

Product ML10 laser
 Serial number G24578
 Date of calibration 7th May 2014
 Customer name Starrag-Heckert, Inc.
 Customer address 2379 Progress Drive., Hebron, KY 41048

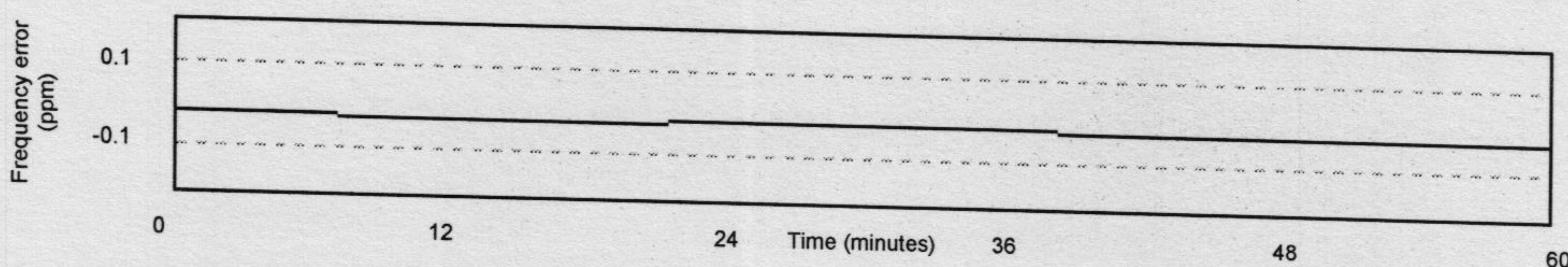


Calibration certificate

Specification

Vacuum wavelength 0.6329905770 μm ±0.1 ppm
Equivalent frequency 473612829.2 MHz

Measured values and uncertainties of calibration



Results

	Value (MHz)	Value (ppm)
Laser frequency:	473612819.0	-
Laser frequency error:	-10.2	-0.021
Stability (peak-to-peak):	5.7	0.012
Maximum laser frequency error:	-13.0	-0.027
Uncertainty of measurement (95% confidence level, k=2):	±5.9	±0.01

Reference standards	Ref. no.	Lab	Certificate no.	Calibration date
Iodine stabilised HeNe laser	MTE/A197	NPL	2010080175-LL03	18 th August 2010
Frequency counter	MTE/A163	Nationwide	13-52009	10 th November 2013
Reference HeNe laser	GOLDSTD13	Renishaw	29U802-131119-00	19 th November 2013
Test procedure	PT-50285			

Laser measurement system accuracy: When a Renishaw ML10 laser is used with a Renishaw EC10 compensator and a Renishaw air temperature sensor (*all within specification*) the laser measurement system accuracy (95% confidence level, k=2) in linear measurement mode will be within: ±1.1 ppm (see the system manual for details).

Authorised signature	Signatory	Position	Issue date
	T. Szewczyk	Service Center Manager	7 th May 2014

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Certificate number
 G24578-140507-00

Calibration Cert # 2707.01

L-9908-1146-04

Product EC10 material temperature sensor
Serial number 52K040
Date of calibration 08 May 14
Customer name Starrag-Heckert, Inc.
Customer address 2379 Progress Drive
Customer reference Hebron, KY 41048



Calibration certificate

Specification Material temperature sensor accuracy

±0.10 °C

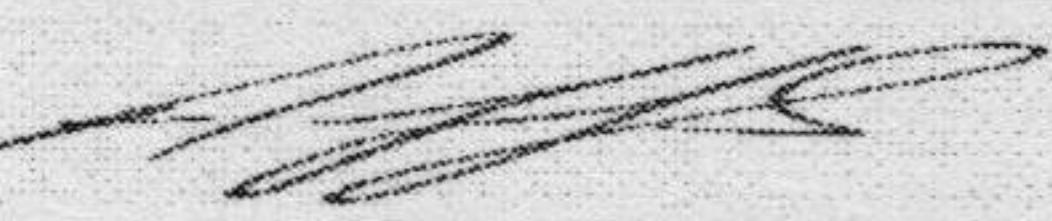
Measured values and uncertainties of calibration

Time (mins)	Material temperature (°C)		
	Reference	Measured	Error
0	21.91	21.97	0.06
10	21.98	22.03	0.05
20	22.02	22.06	0.04
30	22.03	22.08	0.05
40	22.06	22.12	0.06
50	22.11	22.16	0.05
60	22.10	22.16	0.06
Mean error		0.05	
Uncertainty (k=2)		0.07	

Calibrated values only valid when this temperature sensor is used with EC10 serial number G27072.

Reference standards	Ref. no.	Certificate no.	Date
XC material temperature sensor	231X47	231X47-140109-00	09 January 14
Test procedure		PT-50304	01 January 01

Laser measurement system accuracy: The accuracy of the material temperature sensor affects the material thermal expansion compensation applied by the software - see the system manual for details.

Authorised signature	Signatory	Position	Date
	Tony Szewczyk	Service Center Manager	08 May 2014

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Certificate number
52K040-140508-00

L-9908-1141-02

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Product EC10 compensator
Serial number G27072
Date of calibration 08 May 14
Customer name Starrag-Heckert, Inc.
Customer address 2379 Progress Drive
Customer reference Hebron, KY 41048



Calibration certificate

Specification Air pressure sensor accuracy ±2.2 mbar
RH sensor accuracy ±20.0 %RH

Measured values and uncertainties of calibration

Time (mins)	Air pressure (mbar)			Humidity (%RH)		
	Reference	Measured	Error	Reference	Measured	Error
0	978.3	980.5	2.2	44.7	55.7	11.0
10	978.3	980.6	2.3	44.5	55.8	11.3
20	978.3	980.6	2.3	44.5	55.3	10.8
30	977.9	980.4	2.5	45.3	55.6	10.3
40	977.7	980.1	2.4	45.5	55.3	9.8
50	977.9	980.3	2.4	45.0	55.7	10.7
60	978.5	980.7	2.2	45.1	55.8	10.7
Mean error			2.3	Mean error		
Uncertainty (k=2)			0.9	Uncertainty (k=2)		

Reference standards	Ref. no.	Certificate no.	Date
XC-80 (air pressure & humidity)	231Y52	231Y52-131218-00	18 December 13
Test procedure		PT-50304	01 January 01

Laser measurement system accuracy: When a Renishaw ML10 laser is used with a Renishaw EC10 compensator and a Renishaw air temperature sensor (*all within specification*) the laser measurement system accuracy in linear measurement mode will be within: ±1.1 ppm (k=2) - see the system manual for details.

Authorised signature	Signatory	Position	Date
	Tony Szewczyk	Service Center Manager	08 May 2014

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Product EC10 air temperature sensor
Serial number G26032
Date of calibration 08 May 14
Customer name Starrag-Heckert, Inc.
Customer address 2379 Progress Drive
Customer reference Hebron, KY 41048



Calibration certificate

Specification Air temperature sensor accuracy
Gold Standard air temperature sensor accuracy

$\pm 0.50^{\circ}\text{C}$
 $\pm 0.20^{\circ}\text{C}$

Measured values and uncertainties of calibration

Time (mins)	Air temperature ($^{\circ}\text{C}$)		
	Reference	Measured	Error
0	22.24	22.16	-0.08
10	22.39	22.31	-0.08
20	22.29	22.21	-0.08
30	22.27	22.19	-0.08
40	22.37	22.29	-0.08
50	22.41	22.34	-0.07
60	22.25	22.16	-0.07
Mean error			-0.07
Uncertainty (k=2)			0.07

Calibrated values only valid when this air temperature sensor is used with EC10 serial number G27072.

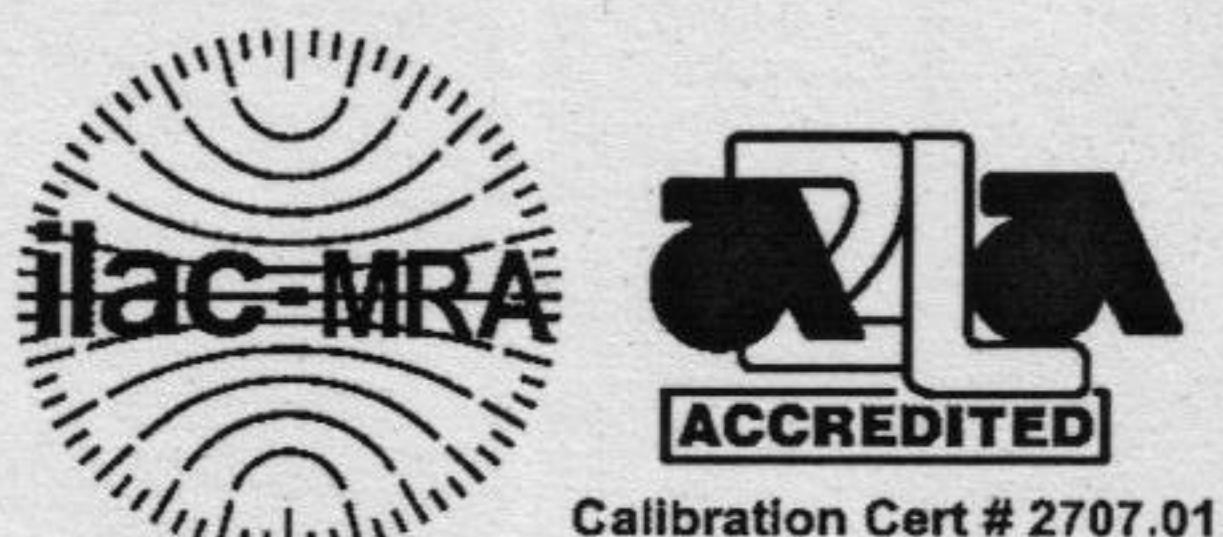
Reference standards	Ref. no.	Certificate no.	Date
XC air temperature sensor	170W74	170W74-140107-00	07 January 14
Test procedure		PT-50304	01 January 01

Laser measurement system accuracy: When a Renishaw ML10 laser is used with a Renishaw EC10 compensator and a Renishaw air temperature sensor (all within specification) the laser measurement system accuracy in linear measurement mode will be within: $\pm 1.1 \text{ ppm} / \pm 0.7 \text{ ppm}$ (k=2) for Gold Standard systems - see the system manual for details.

Authorised signature	Signatory	Position	Date
	Tony Szewczyk	Service Center Manager	08 May 2014

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Product EC10 material temperature sensor
Serial number G25998
Date of calibration 08 May 14
Customer name Starrag-Heckert, Inc.
Customer address 2379 Progress Drive
Customer reference Hebron, KY 41048



Calibration certificate

Specification Material temperature sensor accuracy

$\pm 0.10^\circ\text{C}$

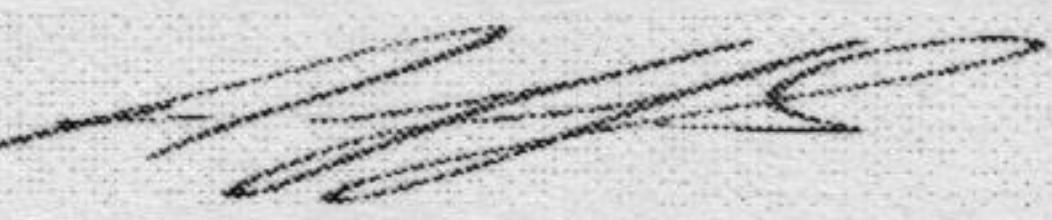
Measured values and uncertainties of calibration

Time (mins)	Material temperature ($^\circ\text{C}$)		
	Reference	Measured	Error
0	21.91	21.91	0.00
10	21.98	21.98	0.00
20	22.02	22.00	-0.02
30	22.03	22.01	-0.02
40	22.06	22.05	-0.01
50	22.11	22.10	-0.01
60	22.10	22.08	-0.02
Mean error		-0.01	
Uncertainty ($k=2$)			0.07

Calibrated values only valid when this temperature sensor is used with EC10 serial number G27072.

Reference standards	Ref. no.	Certificate no.	Date
XC material temperature sensor	231X47	231X47-140109-00	09 January 14
Test procedure		PT-50304	01 January 01

Laser measurement system accuracy: The accuracy of the material temperature sensor affects the material thermal expansion compensation applied by the software - see the system manual for details.

Authorised signature	Signatory	Position	Date
	Tony Szewczyk	Service Center Manager	08 May 2014

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Product EC10 material temperature sensor
Serial number G26014
Date of calibration 08 May 14
Customer name Starrag-Heckert, Inc.
Customer address 2379 Progress Drive
Customer reference Hebron, KY 41048



Calibration certificate

Specification Material temperature sensor accuracy

$\pm 0.10^\circ\text{C}$

Measured values and uncertainties of calibration

Time (mins)	Material temperature ($^\circ\text{C}$)		
	Reference	Measured	Error
0	21.91	21.97	0.06
10	21.98	22.04	0.06
20	22.02	22.06	0.04
30	22.03	22.08	0.05
40	22.06	22.12	0.06
50	22.11	22.16	0.05
60	22.10	22.14	0.04
Mean error		0.05	
Uncertainty ($k=2$)		0.07	

Calibrated values only valid when this temperature sensor is used with EC10 serial number G27072.

Reference standards	Ref. no.	Certificate no.	Date
XC material temperature sensor	231X47	231X47-140109-00	09 January 14
Test procedure		PT-50304	01 January 01

Laser measurement system accuracy: The accuracy of the material temperature sensor affects the material thermal expansion compensation applied by the software - see the system manual for details.

Authorised signature	Signatory	Position	Date
	Tony Szewczyk	Service Center Manager	08 May 2014

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