

# RM22 rotary magnetic encoder



**The RM22 is a compact, high-speed rotary magnetic encoder designed for use in harsh environments. The non-contact two part design removes the need for seals or bearings ensuring long-term reliability and simple installation.**

**The encoder comprises a magnetic actuator and a separate encoder body. Rotation of the magnetic actuator is sensed by a custom encoder chip within the body, and processed to give the required output format.**

The encoder chip processes the signals received to provide resolutions to 13 bit (8,192 positions per revolution) with high operational speeds. Output signals are provided in industry standard absolute, incremental, analogue or linear formats.

The compact encoder body is just 22 mm in diameter and provides dirt immunity up to IP68.

The RM22 can be used in a wide range of applications including marine, medical, print, converting, industrial automation, metal working, motor control and instrumentation.

## **Product range**

### **RM22AC**

Analogue with a single sine/cosine cycle per revolution

### **RM22BC**

Complementary analogue outputs with a single sine/cosine cycle per revolution

### **RM22DC**

BiSS C interface with up to 8,192 counts per revolution and optional revolution counter.

### **RM22IC**

Incremental with 80 to 2,048 pulses per revolution (320 to 8,192 counts per revolution with x 4 evaluation)

### **RM22SC**

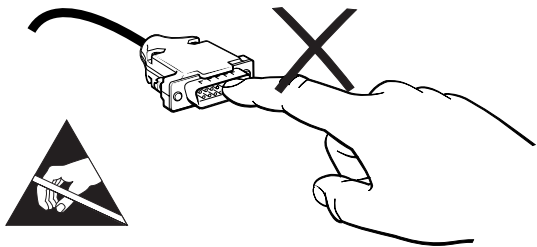
Synchro serial interface (SSI) with 320 to 8,192 positions per revolution

### **RM22Vx**

Linear voltage output in a range of variants

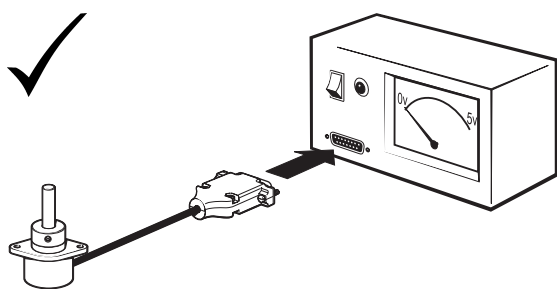
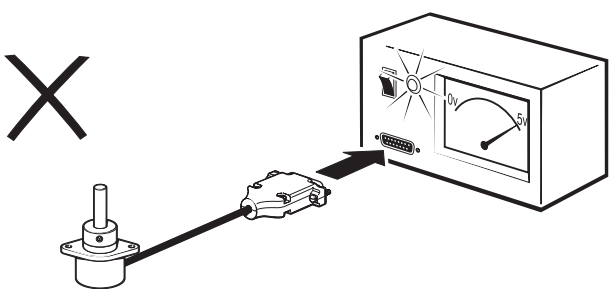
- **Excellent immunity to IP68**
- **Non-contact, frictionless design**
- **High speed operation to 30,000 rpm**
- **Compact - 22 mm diameter body**
- **Absolute - to 13 bit (8,192 positions per revolution)**
- **Industry standard absolute, incremental, analogue and linear output formats**
- **Accuracy to  $\pm 0.5^\circ$**
- **Simple installation**

Storage and handling

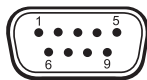
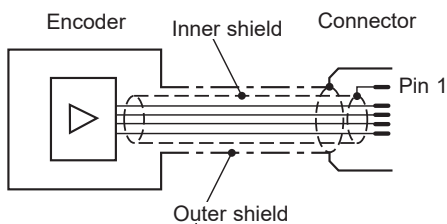


**IMPORTANT:** Power to RM22 encoders must be supplied from a DC SELV supply complying with the essential requirements of EN (IEC) 60950 or similar specification.

The RM22 series encoders have been designed to the relevant EMC standards, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding arrangements is critical.



Connections



D' type connector - 9 way

Pin nr.	RM22AC		RM22BC		RM22DC		RM22IC		RM22SC		RM22V	
	Function	Wire colour	Function	Wire colour	Function	Wire colour	Function	Wire colour	Function	Wire colour	Function	Wire colour
1	Shield - see connection diagram				Shield - see connection diagram		Shield - see connection diagram		Shield - see connection diagram			
2	V <sub>A</sub>	Green	V <sub>A+</sub>	Green	MA+	White	Z	White	Clock	White	NC	–
3	V <sub>B</sub>	Brown	V <sub>B+</sub>	Brown	MA–	Brown	B	Green	Clock–	Brown	V <sub>out</sub>	Green
4	NC	–	NC	–	NC	–	A	Grey	NC	–	NC	–
5	V <sub>dd</sub>	Red	V <sub>dd</sub>	Red	V <sub>dd</sub>	Red	V <sub>dd</sub>	Red	V <sub>dd</sub>	Red	V <sub>dd</sub>	Red
6	NC	–	V <sub>A–</sub>	Yellow	SLO+	Green	Z–	Brown	Data	Green	NC	–
7	NC	–	V <sub>B–</sub>	White	SLO–	Yellow	B–	Yellow	Data–	Yellow	NC	–
8	NC	–	NC	–	NC	–	A–	Pink	NC	–	NC	–
9	GND	Blue	GND	Blue	GND	Blue	GND	Blue	GND	Blue	GND	Blue

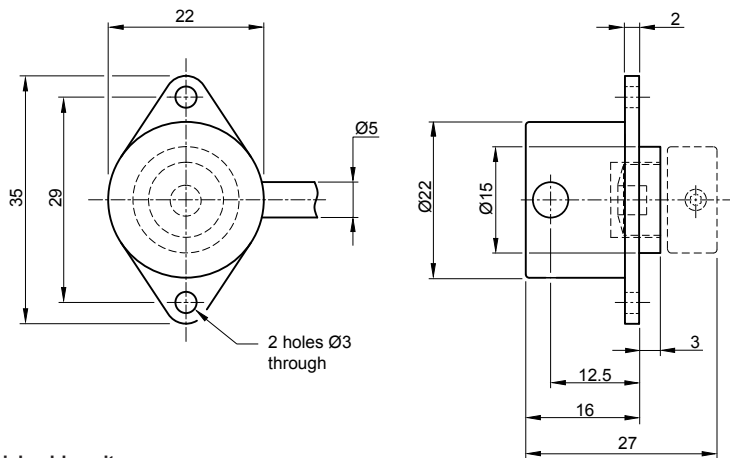
Operating and electrical specifications

EMC compliance	EN 61326
Cable	Outside diameter 5 mm
Connector options	'D' type connector - 9 way Flying lead
Mass	Encoder unit 1 m cable (no connector): 48 g; magnetic actuator: 12 g
Environmental sealing	IP64 (IP68 optional) EN 60529

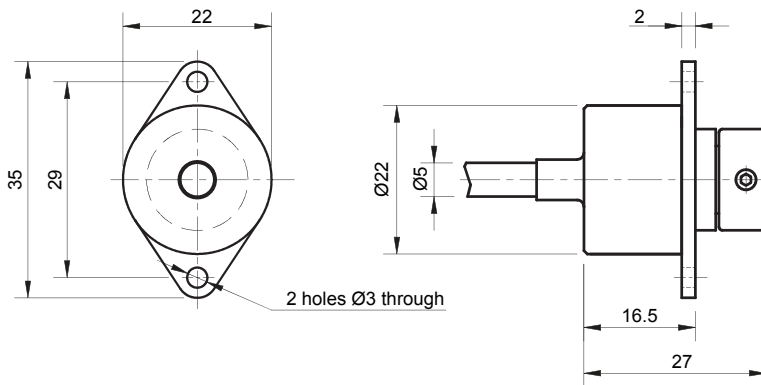
## Dimensions

Dimensions and tolerances in mm

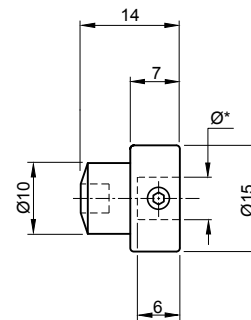
### Radial cable exit



### Axial cable exit



### Magnetic actuator

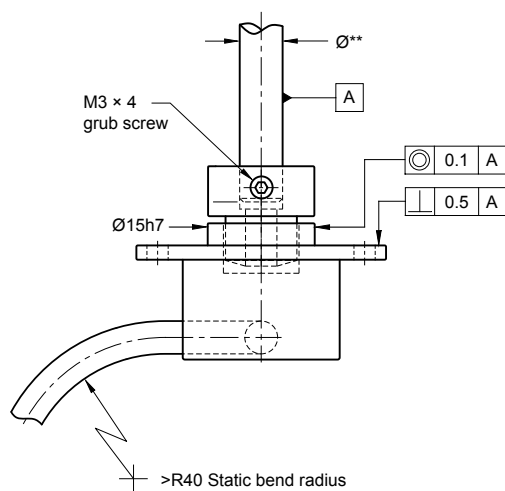


\* Hole diameter for nominal shaft size.

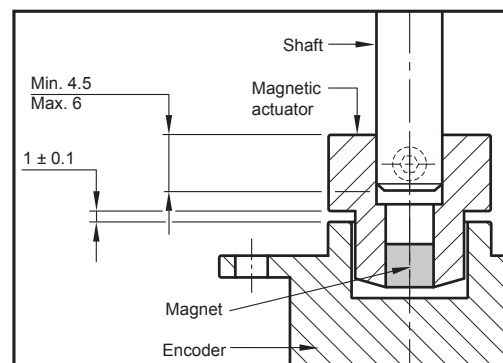


Clockwise (CW) rotation of magnetic actuator.

## Installation drawing



\*\* Nominal shaft size with tolerance h7.

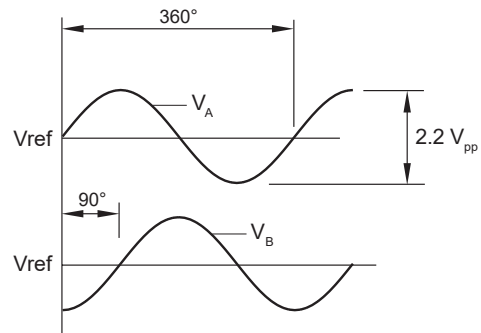


### RM22AC – Analogue sinusoidal outputs

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

<b>Power supply</b>	$V_{dd} = 5\text{ V} \pm 5\%$
<b>Power consumption</b>	30 mA
<b>Outputs</b>	Single ended Signal amplitude $2.2 \pm 0.2\text{ V}_{pp}$ Signal offset (Vref) $2.5\text{ V} \pm 1\%$
<b>Internal serial impedance</b>	10 $\Omega$
<b>Maximum speed</b>	30,000 rpm
<b>Maximum cable length</b>	3 m
<b>Operating temperature</b>	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

Timing diagram



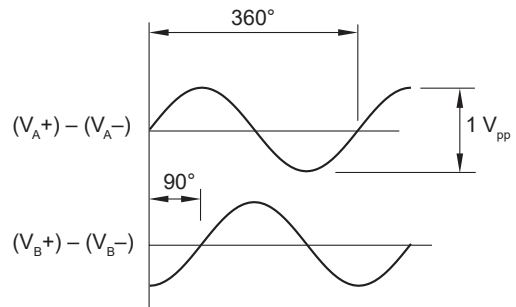
$V_A$  leads  $V_B$  by 90° for clockwise rotation of magnetic actuator.

### RM22BC – Analogue complementary sinusoidal outputs

2 channels  $V_A$  and  $V_B$  differential sinusoids in quadrature (90° phase shifted)

<b>Power supply</b>	$V_{dd} = 5\text{ V} \pm 5\%$
<b>Power consumption</b>	30 mA
<b>Outputs</b>	Differential Signal amplitude $0.5 \pm 0.1\text{ V}_{pp}$ Signal offset (Vref) $0 \pm 5\text{ mV}$
<b>Internal serial impedance</b>	10 $\Omega$
<b>Maximum speed</b>	30,000 rpm
<b>Maximum cable length</b>	20 m
<b>Operating temperature</b>	–40 °C to +85 °C (IP68)

Timing diagram

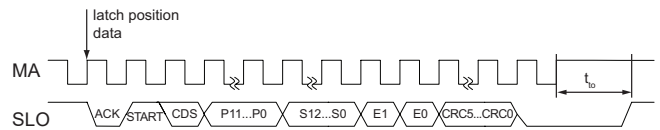


$V_A$  leads  $V_B$  by 90° for clockwise rotation of magnetic actuator.

## RM22DC – Absolute natural binary BiSS C interface

<b>Output code</b>	Natural binary
<b>Power supply</b>	$V_{dd} = 5\text{ V} \pm 5\%$
<b>Current consumption</b>	Max. 50 mA
<b>Clock input</b>	MA (RS422)
<b>Data output</b>	SLO (RS422)
<b>Max MA frequency</b>	8 MHz
<b>Accuracy</b>	Typ. $\pm 0.5^\circ$
<b>Hysteresis</b>	0.18°
<b>Resolution</b>	320, 400, 500, 512, 800, 1,000, 1,024, 1,600, 2,000, 2,048, 4,096, 8,192 positions per revolution
<b>Revolution counter</b>	12 bit (4096 revolutions)
<b>Maximum speed</b>	30,000 rpm
<b>Operating temperature</b>	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

## Timing diagram – BiSS C



Data	Length	Description
P11 – P0	0 or 12 bit	Revolution counter value when enabled (see Part numbering/ resolution)*
S12 – S0	7 to 13 bit	Position inside the revolution (length depends on the resolution)
E1 – E0	2 bit	Error data
CRC5 – CRC0	5 to 6 bit	Cyclic redundancy check data; polynomial 0x43; inverted bit output

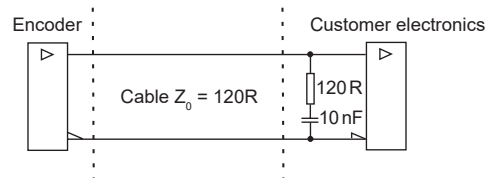
Error	E0	E1
No error	1	1
Amplitude error	0	1
Too high velocity	1	0
Undervoltage; Configuration; System error	0	0

\* The revolution counter counts the number of mechanical revolutions of the shaft or magnet of the encoder. Counting is possible only when the encoder is powered. When the encoder is powered off, the revolution counter is reset to 0.

For more information on BiSS C protocol please visit [www.biss-interface.com](http://www.biss-interface.com).

## Recommended signal termination

For data output lines only



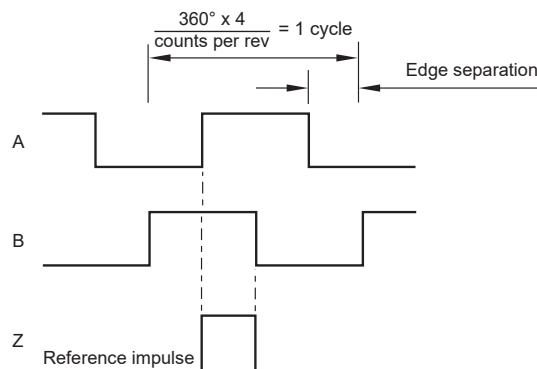
## RM22IC – Incremental, RS422

Square wave differential line driver to RS422

<b>Power supply</b>	$V_{dd} = 5\text{ V} \pm 5\%$
<b>Power consumption</b>	Max. 35 mA
<b>Output signals</b>	A, B, Z, A–, B–, Z– (RS422)
<b>Accuracy</b>	Typ. $\pm 0.5^\circ$
<b>Hysteresis</b>	$0.18^\circ$
<b>Resolution</b>	80 to 2,048 pulses per revolution (320, 400, 500, 512, 800, 1,000, 1,024, 1,600, 2,000, 2,048, 4,096, 8,192 counts per revolution)
<b>Maximum speed</b>	30,000 rpm
<b>Maximum cable length</b>	50 m
<b>Operating temperature</b>	$-40^\circ\text{C}$ to $+125^\circ\text{C}$ (IP64) $-40^\circ\text{C}$ to $+85^\circ\text{C}$ (IP68)

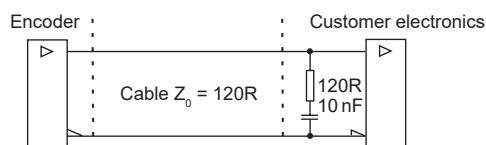
### Timing diagram

Complementary signals not shown



B leads A for clockwise rotation of magnetic actuator.

### Recommended signal termination

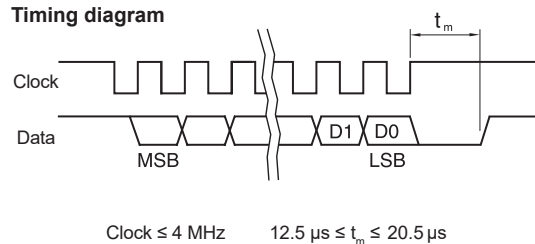


## RM22SC – Absolute binary synchro-serial interface (SSI)

Serial encoded absolute position measurement

<b>Output code</b>	Natural binary
<b>Power supply</b>	$V_{dd} = 5\text{ V} \pm 5\%$
<b>Power consumption</b>	Max. 35 mA
<b>Data output</b>	Serial data (RS422)
<b>Data input</b>	Clock (RS422)
<b>Accuracy</b>	Typ. $\pm 0.5^\circ$
<b>Hysteresis</b>	$0.18^\circ$
<b>Resolution</b>	320, 400, 500, 512, 800, 1,000, 1,024, 1,600, 2,000, 2,048, 4,096, 8,192 positions per revolution
<b>Maximum speed</b>	30,000 rpm
<b>Maximum cable length</b>	100 m (at 1 MHz)
<b>Operating temperature</b>	$-40^\circ\text{C}$ to $+125^\circ\text{C}$ (IP64) $-40^\circ\text{C}$ to $+85^\circ\text{C}$ (IP68)

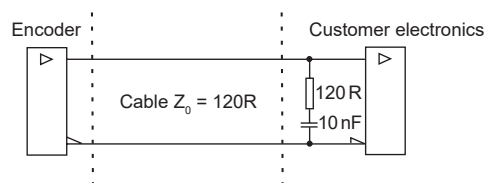
### Timing diagram



Position increases for clockwise rotation of magnetic actuator.

### Recommended signal termination

For data output lines only



## RM22Vx – Linear voltage output

Alternative for potentiometers

<b>Power supply</b>	$V_{dd} = 5 \text{ V} \pm 5 \%$
<b>Power consumption</b>	Typ. 26 mA
<b>Output voltage</b>	0 V to $V_{dd}$
<b>Output loading</b>	Max. 10 mA
<b>Nonlinearity</b>	1 %
<b>Maximum speed</b>	30,000 rpm
<b>Maximum cable length</b>	20 m
<b>Operating temperature</b>	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

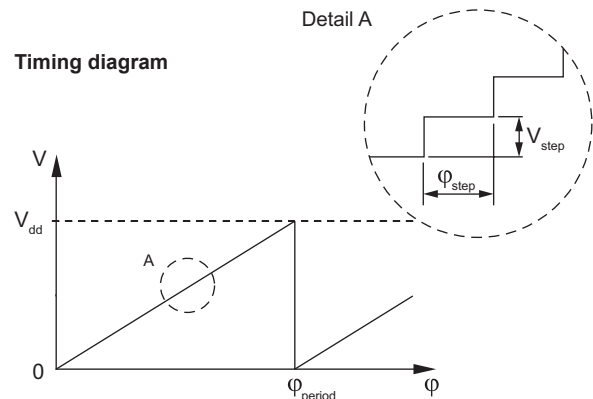
$\phi_{\text{period}}$	$N_{\text{period}}$	$N_{\text{step}}$	$\phi_{\text{step}}$
360°	1	1,024	0.35°
180°	2	1,024	0.18°
90°	4	1,024	0.09°
45°	8	512	0.09°

### Output type and electrical variant

$\phi_{\text{period}}$	360°	180°	90°	45°
<b>Rotation</b>				
<b>Clockwise</b>	VA	VB	VC	VD
<b>Counterclockwise</b>	VE	VF	VG	VH

The digital relative angular position information is converted into linear voltage with a built-in 10 bit D/A converter. The linear output voltage swing ranges from 0 V and  $V_{dd}$  (5 V). The number of periods within one revolution ( $N_{\text{period}}$ ) can be 1, 2, 4 or 8, representing one full swing over an angle ( $\phi_{\text{period}}$ ) of 360°, 180°, 90° or 45° respectively. The signal is made up of steps which represent the angular movement needed to register a change in the position ( $\phi_{\text{step}}$ ) and the resulting change in the output voltage ( $V_{\text{step}}$ ). The number of steps in one period ( $N_{\text{step}}$ ) is given in the table below.

For clockwise rotation of the magnetic actuator, the output voltage increases. For counterclockwise rotation, the output voltage decreases.



$$\phi_{\text{step}} = \frac{\phi_{\text{period}}}{N_{\text{step}}} \quad V_{\text{step}} = \frac{V_{dd}}{N_{\text{step}}}$$

- $\phi_{\text{period}}$  = Angle covered in one period (one sawtooth)
- $V_{\text{period}}$  = Output voltage range for one period
- $\phi_{\text{step}}$  = Step angle (angular movement needed to register a change in the position)
- $V_{\text{step}}$  = Output voltage range for one step
- $N_{\text{period}}$  = Number of periods in one revolution
- $N_{\text{step}}$  = Number of steps in one period

## Part numbering

Encoder system = Encoder body + Magnetic actuator



=



+



Encoder body part number  
eg RM22SC0009B10A1B00

Magnetic actuator  
eg RMA06A2A00

**RM22 SC 00 09B 10 A 1 B 00**

### Output type

**AC** - Analogue sinusoidal 2 V<sub>pp</sub>  
**BC** - Analogue complementary sinusoidal  
**DC** - Absolute natural binary BiSS C, RS422  
**IC** - Incremental, RS422  
**SC** - Absolute binary synchro - serial (SSI), RS422  
**Vx** - Linear voltage:

Linear voltage output 0 - 5 V, supply 5 V DC				
	360°	180°	90°	45°
CW	VA	VB	VC	VD
CCW	VE	VF	VG	VH

### Shaft size

00 - N/A

### Resolution

For **AC** and **BC**:

**01S** - One sine/cosine wave per revolution

For **DC**, **IC** and **SC** (counts/positions per revolution):

Decimal			Binary	
<b>D32</b> - 320	<b>D80</b> - 800	<b>2D0</b> - 2000	<b>09B</b> - 512	<b>12B</b> - 4096
<b>D40</b> - 400	<b>1D0</b> - 1000		<b>10B</b> - 1024	<b>13B</b> - 8192
<b>D50</b> - 500	<b>1D6</b> - 1600		<b>11B</b> - 2048	

For output types **DC** with enabled 12 bit revolution counter:

Decimal			Binary	
<b>M32</b> - 320	<b>M80</b> - 800	<b>2M0</b> - 2000	<b>09M</b> - 512	<b>12M</b> - 4096
<b>M40</b> - 400	<b>1M0</b> - 1000		<b>10M</b> - 1024	<b>13M</b> - 8192
<b>M50</b> - 500	<b>1M6</b> - 1600		<b>11M</b> - 2048	

For **Vx**:

**10B** - 1,024 steps per revolution

### Special requirements

**00** - No special requirements (standard)  
**0M** - Cable length in meters

### Environment and material

**B** - IP64, Aluminium body (standard)  
**C** - IP68, Aluminium body  
**J** - IP68, Stainless steel body (for Body style 1 only)

### Body style and cable exit

**1** - Flanged body, radial cable exit  
**4** - Flanged body, axial cable exit

### Connector option

**A** - 'D' type connector - 9 way  
**F** - Flying lead (no connector)

### Cable length

**10** - 1 meter (or 10 meters if **0M** special requirement is chosen)

**NOTE:** Not all combinations are valid.

## Magnetic actuator ordering information

### Actuator for integration onto shaft



Shaft = Ø\*h7

Fixing: Grub screw provided

\* Hole diameter for nominal shaft size.

### Part numbers:

For resolutions of 9 bit absolute (512 cpr incremental)

**RMA04A2A00** - 4 mm dia shaft  
**RMA05A2A00** - 5 mm dia shaft  
**RMA06A2A00** - 6 mm dia shaft  
**RMA08A2A00** - 8 mm dia shaft

**RMA10A2A00** - 10 mm dia shaft  
**RMA19A2A00** - 3/16" dia shaft  
**RMA25A2A00** - 1/4" dia shaft  
**RMA37A2A00** - 3/8" dia shaft

For resolutions from 10 bit absolute (800 cpr incremental) and above

**RMA04A3A00** - 4 mm dia shaft  
**RMA05A3A00** - 5 mm dia shaft  
**RMA06A3A00** - 6 mm dia shaft  
**RMA08A3A00** - 8 mm dia shaft

**RMA10A3A00** - 10 mm dia shaft  
**RMA19A3A00** - 3/16" dia shaft  
**RMA25A3A00** - 1/4" dia shaft  
**RMA37A3A00** - 3/8" dia shaft

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## Document issues

Issue	Date	Page	Corrections made
1	13. 1. 2009	-	New layout
2	14. 2. 2017	2	Storage and handling, connections added
		3	Axial cable exit drawing added
		6	Linear voltage power consumption updated, Parallel output removed
		7	Parallel output and extended operating temperature range removed, magnetic actuator ordering info and special option 0M added
		General	Data sheet design updated
3	4. 7. 2018	4, 5	Resolution amended
4	2. 2. 2022	General	DC output added
5	19. 1. 2023	General	DC output wire color amended, revolution counter added

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