BALLUFF

sensors worldwide

BML-S1F_-A/Q_ _ _-M_ _ 0-_0-KA/KD/KF_ _
BML-S1F_-A/Q_ _ _-M_ _ 0-_0-KA_ _-S284

User's Guide

english

www.balluff.com

1 Notes to the user

1.1 Validity

This guide describes the construction, function and installation options for the BML magnetic linear encoder. It applies to sensor head series
BML-S1F_-A/Q_ _ _-M_ _ 0-_0-KA/KD/KF_ _ and
BML-S1F_-A/Q_ _ _-M_ _ 0-_0-KA_ _-S284
(see Type code breakdown on pages 22 and 23).

The guide is intended for qualified technical personnel. Read this guide before installing and operating the position measuring system.

> In this guide, a magnetic tape with 1 mm pole width is representative of all other magnetic tapes.

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

– Sensor head
– Condensed guide

> The magnetic tapes are available in different versions and must be ordered separately.

1.4 Approvals and markings

UL approval
File no.
E227256

The CE Mark verifies that our products meet the requirements of the current EMC Directive.

The transducer meets the requirements of the following product standard:
– EN 61326-2-3 (noise immunity and emission)

Emission tests:

– RF emission
  EN 55011

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 1
– 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 BML magnetic linear encoder is intended for communication with a machine controller (e.g. PLC). 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.

Non-approved use is not permitted and will result in the loss of warranty and liability claims against the manufacturer.

2.2 General safety notes for the linear encoder

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 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 position measuring system, take it out of service and secure 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

3.1 Construction

Connection type: ...-KA/KD/KF_ _

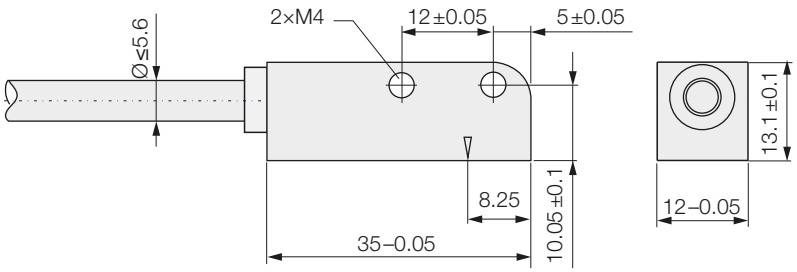


Fig. 3-1: BML-S1F_-A/Q_ _ _-M_ _ 0-_0-KA/KD/KF_ _, construction

- An 8.8 M3 cylinder screw may be tightened with max. 1.5 Nm if it has been screwed in at least 10 mm.
- An 8.8 M4 cylinder screw may be tightened with max. 2.3 Nm if it has been screwed in at least 10 mm.
- Secure the screws against unintended loosening (e.g. with locking paint).

Connection type: ...-KA_ _-S284

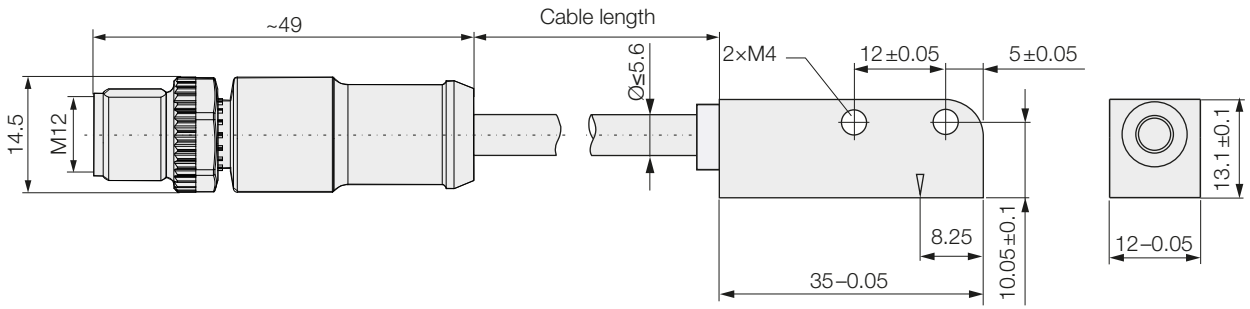


Fig. 3-2: BML-S1F_-A/Q_ _ _-M_ _ 0-_0-KA_ _-S284, construction

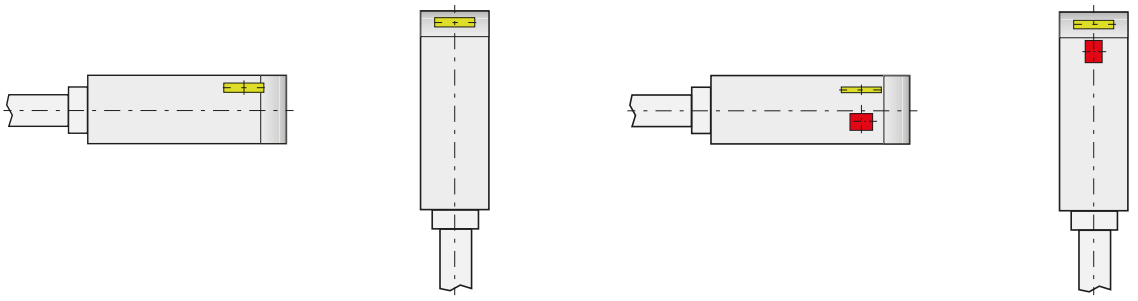
3.1.1 Overview

BML-S1F1…M_00/ BML-S1F1-Q6…M320
- Lengthwise direction
- No reference sensor

BML-S1F2…M_00/ BML-S1F2-Q6…M320
- Crosswise direction
- No reference sensor

BML-S1F1…M310
- Lengthwise direction
- With reference sensor

BML-S1F2…M310
- Crosswise direction
- With reference sensor



Incremental sensor

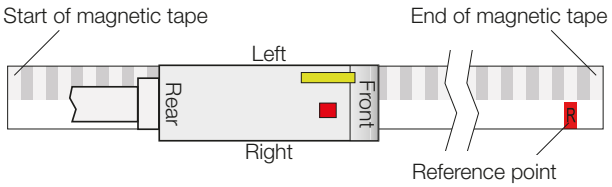
Reference sensor

Fig. 3-3: Overview of versions

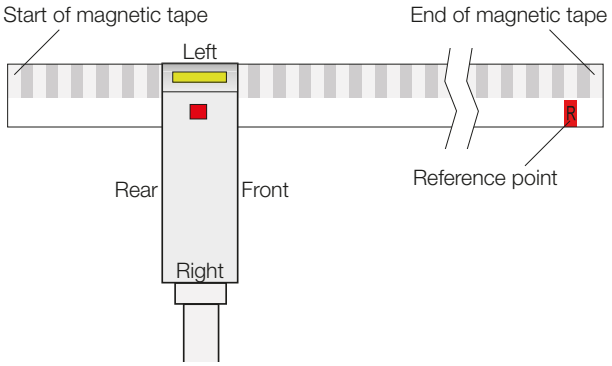
3 Construction and function (continued)

3.1.2 Positioning

BML-S1F1… (lengthwise direction)



BML-S1F2… (crosswise direction)



Incremental sensor

Reference sensor

Fig. 3-4: Positioning of the two BML types BML-S1F1… and BML-S1F2…

3.2 Function

The BML is a magnetically coded, non-contact, incremental position measuring system consisting of a sensor head and magnetic tape. The sensor head and magnetic tape are mounted on the machine. The magnetic tape contains alternating north and south poles.
The incremental sensor in the sensor head measures the magnetic alternating field. Moving without any contact over the magnetic tape, the sensor senses the magnetic periods, allowing the controller to detect the travel range.

- To function correctly, the bottom of the sensor head must always be above the magnetic tape (see Distances and tolerances on page 10).
- For a complete technical description and assembly instructions for magnetic tapes, please see the magnetic tape user's guide at **www.balluff.com**.

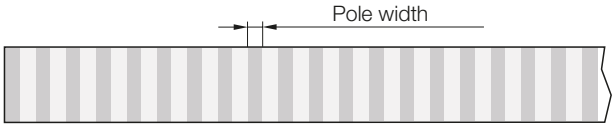
The system is available with or without a reference point function. In a system with a reference point function, the reference position is integrated in the magnetic tape and the function is implemented via magnetic sampling.

Not all variants cover the illustrated functions and deviations from the illustrations shown may occur.

3.2.1 Sensor head and magnetic tape

The magnetic tape is not included in the scope of delivery and must be ordered separately. When selecting the magnetic tape, make sure the magnetic tape and sensor head are compatible. This particularly applies to the following factors:
- Pole width (1 or 2 mm), see below
- Reference points (none, one, two or more (fixed periodic)), see section 3.3

Magnetic tape



Sensor head

BML-S1F_-_ _ _ _-M_ _0-…

Pole width
3 = 1 mm
5 = 2 mm

Reference signal
0 = No reference signal
1 = With single, double, or fixed periodic reference signal (not with 2 mm pole width)
2 = Pole-periodic reference signal (only with BML-S1F…-Q61… (digital), not with 2 mm pole width)

3 Construction and function (continued)

3.3 Reference point function

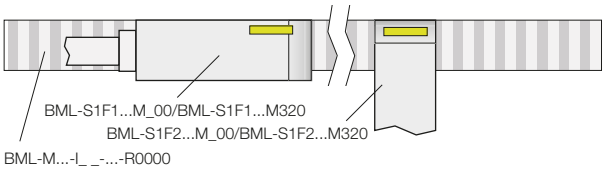
For every incremental position measuring system, the reference position is the indispensable starting point for counting.
The way the reference position is detected depends on the sensor head, the magnetic tape, and the controller.

Advantages of pole-periodic and fixed periodic magnetic tapes: The magnetic tapes can be purchased in long lengths and cut individually.

Reference point functions are possible with both linear and round magnetic tapes.

No or pole-periodic reference signal:

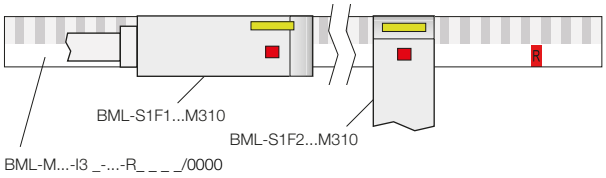
System consisting of:
– BML-S1F…-M_**0**0-… (none) or
BML-S1F…-Q61…-M3**2**0-… (pole-periodic)
– BML-M…-I_ _-…-**R0000** magnetic tape



In the most basic position measuring system, the sensor head detects the magnetic periods using the incremental sensors. The magnetic tape contains a track with magnetic north and south poles. The position is detected by the controller by adding up the counted increments.
With a pole-periodic reference signal, a reference signal is output for each magnetic pole, i.e. every 1 mm. In this case, an external reference switch must be set at the selected reference point signal. The controller evaluates the reference position at the moment when the switch and the reference signal from the sensor head are active.

Single or double reference signal:

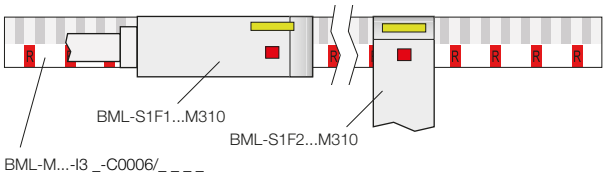
System consisting of:
– BML-S1F…-M3**1**0-…
– BML-M…-I3 _-…-**R**_ _ _ _**/0000** (single signal) or
BML-M…-I3 _-…-**R**_ _ _ _**/**_ _ _ _ (double signal)
magnetic tape



A sensor head with an additional reference point sensor can output a reference signal as soon as it reaches the magnetically coded reference point on the second track of the magnetic tape. An external reference switch is not necessary.

Fixed-periodic reference signals:

System consisting of:
– BML-S1F…-M3**1**0-…
– BML-M…-I3 _-…-**C0006/**_ _ _ _ magnetic tape



The sensor head with additional reference point sensor can also be combined with a magnetic tape with fixed-periodic reference points. Here, the references points are integrated over the entire length of the tape at specific, uniform distances, e.g. every 10 cm.
To determine the exact absolute position, the reference run must be performed up to the external selection switch.

4 Installation and connection

4.1 Distances and tolerances

During assembly, make sure that the sensor is correctly positioned over the magnetic tape. The distances and tolerances must be complied with to ensure the correct function and linearity class of the system. A gap of 0.1 mm (approximately the thickness of a sheet of paper) is recommended.

> For optimum measuring behavior, the free area of magnetizable material must be maintained.

> Body of revolution: The minimum diameter of 30 mm must not be fallen below.

Linear and rotative applications:

BML-S1F1

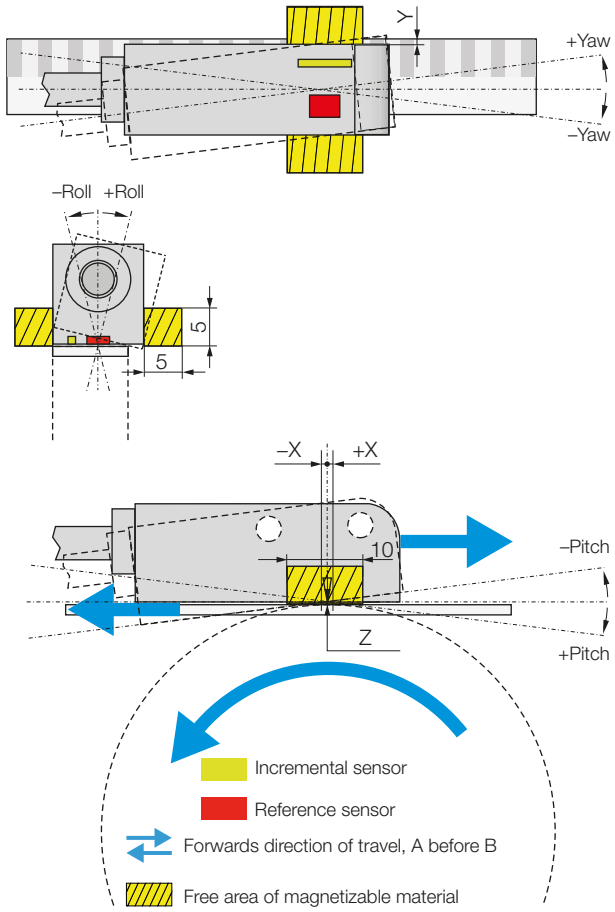


Fig. 4-1: Distances and tolerances BML-S1F1…

BML-S1F2

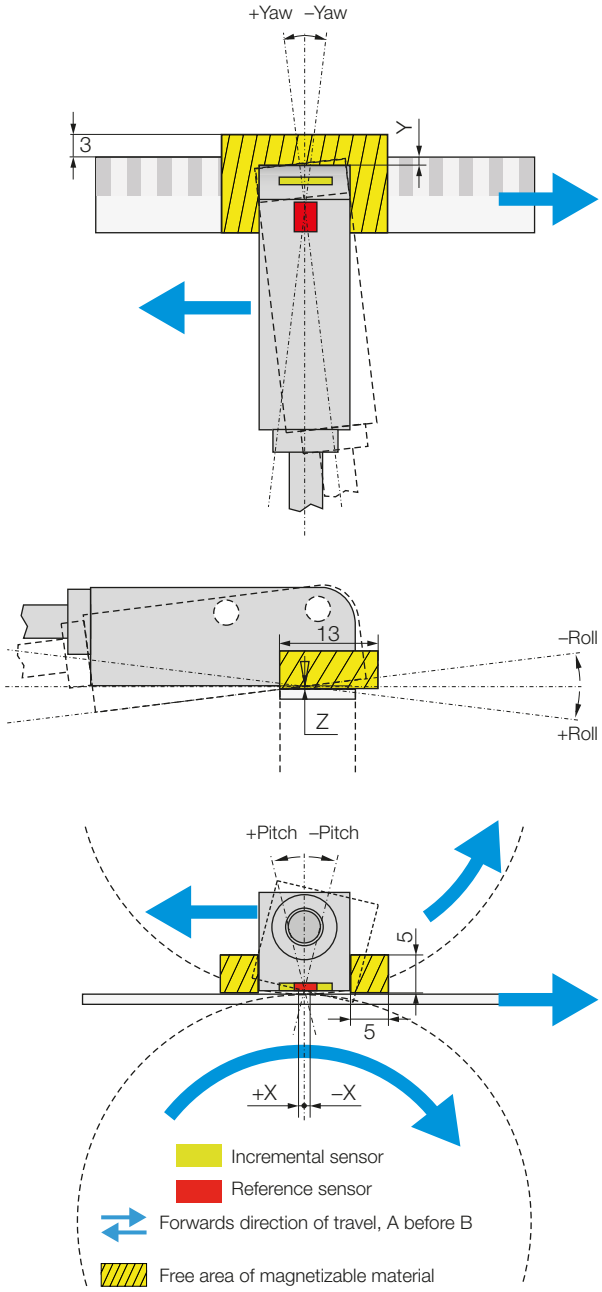


Fig. 4-2: Distances and tolerances BML-S1F2…

4 Installation and connection (continued)

	Distances/angles			
	BML-…M3_ _… (1 mm without/with reference signal)		BML-…M500… (2 mm without reference signal)	
	BML-S1F1-…	BML-S1F2-…	BML-S1F1-…	BML-S1F2-…
Z (sensor/magnetic tape gap)	0.01 to 0.35 mm (with cover strip max. 0.2 mm)		0.01 to 1.25 mm (with cover strip max. 1.1 mm)	
Y (side offset)	0.5 ±0.5	0 ±0.5	0.5 ±0.5	0 ±0.5
X (tangential offset) **Only rotative applications:**	Max. ±0.5 mm			
Yaw	< ±1°			
Pitch	< ±1°			
Roll	< ±1°			

Tab. 4-1: Distances and tolerances

4.2 Assembling the sensor head

NOTICE

Interference in function

Improper assembly of the magnetic tape and sensor head may impair function of the position measuring system and lead to increased wear or damage to the system.

- ▶ All permissible distance and angle tolerances (see section 4.1) must be strictly complied with.
- ▶ The sensor head may not come into contact with the magnetic tape over the entire measuring range. Contact must also be avoided if the magnetic tape is covered by a cover strip (optional).
- ▶ The position measuring system must be installed in accordance with the indicated degree of protection.

External magnetic fields change the functional properties.

- ▶ The magnetic tape may not be influenced by strong external magnetic fields (> 30 mT).
- ▶ Direct contact with magnetic clamps or other permanent magnets must be avoided.

No forces may be exerted on the cable on the housing.

- ▶ Provide the cable with a strain relief.

A too-high tightening torque may damage the housing.

- ▶ Tighten the screws with the appropriate tightening torque (note the information on page 7).

4 Installation and connection (continued)

4.3 Electrical connection

> Note the information on shielding and cable routing on page 13.

4.3.1 Cable connection/connector S284

BML-S1F_ _ _-M_ _ 0-_0-KA/KD_ _ and
BML-S1F_ _ _-M_ _ 0-_0-KA_ _-S284

12-wire cable with sense lines (measuring lines) to avoid voltage drops in the supply (see Tab. 4-2, pins 1 to 12, shield).

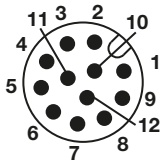


Fig. 4-3: M12 plug pin assignment (view on pin side), BML-S1F_ _ _-M_ _ _-_0- KA_ _-S284

BML-S1F_ _ _-M_ _ _-_0-KF_ _

8-wire cable (see Tab. 4-2, pins 1 to 8, shield).

Pin	Wire color	Signal						Description
		BML-S1F**1**-**A**…		BML-S1F**2**-**A**…		BML-S1F_-**Q**…		
		…-M310-…	**…-M_00-…**	**…-M310-…**	**…-M_00-…**	**…-M310-… …-M320-…**	**…-M_00-…**	
1	WH					+A		Digital rectangular signal
		+B(+cos)		–B(–cos)				Sinusoidal analog signal
2	BN					–A		Digital rectangular signal
		–B(–cos)		+B(+cos)				Sinusoidal analog signal
3	GN					+B		Digital rectangular signal
		–A(–sin)		+A(+sin)				Sinusoidal analog signal
4	YE					–B		Digital rectangular signal
		+A(+sin)		–A(–sin)				Sinusoidal analog signal
5	GY	+Z	Must remain free	+Z	Must remain free	+Z	Must remain free	Reference signal
6	PK	–Z		–Z		–Z		Reference signal
7	BU	GND						Sensor head ground (0 V)
8	RD	+5 V DC						Supply voltage
9	BK*	GND sense						GND sense
10	VT*	UB sense						UB sense
11	GY-PK/TR*	Must remain free						
12	RD-BU/OG*	Must remain free						
Shield	TR	PE						Connector housing/shield

* Not with BML-S1F_ _ _-M_ _ _-_0-KF_ _

Tab. 4-2: Connection assignment BML-S1F_ _ _-M_ _ _-_0-KA/KD_ _ and BML-S1F_ _ _-M_ _ _-_0- KA_ _-S284

4 Installation and connection (continued)

4.4 Voltage drop in the supply

While operating at 5 V, the operating voltage must be 5 V ±5%. To compensate for voltage drops in the supply, we recommend using a regulated power supply with sense input (Fig. 4-4).
If this is not possible or desired, integrate the sense lines of the 12-wire cable (not with 8-wire cable BML-…-KF…) parallel to the +5 V and GND lines (Fig. 4-5).

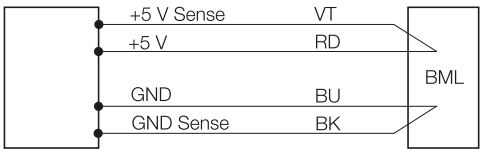


Fig. 4-4: Power supply with sense line

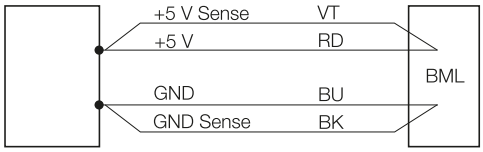


Fig. 4-5: 5-V power supply without sense line

4.5 Shielding and cable routing

Defined ground!
The position measuring system and the control cabinet must be at the same ground potential.

Shielding

To ensure electromagnetic compatibility (EMC), observe the following:

– The cable shield must be grounded on the controller side, i.e. connected to the protective earth conductor.
– When ducting the cable between the sensor, controller, and power supply, it is important to avoid going near high voltage cables due to interferences.
Stray noise from AC harmonics (e.g. from phase angle controls or frequency converters) are especially critical and the cable shield offers very little protection against this.

Magnetic fields

The position measuring system is a magnetically coded system.
It is important to maintain adequate distance between the position measuring system and strong external magnetic fields.

Cable routing

Do not route the cable between the position measuring system, 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

For information on the permissible bending radius, see section 7.6 on page 20.

Cable length

Max. cable length 20 m. Longer cables may be used if their construction, shielding and routing prevent noise interference.

Observe voltage drop in cable!
The cable has a resistance of approx. 0.4 Ohm/m (back and forth). The nominal voltage on the BML must not be undercut.

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 or devices.
2. Turn on the system.
3. Check measured values in the controller and reset if necessary.

5.2 Check system function

Check all functions as follows after assembling the position measuring system or exchanging the sensor head:

1. Switch on the sensor supply voltage.
2. Move the sensor head along the entire measuring range and check that all signals are output. To do this, mark the start position, move slowly forward, and then move back quickly into the start position. Use a BDD counter or the controller to count the impulses. The system has been set correctly if the impulses have the same value as the start value.
3. Check that the count direction corresponds with the direction of travel.

5.3 Operating notes

- Check and record the function of the position measuring system and all associated components on a regular basis.
- If there are malfunctions in the position measuring system, take it out of service and secure it against unauthorized operation (see also Troubleshooting).
- Secure the system against unauthorized use.

6 Interfaces

6.1 Analog output signal
(BML-S1F_-**A**...)

With the analog sine and cosine signals +A (+Sin), –A (–Sin), +B (+Cos) and –B (–Cos) the controller evaluates the relation of the signal amplitudes and, from the signals, interpolates the precise position within a period (Fig. 6-1). For a movement over several periods, the controller also counts the number of periods.

For correct function, the sine signal and the cosine signal must be evaluated depending on the direction.

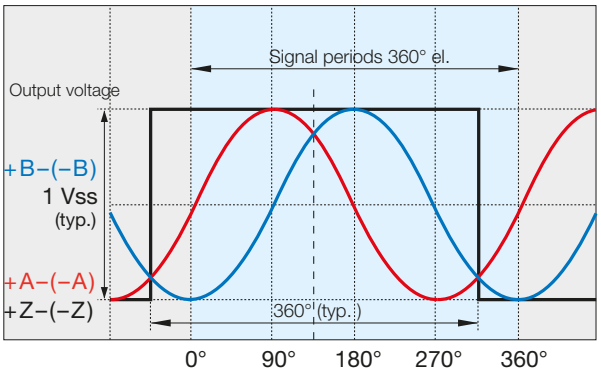


Fig. 6-1: Signals of the sine and cosine sensor, forward movement corresponds to increasing angle

The sensor transmits the measurement as an analog sine/cosine differential signal with an amplitude of approx. 1 Vss (peak/peak value) to the controller.
The period length is dependent on the pole width:

– BML-S1F_-A...M3...: 1 mm
– BML-S1F_-A...M5...: 2 mm

If the sensor is supplied with voltage that is isolated from the processing electronics, the GND for this voltage must be connected to the GND of the processing electronics.

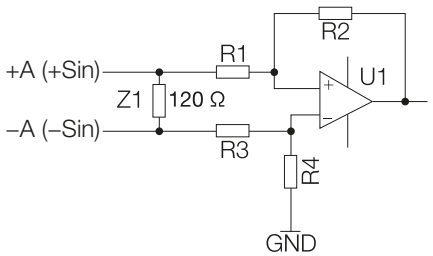


Fig. 6-2: Circuitry example of subsequent electronics with analog output

6 Interface (continued)

6.2 Digital rectangular signal
(BML-S1F_-**Q**…)

The sensor head converts the sine and cosine signals from the incremental sensors in digital A/B impulses and transfers them to the controller.

6.2.1 Digital incremental measuring system

The sensor transmits the measurement to the controller as a differential voltage signal (RS422).
The edge distance A/B corresponds to the mechanical resolution of the sensor head (e.g. 1 µm). The time between two edges is defined by the minimum edge distance and must be adjusted to the controller. The maximum movement speed is defined by the mechanical resolution and the minimum edge distance (see Tab. 6-1 and Tab. 6-2).

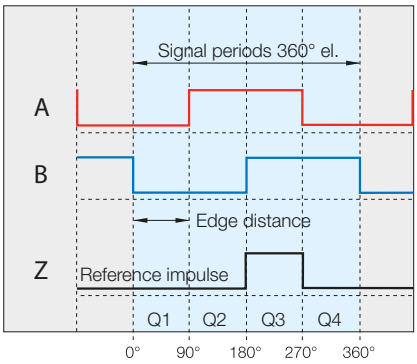


Fig. 6-3: Digital output signals for forward movement

The digital A/B impulses are interpolated in the sensor head. The two digital impulses A and B are electrically phase-delayed by 90°, the algebraic sign of the phase difference depends on the direction of movement of the sensor (Fig. 4-1/Fig. 4-2).
Each edge change of A or B is a counting step for the cycle counter (up/down counter). With a leading signal A, the counter reading increases and it decreases with a leading signal B. The controller knows the precise increment position at all times, without having to periodically query the sensor (real-time capability).
The position of the Z signal may be different in the position measuring systems (Q1 to Q4, see Fig. 6-3). It is, however, always one increment wide.

If the sensor is supplied with voltage that is isolated from the processing electronics, the GND for this voltage must be connected to the GND of the processing electronics.

For correct function, the A and B signal must be evaluated depending on the direction.

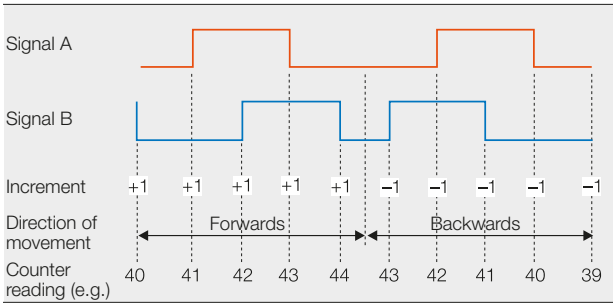


Fig. 6-4: BML output signals with cycle counter

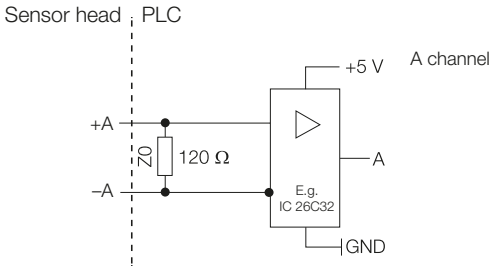


Fig. 6-5: Circuitry of subsequent electronics (RS422)

6 Interface (continued)

6.2.2 Maximum movement speed, resolution, and edge distance

There is a connection between the selected resolution of the sensor head, the minimum edge distance, and the possible movement speed that is illustrated in Tab. 6-1 and Tab. 6-2.

BML-S1F...-M3...: system accuracy up to 10 µm

Min. edge distance [1]	V_{max} acc. to edge distance and resolution			
	Resolution			
	D 1 µm	E 2 µm	F 5 µm	G 10 µm
D 0.12 µs	5 m/s	10 m/s	20 m/s[2]	20 m/s[2]
I 0.29 µs	2 m/s	4 m/s	10 m/s	10 m/s
F 0.48 µs	1 m/s	2 m/s	5.41 m/s	5.41 m/s
G 1 µs	0.65 m/s	1.3 m/s	2.95 m/s	2.95 m/s
H 2 µs	0.3 m/s	0.6 m/s	1.54 m/s	1.54 m/s
K 4 µs	0.15 m/s	0.3 m/s	0.79 m/s	0.79 m/s
L 8 µs	0.075 m/s	0.15 m/s	0.34 m/s	0.34 m/s
N 16 µs	0.039 m/s	0.078 m/s	0.19 m/s	0.19 m/s
P 24 µs	0.026 m/s	0.052 m/s	0.13 m/s	0.13 m/s

[1] Connection between edge distance and counting frequency, see appendix for table.

[2] BML-S1F...-M310-... (with reference sensor): max. movement speed 10 m/s

Tab. 6-1: BML-S1F...-M3...: Selection aid for maximum movement speed

BML-S1F...-M5...: system accuracy up to 20 µm

Min. edge distance [1]	V_{max} acc. to edge distance and resolution			
	Resolution			
	E 2 µm	S 4 µm	G 10 µm	I 20 µm
D 0.12 µs	10 m/s	20 m/s	20 m/s	20 m/s
I 0.29 µs	4 m/s	8 m/s	20 m/s	20 m/s
F 0.48 µs	2 m/s	4 m/s	10.82 m/s	10.82 m/s
G 1 µs	1.3 m/s	2.6 m/s	5.9 m/s	5.9 m/s
H 2 µs	0.6 m/s	1.2 m/s	3.08 m/s	3.08 m/s
K 4 µs	0.3 m/s	0.6 m/s	1.58 m/s	1.58 m/s
L 8 µs	0.15 m/s	0.3 m/s	0.68 m/s	0.68 m/s
N 16 µs	0.078 m/s	0.158 m/s	0.38 m/s	0.38 m/s
P 24 µs	0.052 m/s	0.104 m/s	0.26 m/s	0.26 m/s

1) Connection between edge distance and counting frequency, see appendix for table.

Tab. 6-2: BML-S1F...-M5...: Selection aid for maximum movement speed

If using the reference sensor, the max. movement speed is limited to 10 m/s.

The following applies for 4x evaluation (each edge is counted):

$$\text{Counting frequency of the controller} \geq \frac{1}{\text{Min. edge distance}}$$

$$\text{Period frequency} = \frac{\text{Counting frequency}}{4}$$

Example: edge distance = 1 µs
Counting frequency = 1 MHz
Period frequency = 250 kHz

Important!

- The controller/display must be able to count the minimum timed edge distances indicated in the tables (note the counting frequency of the controller!).
- The min. edge distance can even occur at a standstill due to the internal interpolation process.
- Always select the next-higher movement speed or the next-faster min. edge distance, otherwise position detection errors may be created by the controller during evaluation.

Sensor head design for controlling with 4x evaluation:

Example 1: BML-S1F...-M3...
Required resolution: 5 µm
Max. movement speed: 7 m/s

► In Tab. 6-1: select column F.
► Select the row 10 m/s in column F.
⇒ Edge distance E = 0.29 µs.

Example 2: BML-S1F...-M3...
Required resolution: 10 µm
Max. counting frequency of the controller: 0.5 MHz
Edge distance: 2 µs

► In Tab. 6-1: select row H in column G.
⇒ Maximum possible movement speed: 1.54 m/s

Coding in the type code breakdown

BML-S1F1-Q61_-M310-G_0-KA05 (example)
- G → Min. edge distance
- M → Resolution

For further information, see Type code breakdown on pages 22 and 23.

6 Interface (continued)

6.2.3 Additional parameters for rotative applications

The BML position measuring system enables precise adjustment to the respective application with the rotative magnetic tapes (magnetic rings).

Definition of impulses per rotation

The number of required impulses per rotation varies depending on the application. It defines the resolution of the sensor head and the magnetic ring diameter.

BML-S1F…

Resolution	Impulses/rotation with 4x evaluation		
	Outer Ø of magnetic ring		
	72 mm	75.4 mm	122 mm
	Number of poles (with 1 mm pole width)		
	228	238	384
D 1 µm	228,000	238,000	384,000
I 2 µm	114,000	119,000	192,000
F 5 µm	45,600	47,600	76,800
G 10 µm	22,800	23,800	38,400
	Number of poles (with 2 mm pole width)		
	114	118	192
I 2 µm	114,000	118,000	192,000
S 4 µm	57,000	59,000	96,000
G 10 µm	22,800	23,600	38,400
I 20 µm	11,400	11,800	19,200

Tab. 6-3: BML-S1F…: selection aid for magnetic rings

Maximum speed

The BML system enables recording of rotative movements. The speed and magnetic ring diameter determine the speed of the ring on the sensor head.
The selection of the resolution and edge distance of the sensor head determines the maximum movement speed that the sensor can detect. This results in a maximum speed in accordance with the following formula:

$$\text{Max. speed [rpm]} = \frac{60 \times \text{max. movement speed [m/s]}}{\pi \times \text{magnetic ring diameter [m]}}$$

Maximum movement speed and minimum edge distance, see Tab. 6-1 and Tab. 6-2 on page 17.
Recommendation: max. speed 10 % less than the detected speed value.

Max. movement speed	RPM				
	Outer diameter				
	31 mm	49 mm	72 mm	75.4 mm	122 mm
20 m/s	12322	7795	5305	5066	3131
10 m/s	6161	3898	2653	2533	1565
5 m/s	3080	1949	1326	1266	783
2 m/s	1232	780	531	507	313
1 m/s	616	390	265	253	156

Tab. 6-4: Maximum speed of rotative magnetic tape (magnetic ring)

Example:

BML-S1F…-M3 sensor head with 1 µm (D) resolution and a min. edge distance of 0.12 µs (D).
Tab. 6-1 on page 17 produces a max. movement speed of 5 m/s for this sensor head. With a magnetic ring diameter of 49 mm = 0.049 m, a speed of 1949 rpm can be achieved acc. to the formula (the value can also be read in Tab. 6-4 (column 49 mm/line 5)). Taking into account the recommendation to remain 10% below this, a speed of 1754 rpm should not be exceeded.

6.3 Circuitry for reference position

Depending on the type, the sensor transfers the following signals:

- No reference signal
- Single, double, or fixed-periodic reference signal that is magnetically coded in the magnetic tape
- A pole-periodic reference signal (period = 1 mm, reference signal width = edge distance, Fig. 6-1). If several reference signals must be transferred, an external selection switch must be mounted at the desired reference signal.

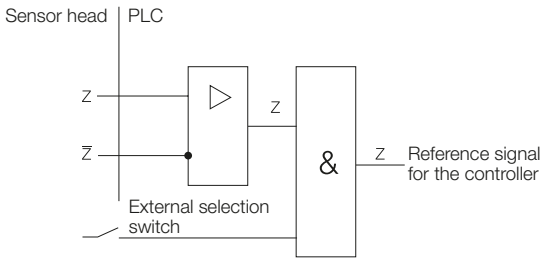


Fig. 6-6: Reference position circuitry

7 Technical data

The specifications are typical values at room temperature.

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

7.1 Accuracy

Position resolution	
Analog	Dependent on evaluation
Digital	
BML…-M**3**_ _-…	1 µm, 2 µm, 5 µm, 10 µm
BML…-M**5**_ _-…	2 µm, 4 µm, 10 µm, 20 µm
Repeat accuracy	< 1 increment
System accuracy	
BML…-M**3**_ _-…	±10 µm
BML…-M**5**_ _-…	±20 µm
Hysteresis	
BML…-M**3**_ _-…	≤ 2 µm
BML…-M**5**_ _-…	≤ 4 µm
Max. non-linearity of processing electronics	
BML…-M**3**_ _-…	≤ ±2 µm
BML…-M**5**_ _-…	≤ ±4 µm

7.2 Ambient conditions[1)]

Operating temperature	–20°C to +80°C
Storage temperature	–30°C to +85°C
Shock rating Continuous shock per EN 60068-2-27[2)]	100 g/6 ms 100 g/2 ms
Vibration load per EN 60068-2-6[2)]	12 g, 10 to 2000 Hz
Degree of protection per IEC 60529	IP67
External magnetic fields	– < 30 mT (to avoid permanent damage) – < 1 mT (to avoid influencing the measurement)
Relative humidity	< 90%, non-condensing

7.3 Supply voltage

Supply voltage[3)]	5 V ±5%
Current draw	< 50 mA + controller current draw (depending on internal resistance), at 5 V supply voltage
Reverse polarity protection	No
Overvoltage protection	No
Dielectric strength (GND to housing)	500 V DC

7.4 Output

Output signals	See Tab. 4-2 on page 12
Output circuit	RS422 (Line Driver)

7.5 Dimensions, weights

Reading distance sensor head/magnetic tape	See Tab. 4-1 on page 11
Maximum movement speed	20 m/s (depending on type, see Tab. 6-1 and Tab. 6-2 on page 17)
Weight (sensor head)	21 g (without cable)
Material (housing)	Aluminum
Magnetic tape temperature coefficient (like steel)	$10.5 \times 10^{-6} K^{-1}$

[1)] For c UL us: Use in enclosed spaces and up to a height of 2000 m above sea level.

[2)] Individual specifications as per Balluff factory standard

[3)] For c UL us: The sensor head 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.

7 Technical data (continued)

7.6 Connection

KA_ _ (cable)	– PUR – 12-wire (6×2×0.08 mm²) – Good environmental resistance – Suitable for use with drag chains
Temperature resistance	–25°C to +80°C
Cable diameter	Max. 5.6 mm
Cable bending radius	Min. 15x cable diameter (moveable) Min. 7.5x cable diameter (permanently mounted)
KA_ _ -S284 (connector)	– PUR – With preassembled, molded plug M12/12-pin (-S284)
KF_ _ (cable)	– PUR – 8-wire (4×2×0.08 mm²) – Good environmental resistance – For fixed routing
Temperature resistance	–40°C to +80°C
Cable diameter	Max. 5.2 mm
Cable bending radius	Min. 5x cable diameter (permanently mounted)
KD_ _ (cable)	– PUR – 12-wire (6×2×0.08 mm²) – Good environmental resistance – Suitable for use with drag chains
Temperature resistance	–40°C to +80°C
Cable diameter	Max. 5.5 mm
Cable bending radius	Min. 7x cable diameter (moveable)

8 Accessories

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

8.1 Magnetic tape

When selecting the magnetic tape, make sure the magnetic tape and sensor head are compatible. This particularly applies to the following factors:
– Pole width (1 or 2 mm), see section 3.2.1
– Reference points (none, one, two or more (fixed periodic)), see section 3.3

For a complete technical description and assembly instructions for magnetic tapes and rotative magnetic tapes (magnetic rings), see the separate user's guides at **www.balluff.com**.

8.2 Connector

Permissible bending radius

– Fixed routing	7.5 x outer diameter
– Moved	15 x outer diameter
Cable material	PUR
Plug	M12x1, 12-pin

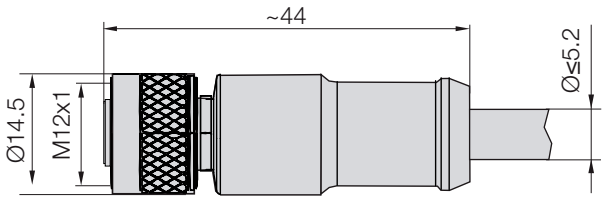


Fig. 8-1: M12 plug, 12-pin

For the pin assignment and colors, see Tab. 4-2 on page 12.

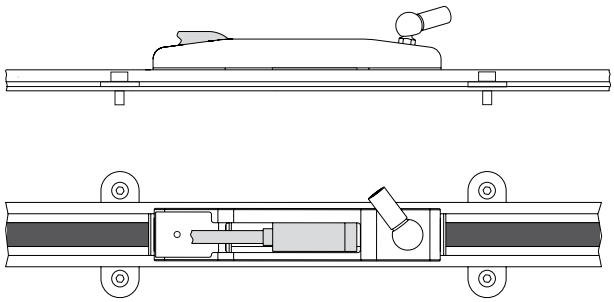
Type	Ordering code
BCC M41C-0000-1A-169-PS0C08-020-C009	BCC09MW
BCC M41C-0000-1A-169-PS0C08-050-C009	BCC09MY
BCC M41C-0000-1A-169-PS0C08-100-C009	BCC09MZ[1)]
BCC M41C-0000-1A-169-PS0C08-150-C009	BCC09N0[1)]
BCC M41C-0000-1A-169-PS0C08-200-C009	BCC09N1[1)]

[1)] For cable lengths ≥ 10 m, the controller for the A/B interface BML-S1F_… must be equipped with a protection circuit against surge (EN 61000-4-5).

Examples:
– BCC M41C-0000-1A-169-PS0C08-**020**-C009 = cable length 2 m
– BCC M41C-0000-1A-169-PS0C08-**050**-C009 = cable length 5 m

8.3 Guided magnetic tape position measuring system

Sensor guide consisting of a **BML-R01-M_ _ _** aluminum rail to hold the magnetic tape and a **BML-C02 (BAM01MH)** slide with gliders to guide the sensor head.



8.4 BDD counter

BDD 611-R3Q4-0-52-N-00 (BAE004K)
– One-axis counter for all BML-S…
– Min. edge distance code E, F, G, H, K, L, M, N, P, R

BDD 622-R3Q4-0-52-N-00 (BAE004M)
– Two-axis counter for all BML-S…
– Min. edge distance code E, F, G, H, K, L, M, N, P, R

BDD 632-R3Q4-0-52-N-00 (BAE004P)
– Three-axis counter for all BML-S…
– Min. edge distance code E, F, G, H, K, L, M, N, P, R

All counters need a 24 V DC operating voltage. A power supply for rail mounting **BAE PS-XA-1W-24-007-001 (BAE0001)** is available for operation with 230 V.

Type code breakdown

BML-S1F_-A…

BML - S1F1 - A62Z - M310 - 90 - KA05

S = Sensor head

Style/housing geometry (W x H x L):
F = 12 mm × 13 mm × 35 mm

Direction:
1 = Lengthwise
2 = Crosswise

Interface:
A = Analog Sin/Cos

Supply voltage/output level:
6 = 5 V DC

Output voltage:
2 = 1 V_{SS}

Resolution:
Z = not relevant

Pole width:
3 = 1 mm
5 = 2 mm

Reference signal:
0 = No signal
1 = Single signal or fixed periodic (not with 2 mm pole width)

Min. edge distance:
9 = not relevant

Connection technology:

KA05 =	PU cable, standard, 5 m cable, possible cable lengths 2, 5, 10, 15, 20 m
KA00.3-S284 =	PU cable, standard, 0.3 m cable with M12 plug, 12-pin
KD05 =	PU cable, for drag chain, 5 m cable, possible cable lengths 2, 5, 10, 15, 20 m
KF05 =	PU cable, for fixed routing, 5 m cable, possible cable lengths 2, 5, 10, 15, 20 m

9 Type code breakdown (continued)

BML-S1F_-Q...

BML - S1F1 - Q61D - M310 - G0 - KA05

S = Sensor head

Style/housing geometry (W x H x L):
F = 12 mm × 13 mm × 35 mm

Direction:
1 = Lengthwise
2 = Crosswise

Interface:
Q = Digital rectangular signal

Supply voltage:
6 = 5 V DC

Output level:
1 = Differential voltage signal (RS422)

Resolution (edge distance A/B):

D = 1 µm	E = 2 µm	S = 4 µm
F = 5 µm	G = 10 µm	I = 20 µm

BML-S1F...**M3**...: only D, E, F, G
BML-S1F...**M5**...: only E, S, G, I

Pole width:
3 = 1 mm
5 = 2 mm

Reference signal:
0 = No signal
1 = Single signal or fixed periodic (not with 2 mm pole width)
2 = Pole-periodic signal (not with 2 mm pole width)

Min. edge distance:

D = 0.12 µs	E = 0.29 µs	F = 0.48 µs
G = 1 µs	H = 2 µs	K = 4 µs
L = 8 µs	N = 16 µs	P = 24 µs

Connection technology:

KA05 =	PU cable, standard, 5 m cable, possible cable lengths 2, 5, 10, 15, 20 m
KA00.3-S284 =	PU cable, standard, 0.3 m cable with M12 plug, 12-pin
KD05 =	PU cable, for drag chain, 5 m cable, possible cable lengths 2, 5, 10, 15, 20 m
KF05 =	PU cable, for fixed routing, 5 m cable, possible cable lengths 2, 5, 10, 15, 20 m

10 Appendix

10.1 Troubleshooting

Errors	Possible causes	Troubleshooting/explanation
The controller does not receive any travel information.	The required supply voltage is not available.	Check if there is any voltage and that the BML is correctly connected.
	The voltage drop is too high.	The position measuring system must have an operating voltage of 5 V ±5%. Check the voltage over the sense line (voltage drop, see page 13).
	Cables are not correctly connected.	Check the cables using the wiring diagrams.
	The orientation of the magnetic tape is incorrect.	Check the orientation of the magnetic tape: The reference point marking must be on the right side of the sensor head (Fig. 3-4). Exchange the magnetic tape.
The controller does not receive any travel information at certain points or an incorrect position is output at certain positions when switched on.	The distance between the sensor head and magnetic tape is incorrect (in some places).	Adjust the height/angle of the sensor head. To check, move the sensor head by hand over the entire measuring range.
	Some of the magnetic poles of the magnetic tape are damaged (mechanically damaged or due to strong magnets).	Exchange the magnetic tape.
Position signal with strong noise interference.	The distance between the sensor head and magnetic tape is too large.	Fasten the sensor head at a shorter distance from the measuring tape.
Reference signal is not output.	The orientation of the magnetic tape with reference point is incorrect.	Check the orientation of the magnetic tape: The reference point marking must be on the right side of the sensor head (Fig. 3-4). Exchange the magnetic tape.
Non-linearity is outside the tolerance.	The sensor head is not moving parallel to the magnetic tape (for tolerance, see Fig. 4-1). The distance/angle between the sensor head and magnetic tape is too large.	Correctly position/orient the sensor head (see section 4).

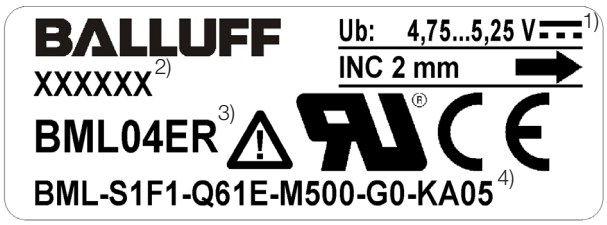
10 Appendix (continued)

10.2 Connection between edge distance/counting frequency

Edge distance (= impulse width) Min. edge separation [µs]		Controller detects at least the max. counting frequency [kHz][1)]	Controller has the min. sampling rate [kHz]
D	0.12	8,333	16,667
I	0.29	3,448	6,897
F	0.48	2,083	4,167
G	1	1,000	2,000
H	2	500	1,000
K	4	250	500
L	8	125	250
m	10	100	200
N	16	63	125
P	24	42	83
R	100	10	20

[1)] Signal periods = 1/4 × counting frequency

10.3 Part label



[1)] Supply voltage

[2)] Serial number

[3)] Ordering code

[4)] Type

Fig. 10-1: Part label BML-S…