

BML-M _ _ -I _ _ -...

User's Guide - Magnetic Rings



www.balluff.com

1	Notes to the user	4
1.1	Validity	4
1.2	Symbols and conventions	4
1.3	Scope of delivery	4
2	Safety	5
2.1	Intended use	5
2.2	General safety notes for the position measuring system	5
2.3	Explanation of the warnings	5
2.4	Disposal	5
3	Construction and function	6
3.1	Overview of the magnetic rings	6
3.2	Construction and function	6
3.3	Magnetic rings - sensor head	6
3.4	Overview of the magnetic rings	7
3.4.1	Hard ferrite rings / plastic rings	7
3.4.2	Steel rings	8
3.5	Specific descriptions of hard ferrite rings/plastic rings	9
3.5.1	BML-M20-I _ _ -A0-M _ _ / _ _ _ -R0	9
3.5.2	BML-M20-I40-A0-M072/054-R1	9
3.5.3	BML-M21-I40-A0-M048/006-R0	10
3.5.4	BML-M22-I40-A0-M031/016-R0	10
3.5.5	BML-M33-I40-A0-M025/020-R0	11
3.6	Specific descriptions of steel rings	11
3.6.1	BML-M30-I _ _ -A0-M122/090-R_	11
3.6.2	BML-M31-I _ _ -A0-M075/060-R_	12
4	Installation	13
4.1	Magnetic ring	13
4.2	Installation options	13
4.2.1	Hard ferrite and plastic ring installation	14
4.2.2	Installing steel rings	14
5	Technical data	15
5.1	Ambient	15
6	Type code breakdown	16
6.1	Type code breakdown for magnetic ring hard ferrite and plastic ring versions	16
6.2	Type code breakdown for magnetic ring steel ring version	17
7	Appendix	18
7.1	Determining the increments per rotation	18
7.2	Determining the system resolution	18

1

Notes to the user

1.1 Validity

This guide describes the construction, function and setup options for the magnetic rings. It applies to types

BML-M _ _ -I _ _ -...

(see Type code breakdown from page 16).

The guide is intended for qualified technical personnel.
Read these instructions before installing and operating the magnetic ring.

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

- Magnetic ring
- Condensed guide

2

Safety

2.1 Intended use

The BML magnetic ring, together with a sensor head (e.g. BML-S...) and a controller (e.g. PLC), comprises a position measuring system. It is installed on a cylindrical surface in a machine or system and is intended to be used in the industrial sector. 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.

The information in these instructions must be observed, particularly information related to installation. Improper use will result in the loss of warranty and liability claims against the manufacturer.

2.2 General safety notes for the position measuring system

Installation and **startup** may only be performed by trained specialists.

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 magnetic ring, the position measuring system should be taken out of service and secured against unauthorized use.

2.3 Explanation of the warnings

Always observe the warnings in these instructions and the measures described to avoid hazards.

The warnings used here contain various signal words and are structured as follows:

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

The individual signal words mean:

NOTICE
Identifies a hazard that could damage or destroy the product .

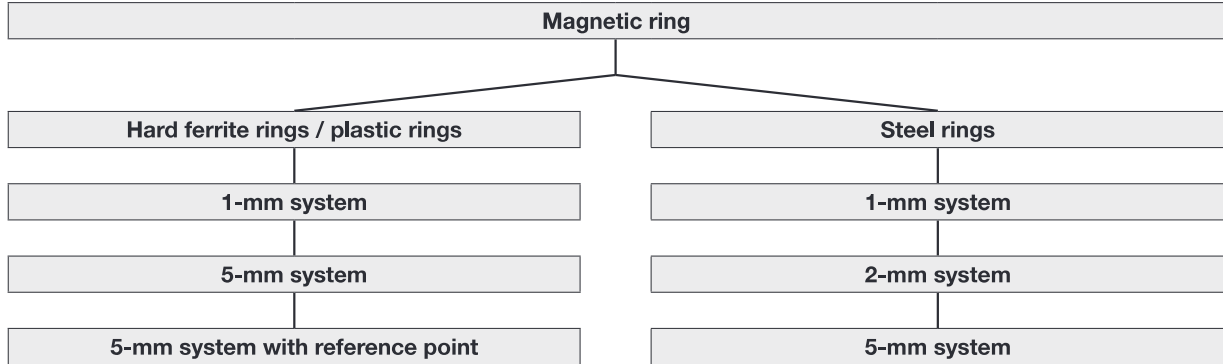
2.4 Disposal

- ▶ Observe the national regulations for disposal.

3

Construction and function

3.1 Overview of the magnetic rings



3.2 Construction and function

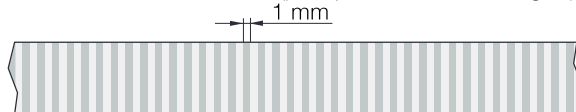
The magnetic ring contains a track with alternating magnetic north and south poles. Some variants have a second track with reference points.

3.3 Magnetic rings - sensor head

The magnetic rings are available with different pole widths, with or without reference point.

1-mm system

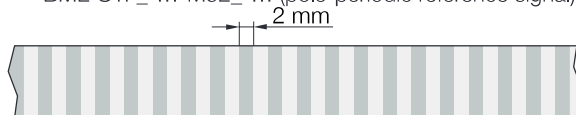
- Magnetic rings without reference point BML-M...-I3_...-R0
- Suitable for sensor heads BML-S1F_...-M30_... (without reference signal) or BML-S1F_...-M32_... (pole-periodic reference signal)



Magnetic ring without reference point

2-mm system

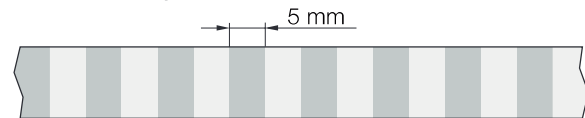
- Magnetic rings without reference point BML-M...-I5_...-R0
- Suitable for sensor heads BML-S1F_...-M50_... (without reference signal) or BML-S1F_...-M52_... (pole-periodic reference signal)



Magnetic ring without reference point

5-mm system

- Magnetic rings without reference point BML-M...-I4_...-R0
- Suitable for sensor heads BML-S2B/2E/1C_...-M40_... (without reference signal) or BML-S2B/2E_...-M42_... (pole-periodic reference signal)



Magnetic ring without reference point

Systems with reference point

- Magnetic rings with reference point BML-M...-I3_...-R1
- Suitable for sensor heads BML-S2B/2E_...-M41_... (reference signal, single)



Magnetic ring with reference point, reference point visually marked











The magnetic rings are available in different versions. Please note that the magnetic rings and sensor head must match.

3

Construction and function (continued)

3.4 Overview of the magnetic rings

3.4.1 Hard ferrite rings / plastic rings

Illustration	Order code Type code	AD [mm] ¹⁾	ID [mm] ¹⁾	B [mm] ¹⁾	No. of poles	Accuracy class [angular seconds] ³⁾	Magnetic ring material /support material	Further information
1 mm pole width ²⁾								
	BML002K BML-M20-I30-A0-M072/054-R0	72±0.05	54±0.5	7±0.1	228	≤ 200	Hard ferrite / –	Sec. 3.5.1
5 mm pole width ²⁾								
	BML002L BML-M20-I40-A0-M031/021-R0	30.9 +0/-0.05	21.3±0.3	5±0.1	20	≤ 300	Hard ferrite / –	Sec. 3.5.1
	BML002M BML-M20-I40-A0-M048/037-R0	48.7 +0/-0.05	37.2±0.6	5±0.1	32	≤ 300		
	BML002N BML-M20-I40-A0-M072/054-R0	72±0.05	54±0.5	7±0.1	46	≤ 300		
	BML002R BML-M21-I40-A0-M048/006-R0	48.7 +0/-0.05	6 H7	16±0.1	32	≤ 300	Hard ferrite / aluminum	Sec. 3.5.3
	BML002T BML-M22-I40-A0-M031/016-R0	30.9 +0/-0.05	16 H7	20±0.1	20	≤ 300		Sec. 3.5.4
	BML04E2 BML-M33-I40-A0-M025/020-R0	25±0.1	20±0.1	6±0.1	16	≤ 600	Plastic / –	Sec. 3.5.5
5 mm pole width ²⁾, with reference point								
	BML002P BML-M20-I40-A0-M072/054-R1	72±0.1	54±0.1	14±0.2	46	≤ 300	Hard ferrite / –	Sec. 3.5.2

- 1) AD = Outer diameter
ID = Inner diameter
B = Width incl. support

2) Incremental track







3) Determined under ideal conditions

Tab. 3-1: Overview of the hard ferrite and plastic magnetic rings

3

Construction and function (continued)

3.4.2 Steel rings

Illustration	Order code Type code	AD [mm] ¹⁾	ID [mm] ¹⁾	B [mm] ¹⁾	No. of poles	Accuracy class [angular seconds] ³⁾	Magnetic ring material/ support material	Further information
1 mm pole width ²⁾								
	BML01KM BML-M31-I30-A0-M075/060-R0	75.4±0.1	60 H7	10±0.2	238	≤ 150	Elastomer, filled with ferrite / stainless steel	Sec. 3.6.2
	BML01EW BML-M30-I30-A0-M122/090-R0	122±0.1	90 H7		384	≤ 150		Sec. 3.6.1
2 mm pole width ²⁾								
	BML04KT BML-M31-I50-A0-M075/060-R0	75.4±0.1	60 H7	10±0.2	120	≤ 200	Elastomer, filled with ferrite / stainless steel	Sec. 3.6.2
	BML04KW BML-M30-I50-A0-M122/090-R0	122±0.1	90 H7		192	≤ 200		Sec. 3.6.1
5 mm pole width ²⁾								
	BML0311 BML-M31-I40-A0-M075/060-R0	75.4±0.1	60 H7	10±0.2	48	≤ 250	Elastomer, filled with ferrite / stainless steel	Sec. 3.6.2
	BML04KU BML-M30-I40-A0-M122/090-R0	122±0.1	90 H7		76	≤ 250		Sec. 3.6.1

- 1) AD = Outer diameter
 ID = Inner diameter
 B = Width incl. support

2) Incremental track

3) Determined under ideal conditions

Tab. 3-2: Overview of the steel magnetic rings

3 Construction and function (continued)

3.5 Specific descriptions of hard ferrite rings/ plastic rings

3.5.1 BML-M20-I...-A0-M.../...-R0

Dimensions

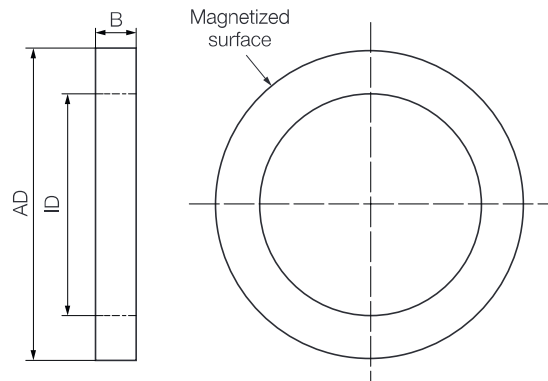


Fig. 3-1: BML-M20-I...-A0-M.../...-R0 dimensions, values for AD, ID and B see Tab. 3-1 on page 7

	...-I30-...	...-I40-...
Pole width	1 mm	5 mm
No. of poles	See Tab. 3-1	
Magnetic ring material/support material	Hard ferrite / –	

BML-...-R0	
Reference point	No

Suitable sensor heads

The magnetic rings can be used with the following sensor heads:

BML-M20-I30-...	BML-M20-I40-...
1-mm system	5-mm system
BML-S1F...-M3...	BML-S2B...-M40... BML-S2B...-M42... BML-S1C...-M40... BML-S2E...-M40... BML-S2E...-M42...

3.5.2 BML-M20-I40-A0-M072/054-R1

Dimensions

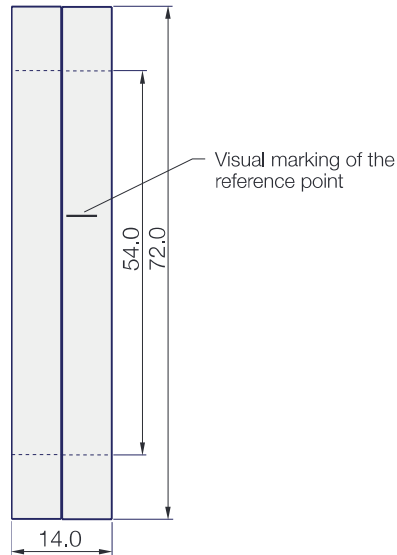


Fig. 3-2: BML-M20-I40-A0-M072/054-R1 dimensions

	...-I40-...
Pole width	5 mm
No. of poles	46
Magnetic ring material/support material	Hard ferrite / –

BML-...-R1	
Reference point	Yes

Suitable sensor heads

The magnetic rings can be used with the following sensor heads:

BML-M20-I40-...
5-mm system
BML-S2B...-M41... BML-S2E...-M41...

i The sensor head for the BML-...-R1 magnetic ring must be equipped with a reference signal (...-M_1-..., single signal).

BML-M...-I...-... Magnetic Ring – Incremental Magnetic Encoder

3

Construction and function (continued)

3.5.3 BML-M21-I40-A0-M048/006-R0

Dimensions

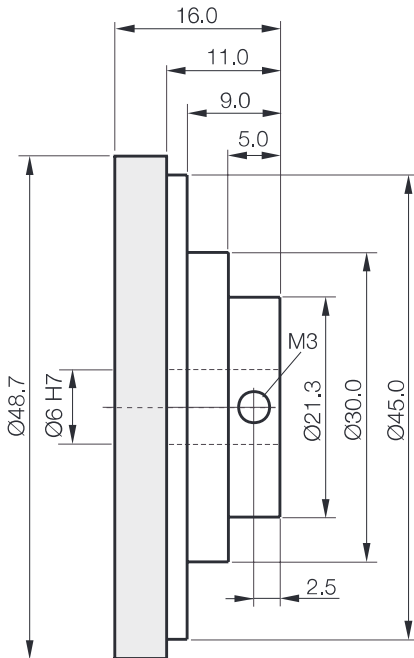


Fig. 3-3: BML-M21-I40-A0-M048/006-R0 dimensions

	...-I40-...
Pole width	5 mm
No. of poles	32
Magnetic ring material/support material	Hard ferrite / aluminum
BML-...-R0	
Reference point	No

Suitable sensor heads

The magnetic rings can be used with the following sensor heads:

BML-M21-I40-...
5-mm system
BML-S2B...-M40...
BML-S2B...-M42...
BML-S1C...-M40...
BML-S2E...-M40...
BML-S2E...-M42...

3.5.4 BML-M22-I40-A0-M031/016-R0

Dimensions

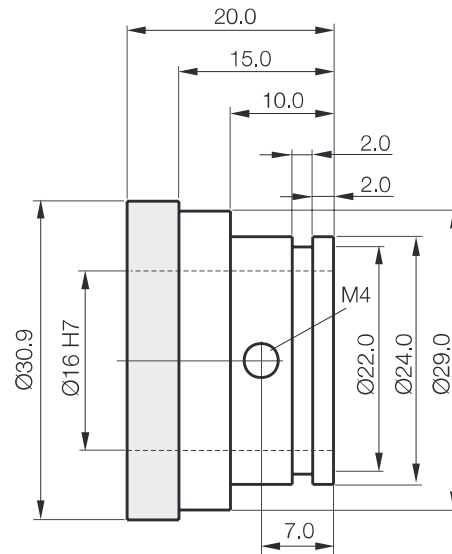


Fig. 3-4: BML-M22-I40-A0-M031/016-R0 dimensions

	...-I40-...
Pole width	5 mm
No. of poles	20
Magnetic ring material/support material	Hard ferrite / aluminum
BML-...-R0	
Reference point	No

Suitable sensor heads

The magnetic rings can be used with the following sensor heads:

BML-M22-I40-...
5-mm system
BML-S2B...-M40...
BML-S2B...-M42...
BML-S1C...-M40...
BML-S2E...-M40...
BML-S2E...-M42...

BML-M _ _ -I _ _ -... Magnetic Ring – Incremental Magnetic Encoder

3

Construction and function (continued)

3.5.5 BML-M33-I40-A0-M025/020-R0

Dimensions

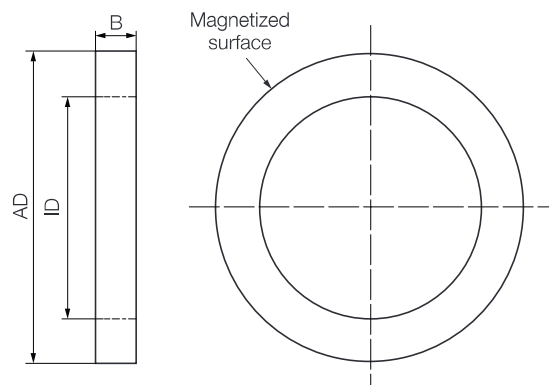


Fig. 3-5: BML-M33-I40-A0-M025/020-R0 dimensions, values for AD, ID and B see Tab. 3-1 on page 7

	...-I40-...
Pole width	5 mm
No. of poles	See Tab. 3-1
Magnetic ring material/support material	Plastic / -
BML-...-R0	
Reference point	No

Suitable sensor heads

The magnetic rings can be used with the following sensor heads:

BML-M33-I40-...
5-mm system
BML-S2B...-M40... BML-S2B...-M42... BML-S1C...-M40... BML-S2E...-M40... BML-S2E...-M42...

3.6 Specific descriptions of steel rings

3.6.1 BML-M30-I _ _ -A0-M122/090-R_

Dimensions

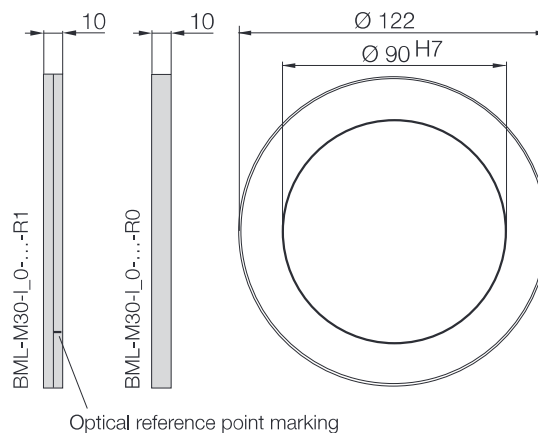


Fig. 3-6: BML-M30... dimensions

	...-I3_ -...	...-I4_ -...	...-I5_ -...
Pole width	1 mm	5 mm	2 mm
No. of poles	384	76	192
Magnetic ring material/support material	Stainless steel with elastomer coating		
BML-...-R0		BML-...-R1	
Reference point	No	Yes	

Suitable sensor heads

The magnetic rings can be used with the following sensor heads:

BML-M30-I30-...	BML-M30-I40-...	BML-M30-I50-...
1-mm system	5-mm system	2-mm system
BML-S1F...-M3...	BML-S2B...-M4... BML-S1C...-M4... BML-S2E...-M4...	BML-S1F...-M5...

i The sensor head for the BML-...-R1 magnetic ring must be equipped with a reference signal (...-M_1-..., single signal).

BML-M _ _ -I _ _ -... Magnetic Ring – Incremental Magnetic Encoder

3

Construction and function (continued)

3.6.2 BML-M31-I _ _ -A0-M075/060-R _

Dimensions

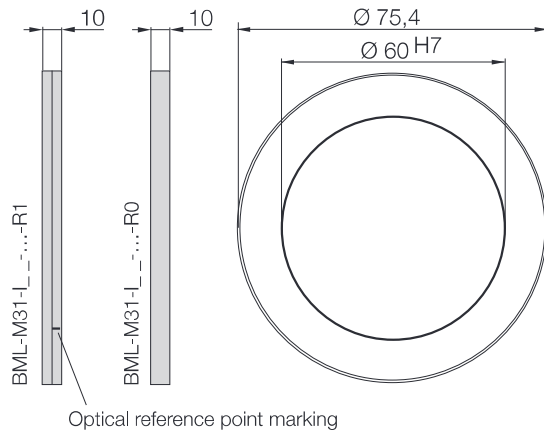


Fig. 3-7: BML-M31... dimensions

	...-I30-...	...-I40-...	...-I50-...
Pole width	1 mm	5 mm	2 mm
No. of poles	238	48	120
Magnetic ring material/ support material	Stainless steel with elastomer coating		
	BML-...-R0	BML-...-R1	
Reference point	No	Yes	

Suitable sensor heads

The magnetic rings can be used with the following sensor heads:

BML-M31-I30-...	BML-M31-I40-...	BML-M31-I50-...
1-mm system	5-mm system	2-mm system
BML-S1F...-M3...	BML-S2B...-M4... BML-S1C...-M4... BML-S2E...-M4...	BML-S1F...-M5...



The sensor head for the BML-...-R1 magnetic ring must be equipped with a reference signal (...-M_1_..., single signal).

4 Installation

4.1 Magnetic ring

NOTICE

Improper installation

Improper installation can compromise the function of the magnetic ring and result in damage.

- ▶ Keep other magnetic rings/magnetic tapes and magnetized parts away from the ring to rule out the formation of defective areas that could result in non-linearity (for areas without magnetizable material see Fig. 4-1).

Surface damage can lower the accuracy and can make it unusable.

- ▶ Surface should avoid contact with substances such as aromatic, chlorinated hydrocarbons, ketones or inorganic acids.

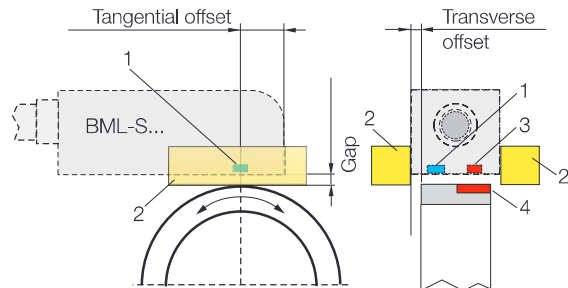
4.2 Installation options

When fitting sensor head and magnetic ring, the following distances and tolerances must be observed.

The dimensions can be found in the respective operating instructions for the sensor head:

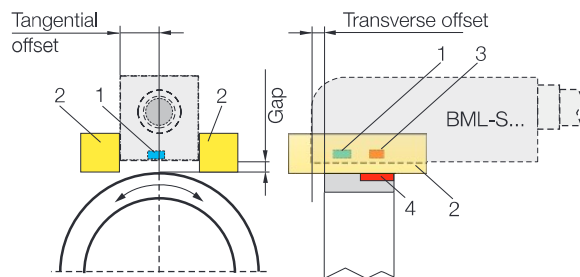
- Gap between the sensor head and reference body
- Transverse offset between the sensor head and reference body
- Tangential offset between the sensor head and reference body
- Permissible angular tolerances
- Position of the reference point sensor/incremental sensor
- Area in which no magnetizable material may be used

Longitudinal direction of installation/travel



Transverse direction of installation/travel

(only BML-S1F2-...)



- 1 Incremental sensor
- 2 Area without magnetizable material
- 3 Reference point sensor
- 4 Reference point marking

Fig. 4-1: Distances between the sensor head and reference body

4 Installation (continued)

4.2.1 Hard ferrite and plastic ring installation

Slide magnetic ring with support on the shaft and fasten with appropriate screw or glue using adhesive.

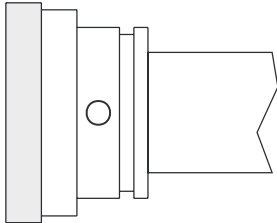


Fig. 4-2: Installing magnetic ring with support

Bond magnetic ring without support to the shaft in such a way that it runs with perfect concentricity (not off-centered).

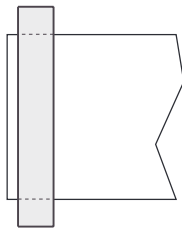


Fig. 4-3: Installing magnetic ring without support

Hard ferrite rings can be fastened by gluing to the shaft.

1. Clean the shaft before the gluing process.
2. Apply sufficient adhesive material (e.g.: UHU Endfest) to the shaft.
3. Allow adhesive to harden after the bonding process.

4.2.2 Installing steel rings

Steel rings can be fastened to a shaft by pressing, sliding or screwing. To ensure the accuracy and process reliability of the installation, the shaft surface must be free from grease and dust.

5 **Technical data**

5.1 Ambient

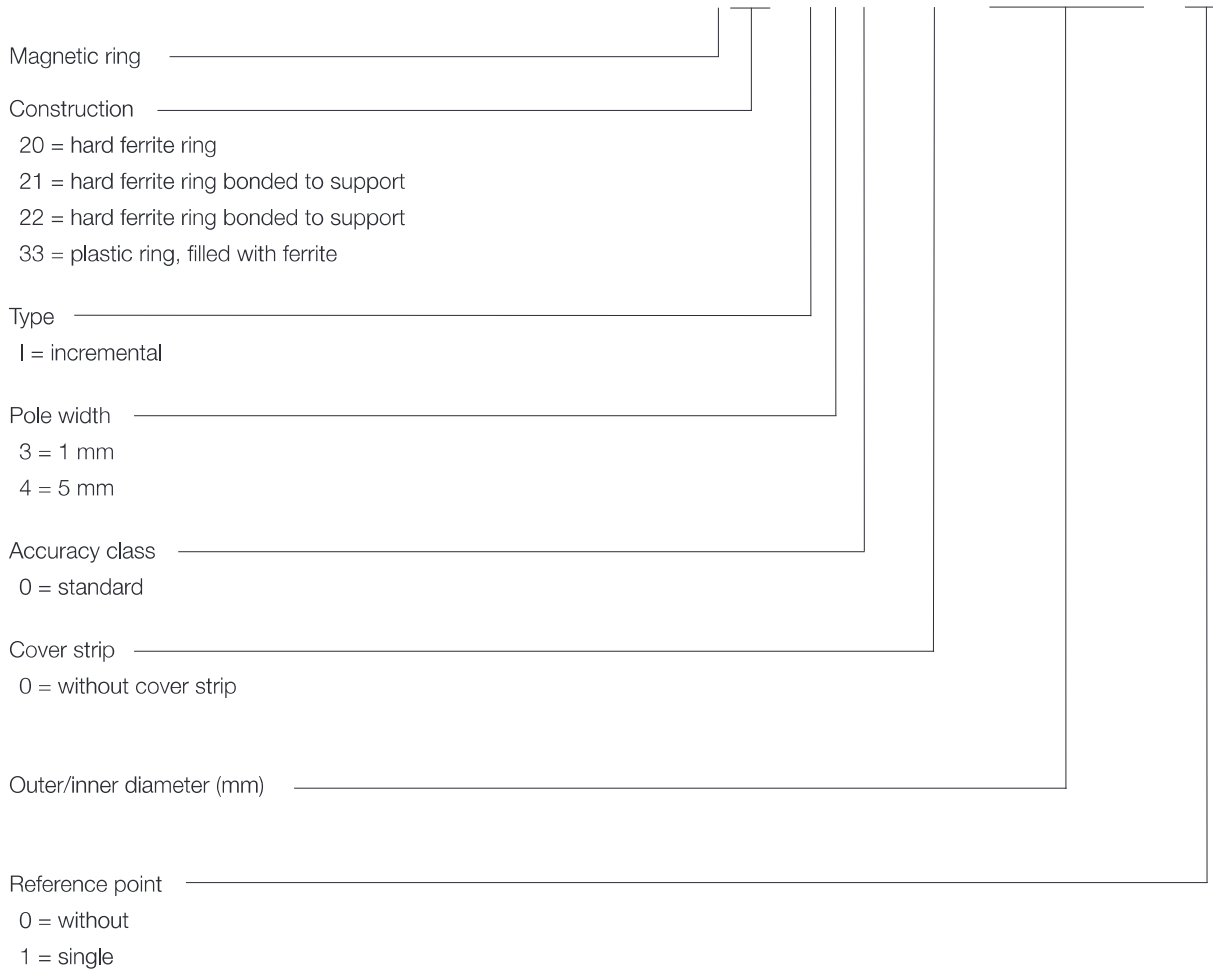
Operating temperature	-20...+80 °C
Storage temperature	-20...+80 °C
Chemical resistance (when installed)	
Resistant to	oils (motor oil, transmission fluid, hydraulic fluid), turpentine, antifreeze, water, kerosene
Not resistant to	aromatic and chlorinated hydrocarbons, ketones, inorganic acids.
External magnetic fields	
to avoid permanent damage	< 30 mT
to avoid influencing the measurement	< 1 mT

6

Type code breakdown

6.1 Type code breakdown for magnetic ring hard ferrite and plastic ring versions

BML - M20 - I 3 0 - A0 - M072/054 - R0



6

Type code breakdown (continued)

6.2 Type code breakdown for magnetic ring steel ring version

BML - M31 - I 3 0 - A0 - M075/060 - R0



7

Appendix

7.1 Determining the increments per rotation

The number of increments per rotation is determined by the resolution of the sensor head and by the number of poles as well as the pole width on the magnetic ring.

Increments per rotation

$$\begin{aligned} &= \frac{\text{Number of poles} \times \text{pole width}}{\text{Sensor head resolution}} \\ &= \text{Number of poles} \times \text{sensor head interpolation factor} \end{aligned}$$

Example

BML-S1F-Q61D-M3-... sensor head

– Resolution D = 1 µm

BML-M30-I30-A0-M122/090-R0 magnetic ring

– Number of poles: 384

– Pole width: 1 mm

Increments per rotation =

$$(384 \times 1 \text{ µm}) / 1 \text{ mm} = 384000$$

7.2 Determining the system resolution

The resolution in degrees or angular seconds is determined by the increments per rotation.

$$\begin{aligned} \text{Resolution [°]} &= \frac{360^\circ}{\text{Increments per rotation}} \\ &= \frac{360^\circ \times \text{sensor head resolution}}{\text{Number of poles} \times \text{pole width}} \\ &= \frac{360^\circ}{\text{Number of poles} \times \text{Sensor head interpolation factor}} \end{aligned}$$

Converting resolution in degrees to angular seconds:

$$\text{Resolution ["]} = \text{Resolution [°]} \times 3600$$

 **www.balluff.com**

Headquarters

Germany

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

Global Service Center

Germany

Balluff GmbH
Schurwaldstrasse 9
73765 Neuhausen a.d.F.
Phone +49 7158 173-370
Fax +49 7158 173-691
service@balluff.de

US Service Center

USA

Balluff Inc.
8125 Holton Drive
Florence, KY 41042
Phone (859) 727-2200
Toll-free 1-800-543-8390
Fax (859) 727-4823
technicalsupport@balluff.com

CN Service Center

China

Balluff (Shanghai) trading Co., Ltd.
Room 1006, Pujian Rd. 145.
Shanghai, 200127, P.R. China
Phone +86 (21) 5089 9970
Fax +86 (21) 5089 9975
service@balluff.com.cn