BTL magnetostrictive linear position sensor with rod housing (BEC/ZEC x00-xxxx-E11Ax010-000Sxx)

BTL BEC_00-____-E11A_010-000S92
BTL ZEC_00-____-E11A_010-000S92



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 BEC_00-_ _ _ _ -E11A_ 010-000S92**
- **BTL ZEC_00-_ _ _ _ -E11A_ 010-000S92**

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

3.2 Transport

► Transport product to location of use in original packaging.

3.3 Storage conditions

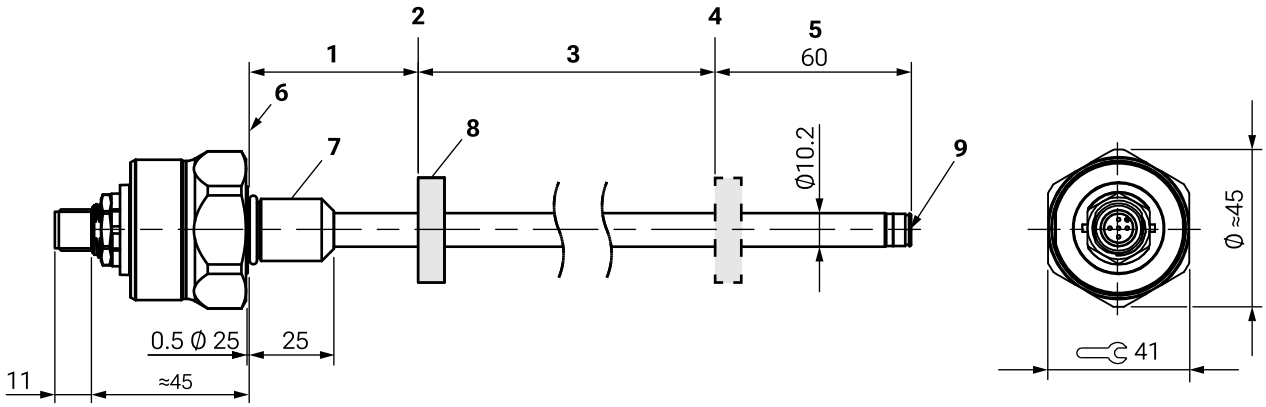
► Store product in original packaging.

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

4 Product information

This section provides information about the product features and specifications.

4.1 Product description



1 Unusable Area:
BTL_EC**A**... 30 -1 mm with thread M4/4.5 deep
BTL_EC**E**... 2“ - 0.04“ with thread M4/4.5 deep
2 Zero point
3 Measuring length
4 End point
5 Unusable area
6 Mounting surface
7 Thread size:
BTL B...:M18x1,5
BTL Z...: 3/4”-16 UNF
8 Magnet[2]
9 Rod end

Fig. 1: Dimensions, design and function

4.1.1 Construction

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

Housing: Housing containing the processing electronics.

Fastening: We recommend assembling the following BTLs on the mounting thread:

- BTL B...: M18×1.5

2 Not included in scope of delivery

- BTL Z...: 3/4"-16UNF

There is an additional thread at the end of the rod to support large measuring lengths.

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

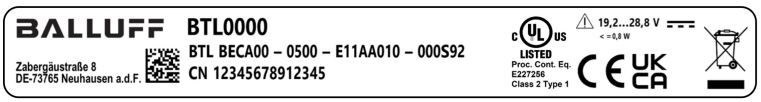
Measuring length: Defines the travel/length range available. Sensors with measuring lengths from 25 mm to 1200 mm are available.

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. 2: Part label (excerpt, example)

4.1.4 Type code

Example	BTL	BECA00	0500	E11AA010	000S92
Definition	BTL	***a***EC**b**00	***cccc***	E11A***d***010	000S92

Code	Parameter	Meaning
BTL	Sensor type	Magnetostrictive Linear Position Sensor
a	Rod version, fastening	B = Rod with metric mounting thread M18x1.5 Z = Rod with inch mounting thread 3/4” - 16UNF
b	Mechanical zero point	A = Zero point at 30 mm; rod end with thread (only for BTL B...) E = Zero point at 50.8 mm; rod end with thread
cccc	Measuring length	Metric specification in mm; measuring length (0025...1200)
A	Interface	A = Analog
d	Output type	A = Voltage output 0...10 V, rising E = Current output 4...20 mA, rising 1 = Voltage output 10...0 V, falling 5 = Current output 20...4 mA, falling
S92	Electrical Connection	5-pin, M12 plug

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 BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R or BTL-P-1014-2R

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	−40…+75 °C
Storage temperature	−40…+85 °C
Relative humidity	≤ 90%, non-condensing
Operating pressure	≤ 350 bar
Short term pressure	530 bar (10 × 1 min)
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 (when threaded together)[4]	IP67

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 Stainless steel
Rod	Stainless steel

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
Rod diameter	10.2 mm
Weight (depends on length)	Approx. 1 kg/m
Rod wall thickness	2 mm
Housing mounting via threads	
BTL **B**...	M18×1.5
BTL **Z**...	3/4"-16UNF

4.2.8 Connector

Parameter	Specification
M12/ S92	5 Pins

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 Magnet

BTL-P-1013-4R

Order code BAM013L

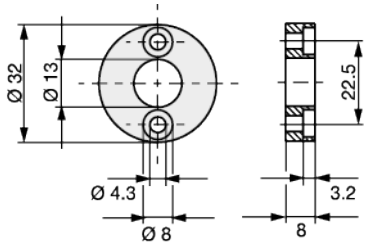


Fig. 3: Installation dimensions of BTL-P-1013-4R magnet

BTL-P-1013-4S

Order code BAM013P

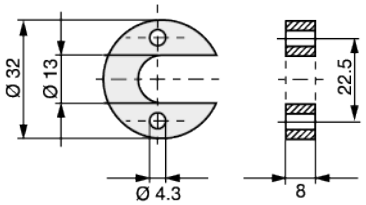


Fig. 4: Installation dimensions of BTL-P-1013-4S magnet

BTL-P-1012-4R

Order code BAM013J

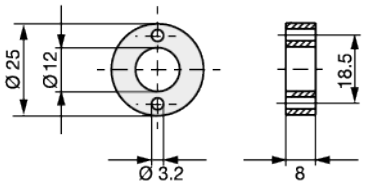


Fig. 5: Installation dimensions of BTL-P-1012-4R magnet

BTL-P-1014-2R

Order code BAM013R

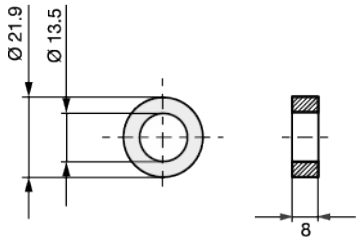


Fig. 6: Installation dimensions of BTL-P-1014-2R magnet

BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R, BTL-P-1014-2R:

Weight
< 15 g

Housing
Aluminum

Included in the scope of delivery for the BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R:

Spacer
8 mm, material: polyoxymethylene (POM)

4.3.2 Mounting nut

BTL-A-FK01-E-M18×1.5

Order code: BAM0118

Mounting nut: M18x1.5

BTL-A-FK01-E-3/4“-16UNF

Order code: BAM0117

Mounting nut: 3/4”-16UNF

5 Installation

5.1 Preparing for installation

Installation information

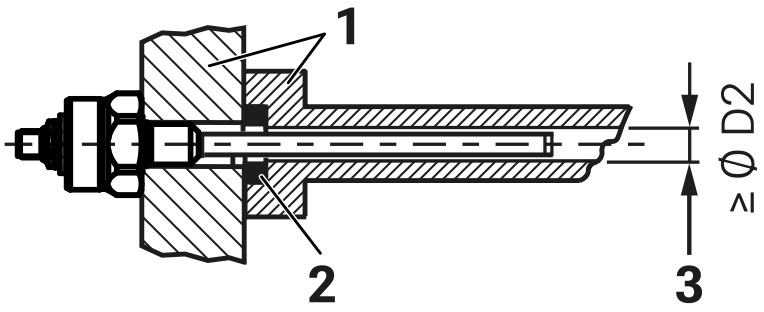
Two mounting options are provided:

- Mounting in a hole with internal thread (mounting hole).
- Mounting in a through-hole (without internal thread) using a mounting nut (see *Accessories*).

Installation guidelines

Installation in non-magnetizable material

We recommend using non-magnetizable material to mount the BTL and magnet.

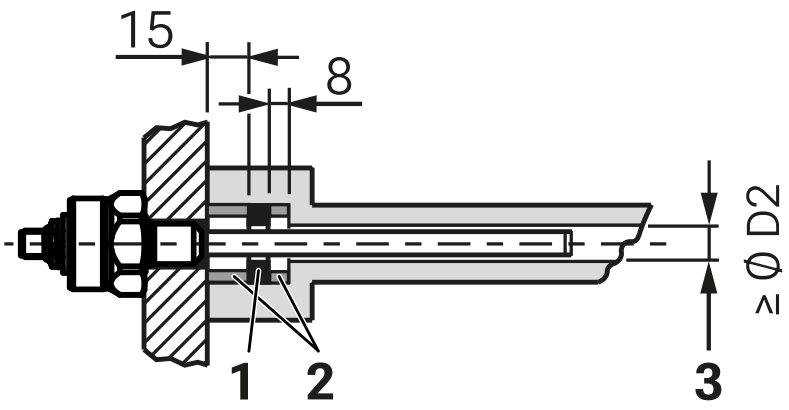


1 Non-magnetizable material
2 Magnet

Fig. 1: min. Ø D2 = Minimum bore diameter (see *Table Bore Diameter*)

Installation in magnetizable material

If using magnetizable material, the BTL must be protected against magnetic interference through suitable measures (e.g. spacer ring made of non-magnetizable material, a suitable distance from strong external magnetic fields).



1 Magnet
2 Spacer ring made of non-magnetizable material

Fig. 2: min. Ø D2 = Minimum bore diameter (see *Table Bore Diameter*)

Installation instructions

Hydraulic cylinder

If installed in a hydraulic cylinder, the magnet should not make contact with the rod. Minimum bore diameter in the support piston:

Rod diameter	Bore diameter D2
10,2 mm	At least 13 mm

Mounting hole

Depending on the version, the BTL comes with an M18×1.5 thread (according to ISO) or a 3/4"-16UNF thread (according to SAE) to secure it. Accordingly, the mounting must be made before assembly.

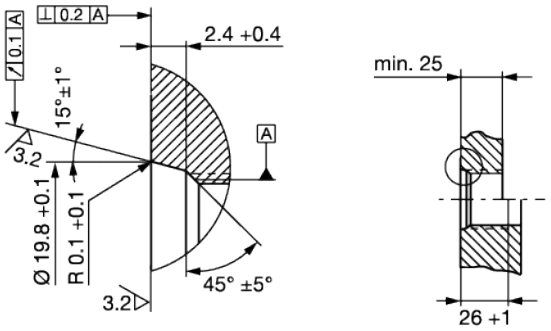


Fig. 3: Mounting hole M18×1.5 according to ISO 6149 O-Ring 15.4×2.1

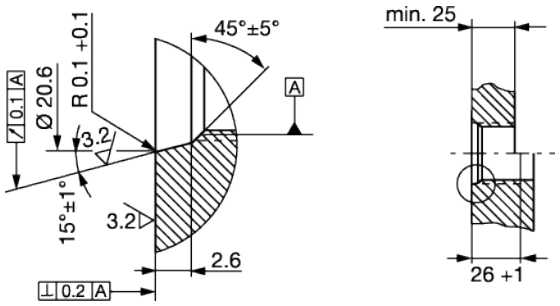


Fig. 4: Mounting hole 3/4”-16UNF according to SAE J475 O-Ring 15.3×2.4

Horizontal mounting

For horizontal mounting with measuring lengths > 500 mm, support the rod and, if necessary, screw it on at the end (with threaded rod end).

Magnet

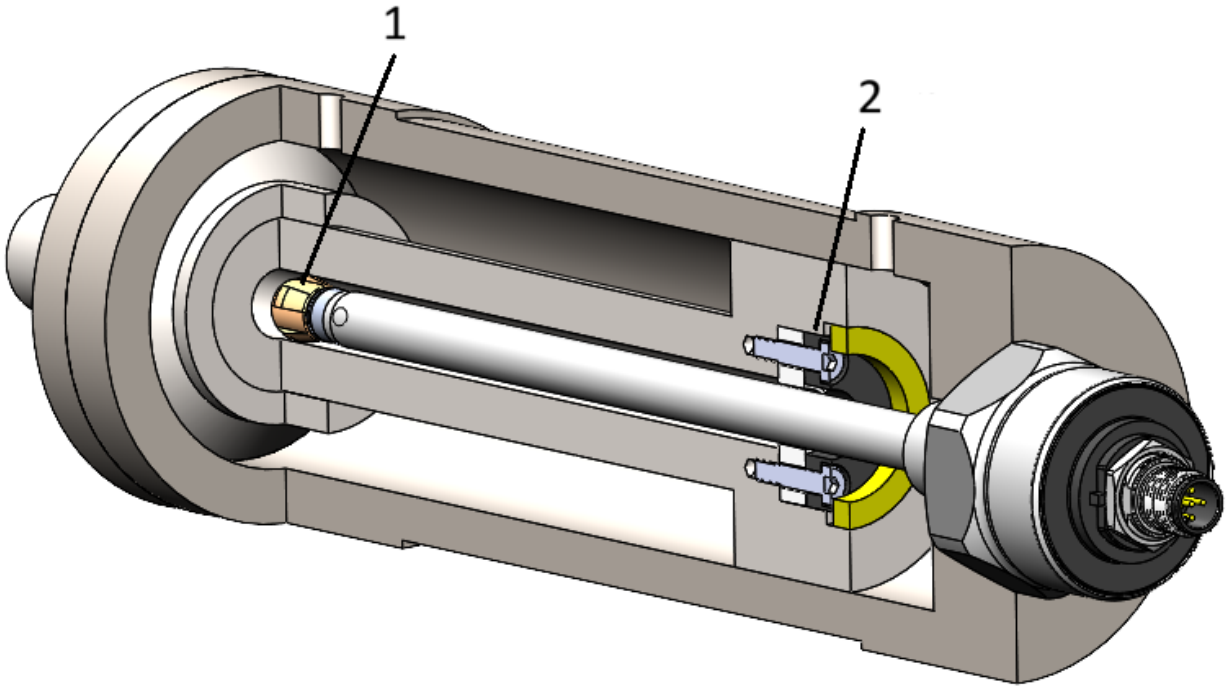
Various magnets are available for the BTL (see *Accessories*).

Installation recommendation for hydraulic cylinders

If installing horizontally in a hydraulic cylinder (measuring lengths > 500 mm), we recommend affixing a slide element to protect the rod end from wear.

> **i Note**
>
> Dimensioning of the detailed solutions is the responsibility of the cylinder manufacturer.

The slide element material must be suitable for the appropriate load case, medium used, and application temperatures. E.g. Torlon, Teflon or bronze are all possible materials.

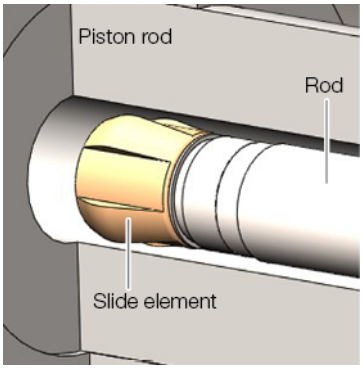


1 Magnet
2 Slide element

Fig. 5: Example 1, BTL is installed with slide element

The slide element can be screwed on or bonded.

- Secure the screws so they cannot be loosened or lost.
- Select a suitable adhesive.



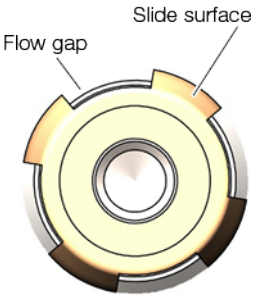


Fig. 6: Detail view and top view of slide element

There must be a gap between the slide element and piston bore that is sufficiently large for the hydraulic oil to flow through.

Options for fixing the magnet:

- Screws
- Threaded ring
- Press fitting
- Notches (center punching)

> **Note**
>
> If installed in a hydraulic cylinder, the magnet should not make contact with the rod.

The hole in the spacer ring must ensure optimum guidance of the rod by the slide element.

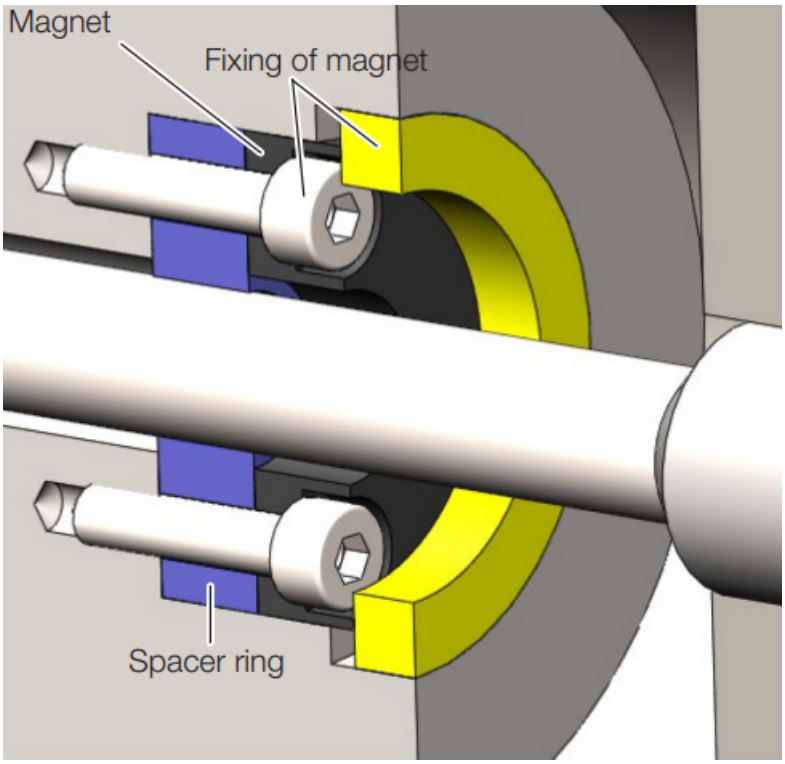


Fig. 7: Fixing of magnet

5.2 Installation

Note

For dimensions, see *structure diagram*.

Note

Suitable nuts for the mounting thread are available as accessories (see *Accessories*).

NOTICE

Interference in function
Improper installation can compromise the function of the BTL and result in increased wear.
- Ensure that the contact surface of the BTL is in full contact with the mounting surface.
- Seal the hole perfectly (O-ring/flat seal).

5.2.1 Mounting in a hole with internal thread (mounting hole)

To mount the BTL in a hole with internal thread, proceed as follows:

1. Make a mounting hole with thread (possibly with countersink for the O-ring) acc. to *Mounting hole figure 1* or *Mounting hole figure 2*.
2. Screw the BTL with mounting thread into the mounting hole (max. torque 75 Nm).

5.2.2 Mounting in a through-hole

Note

Mounting in a through-hole is only permitted under ambient atmospheric pressure.

To mount the BTL in a through-hole, proceed as follows:

1. Guide the BTL through the hole.
2. Screw the mounting nut (max. torque 75 Nm, see *Accessories*) onto the mounting thread on the rod side.

5.2.3 Further steps

- Install the magnet (accessory).
- From measuring length of 500 mm: Support the rod and if necessary screw on at the end.

5.2.4 Electrical Connection

The electrical connection is made via a plug connection

(for pin assignment see *S92 connector*) .

Note

See the information about Shielding and cable routing *here*.

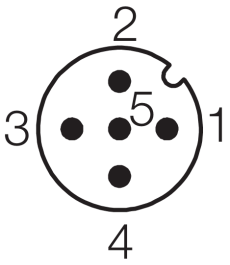


Fig. 8: Pin assignment of S92 (view from above on BTL)

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]			

5.3 Shielding and cable routing

Note

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

5.3.1 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.

5.3.2 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.

5.3.3 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.

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

5.3.4 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.

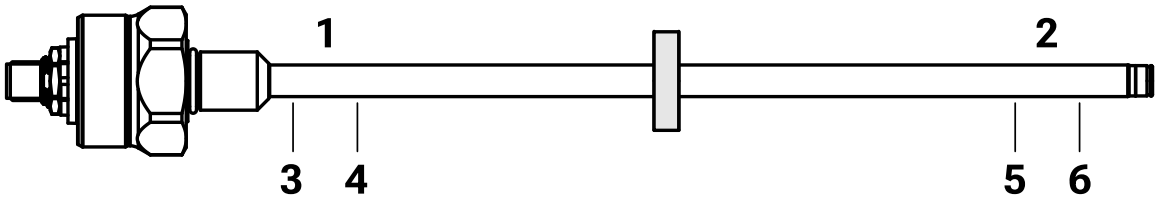
7.2 Operating notes

- 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

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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