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High resolution compensated positioning

Background

The RCU10 provides real-time compensation for the effects of air refractive index changes and material temperature changes on the position reading given by a laser encoder system. It can also compensate for the effects of material expansion on a linear (tape or glass) encoder.

With a standard RLE and RCU10 system the finest digital output resolution that can be obtained from the RCU10 output is 10 nm (for a plane mirror system) and 20 nm (for a retro reflector system).

For most applications this resolution is more than adequate since operating in an air environment introduces other error terms such as air turbulence which can easily have a magnitude of 10's if not 100's of nanometres (see Application note: Air turbulence effects on measurement stability of the RLE10). It is normally physical limitations of the environment that dwarf any advantages gained. Ultimately the best way of making smaller measurements is to remove the air completely and place the metrology area into a vacuum chamber.

If after careful consideration higher resolution compensated quadrature is still required there are a few options open to the user. Firstly however, it should be noted that whilst the **RCU10 is capable of producing an analogue output this sin/cos signal can only be interpolated down to the resolution of the input to the RCU10**. The reason for this is that the output is synthesised and was only designed to provide an analogue input to controllers which do not have digital input capability. Therefore the finest analogue resolution that can be obtained directly from an RLE/RCU10 system is 20 µm.

The remaining options are listed below:

Option 1: Use of an REE Interpolator

Using this method the RLE or encoder system must be set to produce an analogue output (the RCU10 should still be set to produce a digital output). The output from the RLE should therefore be 158 nm (for a plane mirror system) or 316 nm (for a retro reflector system). The output of the RLE should then be sent into the input of the REE interpolator.

The REE will then produce a digital output, the resolution of which will depend on the type of REE. The output of the REE should then go directly to the RCU10 input.

Application note

Since the RCU10 is receiving an input resolution which it is not designed to receive, the RCU10 output position reading as seen on the RCUCS software must be divided by a correction factor. The table below shows the correct configuration settings for the RLE and the RCU10, the division factor and the new system output resolution.

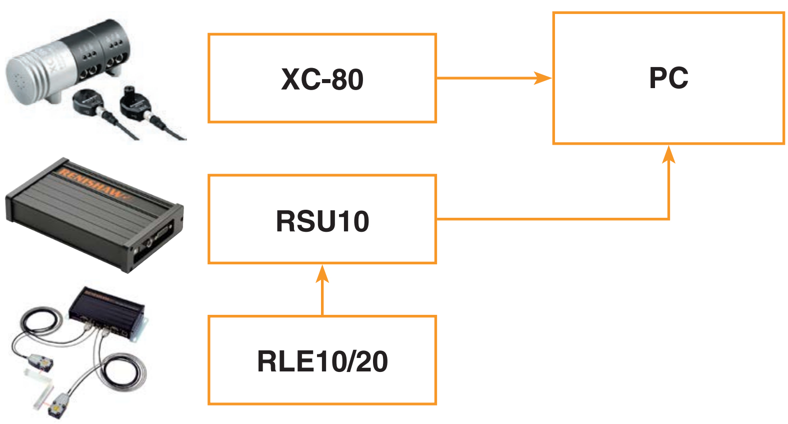
	REE 100		REE 200		REE 400	
	PMI	*RRI*	*PMI*	*RRI*	*PMI*	*RRI*
RLE output (nm)	158	316	158	316	158	316
REE output (nm)	1.58	3.16	0.79	1.58	0.39	0.79
RCU10 input resolution setting (nm)	9.88	19.8	9.88	19.8	9.88	19.8
RCU10 output resolution setting (nm)	10	20	10	20	10	20
Actual RCU10 output (nm)	1.60	3.20	0.8	1.6	0.40	0.8
RCU correction factor	6.2	3.1	12.5	6.2	25.0	12.5

The maximum speed of the system is dependant on the RLE and REE combination, the speed limitations are documented in Application note: Use of REE interpolators with RLE10 laser interferometer encoder system.

NOTE: Only certain combinations of input/output resolutions are allowed in the RCU10 and each combination has a corresponding maximum system velocity (see page 2-11 of the RCU10 manual)

Option 2: Use of an RSU and XC-80 (not to be used in feedback loop)

Using this method the RLE or encoder system must be set to produce an analogue output. The output from the RLE should then go straight into the RSU10 (USB interface).



The RSU10 and an XC-80 can then both be connected to the PC via USB link. The compensated position can be viewed on standard Renishaw calibration software or on custom built software by use of the laser USB software development kit supplied with the RSU available from Renishaw.

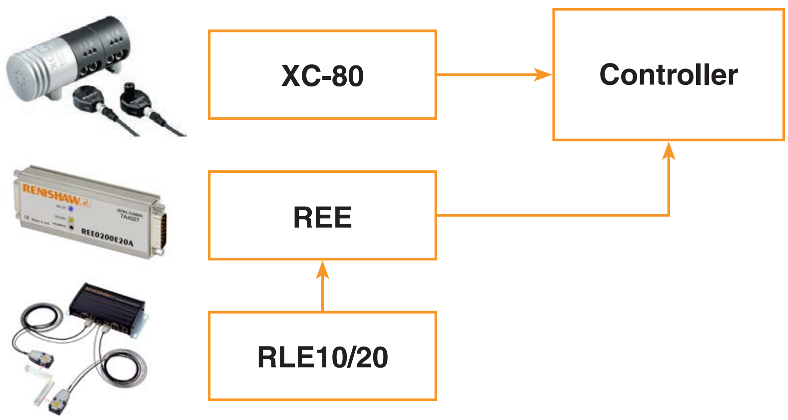
This method can only be used for monitoring the position of the motion stage and cannot be used as part of the feedback loop due to the latency and latency variation of USB. Since the XC-80 was designed for use in a calibration system it does not provide compensation in real time, the sensor readings will be updated once a minute.

NOTE: One RSU10 is needed per axis, i.e.: a dual axis RLE system would need 2 RSU units to monitor axis 1 and axis 2 simultaneously.

Option 3: Compensation inside the controller using XC-80

Some controllers are capable of receiving data via USB connection and performing high speed front end processing. In such circumstances it is possible to send the controller high resolution quadrature into the encoder input port and extract environmental data from the XC-80 via the USB connection.

A schematic of the layout is shown below:



Again, since the XC-80 was designed for use in a calibration system it does not provide compensation in real time, the sensor readings will be updated once a minute. This is also reliant on the correct functionality exisitng within the controller.

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

Products include:

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- Advanced material technologies with a variety of applications in multiple fields
- Dental CAD/CAM scanning and milling systems and supply of dental structures
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- Fixturing for CMMs (co-ordinate measuring machines) and gauging systems
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- Laser and ballbar systems for performance measurement and calibration of machines
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