

LASER TRACKER SERVICE

REPORT AND COMPENSATION DATA



Calibration Certificate Metrology

Product : Leica Absolute Tracker AT401
Article No.: 576371
Serial No. : 391059

Certificate No. : 391059-20220512
Inspection Date: May 12, 2022
P.O. Number : 29291

Customer : HACO A/S
Barrit Langgade 97
DK-7150 Barrit
Denmark

Certification Location:
Hexagon Metrology s.r.o.
Calibration Laboratory
Litvínovská 609/3, 190 00 Praha 9
Czech Republic

Status : After Inspection

Compliance

The accreditation (2397) is in accordance with the standard ISO/IEC 17025 and is granted by the Czech Accreditation Service (SAS). The Swiss Accreditation Service is a member of the International Laboratory Accreditation Cooperation (ILAC) and signatory of the Mutual Recognition Agreement (MRA) which assures international acceptance of the calibration certificates.

The test equipment used is traceable to national standards or to recognized procedures.

Certificate :

We hereby certify that the product described has been tested with the following result:

- Compliance** **The test results are within the specification of the product.**
 Non-Compliance The test results are not within the specification of the product.

The test results have been determined without consideration of the measurement uncertainty ("shared risk").



May 12, 2022



Reviewed and Approved by
Dan Parnham
Technician of Calibration Laboratory

Certificate No. 391059-20220512
Art. No 576371

This Certificate may not be reproduced other than in full
except with prior written approval of the issuing authority
Measured values are valid for the particular equipment, date and calibration lab.

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Hexagon Metrology s.r.o.
Calibration Laboratory
Litvínovská 609/3, 190 00 Praha 9
Czech Republic
www.hexagonmi.com

Specifications

a) Measurement Uncertainty of a spatial length (MPE) of 2500 mm observed at a distance of:	2 m	≤	± 0,036 mm
	10 m	≤	± 0,106 mm
	20 m	≤	± 0,191 mm
b) Maximum deviation (MPE) of the ADM Offset (e_{R0}):		≤	± 0,014 mm
c) Absolute Distance Meter (ADM) Scale:		≤	0,3 ppm
Repeatability of an ADM measurement throughout the entire working range (Expanded Standard Deviation (k=2)): **)		≤	± 0,005 mm
d) Maximum deviation of embedded Meteostation temperature:		≤	± 0,3 °C
Maximum deviation of embedded Meteostation pressure:		≤	± 1,0 hPa
Maximum deviation of embedded Meteostation Relative Humidity:		≤	± 5,0 % r.H.

Test Results

a) Maximum observed deviation of measurements at the spatial distance of :	2,0 m	0,009 mm	± 0,012 mm *)
	10,0 m	-0,020 mm	
	20,4 m	0,015 mm	
b) Maximum observed deviation of ADM offset (e_{R0}) :		-0,004 mm	± 0,007 mm *)
c) Absolute Distance Meter (ADM) Scale :		-0,06 ppm	± 0,03 ppm *)
Maximum observed repeatability of ADM over entire working range :		0,002 mm	**)
d) Maximum observed deviation of temperature:		-0,2°C	± 0,06 °C *)
Maximum observed deviation of pressure:		0,1 hPa	± 0,7 hPa *)
Maximum observed deviation of relative humidity:		-0,4 % r.H.	± 2,5 % r.H. *)

Measurement Uncertainty

*) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$, which for normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA-4/02.

***) Test result not in scope of Accredited Laboratory

Calibration Certificate Metrology - Appendix

Test Procedure

Process Documentation

The verification is performed per the Leica procedure.
 "Recertification Manual for Leica Laser Tracker, T-Scan and T-Probe"

Spatial Length Measurement (Scale Bar)

The spatial length measurements, respective the coordinate determination are carried out on a calibrated scale bar with a length of 2500 mm.

ADM Frequency

The modulation frequency of the distance meter is checked against a calibrated rubidium frequency.

ADM Offset

The determination of the distance meter zero point offset is based on the principle of distance measurements in all combinations of an unknown base line (inside / outside comparison of three stations).

Embedded Meteostation (Temperature / Pressure / Humidity)

The reported measuring results are deviations to measurements of a reference meteo station traceable to national standards, which has been calibrated by an accredited body.

Reference Equipment

Process Documentation

Leica Recertification Procedure Manual Revision Nr. 2.3.1

a) Spatial Length Measurement (Scale Bar)

	Serial No:	Calibration Certificate No:
Brunson Invar Kit	10-MSP-002	L210629B1

c) Distance Repeatability Measurement (ADM)

	Serial No:	Calibration Certificate No:
Rubidium Frequency FS725	147298	1013-KL-40020-20

d) Embedded Meteostation (Temperature/Pressure/Humidity)

	Serial No.:	Calibration Certificate No.:
Lufft XA1000	043.0217.1001.003	1033-KL-70214-20

Measurement Report



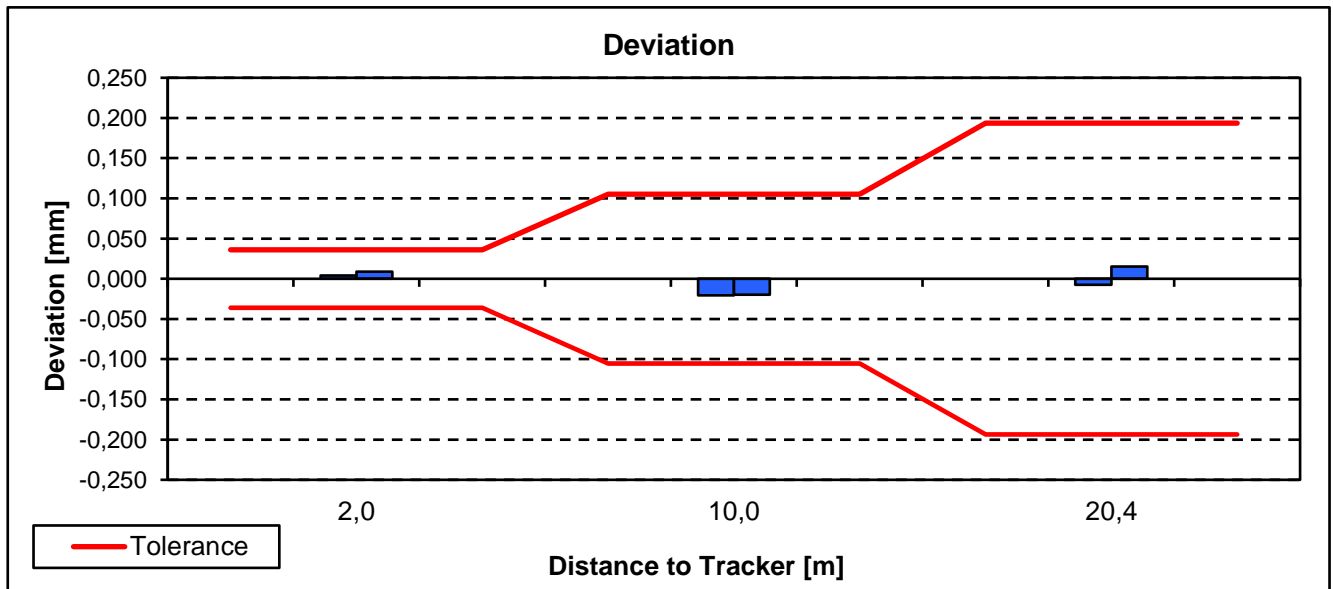
a) Spatial Length Measurement (Scale Bar)

Inspection Date: May 12, 2022
 Inspected by: Dan Parnham

Temperature: 23,7°C
 Pressure: 981,8 hPa
 Humidity: 36,4 %
 Reflector Serial No.: 22247

Product: Leica Absolute Tracker AT401
 Serial No.: 391059

Reference distance [mm]:							2549,986 mm	
Temperatures of scale bar:							@ Reference measurements: 19,9°C	
							@ Scale Bar measurements: 23,7°C	
Distance to System	Ref.-Dist corrected	Measured Distances		Repeatability $\Delta R1 - R2$	Measured - Reference		Max. Dev. Run 1/2	Tolerance
		Run 1	Run 2		Run 1	Run 2		
[m]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
2,0	2550,0031	2550,007	2550,012	0,0048	0,0039	0,0088	0,0088	$\pm 0,036$
10,0	2550,0031	2549,983	2549,983	0,0007	-0,0205	-0,0197	-0,0205	$\pm 0,105$
20,4	2550,0031	2549,996	2550,018	0,0228	-0,0075	0,0152	0,0152	$\pm 0,194$



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Measured values are valid for the particular equipment, date and calibration lab.

Measurement Report



b) Absolute Distance Measurement (ADM): Zero Point Offset and Distance Check

Inspection Date: May 12, 2022
 Inspected by: Dan Parnham
 Temperature: 23,7°C
 Pressure: 981,8 hPa
 Humidity: 36,4 %
 Product: Leica Absolute Tracker AT401
 Serial No.: 391059
 Lector Serial No.: 22247

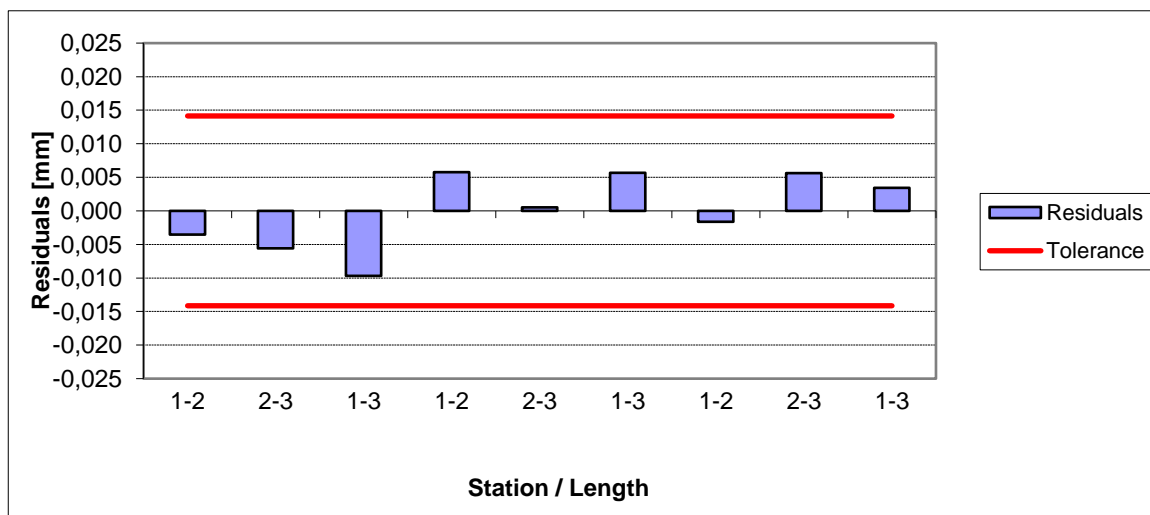
Absolute Distance Meter (ADM) Zero Offset R_0

	Measured [mm]	Active [mm]	Error e_{R_0} [mm]	Tolerance [mm]
ADM Zero Offset R_0	72,9230	72,9190	-0,0040	$\pm 0,010$

Absolute Distance Meter (ADM) Distance Check **)

Station	from Target	to Target	Distance [mm]	Length [mm]	Reference Length [mm]	Error [mm]
1	1	2	5233,825	6098,963	6098,966	-0,004
	2	3	11332,779	6293,775	6293,781	-0,006
	1	3	17626,554	12392,738	12392,747	-0,010
2	1	2	2851,587	6098,972	6098,966	0,006
	2	3	3249,496	6293,782	6293,781	0,001
	1	3	9542,659	12392,753	12392,747	0,006
3	1	2	9246,853	6098,965	6098,966	-0,002
	2	3	3147,889	6293,787	6293,781	0,006
	1	3	3145,905	12392,751	12392,747	0,003

from Target	to Target	max. Error [mm]	Tolerance [mm]
1	2	0,006	$\pm 0,014$
2	3	0,006	$\pm 0,014$
1	3	-0,010	$\pm 0,014$



***) Test result not in scope of Accredited Laboratory

Measurement Report

c) Distance Repeatability Measurement (ADM)

Inspection Date: May 12, 2022
 Inspected by: Dan Parnham

Temperature: 23,7 °C
 Pressure: 981,8 hPa
 Humidity: 36,4 %
 Reflector Serial No.: 22247

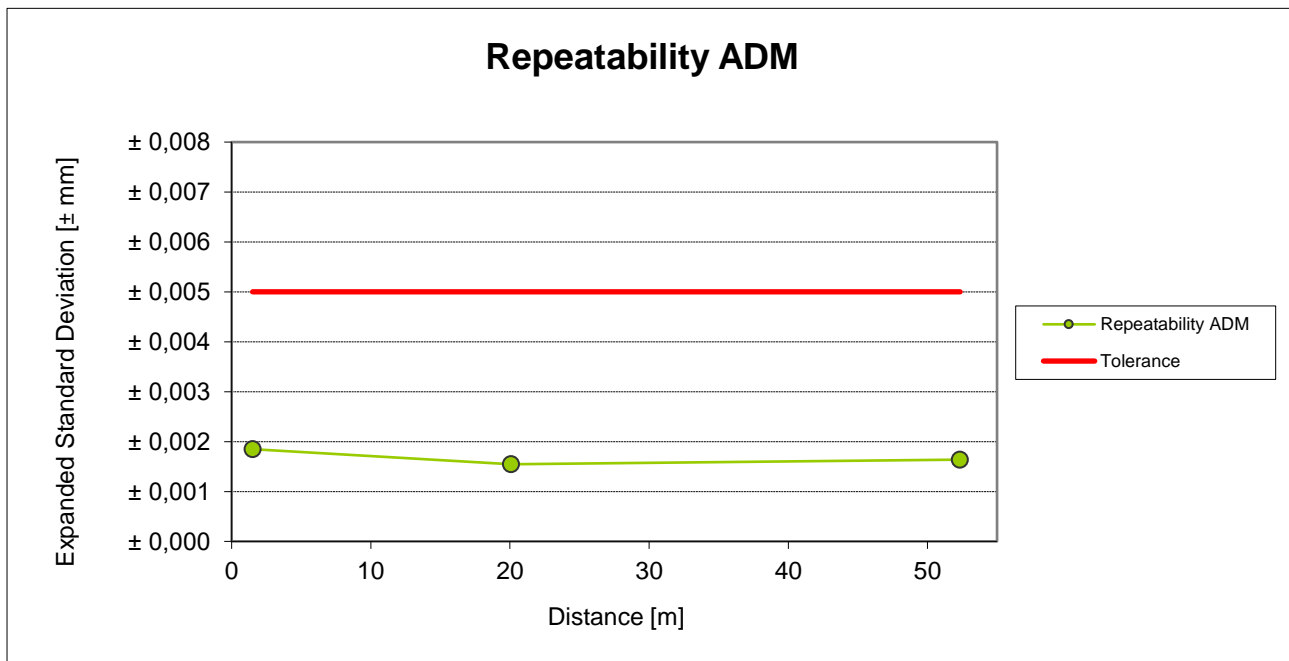
Product: Leica Absolute Tracker AT401
 Serial No: 391059

Absolute Distance Meter (ADM) Scale

ADM Scale [ppm]	Tolerance [ppm]
-0,06	± 0,3

Absolute Distance Meter (ADM) Repeatability **)

Distance approximate [m]	Expanded Standard Deviation (k=2) ADM Repeatability (10 samples) [mm]
1,5	± 0,0018
20	± 0,0015
53	± 0,0016



***) Test result not in scope of Accredited Laboratory

Measurement Report

d) Embedded Meteostation (Temperature / Pressure / Humidity)

Inspection Date: May 12, 2022
 Inspected by: Dan Parnham

Product: AT Controller 400
 Serial No: 391059
 Ext. Temp. Sensor Serial No: 388609/048

Results

	Reference value	Actual value	Deviation	Verdict
Temperature Air	24,2 °C	24,0 °C	-0,2 °C	passed
Temperature Object	24,2 °C	24,1 °C	-0,1 °C	passed
Pressure	981,5 hPa	981,6 hPa	0,1 hPa	passed
Relative Humidity	36,8 %	36,4 %	-0,4 %	passed

Note: The reference values are the environmental conditions recorded by a reference weather station at the time of the meteo station calibration.

Accuracy of air temperature and relative humidity of the device under test is ensured with connected external air temperature sensor only.





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