Data sheet
RM44D01_08
Issue 8, 23rd March 2016

RM44 magnetic encoder base unit

The RM44 is an encoder designed for integration onto electric motors or other devices for shaft position and rotational speed measurement.

The solid metal housing helps achieve the highest IP ratings, high EMC immunity, extended operating temperature range and the best possible shock and vibration resistance.

Output signals are provided in industry standard absolute, incremental, analogue sinusoidal and linear voltage formats. Available are resolutions of up to 13 bit absolute SSI and/or 8,192 counts per revolution incremental for 5 V or 24 V power supply.

With the provided magnet a system accuracy of ±0.5° is achievable. A range of magnetic actuators for easy integration onto or into the shaft is also offered for easy system integration.

Product range

RM44AC
Analogue with a single sine/cosine cycle per revolution.

RM44I
Incremental with 80 to 2,048 pulses per revolution (320 to 8,192 counts per revolution with x 4 evaluation) and/or complementary analogue outputs with a single sine/cosine cycle per revolution.

RM44SC
Synchro serial interface (SSI) with 320 to 8,192 positions per revolution.

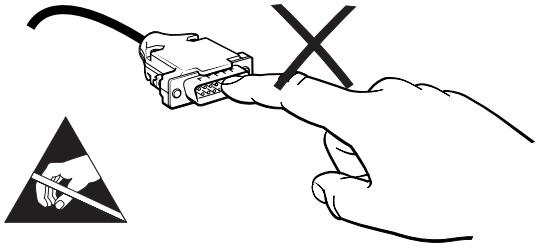
RM44SI
Synchro serial interface (SSI) with 320 to 8,192 positions per revolution and incremental with 80 to 2,048 pulses per revolution (320 to 8,192 counts per revolution with x 4 evaluation).

RM44Vx
Linear voltage output in a range of variants.

RM44Ux
UVW and incremental outputs for commutation of BLDC motors.

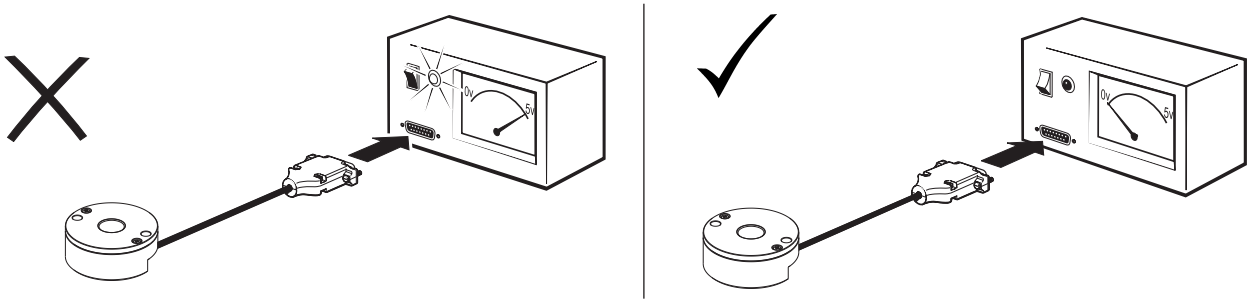
- **Easy to install – with self locating design**
- **Low cost for OEM integration**
- **Fully sealed to IP68**
- **High reliability from proven non-contact sensing technology**
- **RoHS compliant (lead free)**

Storage and handling

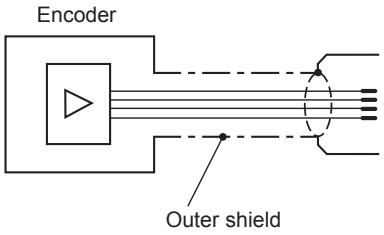


IMPORTANT: Power to RM44 encoders must be supplied from a DC SELV supply complying with the essential requirements of EN (IEC) 60950 or similar specification.

The RM44 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

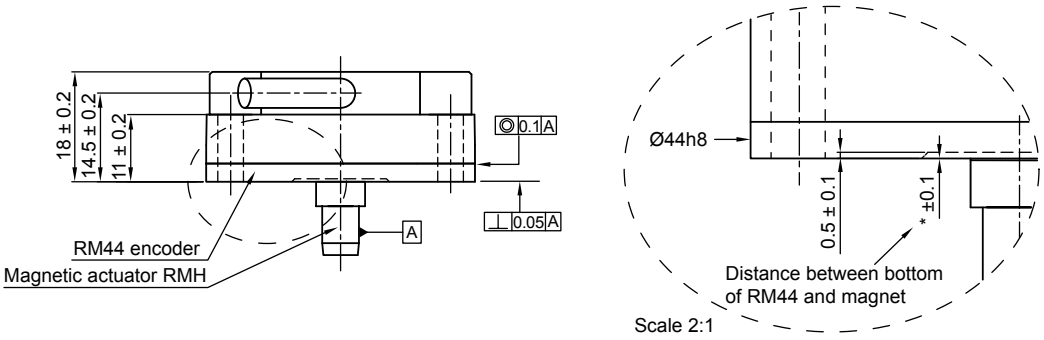


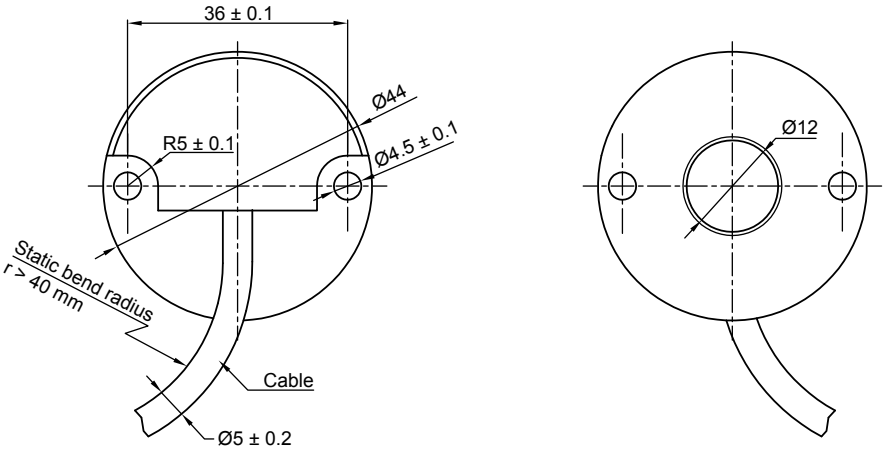
RM44AC		RM44I		RM44SC		RM44SI		RM44Vx		RM44Ux	
Function	**Wire colour**	**Function**	**Wire colour**	**Function**	**Wire colour**	**Function**	**Wire colour**	**Function**	**Wire colour**	**Function**	**Wire colour**
Shield - see connection diagram				Shield - see connection diagram				Shield - see connection diagram			
V_{dd}	Red	V_{dd}	Red	V_{dd}	Red	V_{dd}	Red	V_{dd}	Red	V_{dd}	Red
GND	Orange	GND	Blue	GND	Blue	GND	Blue	GND	Orange	GND	Blue
V_A	Black	A+	Grey	Clock+	White	A+	Grey	V_{out}	Black	A+	Grey
V_B	Brown	B+	Green	Data+	Green	B+	Green			B+	Green
		Z+	White	Clock–	Brown	Z+	White			Z+	White
		A–	Pink	Data–	Yellow	A–	Pink			A–	Pink
		B–	Yellow			B–	Yellow			B–	Yellow
		Z–	Brown			Z–	Brown			Z–	Brown
						Clock+	Black			U	Black
						Data+	Grey/Pink			V	Blue
						Clock–	Violet			W	Grey/Pink
						Data–	Red/Blue				

Operating and electrical specifications

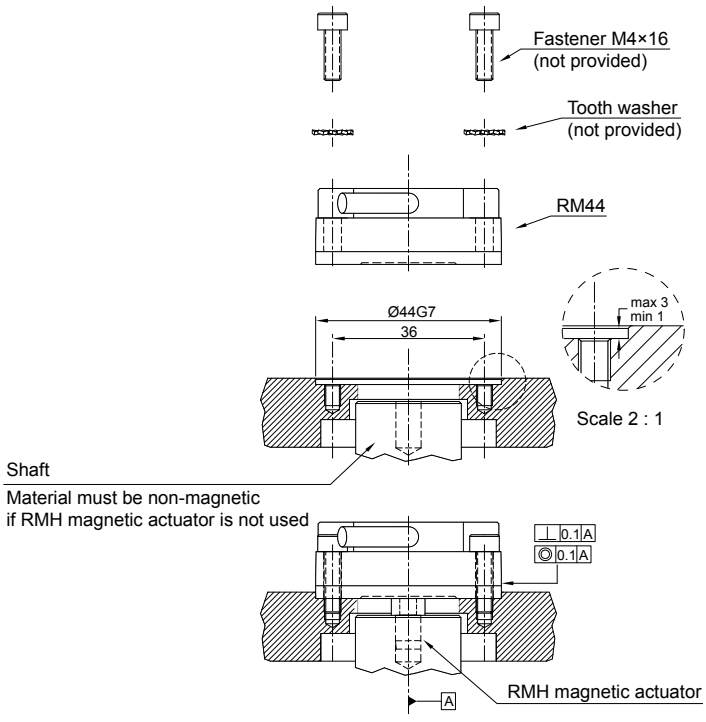
EMC compliance	EN 61326
Cable	Outside diameter 5 mm
Mass	Encoder unit 1 m cable (no connector) IP64 112 g, IP68 129 g. Magnetic actuator <2 g
Environmental sealing	IP64 (IP68 optional) EN 60529

Dimensions
Dimensions and tolerances in mm

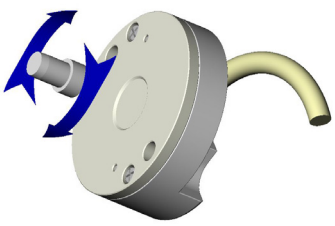




Installation drawing
Dimensions and tolerances in mm



Clockwise (CW) rotation of magnetic actuator



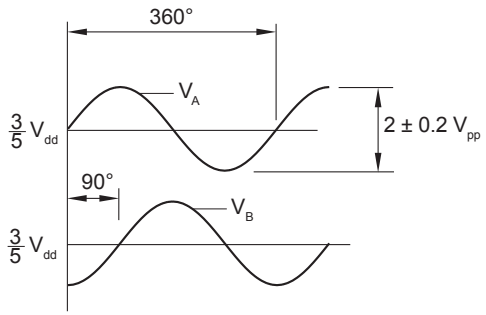
Output specifications – 5 V supply

RM44AC – Analogue sinusoidal outputs, 5 V

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

Power supply	V_{dd} = 5 V ± 5 %
Power consumption	13 mA
Outputs	Signal amplitude $2 \pm 0.2\ V_{pp}$ Signal offset $\frac{3}{5} V_{dd} \pm 5$ mV
Maximum output frequency	1 kHz
Maximum cable length	3 m
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)
Maximum speed	60,000 rpm
Internal serial impedance	720 Ω

Timing diagram



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

RM44IE – Incremental, open collector, 5 V

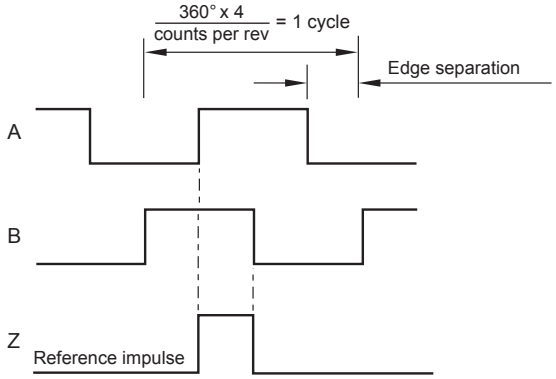
Low cost alternative for ball bearing encoders

Power supply	V_{dd} = 5 V ± 5 %
Power consumption (not loaded)	35 mA
Maximum output load	20 mA
Output signals	A, B, Z
Maximum cable length	20 m
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

Resolution options (cpr)	Maximum speed (rpm)	Accuracy*	Hysteresis
128, 256	30,000	±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°

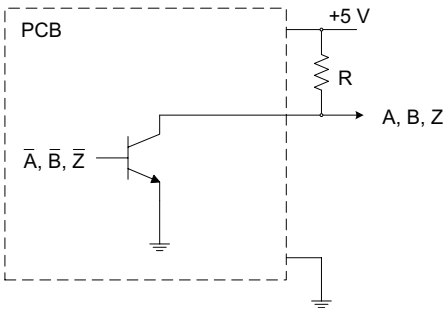
* Worst case within operational parameters including magnet position and temperature.

Timing diagram



B leads A for clockwise rotation of magnetic actuator.

Recommended signal termination



RM44IC – Incremental, RS422, 5 V

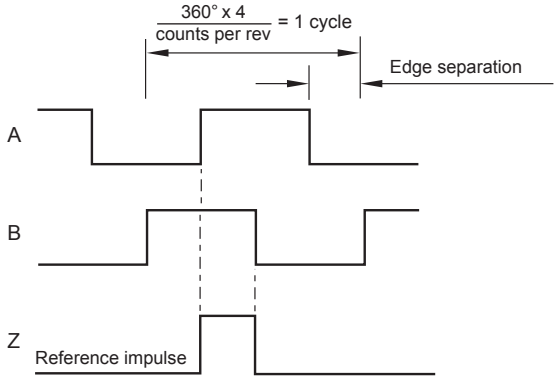
Alternative for optical encoders

Power supply	V_{dd} = 5 V ± 5 %
Power consumption	35 mA for all other resolutions
Output signals	A, B, Z, A–, B–, Z– (RS422)
Maximum cable length	50 m
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

Resolution options (cpr)	Maximum speed (rpm)	Accuracy*	Hysteresis
128, 256	30,000	±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°

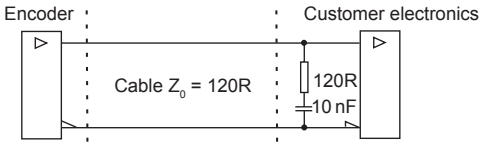
* Worst case within operational parameters including magnet position and temperature.

Timing diagram
Complementary signals not shown



B leads A for clockwise rotation of magnetic actuator.

Recommended signal termination



RM44SC – Absolute binary synchro-serial (SSI), RS422, 5 V

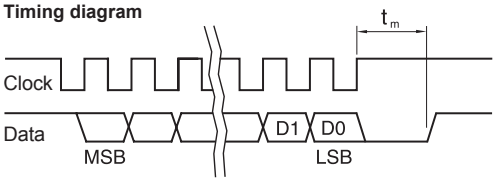
Alternative for optical encoders

Power supply	V_{dd} = 5 V ± 5 %
Power consumption	35 mA for all other resolutions
SSI output code	Natural binary
Data output	Serial data (RS422)
Data input	Clock (RS422)
Repeatability	≤0.07°
Maximum cable length	100 m (at 1 MHz)
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

Resolution options (ppr)	Maximum speed (rpm)	Accuracy*	Hysteresis
256	30,000	±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.

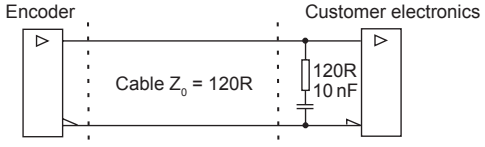
Timing diagram



Clock ≤ 1 MHz 16 µs ≤ t_m ≤ 22 µs (for 8 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

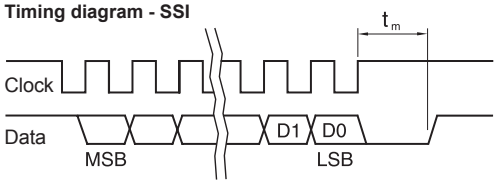


RM44SI – Absolute binary synchro-serial (SSI) + Incremental, RS422, 5 V

Complex feedback device for absolute position at start up as well as during operation + incremental outputs.
Both the incremental and the SSI output always have the same fixed resolution.

Power supply	V_{dd} = 5 V ± 5 %
Power consumption	35 mA
SSI output code	Natural binary
Data output	Serial data (RS422)
Data input	Clock (RS422)
Incremental outputs	A, B, Z, A–, B–, Z– (RS422)
Maximum cable length	50 m
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

Timing diagram - SSI



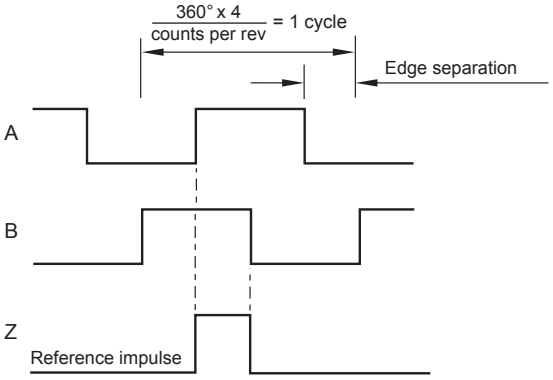
Clock ≤ 4 MHz 12.5 µs ≤ t_m ≤ 20.5 µs

Position increases for clockwise rotation of magnetic actuator.

Resolution options (ppr/cpr)	Maximum speed (rpm)	Accuracy*	Hysteresis
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.

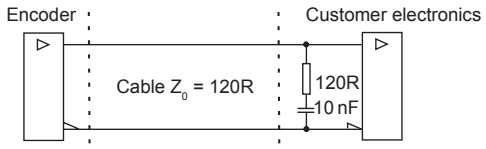
Timing diagram - Incremental
Complementary signals not shown



B leads A for clockwise rotation of magnetic actuator.

Recommended signal termination

For incremental signals + SSI data output lines only



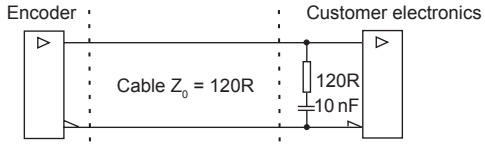
RM44Ux – Commutation single ended + incremental with line driver

Encoder PCB for direct motor assembly

Power supply	V_{dd} = 5 V ± 5 %
Power consumption	30 mA (not loaded)
Maximum speed	30,000 rpm
Accuracy	±0.5°
Incremental outputs	A+, B+, Z+, A–, B–, Z– (RS422)
Incremental resolution	256, 512, 1,024, 12,048, 4,096 cpr
Commutation outputs	U, V, W (±24 mA output drive)
Number of poles for commutation outputs	2, 4, 6, 8, 10, 12, 14, 16
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

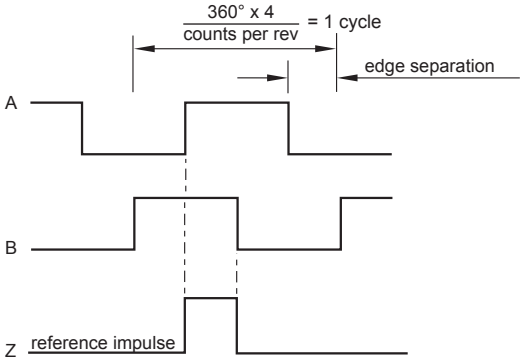
Recommended signal termination

For complementary signals only

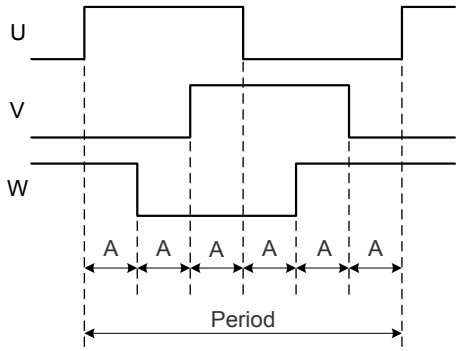


Timing diagram - Incremental

Complementary signals not shown



Timing diagram - Commutation



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.

RM44Vx – Linear voltage output, 5 V

Alternative for potentiometers

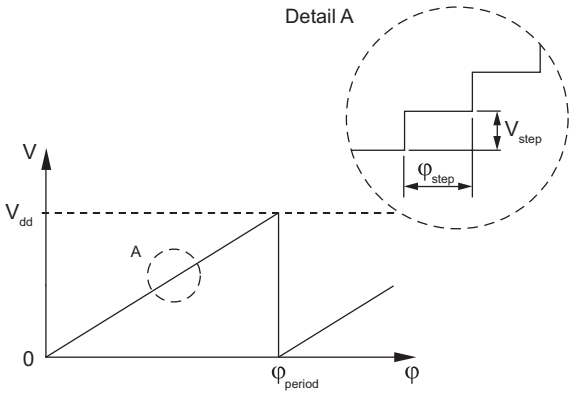
Power supply	V_{dd} = 5 V ± 5 %
Power consumption	26 mA (not loaded)
Output voltage	0 V to V_{dd}
Output loading	Max. 10 mA
Nonlinearity	1 %
Maximum cable length	20 m
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)
Maximum speed	30,000 rpm

φ_{period}	N_{period}	N_{step}	φ_{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

φ_{period} / **Rotation**	**360°**	**180°**	**90°**	**45°**
Clockwise	VA	VB	VC	VD
Counterclockwise	VE	VF	VG	VH

Timing diagram



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

φ_{period} = Angle covered in one period (one sawtooth)
V_{period} = Output voltage range for one period
φ_{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 specifications – 24 V supply

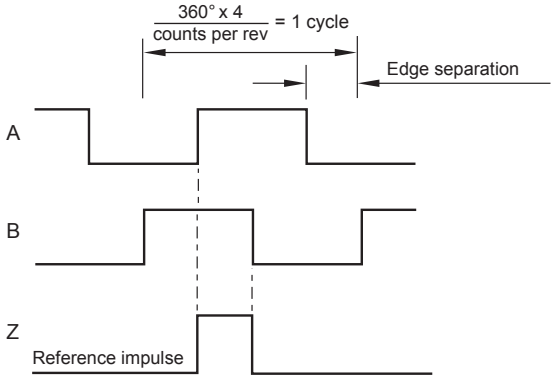
RM44IA – Incremental, push-pull, 24 V

Power supply	V_{dd} = 8 V to 26 V
Power consumption	50 mA (at 24 V)
Maximum output load	30 mA
Output signals	A, B, Z, A–, B–, Z– (RS422)
Maximum cable length	20 m
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

Resolution options (cpr)	Maximum speed (rpm)	Accuracy*	Hysteresis
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.

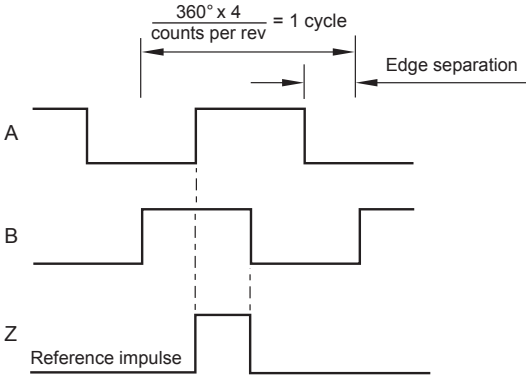
RM44IB – Incremental, open collector NPN, 24 V
Square wave output

Power supply	V_{dd} = 8 V to 26 V
Power consumption	50 mA (at 24 V)
Maximum output load	20 mA
Output signals	A, B, Z
Maximum cable length	20 m
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

Resolution options (cpr)	Maximum speed (rpm)	Accuracy	Hysteresis
128, 256	30,000	±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°

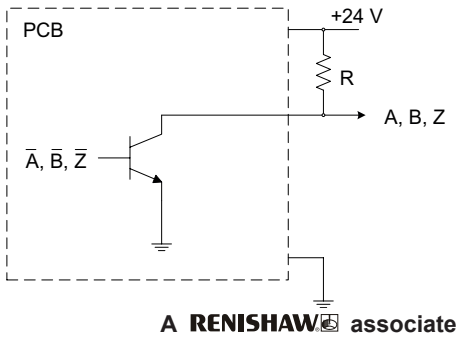
Worst case within operational parameters including magnet position and temperature.

Timing diagram



B leads A for clockwise rotation of magnetic actuator.

Recommended signal termination



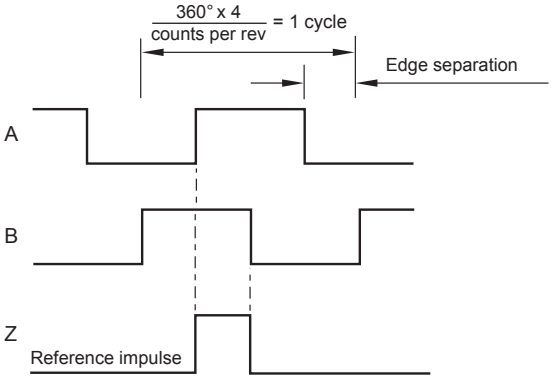
RM44IG – Incremental, RS422 (5 V), 24 V power supply

Power supply	V_{dd} = 8 V to 26 V
Power consumption (at 24 V)	50 mA
Max. output load	20 mA
Output signals	A, B, Z, A–, B–, Z– (RS422)
Max. cable length	20 m (5 V)
Operating temperature	–40 °C to +125 °C (IP64) –40 °C to +85 °C (IP68)

Resolution options (cpr)	Maximum speed (rpm)	Accuracy	Hysteresis
128, 256	30,000	±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.

Ordering code

Encoder system = Encoder body + Magnetic actuator or flange

RM44 encoder-sensor unit
eg. **RM44IC0013B10F2E10**

Magnetic actuator
eg **RMA06A3A00**

Flange
eg **RE58A10**

RM44 IC 00 13B 10 F 2 E 10

Special requirements
10 - No special requirements (standard)
1M - Cable length in meters

Environment and material
E - IP64, die-cast body (Zinc alloy), standard EMC grade (standard)
F - IP68, die-cast body (Zinc alloy), standard EMC grade

Body style and cable exit
2 - Cylindrical body, radial cable exit

Connector options
F - Flying lead (no connector)

Cable length
10 - 1.0 meter (or 10 meters if **1M** special requirement is chosen)

Resolution
For **AC:**
01S - One sine/cosine period per revolution
For output types **IA**, **IB**, **IC**, **IE**, **IG**, **SC** and **SI**:

Decimal			Binary		
D32 - 320	**D80** - 800	**2D0** - 2000	**07B** - 128	**10B** - 1024	**13B** - 8192
D40 - 400	**1D0** - 1000		**08B** - 256	**11B** - 2048	
D50 - 500	**1D6** - 1600		**09B** - 512	**12B** - 4096	

For **Ux** (counts/positions per revolution):

08B - 256	**11B** - 2048
09B - 512	**12B** - 4096
10B - 1024	

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

Output type
AC - Analogue sinusoidal, 5 V
IA - Incremental, push pull, 24 V
IB - Incremental, open collector NPN, 24 V
IC - Incremental, RS422, 5 V
IE - Incremental, open collector, 5 V
IG - Incremental, RS422, 5 V, supply 24 V
SC - Absolute binary synchro-serial (SSI), RS422, 5 V
SI - SSI + Incremental, RS422, 5 V
Ux - Commutation single ended + incremental with line driver

Code	Description	Nr. of poles
UA	one (1) period per revolution	2
UB	two (2) periods per revolution	4
UC	three (3) periods per revolution	6
UD	four (4) periods per revolution	8
UE	five (5) periods per revolution	10
UF	six (6) periods per revolution	12
UG	seven (7) periods per revolution	14
UH	eight (8) periods per revolution	16

Vx - Linear voltage:

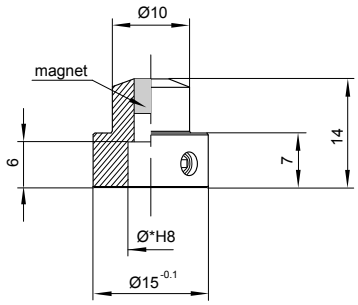
Linear voltage output 0 - 5 V, supply 5 V DC				
	360°	180°	90°	45°
CW	**VA**	**VB**	**VC**	**VD**
CCW	**VE**	**VF**	**VG**	**VH**

Shaft size
00 - n/a

NOTE: Not all combinations are valid.

Magnetic actuators and magnets

Actuator for integration onto shaft



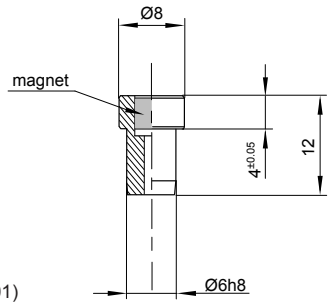
Shaft = Ø*h7
Fixing: Grub screw provided

Part numbers:

For resolutions up to 9 bit absolute (512 cpr incremental)
RMA04A2A00 – Ø4 mm shaft **RMA10A2A00** – Ø10 mm shaft
RMA05A2A00 – Ø5 mm shaft **RMA19A2A00** – Ø3/16" shaft
RMA06A2A00 – Ø6 mm shaft **RMA25A2A00** – Ø1/4" shaft
RMA08A2A00 – Ø8 mm shaft **RMA37A2A00** – Ø3/8" shaft

For resolutions from 10 bit absolute (800 cpr incremental) and above
RMA04A3A00 – Ø4 mm shaft **RMA10A3A00** – Ø10 mm shaft
RMA05A3A00 – Ø5 mm shaft **RMA19A3A00** – Ø3/16" shaft
RMA06A3A00 – Ø6 mm shaft **RMA25A3A00** – Ø1/4" shaft
RMA08A3A00 – Ø8 mm shaft **RMA37A3A00** – Ø3/8" shaft

Actuator for integration into shaft



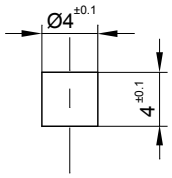
Hole = Ø6G7
Fixing: Glue (recommended – LOCTITE 648 or LOCTITE 2701)

Part numbers:

For resolutions up to 9 bit absolute (512 cpr incremental)
RMH06A2A00

For resolutions from 10 bit absolute (800 cpr incremental) and above
RMH06A3A00

Magnet for direct recessing in non-ferrous shafts



Fixing: Glue (recommended – LOCTITE 648 or LOCTITE 2701)

Part numbers:

For resolutions up to 9 bit absolute (512 cpr incremental)
RMM44A2A00 (individually packed) – for sample quantities only
RMM44A2C00 (packed in tubes)

For resolutions from 10 bit absolute (800 cpr incremental) and above
RMM44A3A00 (individually packed) – for sample quantities only
RMM44A3C00 (packed in tubes)

RE58 flange part numbering

Refer to RE58 datasheet for further details.

Part numbers:

RE58A10 - Ø58 mm, 10 mm shaft

RE58B06 - Ø58 mm, 6 mm shaft

RE58C10 - Ø58 mm, 10 mm shaft

All RE58 flanges are supplied with required washer and M4 fasteners for RM44 encoder attachment.

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Document issues

Issue	Date	Page	Amendments done
2	26. 2. 2008	-	New layout with new images, outputs **V** and **IB**, SSI clock, vibration shock test
3	14. 1. 2009	-	New layout
4	24. 11. 2010	-	New magnet dimensions and RE58 flange images, extended operating temperature range description and RM44AC timing diagram changed
5	14. 8. 2015	2	Storage and handling added
		3	Installation drawing tolerance amended
		4–9	New resolution options added to outputs **IB** and **IE**, **IG** output added, option **18** removed
		10	Loctite information updated
6	2. 11. 2015	3	Dimension picture updated
7	20. 1. 2016	2	Descriptions for RM44SC and RM44SI corrected
		5	Power consumpiton for IC and SC /7 and 8 bit) deleted
		9	Environment and material E and F description updated
8	23. 3. 2016	2, 7, 10	Ux output added