# BTL magnetostrictive linear position sensor with profile housing (BTL PEx400-xxxx-E11Ax010-000Sxx)

BTL PE_400-____-E11A_010-000S92
BTL PE_400-____-E11A_010-000S01



english

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# 1 About this guide

## 1.1 Validity

This guide provides all the information required for the safe use of the BTL magnetostrictive linear position sensor (measurement system) with Analog interface.

It applies to the following models (see *Type code*):

- **BTL PE_400-_ _ _ _ -E11A_ 010-000S92**
- **BTL PE_400-_ _ _ _ -E11A_ 010-000S01**

Read this guide and the other applicable documents completely before installing and operating the product.

### 1.1.1 Original User's guide

This guide was created in English. Other language versions are translations of this guide.

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## 1.2 Other applicable documents

Additional information about this product can be found at www.balluff.com on the product page, e.g. in the following documents:

- Data sheet
- Declaration of Conformity
- Disposal

## 1.3 Symbols and conventions

Individual actions are indicated by a preceding triangle.

► Instruction 1

Action sequences are numbered consecutively:

1. Instruction 1
2. Instruction 2

**Note**

Note, tip
This symbol indicates general notes.

## 1.4 Explanation of the warnings

Always observe the warnings in this guide 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 together with the signal word CAUTION indicates a hazard which can lead to **slight or moderate injuries**.

**⚠ WARNING**

The general warning symbol together with the signal word WARNING indicates a hazard which can lead to **death or 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 serious injury**.

# 2 Safety notes

## 2.1 Intended use

The BTL magnetostrictive linear position sensor, together with a machine controller (e.g. PLC), comprises a position measuring system. It is intended to be installed into a machine or system and used in the industrial sector.

Proper function according to the specifications in the technical data is only assured when the product is used solely as described in the user's guide and the respective documents as well as in compliance with the technical specifications and requirements and only with suitable original Balluff accessories.

Otherwise, there is deemed to be unintended use. Unintended use is not permitted and will result in the loss of warranty and liability claims against the manufacturer.

## 2.2 Reasonably foreseeable misuse

The product is not intended for the following applications and areas and may not be used there:

- In safety-oriented applications in which personal safety depends on the device function
- In explosive atmospheres
- In food applications

## 2.3 General safety notes

Activities such as **installation, connection** and **commissioning** may only be carried out by qualified personnel.

**Qualified personnel** are persons whose technical training, knowledge and experience as well as knowledge of the relevant regulations allow them to assess the work assigned to them, recognize possible hazards and take appropriate safety measures.

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 product will not result in hazards to persons or equipment.

The product must not be opened, modified or changed. If defects and unresolvable faults occur in the product, take it out of service and secure against unauthorized use.

## 2.4 Cybersecurity

The product must be used in a secure environment. The operator or manufacturer of the machine is responsible for ensuring the machine is cybersecure. This also includes a cybersecurity risk analysis. It is important to plan and implement security measures based on this risk analysis. The operator or manufacturer must ensure that all persons working with the device have received cybersecurity training.

**Cybersecure Environment:**

To ensure cybersecurity, you must protect components, networks, and systems from unauthorized access and ensure data integrity.

**Recommended Measures:**

- Take organizational and technical measures for network-capable devices and software.
- Implement an information security management system (ISMS) to manage all information security measures.

**Cybersecurity Resources:**

- BSI Recommendations for ICS Operators
- CISA Best Practices for Industrial Control Systems
- NIST SP 800-82 Guide to Industrial Control Systems (ICS) Security

We recommend using a network secured according to the state of the art. The device are intended for use at **Purdue Level 0 “Field Level / Sensors”**.

**Note on Purdue Level 0:** Purdue Level 0 refers to the lowest level of the Purdue reference architecture for industrial automation systems. This level includes the physical sensors and actuators directly connected to the production environment. Devices at this level are responsible for real-time data acquisition and processing. Access to the devices from outside should only be possible for known and trusted devices and authorized users.

The sensor and its interfaces must be protected against unauthorized physical access by appropriate measures, such as machine access control or physical barriers.

The sensor does not have a digital interface accessible to the user.

# 3 Scope of delivery, transport and storage

## 3.1 Scope of delivery

- Sensor
- Short instructions
- Sufficient number of mounting clamps (only for BTL PE6400-... / BTL PE7400-...)

## 3.2 Transport

► Transport product to location of use in original packaging.

## 3.3 Storage conditions

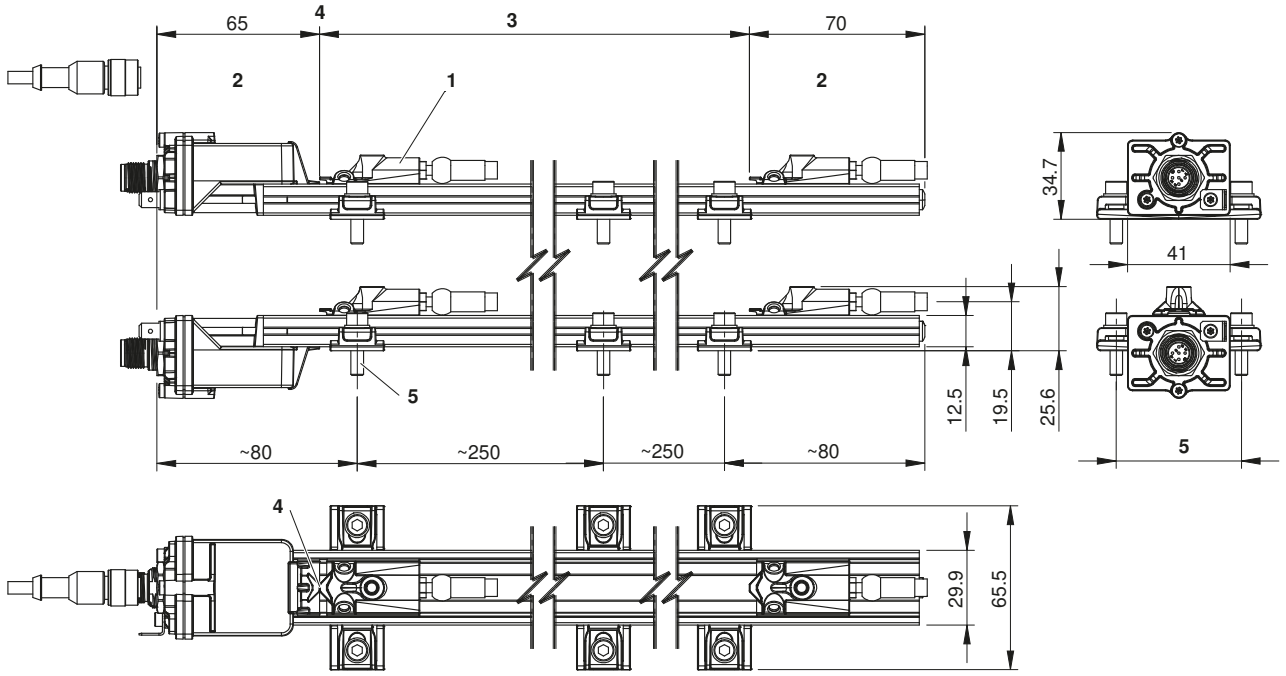
► Store product in original packaging.

► Observe ambient conditions (see *Ambient condition*).

# 4 Product information

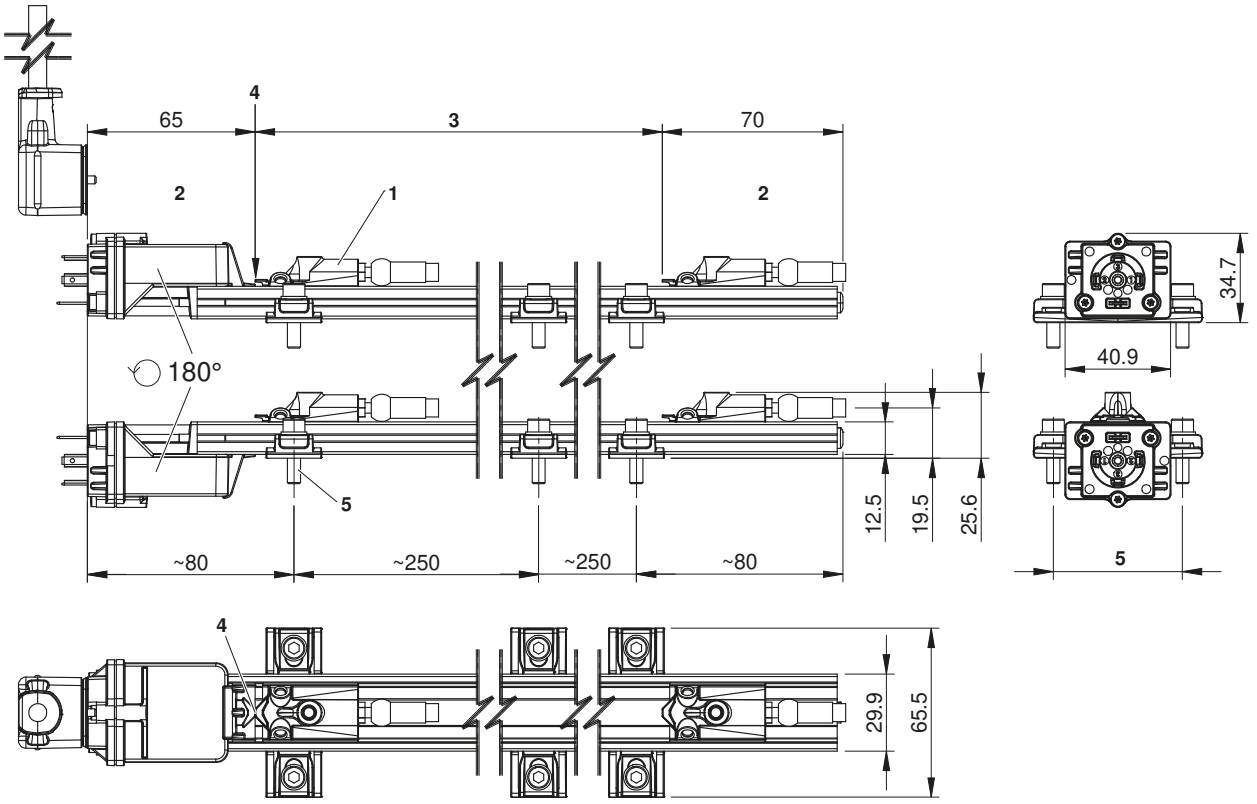
This section provides information about the product features and specifications.

## 4.1 Product description




**1** Position marker
**2** Unusable area
**3** Measuring length
**4** Zero point
**5** BTL PE**6**400… : 50 mm
BTL PE**7**400… : 42.5 mm

Fig. 1: Dimensions, design and function of BTL PE _ 400 _ _ _ _ E11A _ 01 000S92




**1** Position marker
**2** Unusable area
**3** Measuring length
**4** Zero point
**5** BTL PE**6**400… : 50 mm
BTL PE**7**400… : 42.5 mm

Fig. 2: Dimensions, design and function of BTL PE _ 400 _ _ _ _ E11A _ 01 000S01

### 4.1.1 Construction

**Electrical connection:** The electrical connection is made via M12 or DIN plug connection (see *Type code*).

**Housing:** Housing containing the processing electronics.

**Position magnet:** Defines the position to be measured on the waveguide. Magnets are available in various models and must be ordered separately (see *Accessories*).

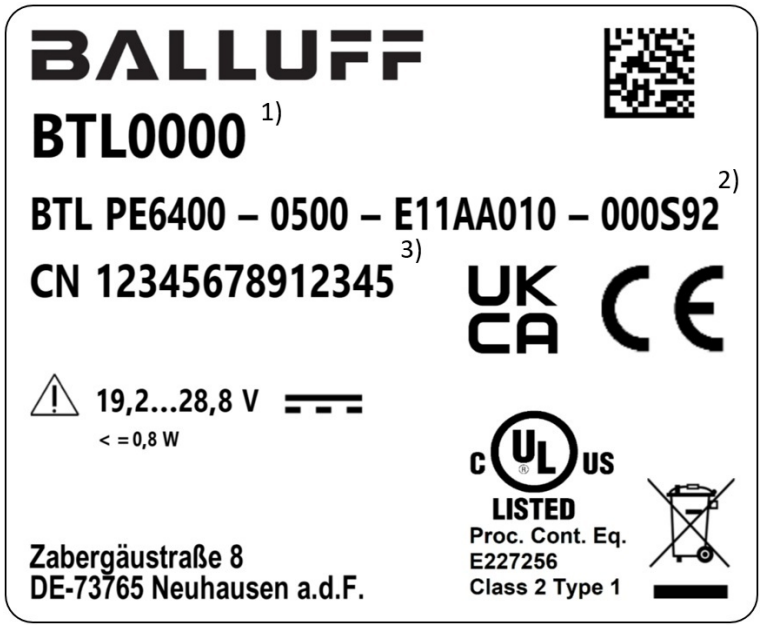
**Measuring length:** Defines the travel/length range available. Sensors with measuring lengths from 25 mm to 1200 mm are available.

### 4.1.2 Function

To determine the position of a plant component, a magnet is connected to the component. Together they are moved along a waveguide located inside the BTL.

An internally generated INIT pulse interacts with the magnetic field of the magnet to generate a torsional wave in the waveguide which propagates at ultrasonic velocity. The component of the torsional wave which arrives at the end of the waveguide is absorbed in the damping zone to prevent reflection. The component of the torsional wave which arrives at the beginning of the waveguide is converted by a coil into an electrical signal. The position of the magnet and thus at the same time that of the plant component is determined from the running time of the shaft.

### 4.1.3 Part label




**1)** Order code
**2)** Type
**3)** Serial number

Fig. 3: Part label (excerpt, example)

### 4.1.4 Type code

| | | | | | |
|---|---|---|---|---|---|
| Example | BTL | PE6400 | 0500 | E11AA010 | 000S92 |
| Definition | BTL | PE**a**400 | ***bbbb*** | E11A***c***010 | 000S***dd*** |

| Code | Parameter | Meaning |
|---|---|---|
| BTL | Sensor type | Magnetostrictive Linear Position Sensor |
| P | Profile Version | |
| E | Profile housing, flat 29,9×12,5 mm | |
| *a* | Installation | 0 = without mounting clamps<br>6 = with mounting clamps (BAM MC-TL-075-PE-1), see *Mounting clamp with M5 mounting screws*<br>7 = with mounting clamps (BAM MC-TL-076-PE-1), see *Mounting clamp with M4 mounting screws* |
| 4 | Mechanical zero point | Zero point at 65 mm |
| *bbbb* | Measuring length | Metric specification in mm; measuring length (0025…1200) |
| A | Interface | A = Analog |
| *c* | Output type | A = Voltage output 0…10 V, rising<br>E = Current output 4…20 mA, rising<br>1 = Voltage output 10…0 V, falling<br>5 = Current output 20…4 mA, falling |
| *dd* | Electrical Connection | 92 = 5-pin, M12 plug<br>01 = 4- Pin, DIN EN 175301-803 Form A |

## 4.2 Technical data

The specifications are typical values at 24 V DC, room temperature and for a measuring length of 500 mm in conjunction with the BAM TG-TL-048, BTL5-P-3800-2, BTL5-P-5500-2, BTL6-A-3800-2 or BTL6-A-3801-2, magnet.

The product is immediately ready for operation, full accuracy is achieved after the warm-up phase.

**Note**

Further data can be found at www.balluff.com on the product page.

### 4.2.1 Ambient condition

**Note**

For UL: Type 1 (UL61010-1), indoor use only. Use in enclosed spaces and up to an altitude of 2000 m above sea level.

| Parameter | Specification |
|---|---|
| Ambient temperature | −20…+75 °C |
| Storage temperature | −20…+85 °C |
| Relative humidity | ≤ 90%, non-condensing |
| Typ. temperature coefficient[1] | ≤ 30 ppm/K |
| Shock rating as per EN 60068-2-27[2],[3] | 100 g/6 ms |
| Continuous shock per EN 60068-2-27[2],[3] | 50 g/2 ms |
| Vibration per EN 60068-2-6[2],[3] | 12 g, 10…2000 Hz |
| **Protection per IEC 60529**[4] | |
| …-S92 | IP67 (when threaded together)[4] |

### 4.2.2 Detection range/Measuring range

| Parameter | Specification |
|---|---|
| Measuring length | 25…1200 mm |
| **Analog position resolution** | |
| E11A**A**/E11A**1** | 336 µV ≥ 16 µm |
| E11A**E**/E11A**5** | 336 nA ≥ 11,5 µm |
| **Repeat accuracy** | |
| with measuring length < 500 mm | ≤ ±20 µm |
| with measuring length > 500 mm | ≤ ±0.002% FS |
| Measuring frequency | 1000 Hz |
| **Linearity deviation**[5] | |
| with measuring length ≤ 500 mm | ±200 µm |
| with measuring length > 500 mm | ±0.04% FS |
| Detectable speed | ≤ 10 m/s |
| Velocity resolution | 0.1 mm/s |

1 Measuring length 500 mm, magnet in the middle of the measuring range
2 Individual specifications as per Balluff standard
3 Resonant frequencies excluded
4 IP protection class not evaluated by UL
5 Configuration for one position magnet

### 4.2.3 Electrical data

| Parameter | Specification |
|---|---|
| Operating voltage Ub[6] | 19,2…28,8 V DC |
| **Typical current draw (at 24 V DC)** | |
| …E11A**A**/E11A**1**… | ≤ 25 mA |
| …E11A**E**/E11A**5**… | ≤ 40 mA |
| **Typical power consumption** | |
| …E11A**A**/E11A**1**… | ≤ 0,55 W |
| …E11A**E**/E11A**5**… | ≤ 0,75 W |
| Maximal power consumption[7] | 1,2 W |
| Overvoltage protection | Ub up to 36 V DC |
| Voltage-proof up to (GND – Housing) | 500 V DC |
| …-E11A**A**/E11A**1**… Output current | ≤5 mA |
| …-E11A**E**/E11A**5**… Load resistance RLC | ≤500 Ohm |

### 4.2.4 Electrical Connection

| Parameter | Specification |
|---|---|
| Short circuit protection | Signal output to GND and to 30 V DC |
| Protected against polarity reversal | Ub up to 30 V DC |

### 4.2.5 Output/ Interface

| Parameter | Specification |
|---|---|
| **Analog, voltage** | |
| …E11A**A**… | 0…10V |
| …E11A**1**… | 10…0V |
| **Analog, current** | |
| …E11A**E**… | 4…20mA |
| …E11A**5**… | 20…4mA |

### 4.2.6 Materials

| Part | Material type |
|---|---|
| Housing | Plastics and Aluminum |
| Cover | Plastics |

6 For UL: The BTL must be externally connected via a limited-energy circuit as defined in UL 61010-1, a lo-power source as defined in UL 60950-1 or a class 2 power supply as defined in UL 1310 or UL 1585.
7 Worst case, assuming 75 °C ambient temperature and active Analog output short circuited in current mode.

### 4.2.7 Mechanical features

| Parameter | Specification |
|---|---|
| Housing height | 34.7 mm |
| Weight (depends on length) | Approx. 1 kg/m |

### 4.2.8 Connector

| Parameter | Specification |
|---|---|
| M12/ S92 | 5 Pins |
| S01 | 4 Pins (DIN EN 175301-803 Form A) |

### 4.2.9 Approvals and markings

| Marking | Meaning |
|---|---|
|  | The BTL Entry Analog position sensors are restricted for use in industrial machinery applications as defined in the Electrical Standard for Industrial Machinery, NFPA 79. |
|  | The CE Mark verifies that our products meet the requirements of the current EU Directive. |

**Note**

Additional information on directives, approvals and standards can be found at www.balluff.com on the product page.

## 4.3 Accessories

Accessories must be ordered separately unless they are listed in the scope of delivery for the selected sensor version.

**Note**

Recommended accessories can be found at www.balluff.com on the product page.

### 4.3.1 Mounting clamps

Mounting clamps can be ordered with the sensor or separately.

#### BAM MC-TL-075-PE-1

**Suitable for**
BTL PE6400 (included with S92/S01, not PE0400; also available separately)

**Mounting screws**
M5

**Maximum tightening torque**
1.5 Nm

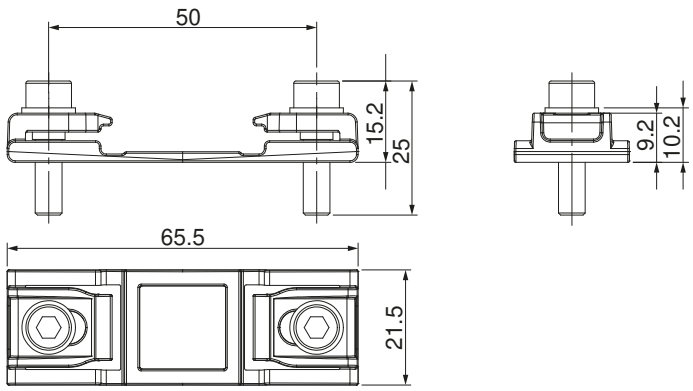



Fig. 4: Mounting clamp with M5 mounting screws

### BAM MC-TL-076-PE-1

**Suitable for**
BTL PE7400 (included with S92/S01, not PE0400; also available separately)

**Mounting screws**
M4

**Maximum tightening torque**
1.1 Nm

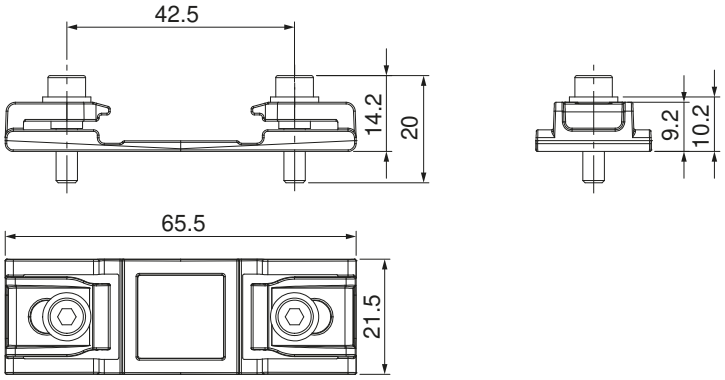



Fig. 5: Mounting clamp with M4 mounting screws

## Number and spacing of mounting clamps

The suggested maximum distance between mounting clamps is 250 mm.

| Measuring length | Minimum number of mounting clamp sets |
|---|---|
| 25…250 mm | 1 |
| 251…750 mm | 2 |
| 751…1200 mm | 3 |

### 4.3.2 Captive magnet

**Note**

Note when installing the magnet:– Avoid lateral forces.– Connect the magnet to the machine member with a joint rod (see Accessories at www.balluff.com).

#### BAM TG-TL-048

Order code BAM04R3

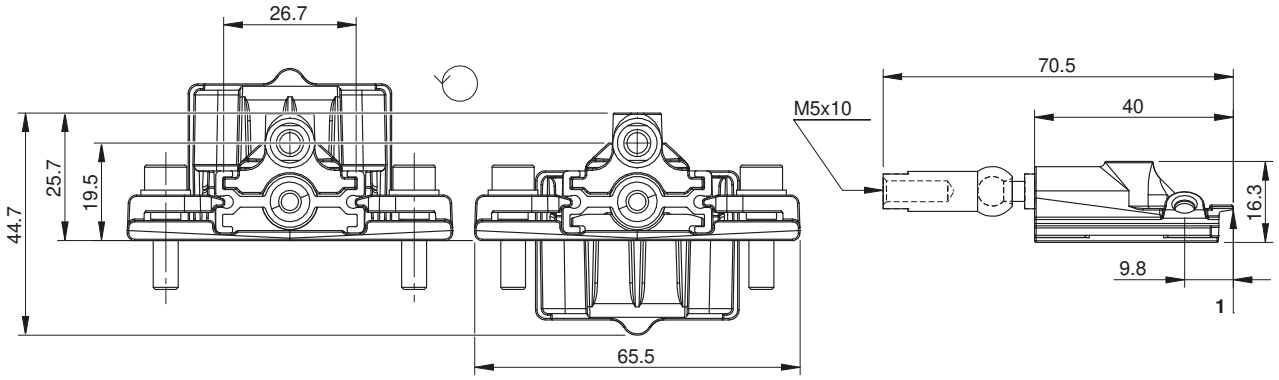



Fig. 6: Dimensions and spacing with magnet BAM TG-TL-048

### 4.3.3 Floating magnet

Observe the following when installing the magnet:

- To ensure the accuracy of the magnetostrictive linear position sensor, fasten the magnet to the moving member of the machine only using non-magnetizable screws (stainless steel, brass, aluminum).
- The moving member must guide the magnet on a parallel line to the BTL.
- Distance A between the magnet and parts made of magnetizable material must be kept to at least 10 mm .
- For distance B between the magnet and the BTL and for the center offset C the following values must be maintained:

| Magnet type | Distance B | Offset C |
|---|---|---|
| BTL5-P-3800-2 | 0.1…4 mm | ±2 mm |
| BTL5-P-5500-2 | 5…15 mm | ±15 mm |
| BTL6-A-3800-2 | 4…8 mm | ±5 mm |
| BTL6-A-3801-2 | 4…8 mm | ±5 mm |

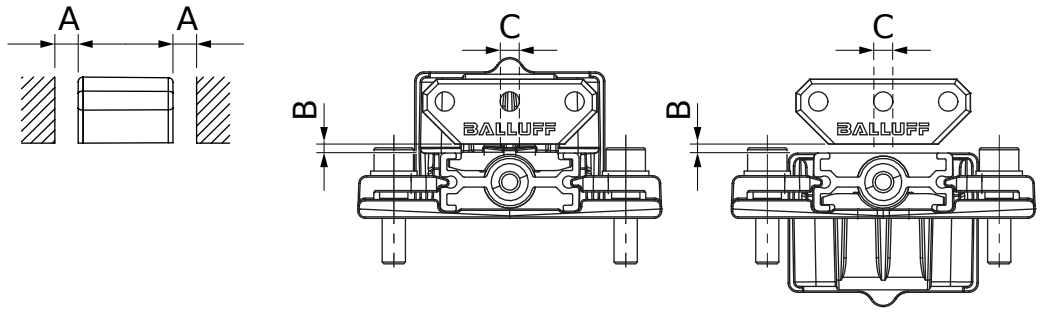



Fig. 7: Dimensions and spacing with magnet BTL5-P-3800-2

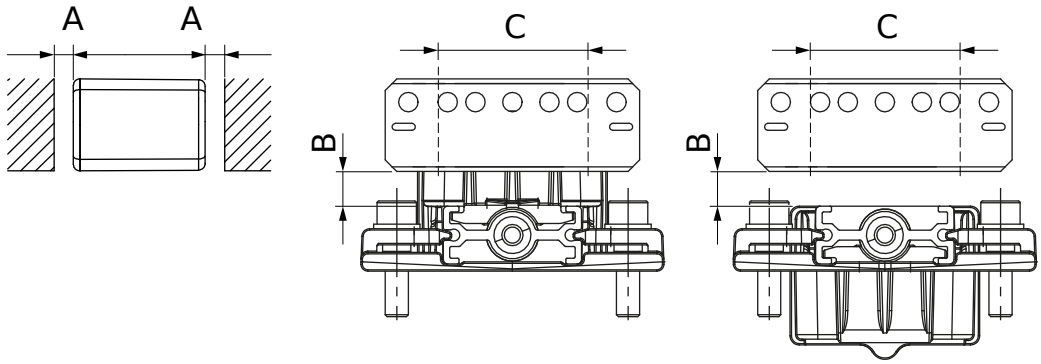



Fig. 8: Dimensions and spacing with magnet BTL5-P-5500-2

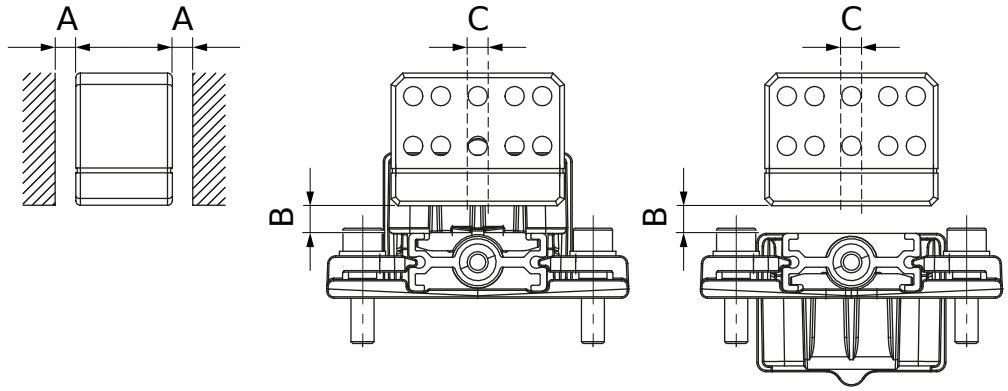



Fig. 9: Dimensions and spacing with magnet BTL6-A-3800-2

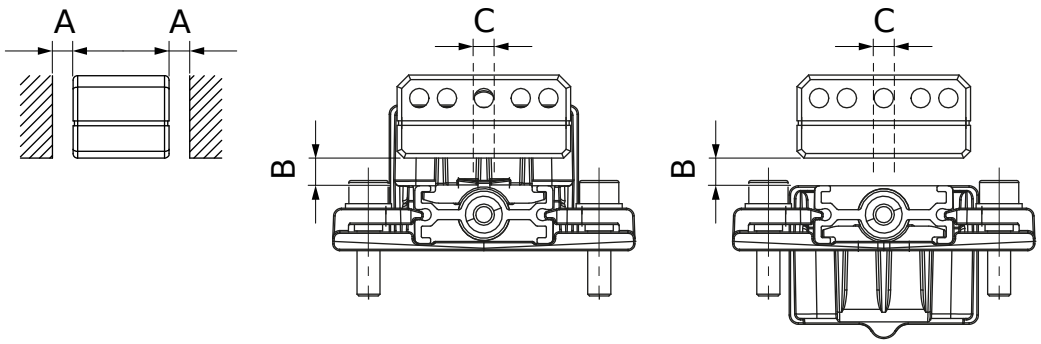



Fig. 10: Dimensions and spacing with magnet BTL6-A-3801-2

# 5 Installation

**NOTICE**

**Improper installation** can compromise the function of the BTL and result in damage.
- Ensure that no strong electrical or magnetic fields are present in the direct vicinity of the BTL.
- Be sure to maintain the specified distances and separations.

**Note**

For dimensions, see *Product description*.

Any orientation is permitted. Mount the BTL on a level surface of the machine using the provided mounting clamps and cylinder-head screws.

Clamp types and the required number of clamps depend on the sensor version and measuring length (see *Mounting clamps*).

Arrange the clamps at irregular intervals to help prevent resonance caused by vibration loads. Observe the recommended maximum distance between clamps (see *Number and spacing of mounting clamps*).

1. Insert the BTL into the mounting clamps.
2. Fasten the BTL to the machine using the mounting screws. Observe the maximum tightening torque for the clamp type (see *Mounting clamps*).
3. Install the magnet (accessory; see *Accessories*).

The profile-housing sensor can be used with both floating (non-contacting) magnets (see {ref}Floatingmagnet) and captive magnets (see {ref}captivemagnet).

```
### Electrical Connection

The electrical connection is made via a plug connection



(for pin assignment see {ref}`tab-s92-connector` or {ref}`tab-s01-connector`) .



```{note}
See the information about Shielding and cable routing {ref}`here <shielding-cable-routing>`.
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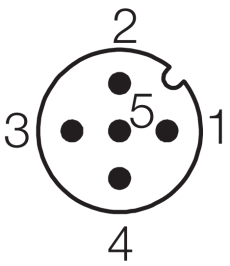



Fig. 1: Pin assignment of S92 (view from above on BTL)
```

Table 1: S92 connector

| Pin | …-E11AA… | …-E11A1… | …-E11AE… | …-E11A5… |
|---|---|---|---|---|
| 1 | 19,2…28,8 V | | | |
| 2 | 0…10 V | 10…0 V | 4…20 mA | 20…4 mA |
| 3 | GND[1] | | | |
| 4 | 0V | | | |
| 5 | Unassigned[2] | | | |

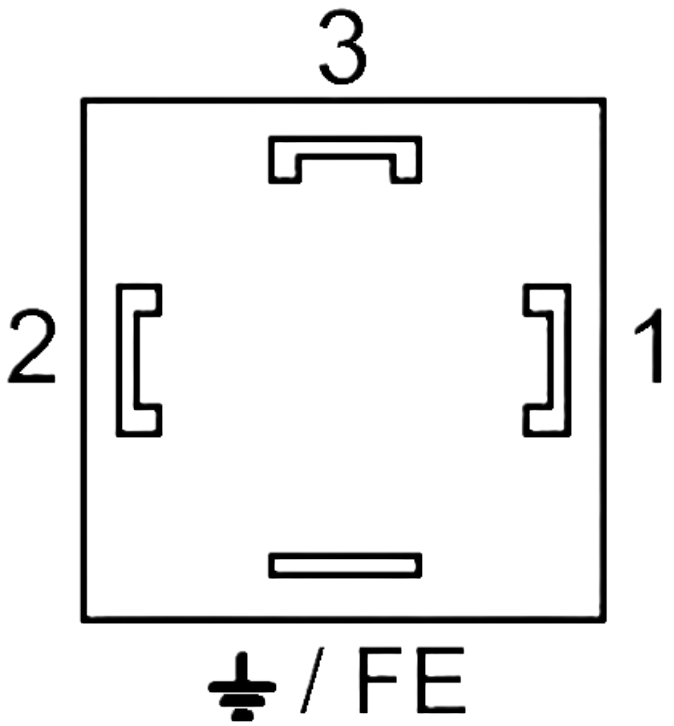



Fig. 2: Pin assignment of S01 (view on BTL connector)

Table 2: S01 connector

| Pin | …-E11AA… | …-E11A1… | …-E11AE… | …-E11A5… |
|---|---|---|---|---|
| 1 | GND / 0 V | | | |
| 2 | 0…10 V | 10…0 V | 4…20 mA | 20…4 mA |
| 3 | 19,2…28,8 V | | | |
| 4 | FE (Functional Earth) | | | |

1 Reference potential for supply voltage and EMC-GND
2 Unassigned leads that are not used can be connected to the GND on the controller side but not to the shield. Proprietary interface, only for configuration by the manufacturer

## 5.1 Shielding and cable routing

**Note**

**Defined ground!**
The BTL and the control cabinet must be at the same ground potential.

### 5.1.1 Shielding

Observe the following instructions to ensure electromagnetic compatibility (EMC):

- A shielded cable between BTL and controller can be used to increase EMC in the application. Shielding: Braided copper shield with minimum 85% coverage.

### 5.1.2 Magnetic fields

The position measuring system is a magnetostrictive system. Ensure that there is sufficient distance between the BTL and the transducer/holding cylinder and strong, external magnetic fields.

### 5.1.3 Cable routing

All cables between BTL, control and power supply must be routed tension-free. To prevent electromagnetic interference, ensure sufficient distance from high-current cables and cables carrying high-frequency voltage signals (e.g. from frequency converters).

**Note**

Only approved cables with a minimum cross-sectional area of AWG 24 may be used. All connected cables must have a temperature resistance of at least 80 °C. Use copper conductor, only.

### 5.1.4 Cable length

The maximum cable length is 30 m.[3]

3 Prerequisite: Construction, shielding and routing preclude the effect of any external noise fields.

# 6 Commissioning

This product is commissioning free. It does not require any commissioning steps to be performed before it can be used.

# 7 Startup and operation

## 7.1 Startup

**DANGER**

**Uncontrolled system movement**
When starting up, if the sensor is part of a closed loop 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 measured values and adjustable parameters and readjust the BTL if necessary. Check the values over the entire measuring range.

**Note**

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

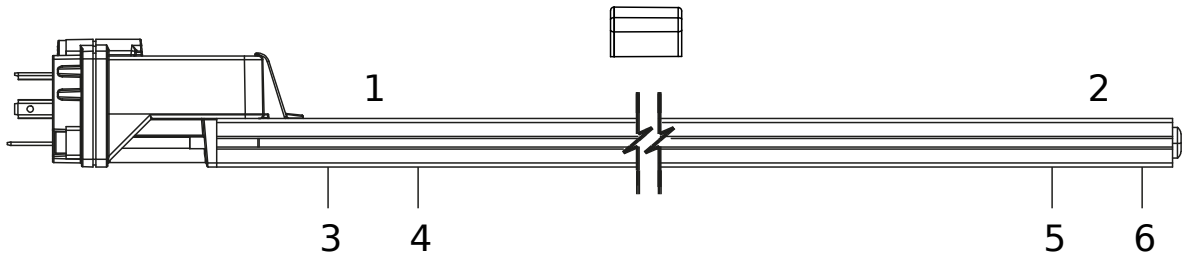
## 7.2 Operating notes

- Regularly check function of the BTL and all associated components.
- Take the BTL out of operation whenever there is a malfunction.
- Secure the system against unauthorized use.
- Check fasteners and retighten if needed.

## 7.3 Maintenance

The product is maintenance-free.

## 7.4 Operation Principle




**1** Null point
**2** End Point
**3** Minimum value
**4** Null value
**5** End value
**6** Maximum value

Fig. 1: Operation schematic (Applies to both, S92 and S01)

| Characteristic curve | BTL | Unit | Minimum value(3) | Null value(4) | End value(5) | Maximum value(6) | Error value |
|---|---|---|---|---|---|---|---|
| Rising | E11A**A** | V | -0.4 | 0 | 10.0 | 10.4 | 10.5 |
| | E11A**E** | mA | 3.6 | 4 | 20 | 20.4 | 1.8 |
| Falling | E11A**1** | V | 10.4 | 10.0 | 0 | -0.4 | 10.5 |
| | E11A**5** | mA | 20.4 | 20 | 4 | 3.6 | 1.8 |

# 8 Decomissioning

## 8.1 Disposal

- Observe the national regulations for disposal.

**Note**

Additional information can be found at www.balluff.com on the product page.

# 9 Support

## 9.1 Repair

Repairs to the product may only be performed by Balluff. If the product is defective, contact our Service Center.

# Headquarters and Technical Service Hubs

www.balluff.com/go/contact

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