Versand der (dekontaminierten) Geräte und Komponenten erfolgt gemäß den gesetzlichen Bestimmungen.

This declaration has been filled out correctly and completely, and signed by an authorized person. The dispatch of the (decontaminated) devices and components takes place according to the legal regulations.

Falls die Ware nicht gereinigt, also kontaminiert bei uns eintrifft, muss die Firma Bühler sich vorbehalten, diese durch einen externen Dienstleister reinigen zu lassen und Ihnen dies in Rechnung zu stellen.

Should the goods not arrive clean, but contaminated, Bühler reserves the right, to comission an external service provider to clean the goods and invoice it to your account.

Firmenstempel/ Company Sign

Datum/ Date [   ]

_____
rechtsverbindliche Unterschrift/ Legally binding signature

Vermeiden von Veränderung und Beschädigung der einzusendenden Baugruppe

Die Analyse defekter Baugruppen ist ein wesentlicher Bestandteil der Qualitätssicherung der Firma Bühler Technologies GmbH. Um eine aussagekräftige Analyse zu gewährleisten muss die Ware möglichst unverändert untersucht werden. Es dürfen keine Veränderungen oder weitere Beschädigungen auftreten, die Ursachen verdecken oder eine Analyse unmöglich machen.

Umgang mit elektrostatisch sensiblen Baugruppen

Bei elektronischen Baugruppen kann es sich um elektrostatisch sensible Baugruppen handeln. Es ist darauf zu achten, diese Baugruppen ESD-gerecht zu behandeln. Nach Möglichkeit sollten die Baugruppen an einem ESD-gerechten Arbeitsplatz getauscht werden. Ist dies nicht möglich sollten ESD-gerechte Maßnahmen beim Austausch getroffen werden. Der Transport darf nur in ESD-gerechten Behältnissen durchgeführt werden. Die Verpackung der Baugruppen muss ESD-konform sein. Verwenden Sie nach Möglichkeit die Verpackung des Ersatzteils oder wählen Sie selber eine ESD-gerechte Verpackung.

Einbau von Ersatzteilen

Beachten Sie beim Einbau des Ersatzteils die gleichen Vorgaben wie oben beschrieben. Achten Sie auf die ordnungsgemäße Montage des Bauteils und aller Komponenten. Versetzen Sie vor der Inbetriebnahme die Verkabelung wieder in den ursprünglichen Zustand. Fragen Sie im Zweifel beim Hersteller nach weiteren Informationen.

Einsenden von Elektroaltgeräten zur Entsorgung

Wollen Sie ein von Bühler Technologies GmbH stammendes Elektroprodukt zur fachgerechten Entsorgung einsenden, dann tragen Sie bitte in das Feld der RMA-Nr. „WEEE" ein. Legen Sie dem Altgerät die vollständig ausgefüllte Dekontaminierungserklärung für den Transport von außen sichtbar bei. Weitere Informationen zur Entsorgung von Elektroaltgeräten finden Sie auf der Webseite unseres Unternehmens.

Avoiding alterations and damage to the components to be returned

Analysing defective assemblies is an essential part of quality assurance at Bühler Technologies GmbH. To ensure conclusive analysis the goods must be inspected unaltered, if possible. Modifications or other damages which may hide the cause or render it impossible to analyse are prohibited.

Handling electrostatically conductive components

Electronic assemblies may be sensitive to static electricity. Be sure to handle these assemblies in an ESD-safe manner. Where possible, the assembles should be replaced in an ESD-safe location. If unable to do so, take ESD-safe precautions when replacing these. Must be transported in ESD-safe containers. The packaging of the assemblies must be ESD-safe. If possible, use the packaging of the spare part or use ESD-safe packaging.

Fitting of spare parts

Observe the above specifications when installing the spare part. Ensure the part and all components are properly installed. Return the cables to the original state before putting into service. When in doubt, contact the manufacturer for additional information.

Returning old electrical appliances for disposal

If you wish to return an electrical product from Bühler Technologies GmbH for proper disposal, please enter "WEEE" in the RMA number box. Please attach the fully completed decontamination declaration form for transport to the old appliance so that it is visible from the outside. You can find more information on the disposal of old electrical appliances on our company's website.

DE000011
12/2022

Bühler Technologies GmbH, Harkortstr. 29, D-40880 Ratingen
Tel. +49 (0) 21 02 / 49 89-0, Fax: +49 (0) 21 02 / 49 89-20
E-Mail: service@buehler-technologies.com
Internet: www.buehler-technologies.com