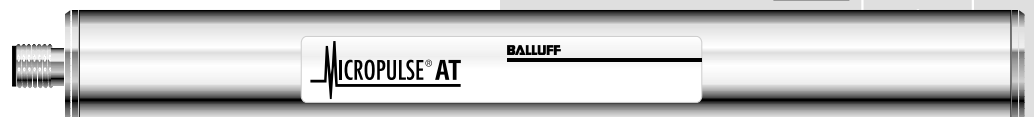


BTL6-P111-M\_ \_ \_ -A1-S115

english Data Sheet



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**1 Safety Advisory**

Read this manual before installing and operating the Micropulse Transducer.

**1.1 Proper application**

The BTL6 Micropulse transducer is intended to be installed in a machine or system. Together with a controller (PLC) or a processor it comprises a position measuring system and may only be used for this purpose.

Unauthorized modifications and non-permitted usage will result in the loss of warranty and liability claims.

**1.2 Qualified personnel**

This guide is intended for specialized personnel who will perform the installation and setup of the system.

**1.3 Use and inspection**

The relevant safety regulations must be followed when using the transducer system. In particular, steps must be taken to ensure that should the transducer system become defective no hazards to persons or property can result.

**1.4 Scope**

This guide applies to the model BTL6-P111...A1-S115 Micropulse transducer.

An overview of the various models can be found in ➔ section 6 Versions (indicated on part label) on page 5.



*The CE Mark verifies that our products meet the requirements of EC Directive*

*89/336/EEC (EMC Directive)*

*and the EMC Law. Testing in our EMC Laboratory, which is accredited by DATech for Testing Electromagnetic Compatibility, has confirmed that Balluff products meet the EMC requirements of the following Generic Standards:*

*EN 50081-2 (emission)*

*EN 61000-6-2 (noise immunity)*

*Emission tests:*

*RF Emission*

*EN 55011 Group 1, Class B*

*Noise immunity tests:*

*Static electricity (ESD)*

*EN 61000-4-2 Severity level 3*

*Electromagnetic fields (RFI)*

*EN 61000-4-3 Severity level 3*

*Fast transients (Burst)*

*EN 61000-4-4 Severity level 3*

*Surge*

*EN 61000-4-5 Severity level 2*

*Line-induced noise induced by high-frequency fields*

*EN 61000-4-6 Severity level 3*

*Magnetic fields*

*EN 61000-4-8 Severity level 4*

**2 Function and Characteristics**

**2.1 Function**

The Micropulse transducer contains a waveguide enclosed by an aluminum housing. A magnet attached to the moving member of the machine is moved across the top of the housing and its position constantly updated.

The magnet defines the measured position on the waveguide. An externally generated INIT pulse interacts with the magnetic field of the magnet to generate a magnetostric-

tive torsional wave in the waveguide which propagates at ultrasonic speed.

The torsional wave arriving at the end of the waveguide is absorbed in the damping zone. The wave arriving at the beginning of the waveguide creates an electrical signal in the coil surrounding the waveguide. The propagation time of the wave is used to derive the position. The position value corresponds to the propagation time of the wave and is output as digital time information between the Start and Stop pulses.

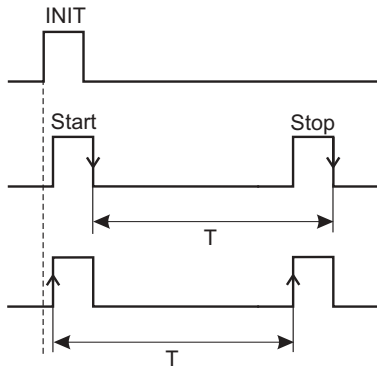


*Note that exact position information can only be obtained by measuring the time between the edges of the Start and Stop pulses.*

Either the leading or trailing edge may be used (➔ Fig. 2-1). This process takes place with measuring high precision and repeatability within the stroke range defined as nominal stroke length.

# BTL6-P111-M\_\_\_-A1-S115 Micropulse AT Transducer in round profile housing

## 2 Function and Characteristics (cont.)



On both ends of the nominal stroke length is an area which provides an unreliable signal, but which may be entered.

The electrical connection between the transducer, the processor card or controller and the power supply is via a cable with connectors.

Dimensions for installing the Micropulse transducer and for the magnets are found on ➔ Figs. 3-1 and 3-2.

### 2.2 Available stroke lengths

To provide for optimum fit in any application, a wide range of standard stroke lengths are available.

stroke lengths	increments
50 ... 1500	25 mm
2 ... 60	1 inches

Additional stroke lengths: 130, 160, 230 and 360 mm (corresponding to standard lengths of potentiometric sensors)

Fig. 2-1: Time/distance measurement

## 3 Installation

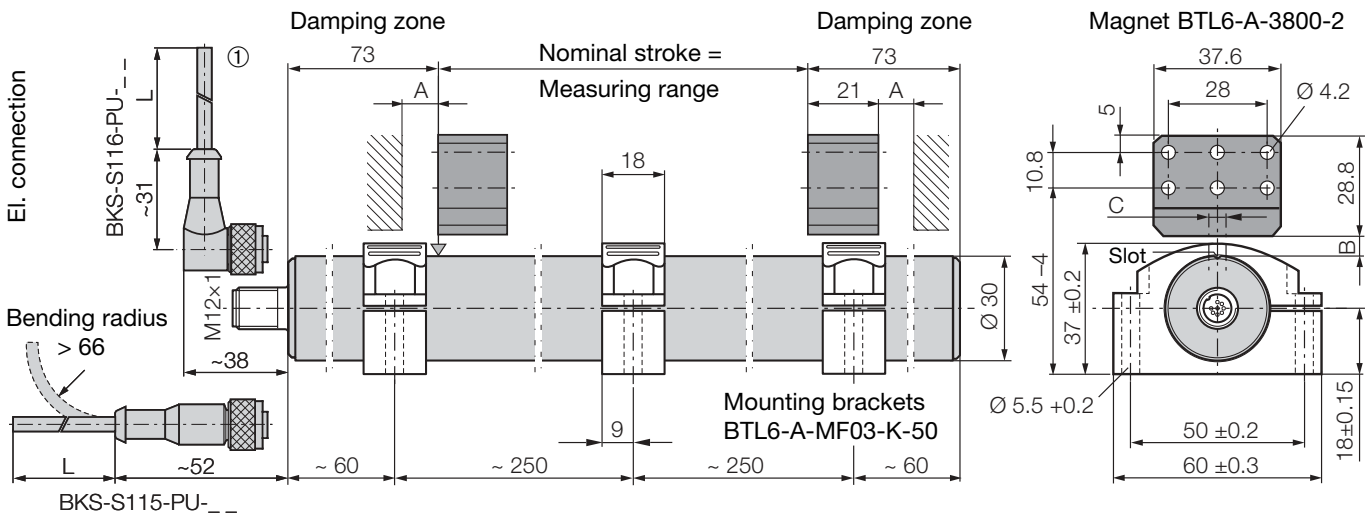


Fig. 3-1: Dimensional drawing (BTL6...A1-S115 transducer with floating magnet BTL6-A-3800-2 and mounting brackets BTL6-A-MF03-K-50)

① Location of angle BKS on BTL

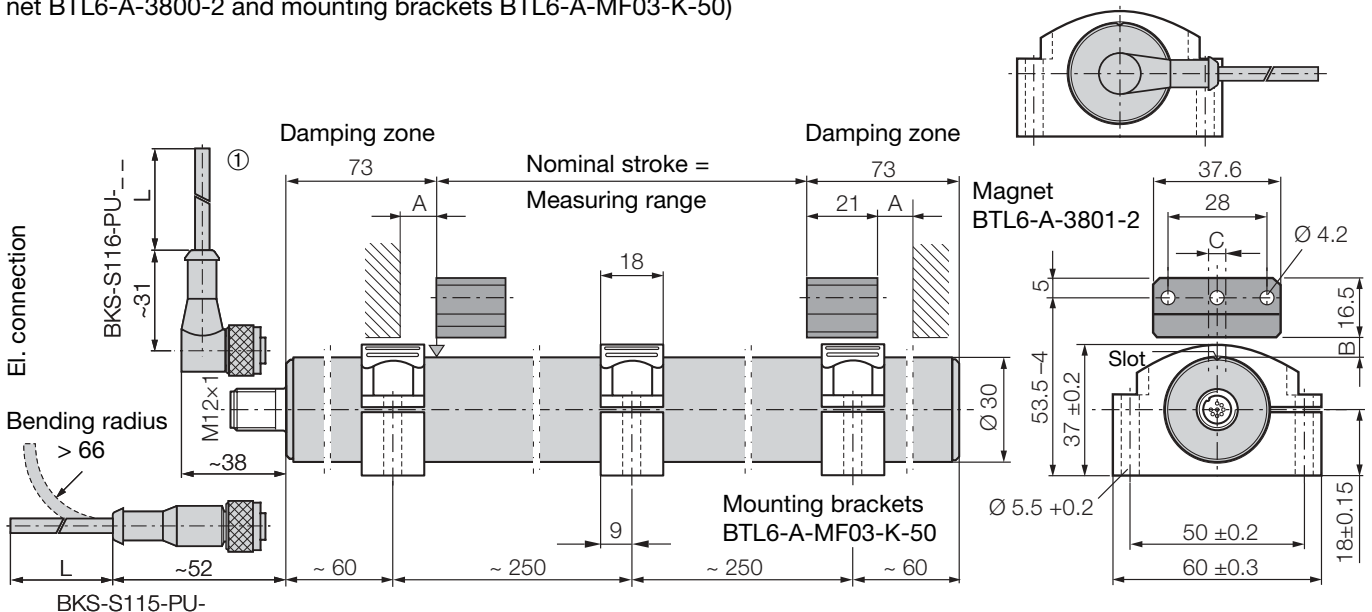
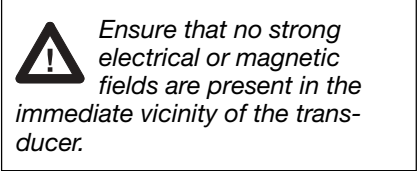


Fig. 3-2: Dimensional drawing (BTL6...A1-S115 transducer with floating magnet BTL6-A-3801-2 and mounting brackets BTL6-A-MF03-K-50)

# BTL6-P111-M\_ \_ \_ -A1-S115 Micropulse AT Transducer in round profile housing

## 3 Installation (cont.)

### 3.1 Transducer installation



Any orientation is permitted. Mount the transducer on a level surface of the machine using the mounting brackets. Observe the recommended spacing of the mounting brackets, dimension ➔ page 3.

1. Align transducer slot with magnet.
2. Tighten mounting screws to a maximum of 3 Nm.

### 3.2 Magnet installation

To ensure the accuracy of the transducer system, the magnet is attached to the non-magnetizable 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.

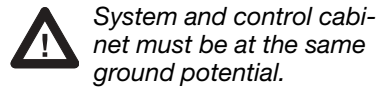
Ensure that the distance " A " between parts made of magnetizable material and the magnet is at least 10 mm (➔ page 3). Maintain the following values in [mm] for distance " B " and center offset " C " between the magnet and the transducer (➔ page 3):

Magnet type	Distance " B "	Offset " C "
BTL6-A-3800-2	4 ... 8	± 2
BTL6-A-3801-2	4 ... 8	± 2

For optimum performance, a distance " B " of 6 ... 8 mm is recommended.

## 4 Wiring

**Note the following when making electrical connections:**



To ensure electromagnetic compatibility (EMC), which Balluff verifies by the CE Marking, the following points must be strictly observed.

- BTL transducer and the processor/control must be connected using shielded cable.
- Shielding: Copper filament braided, 80% coverage.
- The cable shield must be grounded on the control side, i.e., connected to the protection ground.

Pin assignments can be found in ➔ Table 4-1.

Pin	BTL6-P11...	Cable BKS
<b>Control and data signals:</b>		
1	INIT	YE yellow
3	INIT	PK pink
2	START/STOP	GY grey
5	START/STOP	GN green
<b>Supply voltage (external):</b>		
6	GND	BU blue
7	+24 V	BN brown
4	reserved	RD red
8	reserved	WH white

Table 4-1: Wiring assignment

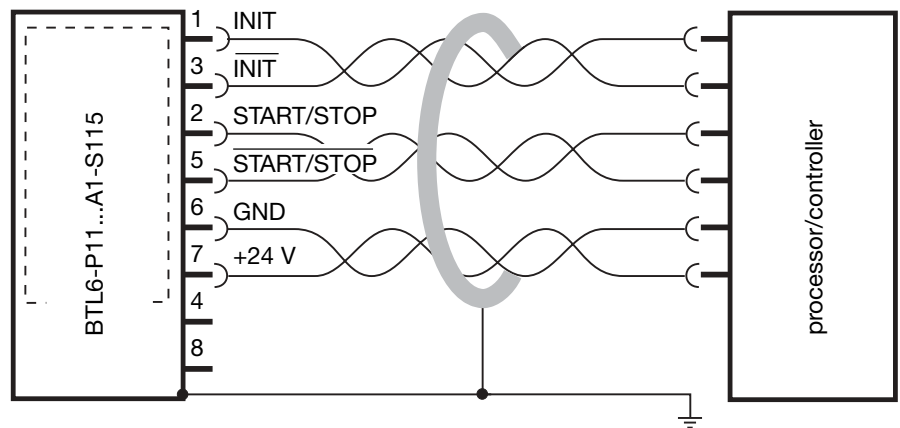


Fig. 4-1: Wiring example BTL6-P11...A1-S115 with processor card/controller

When routing the cable between the transducer, controller and power supply, avoid proximity to high voltage lines to prevent noise coupling. Especially critical is inductive noise caused by AC harmonics (e.g. from phase-control devices), against which the cable shield provides only limited protection.

High noise immunity on the line between the transducer and processor is provided by the differential line drivers used for the RS 422 interface. The signal is processed by the controller or made available by the processor card in the form of analog or digital information.

Cable length max. 500 m.

# BTL6-P111-M\_\_\_\_-A1-S115

## Micropulse AT Transducer in round profile housing

### 4 Wiring (cont.)

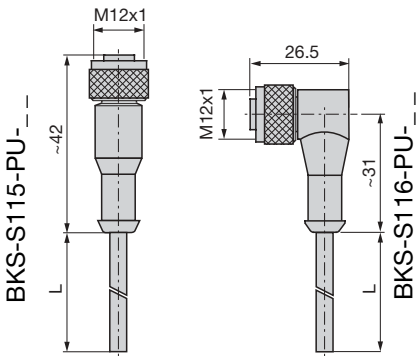


Fig. 4-2: Connection cable BKS-S...

straight  
BKS-S115-00

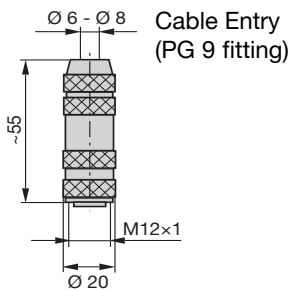


Fig. 4-3: Connector (female)

Pin numbering for connector, view of BTL side

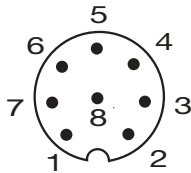


Fig. 4-4: Pin assignments S115, connector type BTL

### 5 Startup

#### 5.1 Check connections

Components can be damaged by improper connections and overvoltage. Before you apply power, check the connections carefully.

#### 5.2 Turning on the system

Note that the system may execute uncontrolled movements when the transducer is part of a closed-loop system whose parameters have not yet been set. Therefore make sure that no hazards could result from these situations.

#### 5.3 Check output values

After replacing a transducer, it is advisable to verify the values for the start and end position of the magnet in manual mode. \*

\* Transducers are subject to modification or manufacturing tolerances.

#### 5.4 Check functionality

The functionality of the transducer system and all its associated components should be regularly checked and recorded.

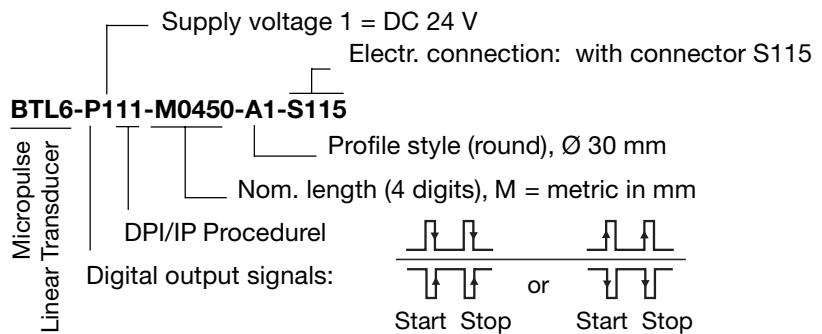
#### 5.5 Fault conditions

When there is evidence that the transducer system is not operating properly, it should be taken out of service and guarded against unauthorized use.

#### 5.6 Noise elimination

Any difference in potential - current flow - through the cable shield should be avoided. Therefore make sure the control cabinet and the system in which the BTL6 is contained are at the same ground potential.

### 6 Versions (indicated on part label)



**7 Using DPI/IP Procedure**

**7.1 Function and characteristics**

DPI/IP procedure uses two operating modes: DPI measurement mode and IP data protocol mode.

DPI = digital pulse interface  
 IP = integrated protocol

**DPI measurement mode:**

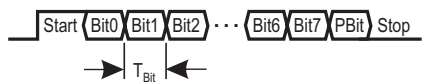
The INIT pulse is sent to the BTL at regular intervals over the INIT line; the rising edge of this pulse triggers a measurement (INIT pulse where  $T_{IP} < 5 \mu s = \text{Start/Stop measurement}$  → Fig. 2-1).

**IP data protocol mode:**

If the length of the INIT pulse  $T_{IP}$  is increased to approx. 15  $\mu s$ , the transducer switches from DPI measurement mode (→ Fig. 7-1).

Following the INIT pulse, a character string (Command) is sent to the BTL as a command. The BTL does still send the Start pulse over the START/STOP line as a response, but instead of the Stop pulses a character string (Response) containing a response appropriate to the command is sent to the controller.

Each character in the transmission protocol has the following bit structure:



Start-Bit Start-of-Frame-Bit  
 Bit0...Bit7 8 data bits  
 PBit Parity-Bit (Even-Parity)  
 Stop Stop-of-Frame-Bit  
 $T_{Bit}$  4  $\mu s$  (bit length at a data rate of 250 Kbps)

Data integrity when transmitting the character string is achieved using parity and CRC16 checking with the polynomial  $X^{16}+X^{12}+X^5+1$  (corresponds to 0x1021). In case of a transmission or protocol error, the BTL sends out a corresponding error message in reply.

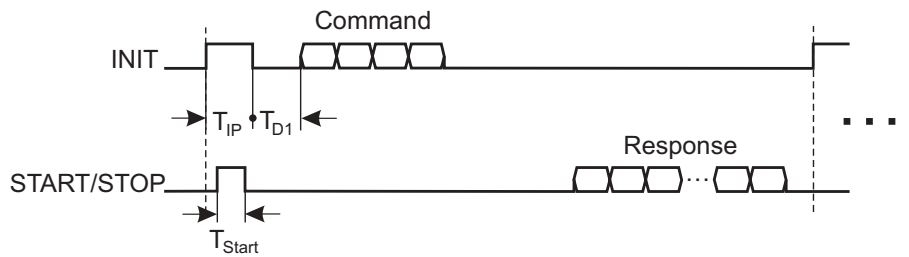


Fig. 7-1: Principle of data transmission with IP data protocol

- $T_{IP}$  INIT pulse  $< 5 \mu s$  Start/Stop measuring technique (→ Fig. 2-1) or:
- $T_{IP}$  approx. 15  $\mu s$  operation with IP data protocol (→ Fig. 7-1)
- Command Command for requesting BTL data ((information stored in the BTL)
- $T_{Start}$  3  $\mu s$  to 5  $\mu s$
- $T_{D1}$   $> 50 \mu s$
- Response Response based on the request or: Error message

**7.2 Protocol parameters**

Read parameter	Request		Response			
	CI	LEN	CR	LEN	D0 ... Dn	n
Vendor code	01h	00h	01h	07h	Vendor name ASCII coded 'B' 'A' 'L' 'L' 'U' 'F' 'F'	6
	06h	00h	06h	04h	Vendor code Hex coded 0x00000001 for BALLUFF	3
Type key	02h	00h	02h	17h	Type key ASCII coded 'BTL6-P111-M0500-A1-S115'	22
Serial-number	03h	00h	03h	0Bh	Serial number ASCII coded '123456789DE'	10
	07h	00h	07h	04h	Serial number Hex coded 0x0001F503 = 128259	3
Ultrasonic velocity	04h	00h	04h	03h	Ultra-sonic velocity BCD coded $v_{us} = 2832.56 \text{ m/s} = 28\text{h } 32\text{h } 56\text{h}$	2
	08h	00h	08h	04h	Ultra-sonic velocity Hex coded 0x00043EF5 = 2782.61 m/s	3
Zero point offset *)	09h	00h	09h	04h	Zero point offset [ $\mu m$ ] 0x000088B8 = 35000 $\mu m$	3
Stroke length	0Ah	00h	0Ah	04h	Stroke length [mm] 0x00001F4 = 500 mm	3
Error message			FFh	02h	Error code 01h = unknown command 02h = transmission error 03h = EEPROM access error	1

\*) Distance from zero point notch to edge of cover

Table 7-1: List of request/response parameters

- CI Command ID
- CR Command Response
- LEN Length of data D0 ... Dn
- D0 ... Dn Data frame
- CRC CRC16 from CI / CR to Dn, → section 7.3

**7 Using DPI/IP Procedure (cont.)****7.3 CRC check**

The CRC in the reply telegram is checked using the characters CI and LEN. In the response telegram, the CRC check includes the characters CR, LEN and D0 ... Dn.

Pseudo-Code for the CRC check:

```
CRC = 0; // initialize shift register
repeat
    CRCNext = NextBit EXOR CRC(15);
    CRC(15:1) = CRC(14:0); // shift left by 1
    CRC(0) = 0;
    if CRCNext then
        CRC(14:0) = CRC(14:0) EXOR 0x1021;
    endif
until (last data bit)
```

Note: NextBit is the next bit of the serial bit stream. The Start, parity and Stop bits are not included in the CRC check; they are treated independently by the UART function. The UART function sends/receives the LSB first, so the CRC must begin with Bit 0.

Implementation of the CRC check in C programming language:

```
typedef unsigned char byte;
typedef unsigned short word;

#define GENERATOR_POLINOM    0x01021

#define CRC_OK    0
#define CRC_BAD  1

#define BUFFSIZE    48

byte bRxBuffer[BUFFSIZE]; // received message, 1st byte @ index 0 */
byte bMessageLength; // number of characters in received message */
// including CRC */

int CRCCalculation(void)
(
    word wCRC;
    byte bNextByte;
    int i, j;

    wCRC = 0;
    for ( i = 0; i < bMessageLength - 2; i++ ) { /* do not calculate on CRC bytes */
        bNextByte = bRxBuffer[i];
        for ( j = 0; j < 8; J++ ) {
            if ( ( bNextByte & 0x01 ) ^ ((wCRC & 0x800) >> 15) ) {
                wCRC <<= 1;
                wCRC ^= GENERATOR_POLINOM;
            }
            else {
                wCRC <<= 1;
            }
            bNextByte >>= 1;
        }
    }
    if ( (byte) ((wCRC & 0xff00) >> 8) == bRxBuffer[i] &&
        (byte) (wCRC & 0x00ff) == bRxBuffer[i+1] ) {
        return CRC_OK;
    }
    else return CRCBAD;
}
```

# BTL6-P111-M\_ \_ \_ -A1-S115

## Micropulse AT Transducer in round profile housing

### 8 Technical Data

The following are typical values at DC 24 V and 25 °C. Fully operational after power-up, with full accuracy after warm-up. Values are with BTL6-A-3800-2 or BTL6-A-3801-2 at a constant offset from the transducer:

Resolution	≤ 10 μm
Repeatability	≤ 20 μm
Repeat accuracy	≤ 10 μm
Non-linearity:	
NL ≤ 500 mm	> 500 mm
≤ ±200 μm	≤ ±0.04 % FS
	typ. ±0.02 % FS

Temperature coefficient  
 ≤ (6 μm + 5 ppm \* NL)/K  
 NL = nominal length in [mm]

#### 8.1 Dimensions, weights, ambient conditions

Nominal length	≤ 1500 mm
Dimensions	➔ page 3
Weight	approx. 1.0 kg/m
Housing	anodized aluminum
Operating temp.	0 °C to +70 °C
Humidity	< 90%, non-condensing
Protection class	
per IEC 60529	IP 67
when closed up	
Shock loading	50 g/6 ms
per IEC 60068-2-27 <sup>1</sup>	
Continuous shock	50 g/2 ms
per IEC 60068-2-29 <sup>1</sup>	
Vibration	12 g, 10 to 2000 Hz
per IEC 60068-2-6 <sup>1</sup>	

<sup>1</sup> Individual specifications as per Balluff factory standard

#### 8.2 Supply voltage (external)

Regulated supply voltage	DC 20 ... 28 V
Ripple	≤ 0.5 V <sub>ss</sub>
Current draw	≤ 60 mA (at 1 kHz)
Inrush	≤ 3 A/0.5 ms
Polarity reverse protection	1.5 * U <sub>B</sub>

#### 8.3 Control signal

INIT pulse	
Level	+5 V RS 422-driver
Pulse widths	
measurement mode	1 to 5 μs
data protocol mode	approx. 15 μs
Sampling rate	0.5 to 2 kHz
Polarity reverse protection	1.5 * U <sub>B</sub>

#### 8.4 Position signal

START/STOP pulse	
Level	+5 V RS 422-driver
Pulse widths	3 to 5 μs
Polarity reverse protection	1.5 * U <sub>B</sub>

#### 8.5 Overvoltage protection

Dielectric strength 500 V to housing  
 Polarity reverse protection 1.5 \* U<sub>B</sub>

#### 8.6 Included in shipment

Transducer with condensed guide Magnets, mounting brackets and connection cable must be ordered separately.

#### 8.7 Magnet

(order separately)

<b>BTL5-A-3800-2</b>	➔ Fig. 3-1
Weight	approx. 30 g
<b>BTL5-A-3801-2</b>	➔ Fig. 3-2
Weight	approx. 25 g
Housing	plastic
Spacing, offset and installation	➔ page 3
Operating temp.	0 °C to +70 °C

#### 8.8 Connection cables, connectors

(order separately)

Shielded cable with connector on one end ➔ Fig. 4-2  
 straight: BKS-S115-PU\_ \_ \_  
 right-angle: BKS-S116-PU\_ \_ \_  
 \_ \_ = length L, 02, 05, 10, 20  
 05 means L = 5 m  
 Wiring assignments ➔ Table 4-1

Connector for shielded cable ➔ Fig. 4-3  
 straight: BKS-S115-00  
 Wiring assignments ➔ Table 4-1

#### 8.9 Mounting brackets

(order separately)

BTL6-A-MF03-K-50	➔ Fig. 3-1
BTL6-A-MF01-A-50	➔ Fig. 8-1
BTL6-A-MF01-A-43	➔ Fig. 8-2

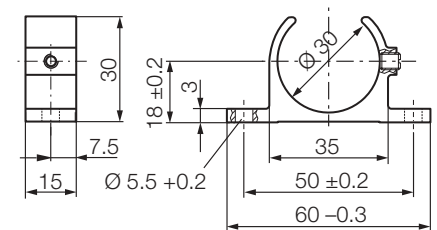


Fig. 8-1: Mounting bracket BTL6-A-MF01-A-50

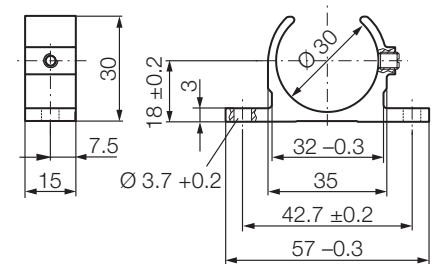


Fig. 8-2: Mounting bracket BTL6-A-MF01-A-43

#### 8.10 Compatible processors and displays

**Analog output processor cards:**  
 BTM-A1 multi-channel processor card with 1 to 4 DC analog outputs

**Digital output processor cards:**  
 BTA-H11 22 bit, BCD, Gray/binary or SSD, Gray

**Displays:**  
 BDD-07-9 digital display, 7-digit for BTA-H  
 BDD-AM10-1-P display and controller with 2 relay outputs  
 BDD-CC08-1-P display and controller with 8 setpoints

No. 825 920 - 726 E • Edition 0205; Specifications subject to change.