**□RLS**®

# RM22 rotary magnetic modular encoder

RoHS compliant Lead free

CE



**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

**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
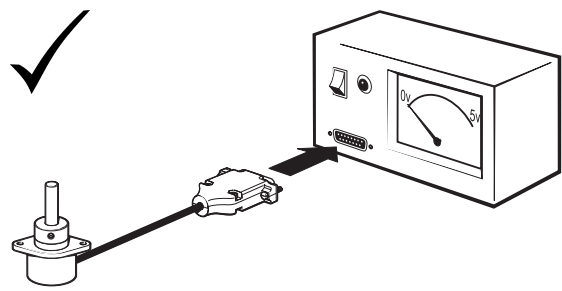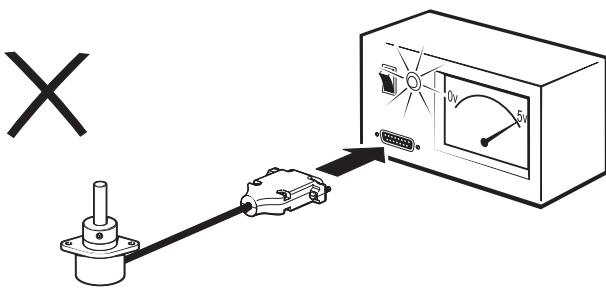
**RM22Vx**

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 ±0.5°**
- **Simple installation**
- **RoHS compliant (lead free) - see Declaration of conformity**

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## Storage and handling
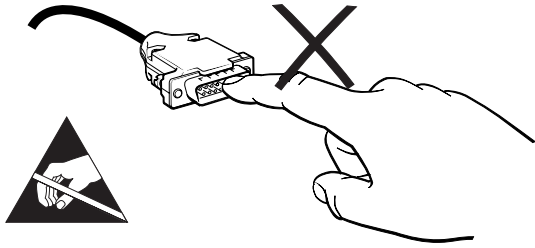


**IMPORTANT:** Power to RM22 encoders must be supplied from a DC SELV supply complying with the essential requirements of EN (IEC) 60950 or similar specification.

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
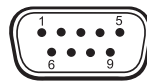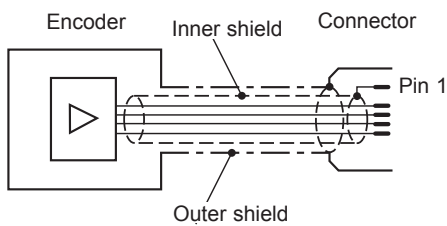


**D' type connector - 9 way**

| Pin nr. | RM22AC | | RM22BC | | RM22IC | | RM22SC | | RM22V | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | $V_A$ | Green | $V_{A+}$ | Green | Z | White | Clock | White | NC | – |
| 3 | $V_B$ | Brown | $V_{B+}$ | Brown | B | Green | Clock– | Brown | $V_{out}$ | Green |
| 4 | NC | – | NC | – | A | Grey | NC | – | NC | – |
| 5 | $V_{dd}$ | Red | $V_{dd}$ | Red | $V_{dd}$ | Red | $V_{dd}$ | Red | $V_{dd}$ | Red |
| 6 | NC | – | $V_{A-}$ | Yellow | Z– | Brown | Data | Green | NC | – |
| 7 | NC | – | $V_{B-}$ | White | B– | Yellow | Data– | Yellow | NC | – |
| 8 | NC | – | NC | – | A– | Pink | NC | – | NC | – |
| 9 | GND | Blue | GND | Blue | GND | Blue | GND | Blue | GND | Blue |

## Operating and electrical specifications

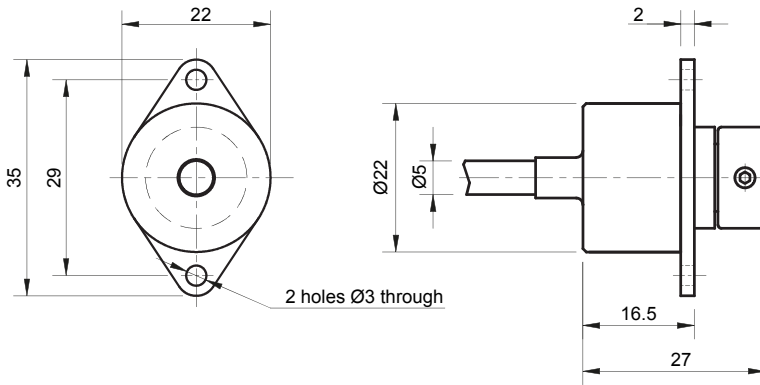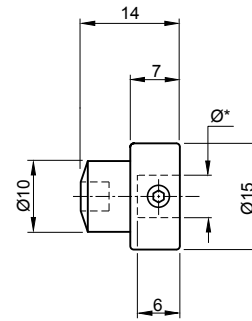| | |
|---|---|
| **EMC compliance** | EN 61326 |
| **Cable** | Outside diameter 5 mm |
| **Connector options** | 'D' type connector - 9 way<br>Flying lead |
| **Mass** | Encoder unit 1 m cable (no connector) 48 g. Magnetic actuator 12 g |
| **Environmental sealing** | IP64 (IP68 optional)    EN 60529 |

## Dimensions

Dimensions and tolerances in mm

**Radial cable exit**
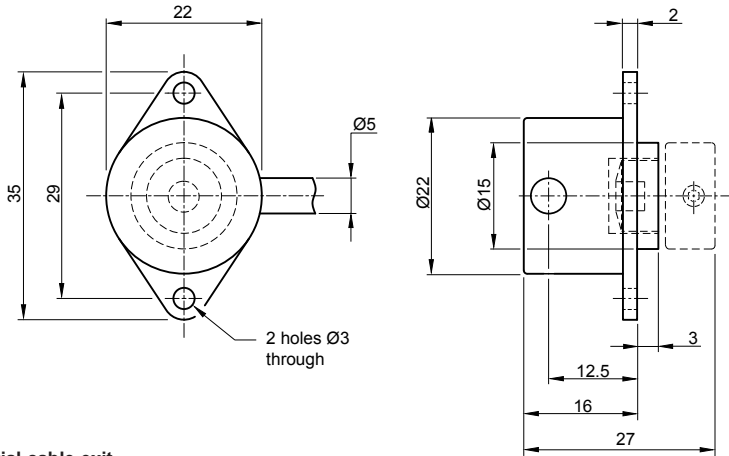
22
35
29
Ø5
2 holes Ø3 through

2
Ø22
Ø15
3
12.5
16
27

**Magnetic actuator**

14
7
Ø*
Ø10
Ø15
6

\* Hole diameter for nominal shaft size.

**Axial cable exit**

22
35
29
2 holes Ø3 through

2
Ø22
Ø5
16.5
27

Clockwise (CW) rotation of magnetic actuator.

## Installation drawing

Ø**
A
M3 × 4 grub screw
0.1 | A
0.5 | A
Ø15h7

Shaft
Min. 4.5 Max. 6
Magnetic actuator
1 ± 0.1
Magnet
Encoder

>R40 Static bend radius
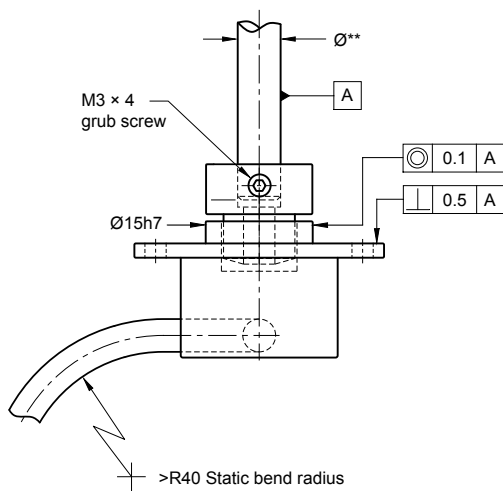
\*\* Nominal shaft size with tolerance h7.
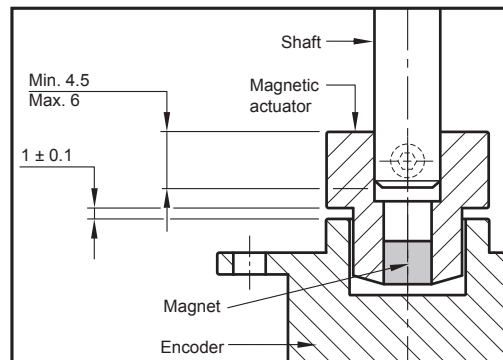
## RM22AC – Analogue sinusoidal outputs

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

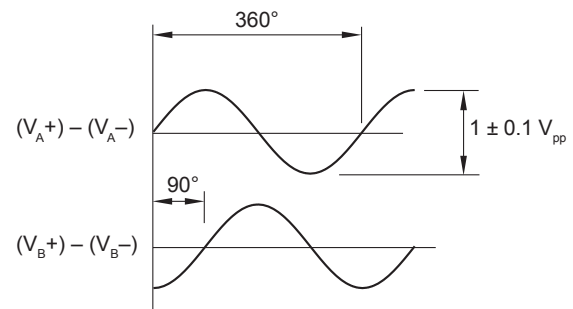| Power supply | $V_{dd}$ = 5 V ± 5 % |
|---|---|
| Power consumption | 20 mA |
| Outputs | Signal amplitude $\quad$ 2 ± 0.2 $V_{pp}$<br>Signal offset $\quad\frac{V_{dd}}{2}$ ± 5 mV |
| Maximum output frequency | 500 Hz |
| Maximum cable length | 3 m |
| Operating temperature | –40 °C to +125 °C (IP64)<br>–40 °C to +85 °C (IP68) |
| Maximum speed | 30,000 rpm |
| Internal serial impedance | 720 Ω |

**Timing diagram**
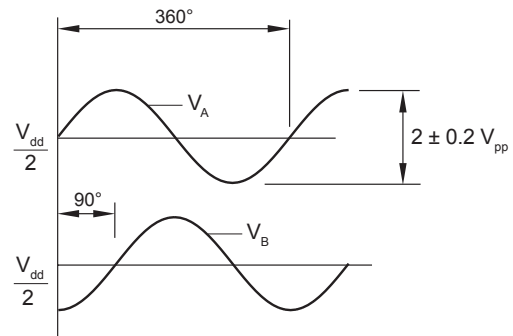


$V_A$ leads $V_B$ by 90° for clockwise rotation of magnetic actuator.

## RM22BC – Analogue complementary sinusoidal outputs

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

| Power supply | $V_{dd}$ = 5 V ± 5 % |
|---|---|
| Power consumption | 20 mA |
| Outputs | Signal amplitude $\quad$ 0.5 ± 0.1 $V_{pp}$<br>Signal offset $\quad\frac{V_{dd}}{2}$ ± 5 mV |
| Maximum output frequency | 500 Hz |
| Maximum cable length | 20 m |
| Operating temperature | –25 °C to +85 °C |
| Maximum speed | 30,000 rpm |
| Internal serial impedance | 100 Ω |

**Timing diagram**



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

## RM22IC – Incremental, RS422, 5 V

Square wave differential line driver to RS422

| Power supply | $V_{dd}$ = 5 V ± 5 % |
|---|---|
| Power consumption | Max. 35 mA |
| Output signals | A, B, Z, A–, B–, Z– (RS422) |
| Maximum cable length | 50 m |
| Operating temperature | –40 °C to +125 °C (IP64)<br>–40 °C to +85 °C (IP68) |
| Edge separation | Min. 1 µs |

| Resolution options<br>(counts per<br>revolution) | Maximum<br>speed (rpm) | Accuracy* | Hysteresis |
|---|---|---|---|
| 128, 256 | 60,000 | ±0.7° | 0.45° |
| 320, 400, 500, 512 | 30,000 | ±0.7° | 0.18° |
| 800, 1,000, 1,024 | 20,000 | ±0.5° | 0.18° |
| 1,600, 2,000, 2,048 | 10,000 | ±0.5° | 0.18° |
| 4,096 | 5,000 | ±0.5° | 0.18° |
| 8,192 | 2,500 | ±0.5° | 0.18° |

* Worst case within operational parameters including magnet position
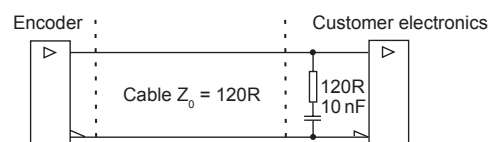and temperature.

**Timing diagram**

Complementary signals not shown
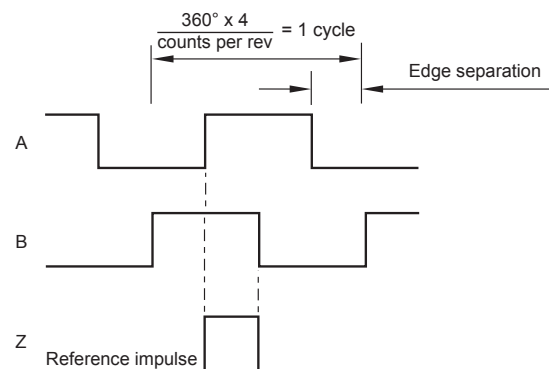


B leads A for clockwise rotation of magnetic actuator.

**Recommended signal termination**

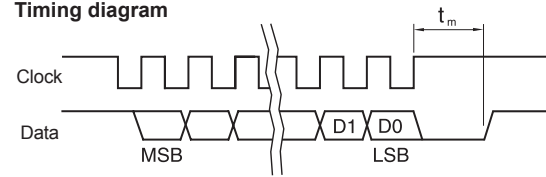## RM22SC – Absolute binary synchro-serial interface (SSI)

Serial encoded absolute position measurement

| | |
|---|---|
| **Output code** | Natural binary |
| **Power supply** | $V_{dd}$ = 5 V ± 5 % |
| **Power consumption** | Max. 35 mA |
| **Repeatability** | ≤ 0.07° |
| **Data output** | Serial data (RS422) |
| **Data input** | Clock (RS422) |
| **Maximum cable length** | 100 m (at 1 MHz) |
| **Operating temperature** | –40 °C to +125 °C (IP64)<br>–40 °C to +85 °C (IP68) |

| Resolution options<br>(counts per<br>revolution) | Maximum<br>speed (rpm) | Accuracy* | Hysteresis |
|---|---|---|---|
| 128, 256 | 60,000 | ±0.7° | 0.45° |
| 320, 400, 500, 512 | 30,000 | ±0.7° | 0.18° |
| 800, 1,000, 1,024 | 20,000 | ±0.5° | 0.18° |
| 1,600, 2,000, 2,048 | 10,000 | ±0.5° | 0.18° |
| 4,096 | 5,000 | ±0.5° | 0.18° |
| 8,192 | 2,500 | ±0.5° | 0.18° |

\* Worst case within operational parameters including magnet position and temperature.

**Timing diagram**



Clock ≤ 900 kHz    16 µs ≤ $t_m$ ≤ 22 µs  (for 9 bit resolution)
Clock ≤ 4 MHz      12.5 µs ≤ $t_m$ ≤ 20.5 µs  (for all other resolutions)

Position increases for clockwise rotation of magnetic actuator.

**Recommended signal termination**
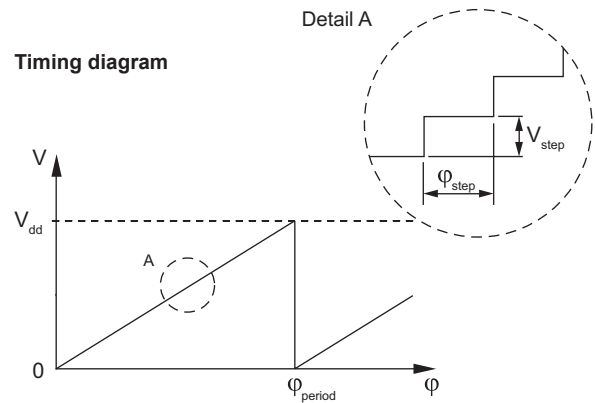
For data output lines only
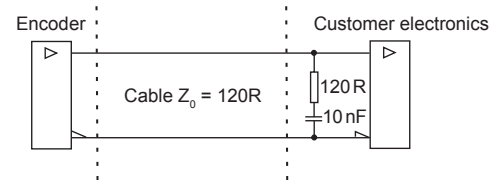
## RM22Vx – Linear voltage output

| Power supply | $V_{dd}$ = 5 V ± 5 % |
|---|---|
| Power consumption | 26 mA typical |
| Output voltage | 0 V to $V_{dd}$ |
| Output loading | Max. 10 mA |
| Nonlinearity | 1 % |
| Maximum cable length | 20 m |
| Temperature | –40 °C to +125 °C (IP64) <br> –40 °C to +85 °C (IP68) |
| Maximum speed | 30,000 rpm |

**Timing diagram**

Detail A



| $\varphi_{period}$ | $N_{period}$ | $N_{step}$ | $\varphi_{step}$ |
|---|---|---|---|
| **360°** | 1 | 1,024 | 0.35° |
| **180°** | 2 | 1,024 | 0.18° |
| **90°** | 4 | 1,024 | 0.09° |
| **45°** | 8 | 512 | 0.09° |

$$\varphi_{step} = \frac{\varphi_{period}}{N_{step}} \qquad V_{step} = \frac{V_{dd}}{N_{step}}$$

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

### Output type and electrical variant

| $\varphi_{period}$ <br> Rotation | 360° | 180° | 90° | 45° |
|---|---|---|---|---|
| **Clockwise** | VA | VB | VC | VD |
| **Counterclockwise** | 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 ($N_{period}$) can be 1, 2, 4 or 8, representing one full swing over an angle ($\varphi_{period}$) 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 ($\varphi_{step}$) and the resulting change in the output voltage ($V_{step}$). The number of steps in one period ($N_{step}$) is given in the table below.

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

# Ordering code

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$_{pp}$
**BC** - Analogue complementary sinusoidal
**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 **IC** and **SC** (counts or positions per revolution):

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

For **Vx**:
**10B** - 1024 counts or positions per revolution

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

**Environment**
**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 reqirement 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      **RMA10A2A00** - 10 mm dia shaft
**RMA05A2A00** - 5 mm dia shaft      **RMA19A2A00** - 3/16'' dia shaft
**RMA06A2A00** - 6 mm dia shaft      **RMA25A2A00** - 1/4'' dia shaft
**RMA08A2A00** - 8 mm dia shaft      **RMA37A2A00** - 3/8'' dia shaft

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

**RMA04A3A00** - 4 mm dia shaft      **RMA10A3A00** - 10 mm dia shaft
**RMA05A3A00** - 5 mm dia shaft      **RMA19A3A00** - 3/16'' dia shaft
**RMA06A3A00** - 6 mm dia shaft      **RMA25A3A00** - 1/4'' dia shaft
**RMA08A3A00** - 8 mm dia shaft      **RMA37A3A00** - 3/8'' dia shaft

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# RLS

## 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 |

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