



Bühler Metal Detector

BMD

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.

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Document information

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Contents

1	Introduction	2
1.1	Intended Use	2
1.2	Functionality	2
1.2.1	Principle Of Measurement	2
1.2.2	Temperature Measurement	2
1.2.3	Fine Ferromagnetic Particles	2
1.2.4	Derived Characteristics	4
1.2.5	Cross-Influences	4
1.3	Model key	4
1.4	Scope Of Delivery	4
2	Safety instructions	5
2.1	Important advice	5
2.2	General hazard warnings	5
3	Installation and connection	7
3.1	Installation	7
3.2	Electrical Connections	8
3.2.1	Analog Current Output (4...20 mA) - Measurement Without Load Resistor	8
3.2.2	Analog Current Output (4...20 mA) - Measurement With Load Resistor	9
3.2.3	Load Resistor Size	9
3.2.4	Setting Analog Current Outputs	9
3.2.5	Calibration	10
4	Operation and Control	11
4.1	RS232 Communication	11
4.1.1	Serial Port (RS232)	11
4.1.2	Interface Parameters	12
4.1.3	Command List	12
4.1.4	List Of Parameter Outputs For Specific Commands	14
4.1.5	Output Triggering	15
4.2	CANopen Communication	16
4.2.1	CAN Interface	16
4.2.2	CANopen Object Directory	16
4.2.3	Initial Operation With CAN Interface	19
5	Cleaning And Maintenance	20
6	Service and repair	21
6.1	Accessories	21
7	Disposal	22
8	Appendices	23
8.1	Technical Data	23
8.2	Standard pin assignment	23
8.3	Permissible Mechanical Loads	24
9	Attached documents	25

1 Introduction

1.1 Intended Use

The BMD measures the wear of mechanical parts by detecting ferromagnetic particles. The sensor has a G1" thread and can be built directly into a gear case or a circulating lubrication circuit. The particle count is continuously detected using an inductive measuring principle and analysed. Data is output via digital and analog interfaces. By detecting wear and damages early, service can be planned and downtimes minimised.

The sensor detects the following parameters:

- Sensor temperature
- Ferromagnetic particles
- Ferromagnetic chunks

1.2 Functionality

1.2.1 Principle Of Measurement

The sensor detects the amount of ferromagnetic particles which collect on the permanent magnet of the sensor head. The sensor can distinguish between fine particles in the micron range and big ferromagnetic chunks in the millimetre range. The output signal from 0 to 100 % can be used to read the ferromagnetic particles or chunks on the sensor surface. In addition, the sensor serves to compensate the magnetic field of the permanent magnet, which in turn releases the particles from the sensor head (automatic cleaning).

The intervals between cleaning processes can thus be used to determine a change in wear.

The following details the individual measured variables and additional sensor functions.

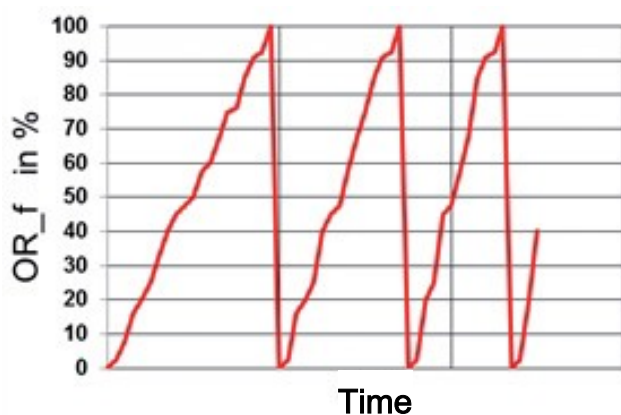
1.2.2 Temperature Measurement

The sensor features internal temperature measurement. The temperature is measured inside the sensor and therefore only serves as a reference point for the actual oil temperature.

1.2.3 Fine Ferromagnetic Particles

Fine ferromagnetic particles are continuously detected and output using a signal from 0 to 100 %. Here, 0 % means a particle-free surface, 100 % on the other hand means the sensor surface has reached the set limit. When this limit is reached, the attached particles are released back into the oil by compensating the magnetic field produced by the permanent magnet and the sensor then starts collecting particles again.

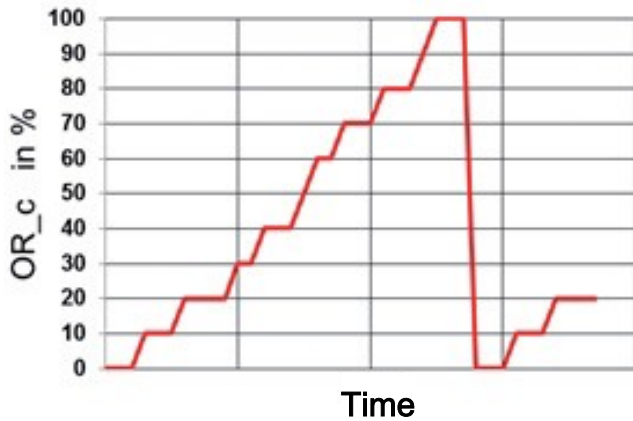
The parameter output by the sensor in this case is: $OR_f = \text{OccupancyRate_fine}$



1.2.3.1 Coarse Ferromagnetic Chunks

Coarse ferromagnetic chunks are by default detected in 10 % increments and output by a signal from 0 to 100 %. Here, 0 % means a chunk-free surface. 100 % on the other hand means the sensor surface has reached the set limit (= 10 chunks). When this limit is reached, the attached particles and chunks are released back into the oil by compensating the magnetic field produced by the permanent magnet and the sensor then starts collecting particles and chunks again.

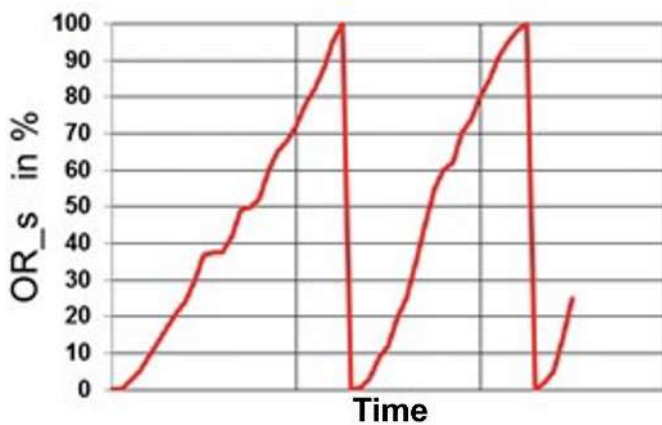
The parameter output by the sensor in this case is: $OR_c = \text{OccupancyRate_chunk}$



1.2.3.2 Sum Signal

To simultaneously output both parameters via the analog output, the sensor calculates the total occupancy rate for fine particles and "Chunks". Here, 0 % mean the sensor surface is free and unoccupied. 100 % on the other hand means the sensor surface has reached the set limit (= 100 % fine particles or 10 chunks or any combination of both). When the limit is reached, the attached particles and chunks are released back into the oil by compensating the magnetic field produced by the permanent magnet and the sensor then starts collecting particles and chunks again.

The parameters output by the sensor are: $OR_s = \text{OccupancyRate_sum}$



1.2.4 Derived Characteristics

The sensor further calculates the following derived parameters and output via the digital or analog interfaces:

Parameter abbreviation	Parameter name	Unit	Explanation
chunk_cnt	Chunk Counter	-	Number of chunks detected
cln_cnt	Clean Counter	-	Number of automatic cleanings since the last manual reset ("SONew" command)
cln	Cleaning	-	Cleaning currently enabled/disabled
tlc	Time since last clean	h	Time since the last manual reset („SONew“ command) or automatic cleaning
tbc	Time between (last two cleans)	h	Time between the last two automatic cleanings
OAge	Oil age	h	Time since the last manual reset („SONew“ command)
RED	Remaining Occupancy Time	h	Estimated time remaining before OR_s reaches 100 % and automatic cleaning is initiated based on the current OR_s value and the last automatic cleaning

1.2.5 Cross-Influences

The sensor signal is largely free from cross-influences, so long as there are no interfering contours or (electro)magnetic fields inside the defined detection radius.

On initial operation a minimal offset (<5 %) can arise in the measurement signal due to a cross-influence of the oil (the sensory is factory adjusted in air). However, this influence is automatically compensated after the first cleaning. The option to already compensate this sooner can be accessed with the SONew command.

1.3 Model key

BMD - 100 - 000 - 1DC1A

Type designation BMD Bühler Metal Detector			
Version 100 Standard compact unit		Outputs 1DC1A	1x RS232/CAN 1x analog signal 4...20 mA

Item no.	Model
1540001000	BMD-100-000-1DC1A

1.4 Scope Of Delivery

- Bühler Metal Detector BMD
- Product Documentation

2 Safety instructions

2.1 Important advice

This device may only be used if:

- The product is being used under the conditions described in the operating- and system instructions, used according to the nameplate and for applications for which it is intended. Any unauthorized modifications to the device will void the warranty provided by Bühler Technologies GmbH,
- the specifications and markings in the type plate are observed,
- the limits in the data sheet and the instructions must be observed,
- monitoring equipment / protection devices must be connected correctly,
- the device is protected from mechanical damage and vibration,
- service and repairs not described in these instructions is performed by Bühler Technologies GmbH,
- using genuine replacement parts.

These operating instructions are a part of the equipment. The manufacturer reserves the right to change performance-, specification- or technical data without prior notice. Please keep these instructions for future reference.

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:



General warning



General information

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,
- compliance with national installation regulations.

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.
- Do not install damaged or defective spare part. If necessary, visually inspect prior to installation to determine any obvious damage to the spare parts.

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

The method for cleaning the devices must be adapted to the IP protection class of the devices. Do not use cleaners which could damage the device materials.

3 Installation and connection

3.1 Installation

Place the sensor at a measuring point characteristic for the system. There is no preferred direction of flow.

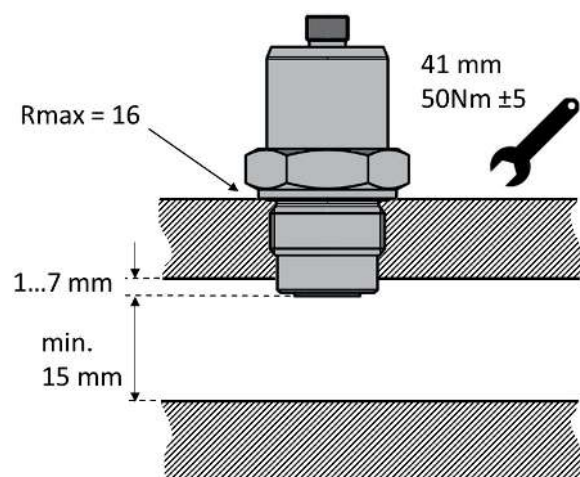


Fig. 1: Installing the sensor and detection radius

To ensure proper function, please note the following guidelines:

- Sensor surface fully covered in oil.
- Observe the minimum and maximum flow rate.
- Adequately mixed oil.
- Avoid foam.
- Do not install in the immediate proximity of motors, pumps or other hot components.

CAUTION



There must be no interfering contours and (electro)magnetic fields within the detection radius (r).

How far the sensor tip reaches into the oil may vary by system. We advise contacting Bühler Technologies GmbH Technical Service.

To ensure reliable measurements, the sensor tip should not be immersed further into the flow channel than specified.

3.2 Electrical Connections

WARNING



Faulty power supply An improperly connected device may result in damage

The device must be installed by an electrician.
Observe national and international regulations on the installation of electrical equipment.

To install, switch off the machine and connect the device as follows:

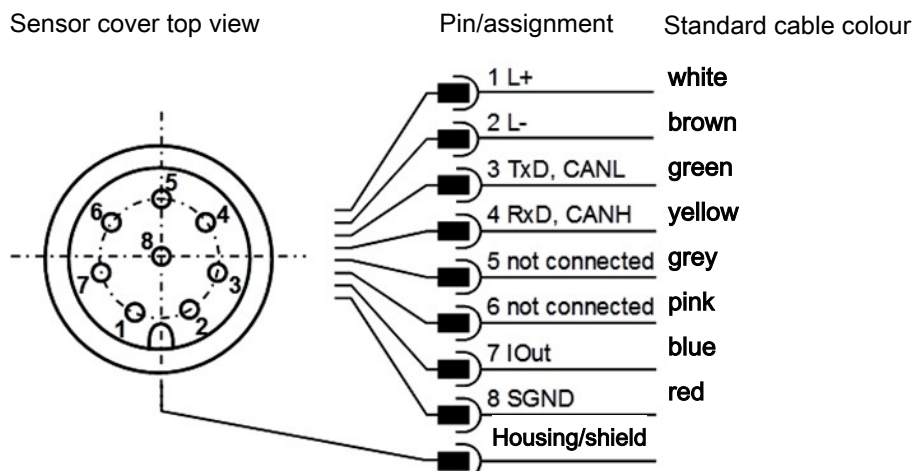


Fig. 2: Pin assignment, top view of sensor cover

The sensor cable must be shielded.

To ensure protective class IP67, only use suitable plugs and cables. The tightening torque for the plug is 0.1 Nm.

The current should be measured with a suitable ammeter or alternatively with a load resistor and voltage metering as described in the following chapters. The maximum permissible load resistance is 100 Ω for 12 V and 400 Ω for 24 V.

CAUTION! When connecting, please note the sensor must either be earthed via the cable shielding or the housing.

3.2.1 Analog Current Output (4...20 mA) - Measurement Without Load Resistor

The current should be measured with a suitable ammeter as shown below.

Sensor cover top view

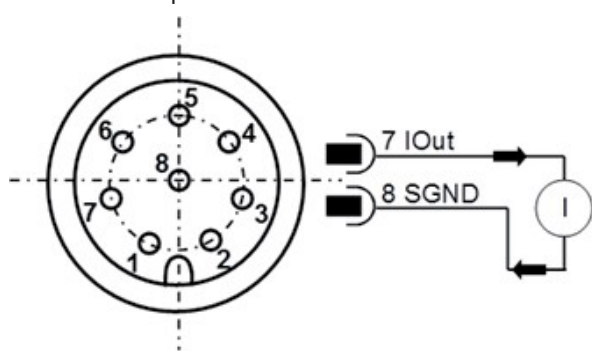


Fig. 3: Measuring the analog 4...20 mA output without load resistor

3.2.2 Analog Current Output (4..20 mA) - Measurement With Load Resistor

To measure the currents of the analog current output with a voltmeter, a load resistor must be connected to the output as shown below. Depending on the supply voltage, the load resistance should be between 25 Ohm and 200 Ohm. A voltmeter can now be used to measure the voltage which drops over the respective resistance.

Sensor cover top view

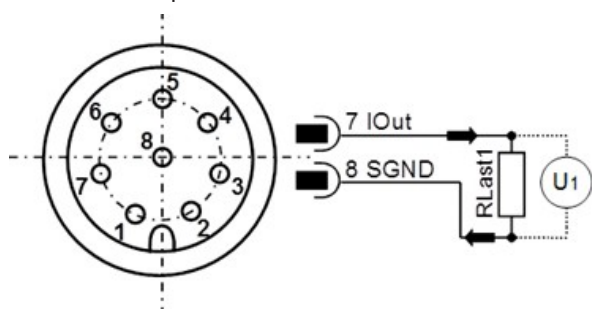


Fig. 4: Connecting the load resistors to measure the analog 4..20 mA output

To determine the respective parameter from the now available currents or from the current calculated from the voltage and the load resistor size, the currents must be converted accordingly using the formulas in [chapter Calibration](#).

3.2.3 Load Resistor Size

The load resistance cannot be selected arbitrarily. It must be adjusted to the supply voltage of the sensor. The maximum load resistance can be calculated using the formula (5-1). Or you can alternatively use the table here.

$$R_{\max} / \Omega = U_{\text{Supply}} / V \cdot 25 (\Omega/V) - 200 \Omega \quad (5-1)$$

R_{\max} in Ω	U_{supply} in V
350	22
400	24
450	26

Tab. 1: Determining the load resistance based on the supply voltage

3.2.4 Setting Analog Current Outputs

The assignment of the analog current output is factory preset. **The default configuration uses the total occupancy of fine and coarse particles (OccupancyRate_sum).** However, the sensor allows changing the preset output parameter. The RS232 command is: „SAOx[CR]“, with the corresponding numerical code x. The table shows the possible parameters for configuring the analog outputs.

x	Parameter name	Abbreviation	Unit	Explanation
0	Temperature	T	°C	Sensor temperature
1	OccupancyRate_sum	OR_s	%	Default Sum signal for OR_f and OR_c
2	OccupancyRate_fine	OR_f	%	Occupancy rate of the sensor surface with fine particles
3	OccupancyRate_chunk	OR_c	%	Occupancy rate with big particles (chunks) 0...100 % in 10% increments
10	Clean Counter	cln_cnt	-	Number of automatic cleanings since the last manual reset (“SONew” command)
16	Chunk Counter	chunk_cnt	-	Number of chunks detected
40	Sequential output	-	-	Output of values 0, 1, 2, 3, 10 and 16 separated by time
100	4 mA	-	-	Output fixed to 4 mA
101	12 mA	-	-	Output fixed to 12 mA
102	20 mA	-	-	Output fixed to 20 mA

Tab. 2: Numerical code for output parameters of the analog current outputs

Key parameters can be output sequentially via the analog interface. In this case the sensor must be configured accordingly. The correspondingly configured sensor outputs the key parameters as shown:

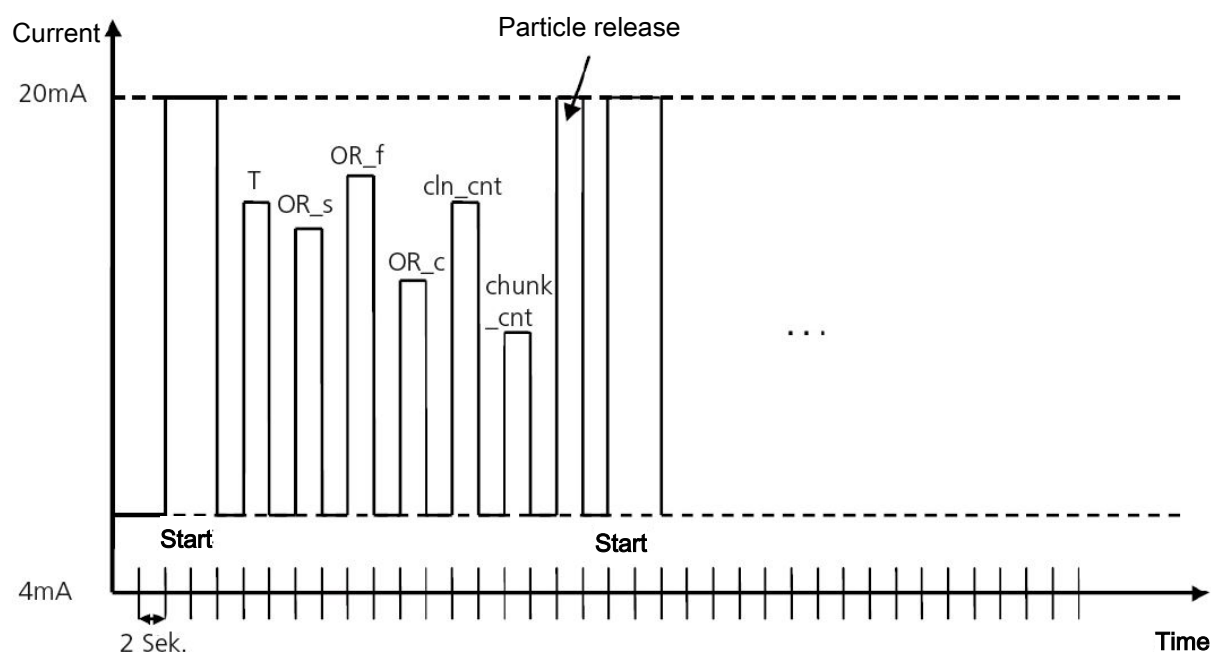


Fig. 5: Sequential output of values via analog interface

3.2.5 Calibration

The output values can be calibrated and calculated with the following formulas:

Output quantity X	Output range	Quantity equation	Formula
Temperature (T)	-20...100 °C	$X = \frac{U/V}{R/\Omega} \cdot 7500 \left(\frac{^{\circ}\text{C}}{\text{A}} \right) - 50 \text{ }^{\circ}\text{C}$	(5-1)
OccupancyRate_sum (OR_s)	0...100 %	$X = \frac{U/V}{R/\Omega} \cdot 6250 \left(\frac{\%}{\text{A}} \right) - 25 \text{ %}$	(5-2)
OccupancyRate_fine (OR_f)	0...100 %	$X = \frac{U/V}{R/\Omega} \cdot 6250 \left(\frac{\%}{\text{A}} \right) - 25 \text{ %}$	(5-3)
OccupancyRate_chunk (OR_c)	0...100 %	$X = \frac{U/V}{R/\Omega} \cdot 6250 \left(\frac{\%}{\text{A}} \right) - 25 \text{ %}$	(5-4)
Clean Counter (cln_cnt)	0...64	$X = \frac{U/V}{R/\Omega} \cdot 4000 \left(\frac{1}{\text{A}} \right) - 16$	(5-5)
Chunk Counter (chunk_cnt)	0...10	$X = \frac{U/V}{R/\Omega} \cdot 625 \left(\frac{1}{\text{A}} \right) - 2,5$	(5-6)
Particle release	enabled or disabled	X = 4 mA = disabled X = 20 mA = enabled	

Tab. 3: Calculating measurements from current

4 Operation and Control

NOTICE



The device must not be operated beyond its specifications.

4.1 RS232 Communication

Communication with the sensor takes place either via serial RS232 port, CANopen or via an analog 4...20 mA output.

The sensors come standard with RS232 port enabled. In this mode it's quite easy to configure the analog interface and to configure the CANopen communication parameters. If necessary, a RS232 command can then be used to switch to CANopen interface (see chapter [Write Commands](#) [> page 13], command "SComMode"), which will be applied after restarting the sensor.

We recommend the software ("CMSensorDataViewer" and "CMSensorConfig") available for download at www.buehler-technologies.com to configure and/or operate the sensor via PC. The software provides easy access to sensor data and configuring the sensor without the use of terminal programs when operating the sensor via PC.

If the sensor is in CANopen mode, it can be permanently changed to the RS232 port with the corresponding entry in the object directory, which will be applied after restarting the sensor.

If the sensor is in CANopen mode, the RS232 port can also be changed temporarily. In this case, the sensor must be connected to the RS232 port configured accordingly and whilst booting, press the pound key (#) until the sensor responds with its ID. If the sensor does not respond within 10 seconds after connecting power, repeat the process.

4.1.1 Serial Port (RS232)

The sensor has a serial port which can be used to read and configure it. This requires a PC and a suitable terminal program or readout software. Both are detailed in the following chapters.

First you will need to select an existing free COM port on your PC to connect the sensor to. A suitable communication cable for the serial connection between the sensor and PC/control unit is available under Item no. 1590001001. If the PC does not have a standard COM port, you can also use serial port cards or USB to serial adapter, Item no. 1590001002.

When starting the sensor in CAN mode, it must first be changed to RS232 mode. After connecting the sensor to power, the sensor checks the line to determine whether it's connected to a serial port and if a defined character ("#") is sent, which must be set during start-up.

If the character is not sent, the sensor switches to CANopen mode. If it understands the sent character, it switches to RS232 mode. Here the command for RS232 mode („SComMode“) can be permanently enabled. When restarting the sensor, it will then automatically start in RS232 mode and the above steps can be skipped.

4.1.2 Interface Parameters

- Baudrate: 9600
- Data bits: 8
- Parity none
- Stop bits: 1
- Flow control: No

4.1.3 Command List

The following lists all interface commands for communication with the sensor. These can be sent to the sensor via terminal program, e.g. Microsoft Windows HyperTerminal.

4.1.3.1 Read Commands

#	Command format	Meaning	Return format
1	RID[CR]	Read identification followed by checksum (CRC)	\$BuehlerTechnologies;BMD100; SN:xxxxx;...;CRC:x[CR][LF]
2	RVal[CR]	Read all measurements followed by checksum (CRC)	\$ Time:x.xxx[h];T:xx.x[°C]; ...;CRC:x[CR][LF]
3	RCon[CR]	Read configuration parameters and CAN configuration followed by checksum (CRC)	\$ Time:x.xxx[h];...; CRC:x[CR][LF]

Tab. 4: Serial communication - read commands

4.1.3.2 Write Commands

#	Command format	Meaning	Return format
1	SONew[CR]	Saves current state as fresh oil. The oil age is set to 0 h, attached particles are released.	ok[CR][LF]
2	SAOx[CR]	Assigns a corresponding measurement value to the current output.	SAO:x[CR][LF]
3	SChunkCntThr[CR]	Limit for the number of chunks (big particles) may be counted in the system before OR_c reaches 100 % (default: 10).	ChunkCntThr:x[CR][LF]
4	SComModex[CR]	Sets the communication mode: x = 0: CANopen x = 1: SAE J1939 x = 2: RS232 (default) Applied after restart	ComMode:x[CR][LF]
5	WCOSpdx[CR]	Sets the baudrate for CANopen mode. x = baudrate in kBit/s supported baudrates (all in kBit/s): 50, 100, 125, 250 (default), 500 Applied after restart	COSpd:x[CR][LF]
6	WCOIDx[CR]	Set node ID for CANopen mode. Range x: 0..127 (default: 100) COB-ID of TPDOs is automatically set to defaults TPDO1 COB-ID: 0x180+node ID TPDO2 COB-ID: 0x280+node ID TPDO3 COB-ID: 0x380+Node-ID Applied after restart	COID:xxx[CR][LF]
6	WCOHBeatx[CR]	Set heart beat time for CANopen mode. Range x: 0..10000ms, resolution: 50ms If x = 0, heart beat off Corresponds to SDO entry Index: 0x1017 Applied after restart	COHBeat:x[ms] [CR][LF]
7	WTPDOyIDx[CR]	Set TPDOy-COB-ID for CANopen mode. Range y: 1..3 Range x: 384..1279 (0x180..0x4FF) Corresponds to SDO entry Index: 0x180y, Sub: 1 Applied after restart	TPDOyID:x[CR][LF]
8	WTPDOyType [CR]	Set TPDOy type for CANopen mode. Range y: 1..3 Range x: 1..240, 254, 255 Corresponds to SDO entry Index: 0x180y, Sub 2 Applied after restart	TPDOyType:x [CR][LF]
9	WTPDOyTimern [CR]	Set TPDOy timer for CANopen mode. Range y: 1..3 Range x: 0..10000ms, resolution: 50ms If x = 0, heart beat off Corresponds to SDO entry Index: 0x1017 Applied after restart	TPDOyTimer:x[ms] [CR][LF]
10	STrAu[CR]	Disables (x = 0) or enables (x = 1..60) automatic transmission of measurements, every x minutes, transmission corresponds to response to command RVal Default x: 0	TrAu:x[min][CR][LF]

Tab. 5: Serial communication - write commands

[CR] = [Carriage Return (0xD)]

[LF] = [Linefeed (0xA)]

4.1.4 List Of Parameter Outputs For Specific Commands

The sensor supports commands to read out the identification, measurements and the configuration. The following tables list the responses to individual commands. Depending on the sensor firmware version, the order or even the contents of the output may vary.

#	Parameter name	Unit	Explanation
1	-	-	Bühler-Technologies (manufacturer)
2	-	-	BMD (product designation)
3	SN	-	Serial number
4	SW	-	Sensor software version (firmware)

Tab. 6: Response to command "RID"

#	Parameter name	Unit	Explanation
1	Time	h	Sensor operating hours counter
2	T	°C	Sensor temperature
3	OR_s	%	OccupancyRate_sum: Occupancy rate - total of OR_f and OR_c
4	OR_f	%	OccupancyRate_fine : Occupancy rate of the sensor surface with fine particles
5	OR_c	%	OccupancyRate_chunk: Occupancy rate with big particles (chunks) 0...100 % in 10% increments (detection of max. 10 chunks)
6	chunk_cnt	-	Number of big particles detected
7	cln_cnt	-	Number of automatic releases since last manual reset („SONew“ command)
8	cln	-	Release currently enabled/disabled
9	tlc	h	Time since the last manual reset („SONew“ command) or automatic release
10	tbc	h	Time between last two automatic releases
11	OAge	h	Time since the last manual reset („SONew“ command)
12	RED	h	Remaining Occupancy Time, estimated remaining time before OR reaches 100 % and automatic cleaning is triggered based on the current OR_s value and the last automatic cleaning

Tab. 7: Response to command "RVal"

#	Parameter name	Unit	Explanation
1	Time	h	Sensor operating hours counter
2	ChunkDetThr	%	Detection limit for big particles (chunks)
3	TrAu	min	Periodic dataset transfer as output for RVal command with an interval of the minutes specified (range 1...60 minutes, if set to 0, automatic transfer is off)
4	AO	-	Analog output setting
5	ChunkCntThr	-	Number of chunks required to reach the 100 % limit
6	TimeOFF	ms	Automatic release off time (multiples of 250 ms)
7	TimeON	ms	Automatic release on time (multiples of 250 ms)
8	pThr	%	Proximity signal limit
9	fThr	%	Frequency signal limit
10	ComMode	-	Communication mode (RS232, CANopen or SAE J1939)
11	COID	-	Sensor CANopen nodeID
12	COSpd	kBit/s	CANopen bus speed (baudrate)
13	TPDO1Type	-	TPDO 1 Type for CANopen
14	TPDO2Type	-	TPDO 2 Type for CANopen
15	TPDO3Type	-	TPDO 3 Type for CANopen
16	TPDO1Timer	ms	TPDO 1 timer for CANopen
17	TPDO2Timer	ms	TPDO 2 timer for CANopen
18	TPDO3Timer	ms	TPDO 3 timer for CANopen
19	TPDO1ID	-	TPDO 1 COB-ID for CANopen
20	TPDO2ID	-	TPDO 2 COB-ID for CANopen
21	TPDO3ID	-	TPDO 3 COB-ID for CANopen
22	COHBeat	ms	Sensor CANopen heartbeat
23	J1939ID	-	SAE J1939 sensor ID
24	J1939BR	kBit/s	SAE J1939 bus speed (baudrate)
25	J1939ti	-	SAE J1939 Timer
26	Verb	-	Switching between general and detailed response to RVal command

Tab. 8: Response to command "RCon"

4.1.5 Output Triggering

On principle there are two different options to output measurements via the RS232 port, time-triggered or command-triggered (see command: "STrAu").

4.2 CANopen Communication

4.2.1 CAN Interface

The CAN interface corresponds to "CAN 2.0B Active Specification". The sensor only supports a limited number of transfer speeds on the CAN bus.

Data rates recommended by CiA and supported by the sensor

Data rate	Supported	CiA Draft 301	Bus length (per CiA Draft Standard 301)
1 Mbit/s	no	yes	25 m
800 kbit/s	no	yes	50 m
500 kbit/s	yes	yes	100 m
250 kbit/s	yes	yes	250 m
125 kbit/s	yes	yes	500 m
100 kbit/s	yes	no	750 m
50 kbit/s	yes	yes	1000 m
20 kbit/s	no	yes	2500 m
10 kbit/s	no	yes	5000 m

CAN interface electrical parameters:

Parameter	Size	Unit
Typ. Response time to SDO queries	<10	ms
Max. Response time to SDO queries	150	ms
CAN-Transceiver supply voltage	3.3	V
Integrated termination	no	-

4.2.2 CANopen Object Directory

The following table shows the full object directory for the sensor. The first table shows the communication portion of the object directory. Apart from a few exceptions, these settings correspond to the CANopen standard as described in DS 301. There are some communication limitations based on the hardware platform used. The configuration steps for "heartbeat time" (Index 1017h), "TPDO1 event timer" (Index 1800h, Subindex 5), "TPDO2 event timer" (Index 1801h, Subindex 5), "TPDO3 event timer" (Index 1802h, Subindex 5) are limited to 10 ms in place of the 1 ms envisaged. This means the objects can for example be configured to 0 ms, 20 ms, 280 ms, but not 33 ms or 125 ms, etc.

Communication Profile Area

Idx	Sub	Name	Type	Attr.	Default	Notes
1000h	0	device type	u32	ro	194h	Sensor, see D S404
1001h	0	error register	u8	ro	00h	mandatory, see DS301
1017h	0	producer heartbeat time	u16	rw	1388h	heartbeat time in ms, range: 0..65535
		identity object	record	ro		
1018h	0	Number of entries	u8	ro	04h	largest sub index
	1	Vendor ID	u32	ro	000000E6h	
	2	Product code	u32	ro	5BCA8CE8	BMD100
	3	Revision number	u32	ro	1000	Device dependent
	4	Serial number	u32	ro		Device dependent
		Transmit PDO1 parameter	record			
1800h	0	Number of entries	u8	ro	05h	largest sub index
	1	COB-ID	u32	rw	180h+NodeID	COB-ID used by PDO, range: 181h..1FFh, can be changed while not operational
	2	transmission type	u8	rw	FFh	cyclic + synchronous, asynchronous values: 1-240, 254, 255
	5	event timer	u16	rw	1F4h	event timer in ms for asynchronous TPDO1 range: 0..65000
		Transmit PDO2 Parameter	record			

1801h	0	Number of entries	u8	ro	05h	largest sub index
	1	COB-ID	u32	rw	280h+NodeID	COB-ID used by PDO, range: 281h..2FFh, can be changed while not operational
	2	transmission type	u8	rw	FFh	cyclic + synchronous, asynchronous values: 1-240, 254, 255
	5	event timer	u16	rw	1F4h	event timer in ms for asynchronous TPDO2 range: 0..65000
		Transmit PDO3 Parameter	record			
1802h	0	Number of entries	u8	ro	05h	largest sub index
	1	COB-ID	u32	rw	380h+NodeID	COB-ID used by PDO, range: 381h..3FFh, can be changed while not operational
	2	transmission type	u8	rw	FFh	cyclic + synchronous, asynchronous values: 1-240, 254, 255
	5	event timer	u16	rw	1F4h	event timer in ms for asynchronous TPDO3 range: 0...65000
		TPDO1 Mapping Parameter	record			
1A00h	0	Number of entries	u8	ro	07h	largest sub index
	1	PDO mapping for 1st app obj. to be mapped	u32	co	0x20000608	Occupancy Rate s-Signal
	2	PDO mapping for 2nd app obj. to be mapped	u32	co	0x20000308	Occupancy Rate f-Signal
	3	PDO mapping for 3rd app obj. to be mapped	u32	co	0x20000508	Occupancy Rate c-Signal
	4	PDO mapping for 4th app obj. to be mapped	u32	co	0x20020108	Temperature
	5	PDO mapping for 5th app obj. to be mapped	u32	co	0x20020b08	Cleaning Counter
		TPDO1 Mapping Parameter	record			
1A00h	6	PDO mapping for 6th app obj. to be mapped	u32	co	0x20020c08	Chunk Counter
	7	PDO mapping for 7th app obj. to be mapped	u32	co	0x20020a01	Cleaning in Progress
		TPDO2 Mapping Parameter	record			
1A01h	0	Number of entries	u8	ro	02h	largest sub index
	1	PDO mapping for 1st app obj. to be mapped	u32	co	0x20010120	Sensor On Time / s
	2	PDO mapping for 2nd app obj. to be mapped	u32	co	0x10180420	Serial number
		TPDO3 Mapping Parameter	record			
1A02h	0	Number of entries	u8	ro	02h	largest sub index
	1	PDO mapping for 1st app obj. to be mapped	u32	co	0x20010210	Oil age in hours
	2	PDO mapping for 2nd app obj. to be mapped	u32	co	0x20010520	Remaining Occupancy Time (ROT)

Tab. 9: Communication-related object directory

All sensor objects are located in the object directory from index 2000h and listed in the table below. This part of the object directory is sensor-specific. Furthermore, some configurations are supported.

Manufacturer-specific profile area

Idx	Sub	Name	Type	Attr.	Default	Notes
OccupancyRate Parameters			record			
2000h	0	Number of entries	u8	ro	06h	largest sub index
	1	Reserved	u8	ro		Reserved
	2	Reserved	u8	ro		Reserved
	3	OccupancyRate_fine (OR_f)	u8	ro		Occupancy rate of the sensor surface with fine particles (multiplied by 2)
	4	Reserved	u8	ro		Reserved
	5	OccupancyRate_chunk (OR_c)	u8	ro		Occupancy rate of the sensor surface with big particles (chunks) (multiplied by 2) OR_c = 100 / chunk_cnt_thr + chunk_cnt
	6	OccupancyRate_sum (OR_s)	u8	ro		Sum signal of OR_f and OR_c (multiplied by 2) OR_s = OR_c + OR_f
Time Parameters			record			
2001h	0	Number of entries	u8	ro	05h	largest sub index
	1	Sensor On Time / s	u32	ro		Sensor On Time / s
	2	Oil Age / h	u16	ro		Time since last SONew / h
	3	Time since last cleaning (tlc) / h	u16	ro		Time since last SONew or automatic particle release/flush / h
	4	Time between two last cleanings (tbc) / h	u16	ro		Time between the last but one and the last particle release / flush
	5	Remaining Occupancy Time (ROT) / h	u32	ro		Time until OR_s reaches 100 %, based on current OR_s value and time since last particle release / flush / h
Measured and Preprocessed Values			record			
2002h	0	Number of entries	u8	ro	0Ch	largest sub index
	1	Temperature (T) / °C	s8	ro		Sensor temperature in °C
	2	Reserved	u16	ro		-
	3	Reserved	s16	ro		-
	4	Reserved	u8	ro		-
	5	Reserved	u8	ro		-
	6	Reserved	u32	ro		-
	7	Reserved	s16	ro		-
	8	Reserved	u8	ro		-
	9	Reserved	u8	ro		-
	10	Cleaning in Progress	boolean	ro		Particle release/flushing currently active / inactive (1/0)
	11	Cleaning Counter (cln_cnt)	u8	ro		Amount of automatic particle releases / flushes since last SONew
	12	Chunk Counter (chunk_cnt)	u8	ro		Amount of detected chunks
Customer Settings			record			
2030h	0	Number of entries	u8	ro	08h	largest sub index
	1	Analogue Output Type	u8	rw	1	0 = Temperature 1 = OR_s 2 = OR_f 3 = OR_c 10 = Clean Counter (0...64 counts) 16 = Chunk Counter (0...10 counts) 40 = sequential output 100 = 4 mA 101 = 12 mA 102 = 20 mA
	2	Chunk Counter Threshold	u8	rw		Amount of big particles (chunks) required to reach OR_c 100%

	3	Set new oil	u8	wo		Reset sensor, release / flush particles, get the current state as fresh oil state (corresponds SONew-command)
		Service Settings	record			
2031h	0	Number of entries	u8	ro	7h	largest sub index
	1	Reserved	u8	rw		-
	2	Reserved	u8	rw		-
	3	Reserved	u8	rw		-
	4	Reserved	s8	rw		-
	5	Reserved	s8	rw		-
	6	Reserved	s8	rw		-
	7	Maximum Temperature / °C	s8	ro		Highest seen temperature on the device / °C
		Device Settings	record			
2032h	0	Number of entries	u8	ro	4h	largest sub index
	1	CANopen Start Mode	u8	rw	0	0 = Network with NMT Master (Init => PreOp => Start_Remote_Node => Operational) >0 = Network without NMT Master (Init => Operational)
	2	CANopen Node ID	u8	rw		CANopen bus node ID
	3	CANopen Baudrate	u8	rw	1 h	0 = 500 Kbit/s 1 = 250 Kbit/s (default) 2 = 125 Kbit/s 3 = 100 Kbit/s 4 = 50 Kbit/s
	4	Communication type	u8	rw	2h	0 = CANopen 1 = J1939 2 = RS232

Tab. 10: Sensor portion of the CANopen communication profile (0.64.16)

4.2.3 Initial Operation With CAN Interface

The sensor comes standard with the RS232 enabled and CAN interface disabled. For permanently enable the CAN interface, the sensor must be configured via RS232 port (command "SComMode").

On delivery, the CANopen interface of the sensor is configured as shown in the table.

Parameter	Set value	RS232 command
Communication mode	2 (RS232 activated / disabled CAN) To activate CANopen, communication mode must be set to 0.	SComMode
Node-ID	0x64 (dec: 100)	WCoid
CAN baudrate	250 kBit/s	WCOSpd
Heart beat timer	500 ms	WCOHBeat
TPDO1 ID	Node ID + 0x180 = 0x1E4 (dec: 484)	WTPDO1ID
TPDO2 ID	Node ID + 0x280 = 0x2E4 (dec: 740)	WTPDO2ID
TPDO3 ID	Node ID + 0x380 = 0x3E4 (dec: 996)	WTPDO3ID
TPDO1 Type	254	WTPDO1Type
TPDO2 Type	254	WTPDO2Type
TPDO3 Type	254	WTPDO3Type
TPDO1 Timer	1000 ms	WTPDO1Timer
TPDO2 Timer	1000 ms	WTPDO2Timer
TPDO3 Timer	1000 ms	WTPDO3Timer

Tab. 11: CANopen default configuration

After configuring the CAN interface for the available CANopen network, the CAN interface of the sensor can be enabled and the sensor can be connected to the CANopen network.

The process for communicating with the sensor via RS232 port with the CAN communication enabled, please refer to chapter [RS232 Communication](#) [> page 11].

5 Cleaning And Maintenance

This device is maintenance-free when used properly.

The method for cleaning the devices must be adapted to the IP protection class of the devices. Do not use cleaners which could damage the device materials.

6 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 attach 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.

6.1 Accessories

Item no.	Description
9144050033	Connecting cable, 8-pin, 5 m
1590001001	RS232 data cable
1590001002	USB/RS232 adapter
1590001003	Power supply

7 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

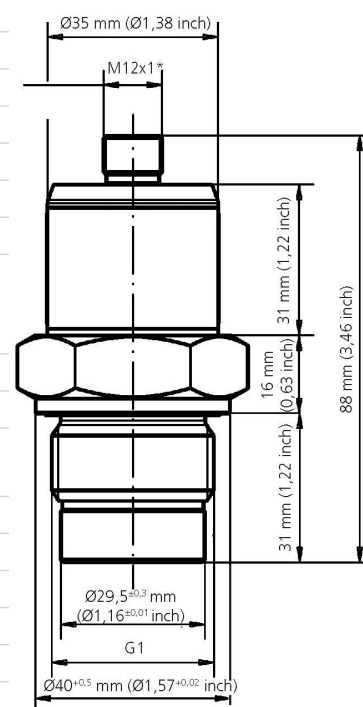
Please also observe data protection regulations and remember you are personally responsible for the returned waste equipment not bearing any personal data. Therefore please be sure to delete your personal data before returning your waste equipment.

8 Appendices

8.1 Technical Data

BMD-100-000-1DC1A	1DC1A
Version:	Compact unit
Process connection:	G1"
Fastening torque:	50 ±5 Nm
Material in contact with media:	aluminium, polyamide (PA6GF30), HNBR, epoxy resin
Medium temperature:	-40 °C to +85 °C
Ambient temperature:	-40 °C to +85 °C
Pressure resistance:	20 bar
Compatible fluids:	mineral oils (H, HL, HLP, HLPD, HVLP), synthetic esters (HETG, HEPG, HEES, HEPR), polyalkylene glycol (PAG), zinc- and ash-free oils (ZAF), poly-alpha-olefins (PAO)
Weight:	190 g
Input value	
Flow rate:	max. 1 m/s min. 0.05 m/s for automatic cleaning
Operating voltage (U _B):	22 – 33 V DC
Power input:	max. 0.5 A
Measuring range	
Fine particles:	0...100 %
Coarse particles:	1...10
Additional secondary measurands:	Temperature (inside device), operating hours
1D output:	RS232/CANopen
1A output:	4-20 mA clocked

Dimensions



8.2 Standard pin assignment

Plug connection	M12 (base)
Number of pins	8-pin
Voltage	max. 33 V DC
IP rating with IP67 cable box attached	IP67
Version	1DC1A
Connection schematic	
1	L+
2	L-
3	TxD, CAN low [OUT]
4	RxD, CAN high [IN]
5	not connected
6	not connected
7	Analog output, 4...20 mA
8	Signal earth
Shield	-

8.3 Permissible Mechanical Loads

This lists the permissible mechanical loads for the sensors:

Load	Size	Unit
max. operating pressure	20	Bar
max. tightening torque	50 ±5.0	Nm
max. longitudinal vibration Test based on DIN EN 60068-2-6	f: 5-9 A: ±15	HZ mm
	f: 9-200 a: 10	HZ g
max. transverse vibration Test based on DIN EN 60068-2-6	f: 5-9 A: ±15	HZ mm
	f: 9-200 a: 10	HZ g

Tab. 12: Permissible Mechanical Loads

9 Attached documents

- Declaration of Conformity KX150003
- 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*

2014/30/EU

(Elektromagnetische Verträglichkeit / *electromagnetic compatibility*)

in ihrer aktuellen Fassung entsprechen.

in its actual version.

Produkt / products: Bühler Metall Detektor / *Bühler Metal Detector*
Typ / type: BMD

Das Betriebsmittel dient zur Überwachung der eisenhaltigen Partikel innerhalb von Öl.
The equipment is intended for monitoring the ferrous particles within the oil.

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 13309:2010

EN ISO 13766:2018

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

ISO 7637-2 Edition 2 (2004-06-15) (partly)

ISO 7637-3 Edition 2 (2007-07-01) (partly)

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 authorised to compile the technical file is Mr. Stefan Eschweiler located at the company's
address.*

Ratingen, den 04.10.2022

Stefan Eschweiler
Geschäftsführer – *Managing Director*

Frank Pospiech
Geschäftsführer – *Managing Director*

RMA-Formular und Erklärung über Dekontaminierung

RMA-Form and explanation for decontamination



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



☐
gesundheitsge-
fährdend/
harmful to
health



☐
gesund-
heitsschädlich/
health hazard



☐
umweltge-
fährdend/
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 commission 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 assemblies 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.

