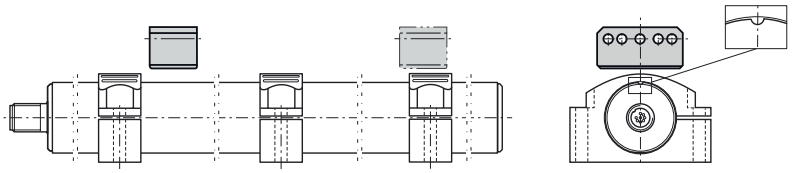
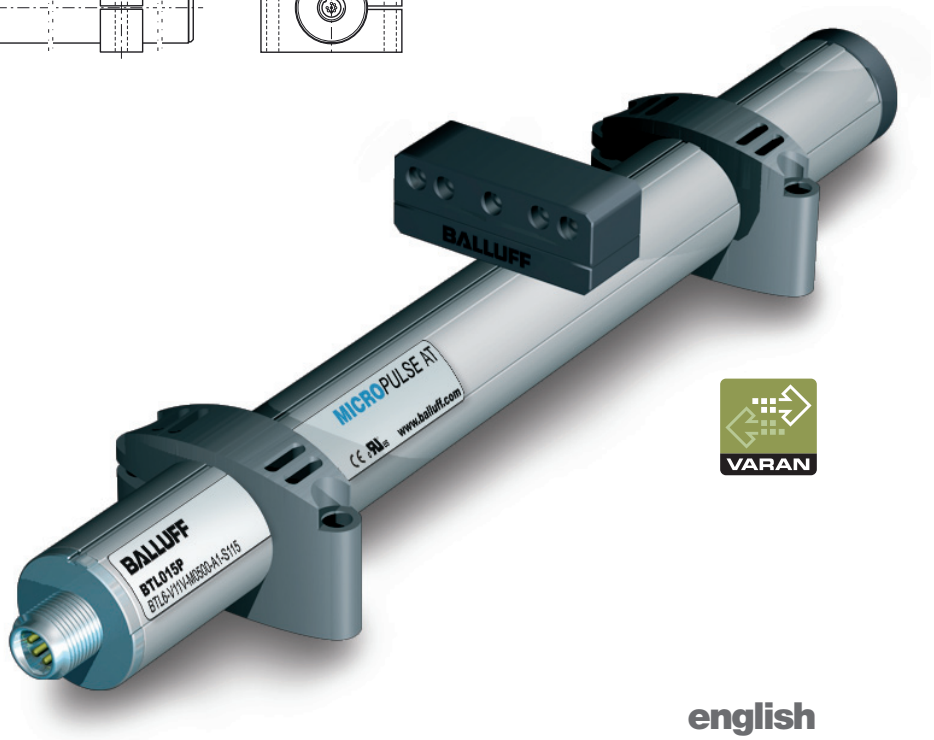
BALLUFF

sensors worldwide

BTL6-V11V-M _ _ _ _ -A1-S115

User's Guide





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1 Notes to the user

1.1 Validity

This guide describes the construction, function and setup options for the BTL6 Micropulse Transducer with VARAN interface. It applies to types
BTL6-V11V-M_ _ _ _ -A1-S115 (see Type code breakdown 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 **instructions** are indicated by a preceding triangle.

► Instruction 1

Action sequences are numbered consecutively:

1. Instruction 1
2. Instruction 2

Note, tip
This symbol indicates general notes.

1.3 Scope of delivery

– BTL6 transducer
– 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.

1.5 Abbreviations

DO	Data object
VARAN	Versatile Automation Random Access Network, on a bus system based on Ethernet technology

2 Safety

2.1 Intended use

The 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:

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

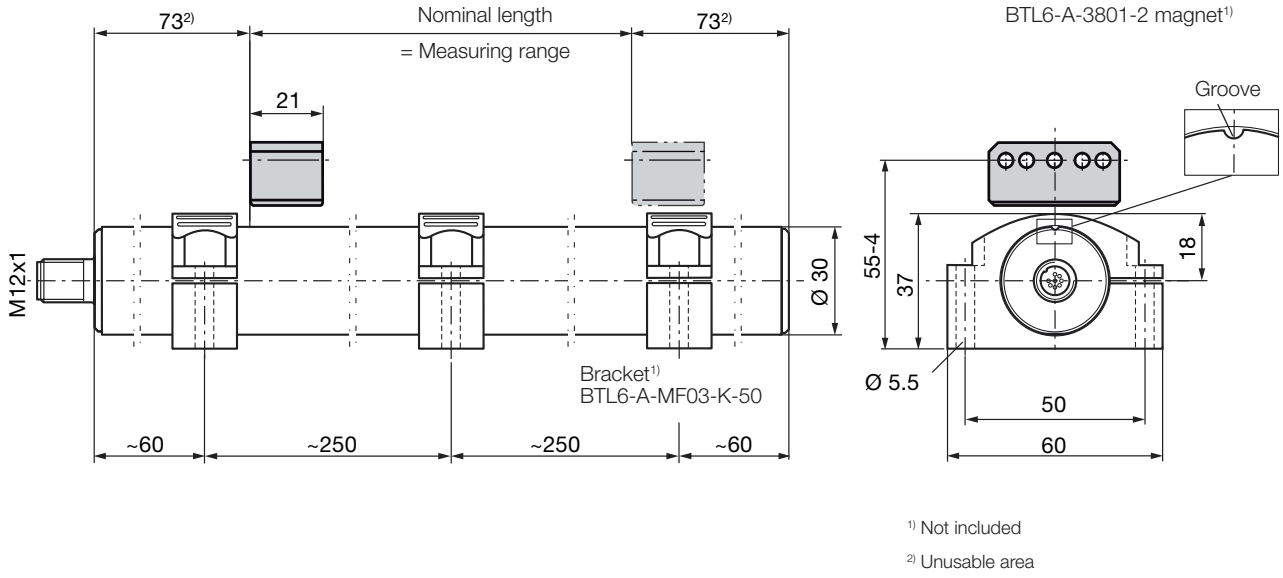
The individual signal words mean:

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



¹⁾ Not included

²⁾ Unusable area

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

3.1 Construction

Electrical connection: The electrical connection is made via a connector (see Type code breakdown on page 15).

BTL housing: Aluminum housing containing 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 13).

Nominal length: To optimally adapt the transducer to the application, the following nominal lengths are available:

Nominal length	Grading
50...4012	25 mm

Other nominal lengths: 130, 160, 230, and 360 mm (corresponds to the standard lengths of potentiometric sensors)

3.2 Function

The BTL6 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 determinated.

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.

This information is transferred via the VARAN interface. VARAN is an industrial bus system based on the physical level of the Ethernet (see www.varan-bus.net).

4 Installation and connection

4.1 Installing the transducer

NOTE!

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.

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 Fig. 4-1, Fig. 4-2).
- Maintain the following values for distance B between the magnet and transducer and for center offset C (see Fig. 4-1, Fig. 4-2):

Type of magnet	Distance B	Offset C
BTL6-A-3800-2	4...8 mm[1)]	± 5 mm
BTL6-A-3801-2	4...8 mm[1)]	± 5 mm

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

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

- When using multiple magnets, the distance between magnets must be at least 65 mm (see Fig. 4-3).

Mount the transducer on a level surface of the machine using the mounting clamps or brackets (both accessories). Any orientation is permitted. Observe the recommended spacing for the clamps or brackets (see Fig. 3-1 on page 6).

1. Guide transducer into the mounting clamps or brackets.
2. Align transducer slot with magnet!
3. Attach transducer to the base using mounting screws (tighten screws in the clamps or brackets to a maximum of 4 Nm).
4. Insert magnet (accessories).

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

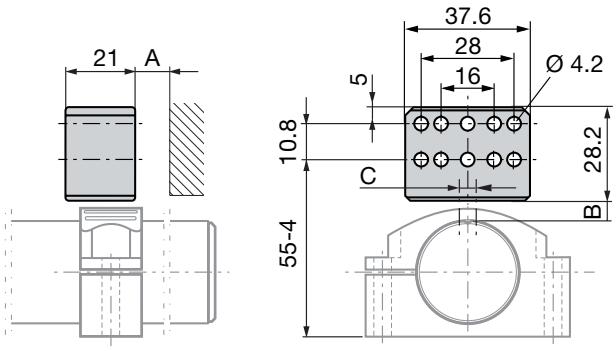


Fig. 4-1: Dimensions and distances with BTL6-A-3800-2 magnet

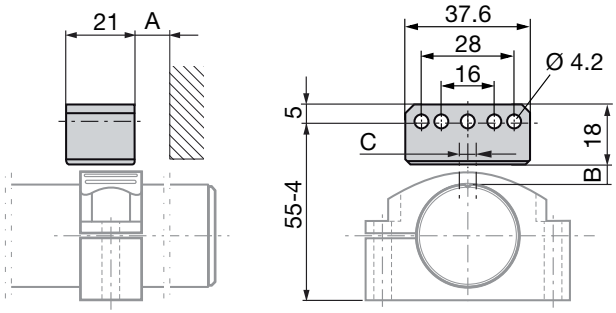


Fig. 4-2: Dimensions and distances with BTL6-A-3801-2 magnet

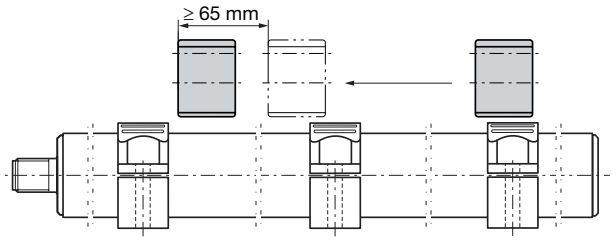


Fig. 4-3: Minimum distance when using multiple magnets

4 Installation and connection (continued)

4.2 Electrical connection

The BTL is connected via a S115 connector (see Accessories on page 14).

PIN	Color		BTL6-V11V-... interface
1	—	—	Not used[1)]
2	OG/WH	Orange/ white	Tx+
3	OG	Orange	Tx-
4	—	—	Not used[1)]
5	GN/WH	Green/white	Rx+
6	BU	Blue	GND[2)]
7	BN	Brown	+24 V
8	GN	Green	Rx-

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

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

Tab. 4-2: Pin assignment of S115 connector

Fig. 4-4: Pin assignment of S115 connector (view from above on transducer plug)

4.3 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
- Horizontally connect the shield in the connector to the plug 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).

Cable length

The maximum cable length when using CAT5e cables is 100 m.

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 transducer).

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 Device profile

6.1 Device profile

The VARAN bus is an industrial real-time bus system based on the IEEE 802.3 100TX Standard Ethernet technology.

6.1.1 Memory address space mapping

The registers are assigned to following memory spaces:

Address (hex)	Description	Size (byte)	Format	Dimension	Access type	Reset
0000	Status Bit 0: Error Bit 1: Busy Bit 3 to 2: Reserved Bit 6 to 4: Stop detected Bit 7: Stop overflow Bit 31 to 6: Reserved	4	bit		r	0
0004	Result position 1	4	dword	inc	r	0
0008	Result position 2	4	dword	inc	r	0
000C	Result position 3	4	dword	inc	r	0
0010	Result position 4	4	dword	inc	r	0
003C	Config Bit 2 to 0: Num of magnets Bit 31 to 3: Reserved	4	bit		r/w	1

Tab. 6-1: Memory assignment

Description of Status register:

- Error: This bit is set if the number of detected stops is less than the number of magnets entered in the Config register.
- Busy: This bit is always 0.
- Stop detected: This bit field indicates the number of magnets. For example, "001" means that 1 stop was detected.
- Stop overflow: This bit is mapped if the number of detected stops is more than the number of magnets entered in the Config register.
- Reserved bits (bit 2, bit 3) in LSB are always 0.

Description of Config register:

- Num of magnets: This bit field must be set to the number of magnets installed on the BTL. For example, "001" means that 1 magnet was installed.
  The default value is 1 magnet. The maximum can be read out from the DO calibration data (see configuration guide).

6 Device profile (continued)

6.2 Position sensing with the Balluff BTL6-V11V-...

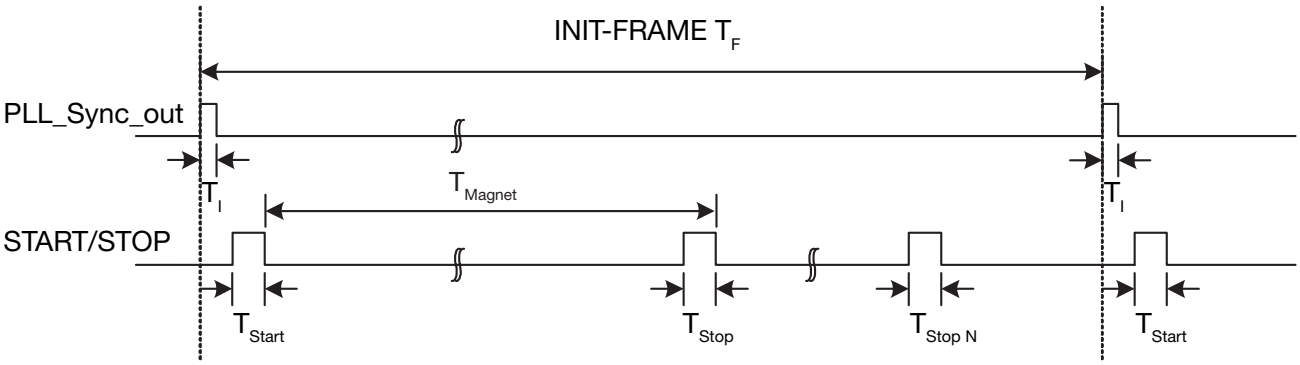


Fig. 6-1: Basic signals for position sensing

Fig. 6-1 displays the basic signals used for position sensing. The sensing cycle starts with PLL-Sync_out[1)], which generates the start pulse. Measurements are taken between the trailing edge of the start pulse and the trailing edge of the corresponding stop pulse (see Fig. 6-1). Time T_{Magnet} is available in the position result register (see Memory address space mapping on page 10).

> The PLL_Sync_out time interval must be defined by the user during startup.

The position of the magnet can be calculated using the following formula:

$$P_{Magnet} = \frac{(R_{Magnet} - Offset) \times Multiplier}{Divisor}$$

P_{Magnet}	The current position of the magnet in µm
R_{Magnet}	Values for the current position of the magnet in increments (example: result position 1 for magnet 1)
Offset	Offset zero position in increments[1)]
Multiplier	Length of BTL in µm[1)]
Divisor	Length of BTL in increments[1)]

[1)] See configuration guide, calibration data

7 Technical data

7.1 Accuracy

The specifications are typical values at 24 V DC and room temperature, with a nominal length of 500 mm in conjunction with the BTL6-A-3800-2 or BTL6-A-3801-2 magnet.
The BTL is fully operational immediately, with full accuracy after warm-up.

> Other technical data could apply to special models.
> Special models are labeled with -SA on the part label.

Resolution	< 15 µm
Repeat accuracy, typical	< 20 µm
Sampling rate	
Dependent on nominal length	250 µs to 3.5 ms
At nominal length = 500 mm	≥ 0.5 ms
Non-linearity at	
Nominal length ≤ 500 mm	±200 µm
Nominal length > 500 mm	±0.04 % FS
Temperature coefficient (nominal length = 500 mm, magnet in the center of the stroke range)	≤ 20 ppm/K

7.2 Ambient conditions

Operating temperature	0 °C to +70 °C
Storage temperature	–40 °C to +100 °C
Relative humidity	< 90%, non-condensing
Shock loading per EN 60068-2-27[1)]	50 g/6 ms
Continuous shock per EN 60068-2-29[1)]	50 g/2 ms
Vibration per EN 60068-2-6[1)]	12 g, 10 to 2000 Hz
Degree of protection per IEC 60529 (when attached)	IP 67

7.3 Supply voltage

Voltage, stabilized[2)]	20 to 28 V DC
Ripple	≤ 0.5 V_{pp}
Current draw (at 24 V DC)	≤ 75 mA
Inrush current	≤ 4 A/0.5 ms
Reverse polarity protection	up to 36 V
Overvoltage protection	up to 36 V (supply cables only!)
Dielectric strength GND to housing	500 V DC

7.4 Inputs/outputs

Short circuit resistance	Signal cable to GND

7.5 Dimensions, weights

Housing diameter	30 mm
Nominal length	≤ 4012 mm
Weight (depends on length)	Approx. 1 kg/m
Housing material	Anodized aluminum

[1)] Individual specifications as per Balluff factory standard

[2)] For c UL us: The transducer 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.

8 Accessories

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

8.1 Magnets

BTL6-A-3800-2

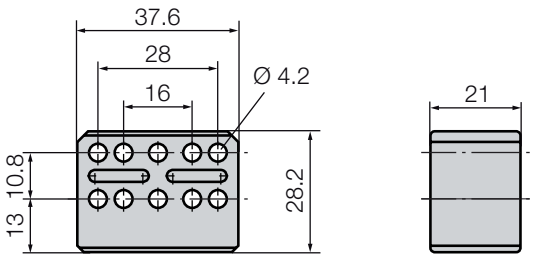


Fig. 8-1: Installation dimensions of BTL6-A-3800-2 magnet

Weight: Approx. 30 g
Housing: Plastic
Operating temperature: –40 °C to +85 °C

BTL6-A-3801-2

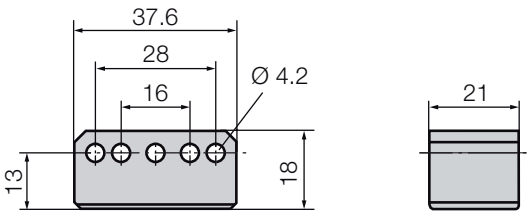


Fig. 8-2: Installation dimensions of BTL6-A-3801-2 magnet

Weight: Approx. 25 g
Housing: Plastic
Operating temperature: –40 °C to +85 °C

8.2 Mounting clamps/bracket

BTL6-A-MF01-A-43

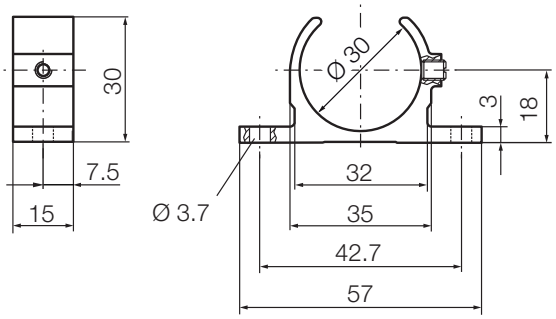


Fig. 8-3: BTL6-A-MF01-A-43 mounting clamp

Material: Anodized aluminum

BTL6-A-MF01-A-50

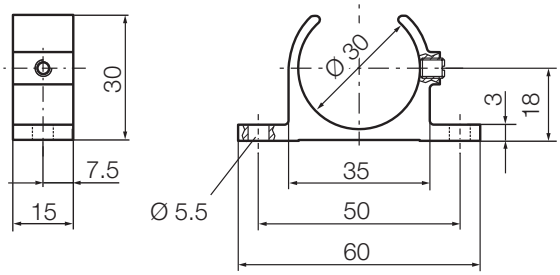


Fig. 8-4: BTL6-A-MF01-A-50 mounting clamp

Material: Anodized aluminum

BTL6-A-MF03-K-50

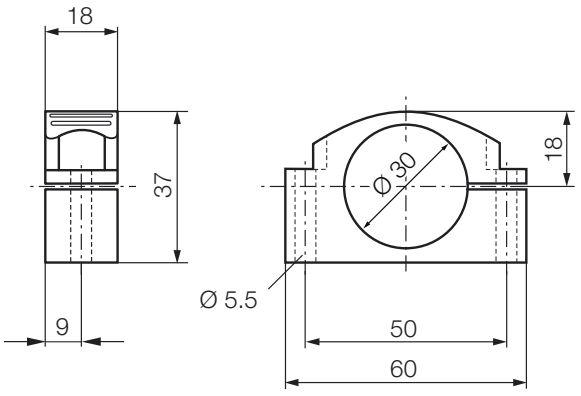


Fig. 8-5: BTL6-A-MF03-K-50 mounting bracket

Material: Plastic

8 Accessories (continued)

8.3 Connectors

For information on pin assignment, see Table 4-2 on page 8.

BCC M488-0000-1A-000-43x834-000

– Angled connector, freely configurable
– M12, 8-pin

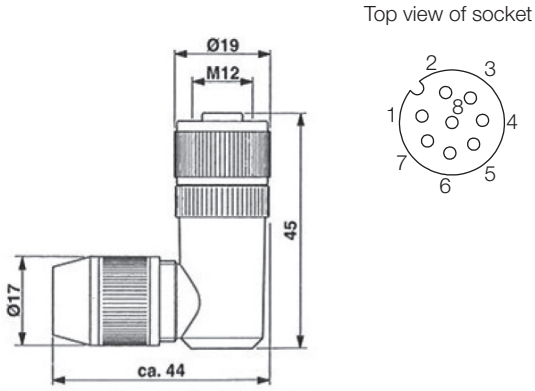


Fig. 8-6: Connector BCC M488-0000-1A-000-43x834-000

BCC M478-0000-1A-000-43x834-000

– Straight connector, freely configurable
– M12, 8-pin

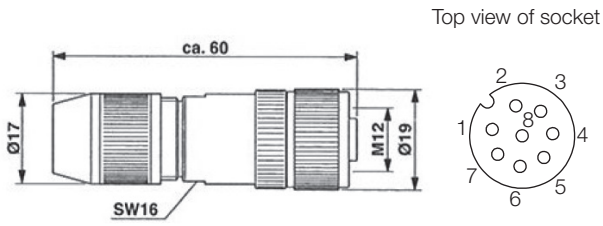


Fig. 8-7: Connector BCC M478-0000-1A-000-43x834-000

9 Ordering code

BTL6 - V 1 1 V - M0500 - A1 - S115

Micropulse transducer

Ethernet interface

Supply voltage
1 = 20 to 28 V DC

Number of magnets
1 = 1 magnet (default)

Ethernet interface type
V = VARAN

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

Construction
A1 = Profile housing, diameter 30 mm

Electrical connection
S115 S115 connector, M12, 8-pin

10 Appendix

10.1 Converting units of length

1 mm = 0.03937008 inches

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: BTL6 part label

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