Data sheet
L-9517-9713-01-E

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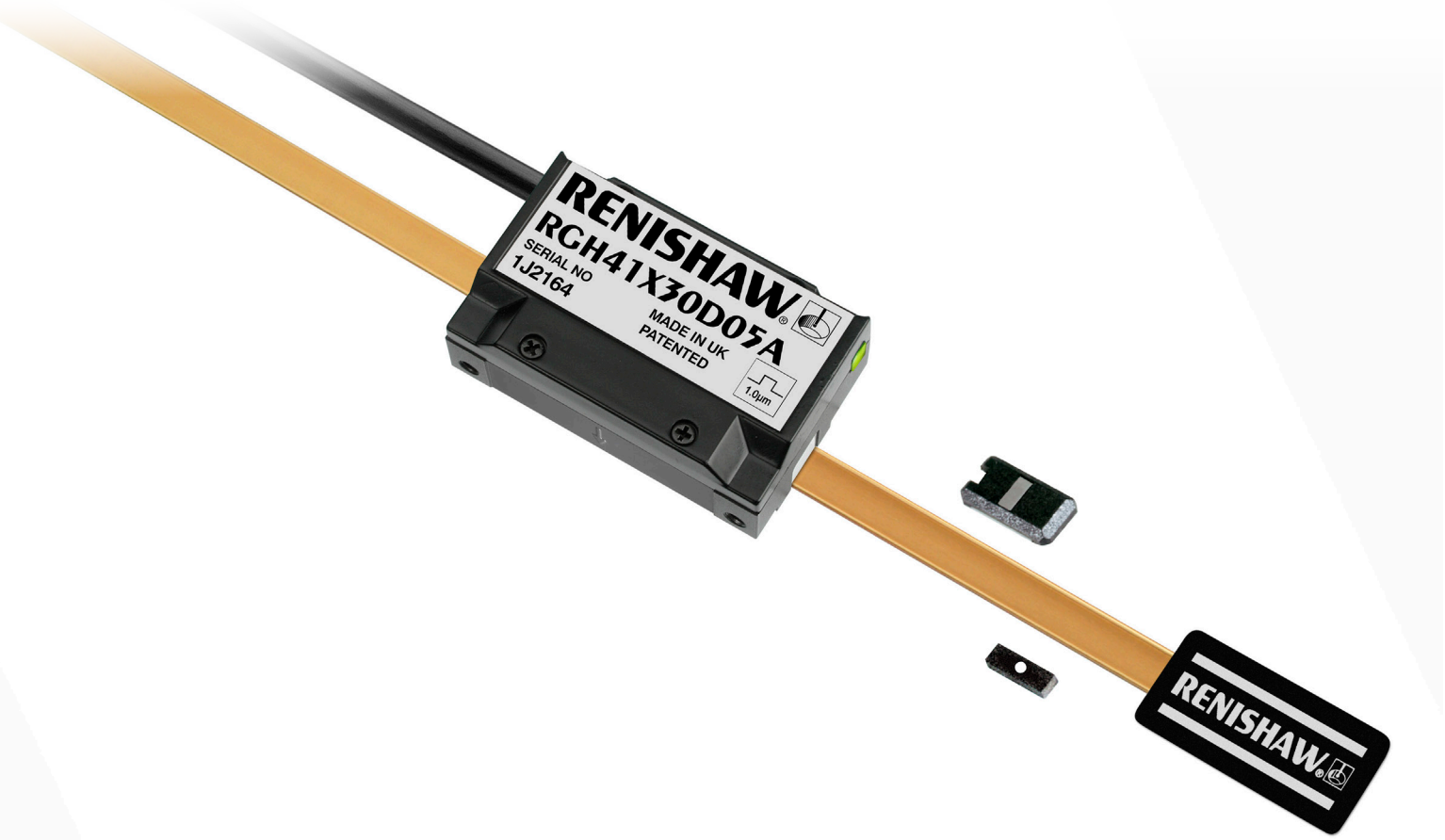
RGH41 encoder system



The Renishaw RGH41 series is a non-contact optical encoder system, providing highly-reliable positional feedback.

The readhead offers the benefits of Renishaw's established encoder series, such as a set-up LED indicator for easy installation, and unique filtering optics for excellent dirt immunity. In addition to these popular features, the RGH41 adds higher speeds for improved productivity, and improved setup tolerances.

The RGH41 reads the 40 µm pitch RGS40-S gold tape-scale and outputs a choice of industry standard 1 Vpp analogue or RS422 digital signals with a wide range of resolutions. RGS40-S is suitable for mounting to most common engineering materials including metals, granites, ceramics and composites. The scale can be mastered to the axis substrate by means of specially formulated pre-applied adhesive and epoxy fastened 'end clamps'. This method ensures the differential movement between the scale and the substrate is close to zero, even with significant temperature swings.

The flexibility of the RGH41 system enables its application in a wide spectrum of industries, from co-ordinate measuring and layout machines to electronics assembly and test, linear motors and a host of custom linear motor solutions.

RGH41 readhead

- Non-contact open optical system
- Integral interpolation
- Industry standard digital and analogue options
- Resolutions from 10 µm to 50 nm
- Integral reference and limit sensors
- Integral set-up LED

RGS40-S scale

- 'Cut-to-length' convenience
- Lengths from 100 mm to over 50 m
- Efficient, accurate installation
- Affixes to most common engineering materials
- Self-adhesive backing tape
- Applicator tool allows scale to be installed using the motion of the axis

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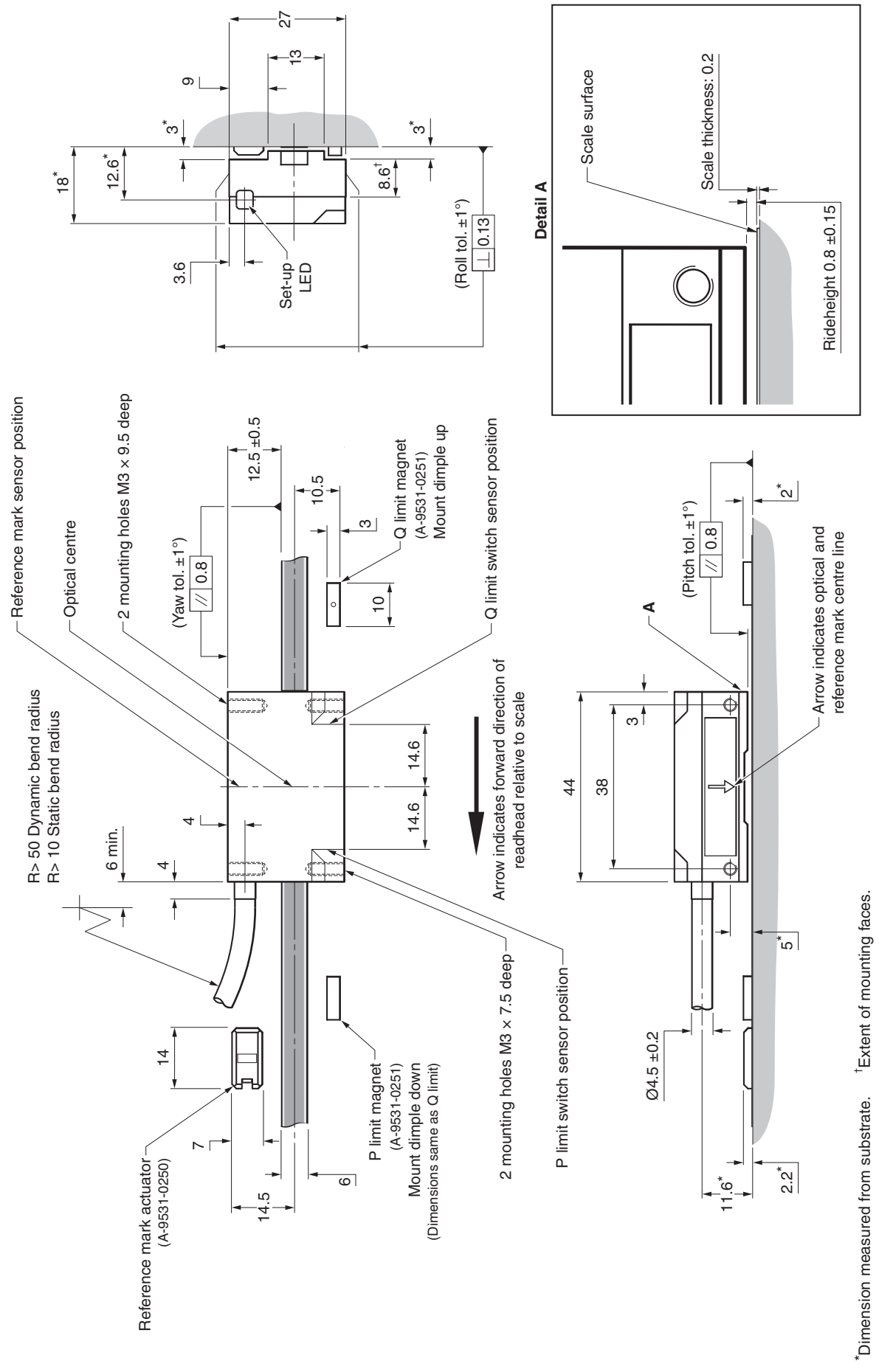
RGH41 readhead installation drawing

Dimensions and tolerances in mm



General specifications

Power supply	5 V ± 5%	RGH41A < 140 mA RGH41B < 120 mA RGH41T, D, G, X < 95 mA RGH41N, W, Y, H < 150 mA **NOTE:** Current consumption figures refer to unterminated readheads. For digital outputs a further 35 mA per channel pair (e.g. A+, A–) will be drawn when terminated with 120 Ω. For analogue outputs a further 20 mA will be drawn when terminated with 120 Ω. Power from a 5 V dc supply complying with the requirements for SELV of standard IEC BS EN 60950-1.
	Ripple	200 mVpp@frequency up to 500 kHz maximum.
Temperature	Storage	–20 °C to +70 °C
	Operating	0 °C to +55 °C
Humidity		95% relative humidity (non-condensing) to EN 60068-2-78
Sealing		IP50
Acceleration	Operating	500 m/s², 3 axes
Shock	Non-operating	1000 m/s², 6 ms, ½ sine, 3 axes
Vibration	Operating	100 m/s² max @ 55 Hz to 2000 Hz, 3 axes
Mass	Readhead	50 g
	Cable	38 g/m
Cable		12 core, double shielded, outside diameter 4.5 ±0.2 mm. Flex life > 20 × 10⁶ cycles at 50 mm bend radius.

Connector options	**Code**	**Connector type**	**Application**
	D	15-way D-type plug	RGH41T, D, G, X, N, W, Y, and H
	L	15-way D-type plug	RGH41A and B
	V	12-way circular plug	RGH41A and B
	W	12-way circular coupling	RGH41A and B
	F	unterminated cable	All readheads
	X	16-way in-line connector	All readheads

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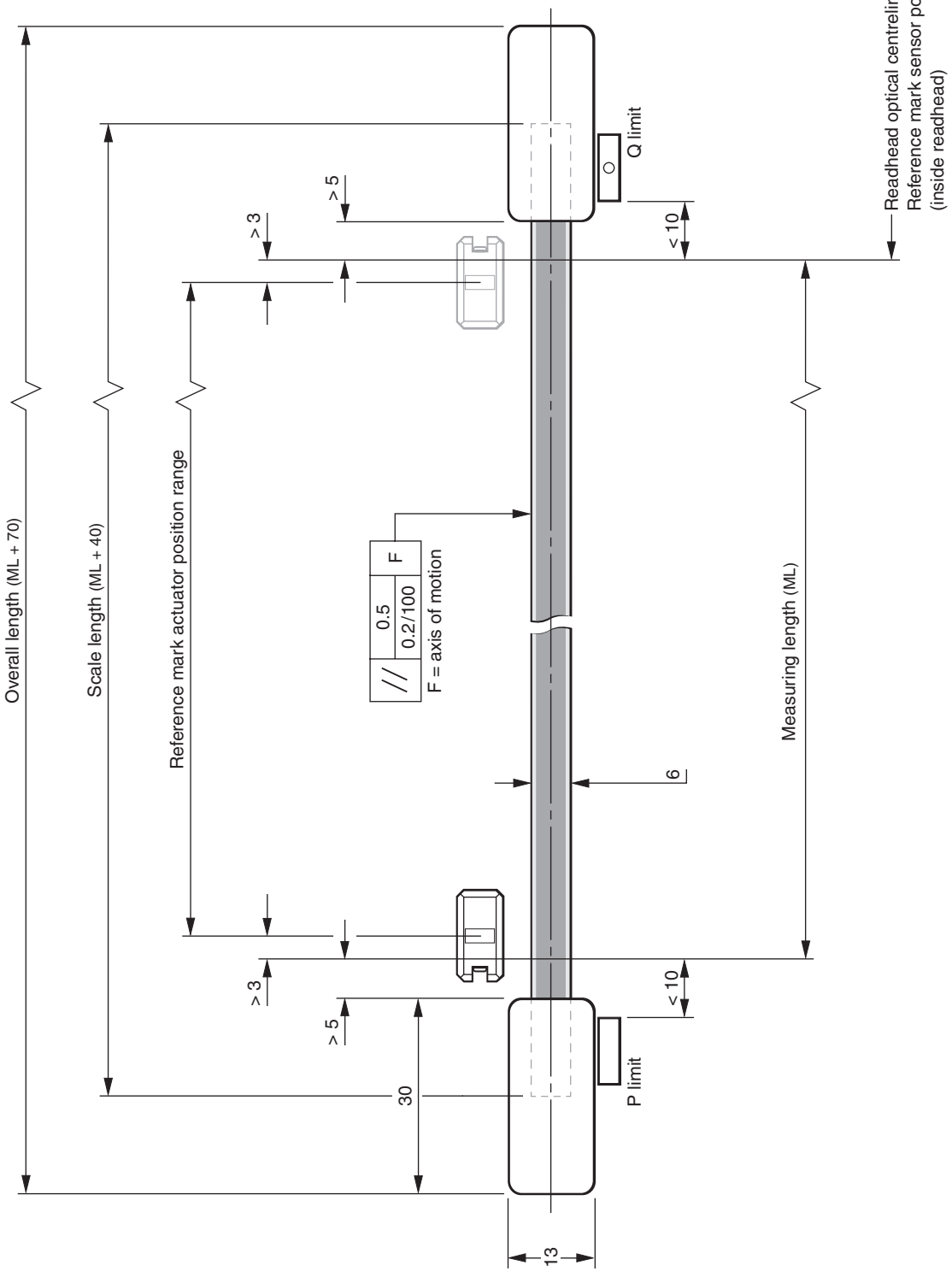
RGS40 scale installation drawing

Dimensions and tolerances in mm



NOTE: The surface roughness of the scale mounting surface must be ≤ 3.2 Ra. The parallelism of the scale surface to the axis of motion (readhead rideheight variation) must be within 0.05 mm.

Scale specifications

Scale type		Reflective gold plated steel tape with protective lacquer coating. Adhesive backing tape allows direct mounting to the machine substrate.
Scale period		40 µm
Linearity		±3 µm/m
Scale length		Up to 50 m (> 50 m by special order)
Form (H × W)		0.2 mm × 6 mm (includes adhesive)
Substrate materials		Metals, ceramics and composites with expansion coefficients between 0 and 22 µm/m/°C (steel, aluminium, Invar, granite, ceramic etc.)
Coefficient of thermal expansion		Matches that of substrate material when scale ends are fixed by epoxy mounted end clamps
End fixing		Epoxy mounted end clamps (A-9523-4015) using 2 part epoxy adhesive (A-9531-0342). Scale end movement typically < 1 µm up to +40 °C.
Temperature	Operating	–10 °C to +120 °C
	Minimum installation	10 °C
	Storage	–20 °C to +70 °C
Humidity		95% relative humidity (non-condensing) to EN 60068-2-78

Speed performance

Digital readheads

Non-clocked output readheads

Head type	Maximum speed (m/s)	Lowest recommended counter input frequency (MHz)
T (10 µm)	15	$\left(\frac{\text{Encoder velocity (m/s)}}{\text{Resolution (µm)}}\right) \times 4$ safety factor
D (5 µm)	12	
G (2 µm)	10	
X (1 µm)	6	

Clocked output readheads

The RGH41N, W, Y, H readheads are available with a variety of different clocked outputs.
Customers must ensure they comply with the lowest recommended counter input frequency.

Options	Maximum speed (m/s)				Lowest recommended counter input frequency (MHz)
	Head type				
	N (0.4 µm)	**W** (0.2 µm)	**Y** (0.1 µm)	**H** (50 nm)	
61	3	2.5	1.3	0.6	20
62	2.6	1.3	0.7	0.3	10
63	1.3	0.7	0.35	0.15	5

Analogue readheads

RGH41A and B - 8 m/s (–3dB)

Output signals

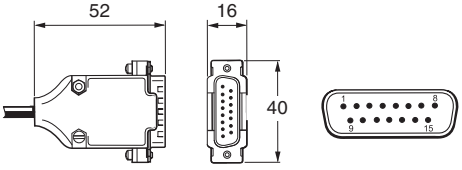
Connections

Digital RS422A outputs - RGH41T, D, G, X, N, W, Y and H

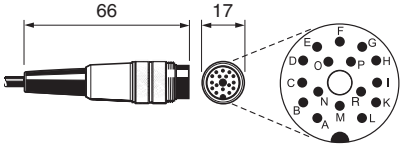
Function	Signal		Colour	15-way D-type plug (D)	16-way in-line connector (X)
Power	5 V		Brown	7	A
			Brown (link)	8	M
	0 V		White	2	B
			White (link)	9	N
Incremental signals	A	+	Green	14	G
		–	Yellow	6	D
	B	+	Blue	13	R
		–	Red	5	F
Reference mark	Z	+	Violet	12	K
		–	Grey	4	O
Limit switch	Q		Pink	10	H
Alarm / limit*	E+/P		Black	11	I
Alarm	E–		Orange	3	P
External set-up	X		Clear	1	E
Shield	Inner		Green / Yellow	15	L
	Outer		–	Case	Case

*Options 05/06 (dual limit) utilise the black wire for limit switch function 'P'.
Options 03/04 (single limit) utilise the blackwire for alarm function 'E+'. Please select the preferred option at time of ordering.

15-way D-type plug (termination code D)



In-line connector plug (termination code X)



Connections

Analogue 1 Vpp outputs - RGH41A and B

Function	Signal		Colour	15-way D-type plug (L)	12-way circular (V)	12-way circular coupling (W)	16-way in-line connector (X)
Power	5 V		Brown	4	2	2	A
			Brown (link)	5	12	12	M
	0 V		White	12	10	10	B
			White (link)	13	11	11	N
Incremental signals	V_1	+	Red	9	5	5	F
		–	Blue	1	6	6	R
	V_2	+	Yellow	10	8	8	D
		–	Green	2	1	1	G
Reference mark	V_0	+	Violet	3	3	3	K
		–	Grey	11	4	4	O
Limit switch	V_q		Pink	8	N/C	N/C	H
Dual limit / external set-up*	V_p / V_x		Clear	7	N/C	N/C	E
BID DIR connections‡	BID		Black	6	9†	9††	I
	DIR		Orange	14	7†	7††	P
Shield	Inner		Green / Yellow	15	11 (link)	11 (link)	L
	Outer		–	Case	Case	Case	Case

*Dual limit versions (RGH41A) utilise the clear wire for limit switch function 'V_p'.
Single limit versions (RGH41B) utilise the clear wire for external set-up function 'V_x'. Please select the preferred readhead version at time of ordering.
†Only connected with option 17 ††Only connected with option 18

‡Reference mark uni-directional operation

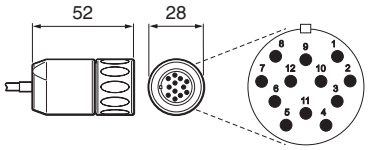
The RGH41 reference mark output is repeatable for one direction of travel only. Certain controllers will flag an error when they detect different reference mark positions in the forward and reverse directions.
BID / DIR pins allow the readhead to be configured to ignore the reference pulse output in one unphased direction (see installation guide for more information on reference mark set-up).

BID / DIR connections

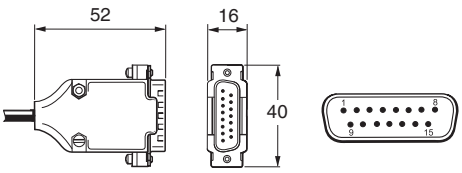
BID / DIR connection For bi-directional operation (normal)	To:-	Reference mark output direction
BID	+5 V or not connected	Forward **and** reverse
DIR	Do not connect	

BID / DIR connection For uni-directional operation	To:-	Reference mark output direction
BID	0 V	
DIR	+5 V or not connected	Forward **only**
DIR	0 V	Reverse **only**

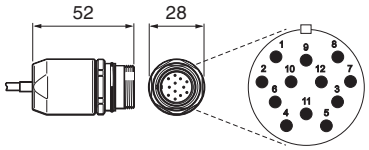
12-way circular plug (termination code V)



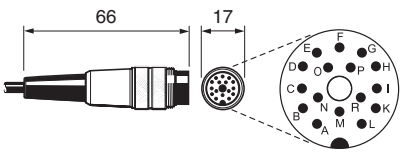
15-way D-type plug (termination code L)



12-way circular coupling (termination code W)

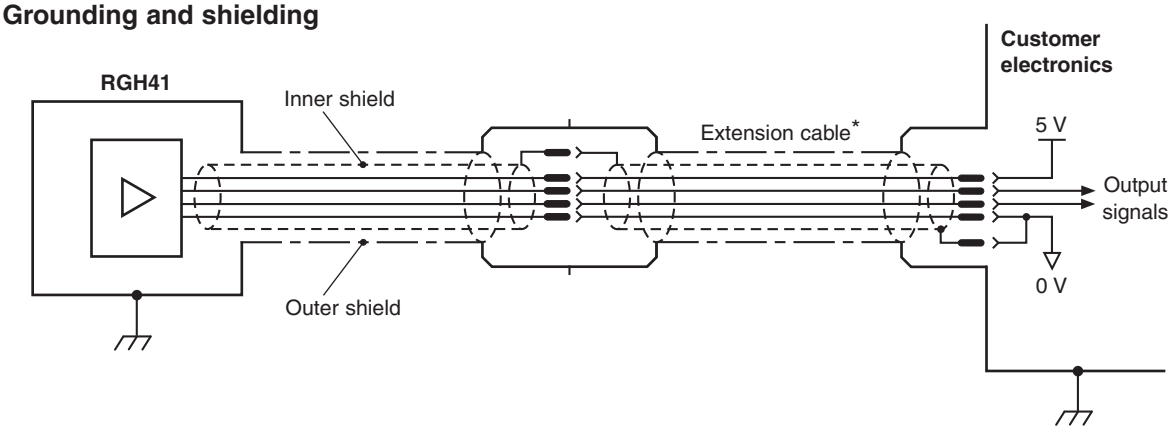


In-line connector plug (termination code X)



Electrical connections

Grounding and shielding

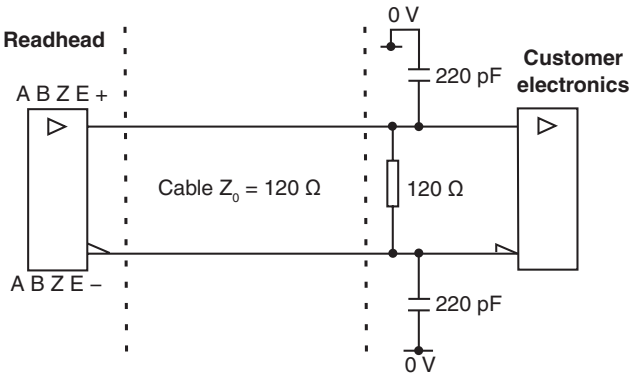


*Maximum extension cable length: RGH41A and B - 100 m, RGH41T, D, G and X - 50 m, RGH41N, W, Y and H - 20 m

IMPORTANT: The outer shield should be connected to the machine earth (Field Ground). The inner shield should be connected to 0 V. Care should be taken to ensure that the inner and outer shields are insulated from each other. If the inner and outer shields are connected together, this will cause a short between 0 V and earth, which could cause electrical noise issues.

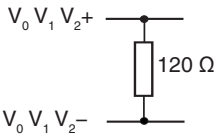
Recommended signal terminations

Digital outputs - RGH41T, D, G, X, N, W, Y and H



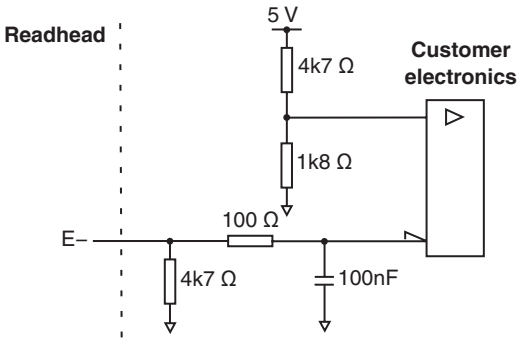
Standard RS422A line receiver circuitry.
Capacitors recommended for improved noise immunity.

Analogue outputs - RGH41A and B

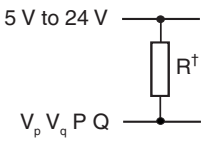


Single ended alarm signal termination

(Option 05/06)



Limit output



†Select R so that the maximum current does not exceed 20 mA.

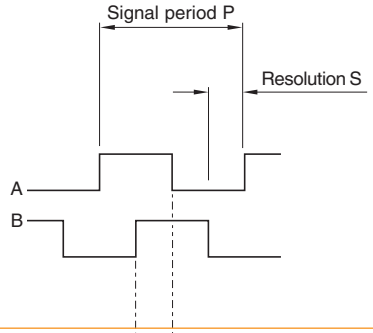
Alternatively, use a relay or opto-isolator.

Output specifications

Digital output signals - RGH41T, D, G, X, N, W, Y and H

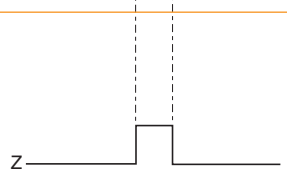
Form - Square wave differential line driver to EIA RS422A (except limit switches P, Q and external set-up signal X)

Incremental† 2 channels A and B in quadrature (90° phase shifted)



Model	P (µm)	S (µm)
RGH41T	40	10
RGH41D	20	5
RGH41G	8	2
RGH41X	4	1
RGH41N	1.6	0.4
RGH41W	0.8	0.2
RGH41Y	0.4	0.1
RGH41H	0.2	0.05

Reference†

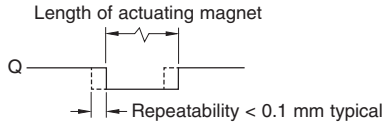


Synchronised pulse Z, duration as resolution S. Repeatability of position (uni-directional) maintained within ±20 °C from installation temperature and for speed < 0.5 m/s.

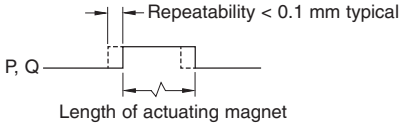
For RGH41N, W, Y and H only the Z pulse is re-synchronised at power-up with any one of the quadrature states (00, 01, 11, 10).

Limit open collector output, asynchronous pulse

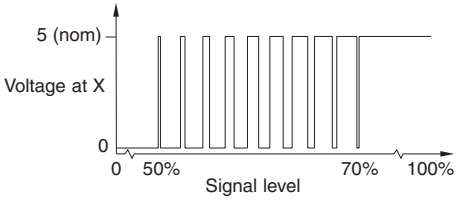
Single limit (option 03/04)



Dual limit (option 05/06)



Set-up



Between 50% and 70% signal level, X is a duty cycle.
Time spent at 5 V increases with signal level.
At > 70% signal level X is nominal 5 V.

Alarm

RGH41T, D, G, and X

Alarm output asserted when < 15% signal.

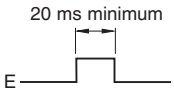
Option	Alarm type
03 (single limit)	differential line driven output
04 (single limit)	3-state output
05 (dual limit)	single ended line driven output
06 (dual limit)	3-state output

RGH41N, W, Y and H

Options 61, 62 and 63 (dual limit only)

Single ended line driven output alarm asserted when > 150% signal or overspeed.
3-state output alarm asserted when < 15% signal.

Line driven alarm output†



E– only on dual limit readheads

3-state alarm output

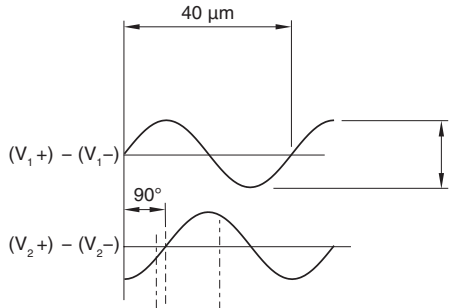
Differentially transmitted signals forced open circuit for > 20 ms when alarm conditions valid.

†Inverse signals not shown for clarity

Output specifications (continued)

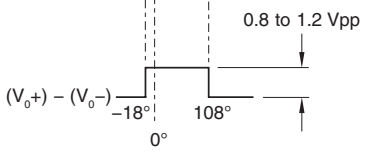
Analogue 1 Vpp output signals – RGH41A and B

Incremental 2 channels V_1 and V_2 differential sinusoids in quadrature (90° phase shifted)



0.6 to 1.2 Vpp with green LED indication and 120 Ω termination

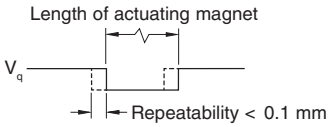
Reference



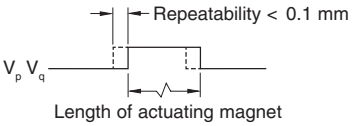
Differential pulse V_0 –18° to 108°. Duration 126° (electrical).
Repeatability of position (uni-directional) maintained within ±20 °C from installation temperature and for speed < 0.5 m/s

Limit open collector output, asynchronous pulse

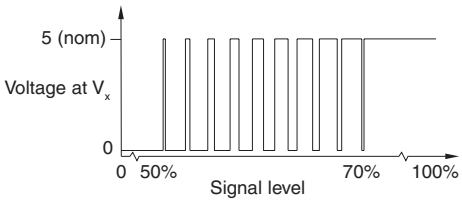
Single limit RGH41B



Dual limit RGH41A



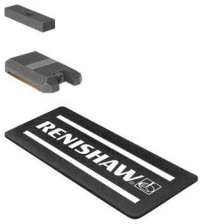
Set-up



Between 50% and 70% signal level, V_x is a duty cycle.
Time spent at 5 V increases with signal level.
At > 70% signal level V_x is nominal 5 V.

RGH41 system = readhead

+ scale



+ accessories

Readhead part numbers

RGH41 B 15 L 00A

Readhead series

Output

Analogue

A = 1 Vpp (dual limits)
B = 1 Vpp (single limit)

Digital

T = 10 µm
D = 5 µm
G = 2 µm
X = 1 µm
N = 0.4 µm
W = 0.2 µm
Y = 0.1 µm
H = 50 nm

Cable length

05 = 0.5 m
10 = 1 m
15 = 1.5 m
30 = 3 m
50 = 5 m

Termination

D = 15-way D-type plug (RGH41T, D, G, X, N, W, Y and H only)
F = Flying lead (unterminated)
L =15-way D-type plug (RGH41A and B only)
S = To be used in conjunction with option 17A and 18A (RGH41B only - limits not available)
V =12-way circular plug for analogue (RGH41B only - limits not available)
W=12-way circular coupling (RGH41B only - limits not available)
X =16-way in-line connector

Options

00A = Analogue 1 Vpp (RGH41A and B only)
03A = Digital head, single limit, differential alarm signal (RGH41T, D, G and X only)
04A = Digital head, single limit, 3-state alarm signal (RGH41T, D, G and X only)
05A = Digital head, dual limit, single ended alarm signal (RGH41T, D, G and X only)
06A = Digital head, dual limit, 3-state alarm signal (RGH41T, D, G and X only)
17A = Analogue 1 Vpp, V termination with BID/DIR (RGH41B only)
18A = Analogue 1 Vpp, W termination with BID/DIR (RGH41B only)
61A = 20 MHz customer clock (RGH41N, W, Y and H only)
62A = 10 MHz customer clock (RGH41N, W, Y and H only)
63A = 5 MHz customer clock (RGH41N, W, Y and H only)

NOTE: Not all combinations are valid. Check valid options online at www.renishaw.com/epc

Scale part numbers

RGS40-S

40 µm pitch lacquered tape scale with self-adhesive backing tape.

Part number	Available lengths	Available in increments of	Ordering instructions
A-9537-3011	100 mm to 50,000 mm*	1 mm	Ordering a quantity of 2455 will result in a length of 2455 mm (multiple orders are required for multiple lengths)
A-9537-3010	1 m to 50 m*	1 m	Ordering a quantity of 15 will result in a length of 15 metres (multiple orders are required for multiple lengths)
A-9537-4xxx	10 cm to 999 cm	1 cm	xxx is the length in cm (ordering A-9537-4450 for example will result in a length of 450 cm)
A-9537-50xx	10 m to 50 m*	1 m	xx is the length in metres (ordering A-9537-5033 for example will result in a length of 33 metres)

*Lengths above 50 m are special order only. Please contact your local Renishaw representative.

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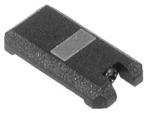
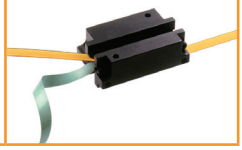
Accessory part numbers

Part number	Description	Image
A-9531-0250	RGM22S reference mark actuator magnet – epoxy mounted. A reference sensor within the readhead is used to determine an absolute datum within an incremental measuring system. The sensor does this by detecting the external RGM22S reference mark actuator magnet as the readhead passes it.	
A-9531-0287	RGM22SB reference mark actuator magnet – screw mounted. A reference sensor within the readhead is used to determine an absolute datum within an incremental measuring system. The sensor does this by detecting the external RGM22SB reference mark actuator magnet as the readhead passes it.	
A-9531-0251	RGP22S limit switch actuator magnet 10 mm long – epoxy mounted. A limit sensor within the readhead detects end of travel by sensing the RGP22S limit switch actuator magnet.	
A-9531-2052	RGP22SM limit switch actuator magnet 24.35 mm long – epoxy mounted. A limit sensor within the readhead detects end of travel by sensing the RGP22SM limit switch actuator magnet.	
A-9531-2054	RGP22SL imit switch actuator magnet 50 mm long – epoxy mounted. A limit sensor within the readhead detects end of travel by sensing the RGP22SL limit switch actuator magnet.	
A-9523-4015	RGC-F end clamp kit – epoxy mounted. The RGC-F end clamps master the RGS scale to the substrate material to match its thermal expansion.	
A-9531-0342	RGG-2 2 part epoxy adhesive. The RGG-2 epoxy is recommended for the mounting of reference marks, limit switches and end clamps.	
A-9531-0265	RGA22 scale applicator kit (for RGS40-S lacquered scale). The RGA22 enables efficient and accurate scale application. It is particularly suited to long axes or limited access installations as the backing paper is automatically removed during scale application requiring minimal intervention.	
A-9531-0239	RGA22G scale applicator guide block (for RGS40-S lacquered scale). The RGA22G offers the benefits of RGA22 in a simplified form, and is ideally suited to shorter axes.	

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