BALLUFF

BMP 01-EL1PP_1A-_ _ _ _-00-P_ _-S75
BMP 01-EL1PP_1A-_ _ _ _-00-P_ _-S4
BMP 01-EL1PP_1A-_ _ _ _-00-P_ _

User's Guide



IO-Link

english

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1 Notes to the user

1.1 Validity

This guide describes the structure, function and setup options of the BMP Magnetic Field Positioning System with analog current and voltage as well as IO-Link interface. It applies to models
BMP 01-EL1PP_1A-_ _ _ _-00-P_ _/P_ _-S4/P_ _-S75
(see type code on page 31).

This guide is intended for qualified technical personnel. Read this guide before installing and operating the BMP.

1.2 Symbols and conventions

Individual **instructions** are indicated by a preceding triangle.

► Instruction 1

Action sequences are numbered consecutively:

1. Instruction 1
2. Instruction 2

Digits without further identification are decimal numbers (e.g. 23). Hexadecimal numbers are shown with the prefix 0x (e.g. 0x12AB).

Note, tip
This symbol indicates general notes.

1.3 Scope of delivery

– BMP Magnetic Field Positioning System
– Condensed guide

The target and mounting accessories depend on the application and are to be ordered separately.

1.4 Approvals and markings

UL approval
File no.
E227256

The CE Mark verifies that our products meet the requirements of the current EMC Directive.

The BMP meets the requirements of the following product standard:
– EN 61326-2-3 (noise immunity and emission)

Emission tests:

– RF emission
  EN 55011

Noise immunity tests:

– Static electricity (ESD)
  EN 61000-4-2 — Severity level 2
– Electromagnetic fields (RFI)
  EN 61000-4-3 — Severity level 3
– Electrical fast transients (burst)
  EN 61000-4-4 — Severity level 3
– Conducted interference induced by high-frequency fields
  EN 61000-4-6 — Severity level 3

More detailed information on the guidelines, approvals, and standards is included in the declaration of conformity.

1.5 Abbreviations

IODD	IO device description
PD	Process data
MDC	Measurement data channel
SSC	Switching signal channel

2 Safety

2.1 Intended use

The BMP Magnetic Field Positioning System, together with a machine control system (e.g. PLC) and IO-Link, master forms a position measuring system. It is intended to be installed into a machine or system and used in the industrial sector. Flawless function in accordance with the specifications in the technical data is ensured only when using original Balluff accessories. Use of any other components (with the exception of cylinders) will void the warranty.

Opening the BMP or non-approved use are not permitted and will result in the loss of warranty and liability claims against the manufacturer.

2.2 General safety notes

Installation and **startup** are to be performed only by qualified personnel with fundamental electrical expertise.

Qualified personnel are those who can assess assigned tasks, recognize possible hazards and initiate appropriate safety measures based on their professional training, knowledge, experience and understanding of relevant regulations.

The **operator** is responsible for ensuring that local safety regulations are observed.
In particular, the operator must take steps to ensure that a defect in the BMP will not result in hazards to persons or equipment.
If defects and unresolvable faults occur in the BMP, take it out of service and secure against unauthorized use.

2.3 Explanation of the warnings

Always observe the warnings in these instructions and the measures described to avoid hazards.

The warnings used here contain various signal words and are structured as follows:

SIGNAL WORD
Type and source of the hazard Consequences if not complied with ► Measures to avoid hazards

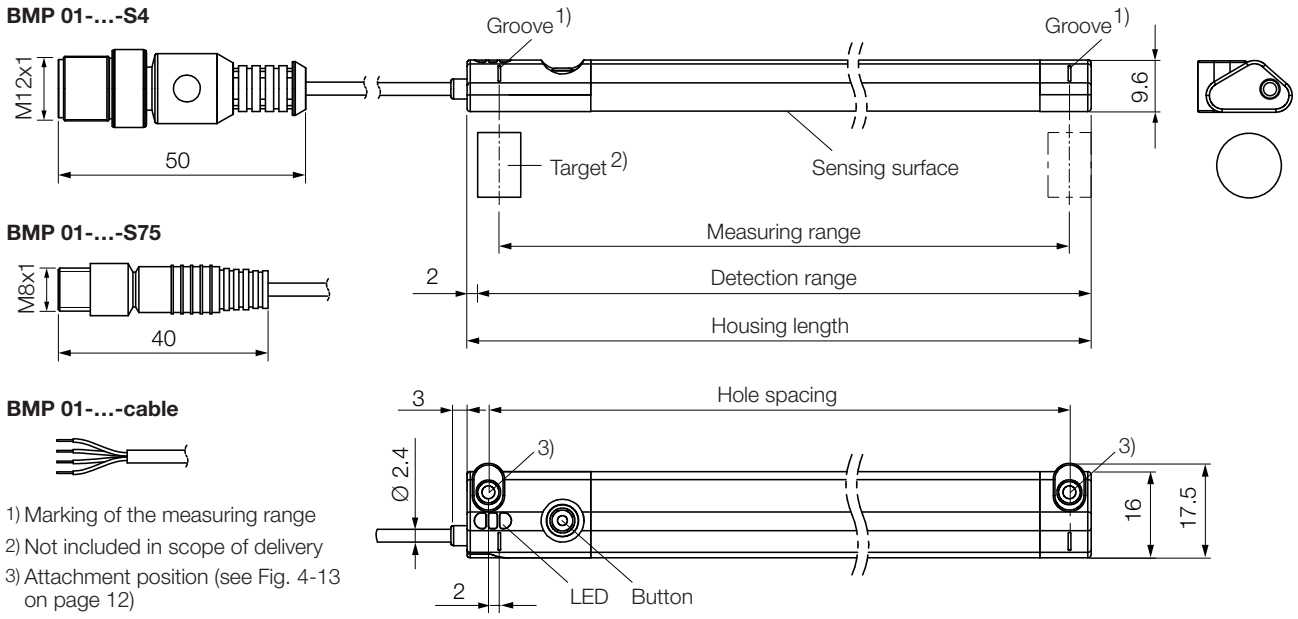
The individual signal words mean:

NOTICE Identifies a danger that could **damage or destroy the product**.
⚠ CAUTION The general warning symbol in conjunction with the signal word CAUTION identifies a danger that could lead to **slight or moderately serious injuries**.
⚠ DANGER The general warning symbol in conjunction with the signal word DANGER identifies a hazard which, if not avoided, will certainly result in **death or severe injury**.

2.4 Disposal

► Observe the national regulations for disposal.

3 Construction and function



1) Marking of the measuring range
2) Not included in scope of delivery
3) Attachment position (see Fig. 4-13 on page 12)

Fig. 3-1: BMP Magnetic Field Positioning System 01-..., structure and function

3.1 Construction

Electrical connection: The electrical connection is made via a cable with or without a connector (see type code on page 31).

Housing: Aluminum housing with plastic closures.

Housing length: Measuring range + 10 mm.

Attachment: Holes are provided in the BMP for attachment using M2 mounting screws or slot nuts (see accessories on page 30).

Target: Defines the position to be measured.

Measuring range: For adapting the BMP to the application optimally, the following measuring ranges are available: 32/64/96/128/160/192/224/256 mm. The values listed in the *Technical data* (see Sec. 8.1 on page 29) are maintained for repeat accuracy and non-linearity.

Detection range: Range in which the BMP detects the position of the target. It extends beyond the measuring range by 4 mm on both sides.

> The detection range which goes beyond the measuring range is only output via the IO-Link interface.

3.2 Function

The BMP is an intelligent magnetic field positioning system. It is used primarily for the non-contact detection of the piston stroke of pneumatic cylinders, grippers and slides with axially magnetized permanent magnets. The BMP ensures continuous, absolute position measurement at an application-relevant level of measuring accuracy.

The analog output of the BMP is easy to evaluate and can be switched between voltage and current. It also offers a switching output that is easy to adjust.

Using the button and the three LEDs, the BMP can be configured without addition auxiliary tools.

Over the IO-Link interface, the BMP offers additional configuration options and state monitoring functions.

The functions of the BMP allow it to support simple format change in different applications.

3 Structure and function (continued)

3.2.1 Analog and switching output

Analog output

- Switchable between:
  - 0…10 V (output value outside of the configured measuring range: 10.5 V)
  - 4…20 mA (output value outside of the configured measuring range: 3.5 mA)
- Start and end point of the measuring range are adjustable.
- 12-bit resolution (adjusted to the configured measuring range)

Switching output

- Adjustable switch-on and switch-off point
- Measuring range display is a factory setting (active over the entire measuring range)
- Normally open/normally closed (switchable)

Analog and switching output are described in Chapter 6 on page 15.

3.2.2 IO-Link interface

- Absolute measured value (µm)
- Measuring range display via status bit
- Four switching signals
- Extensive configuration options for the measured value and switching signals
- Functions for state monitoring:
  - Temperature detection
  - Operating hours counter
  - Boot cycle counter

The IO-Link interface is described in section 7 on page 17.

3.3 LED display

In normal operation, three LEDs indicate the operating state of the BMP.

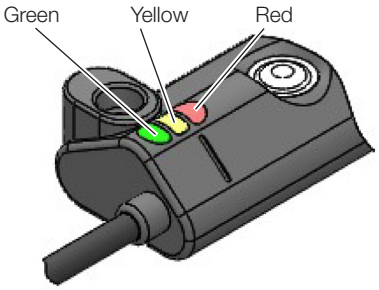


Fig. 3-2: Positions of the LEDs

LED		Operating state
Color	**State**	
Green	on	Power OK
	Inverse flashing	IO-Link communication active
Yellow	off	The target is located within the configured measuring range.
	on	The target is located outside of the configured measuring range.
	Flashing 5 Hz	The excess gain of the measurement is low. The measured magnetic field strength of the target is small.
Red	off	No error
	Flashing 5 Hz	Analog current output is open

Tab. 3-1: LED display

Note, tip
Sustained, asynchronous flashing of all LEDs indicates a serious error. The BMP likely needs to be replaced.

4 Installation and connection

There are three available variants for installation:
– Attachment to a pneumatic cylinder using a C- or T-slot (see section 4.1).
– Attachment to a round cylinder using hose clamps and round cylinder holders (see section 4.2).
– Mount the BMP to a surface using mounting screws and operate it with floating target (see section 4.3).

Important installation notes

⚠ CAUTION

Increased housing temperature
In the event of insufficient heat coupling due to the mounting, the surface temperature of the BMP can increase and cause burns when touched.
► Correct the heat coupling of the installation.
► Reduce the load.

NOTICE

Interference in function
Improper installation can compromise the function of the BMP and result in increased wear.
► The target must not contact the BMP.
► Shield any magnetic fields that can influence the measurement.

Position the BMP so that the measuring range can detect the entire range of movement of the target.

The target must be polarized axially. The orientation (whether the cable end points in the direction of the North or South Pole) does not matter.

The position detected by the BMP is in the middle of the target.

Only the cylinder which has a permanent magnet installed as the target is eligible when mounting to a pneumatic cylinder.

A rotating cylinder head causes inaccuracy that is too large!

i For fastening screws and slot nuts, see *Accessories* on page 30.

4 Installation and connection (continued)

4.1 Mounting to a pneumatic cylinder using a T- or C-Slot

For mounting to a pneumatic cylinder, slot nuts are required (see accessories on page 30).

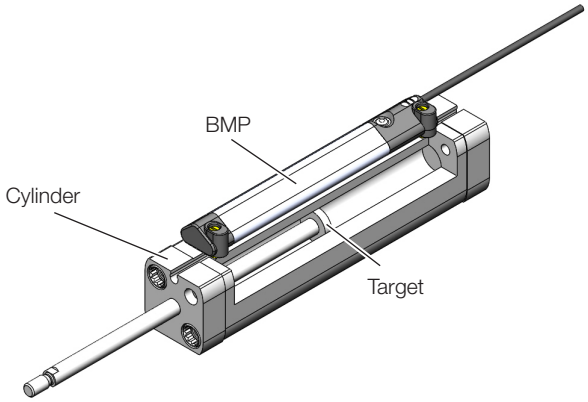


Fig. 4-1: Mounting to a pneumatic cylinder

1. Mount slot nuts on the BMP, tighten loose screws.

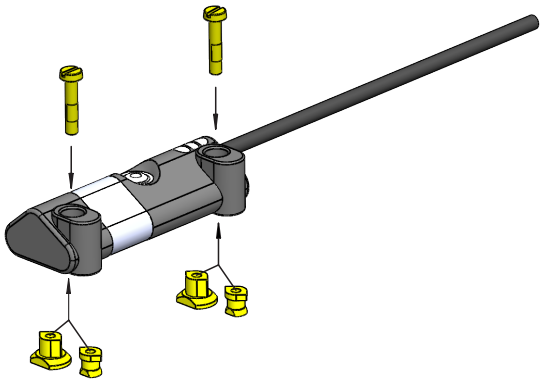


Fig. 4-2: Mounting T-slot nuts (left) or C-slot nuts (right)

2. Align slot nuts with the straight side parallel to the slot.

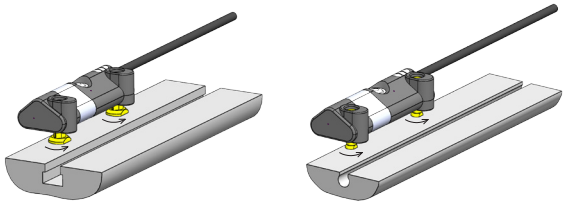


Fig. 4-3: Align slot nuts (T-slot at left, C-slot at right in the image)

3. Guide slot nuts into the slot.

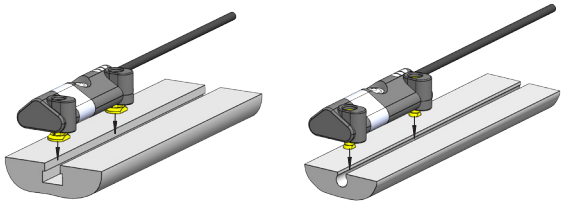


Fig. 4-4: Guiding slot nuts into the slot (T-slot at left, C-slot at right in the image)

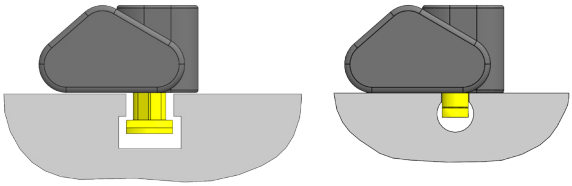


Fig. 4-5: Slot nuts in the slot (side view; T-slot at left, C-slot at right in the image)

4. Position the BMP.

5. Tighten screws (torque: 0.1 Nm).

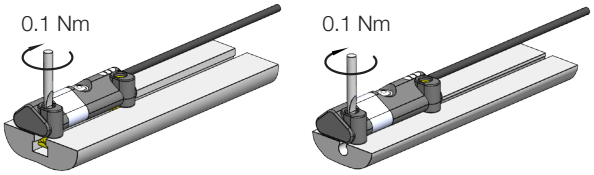


Fig. 4-6: Tightening slotted screws (T-slot at left, C-slot at right in the image)

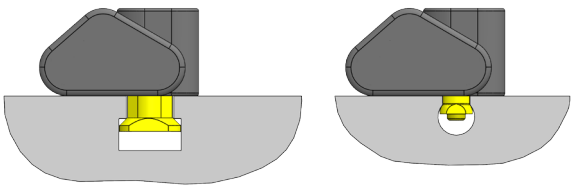


Fig. 4-7: Slot nuts in place in the slot (side view; T-slot at left, C-slot at right in the image)

⇒ Slot nuts are rotated 90°.
⇒ The BMP is fixed in place.

4 Installation and connection (continued)

4.2 Mounting to a round cylinder

Hose clamps and round cylinder holders are used to mount to a round cylinder (see accessories on page 30).

1. Clamp round cylinder holder to the BMP. When doing so, be aware of the orientation of the holder (see Fig. 4-8).

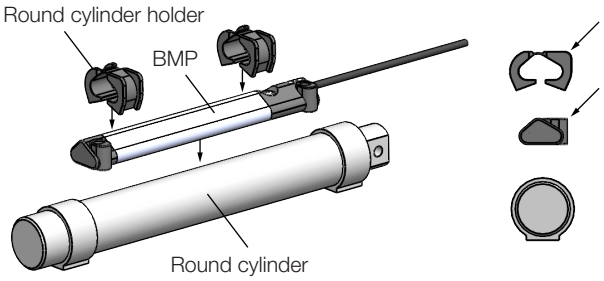


Fig. 4-8: Attaching holder to the BMP

2. Slide hose clamps over the BMP and the holders.

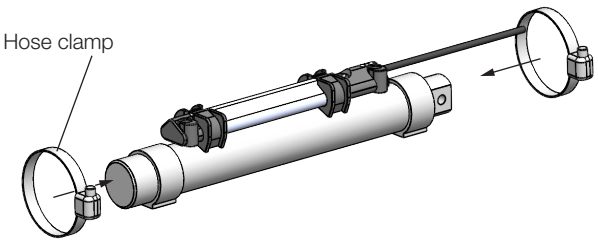


Fig. 4-9: Applying hose clamps

3. Tighten screws of the hose clamps in order to secure the BMP to the round cylinder.

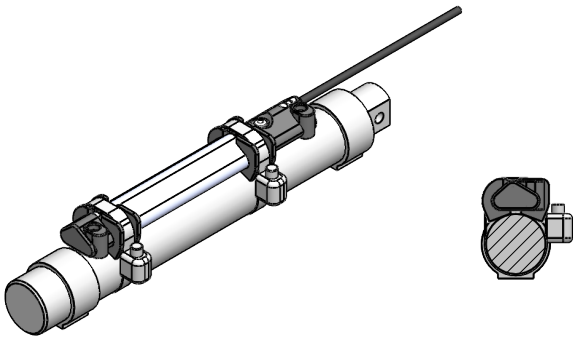


Fig. 4-10: Securing hose clamps

4 Installation and connection (continued)

4.3 Mounting with floating target

For mounting with a floating target, mounting screws are required (see accessories on page 30).

Distances and tolerances to be observed

To guarantee function, the following distances for the target must be observed:

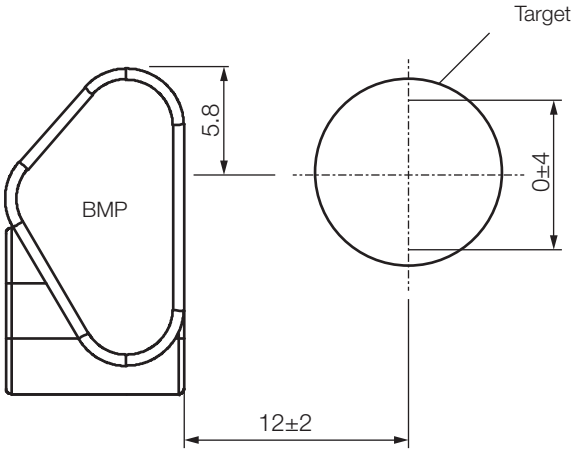


Fig. 4-11: Distances and tolerances, shown using an example of a round magnet target Ø10×10 mm with remanence B_R ~360 mT

Hole spacing

Hole spacing = Measuring range + 2 mm (hole pattern tolerance = ±0.05 mm)

Example: Measuring range 128 mm
Hole spacing = 130 mm ±0.05 mm

Direct and inverse mounting

The BMP can be mounted directly (sensing surface pointing to mounting surface) or inversely.

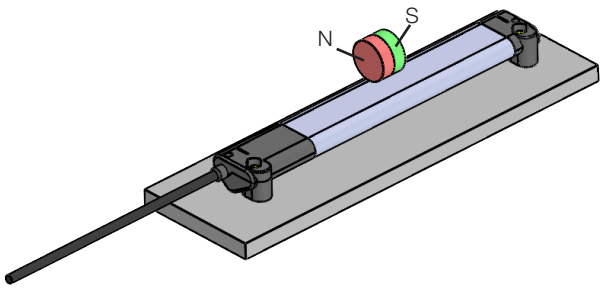


Fig. 4-12: Installation with floating target (inverse mounting), axially polarized target (example, N and S can also be swapped)

For inverse mounting, a recess for the button and the LEDs must be provided (for dimensions, see Fig. 4-13); otherwise, the BMP can only be configured via IO-Link.

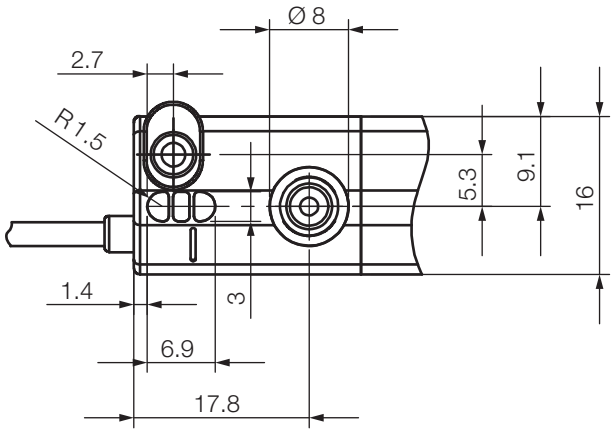


Fig. 4-13: Dimensions and distances of the button and LEDs

1. Provide boreholes (distances depend on type; see Fig. 3-1 on page 7 and *Hole spacing* on page 12).
2. Attach the BMP to a surface using mounting screws (see *Accessories* on page 30) and a torque of 0.1 Nm.

4 Installation and connection (continued)

4.4 Electrical connection

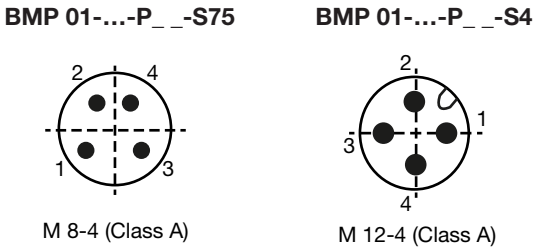


Fig. 4-14: Plug connector pin assignment (top view on pin side)

Pin	Wire color	Signal
1	Brown	+24 V (operating voltage UB+)
2	White	Analog output: Voltage 0…10 V / Current 4…20 mA
3	Blue	GND (operating voltage UB– ; reference potential)
4	Black	OUT1 (switching output S1) or C/Q (IO-Link)

Tab. 4-1: Plug connector pin assignment

4.5 Cable routing

Magnetic fields

Ensure that there is sufficient distance between the BMP and holding cylinder and any strong, external magnetic fields.

Cable routing

Do not route cables between the BMP, control system and power supply near power lines (inductive crosstalk possible) and ensure EMC-compliant cable routing or machine installation.

The cable must be routed tension-free.

Bending radius for fixed cable

The bending radius for fixed cable routing must be at least triple the cable diameter.

Cable length

Cable length max. 20 m.

Longer cables can also be used for the analog output if external interferences remain ineffective due to the structure, shield or routing.

5 Startup

5.1 Starting up the system

⚠ DANGER

Uncontrolled system movement

When starting up, if the positioning system is part of a control system whose parameters have not yet been set, the system may perform uncontrolled movements. This could result in personal injury and equipment damage.

- ► Persons must keep away from the system's hazardous zones.
- ► Startup must be performed only by trained technical personnel.
- ► Observe the safety instructions of the equipment or system manufacturer.

1. Check connections for tightness and correct polarity. Replace damaged connections.
2. Turn on the system.
3. Check measurement values and adjustable parameters and readjust the BMP if necessary.

i Check for the correct values, especially after replacing the BMP or after repair by the manufacturer.

5.2 Operating notes

- Regularly check the function of the BMP and all associated components.
- Take the BMP out of operation whenever there is a malfunction.
- Secure the system against unauthorized use.
- Check the attachment and retighten it if necessary.

6 Analog interface and switching output

When IO-Link communication is active, the analog output is disabled.

The minimum selectable measuring range is 5 mm.

6.1 Voltage Output 0…10 V

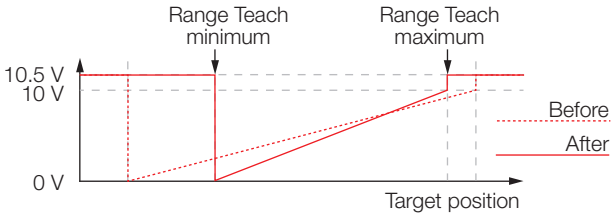


Fig. 6-1: Analog voltage output

For the adjustment process, see section 6.4 on page 16.

6.2 Current Output 4…20 mA

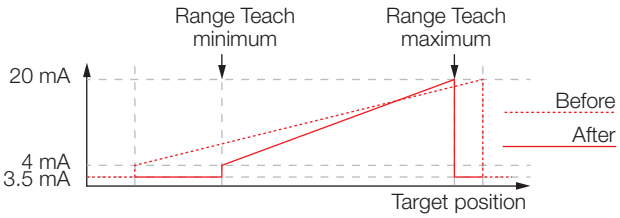


Fig. 6-2: Analog current output

For the adjustment process, see section 6.4 on page 16.

6.3 Switching output

Switching signal (factory setting)



Fig. 6-3: Switching signal (factory setting)

Taught-in switching signal
(Teach 1 (switch-on point) and Teach 2 (switch-off point) carried out)

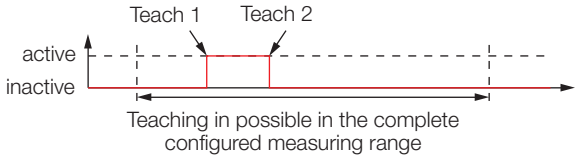


Fig. 6-4: Taught-in switching signal

N.O./N.C.
As standard, the switching output is configured as a normally open contact (image above). It can be converted to normally closed logic.

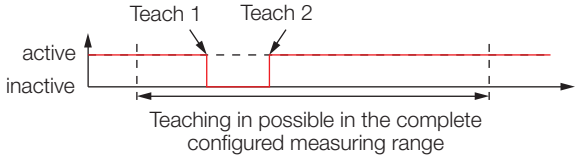


Fig. 6-5: Taught-in switching signal

For the adjustment process, see section 6.4 on page 16.

6 Analog interface and switching output (continued)

6.4 Settings using the button

The settings made using the button apply to the operation using the analog as well as IO-Link interface.

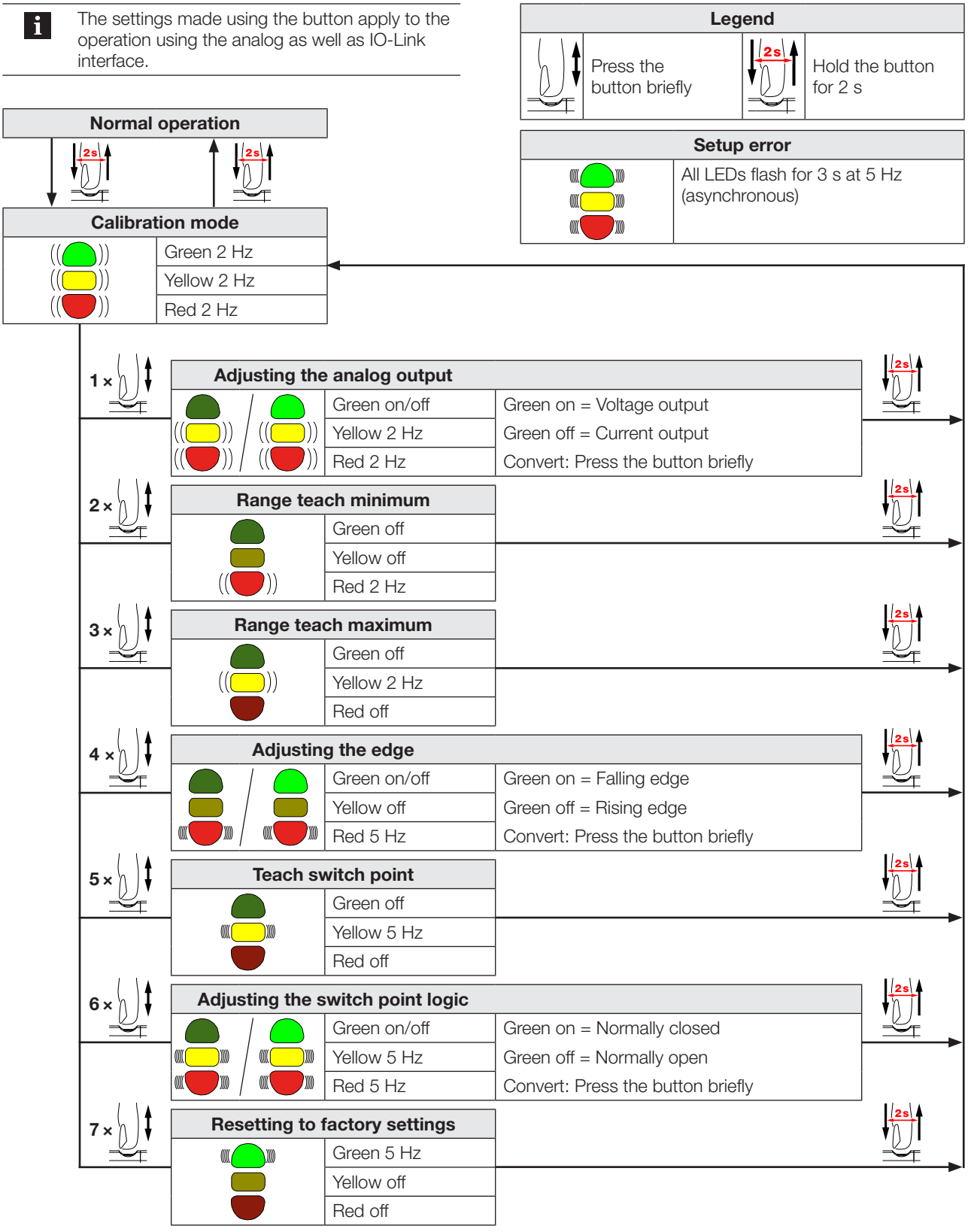


Fig. 6-6: Overview of setup mode

7 IO-Link interface

7.1 Communication parameters

In Tab. 7-1, the basic IO-Link specification for standard variant BMP 01-… is described.

Specification	IO-Link Description	Value
Transmission rate	COM3	230.4 kBaud
Minimum cycle time of device	MinCycleTime	1 ms (0x0A)
Frame specification: – Amount of preoperate data required – Amount of operate data required – ISDU	M-Sequence Capability: – M-Sequence Type Preoperate – M-Sequence Type Operate – ISDU supported	0×19 2 bytes 1 Byte Supported
IO-Link protocol version	Revision ID	0x11 (Version 1.1)
Amount of process data from the device to the master	ProcessDataIn	6 byte (0xC5)
Amount of process data from the master to the device	ProcessDataOut	0 byte (0x00)
Manufacturer ID	Vendor ID	0x0378
Device identification	Device ID	0x0D0101
IO-Link profile	Profile	Smart sensor profile Ed 2 (digital measuring sensor)
IO-Link profile type	Profile Type	SSP 3.2

Tab. 7-1: BMP device specification

The minimum cycle time of the BMP is 1 ms. The master can increase the cycle time as necessary, and as a result, the cycle time actually used (mastercycletime) depends on the master.

7 IO-Link interface (continued)

7.2 Process data (PD)

The BMP variants output a measurement value and additional status and switch point information cyclically via the IO-Link interface.

Byte					
5	4	3	2	1	0
Measurement value				Scaling factor	Status and SSCs

Tab. 7-2: Process data

Measurement value
The measurement value corresponds to the position of the target in µm and consists of a signed 32-bit value.

Scaling factor
The scaling factor indicates the factor by which the measurement value must be multiplied in order to obtain the value in the SI unit.

The scaling factor is for BMP –6 (0xFA):
Measurement value × 10^{-6} = Position [m]

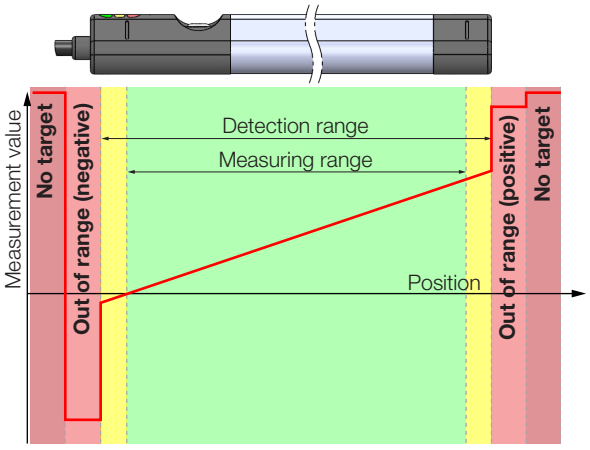
Status and SSC

Bit	Name	Function
7	System Error	The BMP no longer functions (storage error, hardware defective).
6	Out of Range / No Measure-ment Data	The BMP does not detect a target in the detection range.
5	Out of Measurement Range	The target is located outside of the configured measuring range.
4	Measurement Value Unsafe	The target is located within the set measuring range, however the excess gain is low.
3	SSC 4	Switch information for the fourth switch point
2	SSC 3	Switch information for the third switch point
1	SSC 2	Switch information for the second switch point
0	SSC 1	Switch information for the first switch point. SSC 1 is placed on output OUT 1 in SIO mode.

Tab. 7-3: Status and SSCs

In the case of an error, the data is only marked as invalid using the *PD Invalid Bit* if the device absolutely cannot supply valid data.

> The IO-Link functionality *PD Invalid Bit* is handled differently by different IO-Link masters (refer to the manual for the respective master).



Status bits[1]							
Bit 4	0	0	0	0/1[2]	0	0	0
Bit 5	0	0	1	0	1	0	0
Bit 6	1	1	0	0	0	1	1

[1] See Tab. 7-3

[2] If this bit is set, the excess gain is low. The target is magnetized too weakly or it is too far away from the BMP.

Fig. 7-1: Ranges and output

If the target is located below or above the detection range and is still detected by the BMP, the measured value is replaced by the following values:

– Out of range positive: **2'147'483'640 (0x7FFFFFF8)**
– Out of range negative: **–2'147'483'640 (0x80000008)**

In the event of an error (if no valid data can be output), the measured value is replaced by error value **2'147'483'644 (0x7FFFFFFC)**.

7 IO-Link interface (continued)

7.3 Identification data

Index	Subindex	Parameter	Size	Access	Data storage
0×0010 (16)	0	Vendor Name	7 bytes	Read Only	
0×0011 (17)	0	Vendor Text	15 bytes	Read Only	
0×0012 (18)	0	Product Name	Max. 40 bytes	Read Only	
0×0013 (19)	0	Product ID	12 bytes	Read Only	
0×0014 (20)	0	Product Text	27 bytes	Read Only	
0×0015 (21)	0	Serial Number	Max. 18 bytes	Read Only	
0×0016 (22)	0	Hardware Revision	2 bytes	Read Only	
0×0017 (23)	0	Firmware Revision	9 byte	Read Only	
0×0018 (24)	0	Application Specific Tag	Max. 32 bytes	Read/Write	X
0×0019 (25)	0	Function Tag	Max. 32 bytes	Read/Write	X
0×001A (26)	0	Location Tag	Max. 32 bytes	Read/Write	X

Tab. 7-4: Identification data

Application Specific Tag, Function Tag and Location Tag

The *Application Specific Tag, Function Tag* and *Location Tag* tags offer the ability to assign any max . 32-byte string to the IO-Link device. This can only be used for application-specific identification and applied in the parameter manager. The entire object is accessed via subindex 0.

7 IO-Link interface (continued)

7.4 System commands

Different commands are implemented in the BMP that can be reached via parameter *System Command* on *index 2, subindex 0*. Once a system command is transmitted to the BMP, the command triggers the desired action, provided that this action is permitted in the current application state.

Command	Name	Description
0x01 (1)	ParamUploadStart	Starts parameter upload.
0x02 (2)	ParamUploadEnd	Ends parameter upload.
0x03 (3)	ParamDownloadStart	Starts parameter download.
0x04 (4)	ParamDownloadEnd	Ends parameter download.
0x05 (5)	ParamDownloadStore	Completes the configuration and starts the data storage.
0x41 (65)	SP1 Single Value Teach	Saves the currently measured position as *Setpoint 1*.
0x42 (66)	SP2 Single Value Teach	Saves the currently measured position as *Setpoint 2*.
0x4E (78)	Teach Reset	Deletes the SP1 and SP2 values of all SSCs.
0x80 (128)	Device Reset	Re-initializes all device components.
0x82 (130)	Restore Factory Settings	Resets all configurations to the factory setting.
0xA5 (165)	Reset Maintenance	Resets all operating parameters.
0xE0 (224)	Teach Preset	Calculates and saves the PDV offset, sets the current output value to the preset value.
0xE1 (225)	Teach Measurement Range Lower Limit	Teaches in the current position as a lower limit value of the measuring range.
0xE2 (226)	Teach Measurement Range Upper Limit	Teaches in the current position as an upper limit value of the measuring range.

Tab. 7-5: System commands of index 2, subindex 0

7 IO-Link interface (continued)

7.5 Parameter data

Index	Subindex	Parameter	Size	Access	Data storage
MDC (measurement data channel) (see section 7.5.1)					
0x00C1 (193)	0	Offset	4 bytes	Read/Write	X
0x00C2 (194)	0	Preset	4 bytes	Read/Write	X
0x00C3 (195)	0	Output Characteristics	1 byte	Read/Write	X
0x00C4 (196)	0	Enable Detection Range	1 byte	Read/Write	X
0x4080 (16512)	0, 1, 2, 3, 4	MDC Describer	11 bytes	Read Only	
0x0202 (514)	0, 1, 2	Physical Measurement Limits	8 byte	Read/Write	X
SSC (switching signal channels) (see section 7.5.2)					
0x003A (58)	0	Teach-In Select	1 byte	Read/Write	
0x003B (59)	0	Teach-In Result	1 byte	Read Only	
0x003C (60)	0, 1, 2	SSC1 Parameter	8 byte	Read/Write	X
0x003D (61)	0, 1, 2, 3	SSC1 Configurartion	4 bytes	Read/Write	X
0x003E (62)	0, 1, 2	SSC2 Parameter	8 byte	Read/Write	X
0x003F (63)	0, 1, 2, 3	SSC2 Configurartion	4 bytes	Read/Write	X
0x4000 (16384)	0, 1, 2	SSC3 Parameter	8 byte	Read/Write	X
0x4001 (16385)	0, 1, 2, 3	SSC3 Configurartion	4 bytes	Read/Write	X
0x4002 (16386)	0, 1, 2	SSC4 Parameter	8 byte	Read/Write	X
0x4003 (16387)	0, 1, 2, 3	SSC4 Configurartion	4 bytes	Read/Write	X
Device Configuration					
0x00B4 (180)	0, 1, 2	Output Type (see section 7.5.3)	2 bytes	Read/Write	X
0x00F8 (248)	0, 1, 2	Diagnosis Suppression Configuration (see section 7.5.4)	2 bytes	Read/Write	X
Condition Monitoring					
0x0052 (82)	0, 1, 2, 3, 4, 5	Device Temperature (see section 7.5.5)	10 bytes	Read Only	
0x0053 (83)	0, 1, 2	Temperature Thresholds (see section 7.5.6)	4 bytes	Read/Write	X
0x0057 (87)	0, 1, 2, 3	Operating Hours (see section 7.5.7)	12 bytes	Read Only	
0x0058 (88)	0	Boot Cycle counter (see section 7.5.8)	4 bytes	Read Only	
System Parameters					
0x0003 (3)	0, 1, 2, 3, 4, 5	Data Storage (see section 7.5.9)	72 bytes	Read/Write	
0x000C (12)	0	Device Access Locks (see section 7.5.10)	2 bytes	Read/Write	X
0x000D (13)	0, 1, 2, 3, 4	ProfileCharacteristic (see section 7.5.11)	8 bytes	Read Only	
0x000E (14)	0, 1, 2, 3	PD Input Descriptor (see section 7.5.12)	9 byte	Read Only	

Tab. 7-6: Parameter data of IO-Link interface

7 IO-Link interface (continued)

7.5.1 Measurement value configuration (MDC)

The BMP uses the measurement value to transmit the measured position to the IO-Link master. The measurement value can be adjusted to the respective application using the following parameters.

> **i** A change to the measurement value configuration influences the switching behavior. The switching signal configuration (see sec. 7.5.2) also has to be set again.

Parameter	Subindex	Name	Size	Access	Values
Offset 0x00C1 (193)	0	–	4 bytes	Read/Write	–600000 to +600000 µm (default: 0 µm)
Preset 0x00C2 (194)	0	–	4 bytes	Read/Write	–300000 to +300000 µm (default: 0 µm)
Output Charakteristics 0x00C3 (195)	0	–	1 byte	Read/Write	0x00 (false) = Falling (zero point at end cap) 0xFF (true)[1] = Rising (zero point on cable side)
Enable Detection Range 0x00C4 (196)	0	–	1 byte	Read/Write	0 = Detection range deactivated 0xFF (255) = Detection range activated (default: 0xFF)
MDC Describer 0x4080 (16512)	1	Lower Limit	4 bytes	Read Only	The minimum value of the measurement value for the current configuration.[1]
	2	Upper Limit	4 bytes	Read Only	The maximum value of the measurement value for the current configuration.[1]
	3	Unit Code	2 bytes	Read Only	0x1010 (4112) = Meter
	4	Scale	1 byte	Read Only	0xFA (–6) = Measurement value × 10^{-6} = Position [m]
Physical Measurement Limits 0x0202 (514)	1	Lower Limit	4 bytes	Read/Write	Limits of the raw measurement values[2]
	2	Upper Limit	4 bytes	Read/Write	

[1] Minimum and maximum values for the configured measuring range. The measurement value can exceed these limits based on the detection range

[2] These values are required for data storage to function and should not be changed. The measuring range can be adjusted using the *Range Teach* commands.

Tab. 7-7: MDC parameter data

> **i** The parameters can influence each other. Therefore, it is recommended to configure the settings in the following order: Range Teach, Output Characteristics, Offset/Preset Teach

Range Teach
The measuring range of the BMP can be limited by *Range Teach*. System commands *Teach Range Minimum* and *Teach Range Maximum* are available for this function. In the newly configured measuring range, the limits of the output value can be taken from parameter *MDC Describer*.

Output Characteristics
Using parameter *Output Characteristics*, the signal directions of the data value can be rotated. For this purpose, the signal is mirrored within the configured measuring range.

Setting the Offset
An offset can be applied to the output value. To do so, the desired value can be written in parameter *Offset*. The BMP adds this value to the value of the measured position and outputs it.

Preset Teach
The Preset Teach function enables the automatic calculation of the offset value.

1. Write the desired output value in parameter *Preset*.
2. Move the target to the desired position.
3. Execute system command *Teach Preset*.
4. The BMP calculates the offset in order that the preset value is output at the position being approached.

Detection Range
Furthermore, when leaving the configured measuring range, the BMP outputs a position value until the limits of the detection range are exceeded.
If this behavior is not required in the application, it can be switched off using parameter *Enable Detection Range*.

7 IO-Link interface (continued)

7.5.2 Switching signal configuration (SSC)

> Before starting the switching signal configuration, the measurement value configuration (see sec. 7.5.1) must be completed!

The BMP has 4 integrated switching signals. Each switching signal is described by two parameters (*Parameter* and *Configuration*). The BMP has implemented the switching signals in accordance with the smart sensor profile as Window mode.

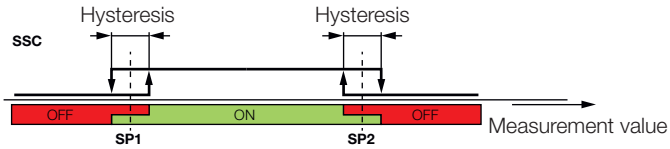


Fig. 7-2: SSC hysteresis

Parameter	Subindex	Name	Size	Access	Values
SSC Parameter SSC1: 0x003C (60) SSC2: 0x003E (62) SSC3: 0x4000 (16384) SSC4: 0x4002 (16386)	1	Setpoint 1 (SP1)	4 bytes	Read/Write	32-bit integer value [µm]
	2	Setpoint 2 (SP2)	4 bytes	Read/Write	32-bit integer value [µm]
SSC Configuration SSC1: 0x003D (61) SSC2: 0x003F (63) SSC3: 0x4001 (16385) SSC4: 0x4003 (16387)	1	Logic	1 byte	Read/Write	0 = Normally open (NO, default) 1 = Normally closed (NC)
	2	Mode	1 byte	Read/Write	0 = Deactivated 2 = Window mode (default)
	3	Hysteresis	2 bytes	Read/Write	100 to 30000 µm (default: 100 µm)

Tab. 7-8: SSC parameter data

> – As the factory default, SSC 1 has an *In-Range* switch point (see section 6.3 on page 15)
> – SSC 1 is placed on output Out 1 in SIO mode.

> The distance between SP1 and SP2 must be at least 2x the hysteresis in order for the switch-point to function.

The BMP supports the *Single-Teach* functions in accordance with the smart sensor profile. Two additional parameters are used for this teach-in process (TI Select and TI Result; see Tab. 7-9).

Index	Subindex	Size	Access	Values
TI Select 0x003A (58)	0	1 byte	Read/Write	0 or 1 = SSC1 (default) 2 = SSC2 3 = SSC3 4 = SSC4
TI Result 0x003B (59)	0	1 byte	Read Only	0x00 (0) = inactive 0x11 (17) = Teach In of SP1 successful 0x42 (66) = Teach In of SP2 successful 0x07 (7) = Error

Tab. 7-9: Teach In parameter data

7 IO-Link interface (continued)

Teach In operation

1. Using TI Select, select the desired switching signal (1 to 4)
2. Move the target to the switch-on position.
3. Execute system command *Single Value Teach SP1* (0x41) (see *System commands* on page 20).
4. Move the target to the switch-off position.
5. Execute system command *Single Value Teach SP2* (0x42) (see *System commands* on page 20).

The steps can be checked using parameter *Teach-In Result*.

7.5.3 Output configuration

Both outputs of the BMP can be configured.

Index	Subindex	Name	Size	Access	Values
Output Type 0x00B4 (180)	1	Out 1	1 byte	Read/Write	0 = Deactivated 1 = PNP (default) 2 = NPN 3 = Push-Pull
	2	Out 2	1 byte	Read/Write	0 = Deactivated 5 = Current 4 to 20 mA 6 = Voltage 0 to 10 V (default)

Tab. 7-10: Configuration of the outputs

7.5.4 Diagnostic suppression

If diagnostic functions are causing problems in the application, these functions can be suppressed.
For diagnostics events implemented in BMP, see *Event list* on page *27*.

Index	Subindex	Name	Size	Access	Values
Diagnosis Suppression Configuration 0x00F8 (248)	1	Suppression Level	1 byte	Read/Write	0 = All events active (default) 1 = Messages suppressed 2 = Messages and warnings suppressed 3 = All events suppressed
	2	PD Invalid Suppression	1 byte	Read/Write	0x00 (0) = PD Invalid active 0xFF (255) = PD Invalid suppressed

Tab. 7-11: Diagnostic suppression

7 IO-Link interface (continued)

7.5.5 Temperature detection

The following temperature values are output by the BMP as signed 16-bit values with the unit °C (Index 0x0052 (82)):

– Current temperature (subindex 1)
– Minimum temperature since starting operation (subindex 2)
– Maximum temperature since starting operation (subindex 3)
– Minimum temperature over the entire lifetime (subindex 4)
– Maximum temperature over the entire lifetime (subindex 5)

> The temperature sensor detects the temperature within the BMP. This is always higher than the ambient temperature.

7.5.6 Threshold values for the temperature warning

The BMP offers the ability to define the following temperature warning threshold (index 0x0053 (83)):

– Threshold for not meeting temperature (subindex 1)
– Threshold for exceeding temperature (subindex 2)

The threshold can be set in the range from –25…+85 °C.

If these threshold values are exceeded or not met, the BMP outputs a warning (see *Event list* on page *27*).

> If the internal temperature of the BMP exceeds 95 °C, error *Excess temperature* is output.

7.5.7 Operating hours counter

The operating hours are recorded within the BMP and saved permanently in hour intervals (index 0x0057 (87)).

– Operating hours over the entire service life (subindex 1)
– Operating hours since the last maintenance (subindex 2)
– Operating hours since the last activation (subindex 3)

Using system command *Reset Maintenance*, the operating hours sensor for maintenance are reset to zero.

7.5.8 Boot cycle counter

In case of any re-initialization, the BMP increases the permanently saved boot cylinder counter. Both system command *Device Reset* as well as a hardware restart lead to an increase of the counter.

Using index 0x0058 (88), subindex 0, the value can be read out.

Using system command *Reset Maintenance*, the boot cylinder counter for maintenance is reset to zero.

7 IO-Link interface (continued)

7.5.9 Data storage

Index	Subindex	Name	Size	Access	Values
Data Storage 0x0003 (3)	1	Command	1 byte	Read/Write	The *Data Storage* parameter is required by the IO-Link master for the data management function. This parameter does not offer the user a setup option.
	2	State Property	1 byte	Read Only	
	3	Size	4 bytes	Read Only	
	4	Parameter Checksum	4 bytes	Read Only	
	5	Index List	62 bytes	Read Only	

Tab. 7-12: Data storage parameter

7.5.10 Access locks (Device Access Locks)

Using this standard parameter, it is possible to activate or deactivate certain functions of the IO-Link device.
In BMP 01-…, there is the option to lock the function of the parameter manager and the button. To do so, the respective bit of the 2-byte value must be set to 1 (locked). In order to unlock the function again, the bit is set to 0.

Bit 0	Lock parameter access (not supported)
Bit 1	Lock parameter management (supported)
Bit 2	Locking the button (supported)
Bit 3	Lock local user interface (not supported)
Bit 4…15	Reserved

Tab. 7-13: Locking parameter data

7.5.11 Profiles and functions (ProfileCharacteristic)

This parameter indicates which profile of the IO-Link device is supported.

- Subindex 1 (DeviceProfileID):
  0×000B (measuring sensor, high resolution according to smart sensor profile edition 2)
- Subindex 2 (DeviceProfileID):
  0×4000 (identification and diagnosis according to common profile)
- Subindex 3 (FunctionClassID):
  0×8001 (SSC function class)
- Subindex 4 (FunctionClassID):
  0×8004 (teach channel)

7.5.12 Process data structure (PD Input Descriptor)

This parameter describes the composition of the process data used.
Every part of the process data is described by 3 bytes.

Subindex	Values	Description
1	0x01 0x08 0x00	Set of Boolean 8-bit length 0-bit offset
2	0x03 0x08 0x08	Signed integer 8-bit length 8-bit offset
3	0x03 0x20 0x10	Signed integer 32-bit length 16-bit offset

Tab. 7-14: Process data structure

Using subindex 0, the complete process data description can be read out (see section *Process data (PD)* on page 18).

7 IO-Link interface (continued)

7.6 Diagnostic data

The BMP reports diagnostic data (events) to the controlling system (see Tab. 7-15), or the controlling system can read out the status using the diagnostic parameters.

7.6.1 Diagnostic parameters

Index	Subindex	Parameter	Size	Access	Values
0x0024 (36)	0	Device Status	1 Byte	Read Only	0 = Normal state 2 = Warning 4 = Error
0x0025 (37)	0	Detailed Device Status	9 Byte	Read Only	Up to 3 active events: 1st byte event type (0 = No event, 0xE4 = Warning, 0xF4 = Error) 2nd and 3rd byte event code (see Sec. 7.6.2)
0x0028 (40)	0	Process Data Input	6 Byte	Read Only	Most recent valid process data (see Sec. 7.2)

Tab. 7-15: Diagnostic parameters

7.6.2 Event list

Event code	Expression	Meaning
0x8D00	Notification	LIMITED ACCURACY PLUS – The target is located in the detection range, but outside of the configured measuring range.
0x8D01	Notification	LIMITED ACCURACY MINUS – The target is located in the detection range, but outside of the configured measuring range.
0x8D02	Warning	OUT OF RANGE PLUS – The target is located outside of the detection range. No valid data is output. The transmitted process data value is 0×7FFFFFF8 or 2'147'483'640.
0x8D03	Warning	OUT OF RANGE MINUS – The target is located outside of the detection range. No valid data is output. The transmitted process data value is 0x80000008 or –2'147'483'640.
0x8D04	Error	NO MEASUREMENT DATA – No target detected. No valid data is output. The transferred process data value is 0×7FFFFFFC or 2147483644.
0x8D06	Warning	MEASUREMENT DATA UNSAFE – The excess gain of the measurement is low. The application must be reviewed.
0x4210	Warning	DEVICE TEMPERATURE OVERRUN (see section 7.5.6) – The configured upper temperature threshold is exceeded.
0x4220	Warning	DEVICE TEMPERATURE UNDERRUN (see section 7.5.6) – The configured lower temperature threshold is not met.
0x4000	Error	TEMPERATURE OVER RUN ERROR – The temperature has exceeded the specified maximum temperature. The heat source must be removed.
0x5000	Error	HARDWARE FAULT – There is a problem with the device hardware. Restart the BMP by interrupting the supply. If the event occurs again, the BMP must be replaced.
0x8D07	Error	OPEN CIRCUIT AT CURRENT OUTPUT – The analog current output is open, check the installation.

Tab. 7-16: Event list

7 IO-Link interface (continued)

7.7 Device error messages

If access is faulty, the device responds with one of the listed error codes.

Error code	Error message
0×8011	Index not available
0×8012	Subindex not available
0x8023	Access denied
0×8030	Value out of range
0×8033	Parameter length overrun
0×8034	Parameter length underrun
0×8036	Function temporarily unavailable
0x8040	Invalid parameter set
0x8082	Application not ready

Tab. 7-17: Error messages of IO-Link specification

8 Technical data

8.1 Detection range/measuring range

Measuring range	32, 64, 96, 128, 160, 192, 224, 256 mm
Resolution	
IO-Link	1 µm
Analog	12 Bit
Linearity deviation[1)]	±250 µm
Repeat accuracy[1)]	±100 µm
Temperature drift (max. from end value)	± 0.3 %
Sampling rate	≤ 1000 Hz

[1)] Applies to the measuring range

8.2 Ambient conditions

Ambient temperature	–25 °C…+85 °C
Storage temperature	–25 °C…+85 °C
Contamination scale	3
Shock rating per EN 60068-2-27	Half-sinus, 30 g, 11 ms
Vibration per EN 60068-2-6	55 Hz, 1-mm amplitude, 3 × 30 min
Degree of protection as per IEC 60529	IP67

8.3 Supply voltage (external)

Operating voltage U_B	15…30 V DC
No-load current $I_{o\,max.}$ at U_e	25 mA
Rated insulation voltage U_i	75 V DC
Rated operating voltage U_e DC	24 V
Readiness delay t_v	≤ 100 ms
Residual ripple (% of U_e)	≤ 10%
Load resistance R_L (Analog I)	≤ 500 Ohm
Output current (Analog U)	≤ 5 mA
Load capacity of switching output	≤ 100 mA

8.4 Electrical connection

Bending radius, fixed routing	≥ 3 × cable diameter
Cable diameter	2.4 mm
Cable length	See *Type code* on page 31
Wire cross-section	0.07 mm²
Connection	
…P_ _-S75	M8×1 connector, 4-pin
…P_ _-S4	M12×1 connector, 4-pin
…P_ _	open cable end
Connection type	Cable with/without connector
Number of conductors	4
Reverse polarity protection	Yes
Short-circuit resistance	Yes
Cable jacket material	PUR

8.5 Output / interface

Analog output	Analog, voltage (0…10 V) / current (4…20 mA) switchable
Interface	IO-Link 1.1
SIO mode	Yes

8.6 Displays

Function indicator	Green LED
Power indicator	Yellow LED
Error display	Red LED

8.7 Mechanical data

Dimensions	42, 74, 106, 138, 170, 202, 234, 266 × 17.5 × 9.6 mm
Tightening torque	0.1 Nm
Housing material	PA12, aluminum

9 Accessories

Accessories are not included in the scope of delivery and must be ordered separately.

9.1 Mounting Set for T-Slot (BAM MC-MP-056-01-2-T5)

Order code: **BAM0383**
- 2 T-slot nuts
- 2 screws

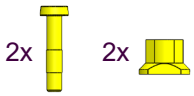


Fig. 9-1: T-Slot mounting set

9.2 Mounting set for C-Slot (BAM MC-MP-056-01-2-C3)

Order code: **BAM0382**
- 2 C-slot nuts
- 2 screws

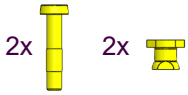


Fig. 9-2: C-Slot mounting set

9.3 Mounting screws (BAM MC-AM-055-056-2)

Order code: **BAM0381**
10 screws



Fig. 9-3: Mounting screws

9.4 Holders for round cylinders (BAM MC-MP-054-01-R)

Order code: **BAM037Z**
2 holders for round cylinders

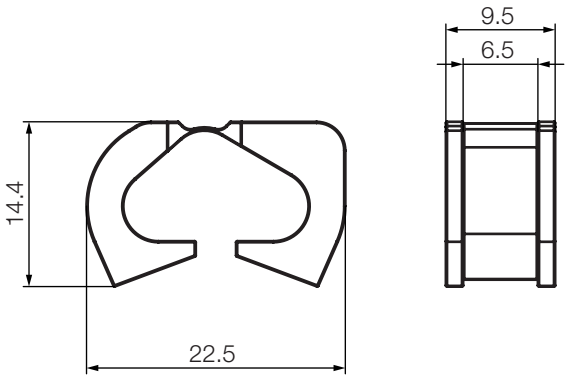


Fig. 9-4: Holder for round cylinder

9.4.1 Hose clamps for attaching the holder

The hose clamp may have a maximum width of 6 mm and must be produced from non-ferromagnetic material.



Fig. 9-5: Hose clamp

Piston diameter	Hose clamp		
	Width	Diameter	Order code
10/20 mm	5 mm	18…29 mm	**BAM00N4**
30 mm	5 mm	28…39 mm	**BAM00N5**
40 mm	5 mm	38…49 mm	**BAM00N6**
50 mm	5 mm	48…59 mm	**BAM00N7**

Tab. 9-1: Hose clamps for corresponding piston diameter

10 Type code

BMP 01-EL1PP21A-0128-00-P00,5-S75

Interface, analog:

E = Voltage output 0 to 10 V (factory setting)
or current output 4 to 20 mA

Interface, IO-Link:

L1 = IO-Link interface, 12 bit

Interface, switching function:

PP = Switching output: PNP, NO/NC programmable

Characteristic curve:

2 = Rising (factory setting), programmable

Switching output:

1 = 1 programmable switching output

Setting:

A = Characteristic and switch points adjustable using Teach In or IO-Link

Measuring range (4-digit):e

0128 = Metric values in mm, measuring range 128 mm
(0032, 0064, 0096, 0128, 0160, 0192, 0224, 0256)

Electrical connection:

P02 = PUR cable, 2 m

P00,5-S4 = PUR cable, 0.5 m with M12 connector, 4-pin

P00,5-S75 = PUR cable, 0.5 m with M8 connector, 4-pin

11 Appendix

11.1 Part label



1) Order code
2) Type
3) Serial number

Fig. 11-1: Part label (example)

No. 939733-726 EN · 02.Vorserie · L18; subject to modification. Replaces I18.