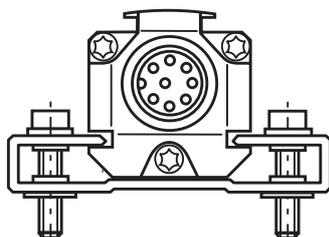


BTL5-A/C/E/G _ _ -M _ _ _ -P-S32/KA _ _

User's Guide



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BTL5-A/C/E/G __ -M ____ -P-S32/KA __ Micropulse Transducer in a Profile Housing

1

Notes to the user

1.1 Validity

This guide describes the construction, function and setup options for the BTL5 Micropulse Transducer with analog interface. It applies to types

BTL5-A/C/E/G __ -M ____ -P-S32/KA __
(see Ordering code on page 15).

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.

- ▶ Action instruction 1

Action sequences are numbered consecutively:

1. Action instruction 1
2. Handling instruction 2



Note, tip

This symbol indicates general notes.

1.3 Scope of delivery

- BTL5 transducer
- Mounting clamps with insulating sleeves and screws
- 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 EU Directive 2004/108/EC (EMC Directive).

The transducer meets the requirements of the following generic standards:

- EN 61000-6-1 (noise immunity)
- EN 61000-6-2 (noise immunity)
- EN 61000-6-3 (emission)
- EN 61000-6-4 (emission)

and the following product standard:

- EN 61326-2-3

Emission tests:

- RF emission
EN 55016-2-3 (industrial and residential areas)

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 BTL5 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.

Qualified personnel 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 conditions 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 Meaning 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 .

2.4 Disposal

- ▶ Observe the national regulations for disposal.

3

Construction and function

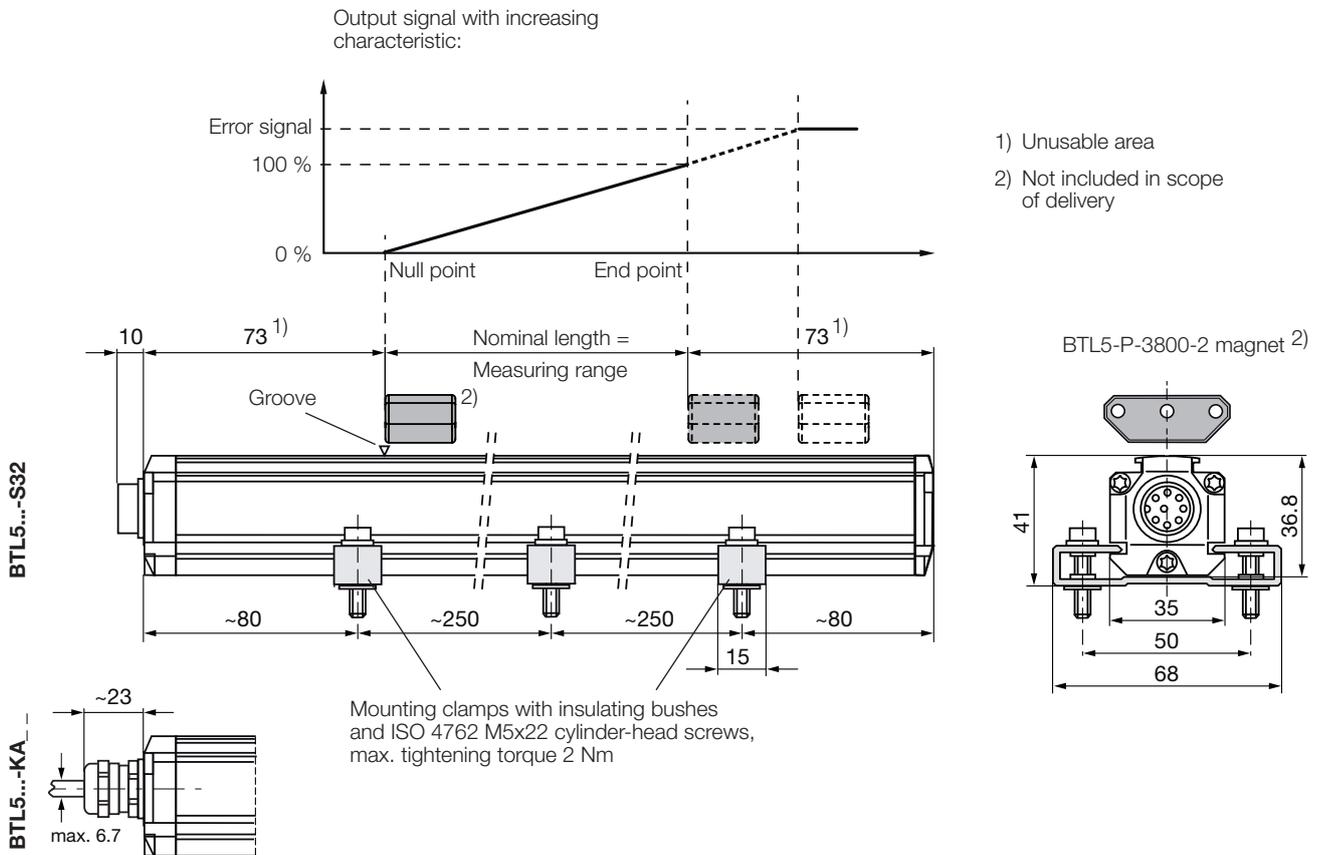


Fig. 3-1: BTL5... transducer, construction

3.1 Construction

Electrical connection: The electrical connection is made via a cable or a connector (see Ordering code on page 15).

BTL housing: Aluminum housing containing the waveguide and processing electronics. The groove on the top side of the profile marks the start of measuring range.

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 13).

Nominal length: To optimally adapt the transducer to the application, nominal lengths from 50 mm to 4572 mm are available.

3.2 Function

The BTL5 transducer 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 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 with rising or falling gradient.

4

Installation and connection

4.1 Installing the transducer

NOTICE!

Improper installation

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

- ▶ For this reason, ensure that no strong electrical or magnetic fields are present in the immediate vicinity of the transducer.
- ▶ The recommended spacing for the installation must be strictly observed.

Any orientation is permitted. Mount the transducer on a level surface of the machine using the provided mounting clamps and cylinder-head screws. A sufficient number of mounting clamps is supplied.

i In order to avoid the development of resonant frequencies from vibration loads, we recommend arranging the mounting clamps at irregular intervals.

The transducer is electrically isolated from the machine with the supplied insulating bushes (see Figure 3-1).

1. Guide the transducer into the mounting clamps.
2. Attach transducer to the base using mounting screws (tighten screws in the clamps with a max. 2 Nm).
3. Insert magnet (accessories).

i The micropulse transducer in profile housing is suitable both for floating, i.e. non-contacting magnets (see Figures 4-4 to 4-8) and for captive magnets (see Figures 4-1 to 4-3).

4.2 Captive magnets

The following must be observed when installing the magnet:

- Avoid lateral forces.
- Connect the magnet to the machine member with a joint rod (see Accessories on page 14).

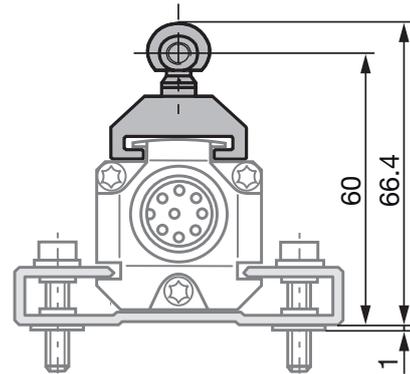


Fig. 4-1: Dimensions and distances with BTL5-F-2814-1S magnet

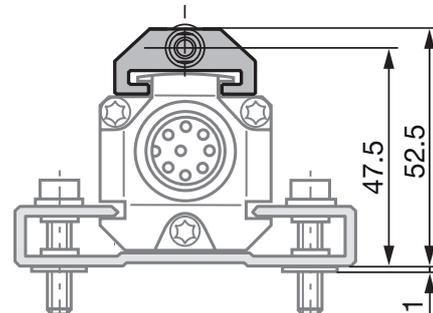


Fig. 4-2: Dimensions and distances with BTL5-T-2814-1S magnet

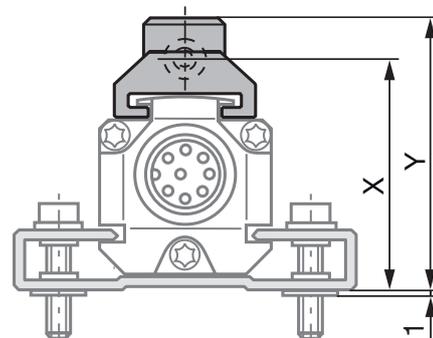


Fig. 4-3: Dimensions and distances with BTL5-M/N-2814-1S magnet

	BTL5-M-2814-1S	BTL5-N-2814-1S
Distance X	48.5 mm	57 mm
Distance Y	51 mm	59.5 mm

Tab. 4-1: Distances with BTL5-M/N-2814-1S magnet

4

Installation and connection (continued)

4.3 Floating magnets

The following must be observed when installing the magnet:

- To ensure the accuracy of the position measuring system, the magnet is attached to the moving member of the machine using non-magnetizable screws (stainless steel, brass, aluminum).
- The moving member must guide the magnet on a track parallel to the transducer.
- Ensure that the distance A between parts made of magnetizable material and the magnet is at least 10 mm (see Figures 4-4 to 4-8).
- Maintain the following values for distance B between the magnet and transducer and for center offset C (see Figures 4-4 to 4-8):

Type of magnet	Distance B	Offset C
BTL5-P-3800-2	0.1 to 4 mm	± 2 mm
BTL5-P-5500-2	5 to 15 mm	± 15 mm
BTL5-P-4500-1	0.1 to 2 mm	± 2 mm
BTL6-A-3800-2	4 to 8 mm ¹⁾	± 2 mm
BTL6-A-3801-2	4 to 8 mm ¹⁾	± 2 mm

¹⁾ For optimum measurement results, a distance B of 6 to 8 mm is recommended.

Tab. 4-2: Distance and offset for floating magnets

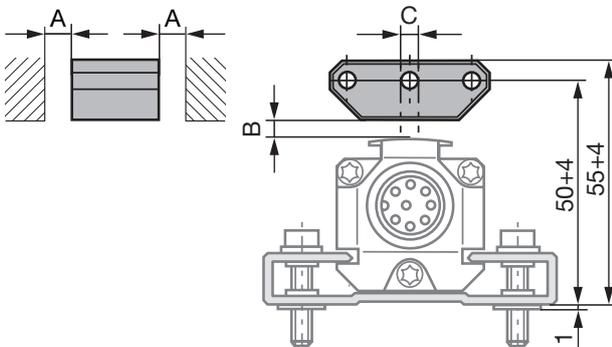


Fig. 4-4: Dimensions and distances with BTL5-P-3800-2 magnet

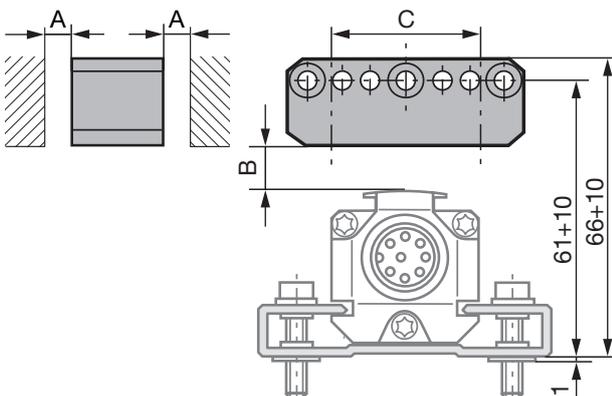


Fig. 4-5: Dimensions and distances with BTL5-P-5500-2 magnet

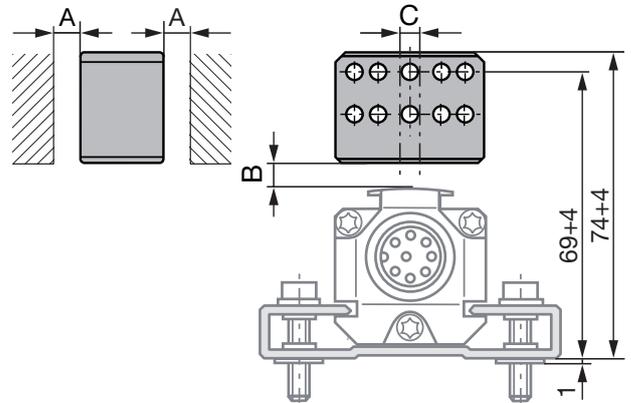


Fig. 4-6: Dimensions and distances with BTL6-A-3800-2 magnet

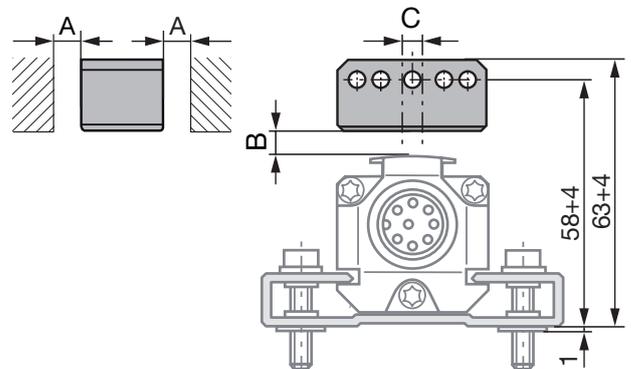


Fig. 4-7: Dimensions and distances with BTL6-A-3801-2 magnet

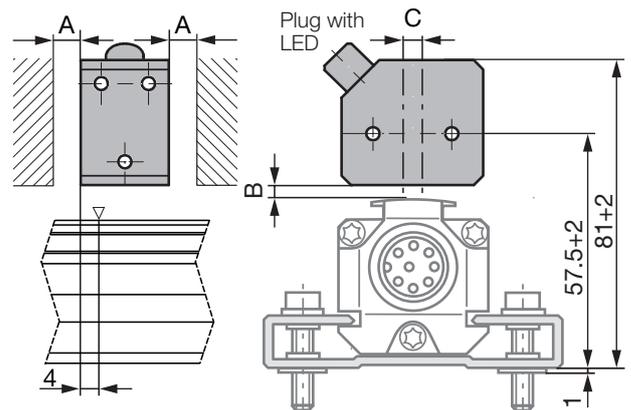


Fig. 4-8: Dimensions and distances with BTL5-P-4500-1 electromagnet (24 V/100 mA)

i The measuring range is offset by 4 mm towards the BTL plug (see Figure 4-8).

BTL5-A/C/E/G __ -M ____ -P-S32/KA __ Micropulse Transducer in a Profile Housing

4

Installation and connection (continued)

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 Table 4-3.



Note the information on shielding and cable routing on page 10.

4.4.1 Connector S32/cable connection KA __

S32 Pin	KA Cable color	-A_1	-G_1	-C_0	-C_7	-E_0	-E_7
1	YE yellow	Not used ¹⁾		0 to 20 mA	20 to 0 mA	4 to 20 mA	20 to 4 mA
2	GY gray	0 V					
3	PK pink ²⁾	10 to 0 V	10...-10 V	10 to 0 V			
4		Not used ¹⁾					
5	GN green ²⁾	0 to 10 V	-10...10 V	0 to 10 V			
		-A/C/E/G1_			-A/C/E/G2_		
6	BU blue	GND ³⁾			GND ³⁾		
7	BN brown	+24 V			+15 V		
8	WH white	Must remain free			-15 V		

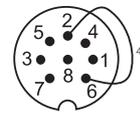


Fig. 4-9: Pin assignment of S32 connector (view of connector pins of transducer)

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

²⁾ Because of the separate output drivers there are small voltage differences between pin 3 and pin 5 (constant offset < 10 mV).

³⁾ Reference potential for supply voltage and EMC-GND.

⁴⁾ The transducer outputs are potential-free. Connecting to a controller with non-potential-free inputs may result in GND loops and malfunctions. This can be prevented by connecting pin 2 and pin 6 to each other in the connector in order to disable the potential separation in the transducer (see Figure 4-9).

Tab. 4-3: Pin assignment of connector S32/KA __

5

Startup

5.1 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 transducer and controller using a shielded cable.
Shield: Braided copper shield with minimum 80%.
- Connector version: Shield is internally connected to connector housing.
- Cable version: On the transducer side, the cable shielding is connected to the housing.

Magnetic fields

The position measuring system is a magnetostrictive system. It is important to maintain adequate distance between the transducer 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).

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

BTL5-A/G	Max. 20 m ¹⁾
BTL5-C/E	Max. 50 m ¹⁾

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

Tab. 5-1: Cable lengths BTL5

Noise elimination

To avoid equipotential bonding – a current flow – through the cable shield, please note the following:

- Use insulating bushes
- Put the control cabinet and the system in which the BTL5 is located to the same ground potential.

5.2 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 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.

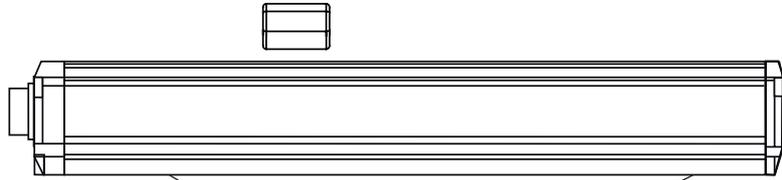
5.3 Operating notes

- 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

Outputs

6.1 Value table for outputs



Output gradient	Linear transducer	Unit	Null value	End value	Error value
Rising (output 1)	BTL5-A...	V	0	+10.0	≥ +11
	BTL5-G...	V	-10	+10.0	≥ +11
	BTL5-C...	mA	0	20	≥ 20.4
	BTL5-E...	mA	4	20	≥ 20.4
Falling (output 2)	BTL5-A...	V	+10	0	≤ -1
	BTL5-G...	V	+10	-10	≤ -10.5
	BTL5-C...	mA	20	0	0
	BTL5-E...	mA	20	4	≤ 3.2

Tab. 6-1: Value table for outputs

BTL5-A/C/E/G __ -M ____ -P-S32/KA __ Micropulse Transducer in a Profile Housing

7

Technical data

7.1 Accuracy

The specifications are typical values for BTL5-A/C/E/G... at 24 V DC and room temperature, with a nominal length of 500 mm in conjunction with the BTL5-P-3800-2, BTL5-P-4500-1, BTL5-P-5500-2¹⁾, BTL6-A-3800-2¹⁾, BTL6-A-3801-2¹⁾, BTL5-F-2814-1S, BTL5-T-2814-1S, BTL5-M-2814-1S or BTL5-N-2814-1S magnet. The BTL is fully operational immediately, with full accuracy after warm-up.

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

Resolution	
BTL5-A/G...	≤ ±0.1 mV
BTL5-C/E...	≤ ±0.16 µA
Reproducibility	≤ ±6 µm
Sampling rate f _{Standard}	1 kHz
Non-linearity with a constant distance between the magnet and profile	
Nominal length ≤ 500 mm	±100 µm
Nominal length > 500 mm	±0.02 % FS
Temperature coefficient	
Voltage output:	
[150 µV/K + (5 ppm/K * P * U/NL)] * ΔT	
Current output:	
[0.6 µA/K + (10 ppm/K * P * I/NL)] * ΔT	
Max. detectable velocity	10 m/s

7.2 Ambient conditions

Operating temperature	-40°C to +85°C
Storage temperature	-40°C to +100°C
Relative humidity	< 90%, non-condensing
Shock rating per EN 60068-2-27 ²⁾	100 g/6 ms
Continuous shock per EN 60068-2-29 ²⁾	100 g/2 ms
Vibration per EN 60068-2-6 ²⁾	12 g, 10 to 2000 Hz
Degree of protection per IEC 60529 (when attached)	IP67

7.3 Supply voltage (external)

Voltage, stabilized	
BTL5-_1...	20 to 28 V DC
BTL5-_2...	±14.7 to ±15.3 V DC
Ripple	≤ 0.5 V _{SS}
Current draw	≤ 150 mA
Inrush current	≤ 3 A/0.5 ms
Reverse polarity protection	Yes
Overvoltage protection	Transzorb diodes
Dielectric strength (GND to housing)	500 V DC

7.4 Output

BTL5-A... Output voltage	0...10/10...0 V
Load current	≤ 5 mA
Ripple	≤ 5 mV
BTL5-C... Output current	0...20/20...0 mA
Load resistance	≤ 500 ohms
BTL5-E... Output current	4...20/20...4 mA
Load resistance	≤ 500 ohms
BTL5-G... Output voltage	-10...10/10...-10 V
Load current	≤ 5 mA
Ripple	≤ 5 mV

7.5 Dimensions, weights, material

Housing height	36.8 mm
Nominal length	50 to 4752 mm
Weight (depends on length)	Approx. 1.4 kg/m
Housing material	Anodized aluminum
Cable diameter ³⁾	Max. 6.7 mm
Permissible cable bending radius ³⁾	
Fixed routing	≥ 34 mm
Movable	≥ 100 mm
Cable material ³⁾	PUR; cULus 20549 80°C, 300 V, internal wiring

¹⁾ In the position range 0...20 mm, the specified linearity limit can be exceeded by ±50 µm.

²⁾ Individual specifications as per Balluff factory standard

³⁾ For BTL5-...-KA_ _

BTL5-A/C/E/G __ -M ____ -P-S32/KA __ Micropulse Transducer in a Profile Housing



Accessories

8.1 Floating magnets

BTL5-P-3800-2

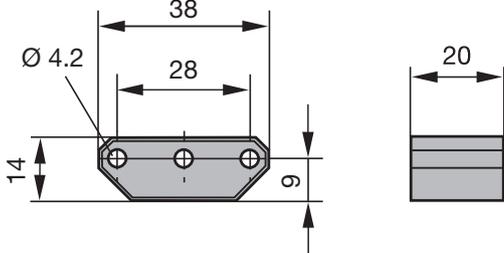


Fig. 8-1: Installation dimensions of BTL5-P-3800-2 magnet

Weight: Approx. 12 g

Housing: Plastic

BTL5-P-5500-2

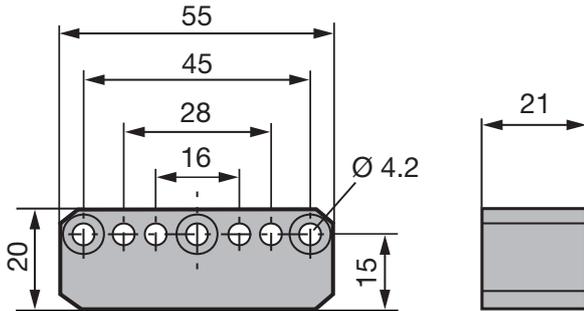


Fig. 8-2: Installation dimensions of BTL5-P-5500-2 magnet

Weight: Approx. 40 g

Housing: Plastic

BTL6-A-3800-2

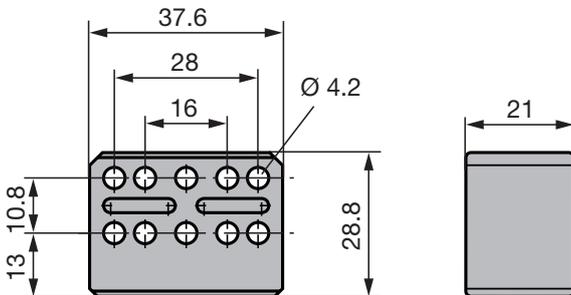


Fig. 8-3: Installation dimensions of BTL6-A-3800-2 magnet

Weight: Approx. 30 g

Housing: Plastic

BTL6-A-3801-2

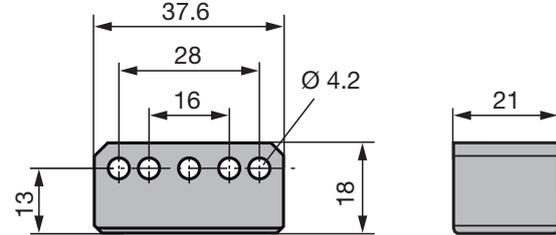


Fig. 8-4: Installation dimensions of BTL6-A-3801-2 magnet

Weight: Approx. 25 g

Housing: Plastic

BTL5-P-4500-1

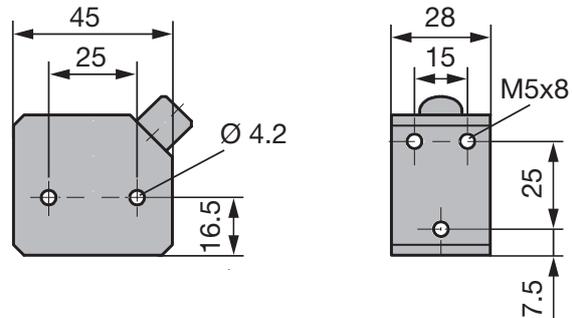


Fig. 8-5: Installation dimensions of BTL5-P-4500-1 magnet

Weight: Approx. 90 g

Housing: Plastic

Operating temperature: -40°C to $+60^{\circ}\text{C}$

Special advantage of the BTL5-P-4500-1 magnet: Several magnets on the same transducer can be separately switched on and off electrically (actuation with a PLC signal).

BTL5-A/C/E/G __ -M ____ -P-S32/KA __ Micropulse Transducer in a Profile Housing

8

Accessories (continued)

8.2 Captive magnets

BTL5-M/N-2814-1S

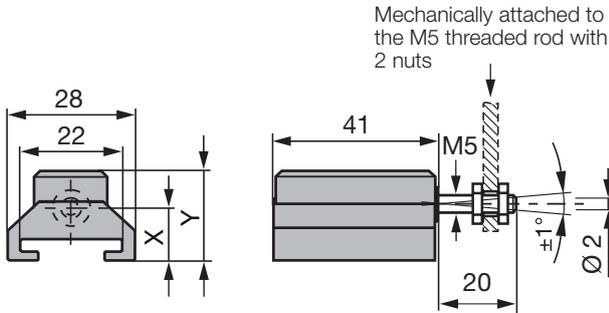


Fig. 8-6: Installation dimensions of BTL5-M/N-2814-1S magnet

	BTL5-M-2814-1S	BTL5-N-2814-1S
Distance X	12.5 mm	15 mm
Distance Y	21 mm	23.5 mm
Weight:	Approx. 32 g	Approx. 35 g
Housing:	Anodized aluminum	Anodized aluminum
Slide surface:	Plastic	Plastic

BTL5-F-2814-1S

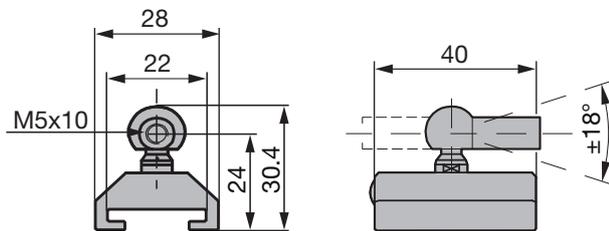


Fig. 8-7: Installation dimensions of BTL5-F-2814-1S magnet

Weight:	Approx. 28 g
Housing:	Anodized aluminum
Slide surface:	Plastic

BTL5-T-2814-1S

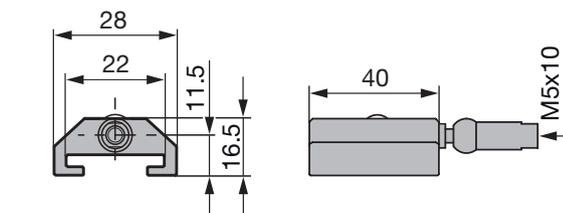


Fig. 8-8: Installation dimensions of BTL5-T-2814-1S magnet

Weight:	Approx. 28 g
Housing:	Anodized aluminum
Slide surface:	Plastic

8.3 BTL2-GS10-____-A joint rod

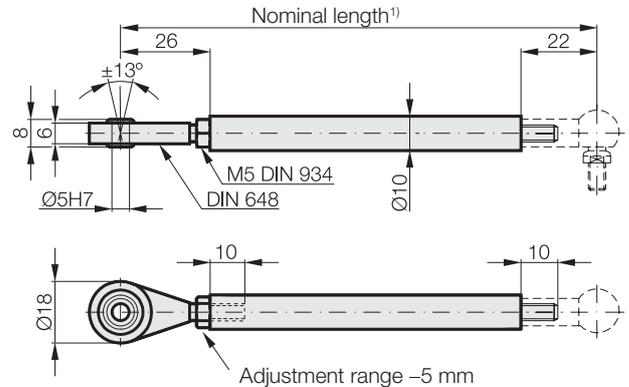


Fig. 8-9: BTL2-GS10-____-A joint rod

Weight: Approx. 150 g/m
Material: Aluminum

¹⁾ State the nominal length when ordering

Example: BTL2-GS10-**0100**-A (nominal length = 100 mm)

8.4 Connectors and cables

BKS-S32M-00

Straight connector, freely configurable
M16 per IEC 130-9, 8-pin

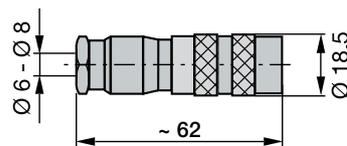


Fig. 8-10: Connector BKS-S32M-00

BKS-S33M-00

Angled connector, freely configurable
M16 per IEC 130-9, 8-pin

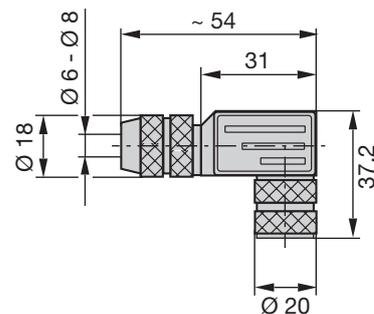


Fig. 8-11: Connector BKS-S33M-00

BTL5-A/C/E/G __ -M ____ -P-S32/KA __ Micropulse Transducer in a Profile Housing

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Type code breakdown

BTL5 - A 1 1 - M0500 - P - S32

Micropulse transducer

Interface:

A = Analog interface, voltage output 0...10 V/10...0 V

C = Analog interface, current output 0...20 mA/20...0 mA

E = Analog interface, current output 4...20 mA/20...4 mA

G = Analog interface, voltage output -10...10 V/10...-10 V

Supply voltage:

1 = 24 V DC

2 = ±15 V DC

Output gradient:

0 = Rising: only C and E (e.g. C_0 = 0...20 mA)

1 = Rising and falling: only A and G (e.g. A_1 = 10...0 V and 0...10 V)

7 = Falling: only C and E (e.g. C_7 = 20...0 mA)

Nominal stroke (4-digit):

M0500 = Metric specification in mm, nominal length 500 mm

Construction:

P = Profile housing

Electrical connection:

S32 = 8-pin, M16 plug per IEC 130-9

KA05 = Cable, 5 m

10 Appendix

10.1 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

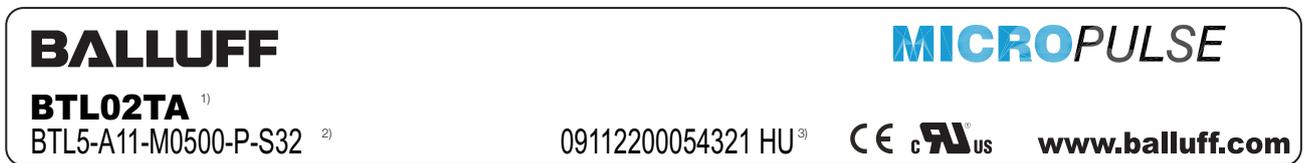
Tab. 10-1: Conversion table mm to inches

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. 10-2: Conversion table inches to mm

10.2 Part label



¹⁾ Ordering code

²⁾ Type

³⁾ Serial number

Fig. 10-1: BTL5 part label

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