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RLU10 laser unit

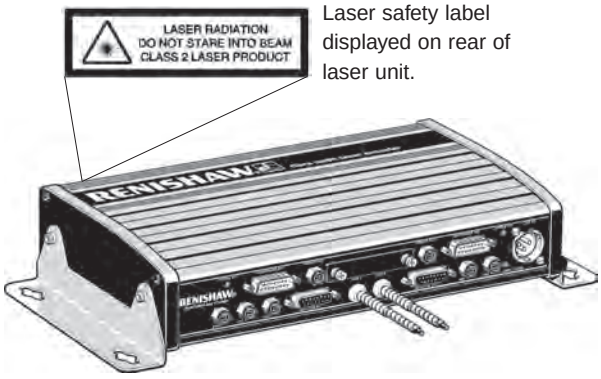
The Renishaw RLE fibre optic laser encoder uses interferometry to provide high resolution, high linearity position feedback.

The RLE system comprises an RLU laser unit and one or two RLD detector heads. The RLU laser unit contains the laser source and signal processing electronics. It is available with one or two fibre optic laser outputs that deliver laser light directly to the RLD detector heads. The detector head is the core of the optical measuring system containing the interferometer optics, novel Renishaw detection scheme and beam steering mechanism(s)*.

The RLE range offers a variety of laser units and detector heads to suit specific application requirements - all system components are compatible with each other.

This datasheet describes the RLU10 laser unit - see performance details overleaf. Position feedback signals are provided for each axis independently, in either digital quadrature format or analogue quadrature format.

* The differential interferometer detector head has separate beam steerers for each pair of beams.



Laser safety label displayed on rear of laser unit.

The resolution and format of the signals are determined by front panel switches and detector head type. The laser unit also provides system status outputs and allows configuration of signal bandwidth, direction sense and error monitoring.

Position feedback signals from the RLU can be used directly, or connected via either the RCU10 compensation system (which automatically compensates for air refraction and/or material expansion effects) or an interpolator unit to produce ultra-high resolution output.

The RLU10 includes an electrical signal input that can be used to shut off the laser beam without destabilising the laser.

General outline and dimensions

Dimensions in mm (inches)

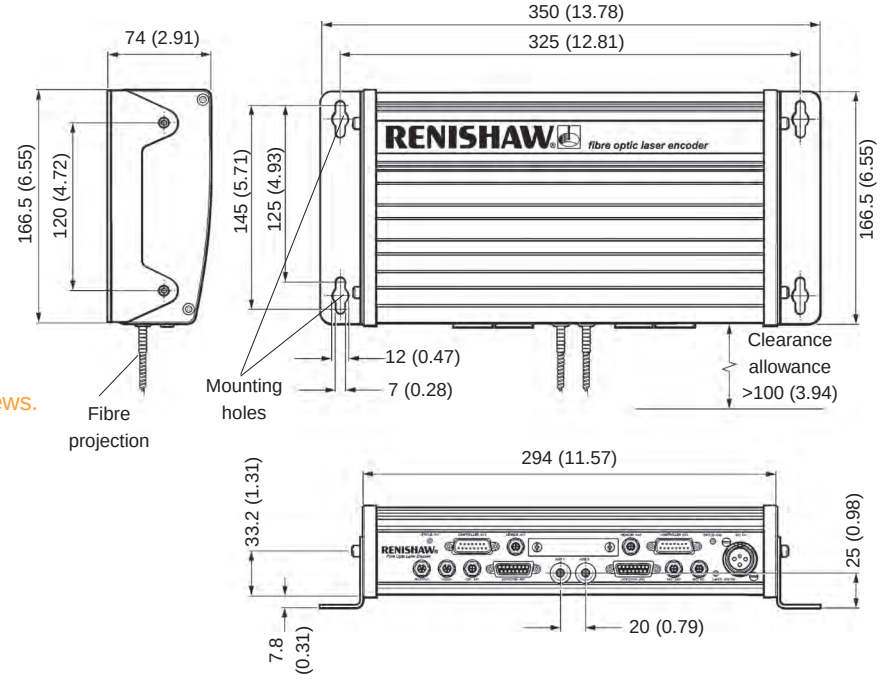
Overall dimensions:

Height:	74	(2.91)
Length:	350	(13.78)
Width:	166.5	(6.55)

The RLU can be mounted in any orientation, provided the surface is reasonably flat and free from vibration. Minimum cable and fibre bend radius is 25 mm (0.98).

Fixing:

4 off M6 x 1.0 x 15 mm or $^{1}/_{4}$-20-UNC x $^{5}/_{8}$ cap head screws.



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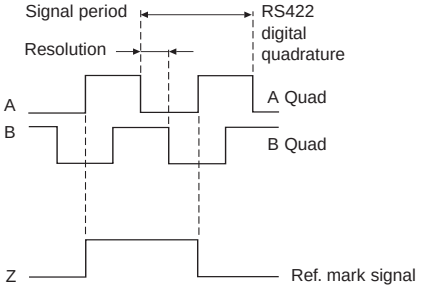
RLU10 laser unit performance

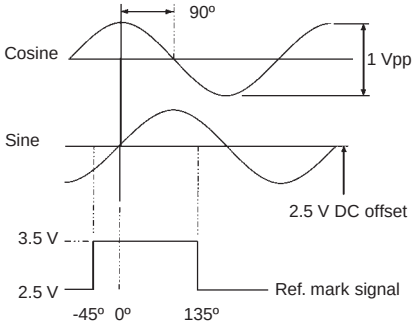
Laser type Output beam intensity	HeNe Class II <300 µW (cw)	Maximum output power from laser tube <1 mW During preheat this can rise up to 600 µW
Laser beam diameter	3 mm	
NTP wavelength T = 20 ºC, P = 1013.25 mbar, RH = 50%	632.818270 nm 632.819719 nm	Axis 1 Axis 2
Vacuum wavelength accuracy	±0.1 ppm over three years	
Laser frequency stability	<±10 ppb <±50 ppb <±50 ppb	1 minute 1 hour 8 hours
Fibre optic diameter (armoured)	5 mm	
Analogue output signal period	158 nm 316 nm	Plane mirror interferometer Retroreflector interferometer
Digital quadrature nominal output resolutions	10, 20, 39.5, 79, 158, and 316 nm 20, 39.5, 79, 158, 316 and 633 nm	Plane mirror interferometer Retroreflector interferometer
Output update rates	0.3125, 0.625, 1.25, 2.5, 5, 10 and 20 MHz	User selectable update rate options
Maximum velocity (resolution dependent)	1 m/sec 2 m/sec	Plane mirror interferometer Retroreflector interferometer
Output formats	Dual RS422 differential digital quadrature 1 V peak to peak sine/cosine signals	
Power supply requirements	24 V ±2 V @ 2.5 A 24 V ±2 V @ 1.6 A 24 V ±2 V @ 0.6 A	Inrush (first 10 ms) Warm-up (~10 mins) Operation at room temperature (20 ºC)
RLU weight	2.8 kg	
Operating environment Pressure Humidity Temperature	 650 mbar to 1150 mbar 0% to 95% RH 10 ºC to 40 ºC	 Normal atmospheric Non-condensing

RLU output signals

Digital incremental - RS422 digital quadrature



Analogue incremental - 1 Vpp differential sine and cosine



RLU identification and ordering

The RLU is normally supplied with the appropriate RLD detector heads as a configured RLE fibre optic laser encoder system. For special applications or spares requirements the RLU10 laser unit is available separately.

For full details of available RLE system configurations and part numbers visit www.renishaw.com or consult a Renishaw representative.

Compliant with EU directive 2011/65/EU (RoHS)

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

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RLU20 laser unit

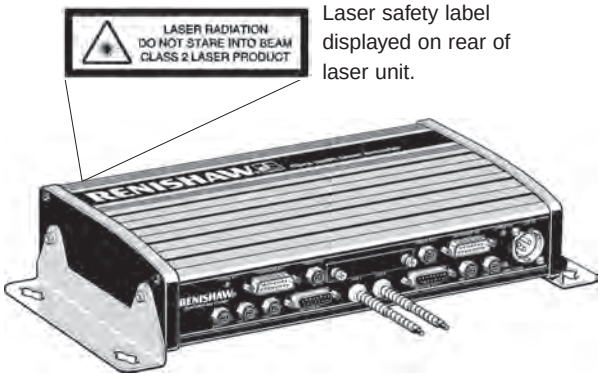
The Renishaw RLE fibre optic laser encoder uses interferometry to provide high resolution, high linearity position feedback.

The RLE system comprises an RLU laser unit and one or two RLD detector heads. The RLU laser unit contains the laser source and signal processing electronics. It is available with one or two fibre optic laser outputs that deliver laser light directly to the RLD detector heads. The detector head is the core of the optical measuring system containing the interferometer optics, novel Renishaw detection scheme and beam steering mechanism(s)*.

The RLE range offers a variety of laser units and detector heads to suit specific application requirements - all system components are compatible with each other.

This datasheet describes the RLU20, a laser unit with enhanced frequency stability - see performance details overleaf. Position feedback signals are provided for each axis independently, in either digital quadrature format or analogue quadrature format.

* The differential interferometer detector head has separate beam steerers for each pair of beams.



Laser safety label displayed on rear of laser unit.

The resolution and format of the signals are determined by front panel switches and detector head type. The laser unit also provides system status outputs and allows configuration of signal bandwidth, direction sense and error monitoring.

Position feedback signals from the RLU can be used directly, or connected via either the RCU10 compensation system (which automatically compensates for air refraction and/or material expansion effects) or via one of the available range of interpolator units to produce an ultra-high resolution output.

The RLU20 includes an electrical signal input that can be used to shut off the laser beam without destabilising the laser.

General outline and dimensions

Dimensions in mm (inches)

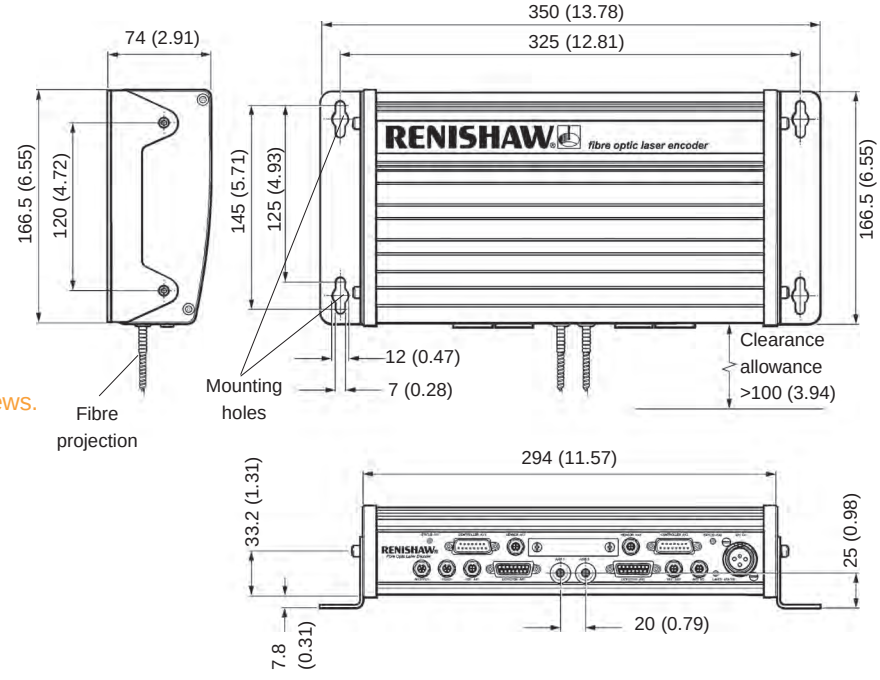
Overall dimensions:

Height:	74	(2.91)
Length:	350	(13.78)
Width:	166.5	(6.55)

The RLU can be mounted in any orientation, provided the surface is reasonably flat and free from vibration. Minimum cable and fibre bend radius is 25 mm (0.98).

Fixing:

4 off M6 x 1.0 x 15 mm or $^{1}/_{4}$-20-UNC x $^{5}/_{8}$ cap head screws.



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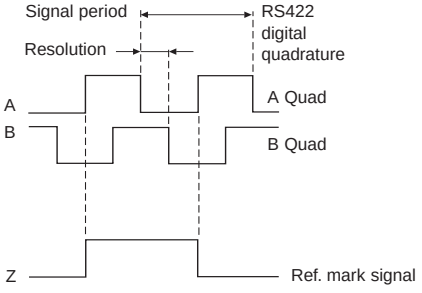
RLU20 laser unit performance

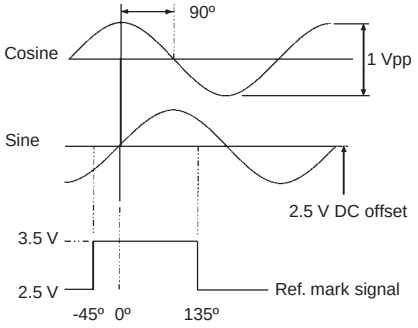
Laser type Output beam intensity	HeNe Class II <300 µW (cw) / axis	Maximum output power from laser tube <1 mW During preheat this can rise up to 600 µW
Laser beam diameter	3 mm	
NTP wavelength T = 20 ºC, P = 1013.25 mbar, RH = 50%	632.818270 nm 632.819719 nm	Axis 1 Axis 2
Vacuum wavelength accuracy	±0.1 ppm over three years	
Laser frequency stability	<±1 ppb <±2 ppb <±20 ppb	1 minute 1 hour 8 hours
Fibre optic diameter (armoured)	5 mm	
Analogue output signal period	158 nm 316 nm	Plane mirror interferometer Retroreflector interferometer
Digital quadrature nominal output resolutions	10, 20, 39.5, 79, 158, and 316 nm 20, 39.5, 79, 158, 316 and 633 nm	Plane mirror interferometer Retroreflector interferometer
Output update rates	0.3125, 0.625, 1.25, 2.5, 5, 10 and 20 MHz	User selectable update rate options
Maximum velocity (resolution dependent)	1 m/sec 2 m/sec	Plane mirror interferometer Retroreflector interferometer
Output formats	Dual RS422 differential digital quadrature 1 V peak to peak sine/cosine signals	
Power supply requirements	24 V ±2 V @ 2.5 A 24 V ±2 V @ 1.6 A 24 V ±2 V @ 0.6 A	Inrush (first 10 ms) Warm-up (~10 mins) Operation at room temperature (20 ºC)
RLU weight	2.8 kg	
Operating environment Pressure Humidity Temperature	 650 mbar to 1150 mbar 0% to 95% RH 10 ºC to 40 ºC	 Normal atmospheric Non-condensing

RLU output signals

Digital incremental - RS422 digital quadrature



Analogue incremental - 1 Vpp differential sine and cosine



RLU identification and ordering

The RLU is normally supplied with the appropriate RLD detector heads as a configured RLE fibre optic laser encoder system. For special applications or spares requirements the RLU20 is available separately.

For full details of available RLE system configurations and part numbers visit www.renishaw.com or consult a Renishaw representative.

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RLE system performance

Renishaw's RLE fibre optic laser encoder uses interferometry to provide high resolution, high linearity position feedback signals suitable for use in precision motion control applications.

The RLE range offers a variety of laser units and detector heads to suit individual application requirements. To maximise application flexibility, all system components are fully compatible.

Each RLE system comprises an RLU laser unit and one or two RLD detector heads.

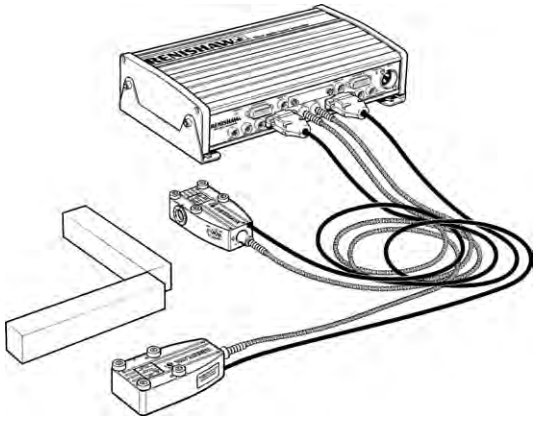
The RLU laser unit, containing the laser source and signal processing electronics, is available in either single or dual axis configuration, with a fibre optic umbilical that delivers laser light directly to the RLD detector head(s). Two RLU performance levels are available - RLU10 and RLU20. The RLU20 provides part per billion (ppb) laser frequency stability and is particularly suitable for vacuum and other controlled environment applications. The choice of laser unit determines the designation of the RLE system: RLE10 systems contain an RLU10 laser unit, RLE20 systems contain an RLU20 laser unit.

The RLD detector head is the core of the optical measuring system, containing interferometer optics, a unique, multi-channel fringe detection system and beam steering mechanisms. As detailed below, current RLDs provide three different interferometer configurations. Additionally, an RLD with no internal optics is available enabling the RLE system to be used with suitable external optics to measure linear displacement, angle and straightness.

The RLD10 differential interferometer detector head measures the relative displacement between two plane mirror targets, one of which is a fixed position reference mirror (usually located on the tool). This ensures accurate positioning between process critical components and eliminates common mode errors.

The RLD10 plane mirror (double pass) interferometer detector head contains measurement optics allowing the system to determine the relative displacement between a reference optic, housed within the RLD10 and a plane mirror target optic, positioned on the measurement axis.

The RLD10 retroreflector (single pass) interferometer detector head contains measurement optics allowing the system to determine the relative displacement between the reference optic, housed within the RLD10 and a retroreflector target optic, positioned on the measurement axis.

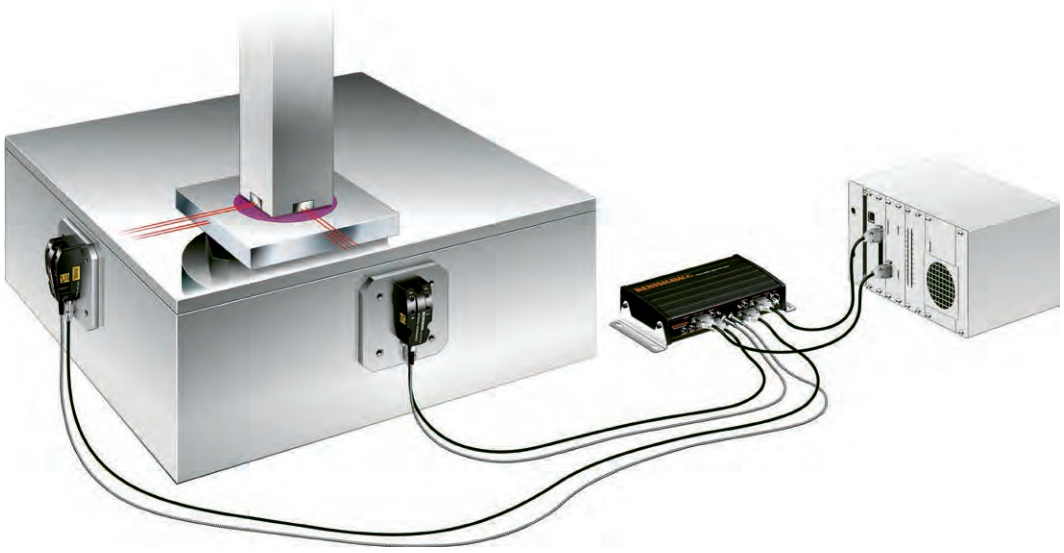


To maximise application flexibility, plane mirror and retroreflector interferometer detector heads are available with either 0º or 90º beam orientation. The heads can be mounted on either their top or bottom face, thereby providing an output beam with an orientation of 0º, 90º or 270º.

The RLE directly produces digital quadrature output resolutions to 10 nanometres with differential and plane mirror (double pass) interferometers, and 20 nanometres when using a retroreflector (single pass) interferometer. Additionally, the RLE system provides low latency 1 Vpp sine / cosine signals which have periods of 158 nanometres and 316 nanometres when used with differential / plane mirror and retroreflector interferometers respectively. Optionally, either an RGE interpolator or RPI20 parallel interface may be used in conjunction with the analogue output of the RLE system to enhance output resolutions to 0.39 nanometres or 38.6 picometres respectively for differential / plane mirror (double pass) interferometer configurations, and 0.79 nanometres or 77.2 picometres for retroreflector (single pass) interferometer configurations.

For non-vacuum applications, the RCU10 real-time quadrature compensation system may be used to provide real-time compensation for both refractive index variation and material expansion effects.

This data sheet provides performance specification information for various RLE system configurations.



Differential interferometer system configuration for vacuum and controlled environment applications

Plane mirror (double pass) RLE interferometer system configuration for X-Y applications

Retroreflector (single pass) RLE interferometer system configuration for linear applications

General outlines and dimensions

Dimensions in mm (inches)

RLU laser unit:

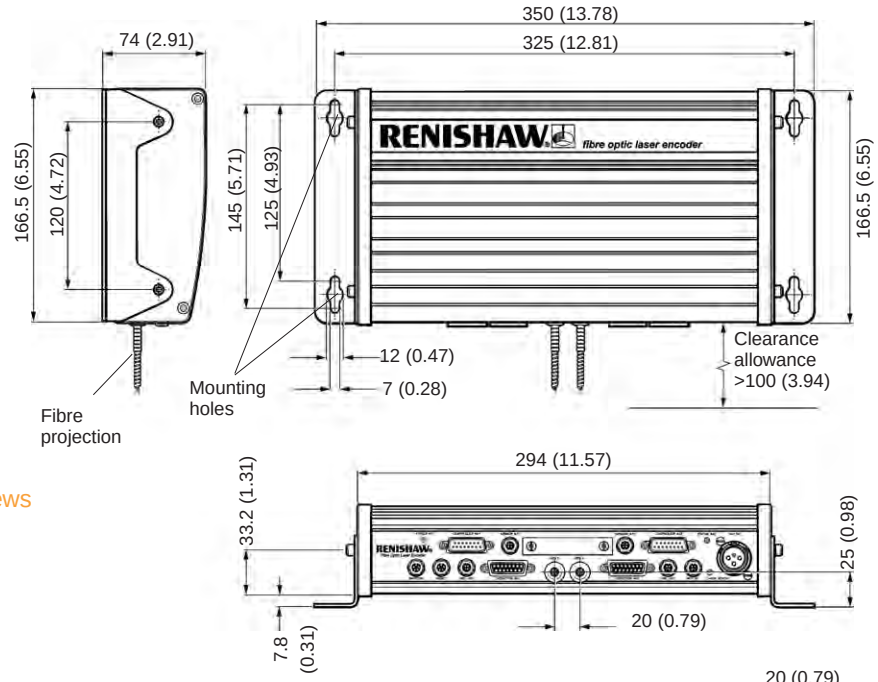
Overall dimensions:

Height: 74 (2.91)
Length: 350 (13.78)
Width: 166.5 (6.55)

The RLU can be mounted in any orientation, provided the surface is reasonably flat and free from vibration. Minimum cable and fibre bend radius is 25 mm

Fixing:

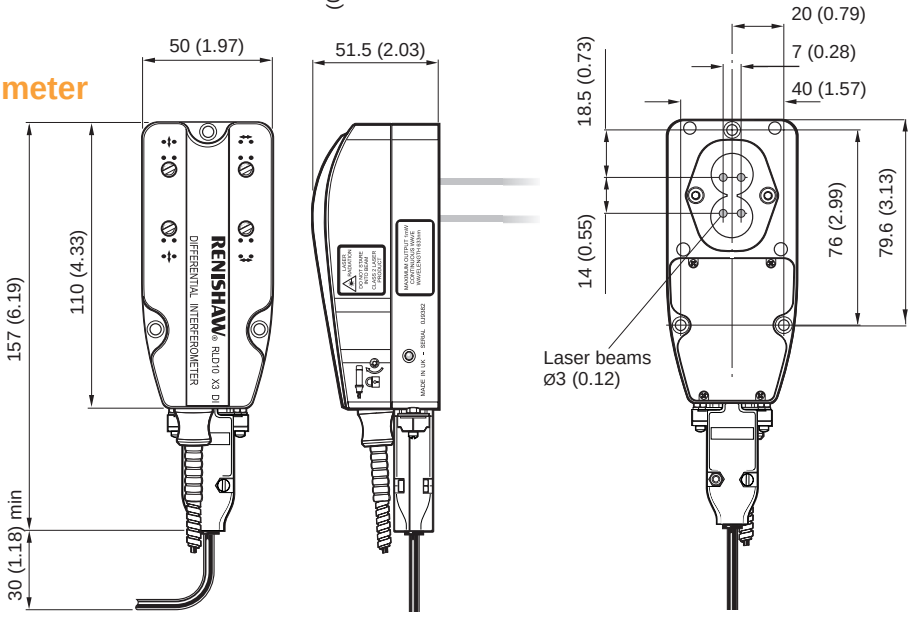
4 off M6 x 1.0 x 15 mm or
$^{1}/_{4}$-20-UNC x $^{5}/_{8}$ cap head screws



RLD10-X3-DI differential interferometer

Overall dimensions:

Height: 51.5 (2.03)
Length: 110 (4.33)
Width: 50 (1.97)



RLD10

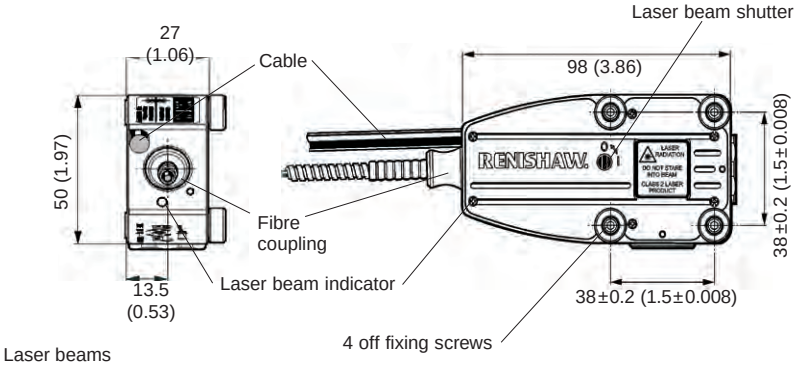
Overall dimensions of the detector head:

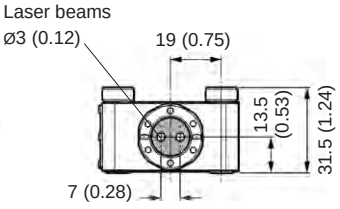
Height: 31.5 (1.24)
Length: 98 (3.86)
Width: 50 (1.97)

Fixing:

4 off M3 x 0.5 x 35 mm or
5-40-UNC x $1^{3}/_{8}$ cap head screws on a 38 mm² pitch

For maximum flexibility RLD10 detector heads may be mounted on either top or bottom face, providing beam launch orientations of 0°, 90° and 270°.

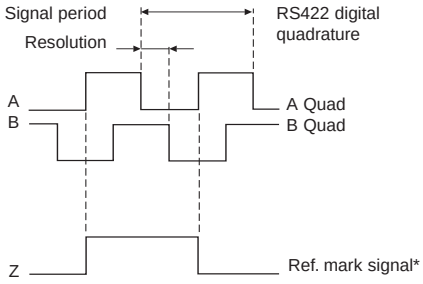




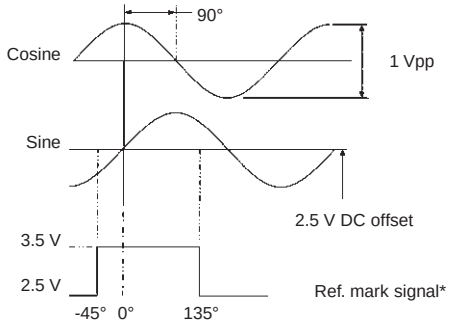
RLD10 detector heads are available for use with either plane mirror or retroreflector target optics. Dimensions and fixing requirements are the same for all optical configurations or beam launch orientations.

RLU output signals

Digital incremental - RS422 digital quadrature



Analogue incremental - 1 Vpp differential sine and cosine

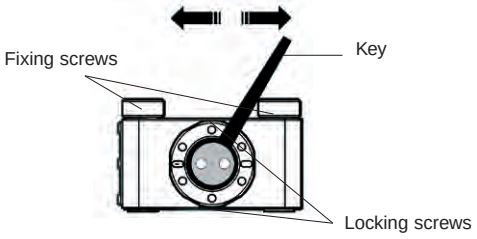


* Reference mark signal can be provided via an additional sensor

Laser beam alignment: RLD10 0° and 90°

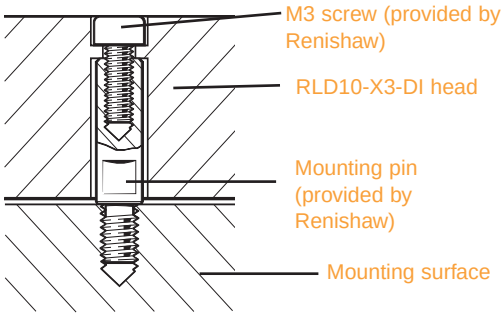
The RLD10 detector head incorporates a beam steerer to simplify the alignment process. Angular alignment in the plane of the mounting face (yaw) is achieved by slackening the fixing screws and rotating the detector head. Angular adjustment out of the mounting plane is achieved by rotating the integral beam steerer using the removable key tool.

Note: The installation and alignment process applies to both 0° and 90° beam launch detector heads, although only the 0° launch model is shown below.



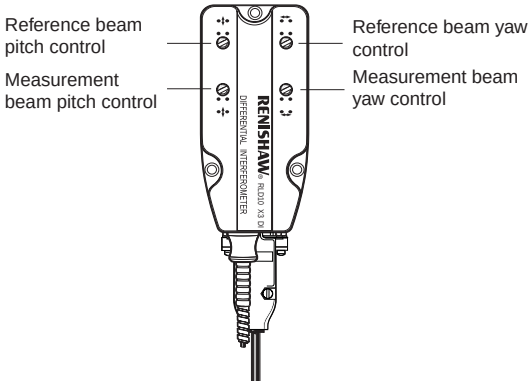
RLD10-X3-DI differential interferometer mounting

The RLD10-X3-DI detector head is designed to mount directly onto three pins (supplied with the detector head), located on the mounting surface. The mounting technique accommodates any differential expansion between the mounting surface and the detector head. The user is required to machine three M4 tapped holes for the pins, and, for vacuum applications, install an anti-reflection optical grade window for the laser beams. For alternative mounting requirements please contact a Renishaw representative.



Laser beam alignment: RLD10-X3-DI differential interferometer

The RLD10-X3-DI detector head contains four integrated beam steerers allowing independent pitch and yaw adjustments of the measurement and reference beams.



Legislative - Laser safety:

In accordance with IEC/EN60825-1, IEC/EN60825-2 and US standards 21CFR 1040 and ANSI Z136.1, Renishaw RLE lasers are Class II lasers and safety goggles are not required, since the blink reaction of a human will protect the eye from damage. Do not stare into the beam or shine it into the eyes of others. It is safe to view a diffuse-reflected beam. Do not dismantle the unit in any way; doing so may expose laser radiation in excess of Class II limits.

System operating parameters

Laser type Output beam intensity	HeNe Class II < 300 µW (cw) / axis	 During preheat this can rise to 600 µW
NTP wavelength T = 20 ºC, P = 1013.25 mB, RH = 50%	632.818270 nm 632.819719 nm	Axis 1 Axis 2
Vacuum wavelength accuracy	±0.1 ppm	(3 years)
Laser frequency stability (RLU10 / RLU20)	±10 ppb / ±1 ppb ±50 ppb / ±2 ppb ±50 ppb / ±20 ppb	1 minute 1 hour 8 hours
Output update rates	0.3125, 0.625, 1.25, 2.5, 5, 10 and 20 MHz	User selectable update rate options
Output formats	Dual RS422 differential digital quadrature 1 Vpp sine / cosine	User selectable resolutions (see below)
Power supply requirements	24 V ±2 V @ 2.5 A 24 V ±2 V @ 1.6 A 24 V ±2 V @ 0.6 A	Inrush (first 10 ms) Warm-up (~ 10 mins) Operation at room temperature 20 ºC
Operating environment Pressure Humidity Temperature	 650 - 1150 millibars 0% - 95% RH 10 ºC to 40 ºC	 Normal atmospheric Non-condensing (15 ºC to 30 ºC for a differential system)
Laser beam diameter	3 mm	Divergence < 0.25 mrad
Cable length (standard)	3 m	Detachable at the laser unit (and detector head in differential systems)
Cable diameter	6.5 mm	Terminated with a 15-way D-type connector and 15-way high density D-type at the other end
Fibre diameter (armoured)	5 mm	Removable from the interferometer head (connector 12 mm diameter)
Cable and fibre bend radii	25 mm static 50 mm dynamic	

	Differential system	**Plane mirror system**	**Retroreflector system**
			
Analogue output signal period	158 nm		316 nm
Digital quadrature nominal output resolutions	10, 20, 39.5, 79, 158 and 316 nm		20, 39.5, 79, 158, 316 and 633 nm
Resolution achievable with REE interpolator	0.39 nm		0.79 nm
Resolution achievable with RPI20 parallel interface	38.6 pm		77.2 pm
Maximum velocity	< 1 m/s		< 2 m/s
System non-linearity error (SDE)* < 5% of maximum velocity with > 70% signal strength at maximum velocity with > 50% signal strength *excluding interface	< ±1 nm < ±6 nm	< ±2.5 nm < ±7.5 nm	< ±5 nm < ±13 nm
Axis travel: measurement arm reference arm	0 - 1 m 0 - 0.5 m	0 - 1 m	0 - 4 m
Thermal drift coefficient	< 50 nm/ºC	< 100 nm/ºC	
Beam separation (centre to centre)	7 mm x 14 mm	7 mm	
Beam alignment adjustment	±1º pitch / ±1º yaw	±0.65º pitch / ±1.5º yaw	
Alignment tolerance	Plane mirror (1 m axis): ±25 arcseconds (tolerance applies to both pitch and yaw during operation)		Retroreflector: ±0.25 mm
Weight	2.8 kg (RLU10 or RLU20) 400 g (RLD10-X3-DI head alone) 690 g (detector head and cable)	2.8 kg (RLU10 or RLU20) 250 g (RLD10 detector head)	2.8 kg (RLU10 or RLU20) 250 g (RLD10 detector head) 12 g (retroreflector)

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About Renishaw

Renishaw is an established world leader in engineering technologies, with a strong history of innovation in product development and manufacturing. Since its formation in 1973, the company has supplied leading-edge products that increase process productivity, improve product quality and deliver cost-effective automation solutions.

A worldwide network of subsidiary companies and distributors provides exceptional service and support for its customers.

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- **Raman spectroscopy systems** for non-destructive material analysis
- **Sensor systems and software** for measurement on CMMs (co-ordinate measuring machines)
- **Styli** for CMM and machine tool probe applications

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0617 Part No. L-9904-2391-04 A

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RLD10 0º detector head

For the fibre optic laser encoder

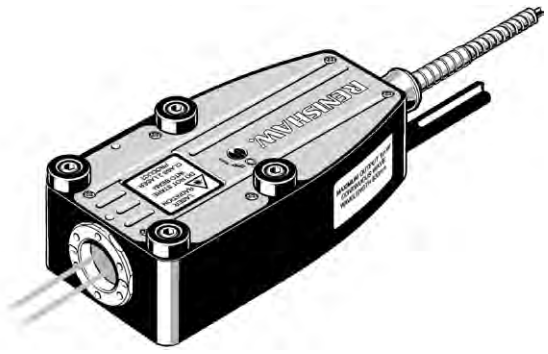
Renishaw's RLE fibre optic laser encoder uses interferometry to provide high resolution, high linearity position feedback.

The RLE system comprises an RLU laser unit and one or two RLD detector heads. This data sheet describes the RLD 0º detector head.

The detector head is the core of the optical measuring system containing the interferometer, reference optics, fringe detector, laser shutter and beam steerer.

To complete the interferometer configuration, only one additional optic is required in either plane mirror or retroreflector based configurations. For easy installation, the integral rotary beam steerer allows final adjustments to be made to optimise beam alignment after the head has been secured.

The head dissipates negligible power (<2 W) and is designed to be thermally stable.



Two versions of the RLD 0° head are available, one of which incorporates a plane mirror interferometer (PMI), the other a retroreflector interferometer (RRI). The fibre optic cable can be disconnected from the detector unit and the electrical cable can be disconnected from the laser head, thus allowing each to be pulled through small cable tracks and ducting. The detector head incorporates a safety interlock that prevents a laser beam being emitted if either the fibre or electrical cable are disconnected.

General outline and dimensions

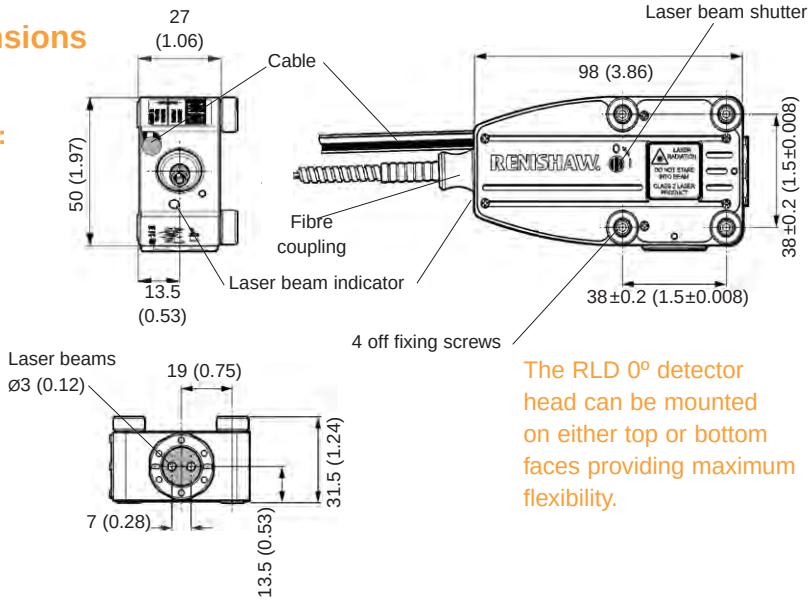
Dimensions in mm (inches)

Overall dimensions of the head:

Height:	31.5	(1.24)
Length:	98	(3.86)
Width:	50	(1.97)

Fixing:

4 off M3 x 0.5 x 35 mm or
5-40-UNC x $1^{3}/_{8}$ cap head screws
on a 38 mm square pitch.



The RLD 0º detector head can be mounted on either top or bottom faces providing maximum flexibility.

Legislative - Laser safety:

In accordance with IEC/EN60825-1, IEC/EN60825-2 and US standards 21CFR 1040 and ANSI Z136.1, Renishaw RLE lasers are Class II lasers and safety goggles are not required, since the blink reaction of a human will protect the eye from damage. Do not stare into the beam or shine it into the eyes of others. It is safe to view a diffuse-reflected beam. Do not dismantle the unit in any way; doing so may expose laser radiation in excess of Class II limits.

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RLD 0º detector head operating parameters

Axis travel	PMI RRI	0 m to 1 m 0 m to 4 m
Optical signal period	PMI RRI	λ/4 (158 nm) λ/2 (316 nm)
System non-linearity error (SDE)* *excludes interface	PMI RRI	<±2.5 nm below 50 mm/sec with >70% signal strength <±7.5 nm at 1 m/sec with >50% signal strength <±5 nm below 100 mm/sec with >70% signal strength <±13 nm at 2 m/sec with >50% signal strength
Thermal drift coefficient	<100 nm/ºC	Measured by mounting mirror and detector close together on a Zerodur® base and changing the temperature
Beam diameter	3 mm	
Beam separation	7 mm	Centre to centre
Beam alignment adjustment	±0.65º pitch ±1.5º yaw	Integrated beam steering to simplify beam alignment
Beam alignment tolerance for plane mirror (1 m axis)	±25 arcseconds	Tolerance applies to both pitch and yaw during operation
Cable length (standard)	3 m	Permanent attachment to the detector head and 15-way D-type connector at the laser
Cable diameter	6.5 mm	Terminated with a 15-way D-type connector
Fibre diameter (armoured)	5 mm	Removable from the detector head (connector 12 mm diameter)
Component weight	0.25 kg	
Operating environment Pressure Humidity Temperature	 650 mbar to 1150 mbar 0% to 95% RH 10 ºC to 40 ºC	 Normal atmospheric Non-condensing

Zerodur® is a registered trademark of Schott Glass Technologies

It is possible to operate an RLE system at axis lengths greather than those stated above, although the resulting signal strength will be affected by axis length, system velocity and optical alignment.

Laser beam alignment

The RLD 0º detector head incorporates a beam steerer to simplify the alignment process. Prior to installation, ensure that the alignment groves are horizontal and that both locking screws are loose, as shown in Figure 1. Align the head on the 4 mounting screws by securing one of the two nearest the aperture and rotate (yaw) the detector head until the maximum output signal strength is achieved. To then increase the output signal strength to its optimum, rotate the beam steerer using the key, as shown in Figure 1 to adjust the pitch. Finally, tighten the locking screw on the top side and 4 fixing screws.

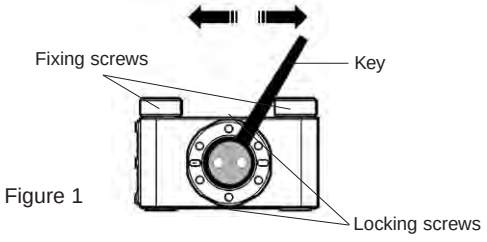
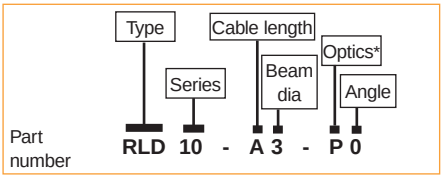


Figure 1

RLD identification and ordering

The RLD is normally supplied with the appropriate RLU laser unit as a configured RLE fibre optic laser encoder system. For full details of available RLE system configurations visit www.renishaw.com or consult a Renishaw representative. For special applications or spares requirements, the RLD is available separately; the generic form RLD detector head part number is shown below:



* P = plane mirror, R = retroreflector

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0617 Part No. L-9904-2348-05

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RLD10 90º detector head

For the fibre optic laser encoder

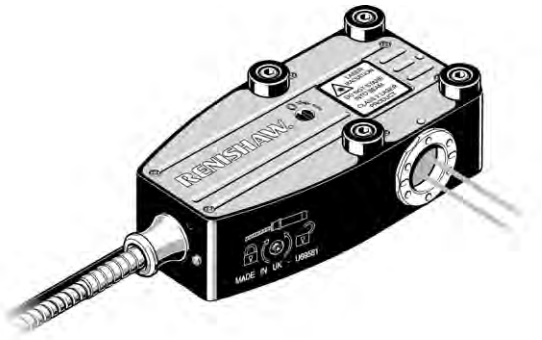
Renishaw's RLE fibre optic laser encoder uses interferometry to provide high resolution, high linearity position feedback.

The RLE system comprises an RLU laser unit and one or two RLD detector heads. This data sheet describes the RLD 90º detector head.

The detector head is the core of the optical measuring system containing the interferometer, reference optics, fringe detector, laser shutter and beam steerer.

To complete the interferometer configuration, only one additional optic is required in either plane mirror or retroreflector based configurations. For easy installation, the integral rotary beam steerer allows final adjustments to be made to optimise beam alignment after the head has been secured.

The head dissipates negligible power (<2 W) and is designed to be thermally stable.



Two versions of the RLD 90° detector head are available, one of which incorporates a plane mirror interferometer (PMI), the other a retroreflector interferometer (RRI). The fibre optic cable can be disconnected from the detector unit and the electrical cable can be disconnected from the laser head, thus allowing each to be pulled through small cable tracks and ducting. The detector head incorporates a safety interlock that prevents a laser beam being emitted if either the fibre or electrical cable are disconnected.

General outline and dimensions

Dimensions in mm (inches)

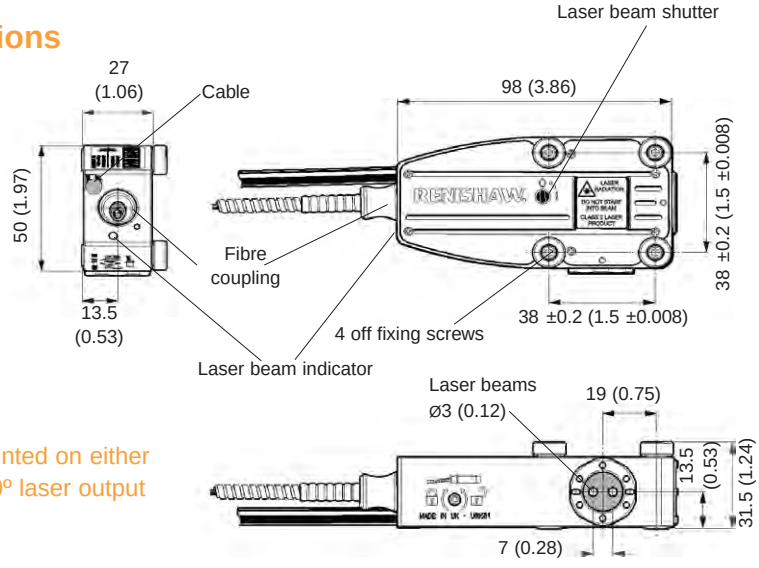
Overall dimensions:

Height:	31.5	(1.24)
Length:	98	(3.86)
Width:	50	(1.97)

Fixing:

4 off M3 x 0.5 x 35 mm or
5-40-UNC x $1^{3}/_{8}$ cap head screws
on a 38 mm square pitch.

The RLD 90º detector head can be mounted on either top or bottom faces providing 90º or 270º laser output from the same unit.



Legislative - Laser safety:

In accordance with IEC/EN60825-1, IEC/EN60825-2 and US standards 21CFR 1040 and ANSI Z136.1, Renishaw RLE lasers are Class II lasers and safety goggles are not required, since the blink reaction of a human will protect the eye from damage. Do not stare into the beam or shine it into the eyes of others. It is safe to view a diffuse-reflected beam. Do not dismantle the unit in any way; doing so may expose laser radiation in excess of Class II limits.

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RLD 90º detector head operating parameters

Axis travel	PMI RRI	0 m to 1 m 0 m to 4 m
Optical signal period	PMI RRI	λ/4 (158 nm) λ/2 (316 nm)
System non-linearity error (SDE)* *excluding interface	PMI RRI	<±2.5 nm below 50 mm/sec with >70% signal strength <±7.5 nm at 1 m/sec with >50% signal strength <±5 nm below 100 mm/sec with >70% signal strength <±13 nm at 2 m/sec with >50% signal strength
Thermal drift coefficient	<100 nm/ºC	Measured by mounting mirror and detector close together on a Zerodur® base and changing the temperature
Beam diameter	3 mm	
Beam separation	7 mm	Centre to centre
Beam alignment adjustment	±0.65º pitch ±1.5º yaw	Integrated beam steering to simplify beam alignment
Beam alignment tolerance for plane mirror (1 m axis)	±25 arcseconds	Tolerance applies to both pitch and yaw during operation
Cable length (standard)	3 m	Permanent attachment to the detector head and 15-way D-type connector at the laser
Cable diameter	6.5 mm	Terminated with a 15-way D-type connector
Fibre diameter (armoured)	5 mm	Removable from the detector head (connector 12 mm diameter)
Component weight	0.25 kg	
Operating environment Pressure Humidity Temperature	 650 mbar to 1150 mbar 0% to 95% RH 10 ºC to 40 ºC	 Normal atmospheric Non-condensing

Zerodur® is a registered trademark of Schott Glass Technologies

It is possible to operate an RLE system at axis lengths greather than those stated above, although the resulting signal strength will be affected by axis length, system velocity and optical alignment.

Laser beam alignment

The RLD 90º detector head incorporates a beam steerer to simplify the alignment process. Prior to installation, ensure that the alignment groves are horizontal and that both locking screws are loose, as shown in Figure 1. Align the head on the 4 mounting screws by securing one of the two nearest the aperture and rotate (yaw) the detector head until the maximum output signal strength is achieved. To then increase the output signal strength to its optimum, rotate the beam steerer using the key, as shown in Figure 1 to adjust the pitch. Finally, tighten the locking screw on the top side and 4 fixing screws.

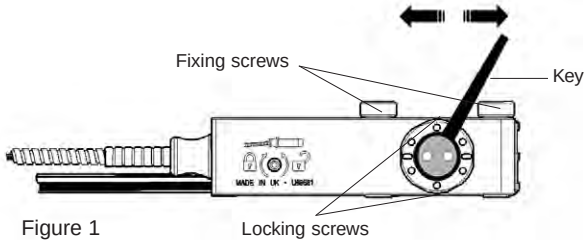
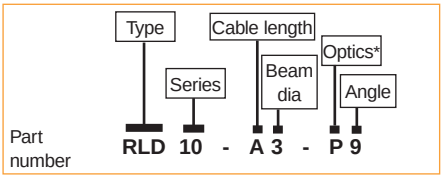


Figure 1

RLD identification and ordering

The RLD is normally supplied with the appropriate RLU laser unit as a configured RLE fibre optic laser encoder system. For full details of available RLE system configurations visit www.renishaw.com or consult a Renishaw representative. For special applications or spares requirements, the RLD is available separately; the generic form RLD detector head part number is shown below:



* P = plane mirror, R = retroreflector

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0617 Part No. L-9904-2347-05

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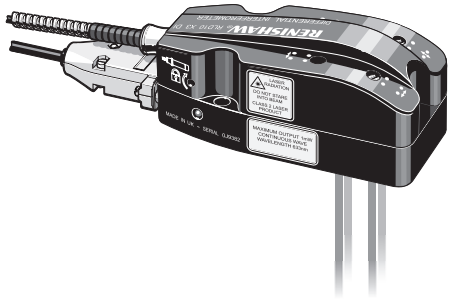
RLD10 DI (differential interferometer) detector head

The Renishaw RLE fibre optic laser encoder uses interferometry to provide high resolution, high linearity position feedback.

The RLE system comprises an RLU laser unit and one or two RLD detector heads. The RLU laser unit contains the laser source and signal processing electronics. It is available with one or two fibre optic laser outputs that deliver laser light directly to the RLD detector heads. The detector head is the core of the optical measuring system containing the interferometer optics, novel Renishaw detection scheme and beam steering mechanisms.

The RLE range offers a variety of laser units and detector heads to suit specific application requirements - all system components are compatible with each other.

This data sheet describes the RLD10-X3-DI differential interferometer detector head, which measures the relative displacement between two plane mirror targets including one fixed-position reference mirror. This ensures accurate positioning between critical process components and eliminates common mode errors.



In vacuum chamber applications, the detector head is mounted on the outside of the chamber with the laser beams entering through a suitably positioned viewport. To enable laser alignment to be completed from outside the chamber, this RLD head includes individual pitch and yaw adjusters for both the reference and measurement beams.

Both the fibre optic and electrical cables can be disconnected from the detector unit, further simplifying integration. The detector head incorporates a safety interlock that prevents a laser beam being emitted if either the fibre or electrical cable are disconnected.

General outline and dimensions

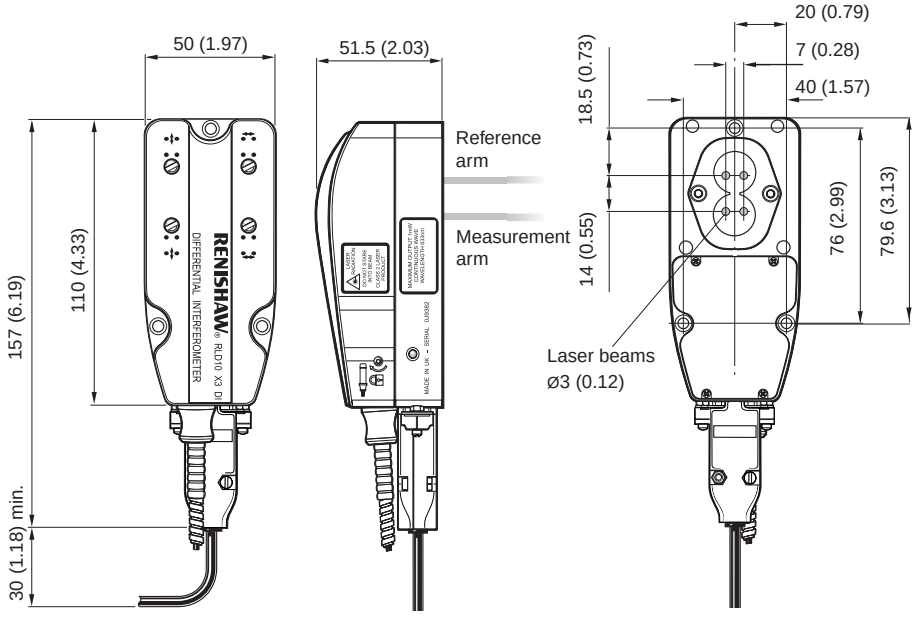
Dimensions in mm (inches)

Overall dimensions:

Height:	51.5	(2.03)
Length:	110	(4.33)
Width:	50	(1.97)

Fixing:

See overleaf



Legislative - Laser safety:

In accordance with IEC/EN60825-1, IEC/EN60825-2 and US standards 21CFR 1040 and ANSI Z136.1, Renishaw RLE lasers are Class II lasers and safety goggles are not required, since the blink reaction of a human will protect the eye from damage. Do not stare into the beam or shine it into the eyes of others. It is safe to view a diffuse-reflected beam. Do not dismantle the unit in any way; doing so may expose laser radiation in excess of Class II limits.

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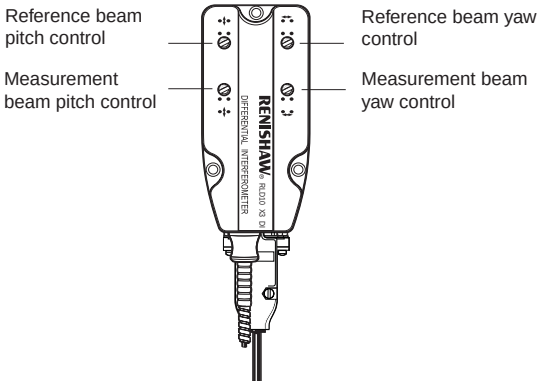
RLD10-X3-DI detector head performance

Axis travel	0 m to 1 m 0 m to 0.5 m	Measurement arm Reference arm (fixed path length)
Optical signal period	λ/4 (158 nm)	
System non-linearity error (SDE)* *excludes interface	<±1 nm <±6 nm	Below 50 mm/sec with >70% signal strength At 1 m/s with >50% signal strength
Thermal drift coefficient	<50 nm/ºC	
Beam diameter	3 mm	
Beam separation	7 mm x 14 mm	See diagram overleaf
Beam alignment adjustment	±1º pitch ±1º yaw	Integrated beam steering to simplify beam alignment
Plane mirror alignment tolerance (1 m axis)	±25 arcseconds	
Cable length (standard)	3 m	Detachable at the laser unit and detector head
Electrical cable diameter	6.5 mm	Terminated with a 15-way D-type connector and 15-way high density D-type at the other end
Fibre cable diameter (armoured)	5 mm	Removable from the detector head (connector 12 mm diameter)
Component weight	400 g 290 g	RLD10-X3-DI head with no cable attached 3 m cable
Operating environment Pressure Humidity Temperature	 650 mbar to 1150 mbar 0% to 95% RH 15 ºC to 30 ºC	 Normal atmospheric Non-condensing

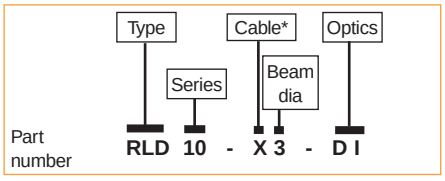
Laser beam alignment

The RLD10-X3-DI detector head contains four integrated beam steerers so that pitch and yaw adjustments can be made on the measurement and reference beams.



RLD identification and ordering

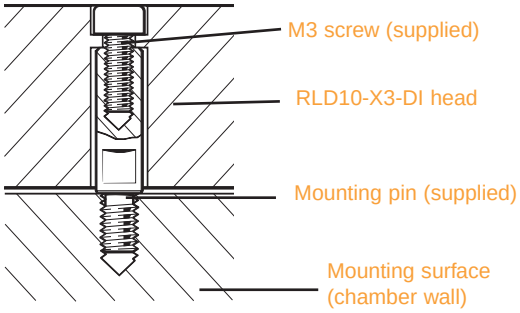
The RLD10-X3-DI detector head is normally supplied with the appropriate RLU laser unit as a configured RLE fibre optic laser encoder system. For full details of available RLE system configurations visit www.renishaw.com or consult a Renishaw representative. For special applications or spares requirements the RLD10-X3-DI is available separately, using the part number shown below:



* Cable only supplied when RLD10-X3-DI is purchased as part of a system. If you require a cable, please order A-5225-0260.

Mounting

The detector head is designed to mount directly onto three pins (supplied with the detector head), located on the mounting surface. The mounting technique accommodates any differential expansion between the mounting surface and head. The user is required to machine three M4 tapped holes for the pins and install an anti-reflection optical grade window for the laser beams. For alternative mounting requirements please contact a Renishaw representative.



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Low power RLD detector heads

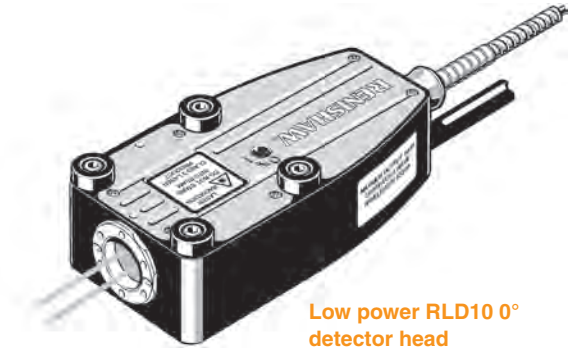
For the fibre optic laser encoder

Renishaw's RLE fibre optic laser encoder uses interferometry to provide high resolution, high linearity position feedback.

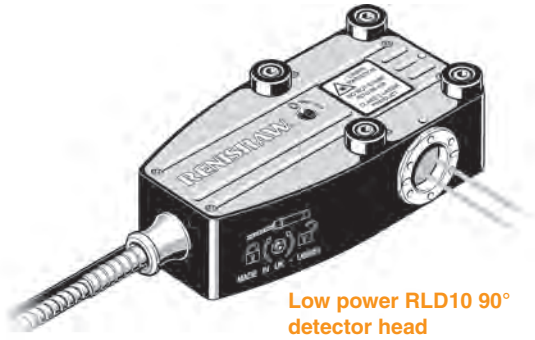
The RLE system comprises an RLU laser unit and one or two RLD detector heads. This data sheet describes the low power variants of the RLD detector head.

Detector heads are available in low power options for applications requiring a power dissipation lower than the specified < 2 W of the standard RLD. To minimise power dissipation the internal circuitry has been changed and the power LED has been removed; its location has been blackened to avoid confusion.

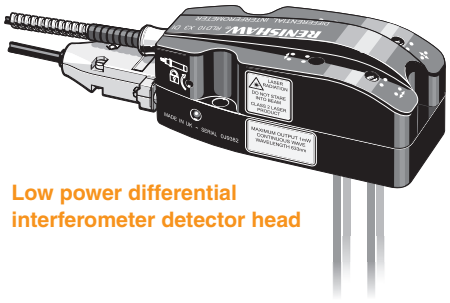
All deviations from the standard RLD10 are covered in this data sheet - other parameters can be assumed identical to the standard RLD10 as detailed in *RLD10 0º detector head data sheet* (Renishaw part no. L-9904-2348) and *RLE fibre optic laser encoder installation guide* (Renishaw part no. M-5225-0568).



Low power RLD10 0° detector head



Low power RLD10 90° detector head



Low power differential interferometer detector head

Specification deviation

Heat dissipation	0.14 W
Nominal data age*	2.9 µs
Maximum speed**	23.7 mm/s (PMI / DI)
	47.4 mm/s (RRI)

* This has an estimated axis-to-axis variation of ±3%
** This applies to all available digital quadrature output resolutions and analogue quadrature output.

Legislative - Laser safety:

In accordance with IEC/EN60825-1, IEC/EN60825-2 and US standards 21CFR 1040 and ANSI Z136.1, Renishaw RLE lasers are Class II lasers and safety goggles are not required, since the blink reaction of a human will protect the eye from damage. Do not stare into the beam or shine it into the eyes of others. It is safe to view a diffuse-reflected beam. Do not dismantle the unit in any way; doing so may expose laser radiation in excess of Class II limits.

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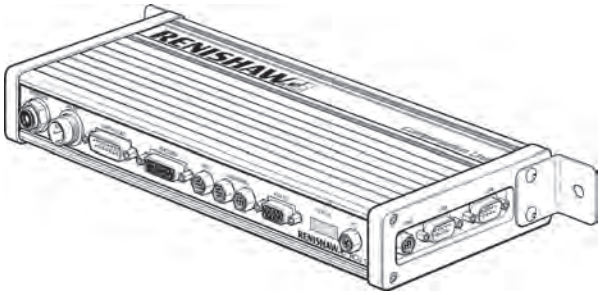
RCU10 real time quadrature compensation system

The RCU10 real time quadrature compensation system overcomes environmental error sources in linear motion systems to improve process accuracy and repeatability.

The RCU10 monitors a machine's ambient environment via a series of sensors and uses advanced digital signal processing to perform real time compensation on the position feedback signals. The unit provides the corrected feedback signals to the motion controller in either RS422 digital AquadB or analogue sine/cosine 1 Vpp formats.

The factory calibrated sensors can be linked via a network and optional sensor distribution box. Each sensor is configured to a unique network address to enable interrogation by any compensator within multi-axis configurations.

Configuration of the RCU10 is achieved via an RS232 link to a PC running the Renishaw RCU10-CS-XX configuration software. This enables the user to select the mode of compensation and define axis specific parameters (input resolution, output resolution, output format etc).

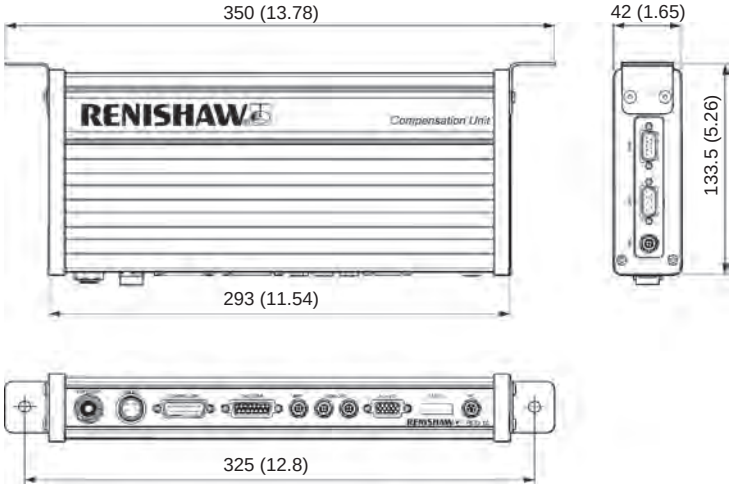


The RCU10 can provide:

- Refractive index compensation for Renishaw laser encoders, using air pressure and temperature sensors.
- Scale expansion compensation for incremental linear encoders, using material temperature sensors.
- Thermal expansion compensation of machine structure using material temperature sensors.
- Work piece thermal expansion compensation, using material temperature sensors.

General outline and dimensions

Dimensions in mm (inches)



Overall dimensions:

Height:	42	(1.65)
Length:	350	(13.78)
Width:	133.5	(5.26)

Fixing:

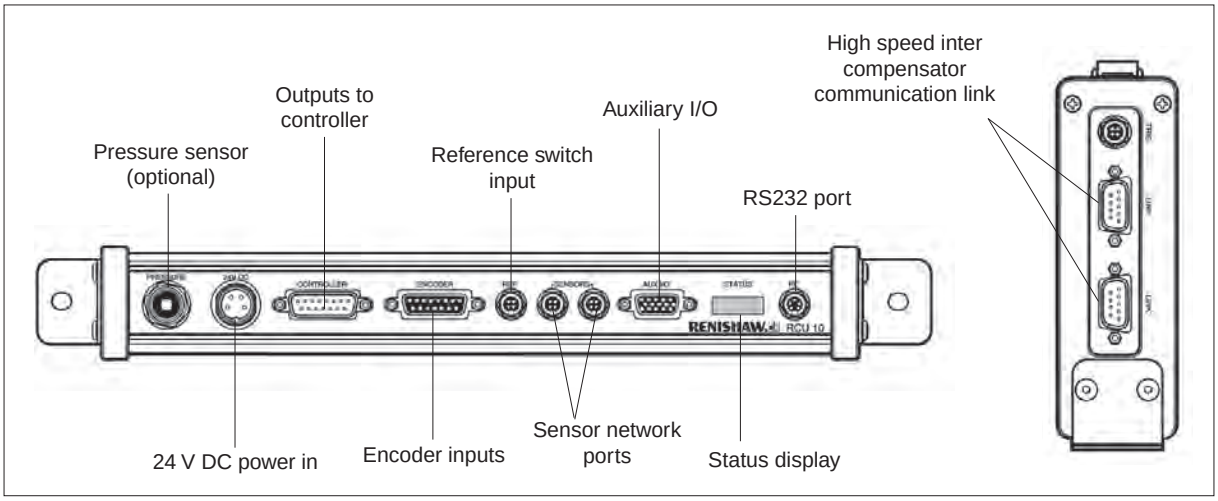
2 off M6 x 1.0 x 15 mm* or
$^{1}/_{4}$-20-UNC x $^{5}/_{8}$ cap head screws*

*Not supplied

The RCU10 has DIN rail compatible mounting brackets and can be mounted in any orientation.

General information:

Weight	2 kg
EMC compliance	BS EN 61326
	FCC 47 CFR PART 15J



RCU10 power supply

Status	Voltage	Current	Power
Operational	24 V ±2 V	<0.25 A*	6 W

*with up to 8 sensors

Operating environment

Pressure	Normal atmospheric (650 mbar to 1150 mbar)
Humidity	0% to 95% RH (non-condensing)
Temperature	0 ºC to 50 ºC
Sealing	IP40

Performance overview

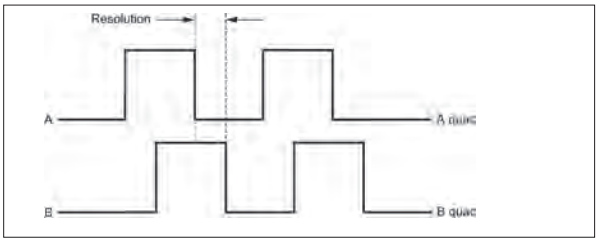
Input resolutions	10 nm to 5 µm (digital only)	
Output resolutions	Digital	10 nm to 5 µm
	Analogue	20 µm to 100 µm
Accuracy**	±1 ppm (refractive index compensation only)*	
	±2 ppm (with 10 ppm/ºC material compensation)	
Maximum velocity	5 m/s for resolutions >400 nm	
	0.2 m/s at 10 nm resolution	
Propagation delay	<1 µs (digital output)	
	<2 µs (analogue output)	
Output update rate	20/10/5/2.5 MHz (digital)	
	10 MHz (analogue)	
Input sample rate	40/20/10/5/2.5 MHz	
Compensation update rate	200 µs	

* Plus the greater of ±3 input counts and ±1 output counts for digital outputs and a further velocity dependent following error for some analogue outputs.

**This assumes a working atmospheric environment that falls within the range as defined in the sensor data opposite.

RCU10 input signals

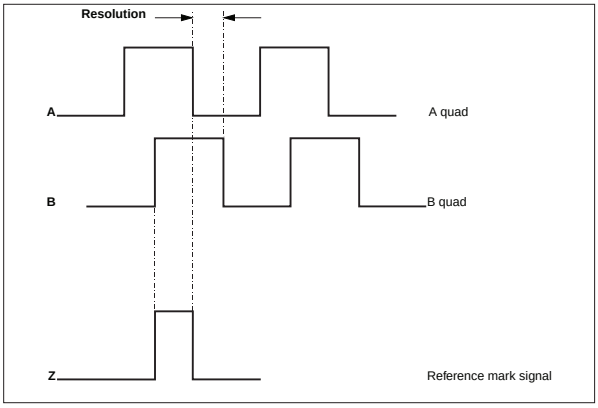
Digital quadrature input*



RCU10 output signals

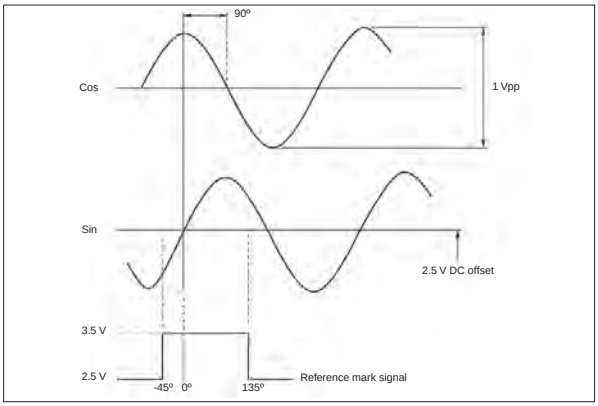
Digital incremental*

RS422 differential line driver outputs



Analogue incremental*

1 Vpp differential sine and cosine line driver outputs



*Only one side of differential signals is shown for clarity

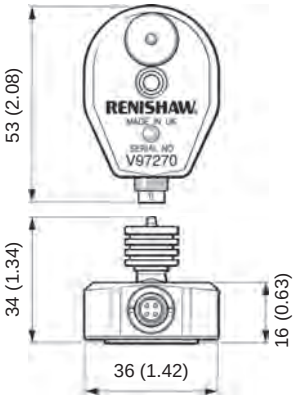
Environmental sensors

In air, the wavelength of light is a function of the refractive index, which is dependent on temperature, pressure and, to a lesser extent, humidity. To compensate for refractive index variations, the RCU10 system has an optional internal air pressure sensor and remote air temperature sensors, to accurately monitor these parameters in real time. A humidity value can be entered manually via the configuration software if required.

Material temperature sensors are also available to provide thermal expansion compensation for incremental linear encoders, machine structure and work pieces.

Air temperature sensor

Dimensions in mm (inches)



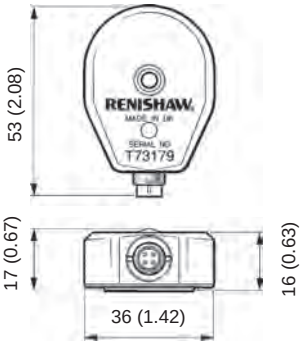
Accuracy	±0.2 °C (k=2)
Measurement range	0 °C to 40 °C
Resolution	0.01 °C
Update rate	1 Hz
Fixing	Magnetic, screw or vacuum*
Cable**	5 m cable (not supplied) Extensions available Armoured version available
Sealing	IP67

* Vacuum mounting requires optional vacuum accessory kit

**Cable must be ordered separately

Material temperature sensor

Dimensions in mm (inches)



Accuracy	±0.1 °C (k=2)
Measurement range	0 °C to 55 °C
Resolution	0.01 °C
Update rate	1 Hz
Fixing	Magnetic, screw or vacuum*
Cable**	5 m cable (not supplied) Extensions available Armoured version available
Sealing	IP67

* Vacuum mounting requires optional vacuum accessory kit

**Cable must be ordered separately

Air pressure sensor

This optional sensor is located inside the RCU10 unit.

Accuracy	±2.0 mbar (k=2)
Measurement range	650 mbar to 1150 mbar
Resolution	0.2 mbar
Update rate	1 Hz

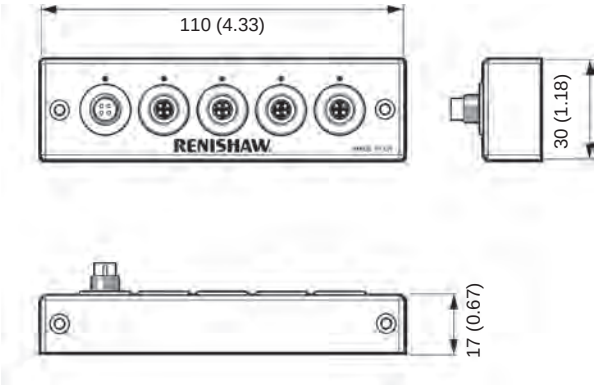
Sensor status LED information

LED status	Sensor status
Slow green flashes	Sensor functional
Fast green flashes	Sensor accessed
Slow red flashes	Sensor error*
Fast red flashes	Communication error*

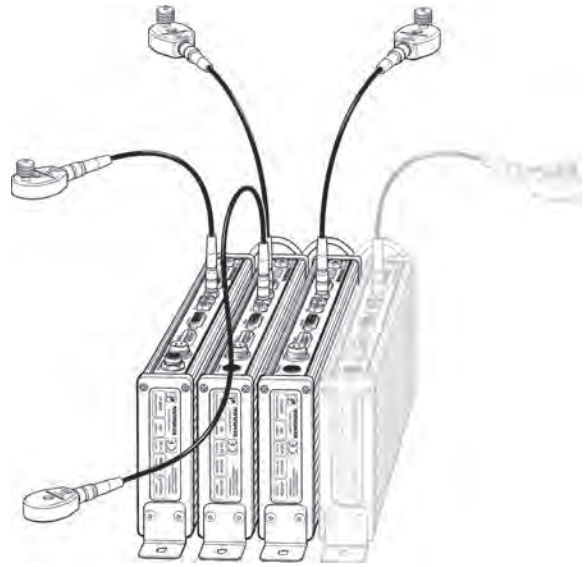
*One red flash on power up

Sensor distribution box

The RCU10-DB-XX distribution box allows a network of up to four sensors to be connected to each sensor port of the RCU10 compensator. A maximum of eight sensors per RCU10 can be used with a maximum of 32 in a multi-axis system.



Dimensions in mm (inches)



A typical multi-axis configuration for laser encoder compensation

A maximum of six RCU10 compensation units can be used in a system.

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Compensation software

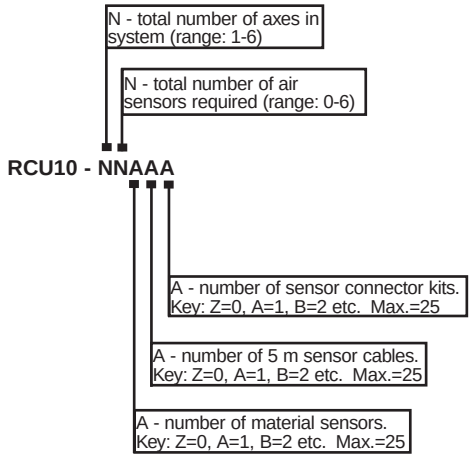
The RCU10-CS-XX software enables a wide range of parameters within the compensator to be configured to match the specific requirements of the application. Users with the software suite installed on their PC - and appropriate access rights - can extract and amend all relevant information from within the compensator system.

The minimum PC specification recommended to run the RCU10-CS-XX software is:

- 200 MHz Pentium processor (or equivalent)
- 20 MB RAM (minimum)
- 40 MB free hard drive space (minimum)
- Windows® XP SP3, Vista™ (32 bit or 64 bit), Windows 7 and Windows 8 (32 bit or 64 bit)
- 800 x 600 screen resolution (minimum); 1024 x 768 (preferred)
- 16-bit colour
- CD-ROM drive
- At least one free serial port - either RS232 or USB used with an RS232 to USB converter (available from Renishaw)

RCU10 kit identification

RCU10 compensation systems are available in a range of pre-defined kits to suit common system configurations from 1 to 6 axes. These kits are numbered using the following system:



These pre-defined RCU10 compensation kits have 24 months warranty and, dependant on selected configuration include:

- RCU10 unit per axis*
- Material temperature sensor
- Pressure sensor (laser encoder kits only)
- Air temperature sensor per axis (laser encoder kits only)
- Sensor cables (1 off 5 m cable for sensor)
- Sensor connector kit
- RCU10 connector kit
- High speed serial link
- PC RS232 cable
- RCU10 CS software
- RCU10 installation manual

* It is assumed that if an air sensor is required, at least one axis will be using refractive index compensation, therefore one of the RCU10s provided will be an RCU10-PX-XX, which contains a pressure sensor.

Should you have an application requiring an RCU10 compensation system, please contact a Renishaw representative to discuss part numbering in detail.

The following accessories are also available:

- Serial-USB adapter (A-8014-0670)
- Sensor distribution box (RCU10-DB-XX)
- Armoured sensor cable (5 m) (RCU10-AC-X5)
- Sensor vacuum accessory kit (RCU10-VA-XX)
- Sensor vacuum connector assembly (A-9904-1711)
- Sensor vacuum seal kit (spare x 5) (A-9904-1712)

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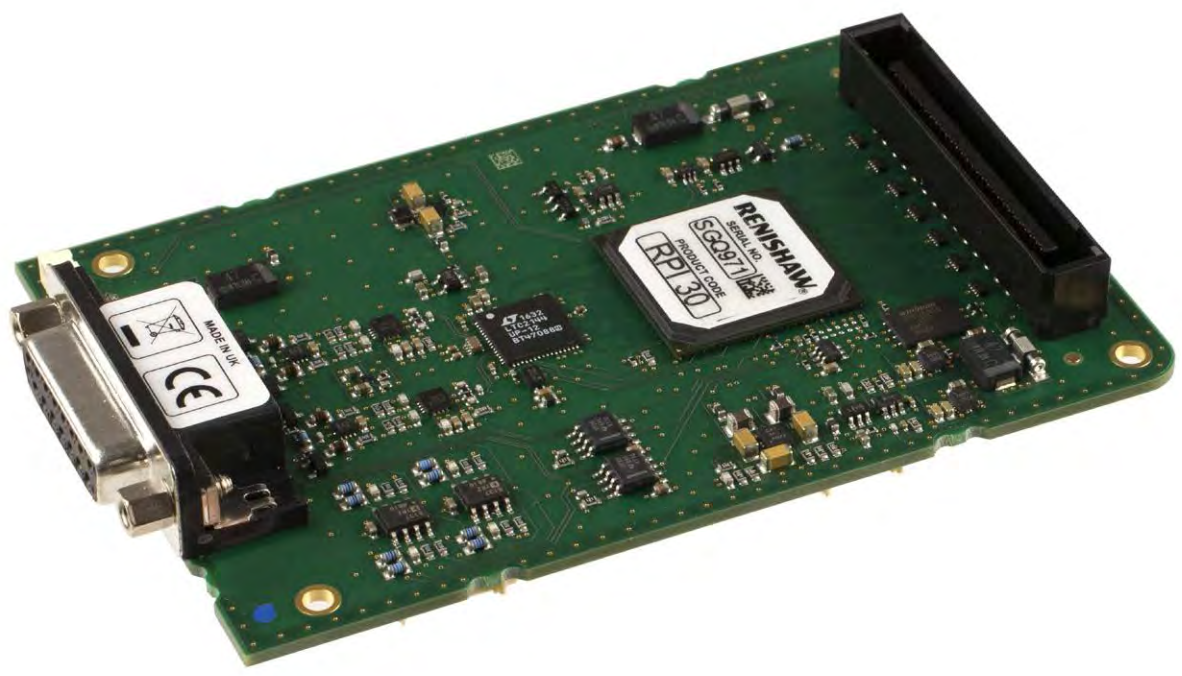
RPI30 parallel interface



This data sheet contains an overview and specification of the Renishaw RPI30 parallel interface. The RPI30 accepts differential analogue 1 Vpp sine/cosine signals, interpolates by 4096 and provides an output in parallel format with up to 36-bits of position data being available. When used in combination with a double pass plane mirror interferometer system (PMI) (fundamental period of sinusoids is nominally 158 nm), this results in an LSB of 38.6 picometres at velocities of up to 2 m/sec. Active lissajous correction can be enabled to compensate for DC offset and AC mismatch from the laser encoder to improve the sub divisional error (SDE) to ±0.1 nm at low velocities.

The parallel interface is similar to the RPI20 running at 3.0V (3.3V tolerant). Control and monitoring of the RPI30 is performed via an SPI interface in the parallel bus connector, options such as address, direction, resolution and lissajous correction are stored in EEPROM and loaded on power up. RPI30s can be configured before installation if no SPI interface is available.

Optional connections for active feedthrough of the analogue quadrature (uncorrected) and RS422 full duplex diagnostics interface are provided.

Information available over the diagnostics (RS422) and control (SPI) interfaces includes:

- Device information including version and serial number
- ADC data at full resolution
- Full range magnitude (signal strength)
- Full resolution position independent of parallel interface settings
- Parallel interface settings
- Full error information and ability to reset errors independently of position
- Lissajous correction status
- Lissajous correction setup and control
- Internal datalogger which can capture position or ADC data up to the full 100 MHz internal sample rate.

Performance Specification

Values stated define the contribution of the RPI30 on the system performance, NOT the complete laser interferometer system performance.

Measurement performance

		Plane mirror - PMI	Retro Reflector - RRI
LSB resolution – user selectable		38.6, 77.2, 154.4 or 308.8 pm	77.2, 154.4, 308.8 or 617.6 pm
Maximum speed		2 m/s	4 m/s
Positional noise contribution (RMS) signal strength >25%		< 38.6 pm	< 72.2 pm
SDE contribution (excluding RLE and without correction enabled)	**Velocity < 50 mm/s (PMI) Velocity < 100 mm/s (RRI) Signal strength > 25%**	< ±0.5 nm	< ±1.0 nm
	Velocity > 50 mm/s and < 2 m/s Velocity > 100 mm/s and < 4 m/s	< ±2.0 nm	< ±4.0 nm
SDE including RLE with correction enabled	**Velocity < 50 mm/s (PMI) Velocity < 100 mm/s (RRI) Signal strength > 50%**	< ±0.1 nm	< ±0.2 nm
Position data format		36-bit (two's compliment)	
Propagation delay (actual position is sampled) before latch enable signal		135 ns	
Propagation delay variation		±5 ns	

RPI30 power requirements

Voltage	5 V ±0.25 V
Operating current	500 mA
Noise and ripple	50 mVpp (DC to 10 MHz)

Note: *the 5 V power supply should be single fault tolerant certified to EN (EC) 60950-1.*

Environmental specification

Pressure	Normal atmospheric pressure (650 mbar – 1150 mbar)	
Humidity	0-95% RH (non-condensing)	
Temperature	Storage	-20 °C to +70 °C
	Operating	+10 °C to +40 °C

Parallel bus and SPI interfaces

	Min (V)	Max (V)
Input low	-0.3	0.8
Input high	1.7	3.5
Output low	0	0.2
Output high	2.8	3.0

Note: *The digital interface on JAE connector is 3.0 V LVCMOS, although they are compatible with 3.3 V LVCMOS*

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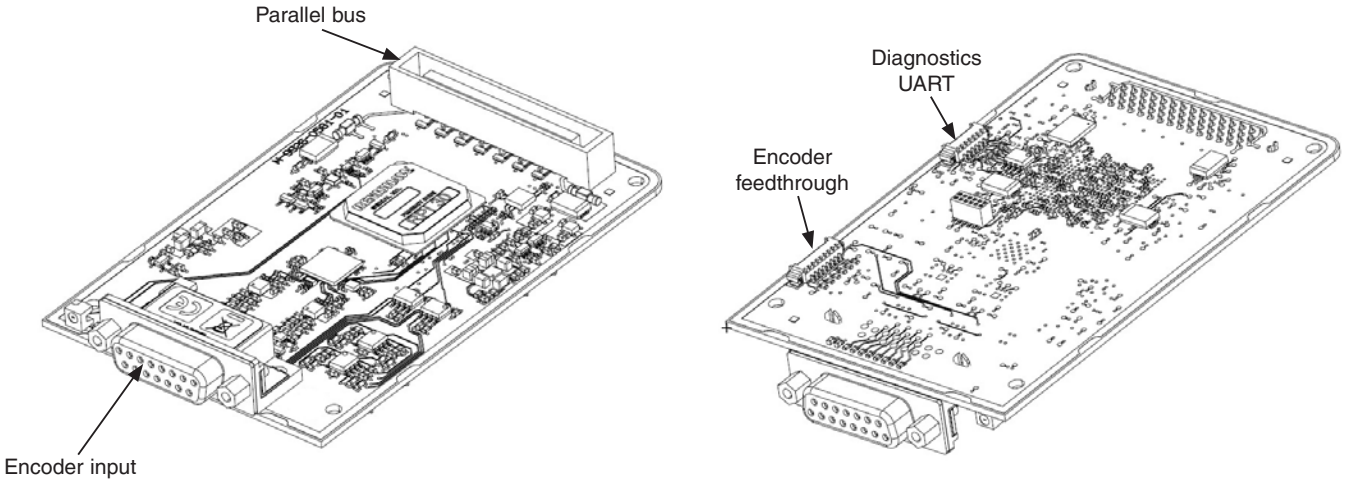
Encoder feedthrough

Analogue quadrature		Nominal 1V p-p into 120ohm termination	Copy of encoder output, no SDE correction applied.
Error		RS422 differential error	Encoder error only.
		Plane Mirror - PMI	**Retro Reflector - RRI**
SDE contribution	**Velocity < 50 mm/s (PMI)** **Velocity < 100 mm/s (RRI)** **Signal strength > 25%**	< ±0.5 nm	< ±1.0 nm
Max velocity		2 m/s	4 m/s

Diagnostics UART

Signal level	RS422 full duplex
Baud rate	3 M
Format	1 start bit, 8 data bits, 1 stop bit, no parity



RPI30 connectors

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RPI20 parallel interface

This data sheet contains an overview and specification of the Renishaw RPI20 parallel interface.

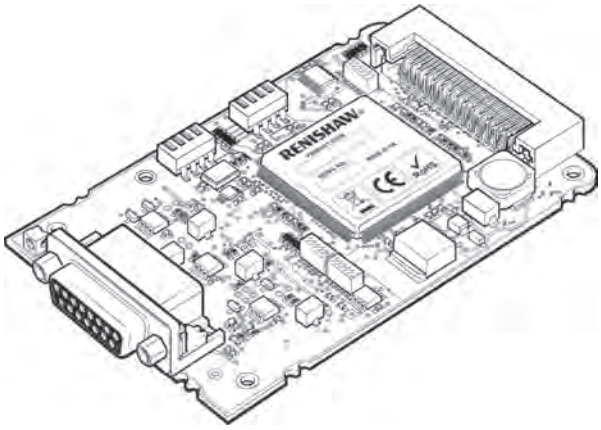
The RPI20 accepts differential analogue 1 Vpp sine/cosine signals, interpolates by 4096 and provides an output in parallel format with up to 36-bits of position data being available.

When used in combination with a double pass plane mirror interferometer system (PMI) (fundamental period of sinusoids is nominally 158 nm), this results in an LSB of 38.6 picometres at velocities of up to 1 m/sec.

The system architecture comprises a daughter board and 'industry standard' (VME) interface motherboards specifically designed to accommodate docking of either one or two (format dependent) daughter boards.

For multi-axis bus based architectures, the daughter board contains switches which allow each board to be assigned a unique address extending capability to up to seven axes. Additional switches enable selection of the LSB value and the direction sense to be changed.

Each daughter board contains four 36-bit wide addressable registers providing access to position, status and control information.



In the VME configuration, no connection is required to the P1 (VME interface) connector; all functions are accessed through the P2 connector.

Data timing is as shown in the timing diagram overleaf.

Parallel interface performance

Resolution	38.6 pm (double pass plane mirror interferometer - PMI) 77.2 pm (single pass retroreflector interferometer - RRI)	
Maximum velocity	1 m/s (double pass plane mirror interferometer - PMI) 2 m/s (single pass retroreflector interferometer - RRI)	
Maximum update rate	4 MHz (single axis) 2.86 MHz (dual axis) 2.22 MHz (three axis) Each additional axis will require a further 100 ns to read, assuming each axis is read in turn	
Data age uncertainty	<±10 ns	
SDE contribution (PMI)	<±0.5 nm (low bandwidth, velocities <50 mm/sec) >70% <120% signal strength <±2 nm (full bandwidth, velocities <1 m/sec) >50% <120% signal strength	
User configurable features	Base address selection LSB value (available selections with double pass PMI 38.6, 77.2, 154.4, 308.8 pm) Direction sense	
Power supply required	5 V @ <500 mA for each parallel interface daughter board	
Connections	15-way D-type (interferometer/encoder input) (female on RPI20) 60-way JAE connector (36-bit parallel data) (male on RPI20)	
Operating environment		
Pressure	650 mbar to 1150 mbar	Normal atmospheric
Humidity	0% to 95% RH	Non-condensing
Temperature	10 ºC to 40 ºC	
Dimensions	110 mm x 72 mm (4.33 inches x 2.83 inches)	

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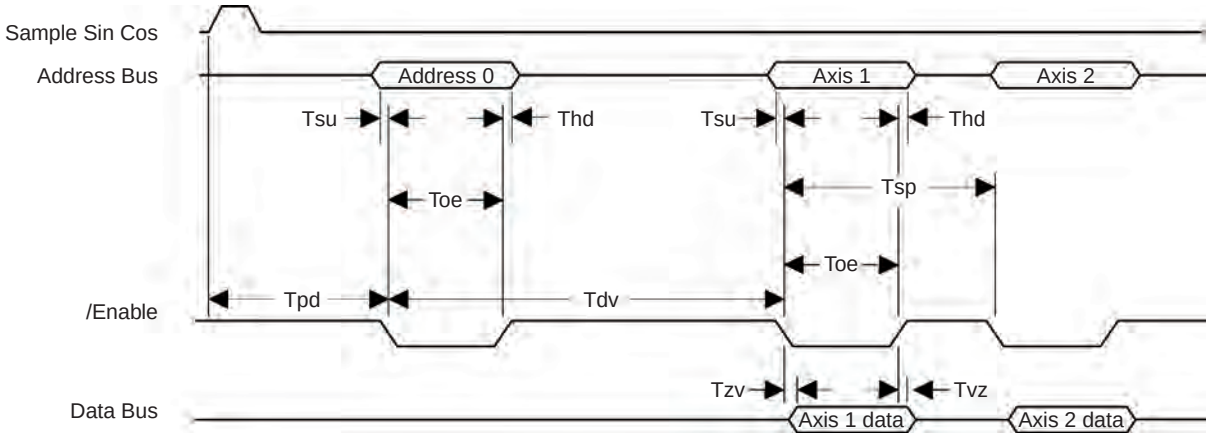
Data transfer timing diagram



Description: Asserting address 000 causes all axes to record their current positions. Individual axis positions may then be read by addressing each axis position register in turn. The pipeline nature of the processing means that the analogue sine and cosine values used for interpolation are those sampled 80 ns ±10 ns (Tpd) before address 000 was asserted.

Parameter	Min	Nom	Max	Units	Comment
Tsu	10			ns	Set-up of address before /Enable falling edge
Toe	50			ns	Minimum period that /Enable must be active
Thd	10			ns	Period address to be held after /Enable rising edge
Tzv			35	ns	/Enable to data valid
Tvz			35	ns	Data valid to hi-impedence state
Tpd	70	80	90	ns	Propagation delay. The time before the /Enable that the sine / cosine signals are sampled
Tdv	140	150	160	ns	Delay between /Enable falling edge and first valid position
Tsp	100			ns	Time between sequential axis access

Data available over the parallel bus

Register 1: Position data
Register 1 of each interface module contains 36-bits of position data.

Register 2: Status information
Register contains system status information including the Lissajous coordinates (digitised sine and cosine), signal strength, error lines and switch settings. Arrangement of data is shown below.

- Digitised input cosine signal — Bits 0 to 9
- Digitised input sine signal — Bits 10 to 19
- Signal strength — Bits 20 to 27
- Errors — Bits 28 to 31
- Switch settings — Bits 32 to 34

Register 3: Module reset
An individual module may be reset by accessing register 3 of the axis concerned. All cards may be simultaneously reset by accessing register 3 of address 0.

Register 4: Reserved for future expansion

Compliant with EU directive 2011/65/EU (RoHS)

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RLI20-P Panasonic interface

This data sheet contains an overview and specification of the Renishaw RLI20-P Panasonic interface.

The RLI20-P provides an interface between a Renishaw laser encoder system (RLE and HS20) and a Panasonic controller (MINAS A5-series). It accepts differential analogue 1Vpp sine/cosine signals. The output is presented in RS485 format and as an incremental position reading.

When used with a double pass plane mirror interferometer system (PMI) (fundamental period of sinusoids is nominally 158 nm), the RLI20-P interpolates the position data and scales it to be 1 nm/LSB. If used with a single pass retroreflector system (RRI) (nominal fundamental period of sinusoids is 316 nm), the scale would be 2 nm/LSB.

The RLI20-P is suitable for single or dual axis laser encoder applications, with each axis scaled for the individual laser wavelength.

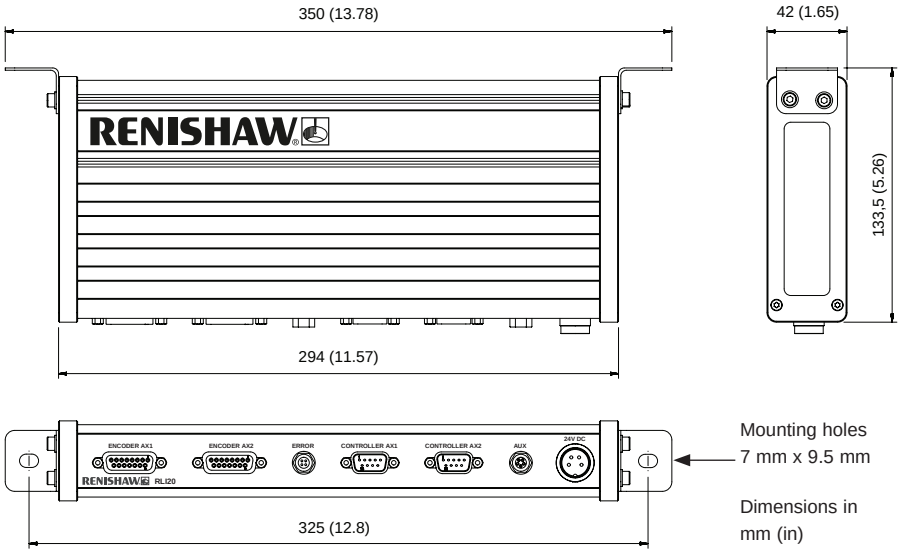
The system architecture consists of:

- 2 input channels, which take analogue quadrature from the Renishaw laser encoder system
- A high speed interpolator that converts input to position readings and formats for Panasonic controllers
- 2 RS485 output channels, an error line and the LED status indicator

RLI20-P performance specification

		RRI	PMI
LSB resolution		2 nm	1 nm
Maximum Velocity (Panasonic interface is limited to 0.4 m/s)		2 m/s	1 m/s
Maximum data rate	Controller position update rate	25 KHz	
	Internal position data update rate	100 MHz	
Positional noise contribution (RMS)		2 nm	1 nm
SDE contribution	Velocity <50 mm/s (PMI) <100 mm/s (RRI)	<±1 nm	<±0.5 nm
	Velocity >50 mm/s (PMI) and <1 m/s (PMI) >100 mm/s (RRI) and <2 m/s (RRI)	<±4 nm	<±2 nm

RLI20-P dimensions



General:

RLI20-P is intended to be mounted in an electrical control cabinet or similar environment. It is constructed with IP20 Protection.

100 mm connector/cable clearance is required from the front face of the RLI20-P.

The RLI20-P connector kit is available to order.
Part number: A-9926-0204.

Fixing:

Supplied with fixing kit:

- 4 off M4 x 5 cap head screws
- 4 off 4 mm plain washers
- 2 off mount brackets

It ensures that earthing is achieved directly through the brackets.

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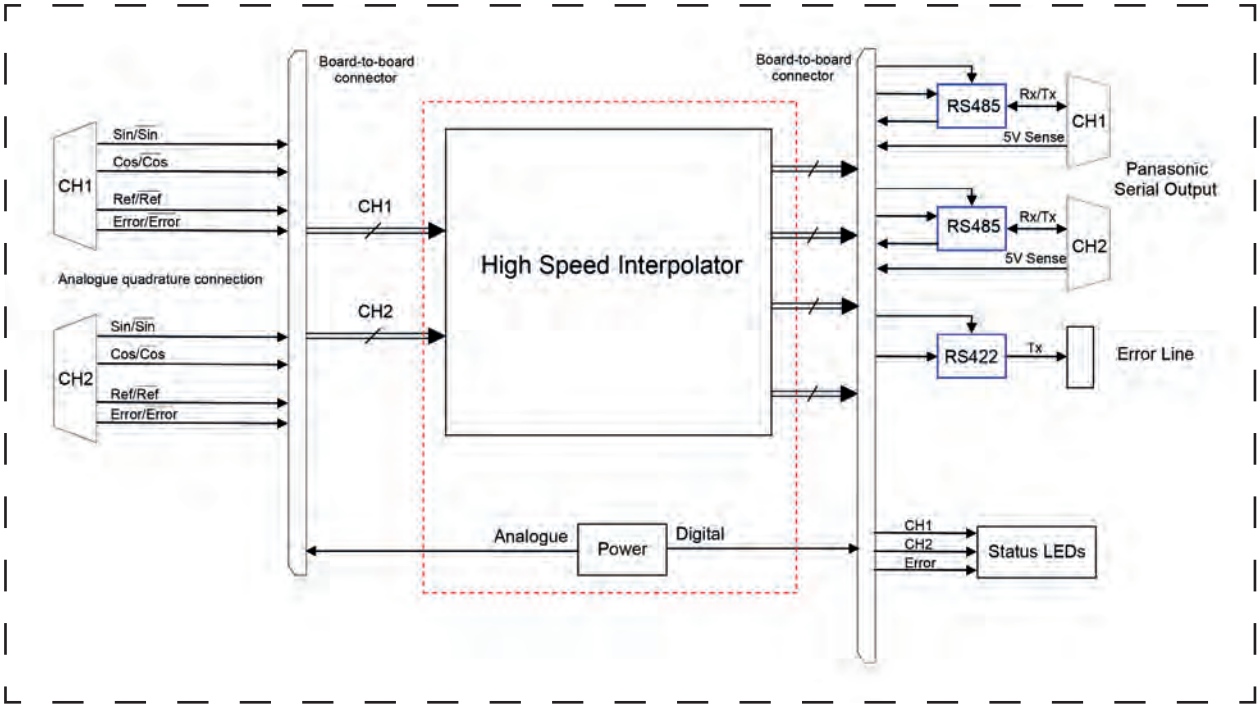
System compatibility

Input	Analogue quadrature sine/cosine, 1 Vpp	
Output	2.5 Mbps RS485, compatible with Panasonic MINAS A5 series controllers	
Error output	RS422	
Power supply	Power	3 W
	Voltage	24 ±5 V

Enviromental requirement

Pressure	Normal atmospheric pressure (650 mbar - 1150 mbar)	
Humidity	0 - 95% RU (non-condensing)	
Temperature	Storage	-20 ˚C to +70 ˚C
	Operating	+10 ˚C to +40 ˚C

Block diagram of the system architecture



0215 Part No. L-9926-0014-01-A

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RSU10 USB interface

This data sheet provides an overview and specifications for the Renishaw RSU10 USB (serial) interface.

The RSU10 accepts differential analogue 1 Vpp sine/cosine signals from an RLE laser interferometer encoder system, interpolates by 16,384 and provides a position reading via a USB output.

When used in combination with a double pass plane mirror interferometer system (PMI) (fundamental period of sinusoids is nominally 158 nm), this results in an LSB of 9.64 picometres at velocities of up to 1 m/sec.

The RSU10 is compatible with the established Renishaw calibration software suite (LaserXL™ and QuickViewXL™) in addition to a software development kit (SDK) which provides customers with the capability to develop their own, application specific software. Note: SDK does not support dynamic data capture (max update rate = 20 Hz).

A TPin trigger input facility allows data to be captured on receipt of a remotely generated trigger signal. This is particularly useful for recording measurements when the machine under test is moving.

The RSU10 provides an ideal solution for use with test rigs, and when used with QuickViewXL™, allows the live display and capture of dynamic measurement data such as that required for vibration analysis applications.

For applications where air refractive index compensation is required, the RSU10 should be used with an XC-80 environmental compensation unit. If an XC-80 is not used, the default environmental parameters (20 °C, 1013.25 mbar and 50% RH) will be applied.

Kit contents

The RSU10-XX-XX kit comprises:

- RSU10 serial interface
- USB cable (3 m)
- RLU to RSU10 connector cable (1.5 m)
- Laser USB SDK software
- Trigger input connector
- Installation guide

Computer specification

The minimum PC specification recommended for use with the RSU10-XX-XX is:

- 1 GHz processor
- 512 MB RAM
- 20 GB hard disk space
- Windows® XP (SP2 or higher), Windows Vista™ or Windows® 7
- 1024 x 768 pixel screen resolution
- CD-ROM drive
- At least one available USB II port (two if an XC-80 environmental compensation unit is also being used)

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USB interface performance

Resolution	9.64 pm (double pass plane mirror interferometer - PMI)	
	19.28 pm (single pass retroreflector interferometer - RRI)	
Maximum velocity	1 m/s (double pass plane mirror interferometer - PMI)	
	2 m/s (single pass retroreflector interferometer - RRI)	
Maximum update rate	50 kHz (20 Hz only with SDK)	
Non-linearity error (SDE)	PMI	3 nm at < 50 mm/s
		4 nm at < 1 m/s
	RRI	6 nm at < 100 mm/s
		8 nm at < 2 m/s
Electrical noise (PMI)	< 0.1 nm RMS (100% signal strength)	
Power supply required	None - USB powered	
Connections	15-way D-type (interferometer/encoder input)	
	Trigger (input)	
	USB (output)	
Operating environment		
Pressure	650 mbar to 1150 mbar	Normal atmospheric
Humidity	0% to 95% RH	Non-condensing
Temperature	10 ºC to 40 ºC	
Dimensions	190 mm x 128 mm x 42 mm (7.6 inches x 5.12 inches x 1.68 inches)	
Weight	700 g	RSU10 USB interface with no cables attached
	200 g	RLU to RSU10 cable
	90 g	USB cable

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Data sheet
L-9517-9319-01-B

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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

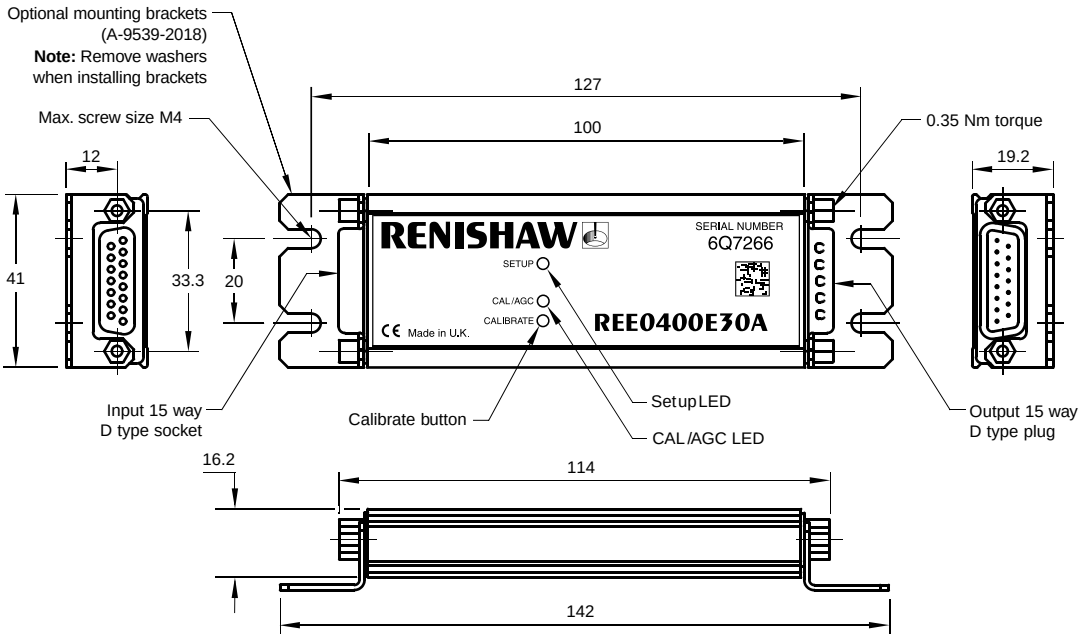
REE0004 - 10 µm resolution
REE0020 - 2 µm resolution
REE0040 - 1 µm resolution
REE0100 - 0.4 µm resolution
REE0200 - 0.2 µm resolution
REE0400 - 0.1 µm resolution
REE1000 - 40 nm resolution
REE2000 - 20 nm resolution
REE4000 - 10 nm resolution

- **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**

Data sheet
REE digital series interpolators

REE installation drawing

Dimensions and tolerances in mm



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

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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.

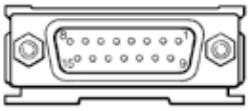
Input signals

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

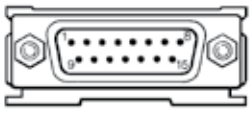


REE input

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

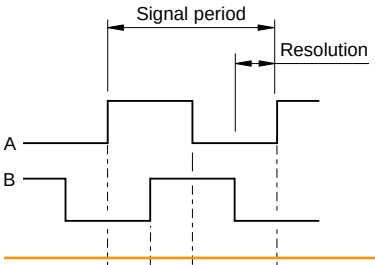


REE output

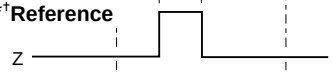
Output specifications

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

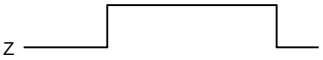
†**Incremental** 2 channels A and B in quadrature (90° phase shifted)



*†**Reference**



*†**Wide reference** (option C)

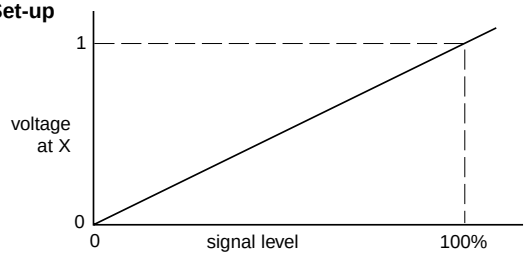


Repeatability of position (uni-directional) is determined by the readhead specification.

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.

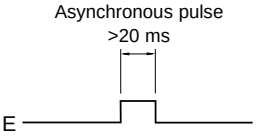
NOTE: Wide reference mark option useful when using long cable lengths and/or high speed operation to overcome effects of skew

Set-up



Setup signal voltage proportional to signal amplitude

†**Alarm**



REE alarm asserted for:

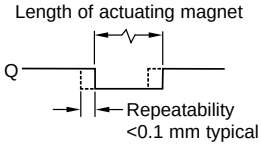
- Incremental signal <20% of nominal
- Incremental signal >135% of nominal
- Readhead speed in excess of specification
- Signal offset excessive

NOTE: 3-state alarm option available

***Limit** RGH22, RGH40 and RGH41 only

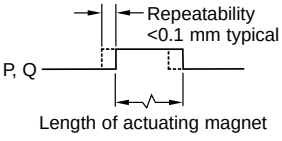
Open collector output

Single limit



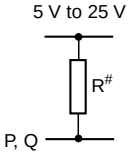
Asynchronous pulse Q

Dual limit



Asynchronous pulse P, Q

Termination



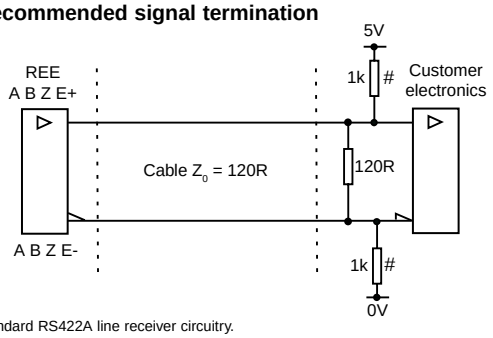
#Select R so that the maximum current does not exceed 20 mA. Alternatively use a relay or opto-isolator.

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

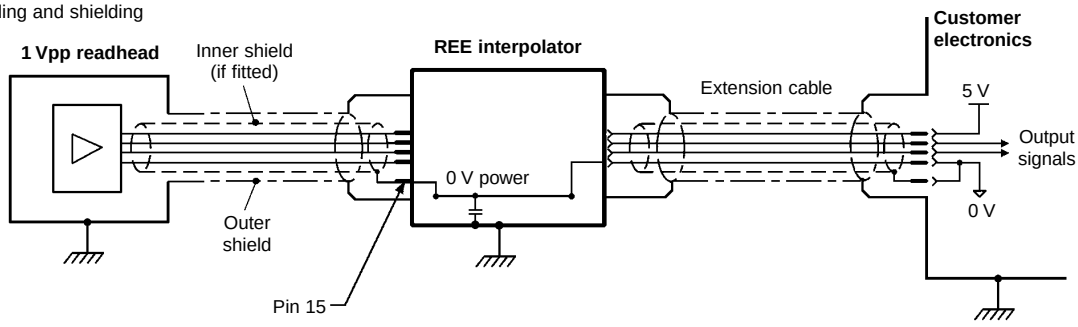


Standard RS422A line receiver circuitry.

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

Electrical connections

Grounding and shielding



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 0V. 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.

The publication of material within this document does not imply freedom from the patent rights of Renishaw plc.

Disclaimer

Considerable effort has been made to ensure that the contents of this document are free from inaccuracies and omissions. However, Renishaw makes no warranties with respect to the contents of this document and specifically disclaims any implied warranties. Renishaw reserves the right to make changes to this document and to the product described herein without obligation to notify any person of such changes.

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

 Issued 0808

L-9517-9319-01

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Plane mirrors and mirror mounts

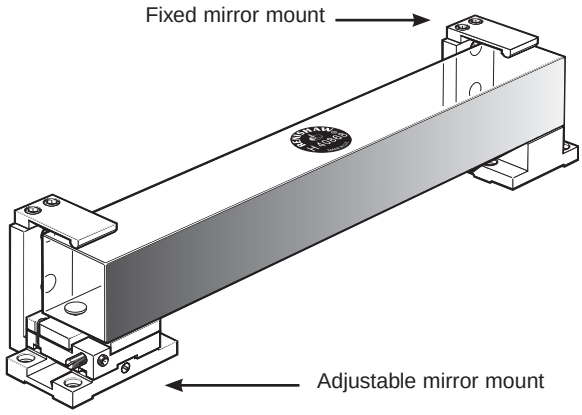
The Renishaw RLE fibre optic laser encoder uses interferometry to provide high resolution, high linearity position feedback.

An RLE system comprises an RLU laser unit, one or two RLD10 detector heads and an additional, target optic - either a plane mirror or a retroreflector, to complete the interferometer configuration.

Whilst Renishaw does not manufacture mirrors, various length mirrors and corresponding mirror mounts can be supplied. This data sheet provides specification details for these mirrors and mirror mounts.

Mirror selection and integration should be carried out carefully to avoid degrading the metrological advantages of the interferometer system. In the case of an X-Y stage system, mirrors can contribute to system errors through:

- Surface non-uniformity (flatness), which can be minimised by using an optically flat mirror and proper mounting techniques
- Thermal expansion, which can be reduced by using the correct substrate materials and mounting techniques
- Misalignment, which can be avoided through careful installation



General outline and dimensions

Dimensions in mm (inches)

Overall dimensions - plane mirrors:

Length: L + 20 (L + 0.79)
Cross section: 25 (0.98)

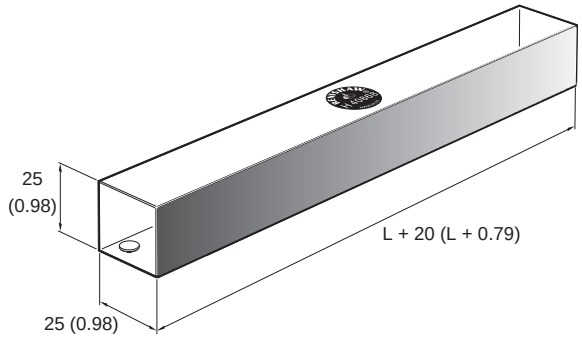
Where L = optical aperture

Renishaw plane mirrors

Mirrors can be ordered using the following part number:

RPM10-YX-XX

- YX-: Y = modified for Renishaw mounts; N = not modified for Renishaw mounts
- -XX: Optical aperture (in cm): 06 - 30, increments of 1 cm only



Plane mirror specification

Reflected beam characteristics	
Intensity of the reflected beam	>97% of incident beam
Cross polarisation	<0.5%
Mirror aperture area	
Local flatness	<λ/10 over an area 12 mm x 7 mm (λ = 633 nm)
Total flatness	<λ/10 per 100 mm (λ = 633 nm); <0.5 µm per 500 mm
Substrate	
Material	Low thermal expansion glass

Plane mirror specification (continued)

Cosmetics	
Scratch/dig	US-MIL-0-13830A 60/40 To be met by a sum of no less than 3 features within 12 mm x 3 mm area No two scratches/digs permissible within 12 mm x 3 mm area
Operating environment	
Temperature	0 °C to 40 °C
Air pressure	Mirrors are vacuum compatible (down to 10^{-8} mbar). Mirror mounts are not vacuum compatible
Relative humidity	0% to 95% non-condensing

Renishaw mirror mount kit

Renishaw supplies three point kinematic mounts for mirrors up to 350 mm in length with a 25 mm x 25 mm cross section that allow fine pitch and yaw adjustment. The mounts are constructed to minimise errors due to differential expansion and have positional locks that provide clamping to overcome acceleration, deceleration and bump forces.

Adjustment sensitivity:

- Yaw: 0.5 arc second/degree of rotation (350 mm mirror)
- Pitch: <1 arc second/degree of rotation

Necessary mirror geometry:

- 80 mm to 350 mm total length with 25 mm square cross section

Yaw adjustment:

- ±2.5º on mirrors of 80 mm length
- ±0.5º on mirrors of 350 mm length

Pitch adjustment:

- ±1º

Mirror mounts can be ordered directly from Renishaw using the following part number:

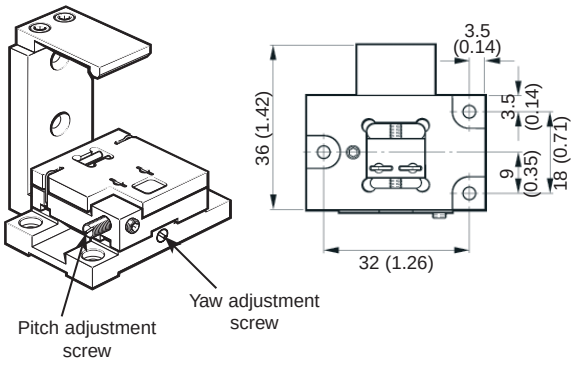
RAM10-SX-XX

Renishaw supplied mirror mounts are not vacuum compatible.

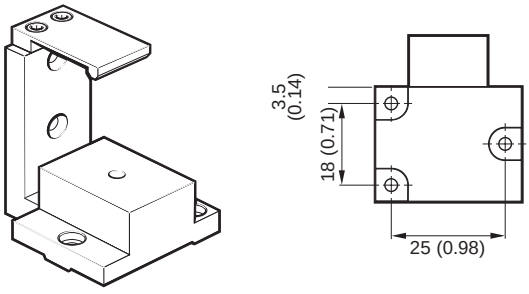
Overall dimensions - mirror mounts:

Height: 44 (1.73)
Footprint: 39 x 36 (1.53 x 1.42) (adjustable mount)
32 x 36 (1.26 x 1.42) (fixed mount)

Adjustable mirror mount



Fixed mirror mount



Mirror mount installation instructions

Mirror selection and installation should be carried out carefully to avoid degrading the metrological advantages of the interferometer system.

This section details a typical alignment procedure which can be used with Renishaw mirrors and mounts to ensure errors are minimised.

The following instructions demonstrate one method for aligning two plane mirrors to an X-Y stage* using Renishaw mirror mounts. It is assumed that:

- The person performing the procedure is familiar with the test equipment
- All mechanical adjustments of the motion stages have been completed
- The RLD10 detector heads are fully mounted
- The axes are fully operational

* If a vertical axis of motion is located under the mirrors, a different method of pitch alignment may be necessary.

Equipment:

- 2 x stick mirrors of required length fitted with mount locations (3 ball pads)
- 2 x Renishaw mounting kits (RAM10-SX-XX) which include: 1 x adjustable mirror mount, 1 x fixed mirror mount, 2 x mirror clamps, 10 x M2.5 by 8 hex head screws, 1 x Allen key (2.0 mm A/F), 1 x mount adjustment tool
- Alignment target (supplied with RLD10 90° and RLD10 0° detector heads)

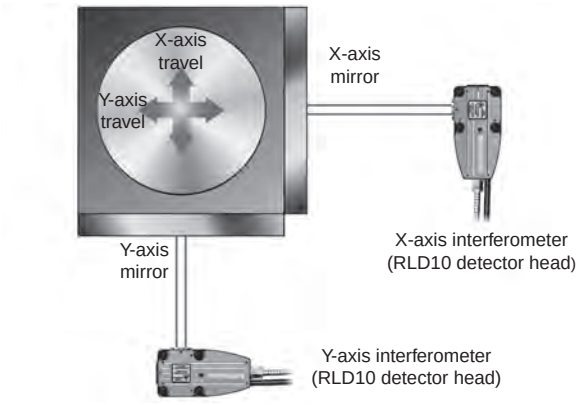


Figure 1: system terminology

1. Install Y-axis mirror into its mount

- The motion stage must provide fixing holes to accept the mirror mounts. These should be machined according to Figure 2 below
- Attach the adjustable mirror mount (see Figure 6 overleaf) to the stage using 3 of the M2.5 screws provided. The screws should be torqued to 0.7 Nm
- Repeat for the fixed mirror mount
- Locate the stick mirror on the two mounts so that the ball pads on the bottom of the mirror sit in the location features on the mounts (as in Figures 3 and 4). **Note:** two ball pads are located at the adjustable mount end and one at the fixed mount end

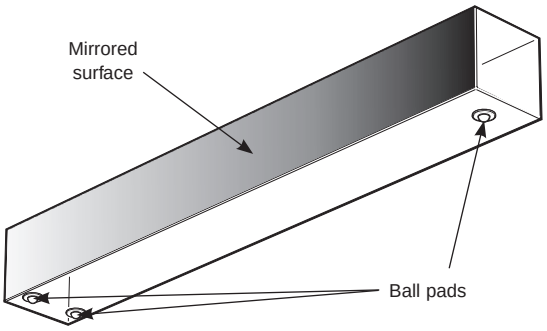


Figure 3: mirror with ball pads

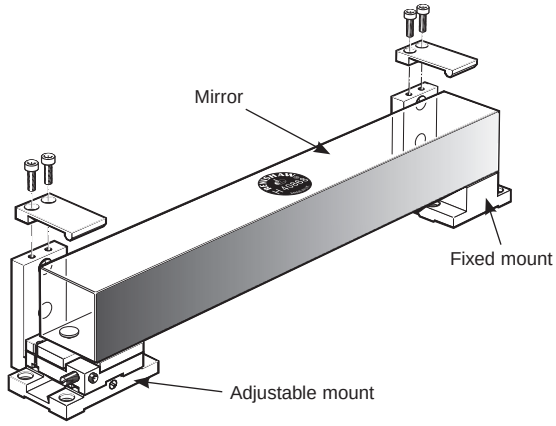


Figure 4: mirror located in mounts

2. Remove Y-axis interferometer (RLD10 detector head) cosine error

- Move the Y-axis (with the X-axis movement locked) to achieve the shortest separation between the Y-axis RLD10 and mirror
- Attach a Renishaw target sticker to the mirror surface so that the laser beam is on the target
- Move the axis to achieve the longest separation between the Y-axis RLD10 and mirror
- Adjust the pitch and yaw of the beam from the RLD10 so that the laser spot does not exhibit any translation from the target. **Note:** this can be an iterative process and may require multiple near and far field adjustments to achieve optimum alignment

3. Align the Y-axis mirror perpendicular to the Y-axis travel

- Remove the target sticker from the front of the mirror
- Move the mirror to the furthest separation and insert a metal Renishaw alignment target under the RLD10 (Figure 5 overleaf)

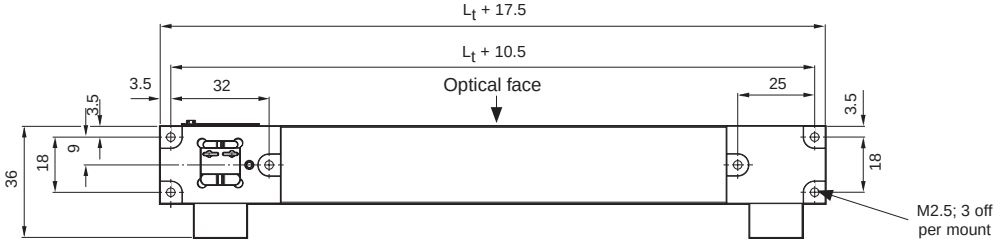


Figure 2: fixing holes for mirror of total length L_t ($L_t \leq 350$): all dimensions in mm
View from underside of mirror mounts. Note: L_t = optical aperture + 20 mm

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- Visually align the mirror yaw using the yaw adjustment screw (see Figure 6) so that the return beam is in line with the centre of the alignment target aperture (mirror is perpendicular to the X-Y plane)
- Visually align the mirror pitch using the adjustment screw (see Figure 6) so that the return beam goes through the centre of the alignment target aperture (mirror surface is now perpendicular to the X-Y plane)
- Remove the alignment target
- Finely adjust the pitch and yaw of the Y-axis mirror to maximise signal strength

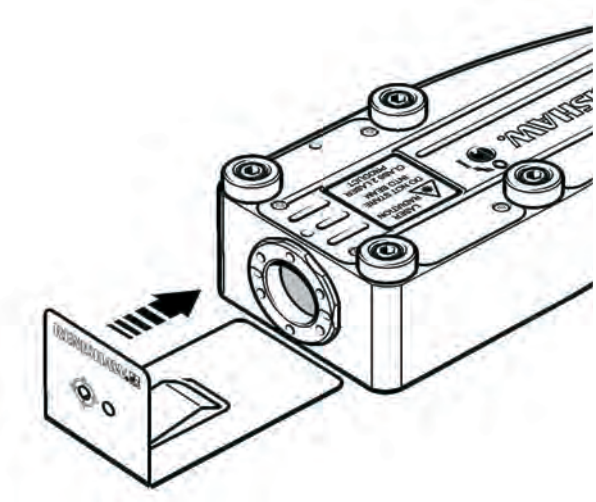

Figure 5: Renishaw alignment target

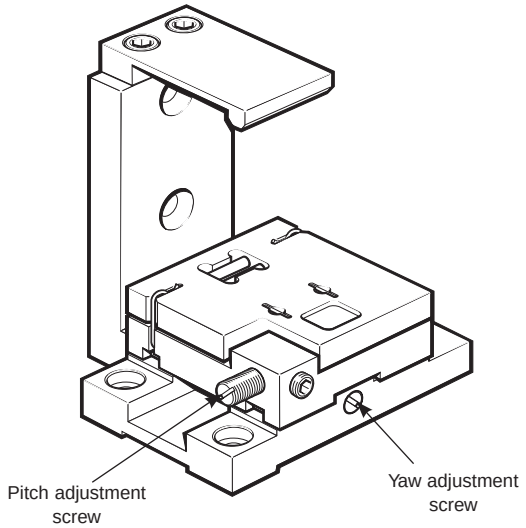

Figure 6: adjustable mirror mount

4. Engage the locking mechanism on the Y-axis mirror

- Place the clamps provided on top of the mounts and half tighten with the screws provided. Torque screws on both sides to 0.2 Nm ±0.05 Nm
- Check the clamping process has not altered the mirror alignment - some re-adjustment of mirrors may be required

5. Align the X-axis mirror and interferometer perpendicular to the X-axis by repeating steps 1, 2, 3 and 4, substituting X for Y

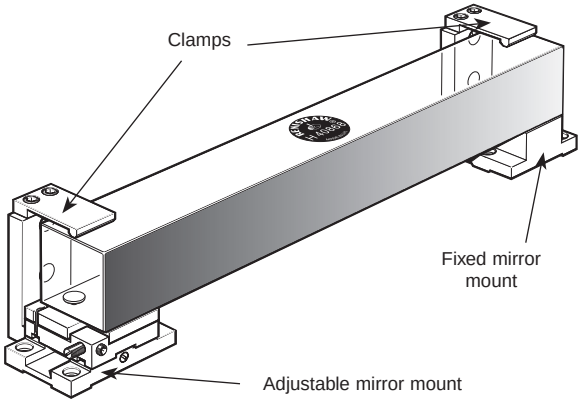

Figure 7: mirror clamped in mount

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0216 Part No. L-9904-2446-03-B

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RVI20 Vacuum compatible plane mirror interferometer

For the fibre optic laser encoder

Renishaw's RLE fibre optic laser encoder uses interferometry to provide high resolution, high linearity position feedback.

This data sheet describes the vacuum compatible plane mirror interferometer.

To complete the interferometer configuration when using this component a target plane mirror is required, in addition to an RLD10-A3-XX detector head which contains the fringe detection scheme and integral beam steerers. For more information on the RLD10 see www.renishaw.com/RLE.

The RVI20-X3-P0 is designed to mount inside a vacuum chamber with the laser measurement beam entering through a suitably positioned viewport.

General outline and dimensions

Dimensions in mm (inches)

Overall dimensions:

Length: 46.1 (1.82)
Depth: 40.1 (1.58)
Height: 20 (0.79)

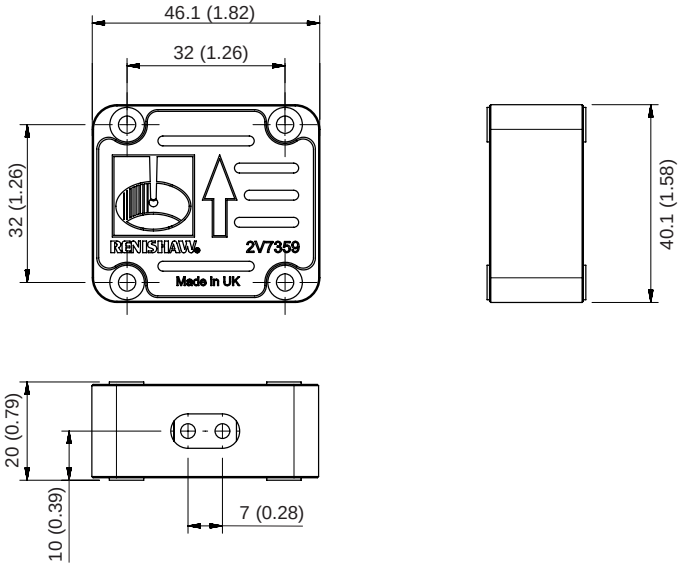
Fixings:

Detector head

4 off M3 x 0.5 x 35 mm or 5-40-UNC x $1^3/_8$ cap head screws on a 38 mm square pitch.

Interferometer

4 off M3 x 0.5 x 35 mm or 5-40-UNC x $1^3/_8$ cap head screws on a 32 mm square pitch



RVI20 Vacuum compatible interferometer operating parameters

Axis travel	PMI	0 m to 1.0 m
Optical signal period	PMI	λ/4 (158 nm)
System non-linearity error (SDE)* *excluding interface	PMI	< ±2.5 nm below 50 mm/sec with > 70% signal strength < ±7.5 nm at 1 m/sec with > 50% signal strength
Thermal drift coefficient	< 100 nm/ºC	Measured by mounting mirror and interferometer close together on a low thermal expansion glass base and changing the temperature
Beam diameter	3 mm	
Beam separation	7 mm	Centre to centre
Beam alignment tolerance for plane mirror (1 m axis)	±25 arcseconds	Tolerance applies to both pitch and yaw during operation
Component weight	0.25 kg	
Operating environment	UHV vacuum compatible	

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39 mm vacuum chamber window

The Renishaw RLE fibre optic laser encoder uses interferometry to provide high resolution, linear position feedback.

The differential interferometer head (RLD10-X3-DI) is designed to mount onto the vacuum chamber wall. A vacuum chamber window then allows the laser beams to pass between the detector head and the measurement mirror. Vacuum chamber windows can also be used with other interferometer head variants where the RLD is required to measure within a vacuum chamber, such as RVI20 vacuum compatible interferometer.

Renishaw's 39 mm vacuum chamber window has been manufactured to a custom specification to maximise the performance of the RLE system.

Mounting recommendations

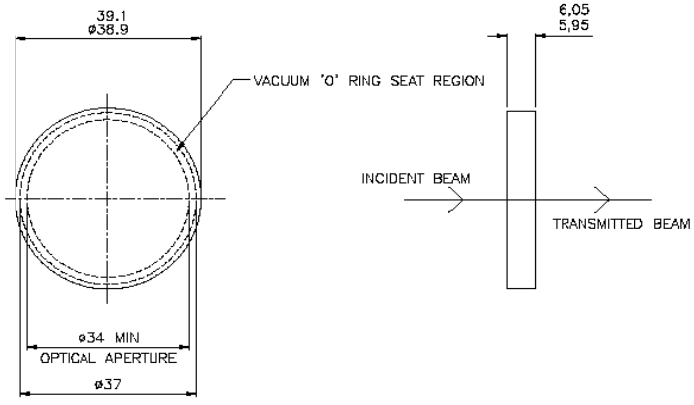
Renishaw recommends the following when mounting the chamber window within the chamber wall.

- The window must not be mounted under tension which could cause the window to distort and the beam to deviate from the nominal.
- An O-ring must be used on at least one side of the chamber window to create and maintain a seal in the vacuum chamber wall.

39 mm vacuum chamber window specification

Incident beam	
Angle of incidence	Normal ± 5°
Operating environment	
Temperature	0 °C to 40 °C
Relative humidity	0% to 95% non-condensing
Vacuum	Suitable up to: x 10^{-7} Torr
Storage environment	
Temperature	-20 ° to 200 °C

General dimensions



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0119 Part No. L-9904-2479-02-A

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Renishaw multi-axis periscope (3-axis) RMAP-3A

For the fibre optic laser encoder

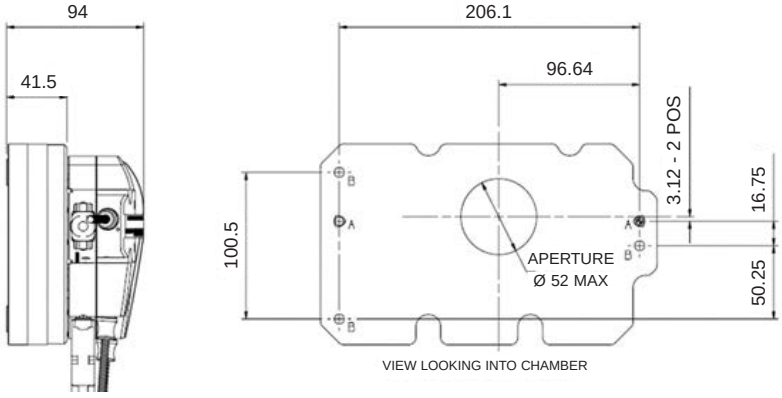
The multi-axis periscope has been designed to enable three RLD10-X3-DI detector heads to measure the linear position, pitch and yaw along a single axis. To achieve this, the multi-axis periscope uses a series of mirrors to minimise the beam foot print from the three detector heads to reduce the size of the target mirror required for these applications. This compact periscope, which can be mounted directly onto the exterior of the vacuum chamber, increases the measurement flexibility of the RLD10-X3-DI detector head.

General outline and dimensions

Dimensions in mm

Overall dimensions:

Length: 231
Width: 41.5
Height: 137.6



System specification

Linear range	With RLD10-X3-DI	0 m to 0.65 m
Angular range	Pitch	± 30 arcsec
	Yaw	
Analogue signal period	Linear	Same as standard RLD10-X3-DI
	Pitch	2.3 arcsec
	Yaw	
Thermal drift coefficient	Linear	Same as standard RLD10-X3-DI
	Pitch	1.8 arcsec/°C
	Yaw	
Beam steerer adjustment range	With RLD10-X3-DI	Reduced to ± 0.5°
Change in signal strength though periscope (relative to linear)	Linear	No change
	Pitch	< 10%
	Yaw	

Operating environment

Pressure	Normal atmospheric (650 – 1150 mbar	
Humidity	0 – 95% RH (non-condensing)	
Temperature	Storage	-20 °C to 70 °C
	Operating	10 °C to 40 °C

For more information on the Multi-axis periscope see www.renishaw.com/rmap.

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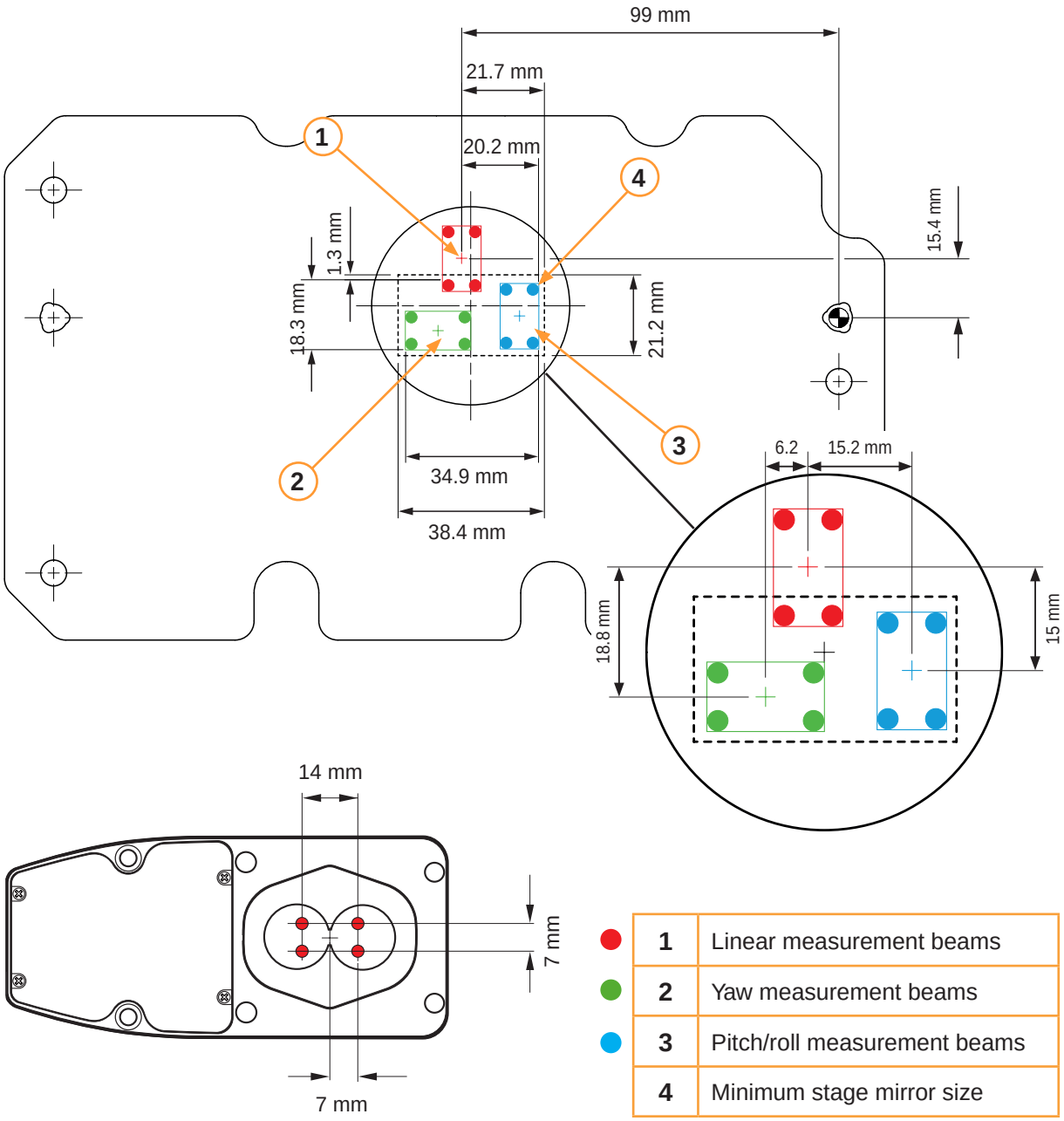
Dimensions and beam foot prints

Beam foot print dimensions



1	Linear measurement beams
2	Yaw measurement beams
3	Pitch/roll measurement beams
4	Minimum stage mirror size

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