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REE series digital interpolators

The REE digital series of interpolators is designed to accompany the RG2 (20 μm) and RG4 (40 μm) encoder systems by offering a wide range of interpolation factors. Industry standard 1 Vpp differential input analogue signals are interpolated to industry standard RS-422A digital quadrature output signals.

These interpolators can be used with any standard 1Vpp differential output encoder system to enable easy integration with industry standard digital controller inputs.

When interfaced with 40 μm pitch systems such as the RGH34, RGH40 and RGH41, the interpolators give resolutions down to 10 nm.

When used with 20 μm pitch systems such as the RGH22, RGH24 and RGH20, the interpolators will resolve down to 5 nm. The REE interpolators are fully RoHS compliant and feature user selectable AGC (Auto Gain Control) that is operational at all speeds. These interpolators are capable of operational speeds of over 3 m/s at 100 nm resolution from a 20 μm encoder signal period.

The REE interpolators feature a tri-coloured setup LED indicating incremental signal strength. This allows ease of setup for optimum performance. A proportional external setup signal and calibration cycle also help to simplify installation.

The REE interpolators have a low cyclic error – less than 50 nm from 20 μm signal period at low speed. This is achieved by active offset, balance and gain control which is operational, when selected, at all speeds.

Using 20 μm scale
REE0004 - 5 μm resolution
REE0020 - 1 μm resolution
REE0040 - 0.5 μm resolution
REE0100 - 0.2 μm resolution
REE0200 - 0.1 μm resolution
REE0400 - 50 nm resolution
REE1000 - 20 nm resolution
REE2000 - 10 nm resolution
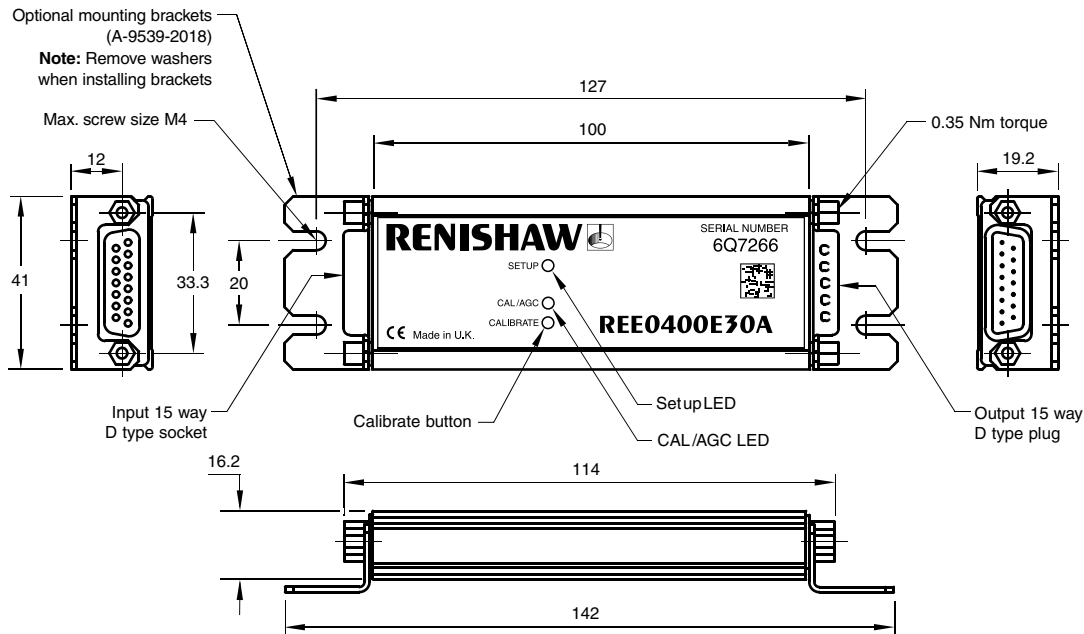REE4000 - 5 nm resolution

Using 40 μm scale
REE0004 - 10 μm resolution
REE0020 - 2 μm resolution
REE0040 - 1 μm resolution
REE0100 - 0.4 μm resolution
REE0200 - 0.2 μm resolution
REE0400 - 0.1 μm resolution
REE1000 - 40 nm resolution
REE2000 - 20 nm resolution
REE4000 - 10 nm resolution

- **Tri-colour integral set-up LED**

- **Compatible with all standard 1Vpp analogue output readheads**

- **Industry standard RS422A output**

- **Interpolation factors from x4 to x4000**

- **Binary interpolation factors from x4 to x4096 available on request.**

- **User selectable automatic gain control (AGC)**

- **Low cyclic error**

- **Automatic offset and balance control (AOC and ABC)**

- **Clock speeds from 1 to 50 MHz**

REE installation drawing

Dimensions and tolerances in mm

Optional mounting brackets
(A-9539-2018)
Note: Remove washers
when installing brackets

Max. screw size M4

127

100

0.35 Nm torque

19.2

12

41

33.3

20

RENISHAW

SERIAL NUMBER
6Q7266

SETUP

CAL/AGC
CALIBRATE

CE Made in U.K.

REE0400E30A

Input 15 way
D type socket

Calibrate button

SetupLED

CAL/AGC LED

Output 15 way
D type plug

16.2

114

142

Operating and electrical specifications

Power supply	5V -5% +10%	130 mA current consumption (interface only). The interface will be fully active <300 ms after power is applied. Provision is given for remote sensing via two cores of the customers cable. **NOTE:** Current consumption figures refer to unterminated interfaces. A further 25 mA per channel pair (eg A+, A-) will be drawn when terminated with 120 Ω. Renishaw encoder systems must be powered from a 5 V dc supply complying with the requirements for SELV of standard EN (IEC) 60950. The interface and readhead are protected from reverse voltage and overvoltage up to 12 V.
	Ripple	200 mVpp maximum @ frequency up to 500 kHz maximum
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 to 2000 Hz BS EN 60068-2-6:1996 (IEC 68-2-6:1995)
Temperature	Storage Operating	-20 °C to +70 °C 0 °C to +55 °C
Humidity	Storage Operating	95% maximum relative humidity (non-condensing) 80% maximum relative humidity (non-condensing)
Sealing		IP40
Mass		95g
EMC compliance		BS EN 61000 BS EN 55011
Connectors (input/output)		15-way D type socket/plug

Maximum analogue input frequency (kHz)

Interpolation (option)	Minimum recommended counter clock frequency (MHz)										
	1	3	5	6	8	10	12	20	25	40	50
x4 (0004)	211	250	250	250	250	250	250	250	250	250	250
x20 (0020)	42	112	202	225	250	250	250	250	250	250	250
x40 (0040)	21	56	101	112	162	202	225	250	250	250	250
x100 (0100)	8.4	22	40	45	65	81	90	135	162	250	250
x200 (0200)	4.2	11	20	22	32	40	45	67	81	135	162
x400 (0400)	2.1	5.6	10	11	16	20	22	33	40	67	81
x1000 (1000)	0.8	2.2	4	4.5	6.5	8.1	9	13	16	27	32
x2000 (2000)	0.4	1.1	2	2.2	3.2	4	4.5	6.7	8.1	13	16
x4000 (4000)	0.2	0.5	1	1.1	1.6	2	2.2	3.4	4	6.7	8.1

Maximum cable length

Interface to receiving electronics

Recommended clock frequency (MHz)	Maximum cable length (m)
⩾25	20
⩽20	50

REE interpolator features

Self-tuning active correction

The REE interpolator corrects for input signal imperfections to optimise 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

The tri-coloured SETUP LED provides visual feedback of signal strength and error condition for setup and diagnostic use.

Flashing **Purple** indicates high signal alarm condition	>135%
Purple indicates high signal	>110% and <135%
Blue indicates optimum signal	>90% and <110%
Green indicates acceptable signal	>70% and <90%
Orange indicates low signal	>50% and <70%
Red indicates unacceptable signal	>20% and <50%
Flashing **Red** indicates unacceptable signal alarm condition	<20%

Flashing **Blue** indicates overspeed alarm condition

Flashes **Off** momentarily to indicate a reference mark, up to 100 mm/s only

The **Yellow** CAL/AGC LED indicates when the REE is in a calibration routine and whether or not AGC is active

LED on indicates AGC active

LED off indicates AGC inactive

LED slow flashing indicates calibration routine

LED fast flashing indicates calibration failure

Alarm output

The REE interpolator asserts the alarm output (E) for the following conditions:-

Incremental signal level below 20% of nominal

Incremental signal level above 135% of nominal

Readhead speed in excess of specification

Signal offset compensation of sine and cosine excessive

Signal balance compensation excessive

Calibration procedure

The calibration procedure is required to optimise the gain, balance and offset of the analogue input signals in the REF interface. These settings are then stored and recalled for initial use at startup.

To calibrate the system, the following sequence should be carried out:

▶ Prior to calibration, AGC should be off. To switch AGC on or off, the CALIBRATE button should be pressed for more than 3 seconds. When AGC is on, the CAL/AGC LED will be on and when AGC is off, the CAL/AGC LED will be off.

▶ Install the readhead and set up to obtain optimum (1 Vpp) signal amplitude

▶ Enter calibration routine by pressing the CALIBRATE button momentarily. The calibration routine is indicated by slow flashing of the CAL/AGC LED.

▶ Traverse the readhead slowly past the scale until the CAL/AGC LED stops flashing. The calibration cycle is now complete.

If calibration fails, the CAL/AGC LED will flash quickly instead of switching off. If this happens the CALIBRATE button should be pressed momentarily to exit the calibration routine. The calibration procedure should then be re-tried.

If the unit continues to fail calibration, factory default settings should be restored by powering down, then pressing the CALIBRATE button as power is re-applied. The calibration procedure should then be repeated.

NOTE: To exit the calibration routine at any time, the CALIBRATE button should be pressed momentarily.
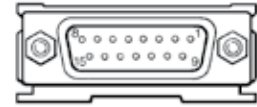
Input signals

REE interpolators are designed to be used with industry standard 1 Vpp readheads. Cos (V_1), Sin (V_2) and reference mark (V_0) differential input signals should have nominal signal amplitude of 1 Vpp developed across 120R input termination resistor.

One or two open collector limit switch signals, active high or active low can also be input.

15 way 'D' type socket

Pin number	Signal name	Description
1	V_1-	Cosine -ve
2	V_2-	Sine -ve
3	V_0+	Reference mark +ve
4	5 V	5 V power supply
5	5 V	5 V power supply
6	–	Not connected
7	V_x/V_p	Setup signal/second (P) limit switch on dual limit readheads
8	V_q	First (Q) limit switch
9	V_1+	Cosine +ve
10	V_2+	Sine +ve
11	V_0-	Reference mark-ve
12	0 V	0 V power supply
13	0 V	0 V power supply
14	–	Do not connect
15	Inner	Cable's inner shield connection to 0 V

REE input

Output signals

15 way 'D' type plug

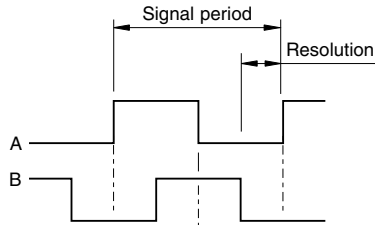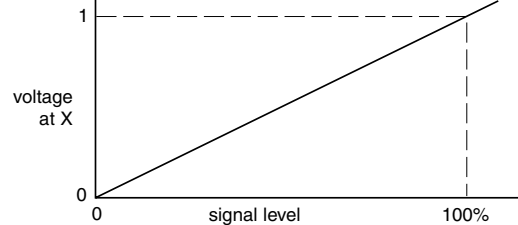| Pin number	Signal name	Description
1	X	External setup signal
2	0 V	0 V power supply
3	E-	Alarm -ve
4	Z-	Reference mark -ve
5	B-	Quad B -ve
6	A-	Quad A -ve
7	5 V	5 V power supply
8	5 V	5 V power supply
9	0 V	0 V power supply
10	Q	Q limit switch
11	E+/P	Alarm +ve/P limit switch
12	Z+	Reference mark +ve
13	B+	Quad B +ve
14	A+	Quad A +ve
15	–	Not connected
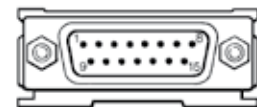
REE output

Output specifications

Form - Square wave differential line driver to EIA RS422A (except open collector limit and external set-up signal X)

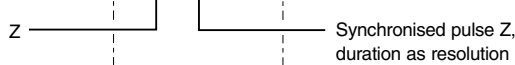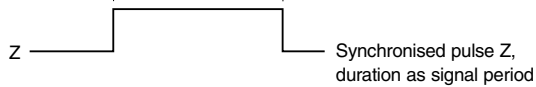[†]**Incremental** 2 channels A and B in quadrature (90° phase shifted)

Signal period

Resolution

A

B

Set-up

voltage at X

signal level   100%

Setup signal voltage proportional to signal amplitude

[*†]**Reference**

Z — Synchronised pulse Z, duration as resolution

[*†]**Wide reference** (option C)

Z — Synchronised pulse Z, duration as signal period

Repeatability of position (uni-directional) is determined by the readhead specification.

NOTE: The set-up LED on the REE interpolator cannot be used for reference mark set-up. Only the readhead LED (on Renishaw readheads) should be used for this purpose.

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

[†]**Alarm**

Asynchronous pulse >20 ms

E
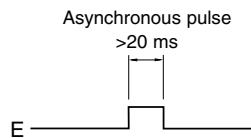
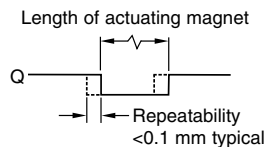REE alarm asserted for:
- Incremental signal <20% of nominal
- Incremental signal >135% of nominal
- Readhead speed in excess of specification
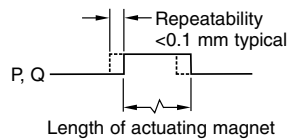- Signal offset excessive

NOTE: 3-state alarm option available

[*]**Limit** RGH22, RGH40 and RGH41 only
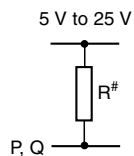Open collector output

Single limit

Length of actuating magnet

Q

Repeatability <0.1 mm typical

Asynchronous pulse Q

Dual limit

Repeatability <0.1 mm typical

P, Q

Length of actuating magnet

Asynchronous pulse P, Q

Termination

5 V to 25 V

R[#]

P, Q

[#]Select R so that the maximum current does not exceed 20 mA. Alternatively use a relay or opto-isolator.

Actuation device A-9531-0251, A-9531-2052, A-9531-2054.

[*]The presence of a reference mark and limit signal is dependent on the specification of the installed readhead.

[†]Inverse signal not shown for clarity

Recommended signal termination

REE
A B Z E+

Cable Z_0 = 120R

A B Z E-

5V

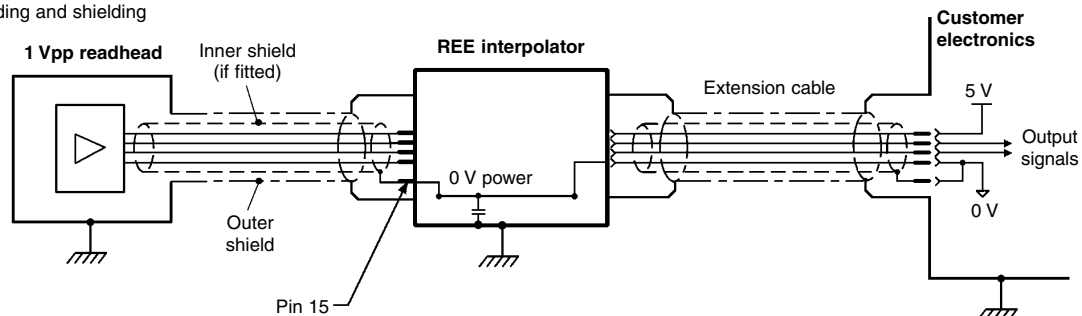1k #   Customer electronics

120R

1k #

0V
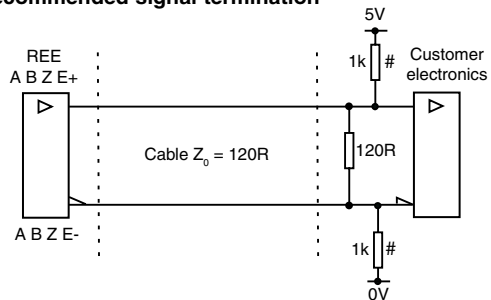
Standard RS422A line receiver circuitry.
[#]Only required on alarm channel E for fail safe operation.

Electrical connections
Grounding and shielding

1 Vpp readhead

Inner shield (if fitted)

REE interpolator

Extension cable

Customer electronics

5 V

Output signals

0 V

0 V power

Outer shield

Pin 15

NOTE: Extension cable inner shield must be connected to 0V at customer electronics only

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.

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EMC compliance

The REE interpolator conforms to the relevant harmonised European standards for electromagnetic compatibility as detailed below.

BS EN 61000   BS EN 55011

Patents

Features of Renishaw's encoder systems and similar products are the subjects of the following patents and patent applications:

US4959542	US4974962	US4926566
EP0383901	US5088209	JP2963926
EP0388453	US5063685	JP2837483
EP0514081	US5241173	JP3202316
EP0543513	US5302820	JP5248895
EP0748436	US5861953	EP826138B
US6051971	JP3676819	EP1094302
US6481115	US6588333 B1	EP1147377
JP2003-512,611	US6772531	GB2397040
CN1585685	WO 03/041905	JP2005-508,760
US2005-0079499	CN1620353	WO 03/061891
EP1469969	JP2005-515,077	US2005-0045586
EP1552251	WO 2004/008079	EP1552248
WO 2004/008076		

Further information

For further information relating to the installation of REE systems, see also related readhead installation guides. These can be downloaded from our website **www.renishaw.com/encoder** and are also available from your local representative.

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Interpolator part numbers

REE 0100 E 25 A

Options
A - Dual limit switch
B - Single limit switch
C - Wide reference mark

Clocked output
50 - 50 MHz customer clock
40 - 40 MHz customer clock
25 - 25 MHz customer clock
20 - 20 MHz customer clock
12 - 12 MHz customer clock
10 - 10 MHz customer clock
08 - 8 MHz customer clock
06 - 6 MHz customer clock
05 - 5 MHz customer clock
03 - 3 MHz customer clock
01 - 1 MHz customer clock

Alarms
Standard alarm E
A - All alarms
B - High and low signal alarms only
C - High and low signal, and overspeed alarms only
3 - state alarms
E- All alarms
F - High and low signal alarms only
G - High and low signal, and overspeed alarms only

Interpolation factor*
0004
0020
0040
0100
0200
0400
1000
2000
4000

Interpolator series

***Binary interpolation factors from x4 to x4096 also available**

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

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

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