Micropulse Transducer - Rod Style

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BTL7-A/C/E/G_ _ _-M_ _ _ _-A/B/Y/Z(8)-S32/S115/S135/KA_ 
Micropulse Transducer - Rod Style

1 Notes to the user

1.1 Validity
This guide describes the construction, function and setup options for the BTL7 Micropulse Transducer with analog interface. It applies to types BTL7-A/C/E/G_ _ _-M_ _ _ _-A/B/Y/Z(8)-S32/S115/S135/KA_ (see Ordering code on page 25).

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

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

Note, tip
This symbol indicates general notes.

These symbols indicate the buttons on the calibration device.

Symbols of this type indicate the LED displays.

1.3 Scope of delivery
= BTL7 transducer
= Calibration device
= Condensed guide

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

1.4 Approvals and markings


The transducer meets the requirements of the following generic standards:
= EN 61000-6-2 (noise immunity)
= EN 61000-6-4 (emission)

Emission tests:
= RF emission
  EN 55016-2-3 Group 1, classes A and B

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

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

UL approval
File no. E227266

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

2.1 Intended use
The BTL7 Micropulse Transducer, together with a machine controller (e.g. PLC), comprises a position measuring system. It is intended to be installed into a machine or system. 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 transducer or non-approved use are not permitted and will result in the loss of warranty and liability claims against the manufacturer.

2.2 General safety notes for the position measuring system

Installation and startup may only be performed by trained specialists with basic electrical knowledge. Specialists are those who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge, and experience, as well as their understanding of the relevant regulations pertaining to the work to be done.

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 position measuring system will not result in hazards to persons or equipment. If defects and unresolvable faults occur in the transducer, it should be taken out of service and secured against unauthorized use.

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

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

<table>
<thead>
<tr>
<th>SIGNAL WORD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard type and source</td>
</tr>
<tr>
<td>Consequences if not complied with</td>
</tr>
<tr>
<td>▶ Measures to avoid hazards</td>
</tr>
</tbody>
</table>

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.

2.4 Disposal

▶ Observe the national regulations for disposal.
**Construction and function**

Output signal with rising characteristic:

- **Null point**: 0 %
- **End point**: 100 %

**Nominal length:** Defines the available measuring range. Rods with various nominal lengths from 25 mm to 7600 mm are available depending on the version:
- Ø 10.2 mm: Nominal length from 25 mm to 7600 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 transducer.

**Electrical connection:** The electrical connection is made via a cable or a connector (see Ordering code on page 25).

**BTL housing:** Aluminum housing containing the processing electronics.

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

**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 23).

**Nominal length:** Defines the available measuring range. Rods with various nominal lengths from 25 mm to 7600 mm are available depending on the version:
- Ø 10.2 mm: Nominal length from 25 mm to 7600 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 transducer.
3.2 Function

The Micropulse Transducer 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 speed.

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

![LED display diagram]

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

In normal operation LED 1 indicates the operating states of the transducer. Both LEDs together are used for displaying additional information in programming mode (see page 16 ff).

<table>
<thead>
<tr>
<th>LED 1</th>
<th>LED 2</th>
<th>Operating state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Off</td>
<td><strong>Normal function</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Magnet is within the measuring range.</td>
</tr>
<tr>
<td>Flashing red</td>
<td>red</td>
<td><strong>Measuring range left</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Magnet is outside the measuring range.</td>
</tr>
<tr>
<td>Red</td>
<td></td>
<td><strong>Error</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No magnet or magnet outside the limits.</td>
</tr>
</tbody>
</table>

Tab. 3-1: LED displays in normal operation
4.1 Installation guidelines

Non-magnetizable material

If using non-magnetizable material, the transducer 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).

Magnetizable material

If using magnetizable material, the transducer 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).

4.2 Preparing for installation

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

Horizontal assembly: If installing horizontally with nominal lengths > 500 mm, we recommend tightening the outer rod at the end (only possible with Ø 10.2 mm) or supporting it.

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: The transducer comes with an M18x1.5 (ISO) or 3/4"-16UNF (SAE) mounting thread. Depending on the version, a mounting hole must be made before assembly.

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

<table>
<thead>
<tr>
<th>Tube diameter</th>
<th>Bore diameter D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2 mm</td>
<td>At least 13 mm</td>
</tr>
<tr>
<td>8 mm</td>
<td>At least 11 mm</td>
</tr>
</tbody>
</table>

Magnet: Various magnets are available for the BTL7 transducer (see Accessories on page 23).
4.3 Installing the transducer

**NOTICE!**

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

- The mounting surface of the transducer 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 transducer with mounting thread into the mounting hole (max. torque 100 Nm).
- Install the magnet (accessories).
- For nominal lengths > 500 mm: Tighten the outer rod at the end (only possible with Ø 10.2 mm) or support it.

Suitable nuts for the mounting thread are available as accessories (see page 23).

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.

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.

The sliding element can be screwed on or bonded.
- Secure the screws so they cannot be loosened or lost.
- Select a suitable adhesive.

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)

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

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

An example of how to install the transducer with a supporting rod is shown in Fig. 4-8 on page 10.
### 4 Installation and connection (continued)

#### 4.4 Electrical connection

Depending on the model, the electrical connection is made using a cable (BTL7...-KA) or a connector (BTL7...-S32, BTL7...-S115, BTL7...-S135). The connection or pin assignments for the respective version can be found in Tables 4-2 to 4-5.

Note the information on shielding and cable routing on page 11.

---

**4.4.1 Connector type S32**

<table>
<thead>
<tr>
<th>Pin</th>
<th>-A_10</th>
<th>-G_10</th>
<th>-C_00</th>
<th>-C_70</th>
<th>-E_00</th>
<th>-E_70</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>0 to 20 mA</td>
<td>20 to 0 mA</td>
<td>4 to 20 mA</td>
<td>20 to 4 mA</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>0 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10 to 0 V</td>
<td>10 to −10 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>La (programming input)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0 to 10 V</td>
<td>−10 to 10 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Lb (programming input)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>GND(^1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>20 to 28 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 to 30 V</td>
</tr>
</tbody>
</table>

\(^1\) 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

---

**4.4.2 Connector type S115**

<table>
<thead>
<tr>
<th>Pin</th>
<th>-A_10</th>
<th>-G_10</th>
<th>-C_00</th>
<th>-C_70</th>
<th>-E_00</th>
<th>-E_70</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>0 V (pin 3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>0 V (pin 5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10 to 0 V</td>
<td>10 to −10 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>La (programming input)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0 to 10 V</td>
<td>−10 to 10 V</td>
<td>0 to 20 mA</td>
<td>20 to 0 mA</td>
<td>4 to 20 mA</td>
<td>20 to 4 mA</td>
</tr>
<tr>
<td>8</td>
<td>Lb (programming input)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>GND(^1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>20 to 28 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 to 30 V</td>
</tr>
</tbody>
</table>

\(^1\) 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. 4-9:** Pin assignment of S32 (view of connector pins of transducer), 8-pin M16 circular plug

**Fig. 4-10:** Pin assignment of S115 (view of connector pins of transducer), 8-pin M12 circular plug
### 4.4.3 Connector type S135

<table>
<thead>
<tr>
<th>Pin</th>
<th>Pin assignment</th>
<th>Pin assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 to 10 V</td>
<td>-10 to 10 V</td>
</tr>
<tr>
<td>2</td>
<td>0 V (pin 1)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10 to 0 V</td>
<td>10 to -10 V</td>
</tr>
<tr>
<td>4</td>
<td>0 V (pin 3)</td>
<td></td>
</tr>
</tbody>
</table>

*BTL7-_1_ _-...*  *BTL7-_5_ _-...*

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

### 4.4.4 Cable connection KA_ _

<table>
<thead>
<tr>
<th>Cable color</th>
<th>Pin assignment</th>
<th>Pin assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>YE yellow</td>
<td>Not used¹</td>
<td>0 to 20 mA</td>
</tr>
<tr>
<td>GY gray</td>
<td></td>
<td>0 V</td>
</tr>
<tr>
<td>PK pink</td>
<td>10 to 0 V</td>
<td>10 to -10 V</td>
</tr>
<tr>
<td>RD red</td>
<td>La (programming input)</td>
<td></td>
</tr>
<tr>
<td>GN green</td>
<td>0 to 10 V</td>
<td>-10 to 10 V</td>
</tr>
<tr>
<td>WH white</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*BTL7-_1_ _-...*  *BTL7-_5_ _-...*

Tab. 4-5: Connection assignment BTL7...-KA_ _

### 4.5 Shielding and cable routing

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

**Shielding**
To ensure electromagnetic compatibility (EMC), observe the following:
- Connect the transducer and controller using a shielded cable.
  - Shielding: Copper filament braided, at least 85% coverage.
- Connector version: Shield is interally connected to connector housing.
- Cable version: On the transducer 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. It is important to maintain adequate distance between the transducer cylinder and strong, external magnetic fields.

**Cable routing**
Do not route the cable between the transducer, controller, and power supply near high voltage cables (inductive stray noise is possible).

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

**Cable length**

<table>
<thead>
<tr>
<th>Cable</th>
<th>Max. length</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTL7-A/G</td>
<td>Max. 30 m¹</td>
</tr>
<tr>
<td>BTL7-C/E</td>
<td>Max. 100 m¹</td>
</tr>
</tbody>
</table>

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.

- 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 transducer, if necessary.

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

5.2 Operating notes

- Check the function of the transducer and all associated components on a regular basis.
- Take the position measuring system out of operation whenever there is a malfunction.
- Secure the system against unauthorized use.
6 Calibration procedure

6.1 Calibration device
The calibration device is an additional device for calibrating the transducer.
- Before calibrating: Place the calibration device on the connection side of the transducer.
- 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.

Calibration device in place
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 16.

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 17 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 19.

Setting start and end values while the system is running.

6.3.4 Reset

The detailed procedure for the reset is described on page 20.

Restoring the transducer to its factory settings.

6.4 Selecting the calibration procedure

Fig. 6-6: Selecting the calibration procedure
6.5 Calibration procedure notes

Prerequisites
- The calibration device is in place or the programming inputs are connected.
- The transducer is connected to the system controller.
- Voltage or current values from the transducer 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.

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

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

<table>
<thead>
<tr>
<th>Output gradient</th>
<th>Linear transducer</th>
<th>Unit</th>
<th>Min. value</th>
<th>Null value</th>
<th>Identification for adjustment</th>
<th>Identification for teach-in</th>
<th>End value</th>
<th>Max. value</th>
<th>Error value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rising</td>
<td>BTL7-A...</td>
<td>V</td>
<td>-0.5</td>
<td>0</td>
<td>2.0</td>
<td>4.0</td>
<td>+10.0</td>
<td>+10.5</td>
<td>+10.5</td>
</tr>
<tr>
<td></td>
<td>BTL7-G...</td>
<td>V</td>
<td>-10.5</td>
<td>-10.0</td>
<td>2.0</td>
<td>4.0</td>
<td>+10.0</td>
<td>+10.5</td>
<td>+10.5</td>
</tr>
<tr>
<td></td>
<td>BTL7-C...</td>
<td>mA</td>
<td>0</td>
<td>0</td>
<td>6.0</td>
<td>12.0</td>
<td>20.0</td>
<td>20.4</td>
<td>20.4</td>
</tr>
<tr>
<td></td>
<td>BTL7-E...</td>
<td>mA</td>
<td>3.6</td>
<td>4.0</td>
<td>6.0</td>
<td>12.0</td>
<td>20.0</td>
<td>20.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Falling</td>
<td>BTL7-A...</td>
<td>V</td>
<td>+10.5</td>
<td>+10.0</td>
<td>8.0</td>
<td>6.0</td>
<td>0</td>
<td>-0.5</td>
<td>-0.5</td>
</tr>
<tr>
<td></td>
<td>BTL7-G...</td>
<td>V</td>
<td>+10.5</td>
<td>+10.0</td>
<td>-2.0</td>
<td>-4.0</td>
<td>-10.0</td>
<td>-10.5</td>
<td>-10.5</td>
</tr>
<tr>
<td></td>
<td>BTL7-C...</td>
<td>mA</td>
<td>20.4</td>
<td>20.0</td>
<td>14.0</td>
<td>8.0</td>
<td>0</td>
<td>0</td>
<td>20.4</td>
</tr>
<tr>
<td></td>
<td>BTL7-E...</td>
<td>mA</td>
<td>20.4</td>
<td>20.0</td>
<td>14.0</td>
<td>8.0</td>
<td>4.0</td>
<td>3.6</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Tab. 6-1: Value table for teach-in and adjustment
NOTICE!
Interference in function
Teach-in while the system is running may result in malfunctions.
▶ Stop the system before performing teach-in.

Initial situation:
- Transducer with magnet within measuring range

1. Activate buttons
  ► Hold down any button for at least 3 s.
  ► Release button.
  ► Within 1 s, hold down  and  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  for at least 2 s.
    ⇒ Indication for "Teach-in" is displayed.
  ► Release  .
    ⇒ Current position value is displayed.

3. Set null point
  ► Bring magnet to the new null point.
  ► Hold down  for at least 2 s.
    ⇒ The new null point is set.

4. Set end point
  ► Bring magnet to the new end point.
  ► Hold down  for at least 2 s.
    ⇒ The new end point is set.

5. Exit teach-in and deactivate buttons
  ► Hold down  and  simultaneously for at least 6 s.
    ⇒ Output indicates error value.
  ► Briefly press  or  (< 1 s).
    ⇒ Buttons are deactivated.
    ⇒ Current position value is displayed.

LED display
Displayed values (example)

LED1 LED2
At 0 to 10 V At 4 to 20 mA

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

Interference in function
Adjustment while the system is running may result in malfunctions.
► Stop the system before performing adjustment.

Initial situation:
- Transducer with magnet within measuring range

1. Activate buttons
  ► Hold down any button for at least 3 s.
  ► Release button.
  ► Within 1 s, hold down 1 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 1 for at least 2 s.
    ⇒ Indication for “Adjust start value” is displayed.
  ► Adjust start value.
    ⇒ The start value can be changed using 1 and 2. The gradient of the output remains constant (see page 14).

► Exit calibration procedure: Press 1 and 2 for no more than 2 s.
    ⇒ Indication for “Adjustment” is displayed.
    ⇒ Set position value is saved.

LED display | Displayed values (example)
--- | ---
LED1 | LED2 | At 0 to 10 V | At 4 to 20 mA
5.39 V | 9.15 mA
10.50 V | 3.60 mA
2.00 V | 6.00 mA
1.04 V | 4.82 mA
0.00 V | 4.00 mA
1.04 V | 4.82 mA
1.00 V | 4.40 mA
2.00 V | 6.00 mA
1.00 V | 4.40 mA

Adjust end value (see page 18)

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

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.
4. Adjust end value
   - Bring magnet to end position.
   - Hold down \( \text{②} \) for at least 2 s.
     ⇒ Indication for “Adjust end value” is displayed.
   - Adjust end value
     ⇒ The end value can be changed using \( \text{②} \) and \( \text{③} \). The gradient of the output is changed, but the zero value remains unchanged (see page 14).

   - Exit calibration procedure: Press \( \text{①} \) and \( \text{②} \) for no more than 2 s.
     ⇒ Indication for “Adjustment” is displayed.
     ⇒ Set position value is saved.

   \[\text{Check values}\]
   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 \( \text{①} \) and \( \text{③} \) simultaneously for at least 6 s.
     ⇒ Output indicates error value.
   - Briefly press \( \text{①} \) or \( \text{③} \) (< 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 \( \mu \)A.
   If a button is held down longer than 1 s, the step interval is increased.
Calibration using online setting

1. Set start value online:
   - Move the system so that the magnet is in the start position.
   - Hold down  for at least 3 s.
   - Hold down  and additionally press  for at least 3 s.

   ⇒ Buttons are activated.
   - Set start value.
     ⇒ Using  and , you can change the start value within the permissible setting range. The gradient of the output remains constant (see page 14).
   - Exit setting (do not press a button for at least 15 s).
     ⇒ The start value is saved, the buttons are deactivated.

   1) 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  for at least 3 s.
   - Hold down  and additionally press  for at least 3 s.

   ⇒ Buttons are activated.
   - Set end value.
     ⇒ Using  and , you can change the end value within the permissible setting range. The gradient of the output is changed, but the zero value remains unchanged (see page 14).
   - 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.
**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 1 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 1 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.
11.1 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, BTL-P-1014-2R or BTL-P-0814-GR-PAF 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 5.5 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 (nominal length = 500 mm, magnet in the middle of the measuring range): ≤ 30 ppm/K

Max. detectable speed: 10 m/s

11.2 Ambient conditions

Operating temperature: -40°C to +85°C
Storage temperature: -40°C to +100°C
Relative humidity: < 90%, non-condensing

Outer rod pressure rating (when installed in hydraulic cylinders)
- For Ø 8 mm: ≤ 250 bar
- For Ø 10.2 mm: ≤ 600 bar

Shock rating per EN 60068-2-27
- 150 g/6 ms

Continuous shock per EN 60068-2-29
- 150 g/2 ms

Vibration per EN 60068-2-6
- 20 g, 10 to 2000 Hz

Degree of protection per IEC 60529
- Connector S32/S115/S135 (when attached): IP67
- Cable KA_ _: IP68

1) Individual specifications as per Balluff factory standard

11.3 Supply voltage (external)

Voltage, stabilized:
- BTL7-_1_ _-...: 20 to 28 V DC
- BTL7-_5_ _-...: 10 to 30 V DC

Ripple: ≤ 0.5 V

Current draw (at 24 V DC): ≤ 150 mA

Inrush current: ≤ 500 mA/10 ms

Reverse polarity protection: 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
- Load current: 0 to 10 V and 10 to 0 V
- ≤ 5 mA

BTL7-C... Output current
- Load resistance: 0 to 20 mA/20 to 0 mA
- ≤ 500 ohms

BTL7-E... Output current
- Load resistance: 4 to 20 mA/20 to 4 mA
- ≤ 500 ohms

BTL7-G... Output voltage
- Load current: −10 to 10 V and 10 to −10 V
- ≤ 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 to 28 V DC

BTL7-_5_ _-...
- 10 to 30 V DC

Overvoltage protection: up to 36 V
## 11.6 Dimensions, weights

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of outer rod</td>
<td>8 mm or 10.2 mm</td>
</tr>
<tr>
<td>Nominal length</td>
<td></td>
</tr>
<tr>
<td>For Ø 8 mm</td>
<td>25 to 1016 mm</td>
</tr>
<tr>
<td>For Ø 10.2 mm</td>
<td>25 to 7600 mm</td>
</tr>
<tr>
<td>Weight (depends on length)</td>
<td>Approx. 2 kg/m</td>
</tr>
<tr>
<td>Housing material</td>
<td>Anodized aluminum</td>
</tr>
<tr>
<td>Outer rod material</td>
<td>Stainless steel 1.4571</td>
</tr>
<tr>
<td>Outer rod wall thickness</td>
<td></td>
</tr>
<tr>
<td>For Ø 8 mm</td>
<td>0.9 mm</td>
</tr>
<tr>
<td>For Ø 10.2 mm</td>
<td>2 mm</td>
</tr>
<tr>
<td>Young’s modulus</td>
<td>Approx. 200 kN/mm²</td>
</tr>
<tr>
<td>Housing mounting via threads</td>
<td>M18×1.5 or 3/4”-16UNF</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Max. 100 Nm</td>
</tr>
<tr>
<td>Cable diameter&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>6.7 mm</td>
</tr>
<tr>
<td>Permissible cable bending radius&lt;sup&gt;1)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Fixed routing</td>
<td>≥ 35 mm</td>
</tr>
<tr>
<td>Movable</td>
<td>≥ 105 mm</td>
</tr>
</tbody>
</table>

<sup>1)</sup> For BTL7---KA---
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**:
- Weight: Approx. 10 g
- Housing: Anodized aluminum

**BTL-P-0814-GR-PAF**:
- Weight: Approx. 2 g
- Housing: Ferrite bound in PA

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
- Operating temperature: −40°C to +60°C

**BTL-P-1028-15R** (special accessories for applications with a supporting rod):
- Weight: Approx. 68 g
- Housing: Anodized aluminum

12.2 Mounting nut

- M18×1.5 mounting nut: BTL-A-FK01-E-M18×1.5
123 Connectors and cables

**BKS-S32M-00**
Straight connector, freely configurable
M16 per IEC 130-9, 8-pin

Fig. 12-2: Connector type BKS-S32M-00

**BKS-S33M-00**
Angled connector, freely configurable
M16 per IEC 130-9, 8-pin

Fig. 12-3: Connector type BKS-S33M-00

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

Fig. 12-4: Connector type BKS-S115-PU-_ _

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

Fig. 12-5: Connector type BKS-S116-PU-_ _

**BKS-S135M-00**
Straight connector, freely configurable
M16 per IEC 130-9, 6-pin

Fig. 12-6: Connector type BKS-S135M-00

**BKS-S136M-00**
Angled connector, freely configurable
M16 per IEC 130-9, 6-pin

Fig. 12-7: Connector type BKS-S136M-00
**BTL7-A/C/E/G_ _ _ -M_ _ _ _-A/B/Y/Z(8)-S32/S115/S135/KA_ _**

**Micropulse Transducer - Rod Style**

### Ordering code

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

**Micropulse transducer**

**Interface:**
- **A** = Analog interface, voltage output 0 to 10 V
- **G** = Analog interface, voltage output -10 to 10 V
- **C** = Analog interface, current output 0 to 20 mA
- **E** = Analog interface, current output 4 to 20 mA

**Supply voltage:**
- **1** = 20 to 28 V DC
- **5** = 10 to 30 V DC

**Output gradient:**
- **00** = Rising (e.g. C_00 = 0 to 20 mA)
- **10** = Rising + falling (e.g. A_10 = 10 to 0 V and 0 to 10 V)
- **70** = Falling (e.g. C_70 = 20 to 0 mA)

**Nominal stroke (4-digit):**
- **M0500** = Metric specification in mm, nominal length 500 mm

**Rod version, fastening:**
- **A** = Metric mounting thread M18x1.5, rod diameter 10.2 mm
- **B** = Metric mounting thread M18x1.5, O-ring, rod diameter 10.2 mm
- **Y** = 3/4"-16UNF thread, rod diameter 10.2 mm
- **Z** = 3/4"-16UNF thread, O-ring, rod diameter 8 mm
- **A8** = Metric mounting thread M18x1.5, rod diameter 8 mm
- **B8** = Metric mounting thread M18x1.5, O-ring, rod diameter 8 mm
- **Y8** = 3/4"-16UNF thread, 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
- **KA05** = Cable, 5 m
14.1 Converting units of length

1 mm = 0.0393700787 inch

<table>
<thead>
<tr>
<th>mm</th>
<th>inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.03937008</td>
</tr>
<tr>
<td>2</td>
<td>0.07874016</td>
</tr>
<tr>
<td>3</td>
<td>0.11811024</td>
</tr>
<tr>
<td>4</td>
<td>0.15748031</td>
</tr>
<tr>
<td>5</td>
<td>0.19685039</td>
</tr>
<tr>
<td>6</td>
<td>0.23622047</td>
</tr>
<tr>
<td>7</td>
<td>0.27559055</td>
</tr>
<tr>
<td>8</td>
<td>0.31496063</td>
</tr>
<tr>
<td>9</td>
<td>0.35433071</td>
</tr>
<tr>
<td>10</td>
<td>0.393700787</td>
</tr>
</tbody>
</table>

Tab. 14-1: Conversion table mm to inches

1 inch = 25.4 mm

<table>
<thead>
<tr>
<th>inches</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25.4</td>
</tr>
<tr>
<td>2</td>
<td>50.8</td>
</tr>
<tr>
<td>3</td>
<td>76.2</td>
</tr>
<tr>
<td>4</td>
<td>101.6</td>
</tr>
<tr>
<td>5</td>
<td>127</td>
</tr>
<tr>
<td>6</td>
<td>152.4</td>
</tr>
<tr>
<td>7</td>
<td>177.8</td>
</tr>
<tr>
<td>8</td>
<td>203.2</td>
</tr>
<tr>
<td>9</td>
<td>228.6</td>
</tr>
<tr>
<td>10</td>
<td>254</td>
</tr>
</tbody>
</table>

Tab. 14-2: Conversion table inches to mm

14.2 Part label

Fig. 14-1: BTL7 part label