BALLUFF

BTL7-A/C/E/G_ _ _-M_ _ _ _-A/B/Y/Z(8)-S32/S115/S135/S140
BTL7-A/C/E/G_ _ _-M_ _ _ _-A/B/Y/Z(8)-KA_ _/FA_ _

User's Guide

english

www.balluff.com

1 Notes to the user

1.1 Validity

This guide describes the construction, function and setup options for the magnetostrictive linear position sensor with analog interface. It applies to types **BTL7-A/C/E/G_ _ _-M_ _ _ _-A/B/Y/Z(8)-S32/S115/S135/S140/KA_ _/FA_ _**(see Type code on page 29).

The guide is intended for qualified technical personnel. Read this guide before installing and operating the BTL.

1.2 Symbols and conventions

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

► Handling instruction 1

Handling sequences are numbered consecutively:

1. Handling instruction 1
2. Handling instruction 2

i	**Note, tip** This symbol indicates general notes.
❶ ②	These symbols indicate the buttons on the calibration device.
	Symbols of this type indicate the LED displays.

1.3 Scope of delivery

– BTL
– Calibration device (not for BTL7-…-S140)
– Condensed guide

i The magnets are available in various models and must be ordered separately.

1.4 Approvals and markings

Not for BTL7-...-FA_ _

US Patent 5 923 164
The US patent was awarded in connection with this product.

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

The BTL 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 3
– Electromagnetic fields (RFI)
  EN 61000-4-3 Severity level 3
– Electrical fast transients (burst)
  EN 61000-4-4 Severity level 3
– Surge
  EN 61000-4-5 Severity level 2
– Conducted interference induced by high-frequency fields
  EN 61000-4-6 Severity level 3
– Magnetic fields
  EN 61000-4-8 Severity level 4

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

By using the DNV GL symbol[1], we confirm that the marked products were type tested according to the guidelines of DNV GL.
The type approval is authenticated with a certificate (www.balluff.com).
Therefore, the marked products can be used according to the specifications of the certificate on ocean-going and inland vessels and on offshore operations in systems subject to mandatory type-testing.
Maximum length:
– BTL7-…-A/B/Y/Z-…: 300 mm (500 mm when supported at the end of the rod using slide bush BAM PC-TL-001-D10,4-4 in bore with a diameter of max. 13 mm)

[1] Not for BTL7-...-S140

2 Safety

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. Flawless function in accordance with the specifications in the technical data is ensured only when using original Balluff accessories. Use of any other components will void the warranty.

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

2.2 Reasonably foreseeable misuse

The products are not intended for the following applications and areas and may not be used there:
– in safety related applications where personal safety depends on functioning of the device
– in explosion hazard areas
– in the food sector

2.3 General safety notes

Installation and **startup** may only be performed by qualified personnel with basic electrical knowledge. **Qualified personnel** are persons whose technical training, knowledge and experience as well as knowledge of the relevant regulations allows 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 BTL will not result in hazards to persons or equipment.
If defects and unresolvable faults occur in the BTL, take it out of service and secure against unauthorized use.

2.4 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
Hazard type and source Consequences if not complied with ► Measures to avoid hazards

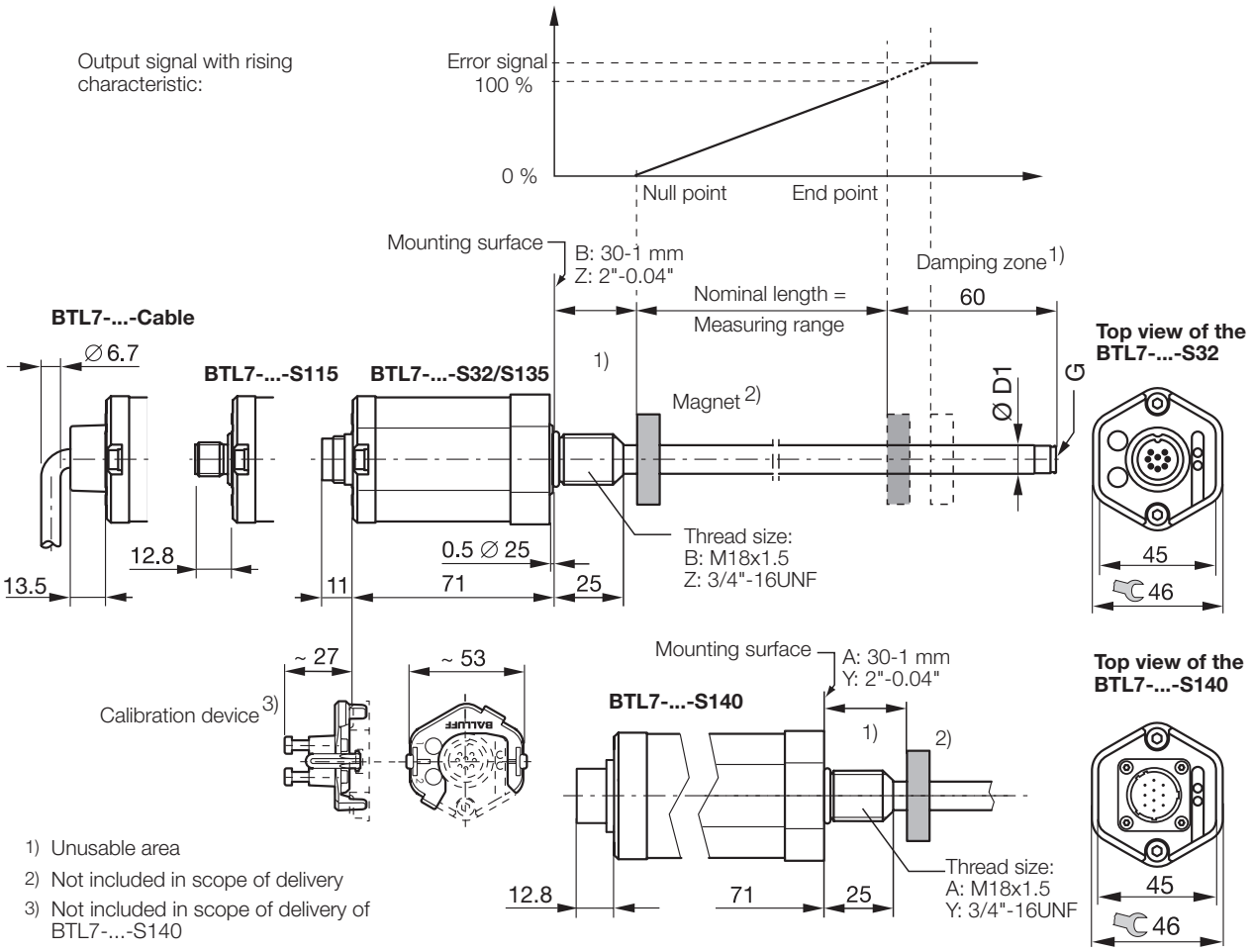
The individual signal words mean:

NOTICE!
Identifies a hazard that could **damage** or **destroy the product**.
⚠ 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**.

2.5 Disposal

► Observe the national regulations for disposal.

3 Construction and function



1) Unusable area
2) Not included in scope of delivery
3) Not included in scope of delivery of BTL7-...-S140

Version	D1	G
...-A/B/Y/Z-...	10.2 mm	Thread M4x4/6 deep
...-A8/B8/Y8/Z8-...	8 mm	No thread

Fig. 3-1: BTL7...A/B/Y/Z(8)... , construction and function

3.1 Construction

Electrical connection: The electrical connection is made via a cable or a connector (see Type code on page 29).

Housing: Aluminum housing containing the processing electronics.

Mounting thread: We recommend assembling the following BTLs on the mounting thread::
– BTL7-…-A/B: M18×1.5
– BTL7-…-Y/Z: 3/4"-16UNF
The BTL with Ø 10.2 mm has an additional thread at the end of the rod to support larger nominal lengths.

Magnet: Defines the position to be measured on the waveguide. Magnets are available in various models and must be ordered separately (see accessories on page 25).

Nominal length: Defines the available measuring range. Rods with various nominal lengths from 25 mm to 7620 mm are available depending on the version of the BTL:
– Ø 10.2 mm: Nominal length from 25 mm to 7620 mm
– Ø 8 mm: Nominal length from 25 mm to 1016 mm

Damping zone: Area at the end of the rod that cannot be used for measurements, but which may be passed over.

Calibration device: Additional device for calibrating the BTL (not for BTL7-….-S140).

3 Construction and function (continued)

3.2 Function

The BTL contains the waveguide which is protected by an outer stainless steel tube (rod). A magnet is moved along the waveguide. This magnet is connected to the system part whose position is to be determined.

The magnet defines the position to be measured on the waveguide.

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 travel time of the wave is used to calculate the position. Depending on the version, this information is made available as a voltage or current output with a rising or falling gradient.

3.3 LED display

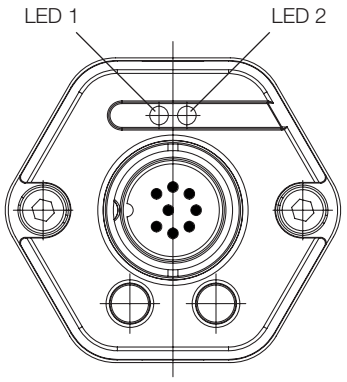


Fig. 3-2: Position of the BTL7 LED displays

> In normal operation LED 1 indicates the operating states of the BTL. Both LEDs together are used for displaying additional information in programming mode (see page 18 ff).

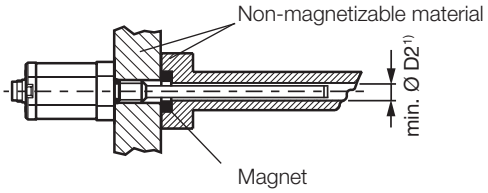
LED 1	LED 2	Operating state
Green	Off	**Normal function** Magnet is within the limits.
Red		**Error** No magnet or magnet outside the limits.

Tab. 3-1: LED displays in normal operation

4 Installation and connection

4.1 Installation guidelines

Non-magnetizable material

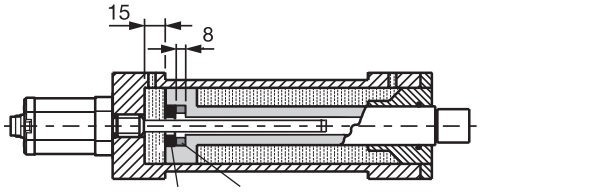


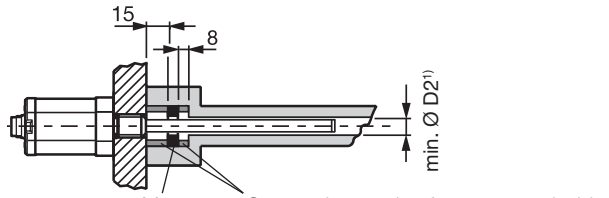
¹⁾ Min. Ø D2 = Minimum diameter of the bore (see Tab. 4-1)

Fig. 4-1: Installation in non-magnetizable material

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⁾ Min. Ø D2 = Minimum diameter of the bore (see Tab. 4-1)

Fig. 4-2: Installation in magnetizable material

Tube diameter	Bore diameter D2
10.2 mm	At least 13 mm
8 mm	At least 11 mm

Tab. 4-1: Bore diameter if installed in a hydraulic cylinder

4.2 Preparing for installation

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

Horizontal assembly: For horizontal assembly with nominal lengths > 500 mm, support the rod and tighten it at the end if necessary (only possible with a diameter of 10.2 mm).

Hydraulic cylinder: If installed in a hydraulic cylinder, ensure that the minimum value for the bore diameter of the support piston is complied with (see Tab. 4-1).

Mounting hole: BTL threads are M18×1.5 (ISO) or 3/4"-16UNF (SAE). Depending on the version, a mounting hole must be made before assembly.

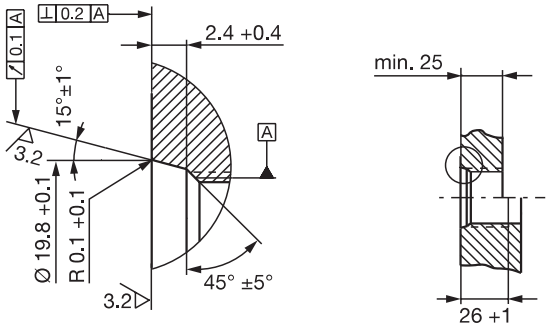


Fig. 4-3: Mounting hole M18x1.5 per ISO 6149 O-ring 15.4x2.1

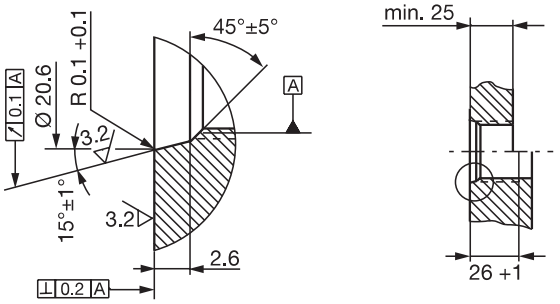


Fig. 4-4: Mounting hole 3/4" 16UNF per SAE J475 O-ring 15.3x2.4

Magnet: Various magnets are available for the BTL (see Accessories on page 25).

4 Installation and connection (continued)

4.3 Installing the BTL

NOTICE!

Interference in function

Improper installation can compromise the function of the BTL and result in increased wear.

- ► The mounting surface of the BTL must make full contact with the supporting surface.
- ► The bore must be perfectly sealed (O-ring/flat seal).

- ► Make a mounting hole with thread (possibly with countersink for the O-ring) acc. to Fig. 4-3 or Fig. 4-4.
- ► Screw the BTL with mounting thread into the mounting hole (max. torque 100 Nm).
- ► Install the magnet (accessories).
- ► From 500 mm nominal length: support the rod and tighten it at the end if necessary (only possible with a diameter of 10.2 mm).

i Suitable nuts for the mounting thread are available as accessories (see page 25).

4.3.1 Installation recommendation for hydraulic cylinders

If you seal the hole with a flat seal, the max. operating pressure will be reduced in accordance with the larger pressurized surface.
If installing horizontally in a hydraulic cylinder (nominal lengths > 500 mm), we recommend affixing a sliding element to protect the rod end from wear.

i Dimensioning of the detailed solutions is the responsibility of the cylinder manufacturer.

The sliding 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.

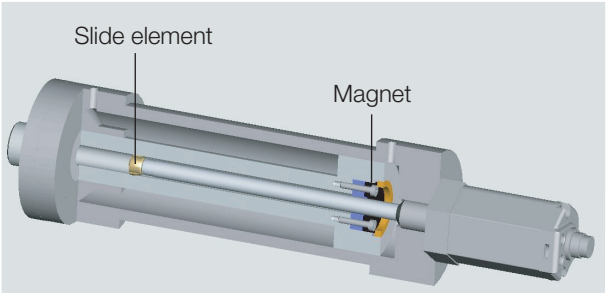


Fig. 4-5: Example 1, BTL installed with sliding element

The sliding element can be screwed on or bonded.

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

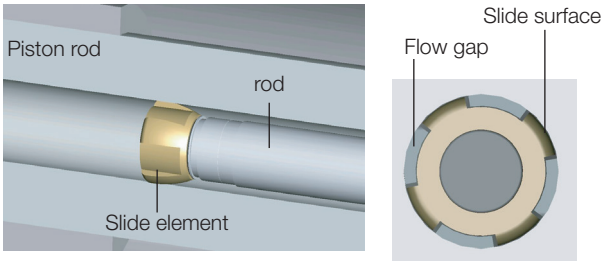


Fig. 4-6: Detailed view and top view of sliding element

There must be a gap between the sliding 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)

i 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 sliding element.

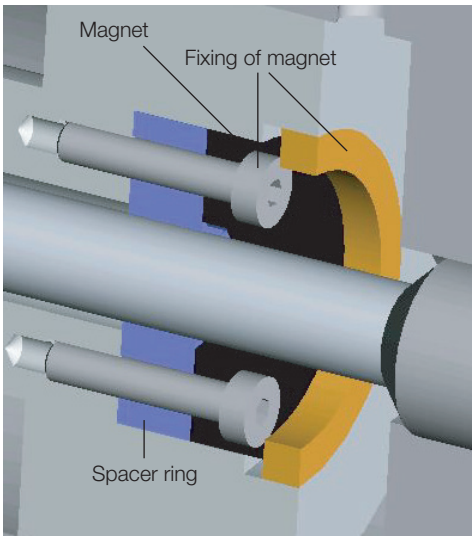


Fig. 4-7: Fixing the magnet

An example of how to install the BTL with a supporting rod is shown in Fig. 4-8 on page 11.

4 Installation and connection (continued)

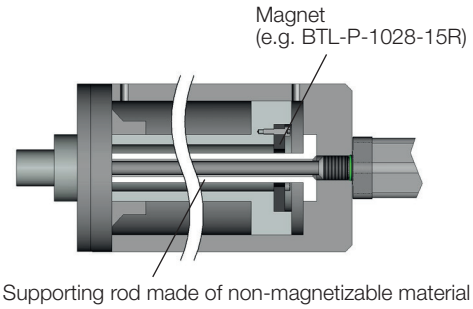


Fig. 4-8: Example 2, BTL installed with supporting rod

4.4 Electrical connection

Depending on the model, the electrical connection is made using a cable or a connector.
The connection or pin assignments for the respective version can be found in Tab. 4-2 to Tab. 4-5.

> Note the information on shielding and cable routing on page 13.

4.4.1 Connector type S32/cable connection

S32 Pin	Wire color	-A_10	-G_10	-C_00	-C_70	-E_00	-E_70
1	YE yellow	Not used[1]		0…20 mA	20…0 mA	4…20 mA	20…4 mA
2	GY gray	0 V					
3	PK pink	10…0 V	10…–10 V	Not used[1]			
4	RD red	La (programming input)					
5	GN green	0…10 V	–10…10 V	Not used[1]			
8	WH white	Lb (programming input)					
		BTL7-_1_ _-...		**BTL7-_5_ _-...**			
6	BU blue	GND[2]		GND[2]			
7	BN brown	20…28 V		10…30 V			

[1] Unassigned leads can be connected to the GND on the controller side but not to the shield.

[2] Reference potential for supply voltage and EMC-GND.

Tab. 4-2: Connection assignment BTL7...-S32

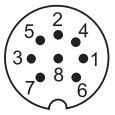


Fig. 4-9: Pin assignment of S32 (view of connector pins of BTL), 8-pin M16 circular plug

4.4.2 Connector type S115

S115 Pin	-A_10	-G_10	-C_00	-C_70	-E_00	-E_70
1	0 V (pin 3)					
2	0 V (pin 5)					
3	10…0 V	10…–10 V	Not used[1]			
4	La (programming input)					
5	0…10 V	–10…10 V	0…20 mA	20…0 mA	4…20 mA	20…4 mA
8	Lb (programming input)					
	BTL7-_1_ _-...		**BTL7-_5_ _-...**			
6	GND[2]		GND[2]			
7	20…28 V		10…30 V			

[1] Unassigned leads can be connected to the GND on the controller side but not to the shield.

[2] Reference potential for supply voltage and EMC-GND.

Tab. 4-3: Connection assignment BTL7...-S115

Fig. 4-10: Pin assignment of S115 (view of connector pins of BTL), 8-pin M12 circular plug

4 Installation and connection (continued)

4.4.3 Connector type S135

S135 Pin	-A_10	-G_10	-C_00	-C_70	-E_00	-E_70
1	0…10 V	–10…10 V	0…20 mA	20…0 mA	4…20 mA	20…4 mA
2	0 V (pin 1)					
3	10…0 V	10…–10 V	Not used[1]			
4	0 V (pin 3)		Not used[1]			
	BTL7-_1_ _-...			**BTL7-_5_ _-...**		
5	20…28 V			10…30 V		
6	GND[2]			GND[2]		

Tab. 4-4: Connection assignment BTL7...-S135

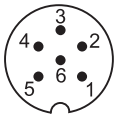


Fig. 4-11: Pin assignment of S135 (view of connector pins of BTL), 6-pin M16 circular plug

[1] Unassigned leads can be connected to the GND on the controller side but not to the shield.

[2] Reference potential for supply voltage and EMC-GND.

4.4.4 Connector type S140

S140 Pin	Interface BTL7-...					
	-A_10	-G_10	-C_00	-C_70	-E_00	-E_70
A	0 V					
B	Not used[1]		0…20 mA	20…0 mA	4…20 mA	20…4 mA
C	10…0 V	10…–10 V	Not used[1]			
F	GND[2]					
G	La (programming input)					
H	Lb (programming input)					
J	0…10 V	–10…10 V	Not used[1]			
K / E	Not used[1]					
	BTL7-_1_ _-...			**BTL7-_5_ _-...**		
D	20…28 V			10…30 V		

Tab. 4-5: Connection assignment BTL7...-S140

Fig. 4-12: Pin assignment of S140 (view of connector pins of BTL), 10-pin circular plug

[1] Unassigned leads can be connected to the GND on the controller side but not to the shield.

[2] Reference potential for supply voltage and EMC-GND.

4 Installation and connection (continued)

4.5 Shielding and cable routing

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

Shielding

To ensure electromagnetic compatibility (EMC), observe the following:

– Connect the BTL and controller using a shielded cable. Shielding: Copper filament braided, at least 85% coverage.
– Connector version: Shield is internally connected to connector housing.
– Cable version: On the BTL side, the cable shielding is connected to the housing.
Ground the cable shielding on the controller side (connect with the protective earth conductor).

Magnetic fields

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

Cable routing

Do not route the cable between the BTL, controller, and power supply near high voltage cables (inductive stray noise is possible).
The cable must be routed tension-free.

Bending radius for fixed cable

The bending radius for a fixed cable must be at least five times the cable diameter.

Cable length

BTL7-A/G	Max. 30 m[1)]
BTL7-C/E	Max. 100 m[1)]

Tab. 4-6: Cable lengths BTL7

[1)] Prerequisite: Construction, shielding and routing preclude the effect of any external noise fields.

5 Startup

5.1 Starting up the system

⚠ DANGER

Uncontrolled system movement

When starting up, if the position measuring system 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.

i Check for the correct values at the null point and end point, especially after replacing the BTL or after repair by the manufacturer.

5.2 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.

6 Calibration procedure

6.1 Calibration device (not for BTL7-…-S140)

The calibration device is an additional device for calibrating the BTL.

- ► Before calibrating: Place the calibration device on the connection side of the BTL.
- ► When finished with calibration: Remove the calibration device to prevent changes.
- ► Keep the calibration device for later use.

Automatic deactivation!
If the buttons on the calibration device are not pressed for approx. 10 min., programming mode is automatically ended.

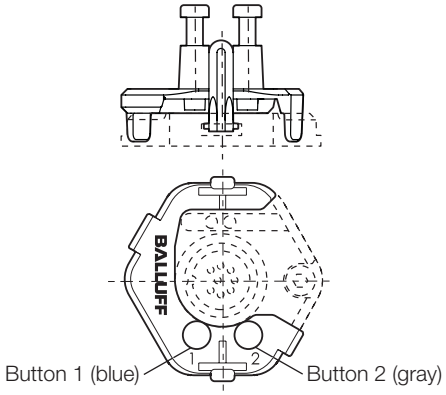


Fig. 6-1: Calibration device in place

6.2 Programming inputs (not for BTL7-…-S135)

Instead of the calibration device, the programming inputs may also be used for setting.

- – La corresponds to button 1,
- – Lb corresponds to button 2,
- – Programming input at 20 to 28 V (BTL7-_1_ _-...) or 10 to 30 V (BTL7-_5_ _-...) corresponds to button depressed (high active).

Automatic deactivation!
If no signals are sent over the programming inputs for approx. 10 min., programming mode is automatically ended.

6.3 Calibration procedure overview

6.3.1 Teach-in

The factory set null point and end point is replaced by a new null point and end point.

The detailed procedure for teach-in is described on page 18.

Steps:

- ► Move magnet to the new zero position.
- ► Read new null point by pressing the buttons.

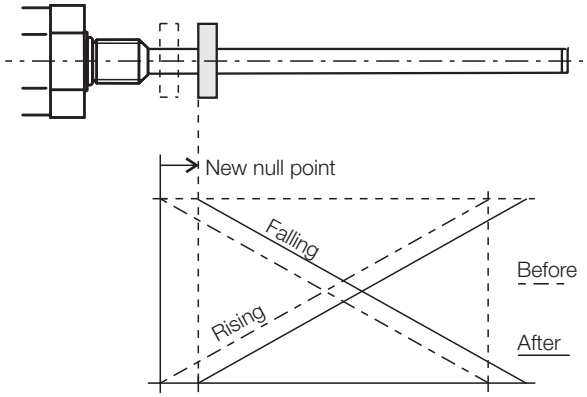


Fig. 6-2: Reading new null point (offset shift)

- ► Move magnet to the new end position.
- ► Read new end point by pressing the buttons.

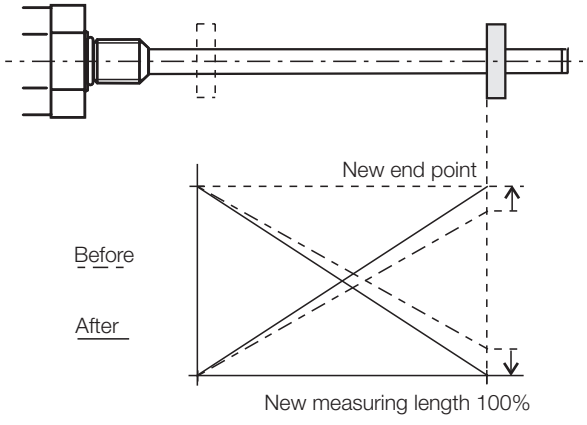


Fig. 6-3: Reading new end point (changing the output gradient)

6 Calibration procedure (continued)

6.3.2 Adjusting

The detailed procedure for adjustment is described on page 19 ff.

A new start and/or end value is adjusted. This is recommended when the magnet cannot be brought to the null point or end point.

Steps

- ► Move magnet to the new start position.
- ► Set the new start value by pressing the buttons.

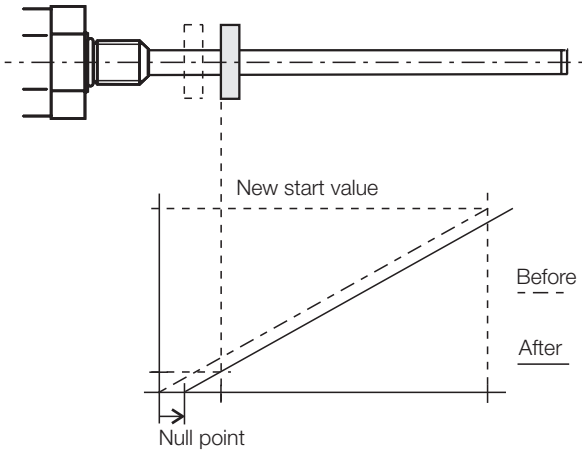


Fig. 6-4: Adjusting new start position (offset shift)

- ► Move magnet to the new end position.
- ► Set the new end value by pressing the buttons.

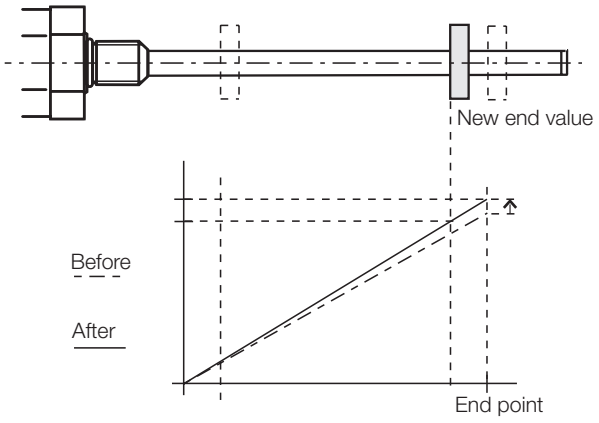


Fig. 6-5: Adjusting new end position (changing the output gradient)

6.3.3 Online setting

The detailed procedure for online setting is described on page 21.

Setting start and end values while the system is running.

6.3.4 Reset

The detailed procedure for the reset is described on page 22.

Restoring the BTL to its factory settings.

6.4 Selecting the calibration procedure

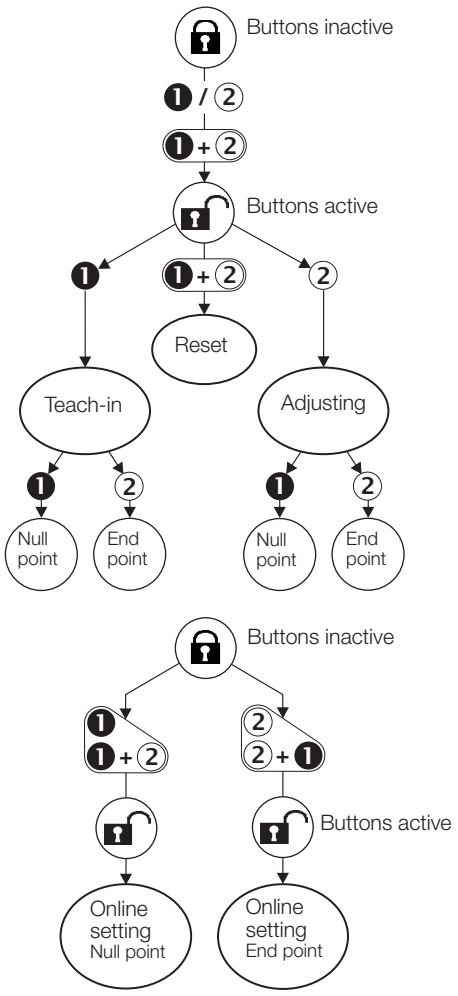


Fig. 6-6: Selecting the calibration procedure

6 Calibration procedure (continued)

6.5 Calibration procedure notes

Prerequisites

- The calibration device is in place or the programming inputs are connected.
- The BTL is connected to the system controller.
- Voltage or current values from the BTL can be read (using a multimeter or the system controller).

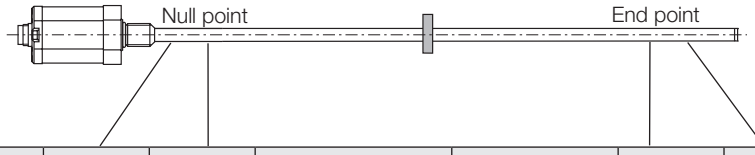
Values for zero and end point

- Any desired position of the magnet can be used as the zero or end point. However, the zero and end points may not be reversed.
- The absolute zero and end points must lie within the minimum or maximum limits of what can be output (see value table).
- The distance between the null point and end point must be at least 4 mm.

> **i** The last set values are always saved, regardless of whether the setting was ended using the buttons, the programming inputs or automatically after 10 min. have expired.

Value table for teach-in and adjustment

> **i** The following examples refer to BTL with 0 to 10 V or 4 to 20 mA output.
> For all other versions, use the values in the value table below.



Output gradient	BTL	Unit	Min. value	Null value	Identification for adjustment	Identification for teach-in	End value	Max. value	Error value
Rising	BTL7-A…	V	–0.5	0	2.0	4.0	+10.0	+10.5	+10.5
	BTL7-G…	V	–10.5	–10.0	2.0	4.0	+10.0	+10.5	+10.5
	BTL7-C…	mA	0	0	6.0	12.0	20.0	20.4	20.4
	BTL7-E…	mA	3.6	4.0	6.0	12.0	20.0	20.4	3.6
Falling	BTL7-A…	V	+10.5	+10.0	8.0	6.0	0	–0.5	–0.5
	BTL7-G…	V	+10.5	+10.0	–2.0	–4.0	–10.0	–10.5	–10.5
	BTL7-C…	mA	20.4	20.0	14.0	8.0	0	0	20.4
	BTL7-E…	mA	20.4	20.0	14.0	8.0	4.0	3.6	3.6

Tab. 6-1: Value table for teach-in and adjustment

7 Calibration using teach-in

NOTICE!

Interference in function

Teach-in while the system is running may result in malfunctions.

► Stop the system before performing teach-in.

Initial situation:

– BTL with magnet within measuring range

1. Activate buttons

► Hold down any button for at least 3 s.

► Release button.

► Within 1 s, hold down ❶ and ② simultaneously for at least 3 s.

⇒ Output indicates error value.

⇒ Buttons are activated.

> If an error or an interruption occurs while activating the buttons, allow a wait time of **12 s** before retrying.

2. Select teach-in

► Hold down ❶ for at least 2 s.

⇒ Indication for “Teach-in” is displayed.

► Release ❶.

⇒ Current position value is displayed.

3. Set null point

► Bring magnet to the new null point.

► Hold down ❶ for at least 2 s.

⇒ The new null point is set.

4. Set end point

► Bring magnet to the new end point.

► Hold down ② for at least 2 s.

⇒ The new end point is set.

5. Exit teach-in and deactivate buttons

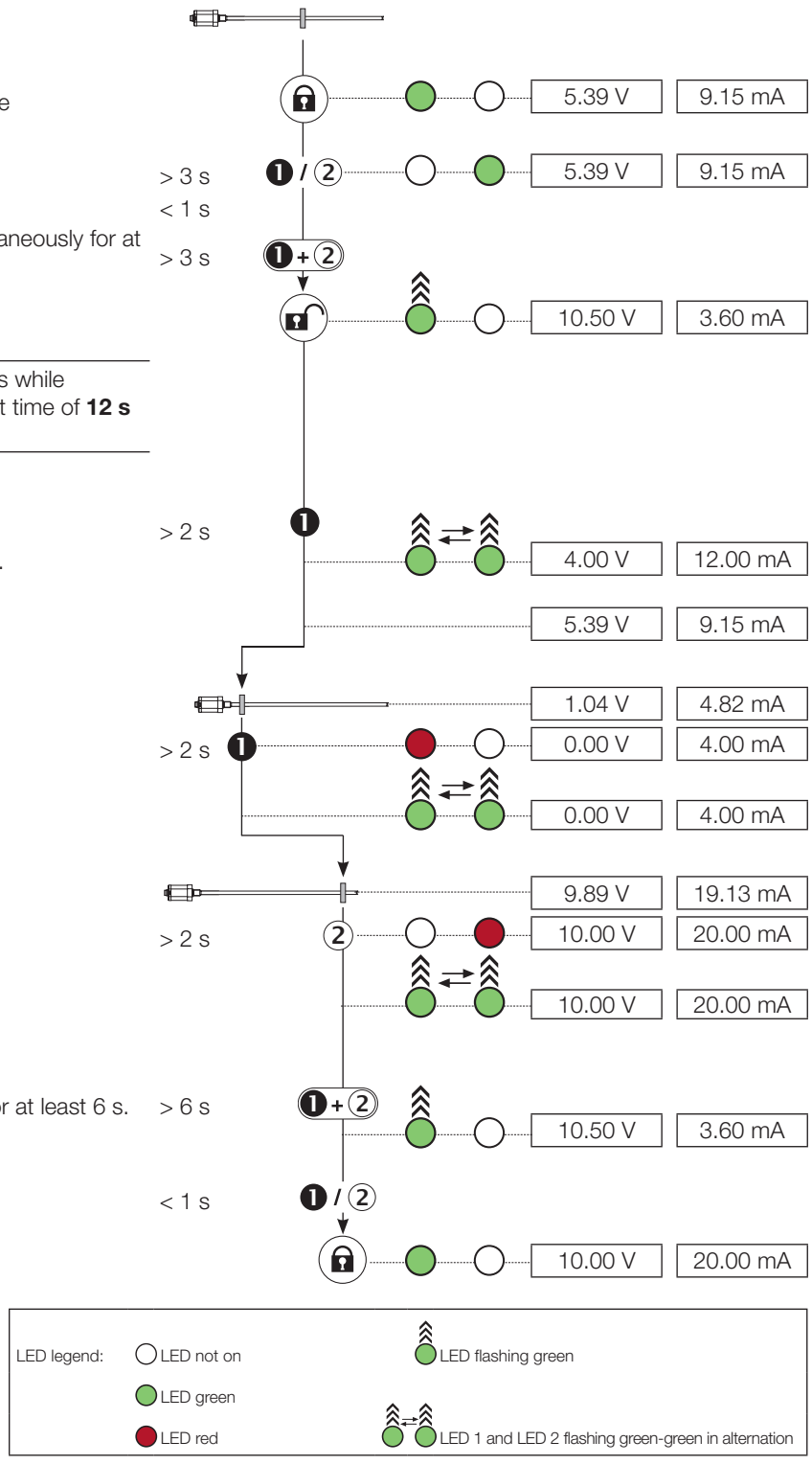
► Hold down ❶ and ② simultaneously for at least 6 s.

⇒ Output indicates error value.

► Briefly press ❶ or ② (< 1 s).

⇒ Buttons are deactivated.

⇒ Current position value is displayed.



8 Calibration using adjustment

NOTICE!

Interference in function

Adjustment while the system is running may result in malfunctions.

► Stop the system before performing adjustment.

Initial situation:

– BTL with magnet within measuring range

1. Activate buttons

► Hold down any button for at least 3 s.

► Release button.

► Within 1 s, hold down ❶ and ② simultaneously for at least 3 s.

⇒ Output indicates error value.

⇒ Buttons are activated.

> If an error or an interruption occurs while activating the buttons, allow a wait time of **12 s** before retrying.

2. Select adjustment

► Hold down ② for at least 2 s.

⇒ Indication for “Adjustment” is displayed.

► Release ②.

⇒ Current position value is displayed.

3. Adjust start value

► Bring magnet to start position.

► Hold down ❶ for at least 2 s.

⇒ Indication for “Adjust start value” is displayed.

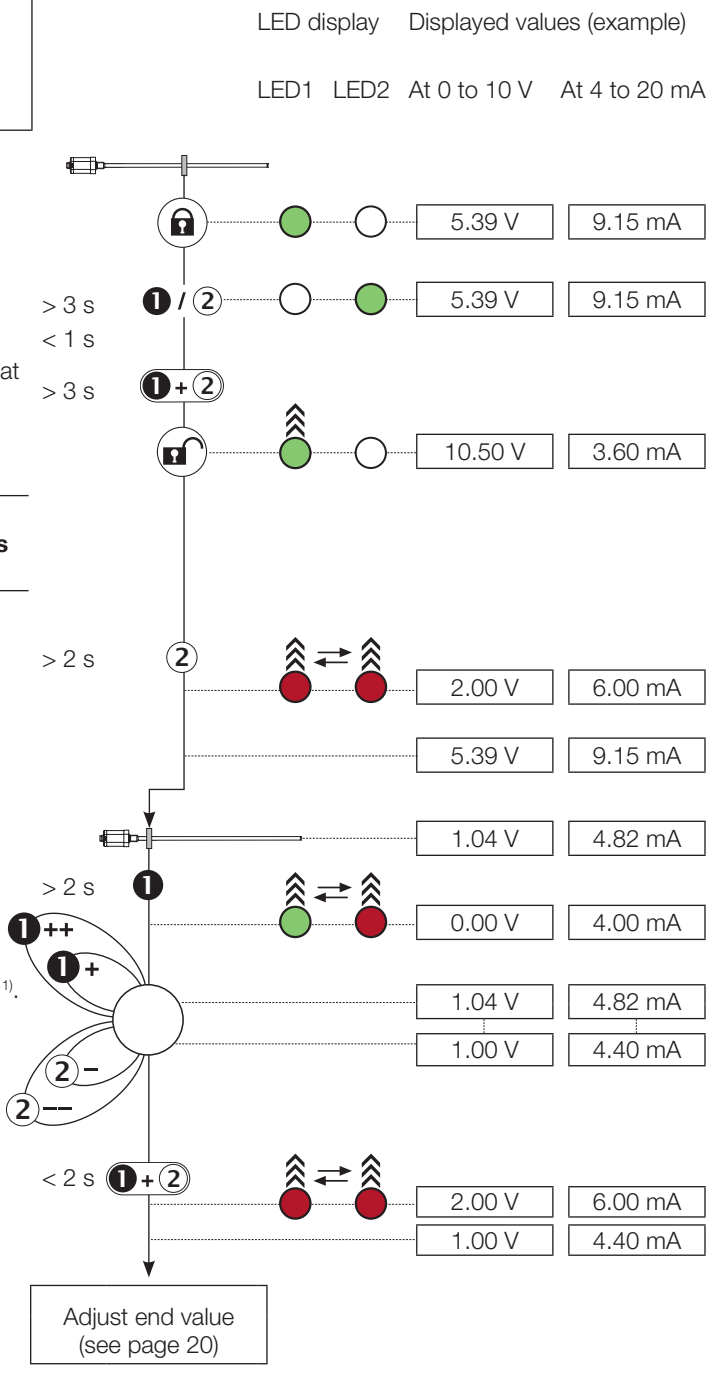
► Adjust start value.

⇒ The start value can be changed using ❶ and ②[1]. The gradient of the output remains constant (see page 16).

► Exit calibration procedure: Press ❶ and ② for no more than 2 s.

⇒ Indication for “Adjustment” is displayed.

⇒ Set position value is saved.



1) Briefly press button: Current value is increased or decreased by approx. 1 mV or 1 µA.
If a button is held down longer than 1 s, the step interval is increased.

LED legend:
- LED not on
- LED green
- LED flashing green
- LED 1 and LED 2 flashing green-red in alternation
- LED 1 and LED 2 flashing red-red in alternation

8 Calibration using adjustment (continued)

4. Adjust end value

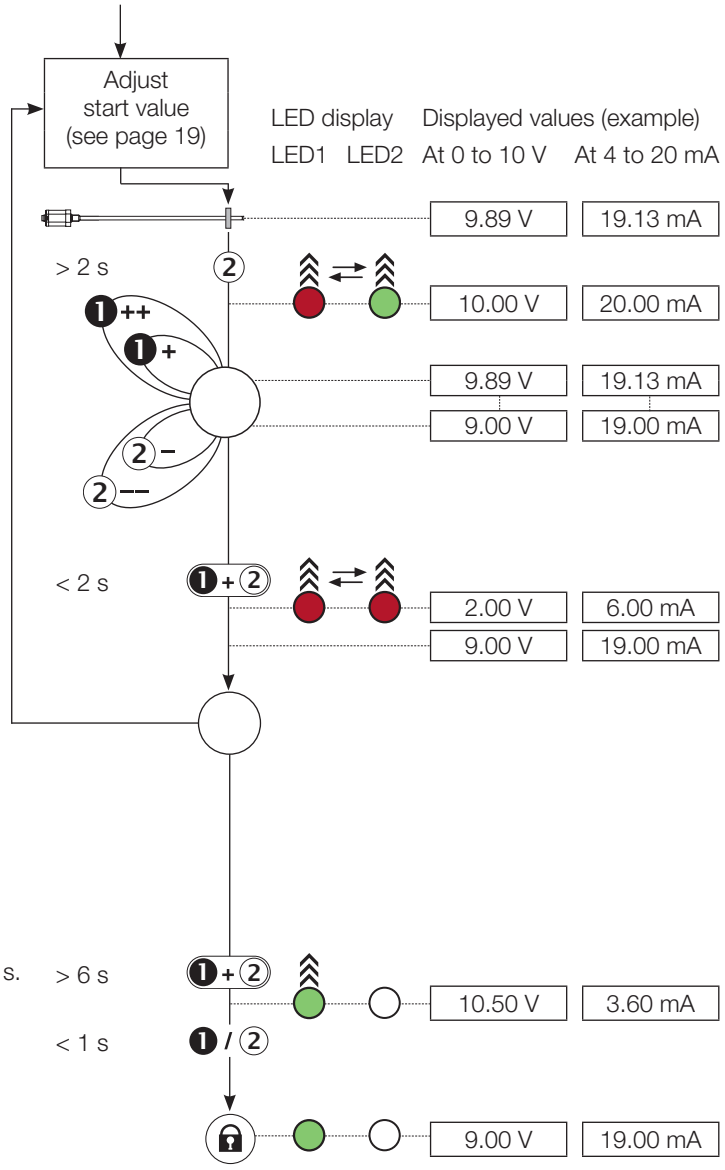
- ► Bring magnet to end position.
- ► Hold down ② for at least 2 s.
  - ⇒ Indication for “Adjust end value” is displayed.
- ► Adjust end value
  - ⇒ The end value can be changed using ❶ and ②[1]. The gradient of the output is changed, but the zero value remains unchanged (see page 16).

- ► Exit calibration procedure: Press ❶ and ② for no more than 2 s.
  - ⇒ Indication for “Adjustment” is displayed.
  - ⇒ Set position value is saved.

Check values
The settings for the start value and end value have a mutual effect depending on the measuring position.
Repeat steps 3 and 4 until the desired values are exactly set.

5. Exit adjustment and deactivate buttons

- ► Hold down ❶ and ② simultaneously for at least 6 s.
  - ⇒ Output indicates error value.
- ► Briefly press ❶ or ② (< 1 s).
  - ⇒ Buttons are deactivated.
  - ⇒ Current position value is displayed.



1) Briefly press button: Current value is increased or decreased by approx. 1 mV or 1 µA.
If a button is held down longer than 1 s, the step interval is increased.

LED legend:
- LED not on
- LED green
- LED flashing green
- LED 1 and LED 2 flashing red-green in alternation
- LED 1 and LED 2 flashing red-red in alternation

9 Calibration using online setting

NOTICE!

Interference in function

Changing the BTL output signal may result in personal injury and equipment damage if the system is ready for operation.

► Persons must keep away from the system's hazardous zones.

In online setting the system is not shut down. The start and end values are set online.

Maximum setting range for each calibration procedure:

Start value: ±25% of present stroke
End value: ±25% of present output value

If the desired value cannot be attained in the first calibration procedure (max. setting range exceeded), the calibration procedure must be started again.

1. Set start value online:

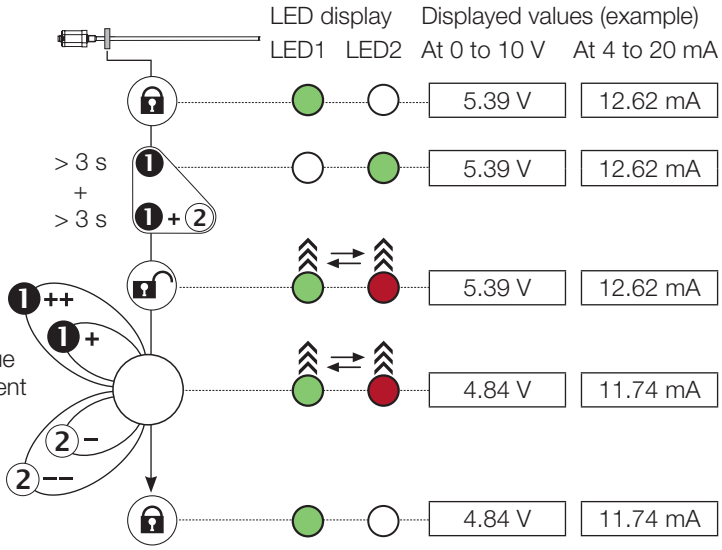
► Move the system so that the magnet is in the start position.

► Hold down ❶ for at least 3 s.
► Hold down ❶ and additionally press ② for at least 3 s.

⇒ Buttons are activated.

► Set start value.
⇒ Using ❶ and ②, you can change the start value within the permissible setting range[1]. The gradient of the output remains constant (see page 16).

► Exit setting (do not press a button for at least 15 s).
⇒ The start value is saved, the buttons are deactivated.



After each calibration procedure you must wait for the lockout time of **15 s**. This also applies to switching between the start value and end value setting.

2. Set end value online:

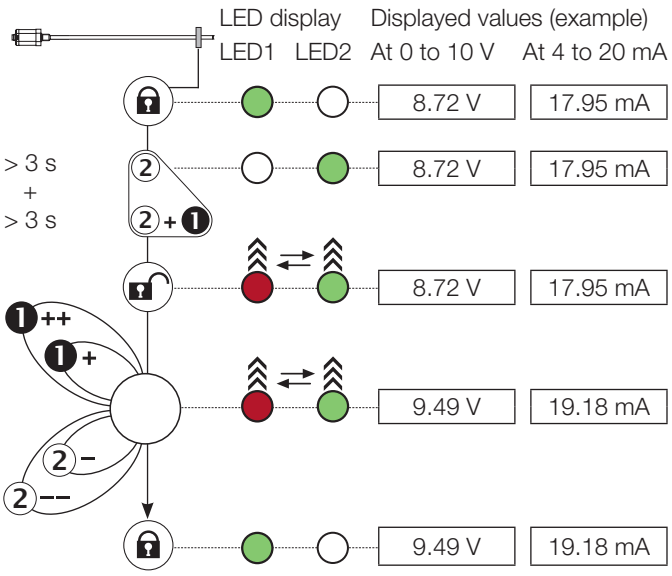
► Move the system so that the magnet is in the end position.

► Hold down ② for at least 3 s.
► Hold down ② and additionally press ❶ for at least 3 s.

⇒ Buttons are activated.

► Set end value.
⇒ Using ❶ and ②, you can change the end value within the permissible setting range[1]. The gradient of the output is changed, but the zero value remains unchanged (see page 16).

► Exit setting (do not press a button for at least 15 s).
⇒ The end value is saved, the buttons are deactivated.



1) Briefly press button: Current value is increased or decreased by approx. 1 mV or 1 µA.
If a button is held down longer than 1 s, the step interval is increased.

LED legend:
- LED not on
- LED green
- LED 1 and LED 2 flashing green-red in alternation
- LED 1 and LED 2 flashing red-green in alternation

10 Resetting all values (reset)

NOTICE!

Interference in function

Resetting the values while the system is running may result in malfunctions.

► Stop the system before performing the reset.

The reset function can be used to restore all the settings to the factory settings. For a reset the magnet may also be located outside the measuring range.

1. Activate buttons

► Hold down any button for at least 3 s.

► Release button.

► Within 1 s, hold down ❶ and ② simultaneously for at least 3 s.

⇒ Output indicates error value.

⇒ Buttons are activated.

> If an error or an interruption occurs while activating the buttons, allow a wait time of **12 s** before retrying.

2. Reset

► Hold down ❶ and ② for at least 6 s.

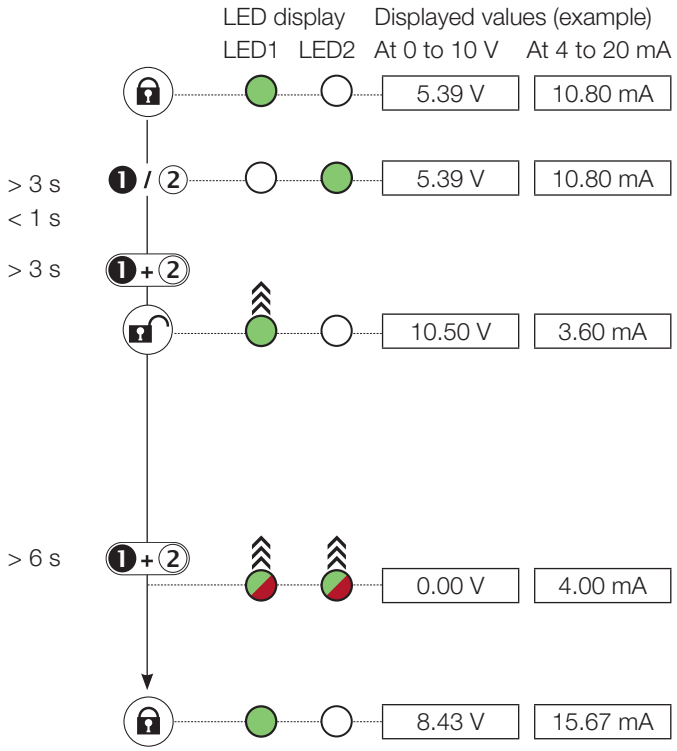
⇒ Output indicates zero value.

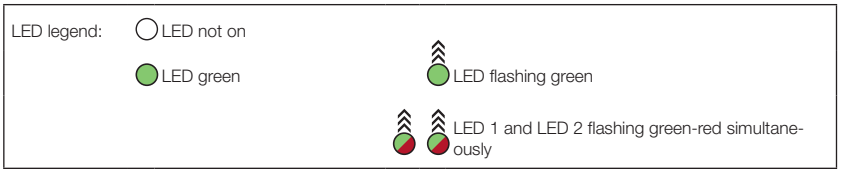
⇒ All values are reset.

► Release buttons.

⇒ Current position value is displayed.

⇒ Buttons are locked.





11 Technical data

11.1 Accuracy

The specifications are typical values for BTL7-A/C/E/G... at 24 V DC and room temperature, with a nominal 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 BTL is fully operational immediately, with full accuracy after warm-up.

> For special versions, other technical data may apply.
> Special versions are indicated by the suffix -SA on the part label.

Repeat accuracy	
Voltage, typical	±10 µm
Current, typical	±5 µm
Sampling rate	
Dependent on nominal length	250 µs to 5.7 ms
At nominal length = 500 mm	500 µs
Non-linearity at	
Nominal length ≤ 500 mm	±50 µm
Nominal length > 500 to ≤ 5500 mm	±0.01% FS
Nominal length > 5500 mm	±0.02% FS
Temperature coefficient[1]	≤ 30 ppm/K
Max. detectable speed	10 m/s

11.2 Ambient conditions[2]

Ambient temperature	–40…+85°C
Ambient temperature for UL (only BTL-…-KA…)	≤ +80°C
Storage temperature	–40…+100°C
Relative humidity	≤ 90%, non-condensing
Rod pressure rating (when installed in hydraulic cylinders)	
For Ø 8 mm	≤ 250 bar
For Ø 10.2 mm	≤ 600 bar
Shock rating	150 g/6 ms
Continuous shock per EN 60068-2-27[3, 4]	150 g/2 ms
Vibration per EN 60068-2-6[3, 4]	20 g, 10…2000 Hz
Degree of protection per IEC 60529	
Connector (when attached)	IP67
Cable	IP68[3]

11.3 Supply voltage (external)

Voltage, stabilized[5]:	
BTL7-_1_ _-...	20…28 V DC
BTL7-_5_ _-...	10…30 V DC
Ripple	≤ 0.5 V_{ss}
Current draw (at 24 V DC)	≤ 150 mA
Inrush current	≤ 500 mA
Reverse polarity protection[6]	Up to 36 V
Overvoltage protection	Up to 36 V
Dielectric strength (GND to housing)	500 V AC

11.4 Output

BTL7-A… Output voltage	0…10 V and 10…0 V
Load current	≤ 5 mA
BTL7-C… Output current	0…20 mA / 20…0 mA
Load resistance	≤ 500 ohms
BTL7-E… Output current	4…20 mA / 20…4 mA
Load resistance	≤ 500 ohms
BTL7-G… Output voltage	–10…10 V and 10…–10 V
Load current	≤ 5 mA
Short circuit resistance	Signal cable to 36 V Signal cable to GND

11.5 Input

Programming inputs La, Lb:	High-active
BTL7-_1_ _-...	20…28 V DC
BTL7-_5_ _-...	10…30 V DC
Overvoltage protection	up to 36 V

[1] Nominal length = 500 mm, magnet in the middle of the measuring range

[2] For UL: Use in enclosed spaces and up to a height of 2000 m above sea level.

[3] Individual specifications as per Balluff factory standard

[4] Resonant frequencies excluded

[5] For UL: The BTL must be externally connected via a limited-energy circuit as defined in UL 61010-1, a low-power source as defined in UL 60950-1, or a class 2 power supply as defined in UL 1310 or UL 1585.

[6] A prerequisite is that no current can flow between GND and 0 V in the event of polarity reversal.

11 Technical data (continued)

11.6 Dimensions, weights

Rod diameter	8 mm or 10.2 mm
Nominal length	
For Ø 8 mm	25…1016 mm
For Ø 10.2 mm	25…7620 mm
Weight (depends on length)	Approx. 2 kg/m
Housing material	Aluminum
Flange material	Stainless steel
Rod material	Stainless steel
Rod wall thickness	
For Ø 8 mm	0.9 mm
For Ø 10.2 mm	2 mm
Housing mounting via threads	M18×1.5 or 3/4"-16UNF
Tightening torque	Max. 100 Nm

BTL7-...-KA_ _

Cable material	PUR cULus 20549 80°C, 300 V, internal wiring
Cable temperature	–40…+90°C
Cable diameter	Max. 7 mm
Permissible bending radius	
Fixed routing	≥ 35 mm
Movable	≥ 105 mm

BTL7-...-FA_ _

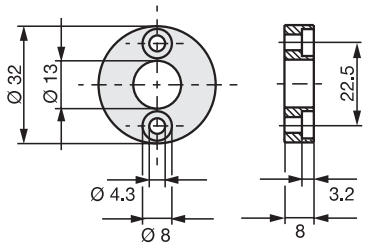
Cable material	PTFE No UL approval available
Cable temperature	–55…+200°C
Cable diameter	Max. 7 mm
Permissible bending radius	
Fixed routing	≥ 35 mm
Movable	No permissible bending radius

12 Accessories

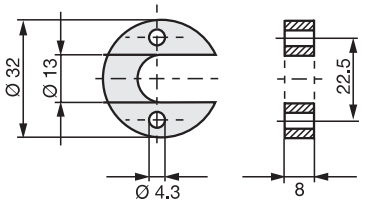
Accessories are not included in the scope of delivery and must be ordered separately.

12.1 Magnets

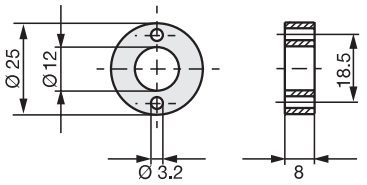
BTL-P-1013-4R



BTL-P-1013-4S



BTL-P-1012-4R



BTL-P-1014-2R

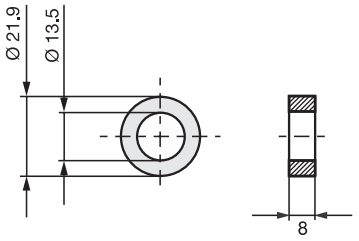


Fig. 12-1: Magnet installation dimensions

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

Weight:	< 15 g
Housing:	Aluminum

The scope of delivery for BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R magnets includes:

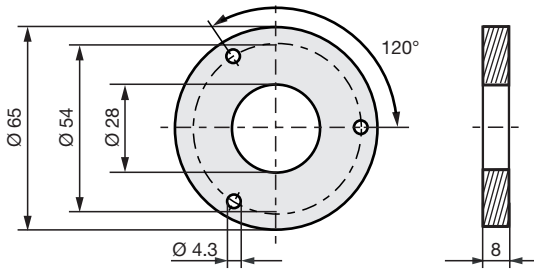
Spacer:	8 mm, material: polyoxymethylene (POM)

BTL5-P-4500-1 magnet (solenoid):

Weight:	Approx. 90 g
Housing:	Plastic
Ambient temperature:	–40…+60°C

BTL-P-1028-15R (special accessories for applications with a supporting rod):

Weight:	Approx. 68 g
Housing:	Aluminum



12.2 Mounting nut

– M18×1.5 mounting nut:
BTL-A-FK01-E-M18×1.5

– 3/4"-16UNF mounting nut:
BTL-A-FK01-E-3/4"-16UNF

12 Accessories (continued)

12.3 Connector type S32

12.3.1 Freely configurable

BKS-S 32M-00

Order code: BCC00TT
Straight connector, M16 per IEC 130-9, 8-pin

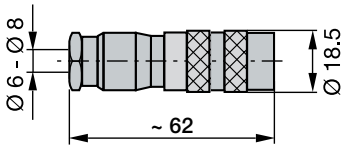


Fig. 12-2: Connector BKS-S32 M-00

BKS-S 33M-00

Order code: BCC00UP
Angled connector, M16 per IEC 130-9, 8-pin

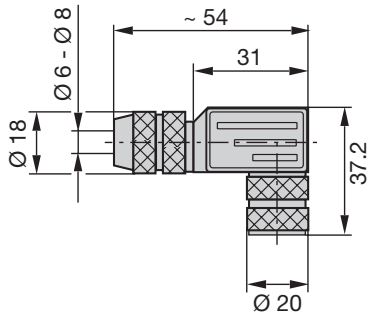


Fig. 12-3: Connector BKS S 33M-00

12.3.2 Preassembled

Straight connector, molded, M16, 8-pin
Various cable lengths can be ordered, e.g.
BCC S518-0000-1Y-133-PS0825-**050**
(Order code: BCC0L21): Cable length 5 m

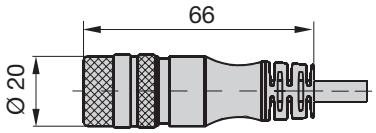


Fig. 12-4: Connector type S32 (preassembled)

Angled connector, molded, M16, 8-pin
Various cable lengths can be ordered, e.g.
BCC S528-0000-1Y-133-PS0825-**050**
(Order code: BCC0L2A): Cable length 5 m

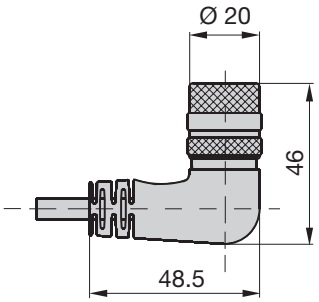


Fig. 12-5: Connector type S32 (preassembled)

Pin	Color
1	YE yellow
2	GY gray
3	PK pink
4	RD red
5	GN green
6	BU blue
7	BN brown
8	WH white

Tab. 12-1: S32 (preassembled) pin assignment

12 Accessories (continued)

12.4 Connector type S115, preassembled

BKS-S115-PU-_ _

Straight connector, molded-on cable, M12, 8-pin
Various cable lengths can be ordered, e.g.
BKS-S115-PU-**05** (Order code: BCC00YF): Cable length 5 m

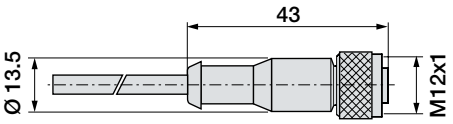


Fig. 12-6: Connector BKS-S115-PU-_ _

BKS-S116-PU-_ _

Angled connector, molded-on cable, M12, 8-pin
Various cable lengths can be ordered, e.g.
BKS-S116-PU-**05** (Order code: BCC00YW): Cable length 5 m

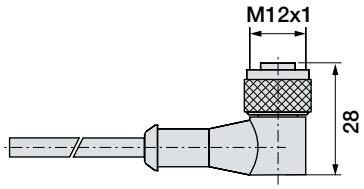


Fig. 12-7: Connector BKS-S116-PU-_ _

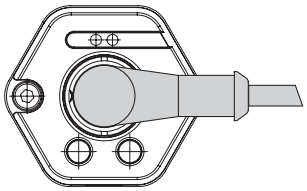


Fig. 12-8: Connector BKS-S116-PU-_ _, outlet

Pin	Color
1	YE yellow
2	GY gray
3	PK pink
4	RD red
5	GN green
6	BU blue
7	BN brown
8	WH white

Tab. 12-2: BKS-S115/S116-PU-_ _ pin assignment

12.5 Connector type S135, freely configurable

BKS-S135M-00

Order code: BCC00Z6
Straight connector, freely configurable
M16 per IEC 130-9, 6-pin

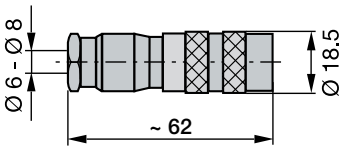


Fig. 12-9: Connector type BKS-S135M-00

BKS-S136M-00

Order code: BCC0117
Angled connector, freely configurable
M16 per IEC 130-9, 6-pin

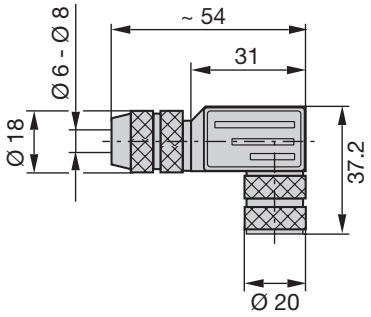


Fig. 12-10: Connector type BKS-S136M-00

12 Accessories (continued)

12.6 Plug-in system, 8-pin

The BTL is available with an 8-pin pigtail plug-in system.
The plug-in system has two parts:

– The M12 contact insert is preassembled to the BTL's cable
– The square flange for assembly using the contact insert is included in the scope of delivery.

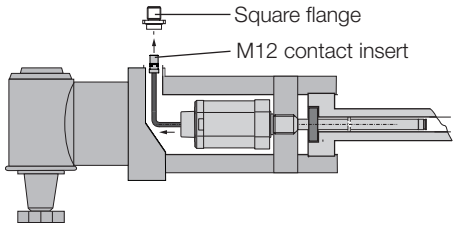


Fig. 12-11: Plug-in system based on the example installing the BTL in a hydraulic cylinder

Series ZA10

Square flange material: Nickel-plated brass
BTL7-…-KA00,2-ZA10, PUR cable 0,2 m
BTL7-…-KA00,3-ZA10, PUR cable 0,3 m

Series ZA15

Square flange material: Stainless steel 1.4404
BTL7-…-KA00,2-ZA15, PUR cable 0,2 m
BTL7-…-KA00,3-ZA15, PUR cable 0,3 m

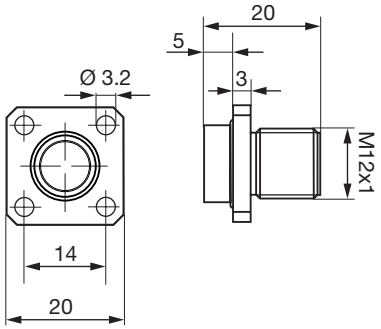


Fig. 12-12: Square flange

13 Type code

BTL7 - A 1 1 0 - M0500 - B - S32

Interface:
A = Analog interface, voltage output 0…10 V
G = Analog interface, voltage output –10…10 V
C = Analog interface, current output 0…20 mA
E = Analog interface, current output 4…20 mA

Supply voltage:
1 = 20…28 V DC
5 = 10…30 V DC

Output gradient:
00 = Rising (e.g. C_00 = 0…20 mA); only with BTL7-C/E
10 = Rising + falling (e.g. A_10 = 10…0 V and 0…10 V); only with BTL7-A/G
70 = Falling (e.g. C_70 = 20…0 mA); only with BTL7-C/E

Nominal stroke (4-digit):
M0500 = Metric specification in mm, nominal length 500 mm
(M0025…M1016: A8, B8, Y8, Z8)
(M0025…M7620: A, B, Y, Z)

Rod version, fastening:
A = Metric mounting thread M18x1.5, for flat seal, rod diameter 10.2 mm
B = Metric mounting thread M18x1.5, O-ring, rod diameter 10.2 mm
Y = 3/4"-16UNF thread, for flat seal, rod diameter 10.2 mm
Z = 3/4"-16UNF thread, O-ring, rod diameter 10.2 mm
A8 = Metric mounting thread M18x1.5, for flat seal, rod diameter 8 mm
B8 = Metric mounting thread M18x1.5, O-ring, rod diameter 8 mm
Y8 = 3/4"-16UNF thread, for flat seal, rod diameter 8 mm
Z8 = 3/4"-16UNF thread, O-ring, rod diameter 8 mm

Electrical connection:
S32 = 8-pin, M16 plug per IEC 130-9
S115 = 8-pin, M12 plug
S135 = 6-pin, M16 plug per IEC 130-9
S140 = 10-pin, plug
KA05 = Cable, 5 m (PUR)
FA05 = Cable, 5m (PTFE)

14 Appendix

14.1 Converting units of length

1 mm = 0.0393700787 inch

mm	inches
1	0.03937008
2	0.07874016
3	0.11811024
4	0.15748031
5	0.19685039
6	0.23622047
7	0.27559055
8	0.31496063
9	0.35433071
10	0.393700787

Tab. 14-1: Conversion table mm to inches

1 inch = 25.4 mm

inches	mm
1	25.4
2	50.8
3	76.2
4	101.6
5	127
6	152.4
7	177.8
8	203.2
9	228.6
10	254

Tab. 14-2: Conversion table inches to mm

14.2 Part label

1) Order code
2) Type
3) Serial number

Fig. 14-1: BTL7 part label (example)

857628_AA · EN · H23; Subject to modification. Replaces L19.