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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.

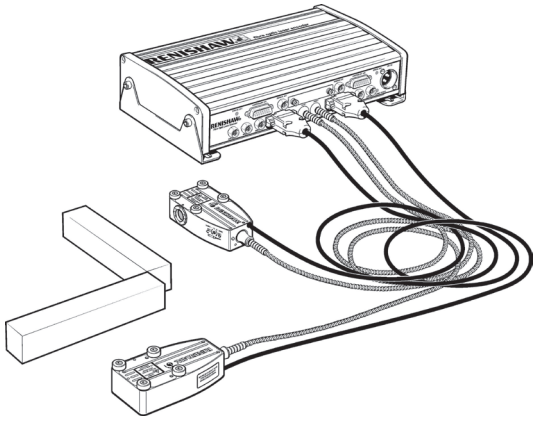
The RLU laser unit, containing the laser source and signal processing electronics, is available in either single or dual axis configuration, with a fibre optic umbilical that delivers laser light directly to the RLD detector head(s). Two RLU performance levels are available - RLU10 and RLU20. The RLU20 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.

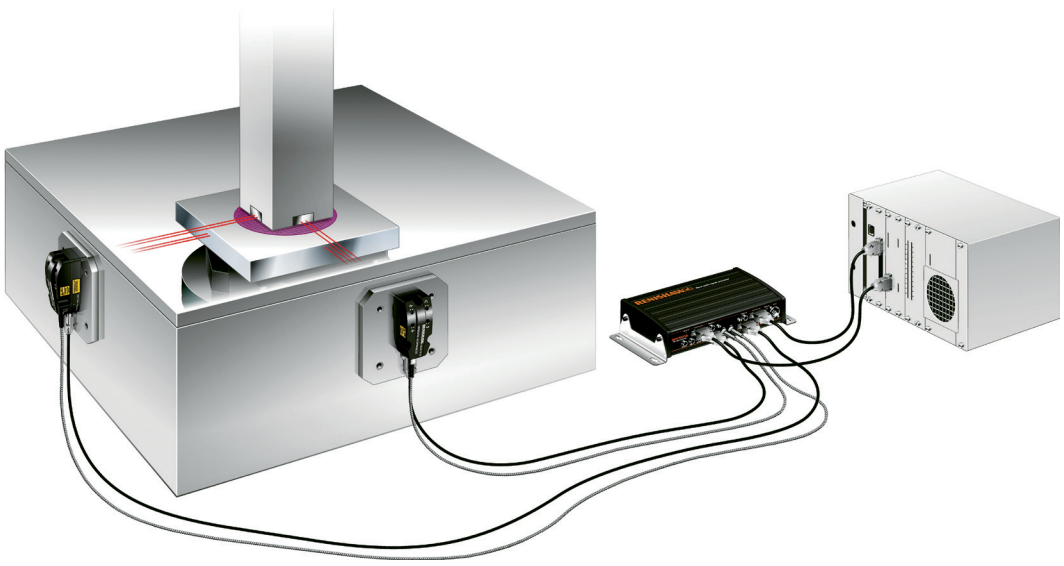


To maximise application flexibility, plane mirror and retroreflector interferometer detector heads are available with either 0º or 90º beam orientation. The heads can be mounted on either their top or bottom face, thereby providing an output beam with an orientation of 0º, 90º or 270º.

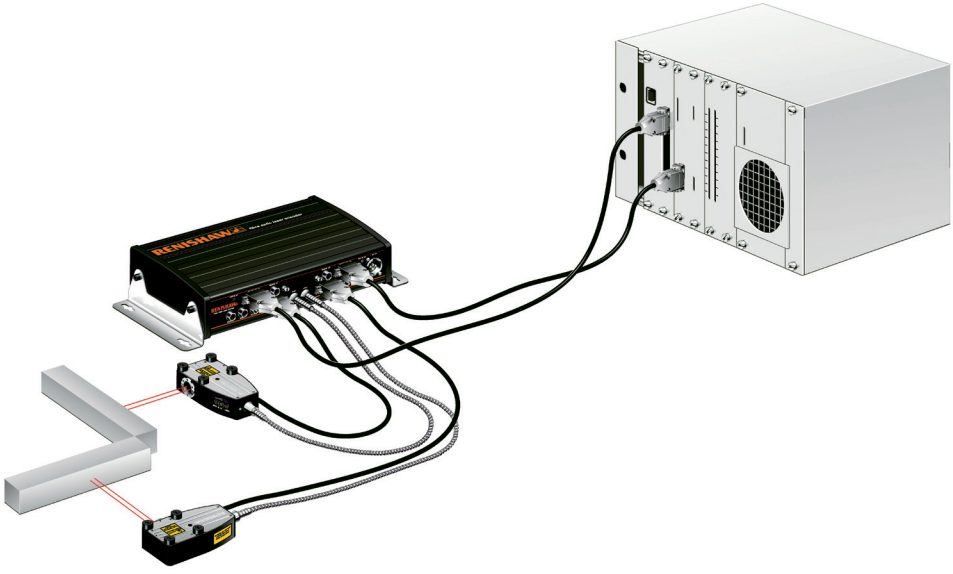
The RLE directly produces digital quadrature output resolutions to 10 nanometres with differential and plane mirror (double pass) interferometers, and 20 nanometres when using a retroreflector (single pass) interferometer. Additionally, the RLE system provides low latency 1 Vpp sine / cosine signals 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.

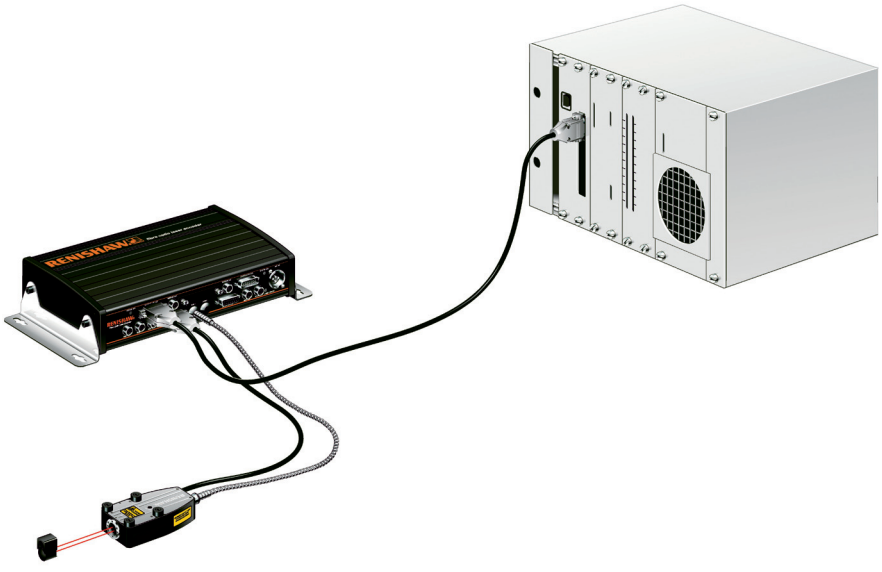
This data sheet provides performance specification information for various RLE system configurations.



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:

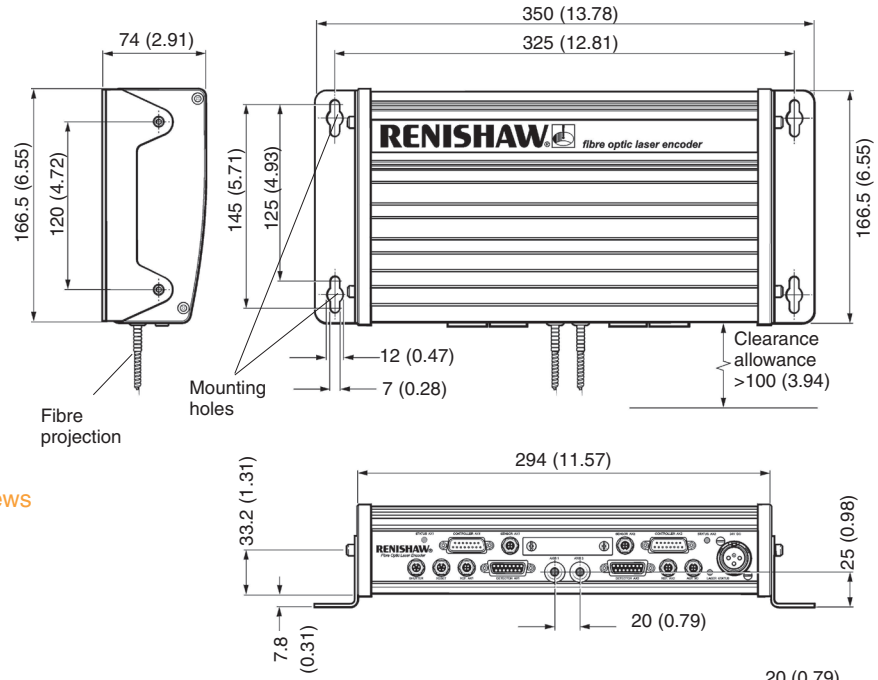
Overall dimensions:

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:

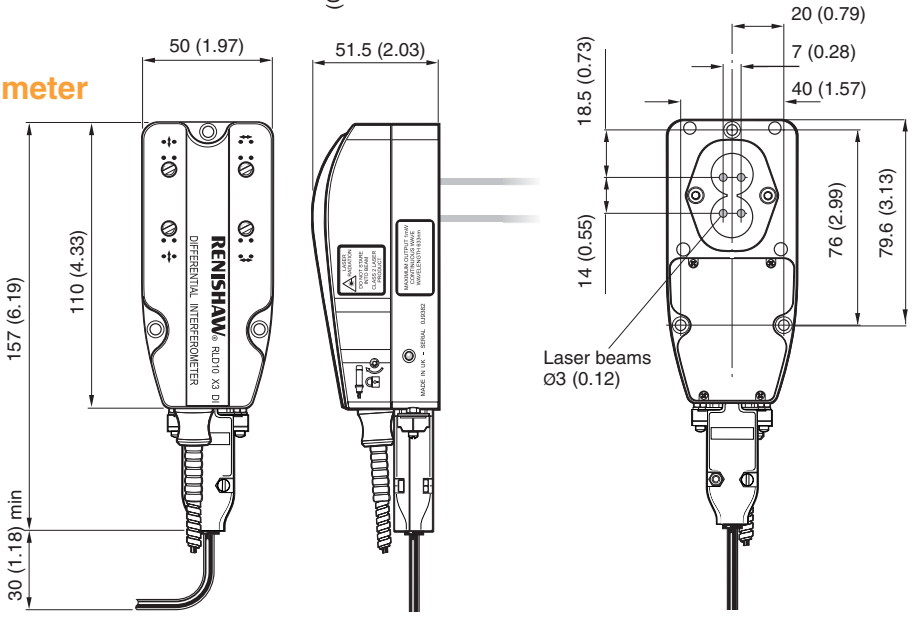
4 off M6 x 1.0 x 15 mm or
$^1/_4$-20-UNC x $^5/_8$ cap head screws



RLD10-X3-DI differential interferometer

Overall dimensions:

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



RLD10

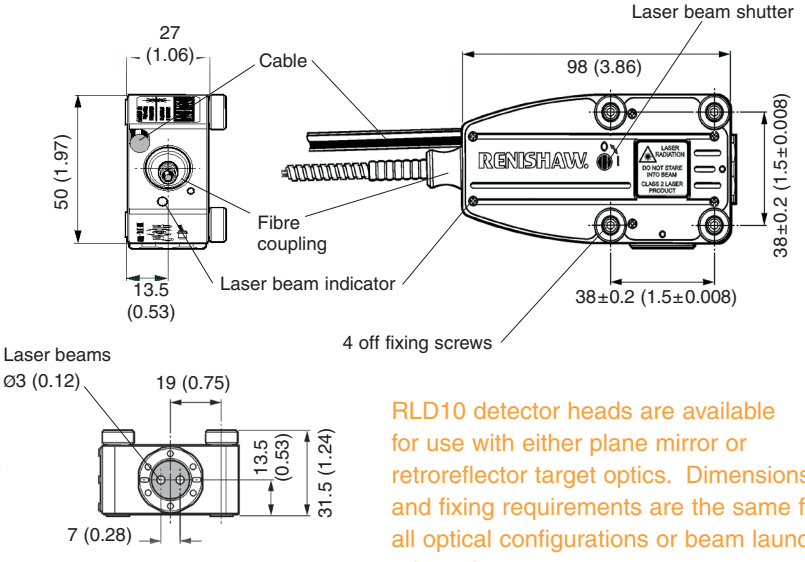
Overall dimensions of the detector head:

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

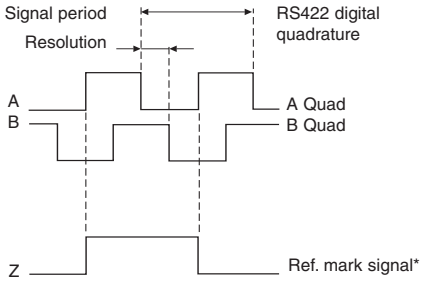
For maximum flexibility RLD10 detector heads may be mounted on either top or bottom face, providing beam launch orientations of 0°, 90° and 270°.



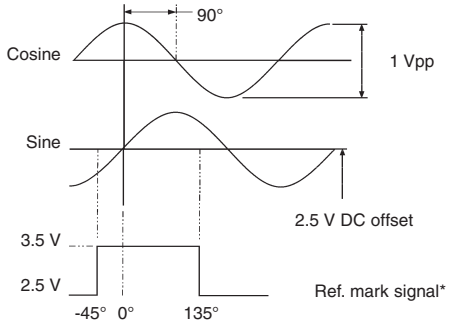
RLD10 detector heads are available for use with either plane mirror or retroreflector target optics. Dimensions and fixing requirements are the same for all optical configurations or beam launch orientations.

RLU output signals

Digital incremental - RS422 digital quadrature



Analogue incremental - 1 Vpp differential sine and cosine

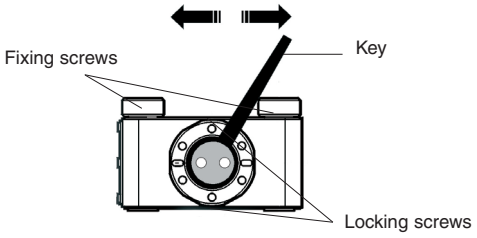


* Reference mark signal can be provided via an additional sensor

Laser beam alignment: RLD10 0° and 90°

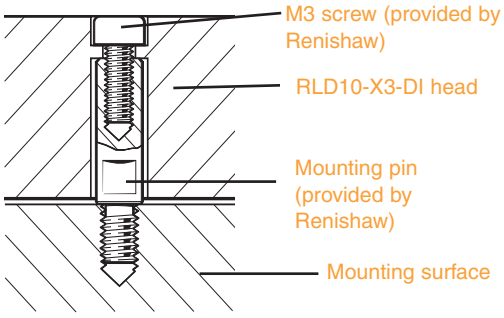
The RLD10 detector head incorporates a beam steerer to simplify the alignment process. Angular alignment in the plane of the mounting face (yaw) is achieved by slackening the fixing screws and rotating the detector head. Angular adjustment out of the mounting plane is achieved by rotating the integral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



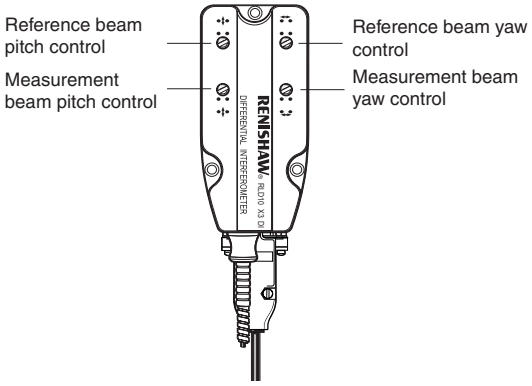
RLD10-X3-DI differential interferometer mounting

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.

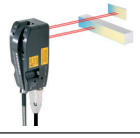


Legislative - Laser safety:

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 °C, 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 °C
Operating environment Pressure Humidity Temperature	 650 - 1150 millibars 0% - 95% RH 10 °C to 40 °C	 Normal atmospheric Non-condensing (15 °C to 30 °C 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
Non-linearity error (@ 70-120 % signal strength) < 5% of maximum velocity at maximum velocity	 < ±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/°C	< 100 nm/°C	
Beam separation (centre to centre)	7 mm x 14 mm	7 mm	
Beam alignment adjustment	±1° pitch / ±1° yaw	±0.65° pitch / ±1.5° 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)

Renishaw plc

New Mills, Wotton-under-Edge,
Gloucestershire GL12 8JR
United Kingdom

T +44 (0) 1453 524524
F +44 (0) 1453 524901
E uk@renishaw.com

www.renishaw.com

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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.

Products include:

- **Dental CAD/CAM** scanning and milling systems
- **Encoder systems** for high accuracy linear, angle and rotary position feedback
- **Laser and ballbar systems** for performance measurement and calibration of machines
- **Medical devices** for neurosurgical applications
- **Probe systems and software** for job set-up, tool setting and inspection on CNC machine tools
- **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

Renishaw worldwide

Australia
T +61 3 9521 0922
E australia@renishaw.com

Austria
T +43 2236 379790
E austria@renishaw.com

Brazil
T +55 11 4195 2866
E brazil@renishaw.com

Canada
T +1 905 828 0104
E canada@renishaw.com

The People's Republic of China
T +86 21 6180 6416
E china@renishaw.com

Czech Republic
T +420 548 216 553
E czech@renishaw.com

France
T +33 1 64 61 84 84
E france@renishaw.com

Germany
T +49 7127 9810
E germany@renishaw.com

Hong Kong
T +852 2753 0638
E hongkong@renishaw.com

Hungary
T +36 23 502 183
E hungary@renishaw.com

India
T +91 80 6623 6000
E india@renishaw.com

Israel
T +972 4 953 6595
E israel@renishaw.com

Italy
T +39 011 966 10 52
E italy@renishaw.com

Japan
T +81 3 5366 5316
E japan@renishaw.com

Malaysia
T +60 3 5361 4420
E malaysia@renishaw.com

The Netherlands
T +31 76 543 11 00
E benelux@renishaw.com

Poland
T +48 22 577 11 80
E poland@renishaw.com

Russia
T +7 495 231 16 77
E russia@renishaw.com

Singapore
T +65 6897 5466
E singapore@renishaw.com

Slovenia
T +386 1 527 2100
E mail@rls.si

South Korea
T +82 2 2108 2830
E southkorea@renishaw.com

Spain
T +34 93 663 34 20
E spain@renishaw.com

Sweden
T +46 8 584 90 880
E sweden@renishaw.com

Switzerland
T +41 55 415 50 60
E switzerland@renishaw.com

Taiwan
T +886 4 2473 3177
E taiwan@renishaw.com

Thailand
T +66 2 746 9811
E thailand@renishaw.com

Turkey
T +90 216 380 92 40
E turkiye@renishaw.com

UK (Head Office)
T +44 1453 524524
E uk@renishaw.com

USA
T +1 847 286 9953
E usa@renishaw.com

For all other countries
T +44 1453 524524
E international@renishaw.com

РЕМСТАНМАШ
ТЕХНОЛОГИИ ДЛЯ ПРОИЗВОДСТВА

ООО «Ремстанмаш»
г. Смоленск, Верхне-Сенная, д.4, офис 223.
сайт. www.cnchelp.ru
Тел. 8-800-511-02-67
Тел. +7(499)704-02-67
Тел. 8-919-046-48-46 (WhatsApp, Viber)

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