Orbis™

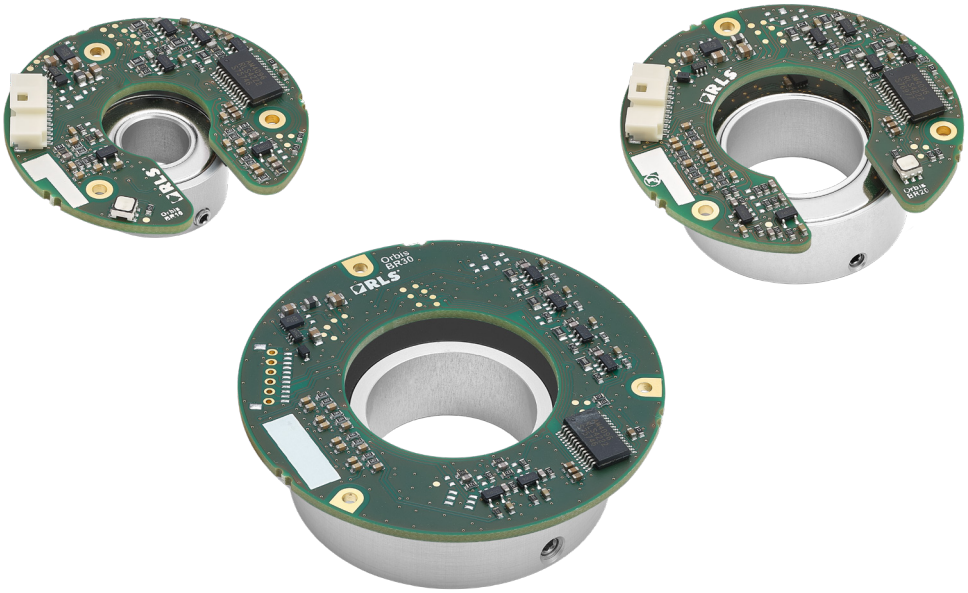
Through-hole Analogue Sin/Cos and Commutation Rotary Encoder

VARIOUS SIZES

WIDE INSTALLATION TOLERANCES

NON-CONTACT

Orbis™ family is extended by Analogue sin/cos, Incremental and Commutation through-hole encoders.
Orbis Analogue provides sinusoidal outputs with a single sine/cosine period per revolution. Orbis Commutation is designed for use in BLDC motor feedback applications requiring both A, B, Z incremental and U, V, W commutation signals. To simplify alignment to the motor rotor, the encoder allows setting of the zero position.



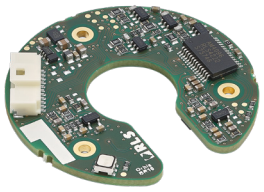
Features and benefits

- 5 V power supply
- Analogue output with one sin/cos per revolution
- Incremental with up to 4096 cpr
- UVW up to 16 poles
- Available ID: 12, 22, 30 mm
- Wide installation tolerances
- Through-hole design
- Zeroing function
- Non-contact, frictionless design

GIMBALS | AGVs | MOTOR FEEDBACK AND COMMUTATION | PRECISE GEAR BOX | AGRICULTURAL AUTOMATION

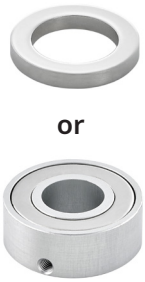
General information

The encoder consists of a diametrically magnetised permanent ring magnet and a printed circuit board. The encoders are available in various designs and sizes, from 12 mm to 30 mm internal diameter. The output signals are provided in industry-standard analogue, commutation and incremental formats.
The geometrical arrangement of RLS's proprietary Hall sensors on the PCB enables the generation of one period of sine and cosine signals per revolution. Resolutions from 64 to 1024 pulses per revolution (256 to 4096 counts per revolution with ×4 evaluation) are available. U, V, W commutation signals are output simultaneously with 1 to 8 pole pairs (2 to 16 poles).
For digital absolute outputs see **BRD01** data sheet at **RLS Media Center**.



Orbis readhead

+



or

Two options available: permanent magnet or magnetic actuator with the permanent magnet

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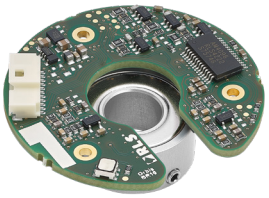
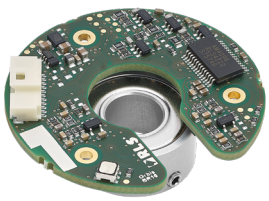


Orbis system

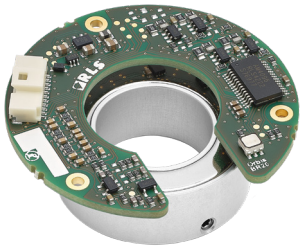
Choose your Orbis absolute magnetic encoder system

Orbis BR10 system



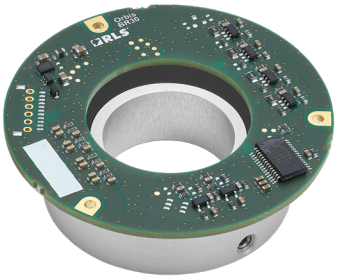
Max. 12 mm ID

Orbis BR20 system



Max. 22 mm ID

Orbis BR30 system



Max. 30 mm ID

Storage and handling

Storage temperature

With connector
−40 °C to +105 °C

Without connector
+15 °C to +30 °C (before soldering)
−40 °C to +120 °C (after wires are soldered)

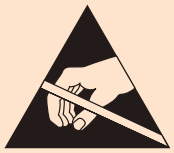
Operating temperature

–40°C to +105 °C (with connector)
–40°C to +120 °C (without connector)

Humidity

With connector
Up to 70% non- condensing

Without connector
Up to 10 % (before soldering)
Up to 70 % non-condensing (after wires are soldered)



Readhead is ESD sensitive - handle with care.
Do not touch electronic circuit, wires or sensor area without proper ESD protection or outside of ESD controlled environment.

Chemical resistance

RLS products are often used in industrial applications and exposed to chemicals that can affect their internal and external components. While our products are designed to be resistant to many harsh chemicals and environments, long-term resistance will depend on exposure, temperature, and concentration. Most chemicals our products are exposed to are not in continuous contact. Therefore, a material that might not be resistant when submerged in a chemical will last indefinitely when wiped down by that same chemical once a day.

For further information or to confirm compatibility with a chemical in your environment, **contact RLS**.

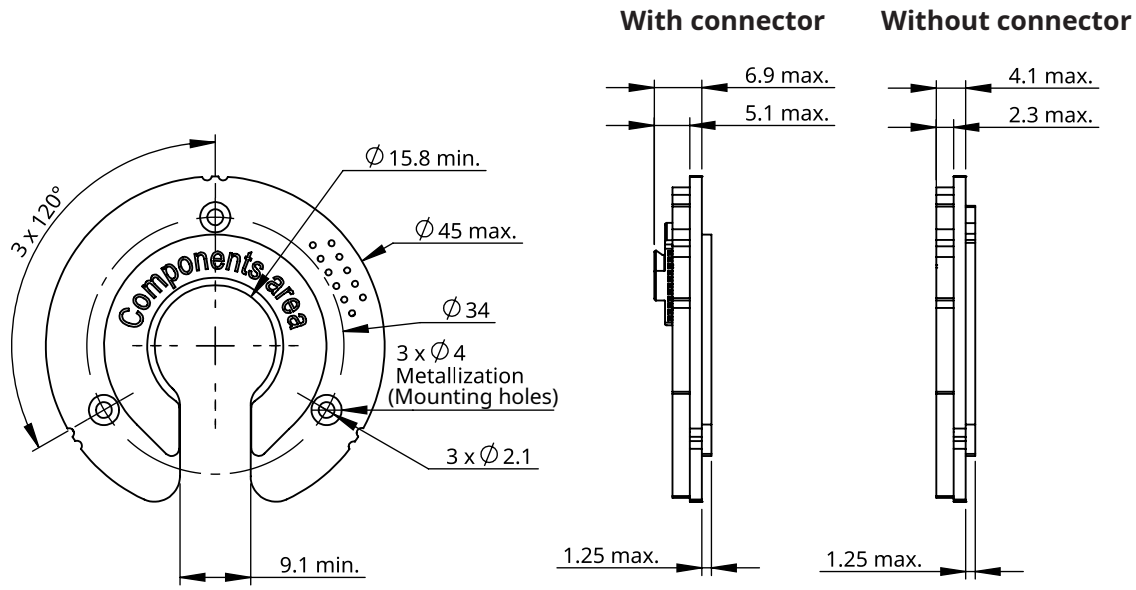
Packaging

Less than 20 products are packed individually in an antistatic box. If the order quantity is 20 systems and larger, the parts are packed in antistatic plastic trays. Magnets and readheads are packed separately.

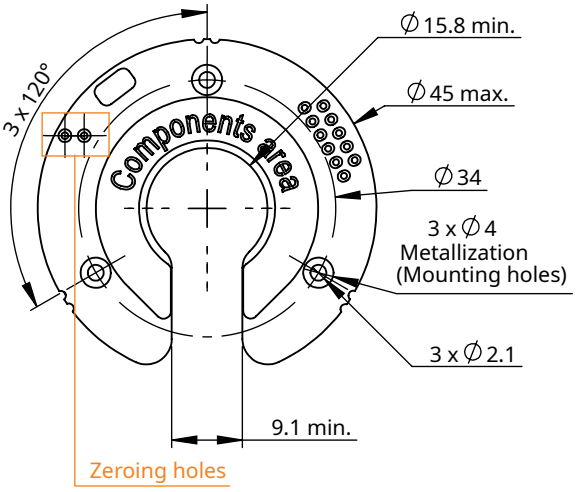
Dimensions drawing

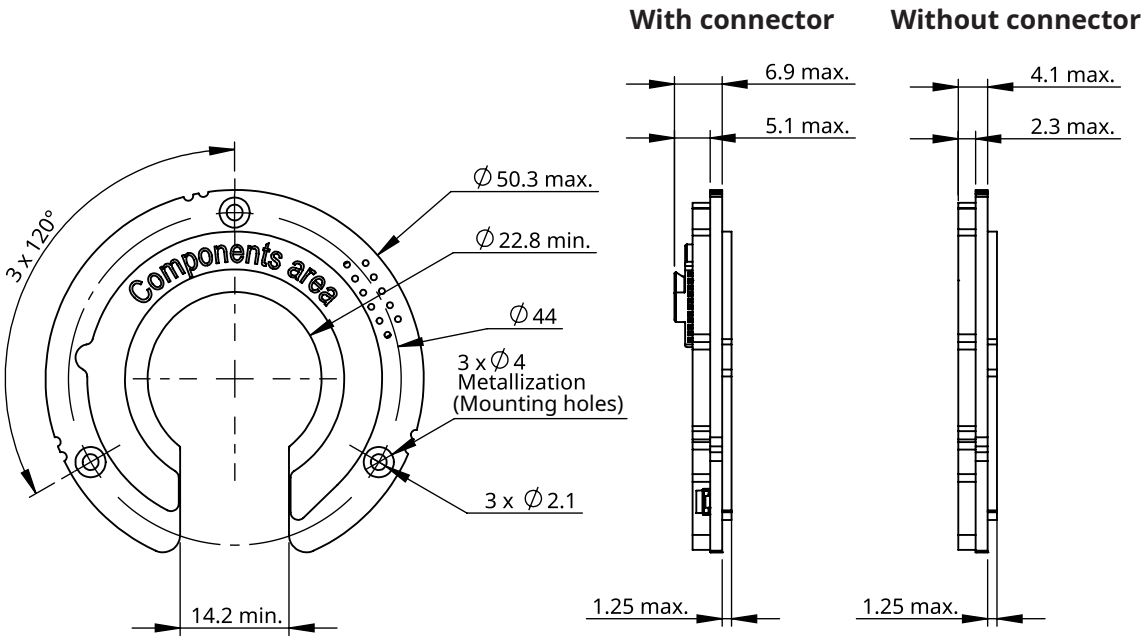
Dimensions and tolerances are in mm. Dimensions without tolerance values are in accordance with ISO 2768-m.

BR10 Readhead

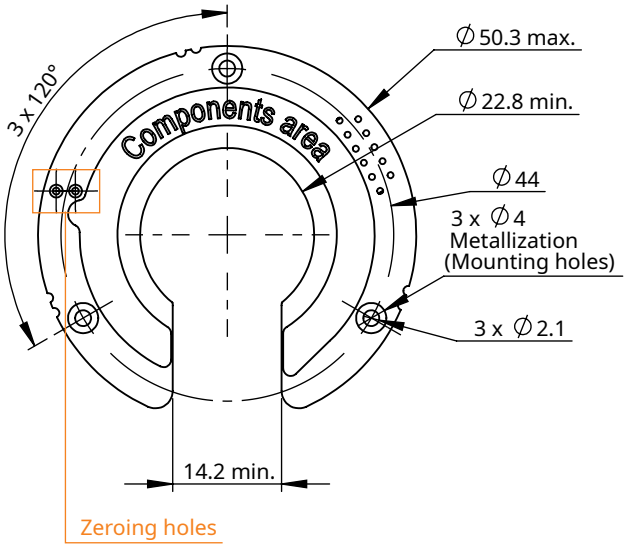


For Ux:

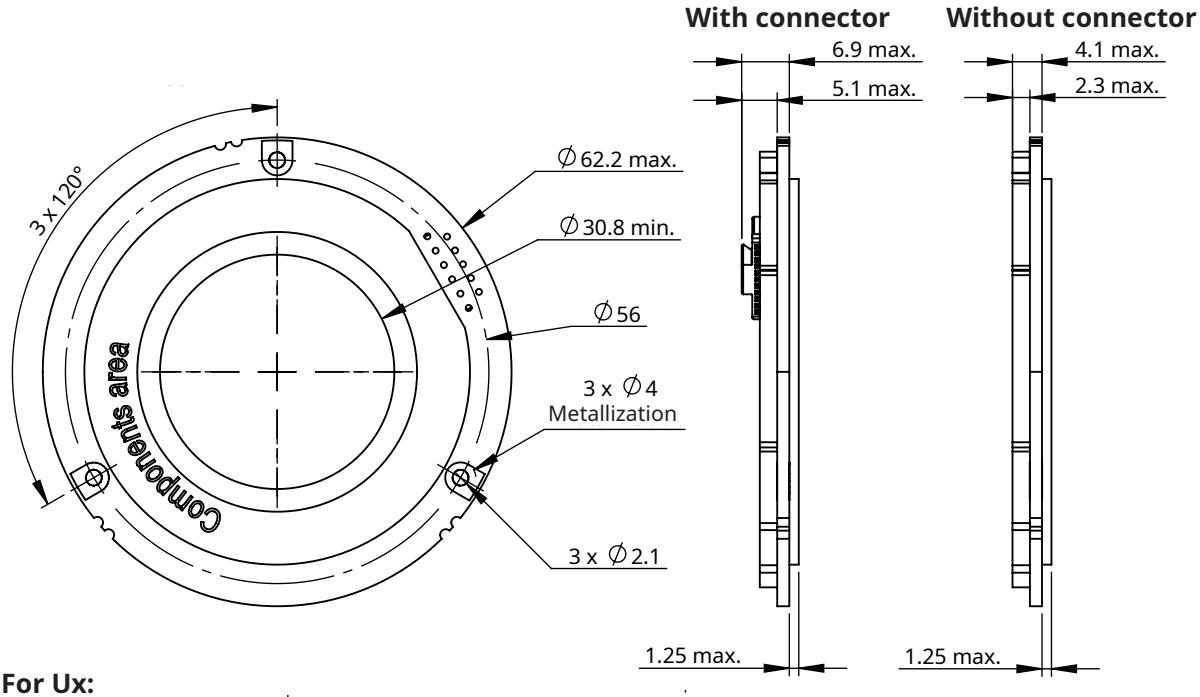



With connector
Without connector
6.9 max.
5.1 max.
4.1 max.
2.3 max.
3 x 120°
Components area
∅50.3 max.
∅22.8 min.
∅44
3 x ∅4
Metallization
(Mounting holes)
3 x ∅2.1
14.2 min.
1.25 max.
1.25 max.

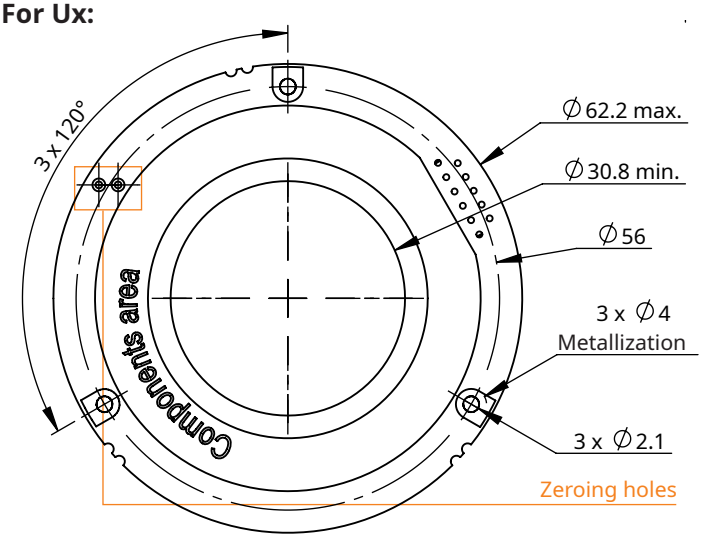
For Ux:


3 x 120°
Components area
∅50.3 max.
∅22.8 min.
∅44
3 x ∅4
Metallization
(Mounting holes)
3 x ∅2.1
14.2 min.
Zeroing holes

BR30 Readhead

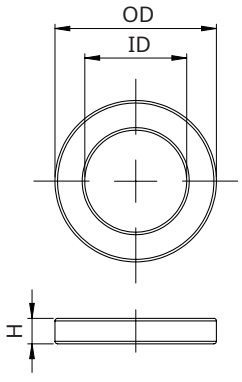


For Ux:



BM magnets and magnetic actuators

Permanent magnet

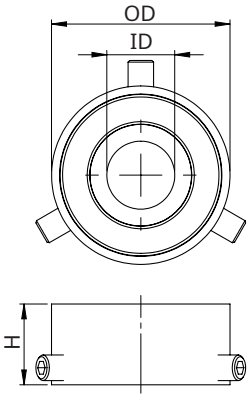


Available magnets:

ID	OD	H
12	19	3
22	32	4
30	44	4

ID, OD and H tolerances are ±0.05.

Magnetic actuator (magnet included)

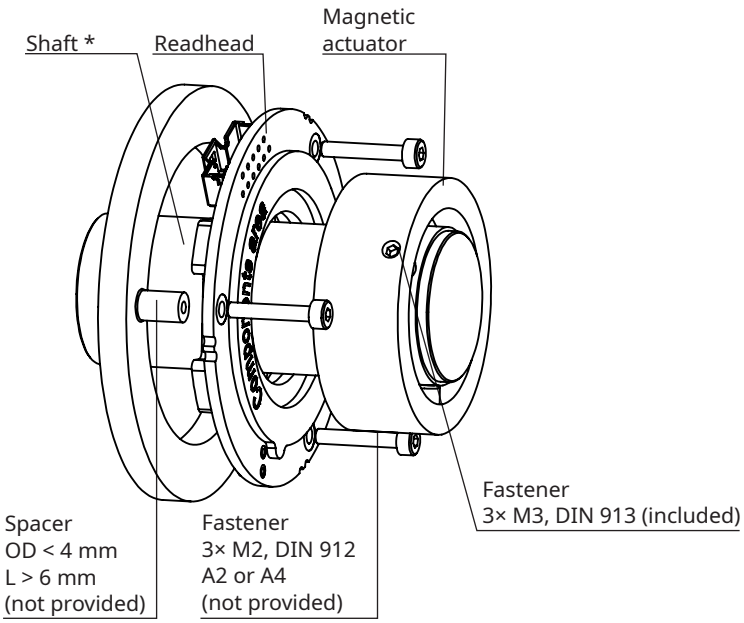


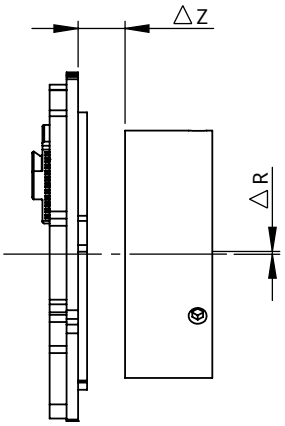
Available actuators:

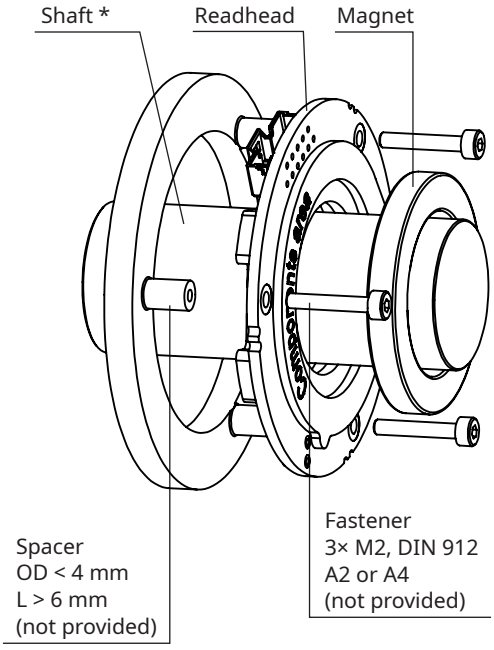
ID	OD	H
6	21	9.5
8	21	9.5
10	22	9.5
20	34	12
25	48	13

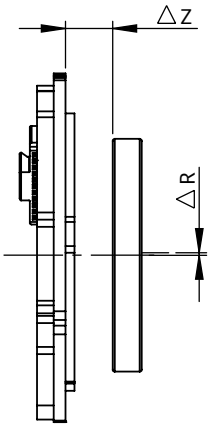
ID tolerances are H7.

Installation drawing









* Recommended shaft tolerance for application with magnetic actuator is g6.

Readhead should only be mounted on the gold plated surfaces around the mounting holes. See **Installation instructions**.

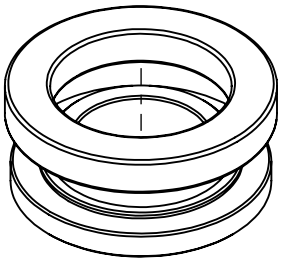
For recommended tightening torques, refer to the document TTD01 available at **RLS Media center**.

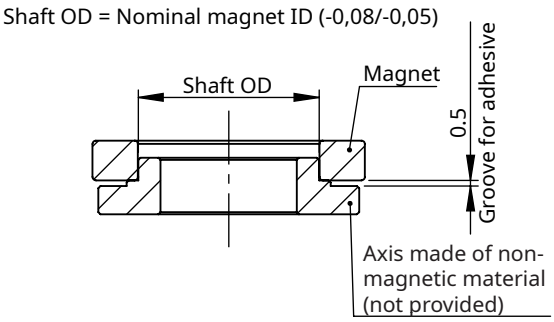
Specifications in this data sheet applies to magnet mounting with non-ferrous shafts. If ferrous shafts are used, the encoder specifications may change. In this case, the use of actuators is recommended.

Installation by gluing

Application

Adhesive mounting is based on the use of adhesive materials such as tapes, glues, or epoxies to bond objects together. Cleaning and degreasing of bounded surfaces is essential. Adhesive materials should be applied in accordance with the manufacturer's instructions.
Installation recommendation (shown in the image below):
- Loctite EA 9514 adhesive.
- Apply adhesive around the entire magnet perimeter.
- Cure at max 130 °C for 45 min.

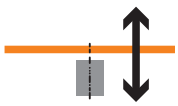
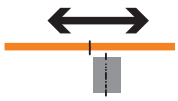
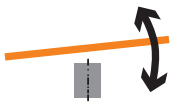
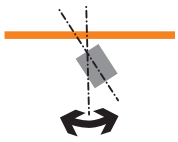




Installation instructions

Precise magnet and readhead installation is key to achieve good overall accuracy.

Installation tolerances

Axial (ΔZ) displacement (ride height)*	Magnet with 12 mm ID Magnet with 22 mm ID Magnet with 30 mm ID	4 mm ±1 mm 5.5 mm ±1 mm 4 mm ± 1 mm	
Radial (ΔR) displacement of the sensor*	Max. 0.5 mm		
Perpendicularity readhead	1°		
Perpendicularity magnet	2°		

- Readhead - Magnet

*See **Installation drawing**.

The specifications in this data sheet applies to magnet mounting with non-ferrous shafts. The encoder specifications may change when using ferrous shafts. In this case, the use of actuators is recommended.

External magnetic field

The operating principle of any magnetic encoder is to sense changes in the magnetic field of the magnetic actuator. External magnetic fields generated by permanent magnets, electric motors, coils, magnetic brakes, etc. can affect the operation of the encoder. The accuracy of Orbis is degraded in the presence of external magnetic field. Magnetic flux density in radial direction to magnet is more critical than axial direction.

Technical specifications

System data

Reading type	Axial reading
Maximum speed	BR10, BR20: 30,000 rpm BR30: 25,000 rpm

Electrical data

Supply voltage	5 V ±10 %
Current consumption	Max. 35 mA
Connection	Molex 501568-1107 or soldering pads (through holes)
Short circuit protection	Yes
Reverse polarity protection	Yes
ESD protection	HBM, max. ±2 kV

Mechanical data

Mass	Readhead	5.3 g
	Magnetic actuator (ID)	6 mm: 6.0 g; 10 mm: 5.7 g; 8 mm: 5.5 g; 20 mm: 25 g; 25 mm; 48 g
	Magnet (ID)	12 mm: 3.8 g ; 30 mm: 16.8 g; 22 mm: 12.7 g
Magnet material	12 mm, 22 mm	NdFeB with Ni-Cu-Ni protective layer
	30 mm	NdFeB + epoxy resin
Actuator material		Anodised aluminium

Environmental data

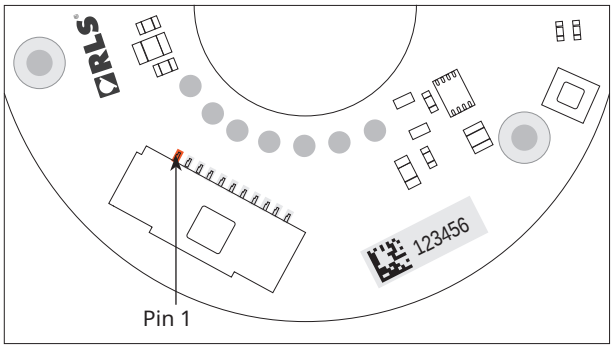
Operating and storage temperature	–40°C to +105 °C (with connector) –40°C to +120 °C (without connector)*
Humidity	0 % to 70 % non-condensing*
External magnetic field	Max. ±10 mT (AC) on top side of readhead. External magnetic field decreases accuracy of encoder.
Shock	100 G (6 ms, standard EN 60068-2-27:2009)
Vibration	40 G (55 Hz – 2000 Hz, standard EN 60068-2-6:2008)

* For limitations see chapter **Storage and Handling**.

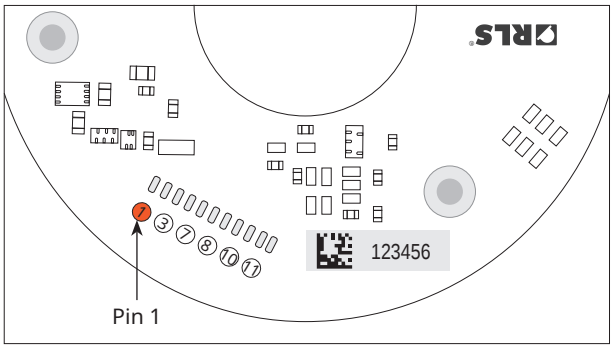
Electrical connections

Pin	AC	BC	Ux
1	Vdd		GND
2			Vdd
3	GND		Z–
4			Z+
5	-		B+
6			B–
7	VB	VB+	A–
8	-	VB–	A+
9	-		U
10	VA	VA+	V
11	-	VA–	W

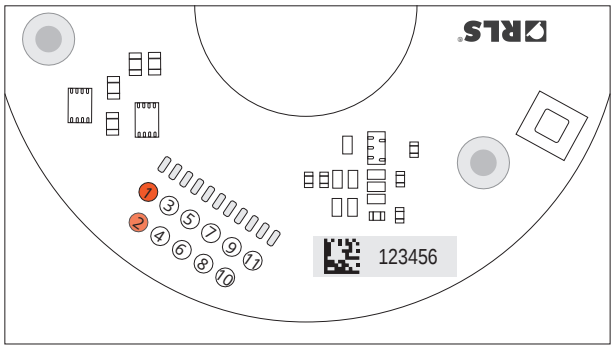
Pinout



With connector Molex 501568-1107
Sizes BR10, BR20, BR30
Outputs AC, BC, Ux



Soldering pads
Sizes BR10, BR20, BR30
Outputs AC, BC



Soldering pads
Sizes BR10, BR20, BR30
Output Ux

Readhead is ESD sensitive - handle with care.
Do not touch electronic circuit, wires or sensor area without proper ESD protection or outside of ESD controlled environment.

Analogue outputs

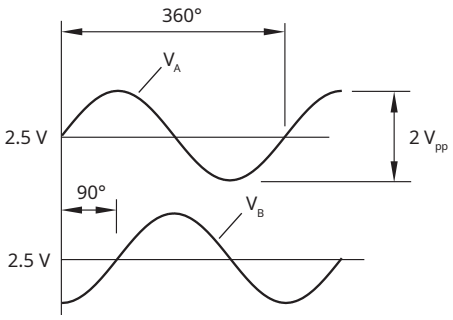
AC - Analogue sinusoidal output

2 channels V_A and V_B sinusoids (90° phase shifted, single ended)

Power supply (V_{dd})	5 V ± 10 %
Current consumption	Max. 35 mA
Internal serial impedance	10 Ω
Signal amplitude*	2 ±0.2 V_{pp}
Temperature drift	–2 mV/°C
Signal offset (Vref)	2.5 V ± 1 %

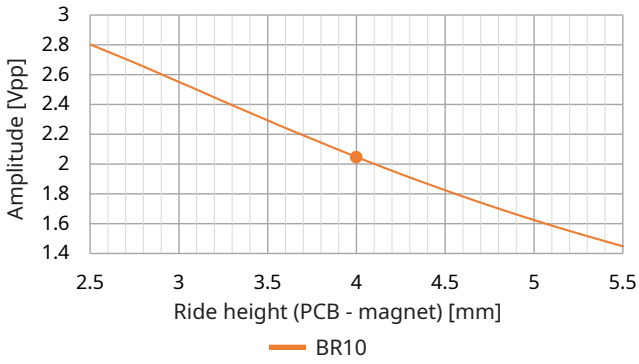
*At 23°C and 4mm ride height (BR10, BR30)
At 23°C and 5.5 mm ride height (BR20)

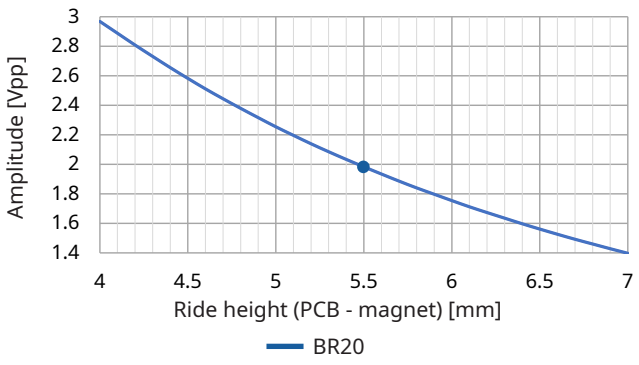
Timing diagram

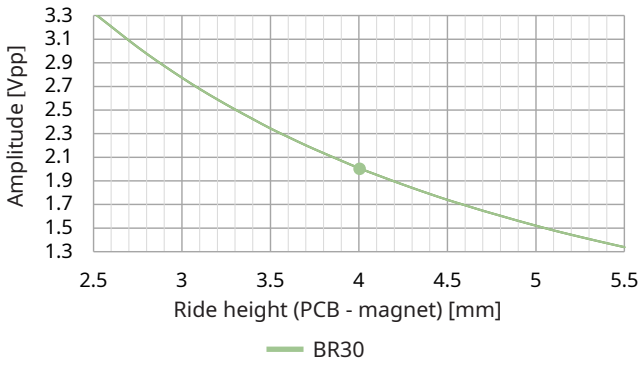


V_A leads V_B for clockwise rotation of the magnet

Amplitude vs. ride height







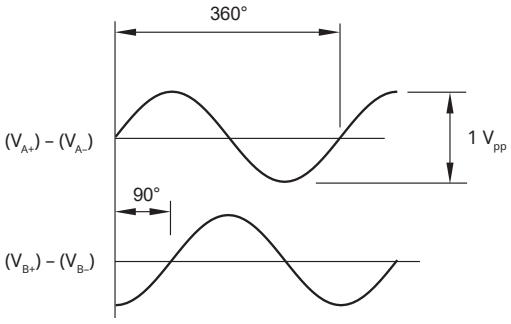
BC - Differential analogue sinusoidal output

4 channels V_{A+}, V_{A-} ,V_{B+}, V_{B-} sinusoids (90° phase shifted, single ended)

Power supply (V_{dd})	5 V ± 10 %
Current consumption	Max. 35 mA
Internal serial impedance	10 Ω
Signal amplitude*	0.5 V ±0.1 V (1 V_{pp})
Temperature drift	–1 mV/°C
Signal offset (Vref)	0 ± 5mV

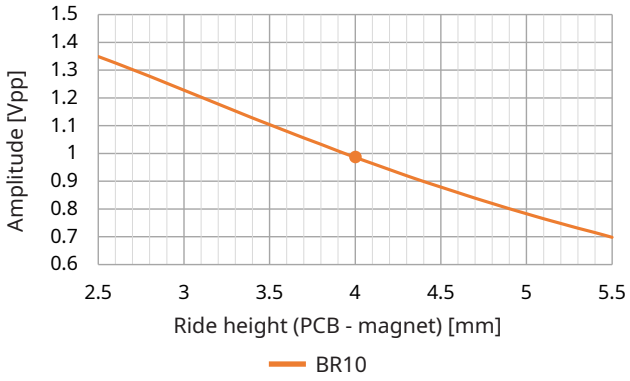
*At 23°C and 4mm ride height (BR10, BR30)
At 23°C and 5.5 mm ride height (BR20)

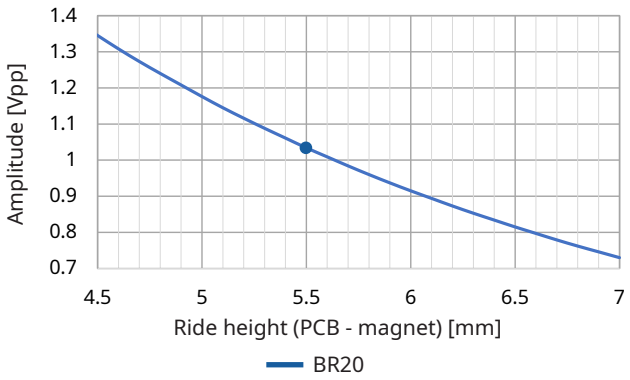
Timing diagram

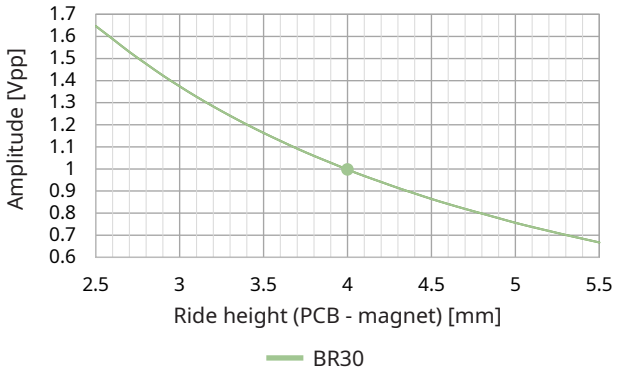


V_A leads V_B for clockwise rotation of the magnet

Amplitude vs. ride height







Commutation outputs

Ux - Commutation single ended + incremental with line driver

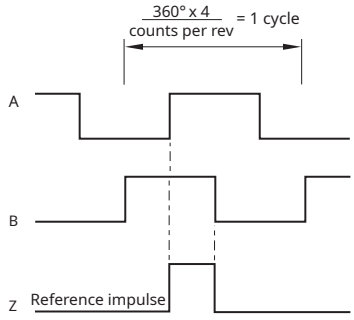
Power supply (V_{dd})	5 V ± 10 %
Current consumption	Max. 35 mA (unloaded output)
Accuracy	±0.5°
Hysteresis	0.2° typ.
Temperature drift	0.004° / C
Incremental outputs	A, B, Z, A–, B–, Z– (RS422)
Incremental resolution (cpr)	256; 512; 1,024; 2,048; 4,096
Commutation outputs	U, V, W (single ended)
Number of poles for commutation outputs	2, 4, 6, 8, 10, 12, 14, 16

Incremental outputs

There are three signals for the incremental output: A, B and Z. Signals A and B are quadrature signals, shifted by 90°, and signal Z is a reference mark. The reference mark signal is produced once per revolution. The width of the Z pulse is 1/4 of the quadrature signal period and it is synchronized with the A and B signals. The position of the reference mark is at zero.
The chart below shows the timing diagram of A, B and Z signals with clockwise (CW) rotation of the magnet and positive counting direction. B leads A for CW rotation.

Timing diagram - Incremental

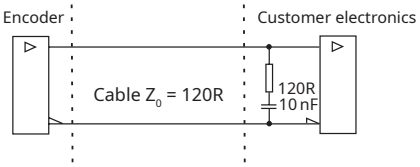
Complementary signals not shown.



B leads A for clockwise rotation of magnet.

Recommended signal termination

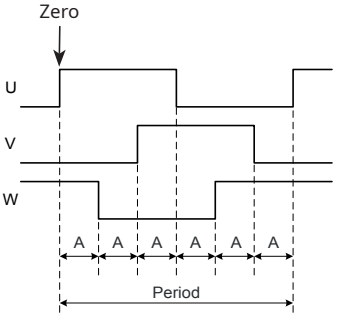
For incremental outputs



Commutation outputs

UVW outputs can be output as digital signals. The number of signal periods equals number of pole pairs. The timing diagram shows the signals when the position data is increasing. The U signal always starts at zero position regardless the signal period length. The resolution should be set to 4096 to ensure accurate transitions of the signals.

Timing diagram - Commutation



Encoder zero position can be set by shortening the zeroing holes on the board.

UVW outputs

Pole	A	Period	Pole pairs*
2	60°	360°	one
4	30°	180°	two
6	20°	120°	three
8	15°	90°	four
10	12°	72°	five
12	10°	60°	six
14	8.57°	51.42°	seven
16	7.50°	45°	eight

* Number of pole pairs equals number of periods per revolution.

Part numbering

Readhead

BR 10 AC A 01S 12 D D 00

Series
BR - Orbis board-level readhead

Size
10 - Magnet type compatibility 12
20 - Magnet type compatibility 22
30 - Magnet type compatibility 30

Communication interface
AC - Absolute analogue single ended, 5 V
BC - Absolute analogue differential, 5 V
Ux - Commutation single ended
- **UA** - One period per revolution (2 poles)
- **UB** - Two periods per revolution (4 poles)
- **UC** - Three periods per revolution (6 poles)
- **UD** Four periods per revolution (8 poles)
- **UE** Five periods per revolution (10 poles)
- **UF** Six periods per revolution (12 poles)
- **UG** Seven periods per revolution (14 poles)
- **UH** Eight periods per revolution (16 poles)

Communication interface variant
A - N/A (standard)

Resolution
01S - one sine/cosine per revolution (for AC and BC only)

For **Ux:**
08B - 256 counts per revolution
09B - 512 counts per revolution
10B - 1,024 counts per revolution
11B - 2,048 counts per revolution
12B - 4,096 counts per revolution

Magnet type compatibility
12 - BM120A190AxABA00 or actuator BA060–BA100
22 - BM220C320AxABA00 or actuator BA200ABxxAA00
30 - BM300C440BxBBA00 or actuator BA250ABxxAA00

Operating temperature range
D - –40 °C to +105 °C
E - –40 °C to +125 °C

Connector option
D - Molex 501568-1107
H - Soldering pads with through holes

Special requirements
00 - No special requrements

Not all part number combinations are valid. Refer to the table of available combinations on the following page.

Table of available combinations

Series	Readhead size	Communication interface	Communication interface variant	Resolution	Magnet type compatibility	Operating temperature range	Connector option	Special requirements
BR	10	AC	A	01S	12	D	D	00
						E	H	
		BC				D	D	
						E	H	
		Ux		08B / 09B / 10B / 11B / 12B		D	D	
						E	H	
	20	AC		01S	22	D	D	
						E	H	
		BC				D	D	
						E	H	
		Ux		08B / 09B / 10B / 11B / 12B		D	D	
						E	H	
	30	AC		01S	30	D	D	
						E	H	
		BC				D	D	
						E	H	
		Ux		08B / 09B / 10B / 11B / 12B		D	D	
						E	H	

For digital absolute outputs see BRD01 data sheet at **RLS Media Center**.

Magnet

BM 220 C 320 A 1 A B A 00

Series
BM - Orbis magnet

Inner diameter
120 - 12 mm
220 - 22 mm
300 - 30 mm

Thickness
A - 3 mm
C - 4 mm

Outer diameter
190 - 19 mm
320 - 32 mm
440 - 44 mm

Material
A - NdFeB
B - NdFeB + epoxy resin

Grade
1 - Grade 1 tested magnet
2 - Graded magnet (for AC and BC outputs only)

Surface finishing
A - NiCuNi
B - None

Temperature range
B - –40 °C to 120 °C

Packaging
A - Standard packaging

Special requirements
00 - No special requrements

Not all part number combinations are valid. Refer to the table of available combinations below.

Table of available combinations

Series	Inner diameter	Thickness	Outer diameter	Material	Grade	Surface finishing	Temperature range	Packaging	Special requirements
BM	120	A	190	A	1/2	A	B	A	00
	220	C	320						
	300	C	440	B		B			

Magnetic actuator

BA 060 AB 01 A A 00

Series
BA - Orbis magnetic actuator

Shaft diameter
060 - 6 mm
080 - 8 mm
100 - 10 mm
200 - 20 mm
250 - 25 mm

Form
AB - With 3 fasteners

Magnet type
01 - BM120A190A1ABA00
03 - BM220C320A1ABA00
04 - BM120A190A2ABA00 (for AC & BC)
05 - BM220C320A2ABA00 (for AC &BC)
06 - BM300C440B1BBA00
07 - BM300C440B2BBA00 (for AC & BC)

Material
A - Anodized aluminium

Packaging
A - Standard packaging

Special requirements
00 - No special requrements

Not all part number combinations are valid. Refer to the table of available combinations below.

Table of available combinations

Series	Shaft diameter	Form	Magnet type	Material	Packaging	Special requirements
BA	060	AB	01 / 04	A	A	00
	080					
	100					
	200		03 / 05			
	250		06 / 07			

Accessories

For AC and BC outputs

Cable assembly, 1 m
ACC048

See chapter **Cable assemblies**.

Cable assembly, 3 m
ACC066

See chapter **Cable assemblies**.

Cable assembly, 1 m
ACC067

See chapter **Cable assemblies**.

For Ux output

Cable assembly, 12 core
ACC001 cable assembly 0.3 m
ACC002 cable assembly 0.5 m
ACC003 cable assembly 1 m

See chapter **Cable assemblies**.

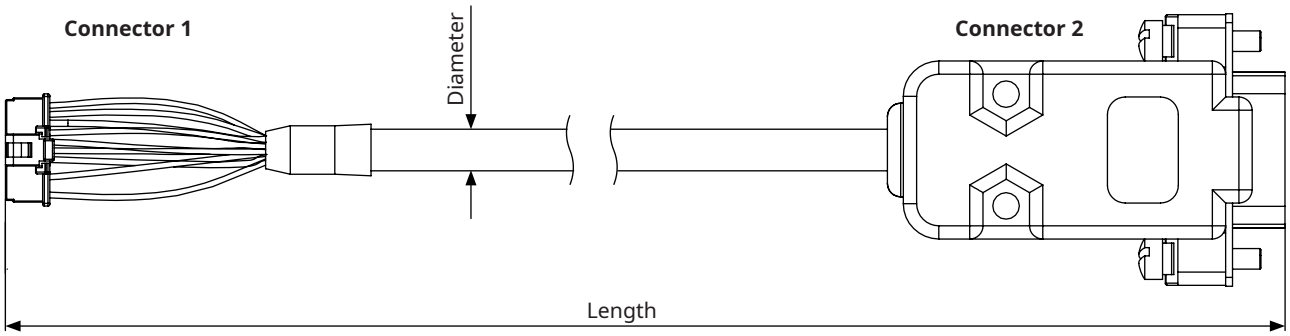
USB interface (incremental encoders)
E201-9Q

Magnet viewer
MM0001

Cable assemblies

Cables with crimped connectors

Part number	Diameter	Length	Connector 1	Connector 2	Notes
ACC001	5 mm	0.3 m	Molex 501330-1100 and 501334-0000	-	Shielded
ACC002		0.5 m			
ACC003		1.0 m			
ACC048	6.2 mm	1.0 m		Flying leads	Twisted pairs, shielded, up to +75 °C
ACC066		3.0 m			
ACC067		1.0 m		DSUB-9 M	



Connector 1	Connector 2			
Pin number		Wire color	AC	BC
1	5	Brown	5 V supply *	
2	-	-		
3	9	White	0 V (GND) *	
4	-	-		
5	8	Pink	-	
6	4	Grey		
7	2	Red	VB	VB+
8	3	Blue	-	VB-
9	1		-	
10	6	Green	VA	VA+
11	7	Yellow	-	VA-

Connector 1		
Pin number	Wire color	Ux
1	Blue	GND
2	Red	Vdd
3	Brown	Z-
4	White	Z+
5	Green	B+
6	Yellow	B-
7	Grey	A-
8	Pink	A+
9	Black	U
10	Violet	V
11	Grey / Pink	W

* Pins are internally connected on PCB.

Cable specifications

Part numbers	ACC001, ACC002, ACC003	ACC048, ACC066, ACC067
Cable specifications	LI12YC12Y	LiYCY (TP)
Configuration	12 × 0.14 mm^2	4 × 2 × 0.14 mm^2
Rated voltage	250 V	350 V
Temperature range	Operating –30 °C to +125 °C Storage –40 °C to +125 °C	Operating –40 °C to +75 °C (fixed) –5 °C to +70 °C (bending) Storage –40 °C to +80 °C
Environmental conformation	RoHS conform 73/23/EWG-Guideline CE conform Halogen free	RoHS and REACH compliant Flame-retardant according IEC 60332-1-2 Approvals based on VDE 0812 Classification ETIM 5.0 Class-ID: EC000104

ACC067 can be used for direct connection to E201-9Q encoder interface.

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Document issues

Issue	Date	Page	Description
01	5. 9. 2024	-	New document