

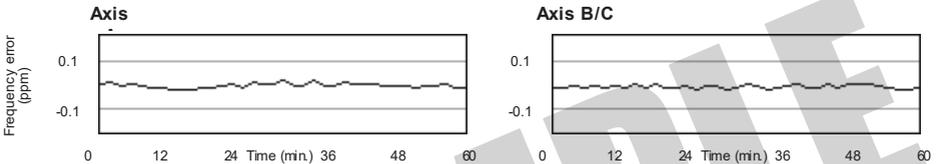
Product **XM laser**  
 Serial number **1CYH71**  
 Date of calibration **2nd February 2021**



# Calibration certificate

<b>Specification</b>	<b>Axis A</b>	<b>Axis B/C</b>
<i>Vacuum wavelength</i>	0.6329900000 $\mu\text{m} \pm 0.1$ ppm	0.6329914500 $\mu\text{m} \pm 0.1$ ppm
<i>Equivalent frequency</i>	473613260.9 MHz	473612176.0 MHz

**Measured values and uncertainties of calibration**



Results	Axis A		Axis B/C	
	Value (MHz)	Value (ppm)	Value (MHz)	Value (ppm)
Laser frequency:	473613258.1	-	473612170.9	-
Laser frequency error:	-2.5	-0.005	-5.2	-0.011
Stability (RMS):	4.2	0.009	4.3	0.009
Maximum laser frequency error:	-13.9	-0.029	-17.3	-0.037
Uncertainty of measurement (k=2):	$\pm 5.9$	$\pm 0.01$	$\pm 5.9$	$\pm 0.01$

Reference standards	Ref. no.	Lab	Certificate no.	Calibration date
Iodine stabilised HeNe laser	RUK27030	NPL	2017050069-LL03	24th May 2017
Frequency counter - axis A	MTE/A164	UKAS0152	U307373	18th March 2020
Frequency counter - axis B	MTE/A162	UKAS0152	U306910	10th March 2020
Reference HeNe laser	XL-80 REF25	Renishaw	23CN40-210121-00	21st January 2021
Test procedure	WI-10923			

**Laser measurement system accuracy:** See the certificate of conformance for details.

Authorised signature	Signatory	Position	Issue date
	Chris Hunt	General Manager	2nd February 2021

*This certificate may not be reproduced other than in full, except with the prior written approval of:*

**Renishaw plc**  
 Laser & Calibration Products Division  
 Bath Road, Woodchester  
 Stroud  
 Gloucestershire  
 GL5 5EY  
 United Kingdom  
 Tel +44 (0) 1453 524524

**Certificate number**  
**1CYH71-210202-00**

L-9921-0203/01

# Calibration notes

1. **Lasers (XM, XL, ML, HS and RLU)** are calibrated by comparison to a reference HeNe laser using an optical beat frequency technique. Reference lasers are routinely calibrated against an iodine-stabilised HeNe laser supplied by the National Physical Laboratory (NPL), or by a national standards laboratory. All frequency measurements are taken over a 1 hour period.
2. **Air pressure and relative humidity (RH) sensors are installed in a compensator (XC and RCU).**  
The air pressure sensors are calibrated over 650 mbar to 1150 mbar range in a temperature controlled oven by direct comparison with a reference pressure meter. The RH sensors (where fitted) are certified by the manufacturer to be within specification. They are calibrated by comparison of the readings with those from a reference RH meter at a single applied humidity.
3. **Air and material temperature sensors (XC and RCU)** are calibrated by direct comparison with transfer platinum resistance thermometers (PRTs) in a temperature controlled water bath over 0 °C to 40 °C (50 °C for material sensor). The transfer PRTs are routinely calibrated against reference PRTs.
4. **Rotary axis calibrators (XR20)** are calibrated using a HeNe laser angular interferometer.
5. **Ballbar transducers (QC20-W and QC10)** are calibrated using a HeNe laser interferometer. The scale factor (QC10 only) is calculated and must be entered into the Renishaw application software prior to use.
6. **Ballbar calibrators** are calibrated by direct comparison with a reference ballbar calibrator (calibrated by a national standards laboratory) using a reference ballbar as a transfer standard. The measured values for the ballbar calibrator must be entered into the Renishaw application software prior to use.
7. **Traceability.** All the reference standards (listed overleaf) used in these calibrations are traceable either directly to major international metrology institutes who have signed the CIPM Mutual Recognition Agreement (e.g. NPL: UK; LNE: France; NIST: USA; PTB: Germany; NMIJ: Japan) or to a national accreditation body (e.g. UKAS: UK; A2LA: USA).
8. **Environment.** The equipment used for calibration is in a facility held between 15 °C and 25 °C.
9. **Uncertainty calculations.** The uncertainty calculations have been carried out according to the European Co-operation for Accreditation document EA-4/02.
10. **Quality accreditation.** All calibrations above are covered by Renishaw's ISO 9001 quality assurance system. The system is audited and certified by an accredited agency.
11. **Re-calibration.** Customers may wish to confirm that systems are performing within published specifications over time. If so, it is recommended that they should be periodically re-calibrated. Please note that compensators and temperature sensors are re-calibrated only at a single applied temperature, air pressure and humidity. Please refer to the appropriate system manual for further details.