SpinCo™
Incremental Magnetic Encoder System

SPINDLE ENCODER

HIGH SPEED

ROBUST DESIGN

SpinCo is an incremental magnetic encoder system designed for use as primary position and speed feedback sensor for machine tool spindles.

It consists of two key elements, a readhead and a magnetic ring.

RLS proven AMR and GMR sensor technologies are used for sensing magnetized pattern on the magnetic ring to ensure accurate and reliable operation over the entire operating range.

Features and benefits

- Speeds up to 55,000 rpm
- From 50 to 556 sin/cos periods per revolution
- ABZ digital incremental outputs with up to 4,096 steps per sin/cos period
- Analogue output signals (1 V_{pp})
- Signal stability
- IP67 protection
- Wide installation tolerances
- Small readhead size
- High accuracy

SPINDLE | INDUSTRIAL AUTOMATION | HARSH ENVIRONMENT | MOTOR CONTROL | ASSEMBLY LINES

General information

The encoder continuously calibrates the sensed signals to ensure accurate and reliable output signals, which are reported as industry standard 1 V_{pp} analogue incremental signals.

The magnetic ring consists of an elastoferrite layer firmly bonded to a stainless steel hub. The elastoferrite layer is magnetised with alternating magnetic poles. The poles can be 1 mm or 2 mm long. To ensure safety and reliability even at the highest rotational speeds, all magnetic rings have a fully welded cover foil. This thin steel layer protects the elastoferrite from damage and the effects of cooling lubricant vapours and ensures optimum performance at high speeds and high temperatures. Various outer diameters are supported, ranging from 31 mm to 176 mm. The magnetic ring can be mounted by shrinkage press fitting, press fitting, gluing or by using fasteners.

The shape of the readhead has been designed to minimise the required mounting space. In addition, a visible status LED is provided to facilitate installation and troubleshooting. The readhead features an AGC that enables an optimum output signal within the installation tolerances, regardless of the ride height.

Three options of SpinCo readheads

+

Radial incremental magnetic ring (Outer diameter from 31 mm to 176 mm)

=

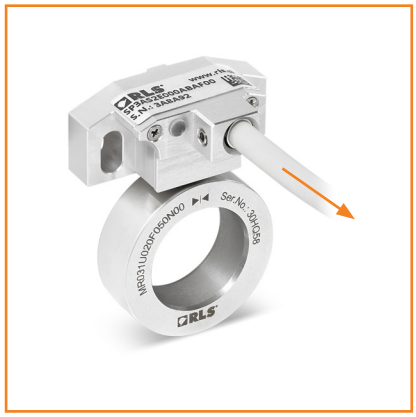
SpinCo incremental magnetic encoder system

Choose your SpinCo magnetic encoder system

SpinCo system with right tangential cable exit

SpinCo system with left tangential cable exit

SpinCo system with axial cable exit



Storage and handling

Storage temperature

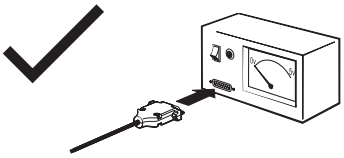
–40 °C to +85 °C

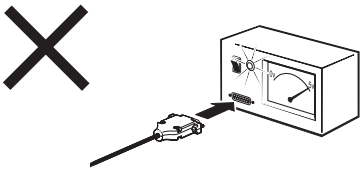
Operating temperature

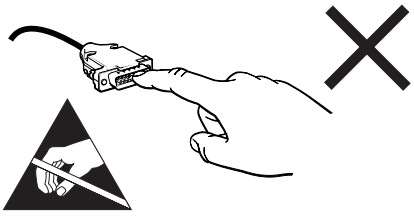
–40 °C to +85 °C

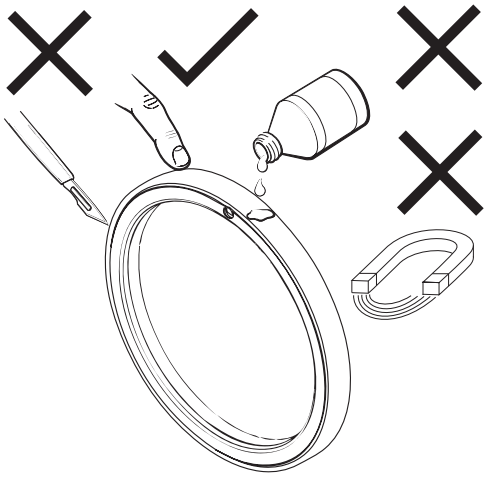
Humidity

High resistance to humidity



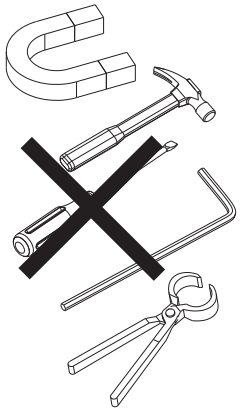






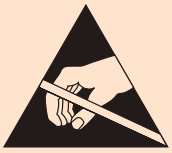
HANDLE WITH CARE. This encoder system is a high performance metrology product and should be handled with the same care as any other precision instrument. The use of industrial tools such as hammers and chisels or exposure to strong magnets such as a magnetic base is unacceptable and carries the risk of irreparable damage to the product.

The magnetic ring should not be exposed to magnetic field densities higher than 25 mT on its surface, as this can damage the ring.



Exposure to external magnetic fields during operation

<1 mT AC (alternating field)
<2 mT DC (static field)



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.

Packaging

Each readhead is packed individually in an antistatic bag.

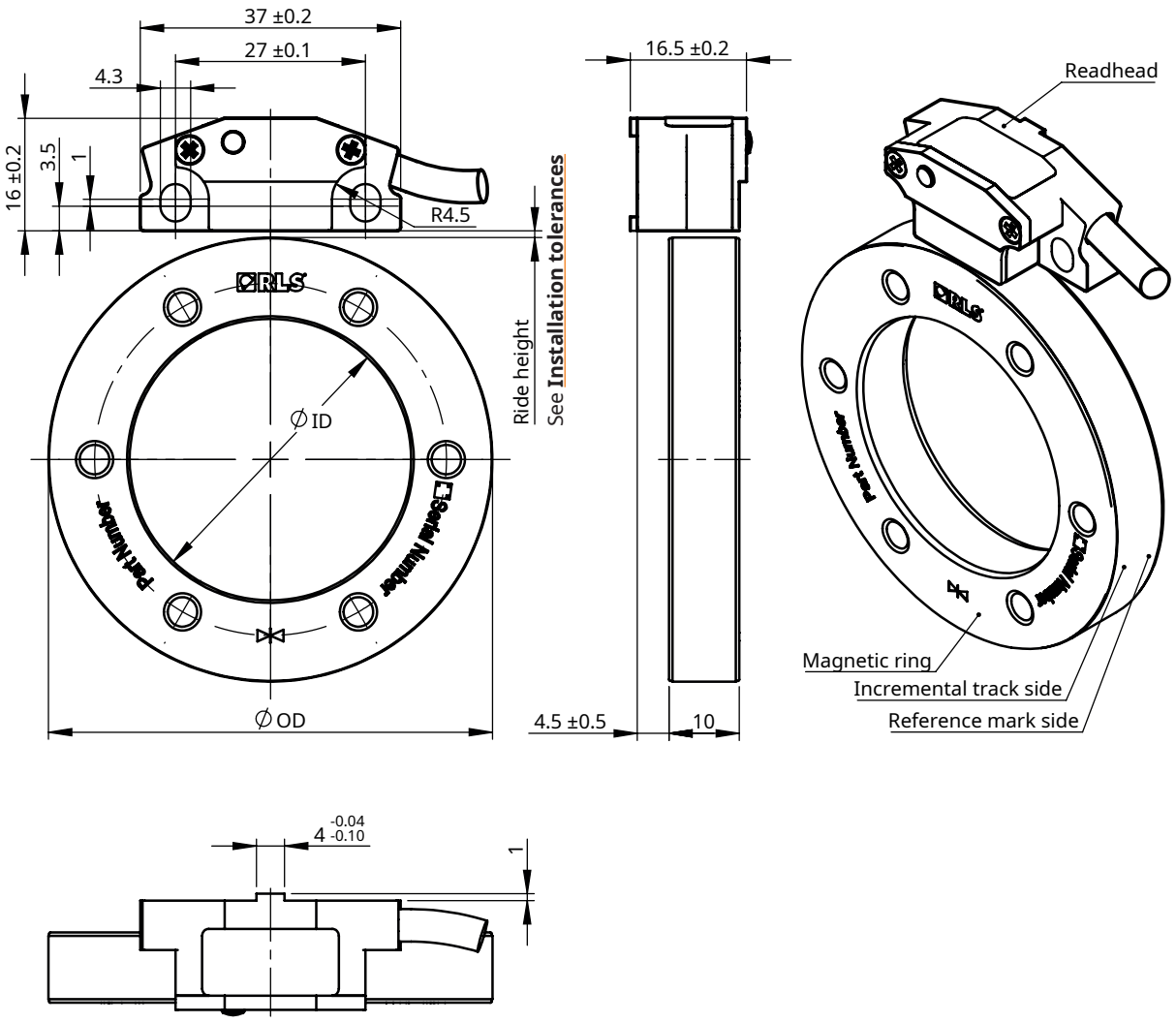
Each magnetic ring is packed individually in an antistatic box.

Dimensions and installation drawings

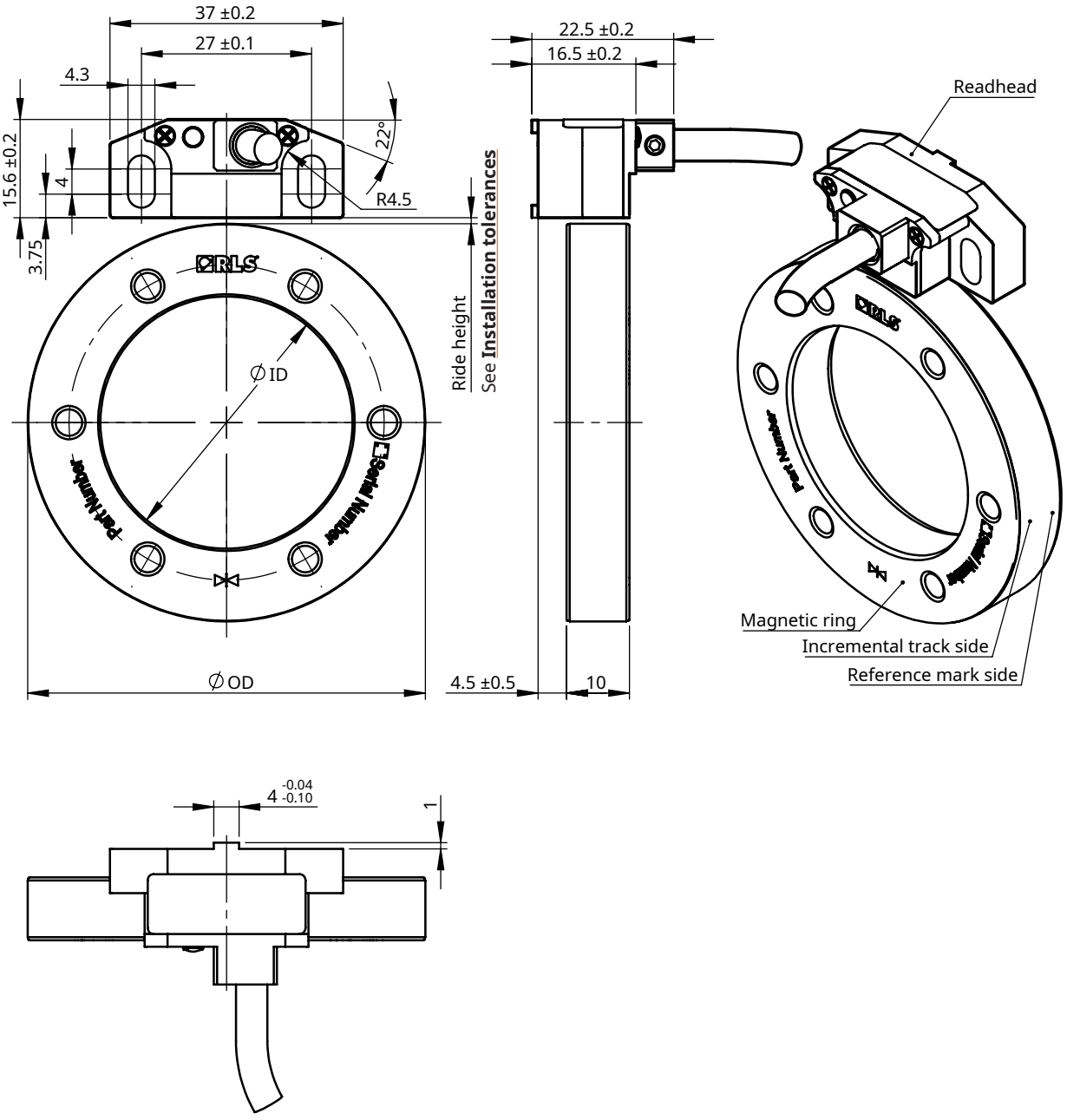
Dimensions and tolerances are in mm.

Encoder assembly with MR063U ring

With tangential cable exit



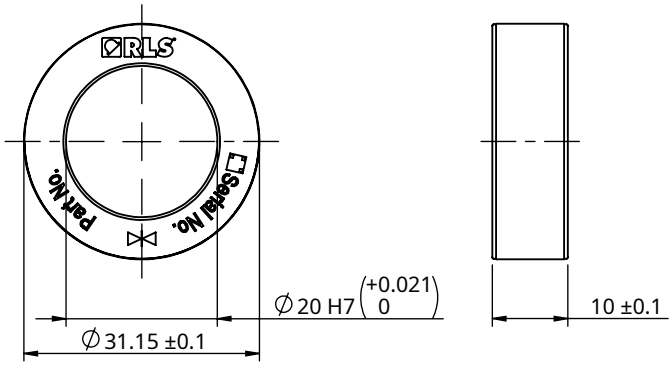
With axial cable exit



Dimensions and installation drawings continued

Magnetic rings

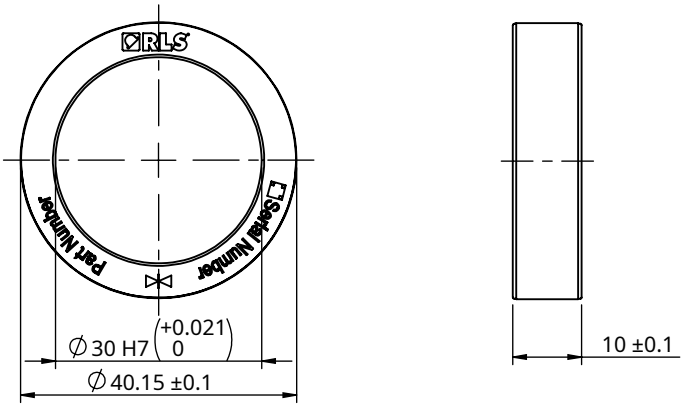
MR031U



Technical features

Pole length (mm)	1	2
Number of poles	100	50
Ride height (mm)	0.2 ±0.1	0.3 ±0.2
Outer diameter (mm)	31.15 ±0.1	
Inner diameter (mm)	20	
Mass (g)	31	
Maximum speed	Refer to **Maximum speed calculator**	
Moment of inertia (kgmm²)	5.3	
Accuracy of magnetisation (°)	±0.06	±0.1
Interpolation accuracy / SDE (°)	±0.015	±0.025

MR040U

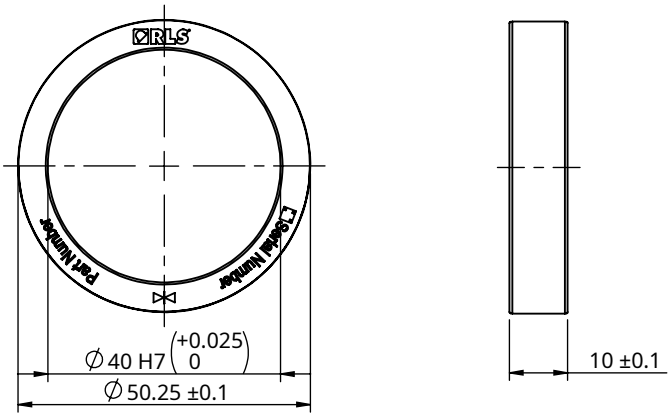


Technical features

Pole length (mm)	1	2
Number of poles	128	64
Ride height (mm)	0.2 ±0.1	0.3 ±0.2
Outer diameter (mm)	40.15 ±0.1	
Inner diameter (mm)	30	
Mass (g)	39	
Maximum speed	Refer to **Maximum speed calculator**	
Moment of inertia (kgmm²)	12.1	
Accuracy of magnetisation (°)	±0.05	±0.08
Interpolation accuracy / SDE (°)	±0.012	±0.022

Dimensions and installation drawings continued

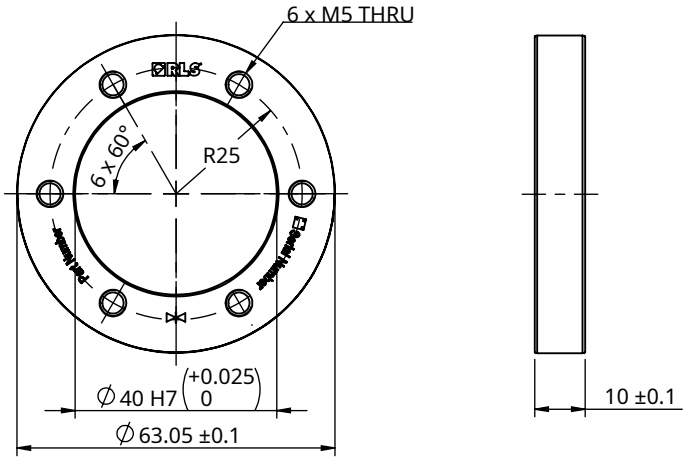
MR050U



Technical features

Pole length (mm)	1	2
Number of poles	160	80
Ride height (mm)	0.2 ±0.1	0.3 ±0.2
Outer diameter (mm)	50.25 ±0.1	
Inner diameter (mm)	40	
Mass (g)	51	
Maximum speed	Refer to **Maximum speed calculator**	
Moment of inertia (kgmm²)	25.9	
Accuracy of magnetisation (°)	±0.04	±0.07
Interpolation accuracy / SDE (°)	±0.01	±0.02

MR063U ID40

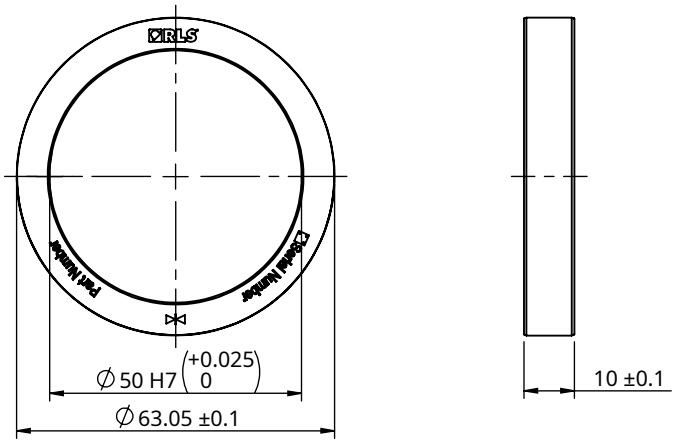


Technical features

Pole length (mm)	1	2
Number of poles	200	100
Ride height (mm)	0.2 ±0.1	0.3 ±0.2
Outer diameter (mm)	63.05 ±0.1	
Inner diameter (mm)	40	
Mass (g)	131	
Maximum speed	Refer to **Maximum speed calculator**	
Moment of inertia (kgmm²)	90.3	
Accuracy of magnetisation (°)	±0.035	±0.06
Interpolation accuracy / SDE (°)	±0.008	±0.015

Dimensions and installation drawings continued

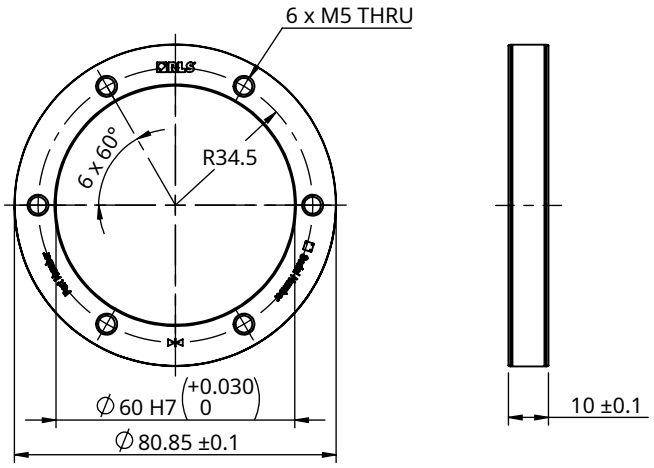
MR063U ID50



Technical features

Pole length (mm)	1	2
Number of poles	200	100
Ride height (mm)	0.2 ±0.1	0.3 ±0.2
Outer diameter (mm)	63.05 ±0.1	
Inner diameter (mm)	50	
Mass (g)	83	
Maximum speed	Refer to **Maximum speed calculator**	
Moment of inertia (kgmm²)	66.3	
Accuracy of magnetisation (°)	±0.035	±0.06
Interpolation accuracy / SDE (°)	±0.008	±0.015

MR081U

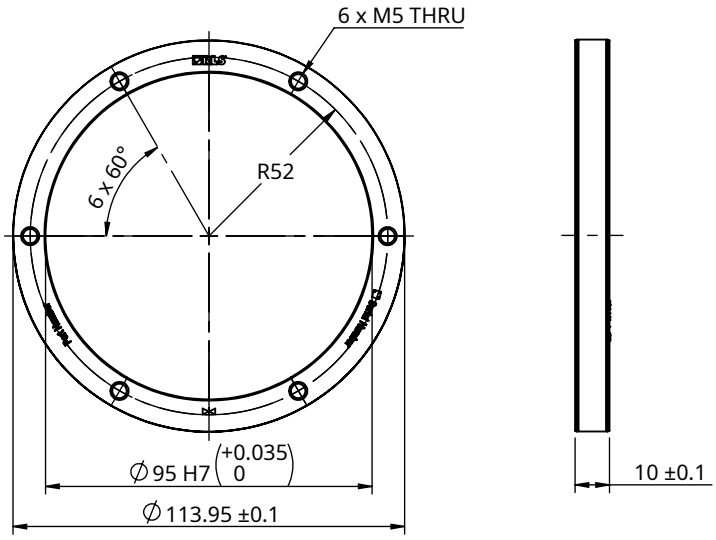


Technical features

Pole length (mm)	1	2
Number of poles	256	128
Ride height (mm)	0.2 ±0.1	0.3 ±0.2
Outer diameter (mm)	80.85 ±0.1	
Inner diameter (mm)	60	
Mass (g)	163	
Maximum speed	Refer to **Maximum speed calculator**	
Moment of inertia (kgmm²)	204.9	
Accuracy of magnetisation (°)	±0.03	±0.05
Interpolation accuracy / SDE (°)	±0.007	±0.014

Dimensions and installation drawings continued

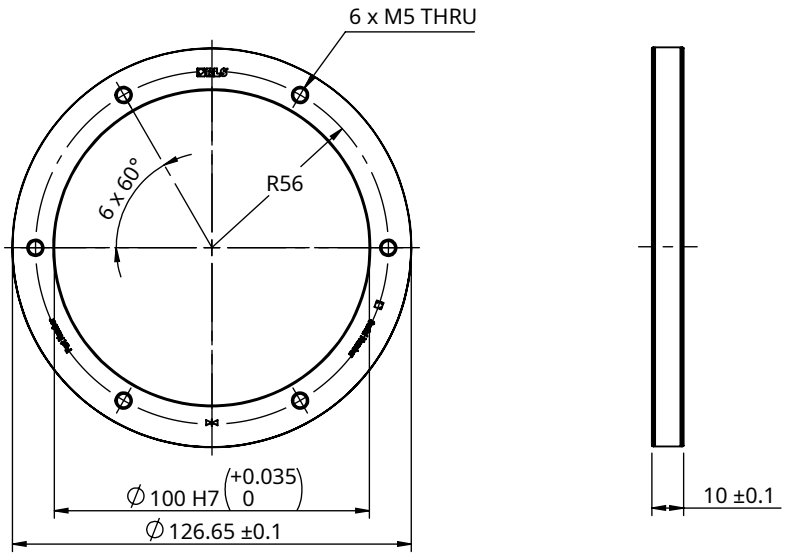
MR114U



Technical features

Pole length (mm)	1	2
Number of poles	360	180
Ride height (mm)	0.2 ±0.1	0.3 ±0.2
Outer diameter (mm)	113.95 ±0.1	
Inner diameter (mm)	95	
Mass (g)	221	
Maximum speed	Refer to **Maximum speed calculator**	
Moment of inertia (kgmm²)	604	
Accuracy of magnetisation (°)	±0.02	±0.04
Interpolation accuracy / SDE (°)	±0.006	±0.012

MR127U

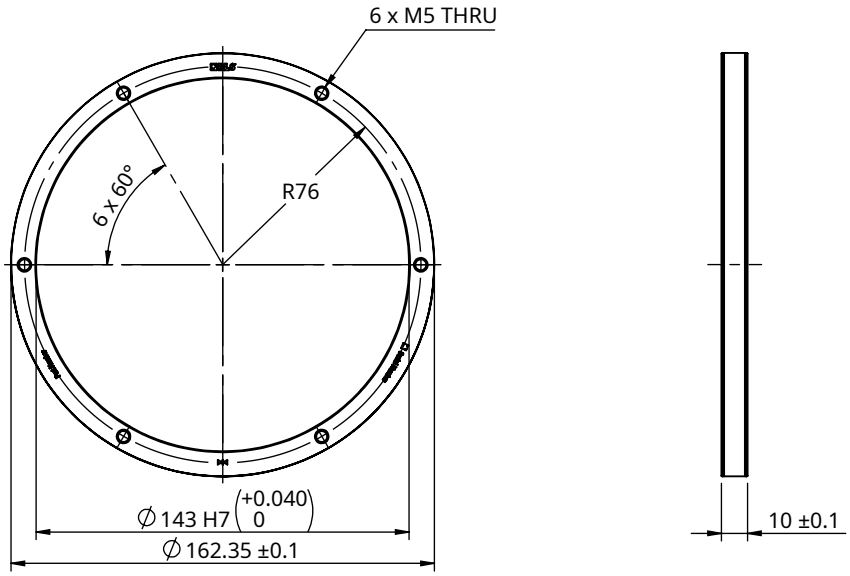


Technical features

Pole length (mm)	1	2
Number of poles	400	200
Ride height (mm)	0.2 ±0.1	0.3 ±0.2
Outer diameter (mm)	126.65 ±0.1	
Inner diameter (mm)	100	
Mass (g)	345	
Maximum speed	Refer to **Maximum speed calculator**	
Moment of inertia (kgmm²)	1118	
Accuracy of magnetisation (°)	±0.02	±0.04
Interpolation accuracy / SDE (°)	±0.005	±0.01

Dimensions and installation drawings continued

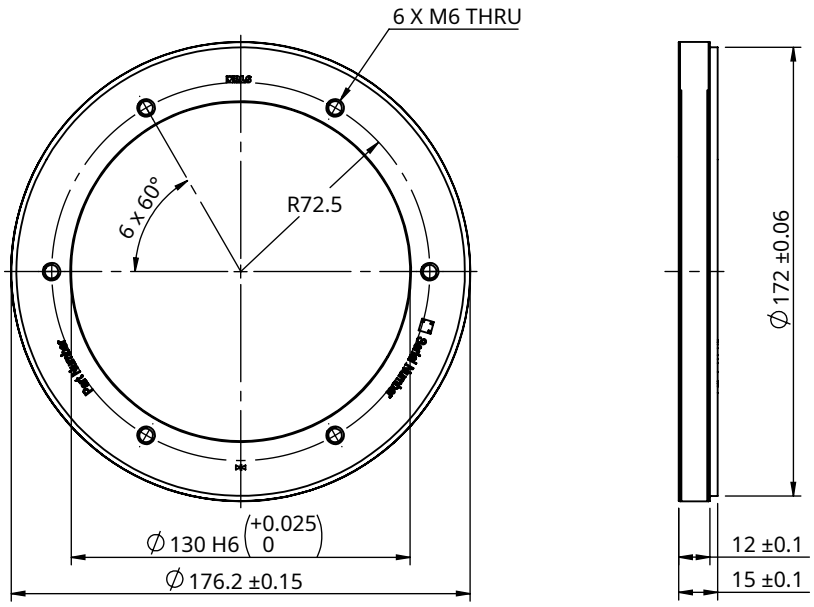
MR162U



Technical features

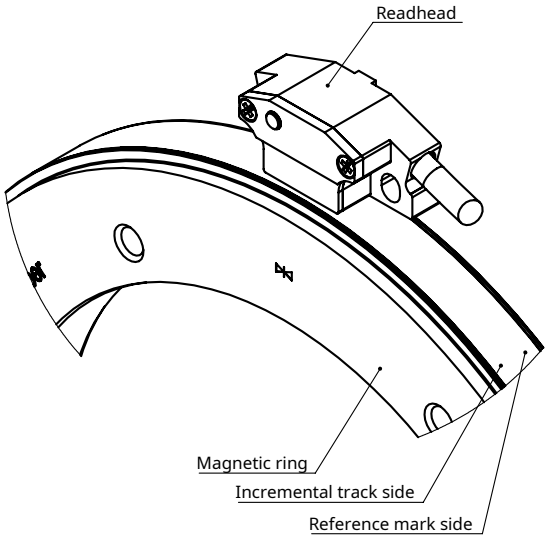
Pole length (mm)	1	2
Number of poles	512	256
Ride height (mm)	0.2 ±0.1	0.3 ±0.2
Outer diameter (mm)	162.35 ±0.1	
Inner diameter (mm)	143	
Mass (g)	334	
Maximum speed	Refer to **Maximum speed calculator**	
Moment of inertia (kgmm²)	1948.1	
Accuracy of magnetisation (°)	±0.015	±0.03
Interpolation accuracy / SDE (°)	±0.003	±0.006

MR176X



Technical features

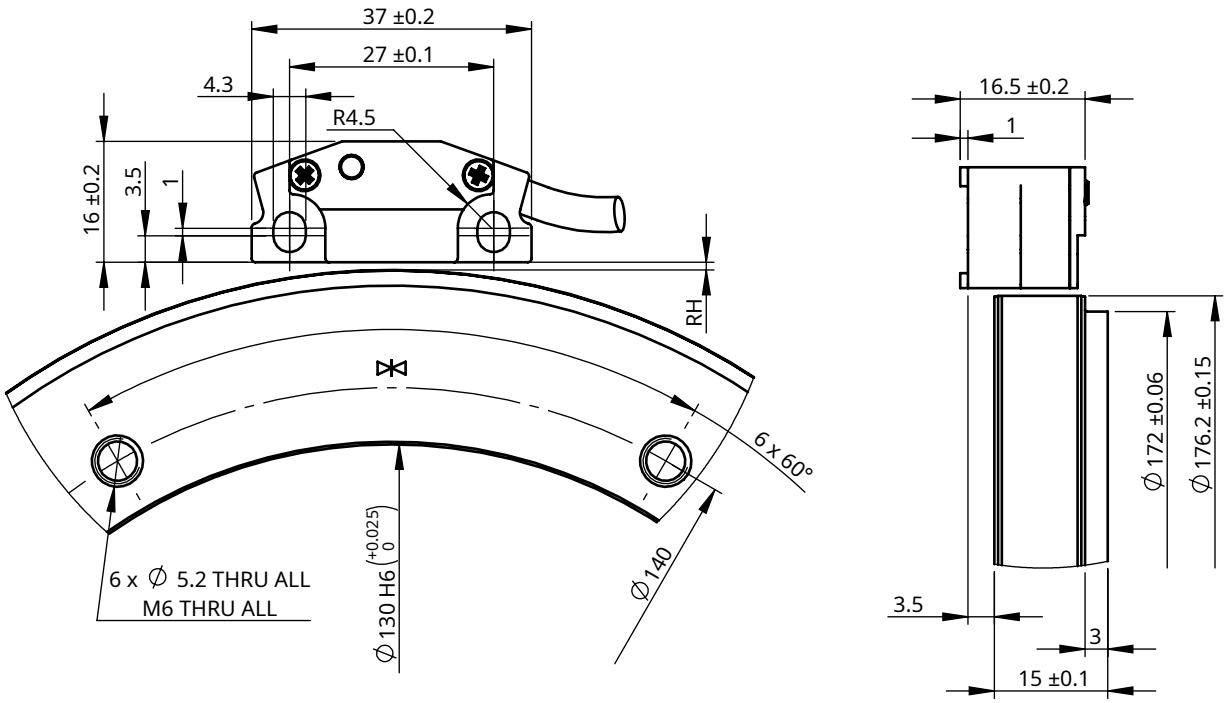
Pole length (mm)	1
Number of poles	556
Ride height (mm)	0.2 ±0.1
Outer diameter (mm)	176.2 ±0.15
Inner diameter (mm)	130
Mass (g)	1200
Maximum speed	Refer to **Maximum speed calculator**
Moment of inertia (kgmm²)	7225
Accuracy of magnetisation (°)	±0.015
Interpolation accuracy / SDE (°)	±0.002



See the encoder assembly on the following page.

Dimensions and installation drawings continued

Encoder assembly with MR176X ring



Installation instructions

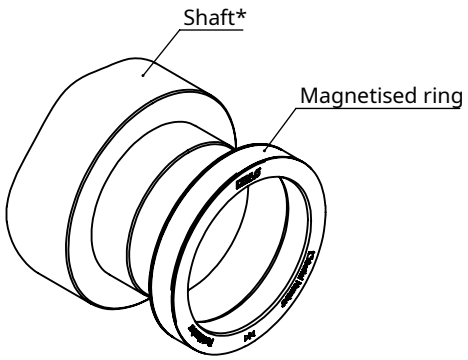
Installation of magnetic rings

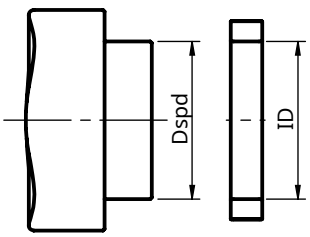
Machine the mounting shaft according to the dimensions given in the table below.
Dimensions and tolerances are in mm.

Ring	Outer diameter - OD	Inner diameter - ID	Shaft diameter (clearance fit installation, fasteners, gluing) - Ds		Shaft outer diameter (press fit or shrinkage press fit) - Dspd	
MR031U020	31.15 ±0.1	20 H7	20 g6	–0.007 –0.02	20 r6	0.041 0.028
MR040U030	40.15 ±0.1	30 H7	30 g6	–0.007 –0.02	30 r6	0.041 0.028
MR050U040	50.25 ±0.1	40 H7	40 g6	–0.009 –0.025	40 r6	0.05 0.034
MR063U040	63.05 ±0.1	40 H7	40 g6	–0.009 –0.025	40 r6	0.05 0.034
MR063U050	63.05 ±0.1	50 H7	50 g6	–0.009 –0.025	50 r6	0.05 0.034
MR081U060	80.85 ±0.1	60 H7	60 g6	–0.01 –0.029	60 r6	0.06 0.041
MR114U095	113.95 ±0.1	95 H7	95 g6	–0.012 –0.034	95 r6	0.073 0.051
MR127U100	126.65 ±0.1	100 H7	100 g6	–0.012 –0.034	100 r6	0.073 0.051
MR162U143	162.35 ±0.1	143 H7	143 g6	–0.014 –0.039	143 r6	0.09 0.065
MR176X130	176.2 ±0.15	130 H6	130 g5	–0.014 –0.032	130 p5	0.061 0.043

Installation by press-fitting

Slip the ring onto the mating shaft applying equal or uniform force along the whole ring circumference.

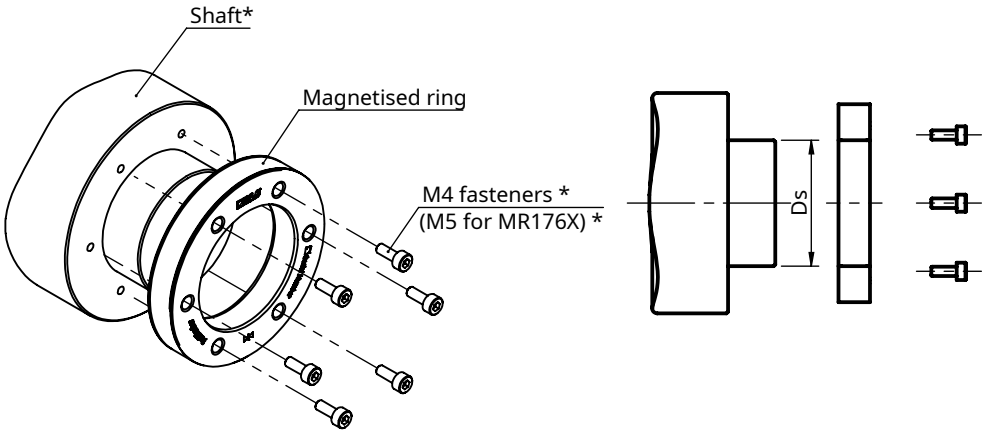




* Not provided.

Installation with fasteners

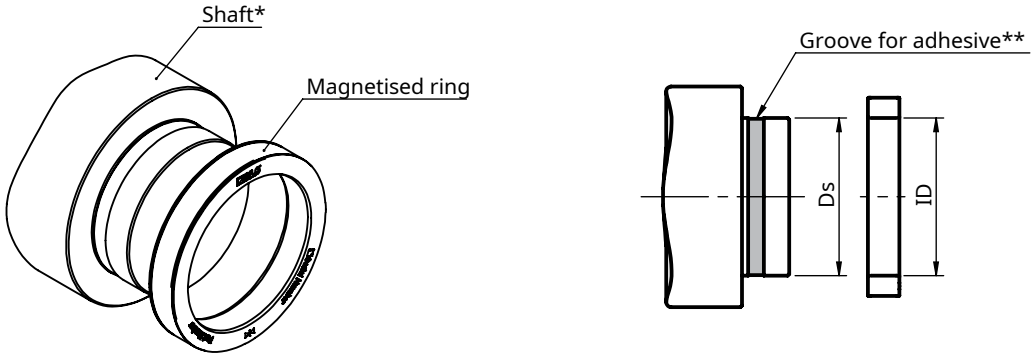
1. Slide the ring onto the mating shaft.
2. Attach the ring with appropriate fasteners.



* Not provided.

See table of recommended tightening torques for RLS products (document TTD01) available at **RLS media center**.

Installation by gluing

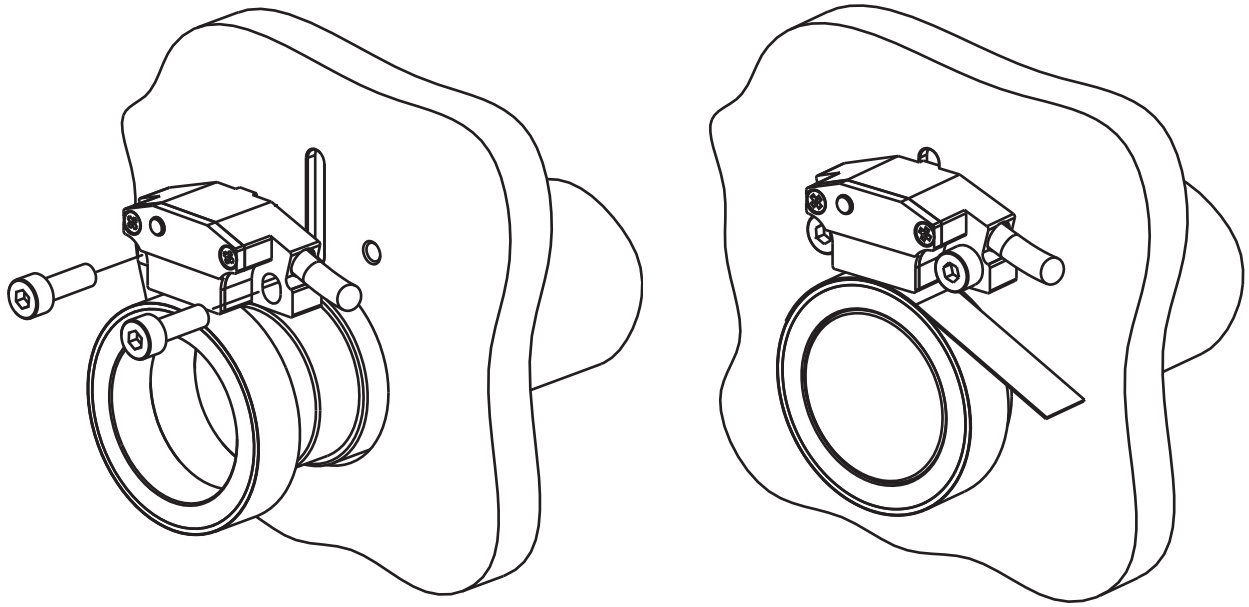


* Not provided.

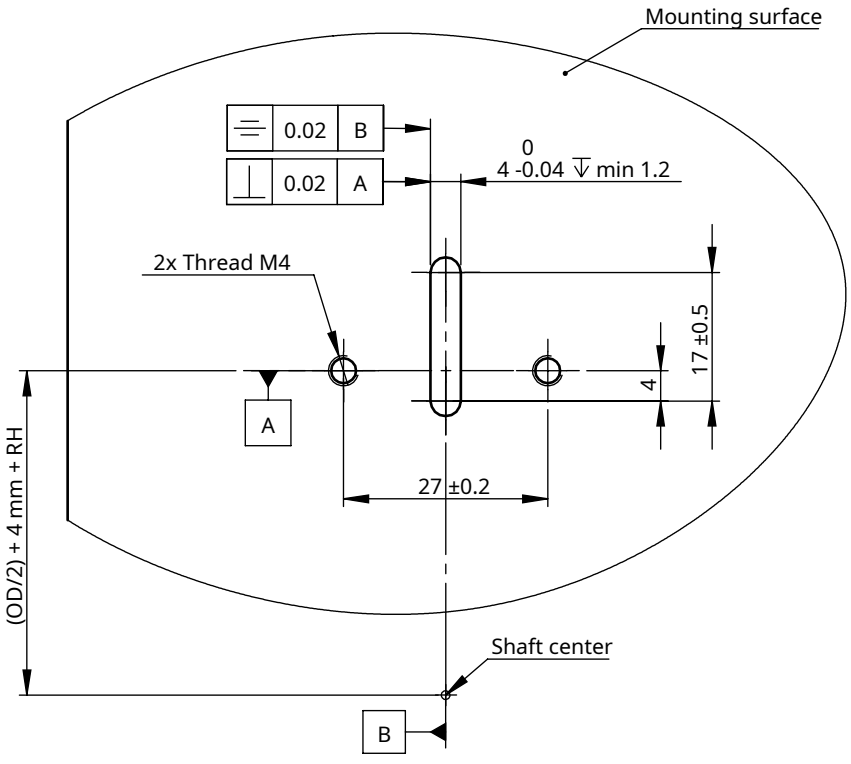
** For the depth of the groove, please check the specifications of the adhesive.

Installation of the readhead

Please use the supplied spacer for optimum ride height. For proper mounting, a mounting base should be made prior to installation.



Mounting base



Installation tolerances (readhead to ring)

Radial displacement (ride height)	1 mm pole length 2 mm pole length	0.2 ±0.1 mm 0.3 ±0.2 mm	
Axial displacement		± 0.5 mm	
Tangential displacement of the sensor		± 0.5 mm	
Non-parallel mounting (roll)		± 0.5°	
Non-parallel mounting (pitch)		± 0.5°	
Non-parallel mounting (yaw)		± 1 °	

Technical specifications

System data

Pole length	1 mm or 2 mm
Hysteresis	Less than 1 electrical degree
Repeatability	Less than ±2 counts for maximum interpolation factor and less than unit of resolution for all other interpolation factors

Electrical data

Supply voltage	5 V ±10 % (absolute maximum 6 V) Reverse polarity and overvoltage protected
Current consumption	<50 mA (without load)
Set-up time	100 ms
Interface	1 Vpp or digital TTL (RS422)

Mechanical data

Mass	Readhead: 120 g (1 m cable, no connector)
Cable	TPE AWG 26, shielded, Ø4.8 ±0.15 mm
Ring hub material	EN 1.4057
Coefficient of thermal expansion (CTE) of steel hub of the ring (ppm/°C)	11.2

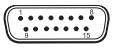
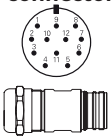
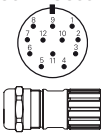
Environmental data

Temperature	–40 °C to +85 °C (Operating and storage)
Environmental sealing	IP67 (according to IEC 60529)*
EMC Immunity	EN 61000-4-2
EMC Emission	EN 61000-6-4
Vibrations	55 Hz to 2000 Hz: 300 m/s^2 (EN 60068-2-6)
Shocks	11 ms: 1000 m/s^2 (EN 60068-2-27)

* IP protection is only guaranteed when suitable connector with same or higher IP is used.

Electrical connections

Connector options

Function	Signal (analogue)	Signal (quadrature)	Colour	15 pin D type plug (option L) 	9 pin D type plug (option A) 	17 pin M23 type plug (option M) 	12 pin M23 coupling connector 	12 pin M23 cable connector 
Power	5 V	5 V	Brown	4	5	10	12	12
	0 V	0 V	White	12	9	7	10	10
	5 V sense	5 V sense	Black	8	-	16	2	2
	0 V sense	0 V sense	Purple	15	-	15	11	11
Incremental / analogue signals	V_1	A	Green	9	4	1	5	5
	V_1–	A–	Yellow	1	8	2	6	6
	V_2	B	Blue	10	3	11	8	8
	V_2–	B-	Red	2	7	12	1	1
Reference mark	V_0	Z	Pink	3	2	3	3	3
	V_0–	Z–	Grey	11	6	13	4	4
Shield	Shield	Shield	-	Case	Case	Case	Case	Case

When using flying lead connection type shield must be connected to custom connector or controllers shield connection pin.

Status indicator LED

LED colour	Output signals	Possible cause
Green	VALID	
Red	INVALID	Rotational speed too high. Sensing distance too high. Improper orientation of magnetised ring relative to readhead. Magnetically damaged magnetised ring. External magnetic field too high.

AGC - automatic gain control

If the strength of the magnetic field is changing, the internal AGC (automatic gain control) circuit is able to control the output signal amplitude around 1 V_{pp}. Via AGC SpinCo can monitor and keep the output signals for the ensuing sine-to-digital conversion constant regardless of changes in input signal level.

Maximum speed

For operation without errors during high speed rotation, correct edge separation setting must be selected.
Edge separation can be calculated according to following equation:

$$t_{MDT} = \frac{1}{\frac{RPM}{60} \times STEP \times Pole\ count}$$

Available edge separations:

B	25 ns	**F**	125 ns	**J**	400 ns	**N**	1.3 µs
C	50 ns	**G**	150 ns	**K**	550 ns	**O**	1.6 µs
D	75 ns	**H**	200 ns	**L**	800 ns	**P**	3.2 µs
E	100 ns	**I**	300 ns	**M**	1 µs	**Q**	6.4 µs

For maximum speed table refer to **Maximum speed calculator for SpinCo radial magnetic rings**.

Test method to confirm maximum speed:

To verify of the prescribed speeds, the magnetic rings were first exposed statically at least 5 % above the temperature characteristics for a specified time and then rotated above their prescribed speed for 1 h.

Communication interfaces

Analogue output signals (1 V_{pp})

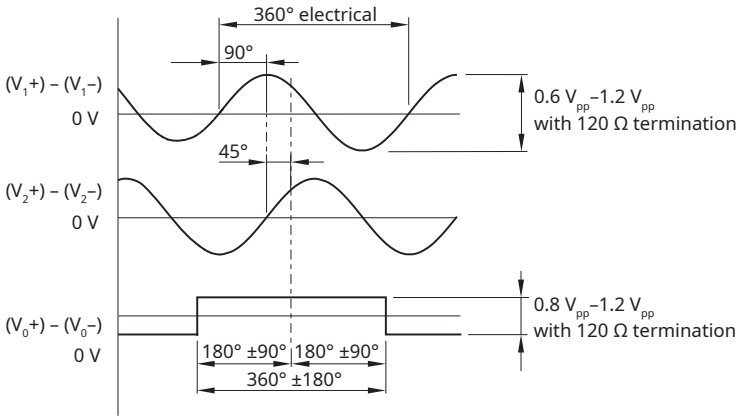
2 channels V_1 and V_2 differential sinusoidals (90° phase shifted) and differential, rectangular index pulse V_0

Power supply * (voltage at readhead)	5 V ±10 % Reverse polarity and overvoltage protected	
Current consumption	<50 mA (without load)	
Voltage drop over cable	~ 24 mV/m (without load) ~ 30 mV/m (with 120 Ω load)	
Output signals	V_1, V_2, V_0	Short circuit protected
Sine / cosine signals	**Amplitude** (with 120 Ω termination)	0.6 V_{pp} to 1.2 V_{pp}
	Phase shift	90° ±1°
Reference signal	**Amplitude** (with 120 Ω termination)	0.8 V_{pp} to 1.2 V_{pp}
	Position	45° ± 45°
	Width	360° ± 180°
Termination	Z_0 = 120 Ω between associated outputs	
Cable length *	Max. 50 m	

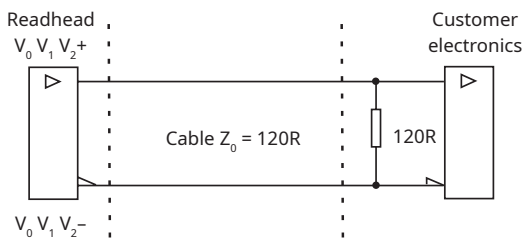
* Please consider voltage drop over cable.

Timing diagram

Rotating in positive direction



Recommended signal termination



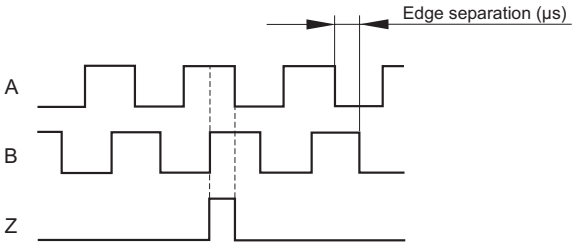
Incremental quadrature output signals (ABZ)

Power supply *	5 V ±10 % – voltage on readhead Reverse polarity and overvoltage protected
Current consumption	<50 mA (without load)
Voltage drop over cable	~ 24 mV/m (without load) ~ 65 mV/m (with 120 Ω load)
Output signals	3 square-wave signals A, B, Z and their inverted signals A–, B–, Z–
Reference signal	1 square-wave pulse Z and its inverted pulse Z–
Signal level	Differential line driver to EIA standard RS422: $U_H \geq 2.5$ V at $-I_H = 20$ mA $U_L \leq 0.5$ V at $I_L = 20$ mA
Permissible load	$Z_0 \geq 120$ Ω between associated outputs
Cable length *	Max. 50 m

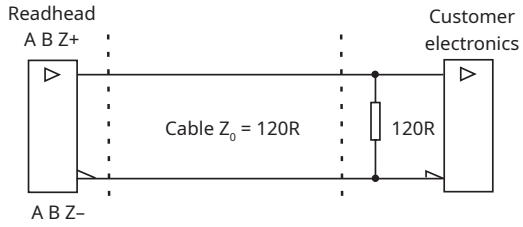
* Please consider voltage drop over cable.

Timing diagram

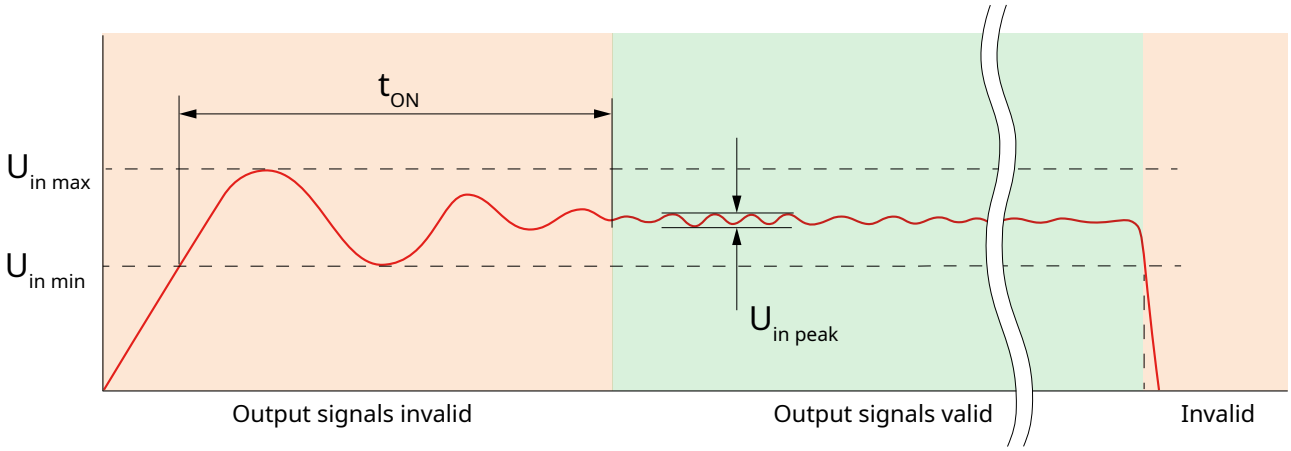
Complementary signals not shown



Recommended signal termination



Transient response of supply voltage



Switch-on/off behavior of the encoder:
After the switch-on time t_{ON}, valid output signals are available.
t_{ON} = 2 s
U_{inmax} = U_{in} +10 %,
U_{inmin} = U_{in} – 10 %

If the power supply is switched off, or when supply voltage falls below U_{inmin}, the output signals are also invalid.

The encoder require a stabilized DC voltage supply U_{in}. The permissible ripple content of the DC voltage is:

- High frequency interference: U_{inpeak} < 250 mV
- Low frequency ripple: U_{inpeak} < 100 mV

The limits of the supply voltage must not be violated by ripple content.
The values apply as measured at the encoder. The voltage can be monitored and adjusted with the encoders sensor lines, if available. If an adjustable power supply is not available, the voltage drop can be reduced by switching the sensor lines parallel to the corresponding supply wires.

Part numbering

Readhead

SP3 AS 1 E 000 A 1 A A 00

Series
SP3 - SP3 flat readhead

Communication interface
AS - Analogue voltage 1 V_{pp}, wide reference, 5 V
IC - Incremental, RS422; 5 V

Pole length
1 - 1 mm pole length
2 - 2 mm pole length

Reference mark
E - With reference mark

Resolution (steps per period)

000 - N/A (for AS only)	**D04** - 40	**D20** - 200	**1D0** - 1000
02B - 4	**06B** - 64	**08B** - 256	**10B** - 1024
03B - 8	**D08** - 80	**D40** - 400	**2D0** - 2000
04B - 16	**D10** - 100	**D50** - 500	**11B** - 2048
D02 - 20	**07B** - 128	**09B** - 512	**4D0** - 4000
05B - 32	**D16** - 160	**D80** - 800	**12B** - 4096

Minimum edge separation

A - N/A (for AS only)	**G** - 150 ns	**M** - 1µs
B - 25 ns	**H** - 200 ns	**N** - 1.3 µs
C - 50 ns	**I** - 300 ns	**O** - 1.6 µs
D - 75 ns	**J** - 400 ns	**P** - 3.2 µs
E - 100 ns	**K** - 550 ns	**Q** - 6.4 µs
F - 125 ns	**L** - 800 ns	

Cable length

A - 0.3 m	**C** - 1.5 m	**3** - 3 m
B - 0.5 m	**2** - 2 m	**5** - 5 m
1 - 1 m	**D** - 2.5 m	**F** - 10 m

Other cable lengths available per special request. Minimum cable length is 10 cm, maximum cable length is 10 m.

Cable outlet
A - Axial
L - Left tangential
R - Right tangential

Connector

A - 9 pin D type plug	**D** - 15 pin D type plug
B - 12 pin M23 coupling connector	**F** - Flying lead
C - 12 pin M23 cable connector	**N** - 17 pin M23 type plug

Special requirements
00 - No special requirements

Not all part number combinations are valid. Please refer to the table of available combinations on the next page.

Table of available combinations

Series	Output type	Pole length	Reference mark	Resolution	Minimum edge separation	Cable length	Cable outlet	Connector	Special require-ments
SP3	AS	1 / 2	E	000	A	1/ 2 / 3 / 5 / A / B / C / D / F	A / L / R	A / B / C / D / F / N	00
	IC			02B / 03B / 04B / D02 / 05B / D04 / 06B / D08 / D10 / 07B / D16 / D20 / 08B / D40 / D50 / 09B / D80 / 1D0 / 10B / 2D0 / 11B / 4D0 / 12B	B / C / D / E / F / G / H / I / J / K / L / M / N / O / P / Q				

Magnetic ring

MR 040 U 030 F 128 N 00

Series

MR - Magnetic incremental ring

Outer diameter

031 - 31 mm
040 - 40 mm
050 - 50 mm
063 - 63 mm
081 - 81 mm
114 - 114 mm
127 - 127 mm
162 - 162 mm
176 - 176 mm

Cross section

U - Height 10 mm, radial magnetisation, fully welded cover foil
X - Cross section defined under Special requirements

Inner diameter

020 - 20 mm
030 - 30 mm
040 - 40 mm
050 - 50 mm
060 - 60 mm
095 - 95 mm
100 - 100 mm
143 - 143 mm
130 - 130 mm

Reference mark

F - GMR reference mark

Number of poles

050 - 50 poles
064 - 64 poles
080 - 80 poles
100 - 100 poles
128 - 128 poles
160 - 160 poles
180 - 180 poles
200 - 200 poles
256 - 256 poles
360 - 360 poles
400 - 400 poles
512 - 512 poles
556 - 556 poles

Material

N - Martensitic stainless steel hub with bonded rubber tape, with cover foil

Special requirements

00 - No special requirements
29 - Height 15 mm, radial magnetisation, fully welded cover foil

Not all part number combinations are valid. The inner diameter of rings is related to the outer diameter and cannot be randomly selected. Please refer to the table of available combinations on the next page.

Other magnetic ring sizes available per special request.

Table of available combinations

Series	Outer diameter	Cross section	Inner diameter	Reference mark	Number of poles	Material	Special requirements
MR	031	U	020	F	050	N	00
					100		
	040		030		064		
					128		
	050		040		080		
					160		
	063				100		
					200		
			050		100		
					200		
	081		060		128		
					256		
	114		095		180		
					360		
	127		100		200		
					400		
	162		143		256		
					512		
	176	X	130		556		29

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Document issues

Issue	Date	Page	Description
01	28. 7. 2021	-	New document
02	20. 9. 2021	25, 26	List of available cable lengths amended
03	3. 1. 2022	4, 5	Additional technical drawings added
		18	Link to Recomended fastener tightening torques table added
		20	Installation tolerances table added
		21	Repeatability data added
		23	Test method to confirm maximum speed described
04	16. 2. 2022	21	Hysteresis added