ISO/IEC 17025:2005 Accredited

PJLA Calibration

Accreditation# 93289

WILLRICH PRECISION INSTRUMENT

THINK MEASUREMENT... THINK WILLRICH

CERTIFICATE OF CALIBRATION

ISSUED BY: WILLRICH PRECISION INSTRUMENT
CALIBRATION DATE: 1/30/2019
CALIBRATION DUE DATE: 1/31/2020
INSTRUMENT SERIAL NUMBER: [redacted]
PURCHASE ORDER NUMBER: 2696-001
CERTIFICATION NUMBER: 1302019-1.1M
START TEMPERATURE: 68° F
END TEMPERATURE: 68° F
MEASUREMENT UNCERTAINTY: 100 µin + 8.47 µin/in

Willrich Precision Instrument
80 Broadway
Cresskill, NJ 07626
866-945-5742 TELEPHONE
201-567-7470 MAIN FAX

CUSTOMER: [redacted]

DESCRIPTION: **AVR300 MEASUREMENT SYSTEM**

GAUGE NUMBER: [redacted]

LOCATION: **LAB**

AS FOUND RESULT: **FAIL**

CORRECTIONS MADE: **YES**

AS LEFT RESULT: **PASS**

NOTES: **SETTINGS FILE CORRUPTED. POSSIBLE POWER OUTAGE**

REPORT: **THIS MACHINE WAS MEASURED & VALIDATED FOR ACCURACY AND REPEATABILITY USING GLASS STANDARDS.**

SIGNATURE: _____

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Willrich Precision Instrument
80 Broadway
Cresskill, NJ 07626

Description	Part Number	Model	ID
Dot Reticle Plate	GLT10324	300mmx200mm	J71031

This dot array has been certified that the calibration data for the artifact mentioned above are within the stated uncertainty. The artifact under test has been calibrated using standards traceable to N.I.S.T. The quality system meets the requirements of ISO/IEC 17025:2005.

Date Calibrated:	1/18/2018	**Uncertainty (k=2):**	+/- 0.86 Microns
Temp. At Calibration:	68.0°F	**Pressure At Calibration:**	1013.25 mBar (1atm)

Calibration Procedure of Standard

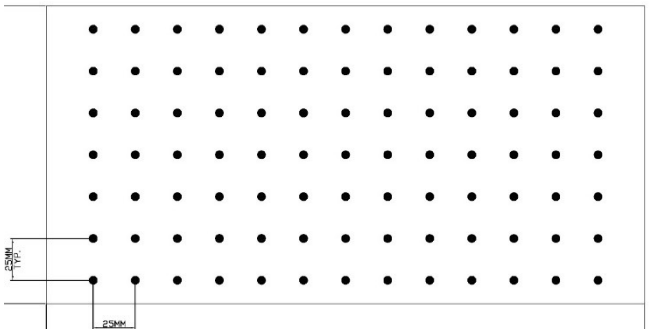
The location of each listed feature is determined by finding the edge location along several radial vectors using machine vision methods. The apparent center of the feature is found by averaging no less than 32 edge measurements. Each feature is sampled 10 times over 5 passes.

The grid was oriented, so the part logo was at the bottom of the part. All measurements were taken on FA103 utilizing a Renishaw RLE-20 Laser Encoder System. A linear scale of Fused Silica CAL-STD-01 was utilized to validate the CMM prior to calibration. The reference scale FA103 has NIST test number 683/282817-13.

The reported expanded uncertainty of measurement is stated as the standard uncertainty of the measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95%

Approved By:

Michael J Martone
Quality Manager



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CERTIFICATE OF CALIBRATION

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Willrich Precision Instrument
80 Broadway
Cresskill, NJ 07626

Description	Serial Number	Uncertainty (k=2)
25.0 Millimeter Steel Gage Block	None	.08 microns
50.0 Millimeter Steel Gage Block	None	.10 microns
75.0 Millimeter Steel Gage Block	None	.13 microns
100.0 Millimeter Steel Gage Block	None	.15 microns

These gage blocks have been certified and the calibration data for the artifacts mentioned above are within the stated uncertainty. The artifacts under test have been calibrated using standards traceable to N.I.S.T. The quality system meets the requirements of ISO/IEC 17025:2005.

Date: 2/6/2018 **Temperature:** 68.0°F

Standard Used to Calibrate Equipment

EC-15 Electronic Gage Block Comparator – N.I.S.T Number 683/288287-16

The reported expanded uncertainty of measurement is stated as the standard uncertainty of the measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95%

Approved By:

Michael J Martone
Quality Manager

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CERTIFICATE OF CALIBRATION

ISSUED BY: Willrich Precision Instrument
Willrich Precision Instrument
80 Broadway
Cresskill, NJ 07626

Calibration Procedure of Repeatability

Ensure all encoders are working properly and the machine has homed. Delete any programs or datums that may be open. Measure a circle feature and datum this feature for X, Y, and Z. Move the stage to a new location and then “home” the machine. Allow the machine to go through its homing process and then remeasure the same circle in order to verify it’s XYZ position.

Measure and datum on a circle feature. Move at least 28mm in a positive XY direction and re-measure the feature. Repeat this process 10 times. Move at least 28mm in a negative XY position and re-measure the circle datum. Repeat this process 10 times. Report repeatability of circle datum coordinates.

Approved By:

Michael J Martone
Quality Manager

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MACHINE INFORMATION

MODEL:	AVR300 TELECENTRIC & ZOOM LENS
DESCRIPTION:	STARRETT VERTICAL PROJECTOR
SERIAL NUMBER:	
TYPE OF CALIBRATION PERFORMED:	NON-LINEAR ERROR CORRECTION (GRID)
CALIBRATION FREQUENCY:	12 MONTH
DATE OF CALIBRATION:	1/30/2019
RECOMMENDED RECALIBRATION DATE:	1/31/2020

TEST EQUIPMENT USED

GRID CALIBRATION STANDARD SERIAL NUMBER:	CAL-L-01
CALIBRATION DUE DATE:	1/6/2021
MEASUREMENT UNCERTAINTY:	±1.0µm
LINEAR CALIBRATION STANDARD SERIAL NUMBER:	10073
CALIBRATION DUE DATE:	1/6/2021
MEASUREMENT UNCERTAINTY:	± 1.0µm
FOV CALIBRATION STANDARD SERIAL NUMBER:	10073
CALIBRATION DUE DATE:	1/6/2021
MEASUREMENT UNCERTAINTY:	± 1.0µm

MEASURED FIDUCIAL LOCATION

AXIS POSITION (mm)	**X**	**Y**
REPEATABILITY X & Y AXES		
RUN 1	0.0000	0.0001
RUN 2	0.0001	0.0001
RUN 3	0.0002	0.0000
RUN 4	0.0005	0.0002
RUN 5	0.0003	0.0002
RUN 6	0.0000	0.0000
RUN 7	0.0001	0.0003
RUN 8	0.0002	0.0001
RUN 9	0.0002	0.0000
RUN 10	0.0002	0.0001
REPEATABILITY (µm)	**0.50**	**0.30**
NEGATIVE DIRECTION X & Y AXES		
RUN 1	0.0002	0.0000
RUN 2	0.0005	0.0002
RUN 3	0.0001	0.0001
RUN 4	0.0002	0.0001
RUN 5	0.0006	0.0000
RUN 6	0.0004	0.0000
RUN 7	0.0002	0.0000
RUN 8	0.0000	0.0002
RUN 9	0.0004	0.0002
RUN 10	0.0002	0.0002
REPEATABILITY (µm)	**0.56**	**0.20**

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ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS

NOMINAL DISTANCE (mm)	1.00121	2.50040	5.00010	10.00056
ACCURACY SPECIFICATION (µm)	**4.01**	**4.01**	**4.03**	**4.05**
Telecentric				
RUN 1	0.9981	2.4988	4.9987	9.9995
RUN 2	0.9985	2.4992	4.9987	9.9995
RUN 3	0.9984	2.4988	4.9987	9.9995
AVERAGE (mm)	0.9983	2.4989	4.9987	9.9995
MEASURED ACCURACY (µm)	**2.88**	**1.47**	**1.40**	**1.06**
REMAINING TOLERANCE (µm)	**1.13**	**2.55**	**2.63**	**2.99**
PASS OR FAIL	**PASS**	**PASS**	**PASS**	**PASS**

ACCURACY VALIDATION RESULTS AFTER CORRECTIONS

NOMINAL DISTANCE (mm)	1.00121	2.50040	5.00010	10.00056
ACCURACY SPECIFICATION (µm)	**4.01**	**4.01**	**4.03**	**4.05**
Telecentric				
RUN 1	1.0013	2.5000	4.9999	10.0005
RUN 2	1.0013	2.5001	4.9997	10.0005
RUN 3	1.0013	2.5000	4.9997	10.0005
AVERAGE (mm)	1.0013	2.5000	4.9998	10.0005
MEASURED ACCURACY (µm)	**0.09**	**0.37**	**0.33**	**0.06**
REMAINING TOLERANCE (µm)	**3.92**	**3.65**	**3.69**	**3.99**
PASS OR FAIL	**PASS**	**PASS**	**PASS**	**PASS**

ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS

NOMINAL DISTANCE (mm)	1.00121	2.50040	5.00010
ACCURACY SPECIFICATION (µm)	**1.01**	**1.01**	**1.03**
M0.7			
RUN 1	1.0088	2.5184	5.0353
RUN 2	1.0085	2.5185	5.0350
RUN 3	1.0085	2.5185	5.0355
AVERAGE (mm)	1.0086	2.5185	5.0353
MEASURED ACCURACY (µm)	**7.39**	**18.07**	**35.17**
REMAINING TOLERANCE (µm)	**-6.38**	**-17.05**	**-34.14**
PASS OR FAIL	**FAIL**	**FAIL**	**FAIL**

ACCURACY VALIDATION RESULTS AFTER CORRECTIONS

NOMINAL DISTANCE (mm)	1.00121	2.50040	5.00010
ACCURACY SPECIFICATION (µm)	**1.01**	**1.01**	**1.03**
M0.7			
RUN 1	1.0020	2.5009	5.0001
RUN 2	1.0017	2.5009	5.0005
RUN 3	1.0017	2.5008	5.0005
AVERAGE (mm)	1.0018	2.5009	5.0004
MEASURED ACCURACY (µm)	**0.59**	**0.47**	**0.27**
REMAINING TOLERANCE (µm)	**0.42**	**0.55**	**0.76**
PASS OR FAIL	**PASS**	**PASS**	**PASS**

ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS

NOMINAL DISTANCE (mm)	1.00121	2.50040
ACCURACY SPECIFICATION (µm)	**1.01**	**1.01**
M1		
RUN 1	1.0076	2.5137
RUN 2	1.0075	2.5135
RUN 3	1.0075	2.5135
AVERAGE (mm)	1.0075	2.5136
MEASURED ACCURACY (µm)	**6.32**	**13.17**
REMAINING TOLERANCE (µm)	**-5.32**	**-12.15**
PASS OR FAIL	**FAIL**	**FAIL**

ACCURACY VALIDATION RESULTS AFTER CORRECTIONS

NOMINAL DISTANCE (mm)	1.00121	2.50040
ACCURACY SPECIFICATION (µm)	**1.01**	**1.01**
M1		
RUN 1	1.0017	2.5008
RUN 2	1.0017	2.5008
RUN 3	1.0017	2.5008
AVERAGE (mm)	1.0017	2.5008
MEASURED ACCURACY (µm)	**0.49**	**0.40**
REMAINING TOLERANCE (µm)	**0.52**	**0.61**
PASS OR FAIL	**PASS**	**PASS**

ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS

NOMINAL DISTANCE (mm)	0.20046	1.00121
ACCURACY SPECIFICATION (µm)	**1.00**	**1.01**
M2		
RUN 1	0.2035	1.0087
RUN 2	0.2030	1.0088
RUN 3	0.2033	1.0088
AVERAGE (mm)	0.2033	1.0088
MEASURED ACCURACY (µm)	**2.81**	**7.56**
REMAINING TOLERANCE (µm)	**-1.81**	**-6.55**
PASS OR FAIL	**FAIL**	**FAIL**

ACCURACY VALIDATION RESULTS AFTER CORRECTIONS

NOMINAL DISTANCE (mm)	0.20046	1.00121
ACCURACY SPECIFICATION (µm)	**1.00**	**1.01**
M2		
RUN 1	0.2010	1.0012
RUN 2	0.2010	1.0012
RUN 3	0.2009	1.0012
AVERAGE (mm)	0.2010	1.0012
MEASURED ACCURACY (µm)	**0.51**	**0.01**
REMAINING TOLERANCE (µm)	**0.49**	**1.00**
PASS OR FAIL	**PASS**	**PASS**

ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS

NOMINAL DISTANCE (mm)	0.20046	1.00121
ACCURACY SPECIFICATION (µm)	**1.00**	**1.01**
M3		
RUN 1	0.2030	1.0066
RUN 2	0.2030	1.0065
RUN 3	0.2030	1.0066
AVERAGE (mm)	0.2030	1.0066
MEASURED ACCURACY (µm)	**2.54**	**5.36**
REMAINING TOLERANCE (µm)	**-1.54**	**-4.35**
PASS OR FAIL	**FAIL**	**FAIL**

ACCURACY VALIDATION RESULTS AFTER CORRECTIONS

NOMINAL DISTANCE (mm)	0.20046	1.00121
ACCURACY SPECIFICATION (µm)	**1.00**	**1.01**
M3		
RUN 1	0.2008	1.0015
RUN 2	0.2009	1.0015
RUN 3	0.2009	1.0015
AVERAGE (mm)	0.2009	1.0015
MEASURED ACCURACY (µm)	**0.41**	**0.29**
REMAINING TOLERANCE (µm)	**0.59**	**0.72**
PASS OR FAIL	**PASS**	**PASS**

ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS

NOMINAL DISTANCE (mm)	0.20046	1.00121
ACCURACY SPECIFICATION (µm)	**1.00**	**1.01**
M4		
RUN 1	0.2033	1.0079
RUN 2	0.2033	1.0078
RUN 3	0.2033	1.0078
AVERAGE (mm)	0.2033	1.0078
MEASURED ACCURACY (µm)	**2.84**	**6.62**
REMAINING TOLERANCE (µm)	**-1.84**	**-5.62**
PASS OR FAIL	**FAIL**	**FAIL**

ACCURACY VALIDATION RESULTS AFTER CORRECTIONS

NOMINAL DISTANCE (mm)	0.20046	1.00121
ACCURACY SPECIFICATION (µm)	**1.00**	**1.01**
M4		
RUN 1	0.2010	1.0015
RUN 2	0.2010	1.0018
RUN 3	0.2010	1.0017
AVERAGE (mm)	0.2010	1.0017
MEASURED ACCURACY (µm)	**0.54**	**0.46**
REMAINING TOLERANCE (µm)	**0.46**	**0.55**
PASS OR FAIL	**PASS**	**PASS**

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ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS

NOMINAL DISTANCE (mm)	0.20046	1.00121
ACCURACY SPECIFICATION (µm)	**1.00**	**1.01**
M4.5		
RUN 1	0.2054	1.0100
RUN 2	0.2050	1.0100
RUN 3	0.2054	1.0100
AVERAGE (mm)	0.2053	1.0100
MEASURED ACCURACY (µm)	**4.81**	**8.79**
REMAINING TOLERANCE (µm)	**-3.81**	**-7.78**
PASS OR FAIL	**FAIL**	**FAIL**

ACCURACY VALIDATION RESULTS AFTER CORRECTIONS

NOMINAL DISTANCE (mm)	0.20046	1.00121
ACCURACY SPECIFICATION (µm)	**1.00**	**1.01**
M4.5		
RUN 1	0.2007	1.0015
RUN 2	0.2005	1.0014
RUN 3	0.2005	1.0015
AVERAGE (mm)	0.2006	1.0015
MEASURED ACCURACY (µm)	**0.11**	**0.26**
REMAINING TOLERANCE (µm)	**0.89**	**0.75**
PASS OR FAIL	**PASS**	**PASS**

ACCURACY VALIDATION RESULTS BEFORE CALIBRATION

NOMINAL DISTANCE (mm)	25.0000	50.0000	75.0000	100.0000	125.0000
SPECIFICATION (µm)	**2.63**	**2.75**	**2.88**	**3.00**	**3.13**
VALIDATION					
RUN 1	24.9996	49.9893	74.9829	99.9800	124.9756
RUN 2	24.9996	49.9893	74.9830	99.9800	124.9755
RUN 3	24.9997	49.9893	74.9830	99.9800	124.9755
AVERAGE (mm)	24.9996	49.9893	74.9830	99.9800	124.9755
MEASURED ACCURACY (µm)	**0.37**	**10.70**	**17.03**	**20.00**	**24.47**
REMAINING TOLERANCE (µm)	**2.26**	**-7.95**	**-14.16**	**-17.00**	**-21.34**
PASS OR FAIL	**PASS**	**FAIL**	**FAIL**	**FAIL**	**FAIL**

ACCURACY VALIDATION RESULTS AFTER CALIBRATION

NOMINAL DISTANCE (mm)	25.0000	50.0000	75.0000	100.0000	125.0000
SPECIFICATION (µm)	**2.63**	**2.75**	**2.88**	**3.00**	**3.13**
VALIDATION					
RUN 1	24.9997	49.9995	75.0000	99.9988	125.0020
RUN 2	24.9997	49.9991	75.0000	99.9989	125.0019
RUN 3	24.9997	49.9991	7I5.0004	99.9990	125.0020
AVERAGE (mm)	24.9997	49.9992	75.0000	99.9989	125.0020
MEASURED ACCURACY (µm)	**0.30**	**0.77**	**0.00**	**1.10**	**1.97**
REMAINING TOLERANCE (µm)	**2.33**	**1.98**	**2.88**	**1.90**	**1.16**
PASS OR FAIL	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**

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ACCURACY VALIDATION RESULTS BEFORE CALIBRATION

NOMINAL DISTANCE (mm)	25.0000	50.0000	75.0000	100.0000	125.0000	150.0000	175.0000	200.0000	225.0000	250.0000	275.0000	300.0000
ACCURACY SPECIFICATION (µm)	**2.03**	**2.15**	**2.28**	**2.40**	**2.53**	**2.65**	**2.78**	**2.90**	**3.03**	**3.15**	**3.28**	**3.40**
X Validation												
RUN	25.0004	50.0006	74.9993	100.0009	125.0010	150.0012	174.9988	199.9987	224.9980	249.9969	274.9964	299.9967
AVERAGE (mm)	25.0004	50.0006	74.9993	100.0009	125.0010	150.0012	174.9988	199.9987	224.9980	249.9969	274.9964	299.9967
MEASURED ACCURACY (µm)	**0.40**	**0.60**	**0.70**	**0.90**	**1.00**	**1.20**	**1.20**	**1.30**	**2.00**	**3.10**	**3.60**	**3.30**
REMAINING TOLERANCE (µm)	**1.63**	**1.55**	**1.58**	**1.50**	**1.52**	**1.45**	**1.57**	**1.60**	**1.02**	**0.05**	**-0.33**	**0.10**
PASS OR FAIL	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**FAIL**	**PASS**

Y Validation								
RUN	24.9993	49.9992	74.9978	99.9965	124.9962	149.9969	174.9960	199.9960
AVERAGE (mm)	24.9993	49.9992	74.9978	99.9965	124.9962	149.9969	174.9960	199.9960
MEASURED ACCURACY (µm)	**0.70**	**0.80**	**2.20**	**3.50**	**3.80**	**3.10**	**4.00**	**4.00**
REMAINING TOLERANCE (µm)	**1.33**	**1.35**	**0.07**	**-1.10**	**-1.27**	**-0.45**	**-1.22**	**-1.10**
PASS OR FAIL	**PASS**	**PASS**	**PASS**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**

ACCURACY VALIDATION RESULTS AFTER CALIBRATION

NOMINAL DISTANCE (mm)	25.0000	50.0000	75.0000	100.0000	125.0000	150.0000	175.0000	200.0000	225.0000	250.0000	275.0000	300.0000
ACCURACY SPECIFICATION (µm)	**2.03**	**2.15**	**2.28**	**2.40**	**2.53**	**2.65**	**2.78**	**2.90**	**3.03**	**3.15**	**3.28**	**3.40**
X Validation												
RUN	24.9999	49.9999	74.9997	99.9995	124.9996	149.9996	174.9997	199.9997	224.9996	249.9996	275.0000	300.0000
AVERAGE (mm)	24.9999	49.9999	74.9997	99.9995	124.9996	149.9996	174.9997	199.9997	224.9996	249.9996	275.0000	300.0000
MEASURED ACCURACY (µm)	**0.10**	**0.10**	**0.30**	**0.50**	**0.40**	**0.40**	**0.30**	**0.30**	**0.40**	**0.40**	**0.00**	**0.00**
REMAINING TOLERANCE (µm)	**1.93**	**2.05**	**1.98**	**1.90**	**2.13**	**2.25**	**2.47**	**2.60**	**2.62**	**2.75**	**3.28**	**3.40**
PASS OR FAIL	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**

Y Validation								
RUN	25.0000	50.0000	75.0001	100.0000	125.0000	150.0000	175.0001	200.0000
AVERAGE (mm)	25.0000	50.0000	75.0001	100.0000	125.0000	150.0000	175.0001	200.0000
MEASURED ACCURACY (µm)	**0.00**	**0.00**	**0.10**	**0.00**	**0.00**	**0.00**	**0.10**	**0.00**
REMAINING TOLERANCE (µm)	**2.03**	**2.15**	**2.17**	**2.40**	**2.53**	**2.65**	**2.67**	**2.90**
PASS OR FAIL	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**