

Product
Serial number
Date of calibration

XM laser
4KGH59
29th Aug 2024

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Calibration certificate

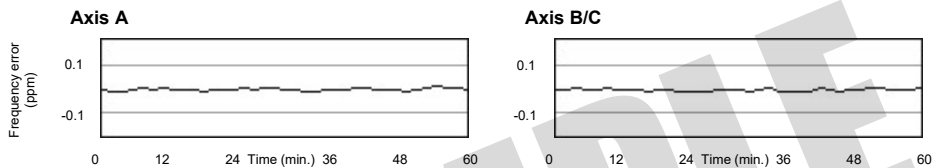
Specification

Vacuum wavelength
Equivalent frequency

Axis A
0.6329900000 $\mu\text{m} \pm 0.1$ ppm
473613260.9 MHz

Axis B/C
0.6329914500 $\mu\text{m} \pm 0.1$ ppm
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:	473613257.4	-	473612172.2	-
Laser frequency error:	-3.6	-0.008	-3.8	-0.008
Stability (RMS):	2.5	0.005	2.6	0.005
Maximum laser frequency error:	-9.7	-0.020	-10.3	-0.022
Uncertainty of measurement (k=2):	± 5.9	± 0.01	± 5.9	± 0.01

Reference standards	Ref. no.	Lab	Certificate no.	Calibration date
Iodine stabilised HeNe laser	RUK27030	NPL	2022080011-LL03	11th Aug 2022
Frequency counter - axis A	MTE/A82	UKAS0152	U382830	12th Dec 2023
Frequency counter - axis B	MTE/A119	UKAS0152	U383512	2nd Jan 2024
Reference HeNe laser	XL-80 REF25	Renishaw	23CN40-240809-00	9th Aug 2024
Test procedure	WI-10923			

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

Authorised signature	Signatory	Position	Issue date
	Dave Wall	Director & General Manager	30th Aug 2024

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Certificate number
4KGH59-240829-00

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 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.