BTL5-S1_ _-M_ _ _ _-HB/WB-FA_ _/F_ _-C
Micropulse Linear Transducer - Rod Style

User's Manual

Balluff GmbH
Schurwaldstraße 9
73765 Neuhausen a.d.F.
Germany
Phone +49 7158 173-0
Fax +49 7158 5010
balluff@balluff.de
www.balluff.com

Contents

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...-M...HB/WB... Micropulse transducer.

An overview of the various models can be found in chapter 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.).*

2 Function and Characteristics

2.1 Characteristics

Micropulse transducers feature:

- High data security: Output data are checked for validity and plausibility in the µC.
- Very high resolution, repeatability and linearity
- Absolute output signal
- Measurement range monitoring with "Out of Range" Bit 2^{21}.
- Immunity to shock, vibration, and contamination
- Tough assembly
- Housing of stainless steel
- Wear- and maintenance-free measuring principle
- Pressure rated to 600 bar
- Teflon cable
- Capability of connecting cable guard systems
- Enclosure rating per IEC 60529:
  Cable version IP 68
  (type tested at 5 bar / 48 h)
  IP69/K with connected cable guard system

2.2 Function

The transducer contains a tubular waveguide enclosed by an outer stainless steel rod. A magnet attached to the moving member of the machine or to the cylinder piston is moved over the rod 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.

At the rod end is a damping zone, within which no reliable signal is available, but which may be entered by the magnet.

The electrical connection between the transducer, the processor/controller and the power supply is via a cable.

Dimensions for installing the Micropulse transducer: ➥ Fig. 3-1
Dimensions for installing the magnet: ➥ Fig. 3-4

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. The max. clock frequency t depends on the cable length ➥ section 8 Technical Data on page 9.

For the purposes of error detection bit 2^{21} is provided as an “Out of Range” message, ➥ Fig. 2-1 and Fig. 2-2.

Sending of the position values is finished within time t_m. It is started with the falling edge of the last clock pulse. After this time the BTL is ready for the next data transmission.

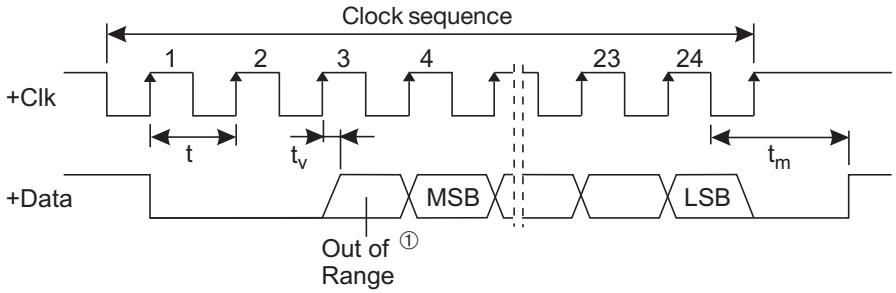


Fig. 2-1: Pulse diagram, example with 24 bit coding
① only for resolution ≥ 5 µm

$t < t_m$

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

The time t_m 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.

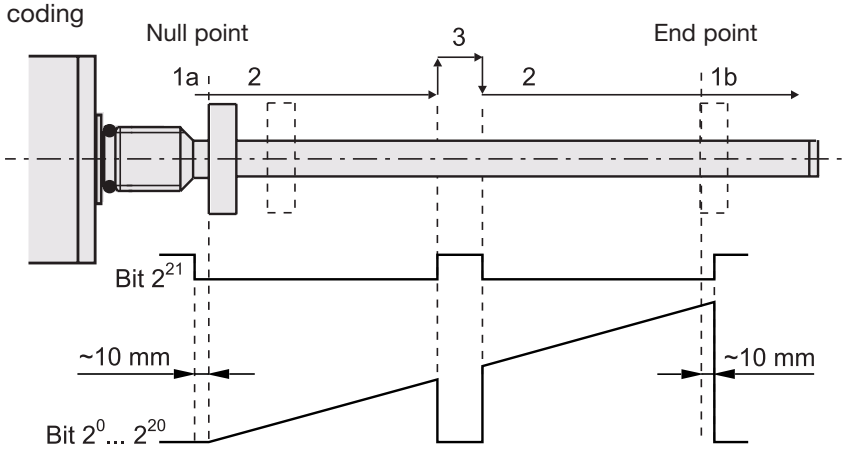
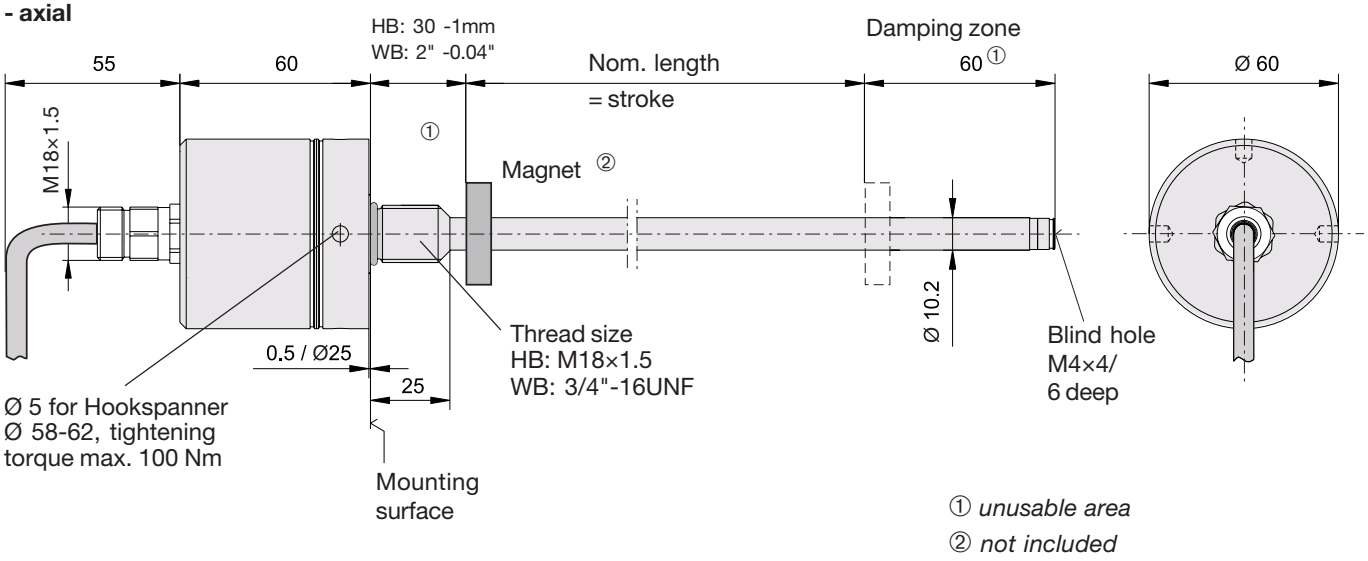


Fig. 2-2: Output data shown with "Out of Range" situation

3 Installation

BTL5...HB/WB-...-C
- axial



BTL5...HB/WB-...-C
- radial

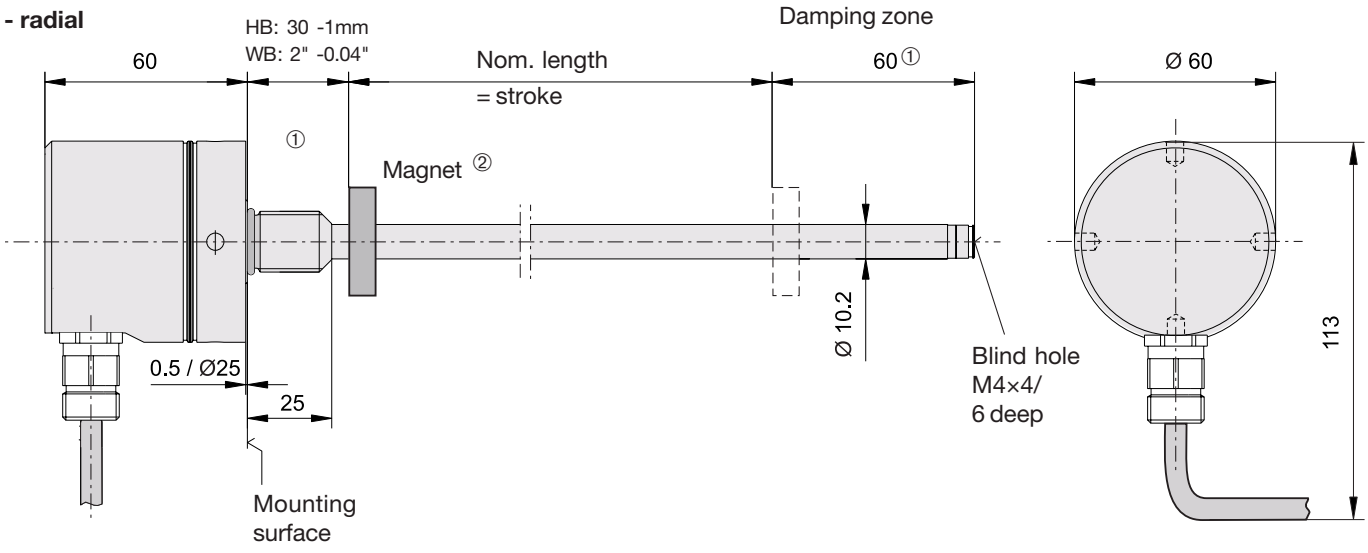


Fig. 3-1: Transducer BTL5-...HB/WB-..., Dimensions

Important Installation Notes:

The contact surface of the transducer must be completely contacted by the mounting surface. The O-ring supplied must make a perfect pressure seal, i.e. the bevel for the O-ring must be configured exactly as shown in Fig. 3-3.

To achieve secure mounting, use the proper nut for the mounting thread. When tightening the transducer, do not exceed a tightening torque of 100 Nm.

For horizontal mounting of transducer with stroke lengths greater than 500 mm, the pressure tube should be supported or attached at its end.

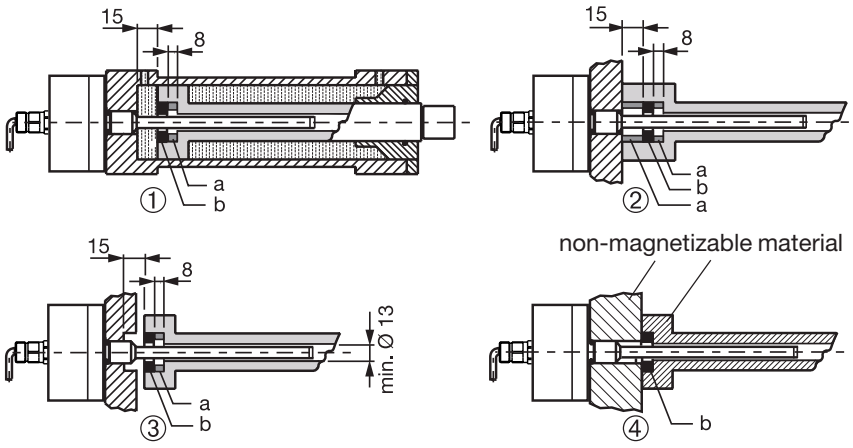
When installing in a hydraulic cylinder, do not allow the magnet ring to rub against the pressure tube. The bore diameter in the piston and cylinder rod should be at least 13 mm.

3 Installation (cont.)

3.1 Mounting

When possible, use non-magnetizable material for attaching the transducer and magnet ring. ➥ Fig. 3-2.

When attaching the transducer to magnetizable materials, appropriate measures must be taken to protect against magnetic disturbances ➥ Fig. 3-2. Note the recommended distance of the transducer and cylinder from strong, external magnetic fields.



① - ③ for magnetizable materials
④ for non-magnetizable materials

a = Spacer made of non-magnetizable materials
b = Magnet

Fig. 3-2: Mounting

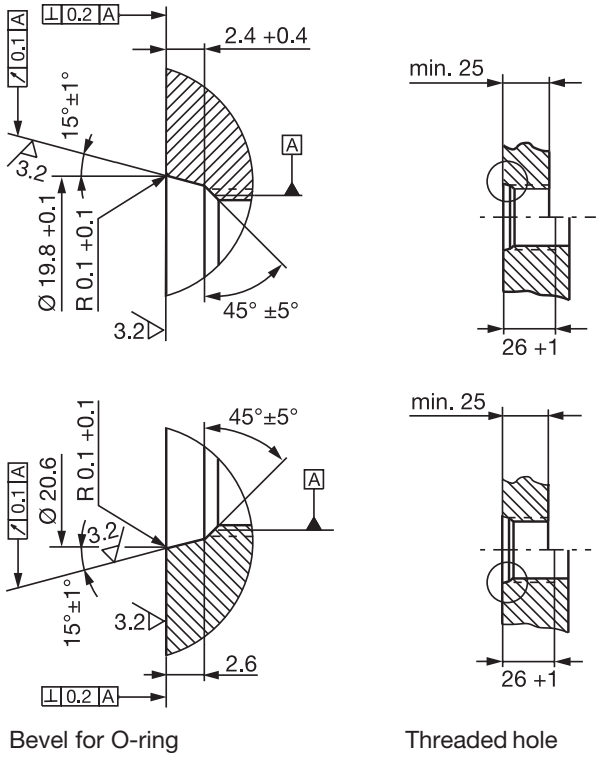
3.2 Transducer, Installation

The smallest permissible distance between magnet ring and rod mounting surface is shown in ➥ Fig. 3-1.

The transducer has either a M18×1.5 thread or a 3/4"-16UNF thread for mounting. The sealing is carried cut with the O-ring supplied at the flange facing.

Threaded hole
M18×1.5 per
ISO 6149
O-ring 15.4 × 2.1

Threaded hole
3/4"-16UNF per
SAE J475
O-ring 15.3 × 2.4



Bevel for O-ring

Threaded hole

Fig. 3-3: Threaded hole for mounting the BTL with O-ring

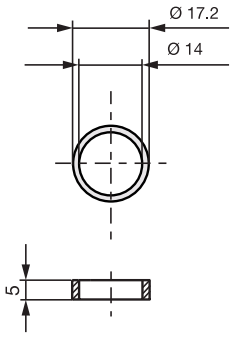
3 Installation (cont.)

3.3 Magnets, Installation

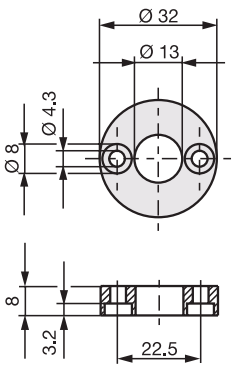
A magnet is required for each transducer. This must be ordered separately. ➥ Fig. 3-4.

For mounting the magnet we recommend to use non-magnetizable material. ➥ Fig. 3-2.

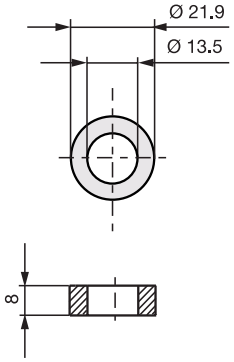
BTL-P-0814-GR-PAF



BTL-P-1013-4R



BTL-P-1014-2R



BTL-P-1012-4R

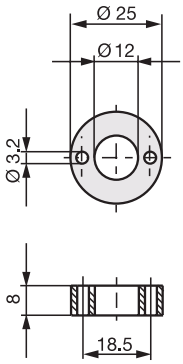


Fig. 3-4: Magnet (optional)

4 Wiring

4.1 Cable axial and radial

Cable length max. 400 m;
Ø 6 to 8 mm. Longer lengths may be used if construction, shielding and routing are such that external noise fields will have no effect on signal integrity.

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

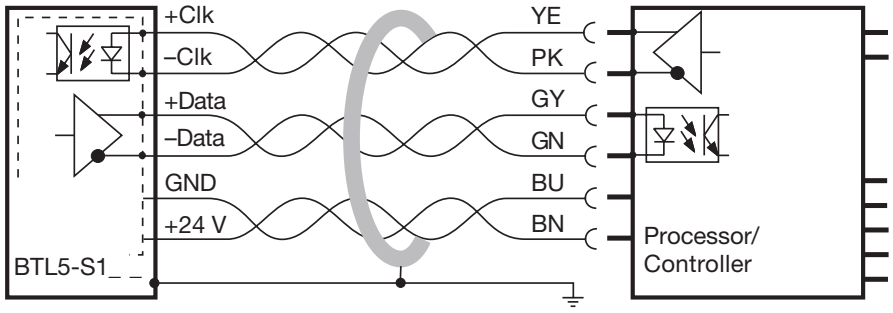


Fig. 4-1: BTL5-S1_ _-... with Processor/Controller, connection example

4 Wiring (cont.)

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 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. Connections on the controller side may vary according to the controller and configuration used.

To avoid coupled noise, avoid proximity to high-current lines when routing cable between transducer, controller and power supply. Inductive coupled noise from AC harmonics (e.g., from phase controls) are especially critical, against which the cable shield offers very little protection.

Colors	BTL5-S1...
Interface signals	
YE yellow	+Clk
PK pink	-Clk
GY gray	+Data
GN green	–Data
Supply voltage (external)	
BU blue	GND
BN brown	+24 V
WH white	do not connect

Table 4-1: 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.

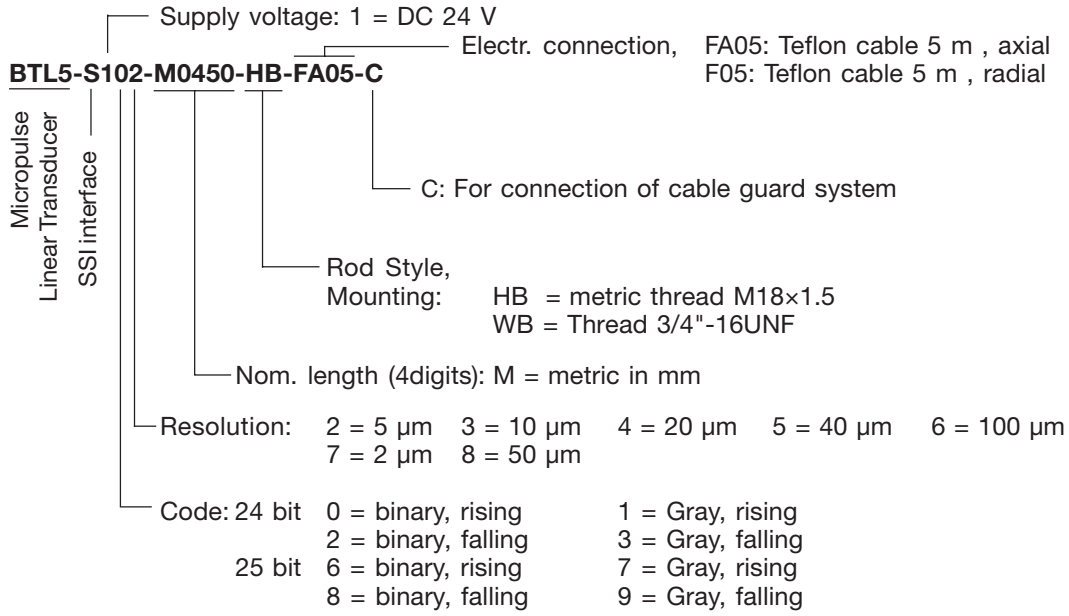
5.4 Check functionality

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.

6 Versions (indicated on part label)



6.1 Included in shipment

Transducer with condensed guide

6.2 Available lengths

Nominal stroke lengths of from 25 to 4000 mm are available for ideally sizing the transducer to the application.

7 Accessories (order separately)

7.1 Magnets

Magnet BTL-P-1013-4R, BTL-P-1012-4R

Dimensions	➥ Fig. 3-4
Weight	approx. 10 g
Housing	anodized aluminum
Operating temp.	–40 °C to +85 °C

included in shipment
Spacer 8 mm
Material POM (Polyoxymethylene)

Magnet BTL-P-1014-2R

Dimensions	➥ Fig. 3-4
Weight	approx. 10 g
Housing	anodized aluminum
Operating temp.	–40 °C to +85 °C

Magnet BTL-P-0814-GR-PAF

Dimensions	➥ Fig. 3-4
Weight	approx. 2 g
Housing	Polyamide bound ferrite
Operating temp.	–40 °C to +85 °C

7.2 Compatible devices

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

7.3 Mounting nut

BTL5...-HB...
Mounting nut M18x1.5
BTL-A-FK01-E-M18x1.5

BTL5...-WB...
Mounting nut 3/4"-16UNF
BTL-A-FK01-E-3/4"-16UNF

8 Technical Data

Typical values at DC 24 V, room temperature and BTL with nominal length of 500 mm. Ready for operation at once, full accuracy after warm-up. With magnet BTL-P-1013-4R, BTL-P-1014-2R or BTL-P-1012-4R:

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
Hysteresis	≤ 1 LSB
Repeatability	≤ 2 LSB
(resolution + hysteresis)	
Temperature coefficient	
≤ (6 µm + 5 ppm * nominal length)/K	
lag error	2.5 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]	
(take care to avoid inherent resonances of protective tube)	
Pressure	up to 600 bar
when installed in a hydraulic cylinder	

[1] Individual specifications as per Balluff factory standard

8.1 Dimensions, weights, ambient conditions

Nominal length	≤ 4000 mm
Dimensions	➥ Fig. 3-1
Weight	approx. 2 kg/m
Housing	Stainless steel
Pressure tube	Stainless steel 1.4571
Diameter	10.2 mm
Wall thickness	2 mm
E-modulus	approx. 200 kN/mm²
Mounting threads	M18×1.5 or 3/4"-16UNF
Operating temp.	–40 °C to +85 °C
Humidity	< 90 %, non-dewing
Protection rating per IEC 60529 with connector attached:	
cable version	IP 68
(type tested at 5 bar / 48 h)	
IP69/K with connected cable guard system	

8.2 Supply voltage (external)

Regulated supply voltage	
BTL5-_1...	20 to 28 V DC
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 DC

8.3 Control signals

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

8.4 Connection to processor

BTL5-...-FA05
with connecting cable,
axial arrangement, 5 m long

BTL5-...-F05
with connecting cable,
radial arrangement, 5 m long

Teflon cable -40 °C to +200 °C

The clock frequency 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

UL authorization
File No.
E227256

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

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

2004/108/EC (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. 857 937 - 726 E • 00.000000 • Edition 0709; specifications subject to changes.