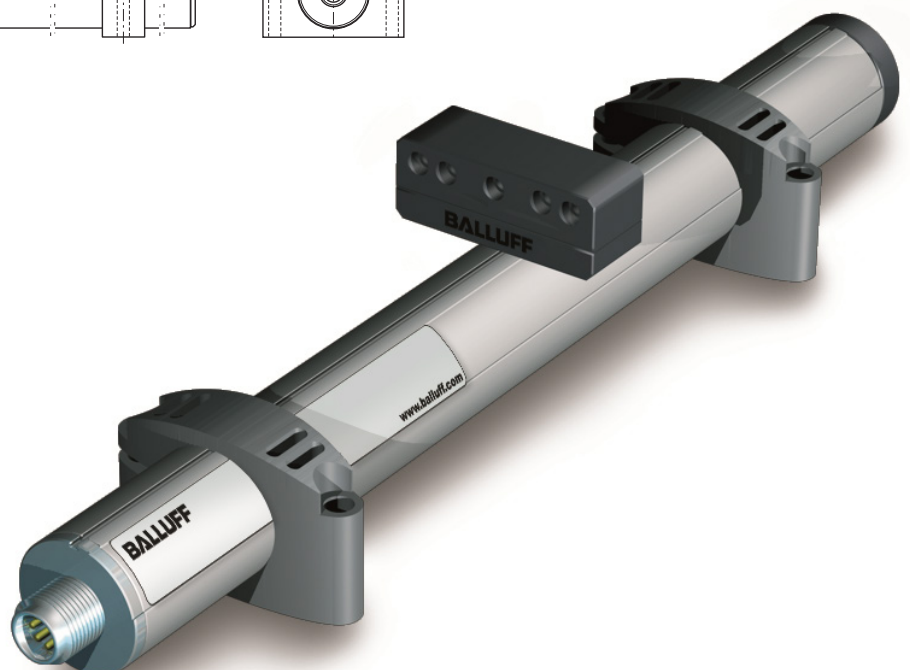
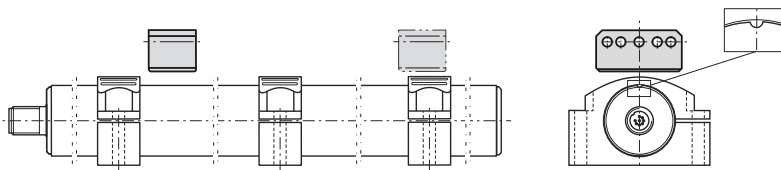


## BTL6-A/G\_1\_-M\_ \_ \_ \_-A1-S115

User's Guide



**[www.balluff.com](http://www.balluff.com)**

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# BTL6-A/G\_1\_-M\_ \_ \_ \_ -A1-S115

## Magnetostrictive Linear Position Sensor – Profile Style

### 1

#### Notes to the user

#### 1.1 Validity

This guide describes the construction, function and setup options for the BTL6 magnetostrictive linear position sensor with analog interface. It applies to models **BTL6-A/G\_1\_-M\_ \_ \_ \_ -A1-S115** (see part numbering on page 13).

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

#### 1.2 Symbols and conventions

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

- ▶ Instruction 1
- ⇒ Result

**Action sequences** are numbered consecutively:

1. Instruction 1
2. Instruction 2



#### Note, tip

This symbol indicates general notes.

#### 1.3 Scope of delivery

- BTL
- Condensed guide



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

#### 1.4 Approvals and markings



UL approval  
File no.  
E227256

#### 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



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

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 General safety notes for the linear encoder system

**Installation** and **startup** may only be performed by trained specialists with basic electrical knowledge.

**Qualified personnel** are persons whose technical training, knowledge and experience as well as knowledge of the relevant regulations allows him to assess the work assigned to him, 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.


2.3 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:

<b>SIGNAL WORD</b>
<p><b>Type and source of the hazard</b>                  Consequences if not complied with                  ► Measures to avoid hazards</p>

The individual signal words mean:

<b>NOTICE</b>
<p>Identifies a danger that could <b>damage</b> or <b>destroy the product</b>.</p>
 <b>DANGER</b>
<p>The general warning symbol in conjunction with the signal word <b>DANGER</b> identifies a hazard which, if not avoided, will certainly result in <b>death</b> or <b>serious injury</b>.</p>

2.4 Disposal

- Observe the national regulations for disposal.

# BTL6-A/G\_1\_-M\_...-A1-S115

## Magnetostrictive Linear Position Sensor – Profile Style

### 3

#### Construction and function

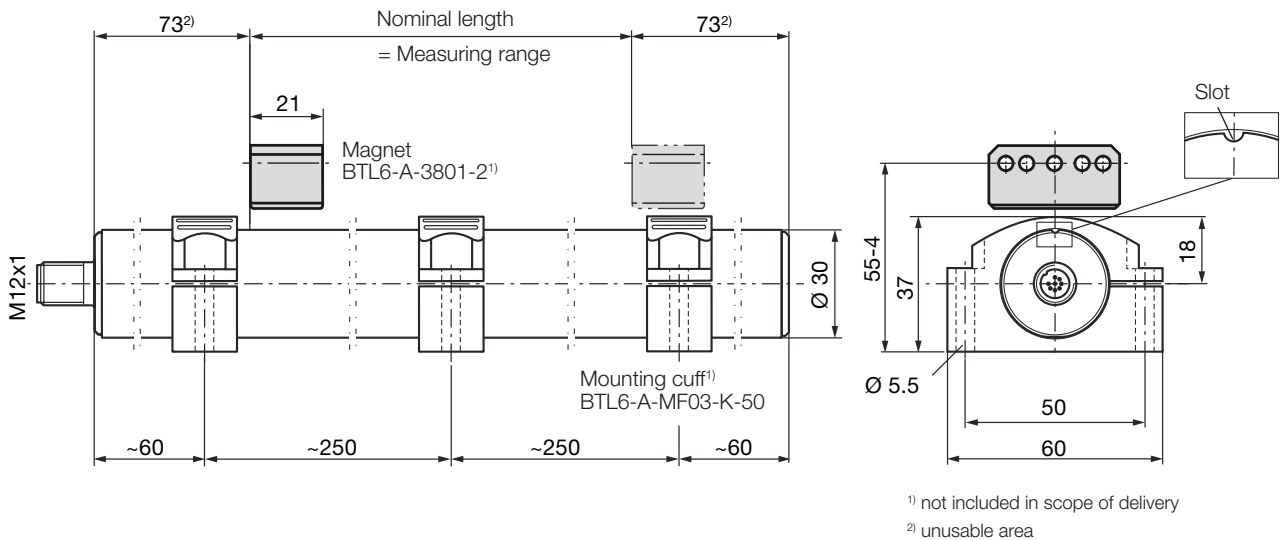


Fig. 3-1: BTL6..., construction

#### 3.1 Construction

**Electrical Connection:** The electrical connection is made using a connector.

**Housing:** Aluminum, contains the processing electronics.

**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 11).

**Nominal length:** The following standard nominal lengths are available for compatibility with any application:

	Nominal length
BTL6-A/G...	50...1500

#### 3.2 Function

The BTL contains the waveguide which is protected by an aluminum housing. 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 a 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 is determined from the propagation time of the wave. This is output as a voltage which is either rising or falling.

When there is no magnet within the measuring area, a voltage of approx. 10.5 V is output as an error signal.

**4**

**Installation and connection**

**4.1 Installing the BTL**

**NOTICE**

**Improper installation**

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

- ▶ Ensure that no strong electrical or magnetic fields are present in the direct vicinity of the BTL.
- ▶ Be sure to maintain the specified distances and separations.

Note when installing the magnet:

- To ensure the accuracy of the magnetostrictive linear position sensor, fasten the magnet to the moving member of the machine only using non-magnetizable screws (stainless steel, brass, aluminum).
- The moving member must guide the magnet on a parallel line to the BTL.
- Distance A between the magnet and parts made of magnetizable material must be kept to at least 10 mm (see Fig. 4-1 and Fig. 4-2).
- For distance B between the magnet and the BTL and for the center offset C (see Fig. 4-1 and Fig. 4-2) the following values must be maintained:

Magnet type	Distance B <sup>1)</sup>	Offset C
BTL6-A-3800-2	4...8 mm <sup>2)</sup>	± 5 mm
BTL6-A-3801-2	4...8 mm <sup>2)</sup>	± 5 mm

<sup>1)</sup> The selected distance must remain constant over the entire stroke length.

<sup>2)</sup> For optimal measuring results a distance B of 6...8 mm is recommended.

Tab. 4-1: Distance and offset for magnets (see Fig. 4-1 and Fig. 4-2)

The BTL is installed on a flat surface of the machine using mounting clamps or cuffs (available accessories). Any orientation is permitted. Note the recommended spacing for the location of clamps or cuffs (see Fig. 3-1 on page 6).

1. Slide BTL into the mounting clamps or cuffs.
2. Align BTL slot in the direction of the magnet(s)!
3. Attach the BTL to the base (tighten screws in clamps or cuffs to max. 4 Nm tightening torque).
4. Installing magnet (accessory).



Check orientation of the BTL. If the slot is not in the direction of the magnet, the mounting screws must be loosened and steps 2 and 3 repeated.

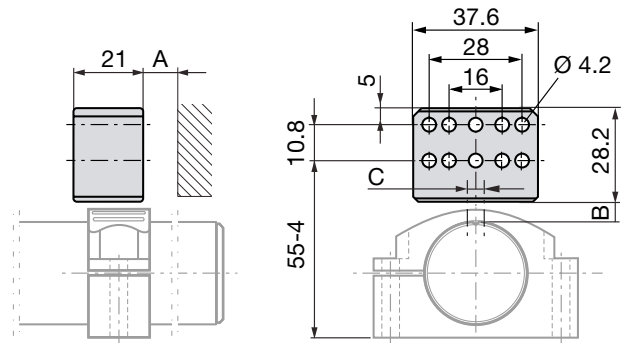


Fig. 4-1: Dimensions and spacing with magnet BTL6-A-3800-2

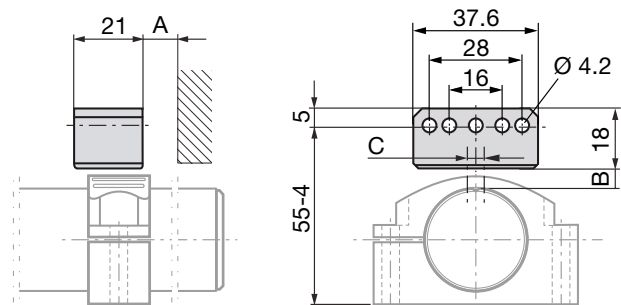


Fig. 4-2: Dimensions and spacing with magnet BTL6-A-3801-2

# BTL6-A/G\_1\_-M\_...-A1-S115

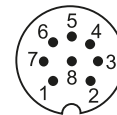
## Magnetostrictive Linear Position Sensor – Profile Style

### 4 Installation and connection (continued)

#### 4.2 Electrical Connection

The BTL is connected using a plug connection (see Accessories on page 12).

Pin	BTL6-A_1_-...	BTL6-G_1_-...
1	0 V <sup>1)</sup>	
2	0 V <sup>1)</sup>	
3	10...0 V <sup>2)</sup>	+10...-10 V <sup>2)</sup>
4	Must remain free	
5	0...10 V <sup>2)</sup>	-10...+10 V <sup>2)</sup>
6	GND <sup>3)</sup> 4)	
7	20...28 V	
8	Must remain free	



Pin assignment of S115 (view from above on BTL connector), 8-pin M12 circular plug

- <sup>1)</sup> Reference potential for output  
<sup>2)</sup> When there is no magnet within the measuring area, a voltage of approx. 10.5 V is output as an error signal.  
<sup>3)</sup> Reference potential for supply voltage and EMC-GND.  
<sup>4)</sup> BTL6-**31**-...: potential-isolated (GND is not connected to 0 V).

Tab. 4-2: Pin assignment of S115 connector

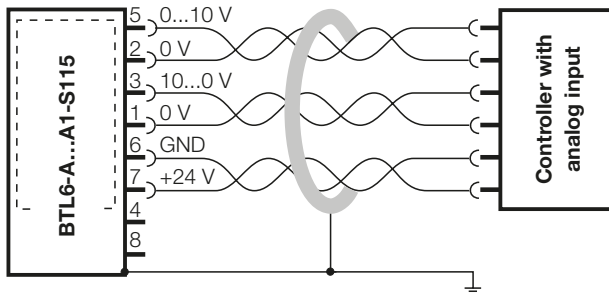


Fig. 4-3: Connection example BTL6-A/G...A1-S115 to controller

#### 4.3 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 BTL and controller using a shielded cable. Shielding: Braided copper shield with minimum 85% coverage.
- Shield is internally connected to connector housing.

##### Magnetic fields

The position measuring system is a magnetostrictive system. Be sure to provide sufficient distance of the BTL from 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.

##### Cable length

BTL6-A/G...	Max. 20 m <sup>1)</sup>
-------------	-------------------------

<sup>1)</sup> Longer cables may be used if their construction, shielding and routing prevent noise interference.

Tab. 4-3: Cable length BTL6-A/G...



**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 (especially after replacing the BTL).

**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.

# BTL6-A/G\_1\_-M\_ \_ \_ -A1-S115

## Magnetostrictive Linear Position Sensor – Profile Style

### 6

#### Technical data

##### 6.1 Accuracy

The values are typical at 24 V DC, room temperature and a nominal length of 500 mm together with magnet BTL6-A-3800-2 or BTL6-A-3801-2.

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.

Resolution	
BTL6- <b>A</b> ...	≤ ±0,2 mV/ ≤ ±10 μm
BTL6- <b>G</b> ...	≤ ±0,4 mV/ ≤ ±10 μm
Repeat accuracy, typical	≤ ±0,2 mV/ ≤ ±10 μm
Sampling rate	
BTL6- _ _ <b>11</b>	
nominal length ≤ 275 mm	4 kHz
nominal length ≤ 600 mm	2 kHz
BTL6- _ _ <b>10</b>	
nominal length ≤ 1100 mm	1 kHz
nominal length > 1100 mm	0,5 kHz
Non-linearity at	
nominal length ≤ 500 mm	± 200 μm
nominal length > 500 mm	±0.04 % FS (typ. ±0.02 % FS)
Temperature coefficient <sup>1)</sup>	≤ 30 ppm/K

##### 6.2 Ambient conditions

Ambient temperature	0 °C...+70 °C
Storage temperature	-40 °C...+100 °C
Relative humidity	< 90%, non-condensing
Continuous shock per EN 60068-2-27 <sup>2)</sup>	50 g/6 ms 50 g/2 ms
Vibration per EN 60068-2-6 <sup>2)</sup>	12 g, 10 ...2000 Hz
Degree of protection as per IEC 60529 with connector installed	IP67

##### 6.3 Power supply

Stabilized voltage <sup>3)</sup>	
BTL6- _ 1 _ -...	20...28 V DC
BTL6- _ 3 _ -...	20...28 V DC
Ripple	≤ 0.5 V <sub>pp</sub>
Current draw (at 24 V DC)	≤ 100 mA
Inrush current	≤ 3 A
Reverse polarity protection	to 36 V
Overvoltage protection	up to 33 V (power lines only)
Dielectric strength (GND to housing)	500 V DC

##### 6.4 Output signals


Output voltage	
BTL6- <b>A</b> ...	0...+10 V
BTL6- <b>G</b> ...	-10...+10 V
Load current	≤ 5 mA

##### 6.5 Dimensions, weights

Housing diameter	30 mm
Nominal length	50...1500 mm
Weight (depends on length)	Approx. 1 kg/m
Housing material	Aluminum

<sup>1)</sup> Nominal length = 500 mm, magnet in the middle of the measuring range

<sup>2)</sup> Individual specifications as per Balluff factory standard, resonant frequencies excluded

<sup>3)</sup> For : 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.

# BTL6-A/G\_1\_-M\_\_\_\_-A1-S115 Magnetostrictive Linear Position Sensor – Profile Style

## 7

### Accessories

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

#### 7.1 Magnets

##### BTL6-A-3800-2

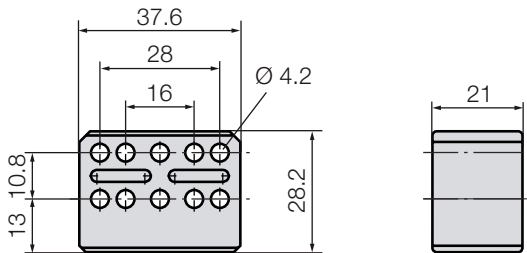


Fig. 7-1: Installation dimensions for BTL6-A-3800-2

Weight: Approx. 30 g  
Housing: Plastic  
Ambient temperature: -40 °C...+85 °C

##### BTL6-A-3801-2

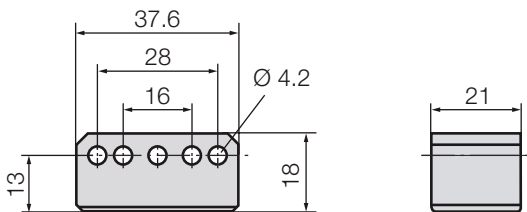


Fig. 7-2: Installation dimensions for BTL6-A-3801-2

Weight: Approx. 25 g  
Housing: Plastic  
Ambient temperature: -40 °C...+85 °C

#### 7.2 Mounting brackets/cuff

##### BTL6-A-MF01-A-43

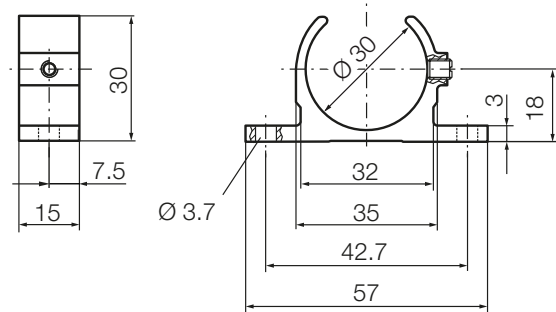


Fig. 7-3: Mounting bracket BTL6-A-MF01-A-43

Material: Anodized

##### BTL6-A-MF01-A-50

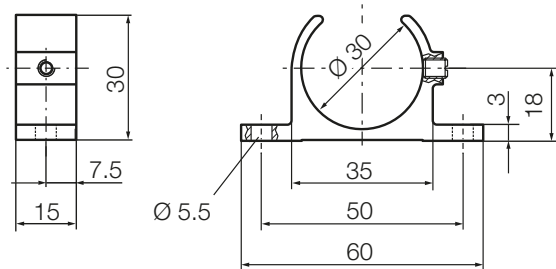


Fig. 7-4: Mounting bracket BTL6-A-MF01-A-50

Material: Anodized

##### BTL6-A-MF03-K-50

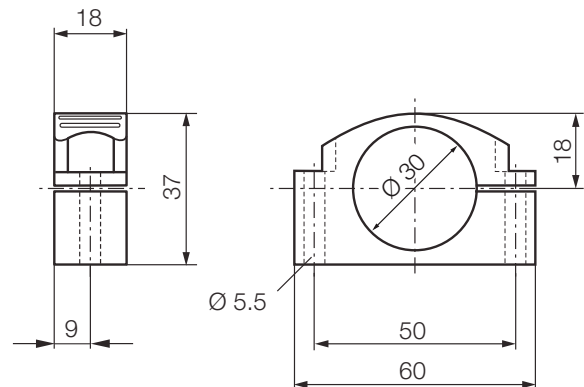


Fig. 7-5: Mounting cuff BTL6-A-MF03-K-50

Material: Plastic

**7**

**Accessories (continued)**

**7.3 Connectors**

**BKS-S115-PU- \_ \_**

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

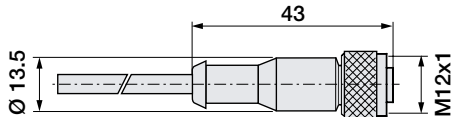


Fig. 7-6: Connector type BKS-S115-PU- \_ \_

**BKS-S116-PU- \_ \_**

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

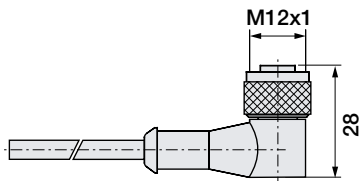


Fig. 7-7: Connector BKS-S116-PU- \_ \_

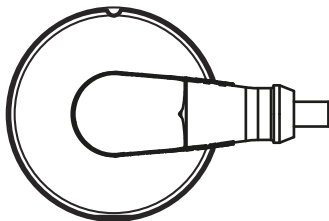


Fig. 7-8: Connector BKS-S116-PU- \_ \_ , outlet

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. 7-1: BKS-S115/116-PU- \_ \_ pin assignment

**BTL6-A/G\_1\_-M\_\_\_\_-A1-S115**  
**Magnetostrictive Linear Position Sensor – Profile Style**

**8**

**Type code**

**BTL6 - A 1 10 - M0500 - A1 - S115**

Interface

A = 0...+10 V  
 G = -10...+10 V

Supply voltage

1 = 20...28 V DC  
 3 = 20...28 V DC (potential-isolated)

Outputs/sampling rate

10 = rising + falling (e.g. A\_10 = 10...0 V and 0...10 V); sampling rate 1 kHz  
 11 = rising + falling (e.g. A\_10 = 10...0 V and 0...10 V);  
 sampling rate 4 kHz at nominal length ≤ 275 mm, 2 kHz at nominal length ≤ 600 mm

Nominal length (4-digit)

M0500 = Metric specification in mm, nominal length 500 mm  
 (M0050...M1500)

Style

A1 = Profile housing, diameter 30 mm

Electrical Connection

S115 = 8-pin, M12 plug

# BTL6-A/G\_1\_-M\_ \_ \_ -A1-S115

## Magnetostrictive Linear Position Sensor – Profile Style

### 9

#### Appendix

#### 9.1 Converting units of length

1 mm = 0.03937008 inches

mm	inch
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

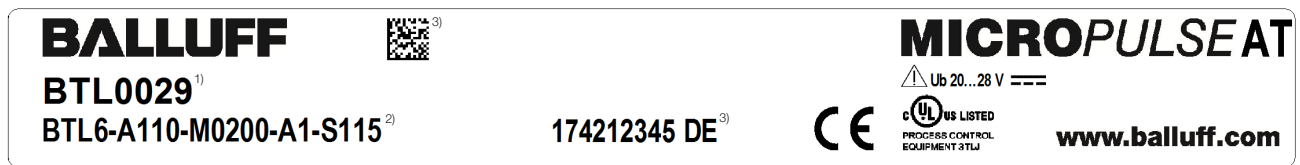
Tab. 9-1: Conversion table mm to inches

1 inch = 25.4 mm

inch	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. 9-2: Conversion table inches to mm

#### 9.2 Part label



- <sup>1)</sup> Order code
- <sup>2)</sup> Type
- <sup>3)</sup> Serial number

Fig. 9-1: Part label BTL6