Data sheet
L-9517-9125-06-A

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RGH20 encoder system

The RGH20 is a compact readhead for use with Renishaw's range of 20 µm RESR angle encoders and RSLR high accuracy linear scale.

Like all Renishaw encoders, the RGH20 offers reliable, high speed, open, non-contact performance with excellent immunity to dust, scratches and light oils on the scale.

The RGH20 also benefits from Renishaw's integral readhead set-up LED which simplifies installation and monitors signal condition during operation.

The ultra compact RGH20F connects to the REF interface to give high accuracy digital and analogue outputs. The REF interface incorporates advanced signal processing and offers high speed and resolution.

Digital and analogue RGH20
RGH20D - 5 µm resolution
RGH20X - 1 µm resolution
RGH20Z - 0.5 µm resolution
RGH20W - 0.2 µm resolution
RGH20Y - 0.1 µm resolution
RGH20H - 50 nm resolution
RGH20I - 20 nm resolution
RGH20O - 10 nm resolution
RGH20B - 1 Vpp differential

RGH20F/REF system options
REF0004 - 5 µm resolution
REF0020 - 1 µm resolution
REF0040 - 0.5 µm resolution
REF0100 - 0.2 µm resolution
REF0200 - 0.1 µm resolution
REF0400 - 50 nm resolution
REF1000 - 20 nm resolution
REF2000 -10 nm resolution
REF4000 - 5 nm resolution
REF0000 - 1 Vpp differential

- **Compatible with 20 µm RESR angle encoder and RSLR high accuracy linear scales**
- **Filtering optics provide excellent dirt immunity**
- **Compact and robust housing**
- **Industry standard digital and analogue outputs**
- **Integral interpolation and set-up LED on RGH20 option**
- **Ultra-compact RGH20F/REF system gives high accuracy and high resolution**
- **Resolutions from 5 µm to 5 nm**
- **Reference mark or single limit switch sensor**
- **Hi-flex double screen 8 core cable**

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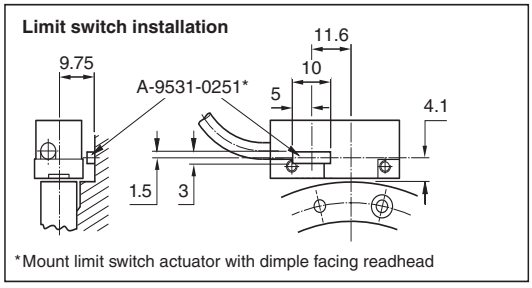
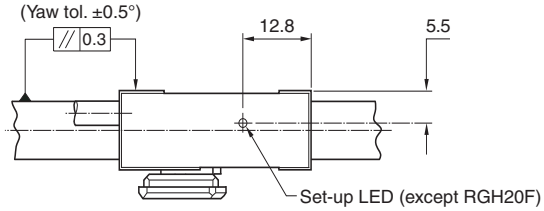
Introduction

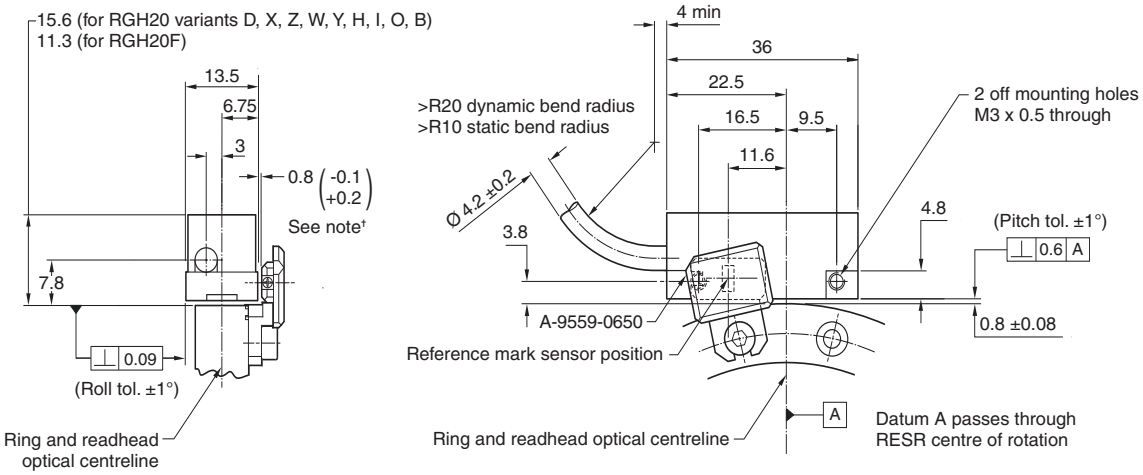
For clarity, SECTION 1 contains information relating to direct output RGH20 readheads only (RGH20D, X, Z, W, Y, H, I, O and B)
Section 2 contains information relating to RGH20F readhead and associated REF interfaces only.

RGH20 Installation drawing (on RESR A section encoder ring)

Dimensions and tolerances in mm







NOTE: RGH20/RESR only shown. For detailed installation drawings, refer to relevant RGH20 Installation guide or Data sheet.

†Required nominal 0.8 gap can be set using blue readhead spacer (supplied) positioned between readhead and actuator when positioning/fixing the actuator.

SECTION 1 - RGH20 direct output readheads

Speed

Digital readheads

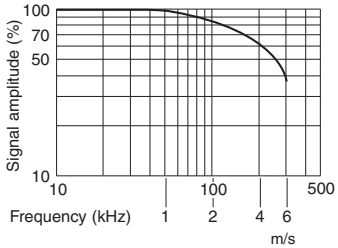
The tables below show the maximum speed and associated minimum receiver clock frequency for all digital output readheads.

Head type	Maximum speed (m/s)	Minimum receiver clock frequency (MHz)
RGH20D (5 µm) RGH20X (1 µm) RGH20Z (0.5 µm)	8 5 3	$\left(\frac{\text{encoder velocity (m/s)}}{\text{resolution (µm)}}\right)$ x 4 safety factor

The RGH20Y, RGH20W, RGH20H, RGH20I and RGH20O digital output readheads have clocked outputs. These are designed to prevent fine edge separations being missed by receiving electronics utilising slower clock speeds.

Option code ▼ / Head type ▶	Maximum speed (mm/s)					Minimum receiver clock frequency (MHz)
	RGH20W (0.2 µm)	RGH20Y (0.1 µm)	RGH20H (50 nm)	RGH20I (20 nm)	RGH20O (10 nm)	
30	–	700	350	130	65	12
31	–	500	250	90	45	8
32	700	–	–	–	–	6
33	500	250	120	40	20	4

Analogue readhead (1Vpp) RGH20B



SECTION 1 - RGH20 direct output readheads (continued)

General specifications

Power supply	5V ± 5%	RGH20D, X, Z <90 mA RGH20W, Y, H, I, O <120 mA RGH20B <110 mA
	Ripple	200 mVpp @ frequency up to 500 kHz
		NOTE: Current consumption figures refer to unterminated readheads. For digital outputs a further 35 mA per channel pair (eg 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 EN (IEC) 60950.

Connector options	**Code - connector type**	**Readhead variant**
	A - 9 pin D type plug	RGH20D, X, Z, W, Y, H, I, O, B
	D - 15 pin D type plug	RGH20D, X, Z, W, Y, H, I, O
	L - 15 pin D type plug	RGH20B
	F - Flying lead	RGH20D, X, Z, W, Y, H, I, O, B

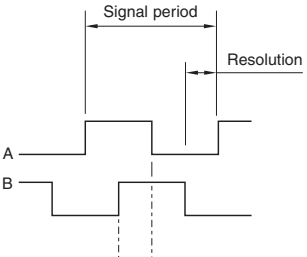
Temperature	Storage	-20 °C +70 °C
	Operating	0 °C to +55 °C
Humidity		Rated up to +40 °C, 95% maximum relative humidity (non-condensing)
Sealing		IP40
Acceleration	Operating	500 m/s² BS EN 60068-2-7:1993 (IEC 68-2-7:1983)
Shock	Non-operating	1000 m/s², 6 ms, ½ sine BS EN 60068-2-27:1993 (IEC 68-2-27:1987)
Vibration	Operating	100 m/s² max @ 55 Hz to 2000 Hz BS EN 60068-2-6:1996 (IEC 68-2-6:1995)
Mass	Readhead	11 g
	Cable	34 g/m
Cable		Double-shielded, outside diameter 4.2 ±0.2 mm Flex life >20 x 10^6 cycles at 20 mm bend radius
EMC compliance		BS EN 61326-1: 2006
Environmental		Compliant with EU Directive 2002/95/EC (RoHS)

SECTION 1 - RGH20 direct output readheads (continued)

Output specifications

Digital output signals - type RGH20D, X, Z, W, Y, H, I, O
Form - Square wave differential line driver to EIA RS422A

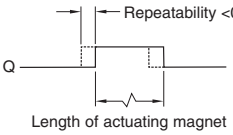
Incremental† 2 channels A and B in quadrature (90° phase shifted)



Reference†

Synchronised pulse Z, duration as resolution.
Repeatability of position
(uni-directional) maintained within
±10 °C from installation temperature and for
speed <250 mm/s

Limit† Asynchronous pulse Q



NOTE: RGH20 readheads are available with reference mark **or** limit switch output. Select output option at order.

Alarm

3-state alarm

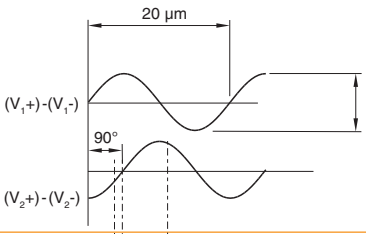
For RGH20D, X, Z readheads only, differentially transmitted signals forced open circuit for >20 ms when signal too low for reliable operation.

For RGH20W, Y, H, I, O readheads only, differentially transmitted signals forced open circuit for >10 ms when signals too low or speed too high for reliable operation.

†Inverse signals not shown for clarity

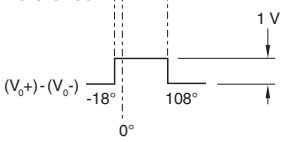
Analogue output signals - type RGH20B
Form - 1 Vpp differential

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



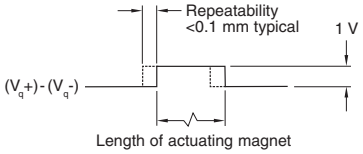
0.7 to 1.2 Vpp with
green LED indication
and 120 R termination

Reference



Differential pulse V_0 -18° to 108°
Duration 126° (electrical)
Repeatability of position
(uni-directional) maintained within
±10 °C from installation temperature
and for speed <250 mm/s

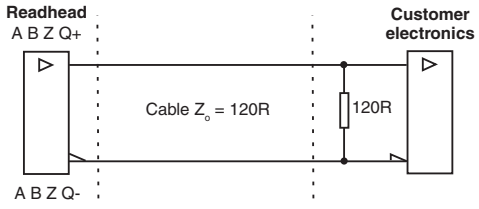
Limit Asynchronous pulse V_q



NOTE: RGH20 readheads are available with reference mark **or** limit switch output. Select output option at order.

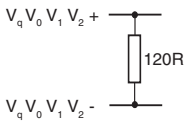
Recommended signal termination

Digital readheads
- RGH20D, X, Z, W, Y, H, I, O



Standard RS422A line receiver circuitry.
Contact Renishaw for further details on receiver termination for 3-stated output.

Analogue readhead
- RGH20B



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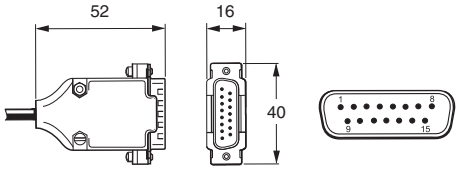
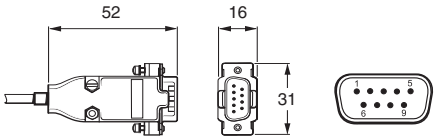
SECTION 1 - RGH20 direct output readheads (continued)

Output signals



15 pin D type plug (termination code D, L)



9 pin D type plug (termination code A)
Flying lead (termination code F)

RGH20 D, X, Z, W, Y, H, I, O RS422A digital

Function	Signal		Colour (F)	9 pin D type (A)	15 pin D type (D)
Power	5 V		Brown	5	7, 8
	0 V		White	1	2, 9
Incremental signals	A	+	Green	2	14
		-	Yellow	6	6
	B	+	Blue	4	13
		-	Red	8	5
Reference mark/limit switch	Z+/Q-		Pink	3	12
	Z-/Q+		Grey	7	4
Shield	Inner		Inner shield	9	15
	Outer		Outer shield	Case	Case

RGH20 B, 1 Vpp analogue

Function	Signal		Colour (F)	9 pin D type (A)	15 pin D type (L)
Power	5 V		Brown	5	4, 5
	0 V		White	1	12, 13
Incremental signals	V_1	+	Green	2	9
		-	Yellow	6	1
	V_2	+	Blue	4	10
		-	Red	8	2
Reference mark/limit switch	V_0+/V_q-		Pink	3	3
	V_0-/V_q+		Grey	7	11
Shield	Inner		Inner shield	9	15
	Outer		Outer shield	Case	Case

Readhead part numbers

RGH20 B 30 L 00 A

Output

Analogue
B = 1 Vpp

Digital
D = 5 µm
X = 1 µm
Z = 0.5 µm
W = 0.2 µm
Y = 0.1 µm
H = 50 nm
I = 20 nm
O = 10 nm

Cable length
15 = 1.5 m
30 = 3 m
50 = 5 m

Termination
A = 9 pin D type plug
(RGH20B, D, H, W, X, Y, I, O and Z)
D = 15 pin D type plug
(RGH20D, H, W, X, Y, I, O and Z only)
F = unterminated cable
(RGH20B, D, H, W, X, Y, I, O and Z)
L = 15 pin D type plug
(RGH20B only)

Options
00 = standard head
(RGH20B, D, X and Z only)
30 = 12 MHz customer clock
(RGH20Y, H, I and O only)
31 = 8 MHz customer clock
(RGH20Y, H, I and O only)
32 = 6 MHz customer clock
(RGH20W only)
33 = 4 MHz customer clock
(RGH20W, Y, H, I and O only)

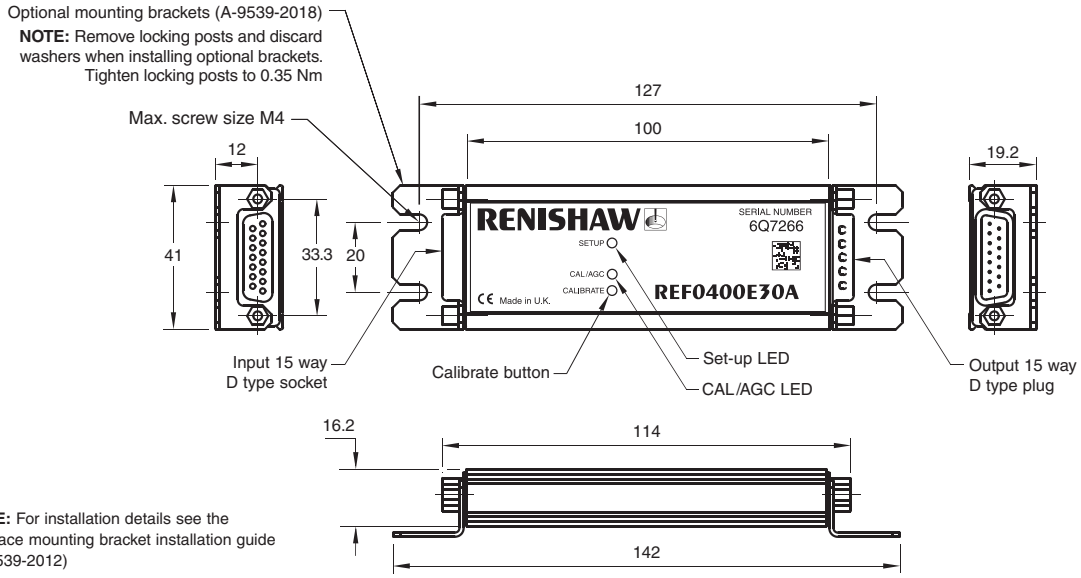
Datum
A = reference mark
B = limit switch

NOTE: Not all combinations are valid. For valid options and to acquire a part number for any combination of the nomenclature above please visit the product configurator at **www.renishaw.com/epc**

SECTION 2 - RGH20F/REF systems

REF installation drawing - interface required for use with RGH20F only

Dimensions and tolerances in mm

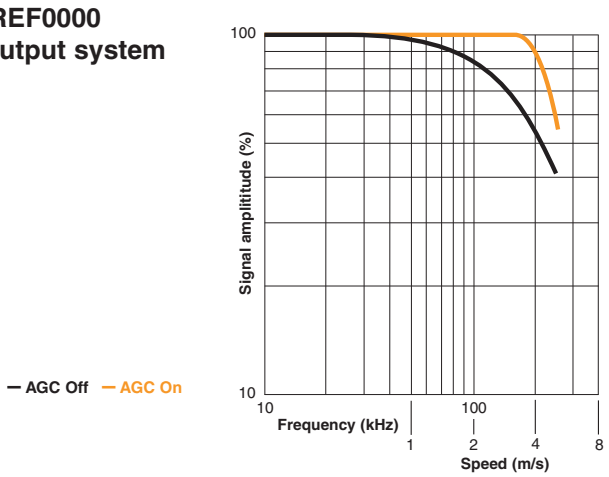


NOTE: For installation details see the Interface mounting bracket installation guide (M-9539-2012)

Speed Digital systems, maximum speed (m/s)

Minimum receiver clock frequency (MHz)	Resolution (µm)									Internal clock frequency (MHz)
	5	1	0.5	0.2	0.1	50 nm	20 nm	10 nm	5 nm	
50	5.000	5.000	5.000	5.000	3.24	1.620	0.648	0.324	0.162	**36**
40	5.000	5.000	5.000	5.000	2.700	1.350	0.540	0.270	0.135	**30**
25	5.000	5.000	5.000	3.240	1.620	0.810	0.324	0.162	0.081	**18**
20	5.000	5.000	5.000	2.700	1.350	0.675	0.270	0.135	0.068	**15**
12	5.000	5.000	4.500	1.800	0.900	0.450	0.180	0.090	0.045	**10**
10	5.000	5.000	4.050	1.620	0.810	0.405	0.162	0.081	0.041	**9**
8	5.000	5.000	3.240	1.296	0.648	0.324	0.130	0.065	0.032	**7.2**
6	5.000	4.500	2.250	0.900	0.450	0.225	0.090	0.045	0.023	**5**
5	5.000	4.050	2.025	0.810	0.405	0.203	0.081	0.041	0.020	**4.5**
3	5.000	2.250	1.125	0.450	0.225	0.113	0.045	0.023	0.011	**2.5**
1	4.219	0.844	0.422	0.169	0.084	0.042	0.017	0.008	0.004	**0.9**
	4	**20**	**40**	**100**	**200**	**400**	**1000**	**2000**	**4000**	
	Interpolation factor (period to resolution)									

RGH20F + REF0000 analogue output system



SECTION 2 - RGH20F/REF systems (continued)

General specifications

Power supply	5V -5% +10% Ripple	200 mA maximum (system) 200 mVpp @ frequency up to 500 kHz max The interface will be fully active <300 ms after power is applied. The interface and readhead are protected from reverse voltage and over voltage up to 12 V. **NOTE:** Current consumption figures refer to unterminated interfaces. For digital interfaces a further 35 mA per channel pair (eg 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 EN (IEC) 60950
Temperature (system)	Storage Operating	-20 °C +70 °C 0 °C to +55 °C
Humidity (system)		Rated up to +40 °C, 95% maximum relative humidity (non-condensing)
Sealing (readhead)		IP40
Acceleration (readhead)	Operating	500 m/s² BS EN 60068-2-7:1993 (IEC 68-2-7:1983)
Shock (readhead)	Non-operating	1000 m/s², 6 ms, ½ sine BS EN 60068-2-27:1993 (IEC 68-2-27:1987)
Vibration (readhead)	Operating	100 m/s² max @ 55 Hz to 2000 Hz BS EN 60068-2-6:1996 (IEC 68-2-6:1995)
Mass	Readhead Interface Cable	9 g 100 g 34 g/m
Cable		Double-shielded, outside diameter 4.2 ±0.2 mm Flex life >20 x 10^6 cycles at 20 mm bend radius
EMC compliance (system)		BS EN 61326-1: 2006
Environmental		Compliant with EU Directive 2002/95/EC (RoHS)

REF interface features

Self-tuning active correction

The REF interface actively corrects for input signal imperfections to improve system accuracy.

Corrections are made for the following:

Automatic Offset Control (AOC)
– adjusts offset independently for the sine and cosine signals

Automatic Gain Control (AGC)
– ensures consistent 1 Vpp signal amplitude

Automatic Balance Control (ABC)
– adjusts the gain to equalise the sine and cosine signals

These correction mechanisms operate over the full working speed range of the readhead.

The user can disable/enable the AGC by pressing the CALIBRATE button for greater than 3 seconds.

LED indicators

REF LED	Indication	Status	Alarm output
SETUP	Purple	Normal setup; signal level 110% to 135%	No
	Blue	Optimum setup; signal level 90% to 110%	No
	Green	Normal setup; signal level 70% to 90%	No
	Orange	Acceptable set-up; signal level 50% to 70%	No
	Red	Poor setup; signal may be too low for reliable operation; signal level <50%	No
	Purple/blank -flashing	Over signal; signal level >135%; system in error	Yes
	Red/blank -flashing	Poor setup; signal level <20%; system in error	Yes
	Red flash when traversing reference mark*	Normal phasing of reference mark	No
	Orange flash when traversing reference mark*	Acceptable phasing of reference mark	No
	Blank flash when traversing reference mark*	Poor phasing of reference mark; recalibrate	No
CAL/AGC	On	Automatic Gain Control - On	No
	Off	Automatic Gain Control - Off	No
	Slow flashing	Calibrating system	No
	Fast flashing	Calibration failed	No

*NOTE: Reference mark flashes only occur up to 100 mm/s traverse speed

Alarms can also be output for the following conditions, depending on REF alarm option:

- Readhead speed in excess of specification
- Automatic Offset Control excessive

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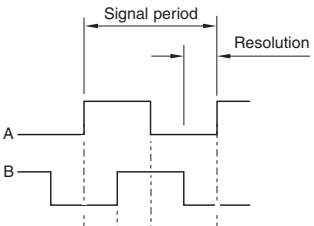
SECTION 2 - RGH20F/REF systems (continued)

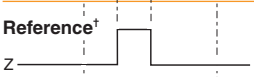
Output specifications

Digital output signals - type REF digital
Form - Square wave differential line driver to EIA RS422A

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



Reference†



Synchronised pulse Z, duration as resolution

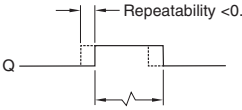
Wide reference† (option C)

Synchronised pulse Z, duration as signal period

Repeatability of position (uni-directional) maintained within ±10 °C from installation temperature and for speed <250 mm/s

NOTE: Wide reference mark option useful when using long cable lengths and/or high speed operation to overcome effects of skew

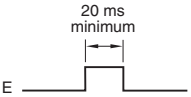
Limit†



NOTE: RGH20F readheads and REF interfaces are available with reference mark **or** limit switch output. Select output option at order.

Asynchronous pulse Q

Alarm†



Depending on REF alarm option, alarm asserted when:

- 20%> signal amplitude >135%
- Readhead exceeds specified maximum speed
- Signal offset excessive

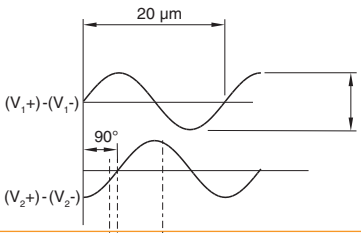
Asynchronous pulse E

NOTE: 3-state alarms option also available for REF digital interfaces

†Inverse signals not shown for clarity

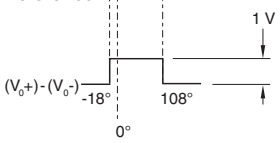
Analogue output signals - type REF0000
Form - 1 Vpp differential

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



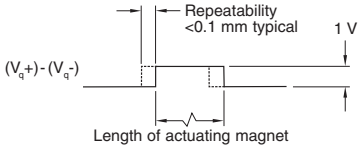
1 Vpp (nominal) with AGC active

Reference



Differential pulse V_0 -18° to 108°. Duration 126° (electrical) Repeatability of position (uni-directional) maintained within ±10 °C from installation temperature and for speed <250 mm/s

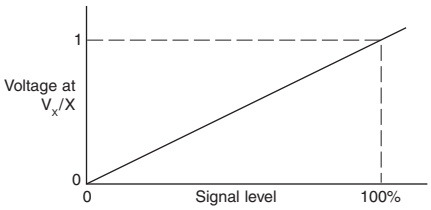
Limit



NOTE: RGH20F readheads and REF interfaces are available with reference mark **or** limit switch output. Select output option at order.

Asynchronous pulse V_q

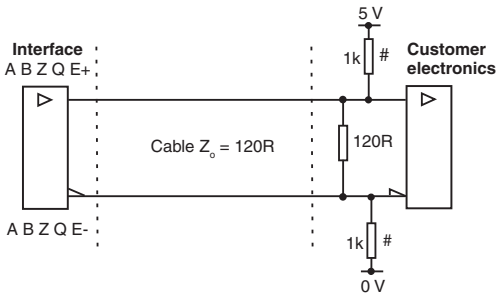
Set-up signal - all REF interfaces



Setup signal voltage proportional to signal amplitude

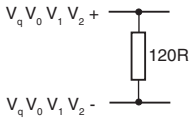
Recommended signal termination

REF interfaces (digital output)



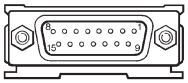
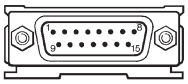
#Only required on alarm channel E for fail safe operation.

REF0000 interface (analogue output)



SECTION 2 - RGH20F/REF systems (continued)

Output signals

		Input		Output			
		 15 way D type socket		 15 way D type plug			
		Analogue input		Digital output		Analogue output	
Function	**Wire colours from readhead**	**Signal**	**Pin**	**Signal**	**Pin**	**Signal**	**Pin**
Power	Red	5 V	8	5 V	7, 8	5 V	4, 5
	White	0 V	9	0 V	2, 9	0 V	12, 13
Incremental signals	Green	A	6	A+	14	V_1+	9
	Yellow	B	5	A-	6	V_1-	1
	Blue	C	4	B+	13	V_2+	10
	–	–	–	B-	5	V_2-	2
Reference mark/limit	Pink	Hall	1	Z+/Q+	12	V_0+/V_q+	3
				Z-/Q-	4	V_0-/V_q-	11
Alarm	–	–	–	E+	11	–	–
				E-	3	–	–
Ired servo	Brown	Servo	3	–	–	–	–
External set-up	Interface outputs only	V_X	13	X	1	–	–
V_{MID}		V_{MID}	7	–	–	–	–
Sin monitor*		Sin monitor	11	–	–	–	–
Cos monitor*		Cos monitor	10	–	–	–	–
Shield	–	Inner	15	–	–	–	–
		Outer	Case	Outer	Case	Outer	Case
Do not connect	–	–	14	–	10	–	8
Not connected	–	–	2, 12	–	15	–	6, 14, 15

*2.25 Vpp @ 100% signal amplitude centred on 1.65 V

SECTION 2 - RGH20F/REF systems (continued)

Interface part numbers (digital output) for use with RGH20F

REF 0100 E 25 A

Options
A = Reference mark
B = Limit switch
C = Wide reference mark

Minimum receiver clock frequency

50 = 50 MHz	08 = 8 MHz
40 = 40 MHz	06 = 6 MHz
25 = 25 MHz	05 = 5 MHz
20 = 20 MHz	03 = 3 MHz
12 = 12 MHz	01 = 1 MHz
10 = 10 MHz	

Alarms
A = Line driven E output; all alarms
B = Line driven E output; low signal, high signal
E = 3-state; all alarms
F = 3-state; low signal, high signal

Interpolation factor*

0004 = 5 µm	0400 = 50 nm
0020 = 1 µm	1000 = 20 nm
0040 = 0.5 µm	2000 = 10 nm
0100 = 0.2 µm	4000 = 5 nm
0200 = 0.1 µm	

Interface series

*Binary interpolation factors from x4 to x4096 also available

Interface part numbers (analogue output) for use with RGH20F

REF 0000 A 00 A

Options
A = Reference mark
B = Limit switch
C = Wide reference mark

Readhead part numbers

RGH20F 30 J 02 A

Datum standard
A = standard reference mark
B = limit switch
C = vacuum reference mark

Options
02 = standard head
03 = vacuum head

Termination
J = 15 pin D type plug (standard head)
M = 15 pin D type plug (vacuum head)

Cable length
15 = 1.5 m
30 = 3 m
50 = 5 m

NOTE: Not all combinations are valid. For valid options and to acquire a part number for any combination of the nomenclature above please visit the product configurator at **www.renishaw.com/epc**

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RESR
Installation guide
M-9559-0675
Data sheet L-9517-9128

RSLM
Installation guide M-9572-9110
Data sheet L-9517-9305

Interface mounting bracket
Installation guide M-9539-2017

RGH20F UHV
Data sheet L-9517-9164

For worldwide contact details, please visit our main website at www.renishaw.com/contact

L-9517-9125-06