BALLUFF

BTL5-S1_ _B-M_ _ _ _-P-(SA244)-S32/S147/KA_ _

english User's Guide



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The following patents have been granted in connection with this product:

US Patent 5 923 164
Apparatus and Method for Automatically Tuning the Gain of an Amplifier

1 Safety Advisory

Read this manual before installing and operating the Micropulse Transducer.

1.1 Proper application

The BTL5 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. This includes the installation of additional safety limit switches, emergency shutoff switches and maintaining the permissible ambient conditions.

1.4 Scope

This guide applies to the model BTL5-S1...B...P... Micropulse transducer.

An overview of the various models can be found in section 6 Versions (indicated on part label) on page 7.

Note: *For special versions, which are indicated by an -SA_ _ _ designation in the part number, other technical data may apply (affecting calibration, wiring, dimensions etc.).*

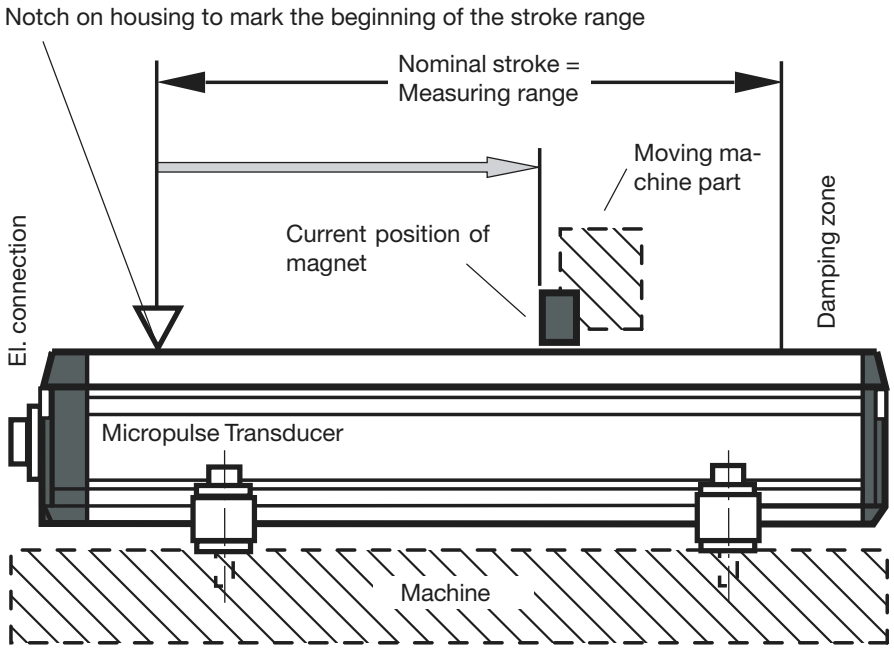


Fig. 1-1: Basic arrangement

2 Function and Characteristics

2.1 Characteristics

Micropulse transducers feature:

- Measured position can be used for loop feedback (real-time)
- High data security: Output data are checked for validity and plausibility in the µC
- Very high resolution, repeatability and linearity
- Measurement range monitoring with "Out of Range" Bit 2^{21}
- Immunity to shock, vibration, and contamination
- An absolute output signal
- Wear- and maintenance-free
- BTL to processor cable lengths up to 400 m
- IP 67 per IEC 60529

2.2 Function

The Micropulse transducer contains a waveguide enclosed by an extruded 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 internally generated INIT pulse interacts with the magnetic field of the magnet to generate a magnetostrictive 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 corresponding value is output as synchronous serial data (SSI) via the RS 485/422 interface. This takes place with high precision and repeatability within the measuring range indicated as the nominal stroke length.

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/controller and the power supply is via a cable, which is connected using a female connector.

Dimensions for installing the Micropulse transducer and for the magnets and control arm are found on ➥ page 5.

2.3 SSI interface

Depending on the BTL version, the SSI interface uses 24 or 25 bits and the position values are transmitted in Gray or binary code. Transmission of the position values is finished in time t_m. The max. clock frequency t depends on the cable length ➥ section 8 Technical Data on page 9.

Bit 2^{21} can be used as an "Out-of-Range" message, see Figs. 2-1 and 2-2.

The position values and data from the BTL can be polled at any desired sampling rate f_A. They are obtained and output synchronous with the sampling rate in real-time. The maximum sampling rate is a function of the working stroke ➥ section 8 Technical Data on page 9. If this rate is exceeded, the same data value will be output multiple times, e.g. a new position value will be available only for every second sampling.

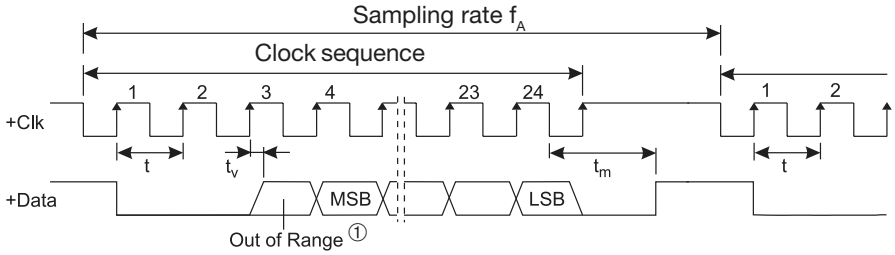


Fig. 2-1: Pulse diagram, example with 24 bit coding
① only by an resolution of ≥ 5 µm

$t < t_m$
t_v = 150 ns — measured with 1 m cable
t_m = 31 µs — independent of the clock frequency

The time tm starts with the falling edge of the last clock impulse (bit 24 or bit 25 depending on the version).

Position of magnet:
1) out of the measurement range
2) within the measurement range
3) magnet not present

"Out of Range" Bit 2^{21} will be set after the occurence of the event.

Value of the output data 2^0 ... 2^{20}:
1a) 0
1b) max. at end point + 10 mm
2) proportional to distance
3) 0

Technical data are valid within the measurement range only, i.e. between null and end point.

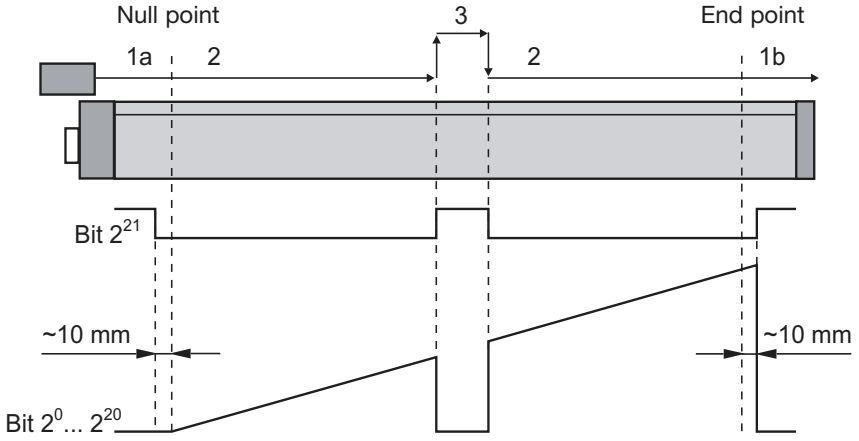


Fig. 2-2: Output data shown with "Out of Range" situation

3 Installation

3.1 Transducer installation

Ensure that no strong electrical or magnetic fields are present in the immediate vicinity of the transducer.

Any orientation is permitted.

The supplied mounting brackets and cylinder head screws allow the transducer to be mounted on a flat machine surface.

A sufficient quantity of mounting brackets is supplied.

Recommended installation:
Distance A = approx. 80 mm
Distance B = approx. 250 mm (between the individual clamps)

To prevent resonant frequencies under vibration loads of >50 g, we recommend placing the mounting clamps at irregular intervals.

The supplied isolation bushings are used to electrically insulate the transducer from the machine (➥ Fig. 3-1 respectively 3-2 and section 5.6 Noise elimination).

The Micropulse transducer in profile housing is suitable both for floating, i.e. non-contacting magnets (➥ page 5) and for captive magnets (➥ page 5).

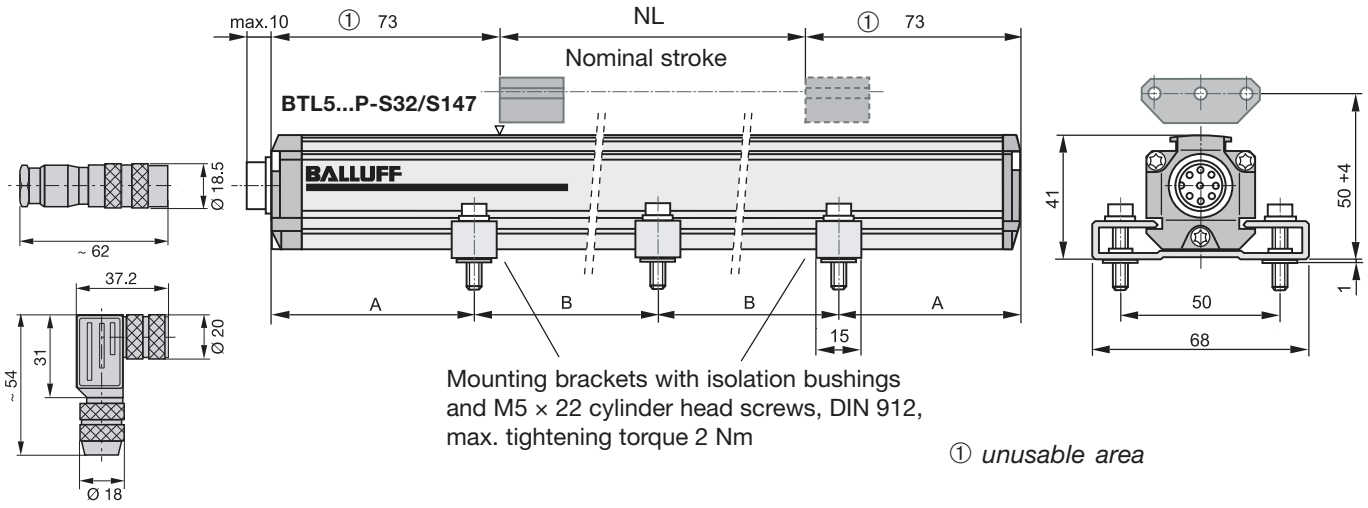


Fig. 3-1: Dimensional drawing (BTL5...P-... transducer with floating magnet BTL5-P-3800-2)

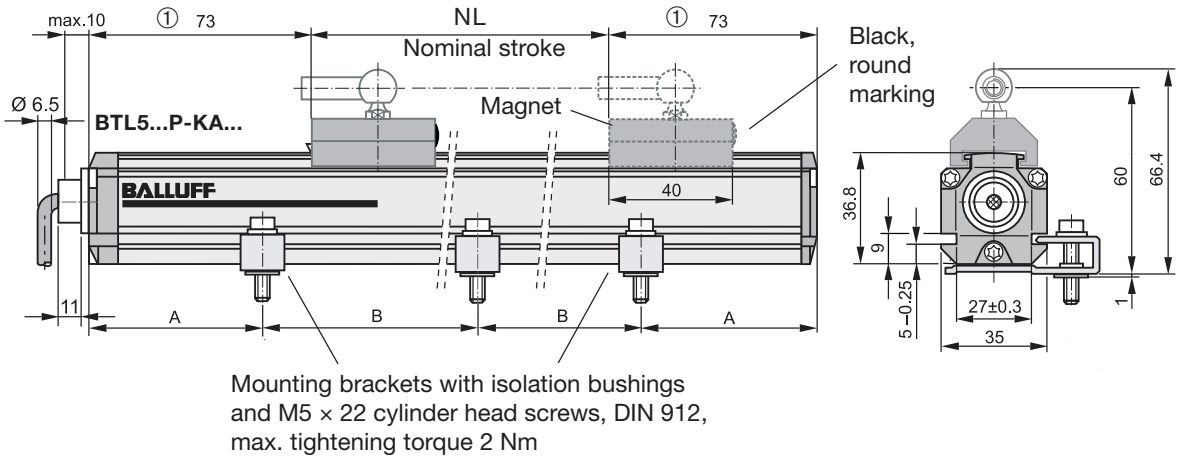


Fig. 3-2: Dimensional drawing (BTL5...P-... transducer with captive magnet BTL5-F-2814-1S)

3 Installation (cont.)

3.2 Floating magnets

The floating magnet (➥ Figs. 3-3 to 3-5) is attached to the moving member of the machine using non-magnetizable screws (brass, aluminum). To ensure the accuracy of the transducer system, the moving member must carry the magnet on a track parallel to the transducer.

The following table provides figures in [mm] for the spacing which must be maintained between magnet and transducer and for the permissible center offset:

Magnet type	Distance " D "	Offset " C "
BTL5-P-3800-2	0.1 ... 4	± 2
BTL5-P-5500-2	5 ... 15	± 15
BTL5-P-4500-1	0.1 ... 2	± 2

Ensure that the distance E between parts made of magnetizable material and the BTL5-P-5500-2 magnet is at least 10 mm (➥ Fig. 3-4).

BTL5-P-4500-1 magnet, special features: Multiple magnets on the same transducer can be electricely turned on and off individually (PLC control signal, 24 V/ 100 mA).

The stroke range is offset 4 mm towards the BTL connector/cable (➥ Fig. 3-5).

max. permissible tightening torque 2 Nm

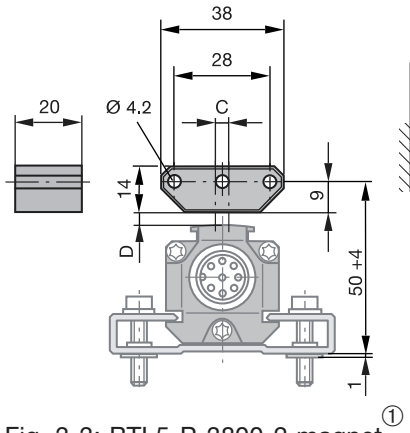


Fig. 3-3: BTL5-P-3800-2 magnet ①

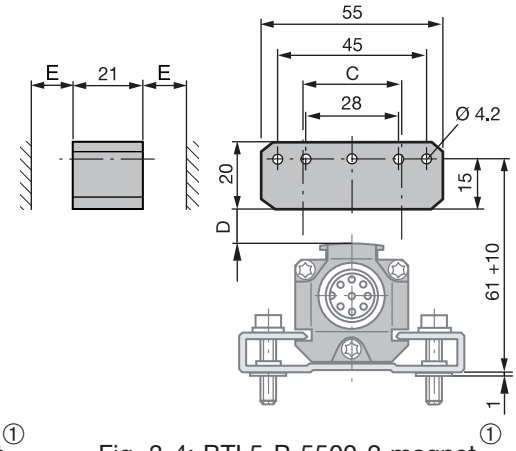


Fig. 3-4: BTL5-P-5500-2 magnet ①

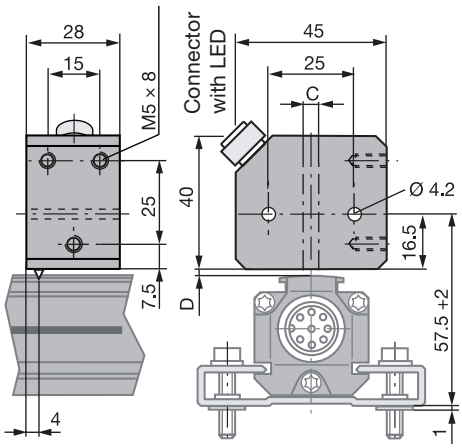


Fig. 3-5: BTL5-P-4500-1 ①

① *not included*

3.3 Captive magnets

Lateral forces are to be avoided when using captive magnets (➥ Figs. 3-6 and 3-7). Connections are required here which permit the corresponding degree of freedom with respect to the direction of movement of the magnet along the stroke range. It is assumed that the BTL5-F-2814-1S magnet is connected to the machine member using a connecting rod.

The BTL2-GS10...A connecting rod (➥ Fig. 7-2) is available as an accessory (please indicate length LG when ordering).

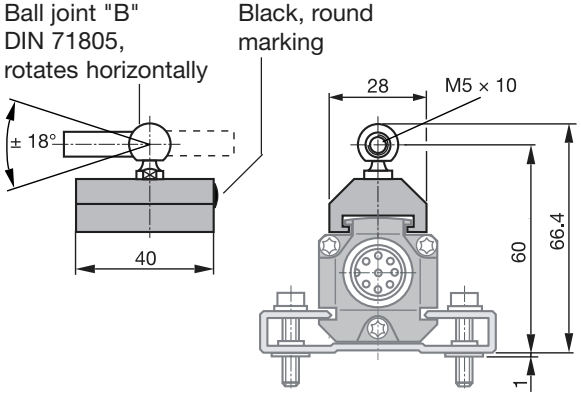
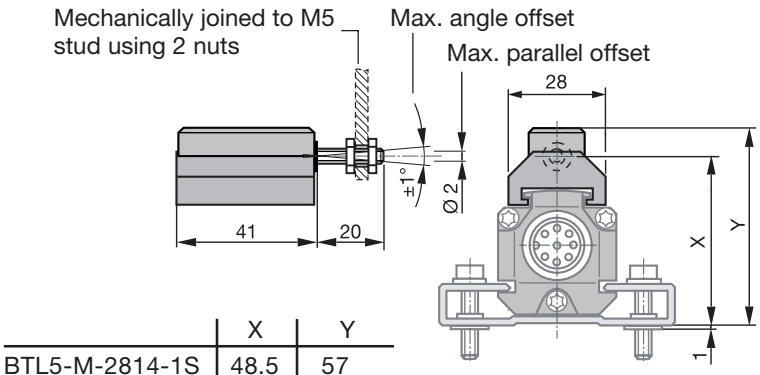


Fig. 3-6: BTL5-F-2814-1S magnet ①



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

Fig. 3-7: BTL5-M/N-2814-1S magnet ①

4 Wiring

Note the following when making electrical connections:

System and control cabinet must be at the same ground potential.

To ensure the electromagnetic compatibility (EMC) which Balluff warrants with the CE Mark, the following instructions must be strictly followed.

BTL transducer and the processor/ control must be connected using shielded cable.

Shielding: Copper filament braided, 85 % coverage.

The shield must be tied to the connector housing in the BKS connector; see instructions accompanying the connector.

In the cable version the cable shield is connected to the housing in the PG fitting.

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, 4-2 or 4-3. Connections on the controller side may vary according to the controller and configuration used.

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.

Position information is sent over the RS 485/422 interface as synchronous serial data (SSI) to the host controller. High noise immunity is assured by the differential drivers used for sending and receiving signals.

Cable length max. 400 m;
Ø 6 to 8 mm.

4.1 Connector S32

BKS Connector,
View of solder end
of connector body
BKS-S32M-00
or BKS-S33M-00

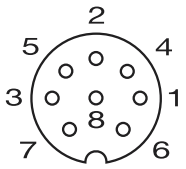


Fig. 4-1: Pin arrangement BKS on BTL

Pin	BTL5-S1_ _...S32
Interface signals	
1	+Clk
2	+Data
3	–Clk
4	do not connect
5	–Data
Supply voltage (external)	
6	GND
7	+24 V
8	do not connect

Table 4-1: Wiring

4.2 Connector S147

BKS Connector,
View of solder end
of connector body
BKS-S147M-00 or
BKS-S148M-00

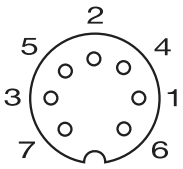


Fig. 4-2: Pin arrangement BKS on BTL

Pin	BTL5-S1_ _...S147
Interface signals	
1	–Data
2	+Data
3	+Clk
4	–Clk
Supply voltage (external)	
5	+24 V
6	GND
7	do not connect

Table 4-2: Wiring

Caution! *False data will result from reversing the +Clk and –Clk inputs.*

4.3 Cable KA_ _

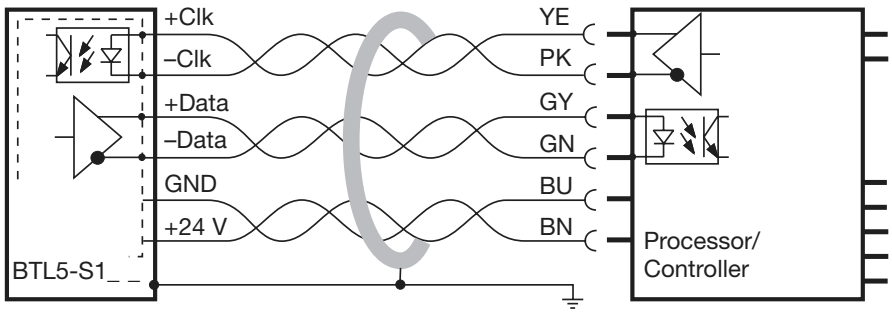


Fig. 4-3: BTL5-S1_ _-...KA_ _ with Processor/Controller, Connection example

Colors	BTL5-S1_ _...-KA_ _
Interface signals	
YE yellow	+Clk
PK ping	–Clk
GY gray	+Data
GN green	–Data
Supply voltage (external)	
BU blue	GND
BN brown	+24 V
WH white	do not connect

Table 4-3: Wiring

5 Startup

5.1 Check connections

Although the connections are polarity reversal protected, 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 first turned on or 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 or repairing a transducer, it is advisable to verify the values for the start and end position of the magnet in manual mode. If values other * than those present before the replacement or repair are found, a correction should be made.

* 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

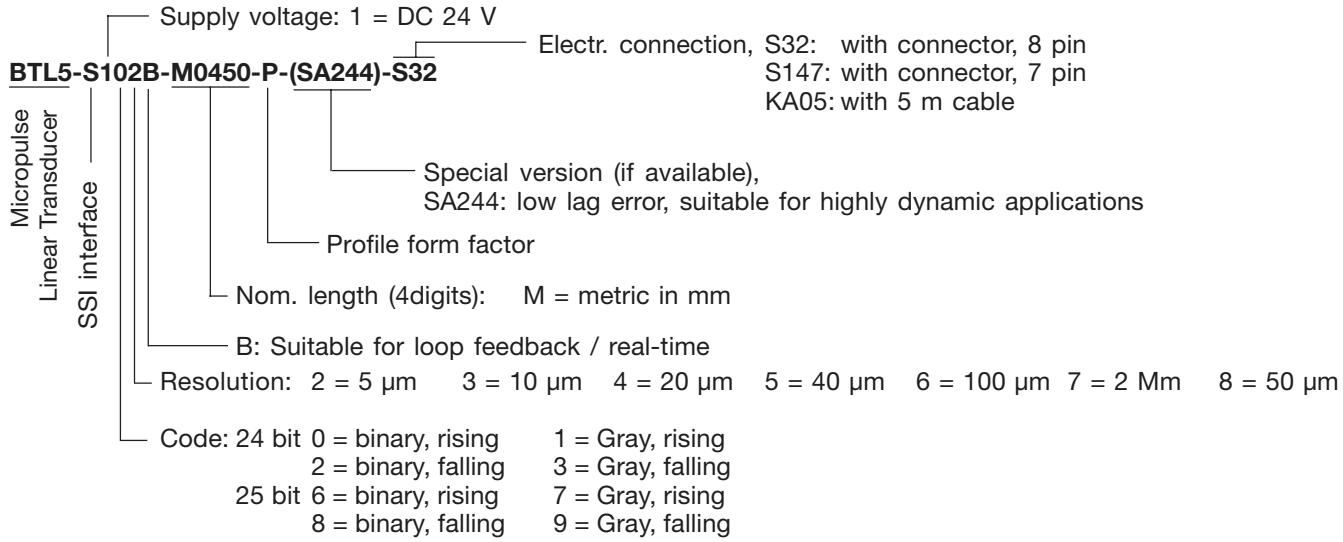
When there is evidence that the transducer system is not operating properly, it should be taken out of service and guarded against unauthorized use.

5.6 Noise elimination

Any difference in potential - current flow - through the cable shield should be avoided. Therefore:

– Use the isolation bushings, and
– Make sure the control cabinet and the system in which the BTL5 is contained are at the same ground potential.

6 Versions (indicated on part label)



6.1 Included in shipment

Transducer with condensed guide

Mounting brackets

6.2 Available lengths

To ensure flexible application, nominal transducer lengths of from 50 to 4000 mm with following increments are available:

Stroke lengths [mm]			Increments [mm]
50	...	1000	50
1000	...	2000	100
2000	...	4000	250

Other stroke lengths on request.

7 Accessories (order separately)

7.1 Magnets

Regarding distance, offset, and dimensions see ➥ pages 4 and 5.
Operating temp. –40 to +85 °C

BTL5-P-3800-2 ➥ Fig. 3-3
Weight approx. 12 g
Housing plastics

BTL5-F-2814-1S ➥ Fig. 3-6
Weight approx. 28 g
Housing plastics

BTL5-M-2814-1S ➥ Fig. 3-7
Weight approx. 32 g
Housing aluminum, anodized
Sliding surface plastics

BTL5-N-2814-1S ➥ Fig. 3-7
Weight approx. 35 g
Housing aluminum, anodized
Sliding surface plastics

BTL5-P-3800-2 and BTL5-F/M/N-2814-1S:

The stated non-linearity of ± 30 µm is valid when guided exactly with a constant gap from the profile within the permissible distance "D".

BTL5-P-5500-2 ➥ Fig. 3-4
Weight approx. 40 g
Housing plastics

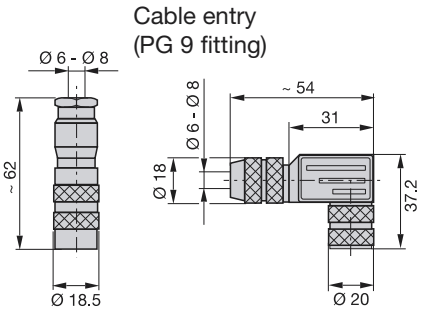
BTL5-P-4500-1 ➥ Fig. 3-5
Weight approx. 80 g
Housing plastics
Operating temp. -40 °C to +60 °C

BTL5-P-5500-2 and BTL5-P-4500-1:
Recommended resolutions 20 µm or 40 µm
Non-linearity ≤ ± 100 µm

The stated non-linearity of ≤ ± 100 µm is valid when guided exactly with a constant gap from the profile within the permissible distance "D".

7.2 Connector

straight **BKS-S147M-00** right-angle **BKS-S148M-00**



straight **BKS-S32M-00** No. 99-5672-19-08 Binder Corp.
right-angle **BKS-S33M-00** No. 99-5672-78-08

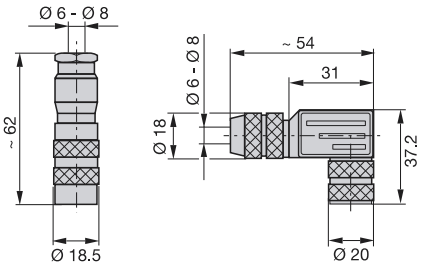


Fig. 7-1: Connector

7.3 Compatible devices

Display:
BDD-AM10-1-SSI
display and limit controller with 2 relay outputs

7.4 Connecting rod

BTL2-GS10-_ _ _ _-A
Aluminum, dimensions ➥ Fig. 7-2
Various standard lengths LG available (please specify when ordering)

Ball joint "B" DIN 71805, rotates horizontally (part of BTL5-F-2814-1S magnet) magnet)

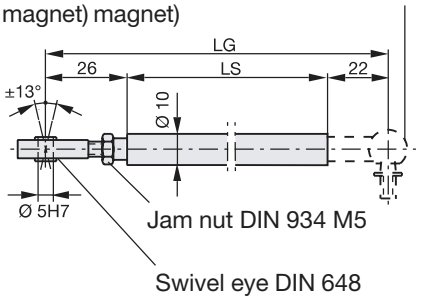


Fig. 7-2: Connecting rod

8 Technical Data

The following are typical values at DC 24 V and room temperature. Fully operational after power-up, with full accuracy after warm-up. Values are with BTL5-P-3800-2, BTL5-P-4500-1 or BTL5-P-5500-2 magnet held at a constant offset from the transducer or with captive magnet BTL5-F/M/N-2814-1S (see magnet section for exceptions):

Resolution (LSB)
depending on version:
BTL5-S1_**2**... 5 µm
BTL5-S1_**3**... 10 µm
BTL5-S1_**4**... 20 µm
BTL5-S1_**5**... 40 µm
BTL5-S1_**6**... 100 µm
BTL5-S1_**7**... 2 µm
BTL5-S1_**8**... 50 µm

Non-linearity
for resolution ≤ 10 µm ± 30 µm
for resolution > 10 µm ± 2 LSB

Output data
The **maximum sampling frequency f_A** at which each sample provides a new actual value can be determined from the following table:

	[mm]	[Hz]
Nom. length	≤ 100	1500
Nom. length	≤ 1000	1000
Nom. length	≤ 1400	666
Nom. length	≤ 2600	500
Nom. length	≤ 4000	333

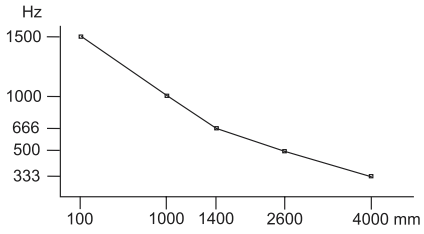


Fig. 8-1: Diagram

Hysteresis ≤ 1 LSB
Repeatability ≤ 2 LSB
(resolution + hysteresis)
Temperature coefficient
(6 µm + 5 ppm ∗ nominal length)/K
Lag error
Standard 2.5 frames
SA244 < 1 frame
Shock loading 100 g/6 ms
per IEC 60068-2-27 [1]
Continuous shock 100 g/2 ms
per IEC 60068-2-29 [1]
Vibration 12 g, 10 to 2000 Hz
per IEC 60068-2-6 [1]

[1] Individual specifications as per Balluff factory standard

8.1 Dimensions, weights, ambient conditions

Nominal length ≤ 4000 mm
Dimensions ➥ page 4
Weight approx. 1.4 kg/m
Housing anodized aluminum
Housing attachment
Mounting clamps with isolation bushings and screws
Operating temp. –40 °C to +85 °C
Humidity < 90%, non-condensing
Protection class per IEC 60529
IP 67 when closed up

8.2 Supply voltage (external)

Regulated supply voltage
BTL5-S1... DC 20 to 28 V
Ripple ≤ 0.5 V_{pp}
Current draw ≤ 90 mA
Inrush ≤ 3 A/0.5 ms
Polarity reversal protection built-in
Overvoltage protection
Transzorb diodes
Electric strength
GND to housing 500 V

UL authorization
File No.
E227256

8.3 Control signals

IInterface RS 485/422
Clock input +Clk, –Clk
(via optical coupler)
Clock frequency max. 1000 kHz
Output data 24 or 25 bit serial
Position information +Data, –Data

8.4 Connection to processor

+Clk, –Clk, +Data, –Data, 24 V, GND

Cable, twisted-pair, shielded
max. length 400 m, Ø 6 to 8 mm

The clock frequency t is a function of the cable length:

Cable length	Clock frequency
< 25 m	< 1000 kHz
< 50 m	< 500 kHz
< 100 m	< 400 kHz
< 200 m	< 200 kHz
< 400 m	< 100 kHz

Table 8-1: Clock frequency

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 61000-6-4 (emission)

EN 61000-6-2 (noise immunity)

Emission tests:
RF Emission
EN 55011 Group 1, Class A+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

No. 836 063 - 726 E • 01.105919 • Edition 0511; specifications subject to changes. • Replaces edition 0506.