



Accreditation# 93289

## 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  $\mu$ m + 8.47  $\mu$ m/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: 

THIS CERTIFICATE PROVIDES MEASUREMENT TRACEABILITY TO THE S.I. IS ACHIEVED THROUGH NIST/NMI. CALIBRATION IS IN ACCORDANCE WITH ISO/IEC 17025:2005 AND ANSI/NCSL Z540-1-1994. REPORTED UNCERTAINTY VALUE WAS CALCULATED USING MU AT APPROXIMATELY A 95% CONFIDENCE LEVEL AND USING A COVERAGE FACTOR OF K=2. CALIBRATION METHODS LISTED IN WILLRICH PRECISION INSTRUMENT WORK INSTRUCTION (WPI\_VS13). THIS CERTIFICATE MAY NOT BE REPRODUCED OTHER THAN IN FULL, EXCEPT WITH THE PRIOR WRITTEN APPROVAL OF THE ISSUING LABORATORY.



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 Willrich Precision Instrument  
 80 Broadway  
 Cresskill, NJ 07626

| <u>Description</u> | <u>Part Number</u> | <u>Model</u> | <u>ID</u> |
|--------------------|--------------------|--------------|-----------|
| 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

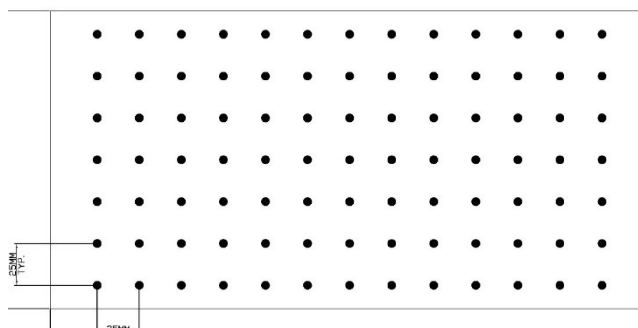
The location of each listed feature is determined by finding the edge location along several radial vectors using machine vision methods. The apparent center of the feature is found by averaging no less than 32 edge measurements. Each feature is sampled 10 times over 5 passes.

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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 80 Broadway  
 Cresskill, NJ 07626

| <u>Description</u>                | <u>Serial Number</u> | <u>Uncertainty (k=2)</u> |
|-----------------------------------|----------------------|--------------------------|
| 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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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:

A handwritten signature in black ink, appearing to read 'M. J. Martone', written over a horizontal line.

Michael J Martone  
Quality Manager



Accreditation# 93289

**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  |

| <b>MEASURED FIDUCIAL LOCATION</b> |             |             |  |
|-----------------------------------|-------------|-------------|--|
| <b>AXIS POSITION (mm)</b>         | <b>X</b>    | <b>Y</b>    |  |
| 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      |  |
| <b>REPEATABILITY (µm)</b>         | <b>0.50</b> | <b>0.30</b> |  |
| 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      |  |
| <b>REPEATABILITY (µm)</b>         | <b>0.56</b> | <b>0.20</b> |  |

**ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS**

|                                    |             |             |             |             |
|------------------------------------|-------------|-------------|-------------|-------------|
| NOMINAL DISTANCE (mm)              | 1.00121     | 2.50040     | 5.00010     | 10.00056    |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>4.01</b> | <b>4.01</b> | <b>4.03</b> | <b>4.05</b> |
| 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      |
| <b>MEASURED ACCURACY (µm)</b>      | <b>2.88</b> | <b>1.47</b> | <b>1.40</b> | <b>1.06</b> |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>1.13</b> | <b>2.55</b> | <b>2.63</b> | <b>2.99</b> |
| <b>PASS OR FAIL</b>                | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> |

**ACCURACY VALIDATION RESULTS AFTER CORRECTIONS**

|                                    |             |             |             |             |
|------------------------------------|-------------|-------------|-------------|-------------|
| NOMINAL DISTANCE (mm)              | 1.00121     | 2.50040     | 5.00010     | 10.00056    |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>4.01</b> | <b>4.01</b> | <b>4.03</b> | <b>4.05</b> |
| 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     |
| <b>MEASURED ACCURACY (µm)</b>      | <b>0.09</b> | <b>0.37</b> | <b>0.33</b> | <b>0.06</b> |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>3.92</b> | <b>3.65</b> | <b>3.69</b> | <b>3.99</b> |
| <b>PASS OR FAIL</b>                | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> |

**ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS**

|                                    |              |               |               |
|------------------------------------|--------------|---------------|---------------|
| NOMINAL DISTANCE (mm)              | 1.00121      | 2.50040       | 5.00010       |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.01</b>  | <b>1.01</b>   | <b>1.03</b>   |
| 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        |
| <b>MEASURED ACCURACY (µm)</b>      | <b>7.39</b>  | <b>18.07</b>  | <b>35.17</b>  |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>-6.38</b> | <b>-17.05</b> | <b>-34.14</b> |
| <b>PASS OR FAIL</b>                | <b>FAIL</b>  | <b>FAIL</b>   | <b>FAIL</b>   |

**ACCURACY VALIDATION RESULTS AFTER CORRECTIONS**

|                                    |             |             |             |
|------------------------------------|-------------|-------------|-------------|
| NOMINAL DISTANCE (mm)              | 1.00121     | 2.50040     | 5.00010     |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.01</b> | <b>1.01</b> | <b>1.03</b> |
| 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      |
| <b>MEASURED ACCURACY (µm)</b>      | <b>0.59</b> | <b>0.47</b> | <b>0.27</b> |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>0.42</b> | <b>0.55</b> | <b>0.76</b> |
| <b>PASS OR FAIL</b>                | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> |

**ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS**

|                                    |              |               |
|------------------------------------|--------------|---------------|
| NOMINAL DISTANCE (mm)              | 1.00121      | 2.50040       |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.01</b>  | <b>1.01</b>   |
| 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        |
| <b>MEASURED ACCURACY (µm)</b>      | <b>6.32</b>  | <b>13.17</b>  |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>-5.32</b> | <b>-12.15</b> |
| <b>PASS OR FAIL</b>                | <b>FAIL</b>  | <b>FAIL</b>   |

**ACCURACY VALIDATION RESULTS AFTER CORRECTIONS**

|                                    |             |             |
|------------------------------------|-------------|-------------|
| NOMINAL DISTANCE (mm)              | 1.00121     | 2.50040     |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.01</b> | <b>1.01</b> |
| 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      |
| <b>MEASURED ACCURACY (µm)</b>      | <b>0.49</b> | <b>0.40</b> |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>0.52</b> | <b>0.61</b> |
| <b>PASS OR FAIL</b>                | <b>PASS</b> | <b>PASS</b> |

**ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS**

|                                    |              |              |
|------------------------------------|--------------|--------------|
| NOMINAL DISTANCE (mm)              | 0.20046      | 1.00121      |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.00</b>  | <b>1.01</b>  |
| 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       |
| <b>MEASURED ACCURACY (µm)</b>      | <b>2.81</b>  | <b>7.56</b>  |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>-1.81</b> | <b>-6.55</b> |
| <b>PASS OR FAIL</b>                | <b>FAIL</b>  | <b>FAIL</b>  |

**ACCURACY VALIDATION RESULTS AFTER CORRECTIONS**

|                                    |             |             |
|------------------------------------|-------------|-------------|
| NOMINAL DISTANCE (mm)              | 0.20046     | 1.00121     |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.00</b> | <b>1.01</b> |
| 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      |
| <b>MEASURED ACCURACY (µm)</b>      | <b>0.51</b> | <b>0.01</b> |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>0.49</b> | <b>1.00</b> |
| <b>PASS OR FAIL</b>                | <b>PASS</b> | <b>PASS</b> |



**ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS**

|                                    |              |              |
|------------------------------------|--------------|--------------|
| NOMINAL DISTANCE (mm)              | 0.20046      | 1.00121      |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.00</b>  | <b>1.01</b>  |
| 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       |
| <b>MEASURED ACCURACY (µm)</b>      | <b>2.54</b>  | <b>5.36</b>  |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>-1.54</b> | <b>-4.35</b> |
| <b>PASS OR FAIL</b>                | <b>FAIL</b>  | <b>FAIL</b>  |

**ACCURACY VALIDATION RESULTS AFTER CORRECTIONS**

|                                    |             |             |
|------------------------------------|-------------|-------------|
| NOMINAL DISTANCE (mm)              | 0.20046     | 1.00121     |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.00</b> | <b>1.01</b> |
| 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      |
| <b>MEASURED ACCURACY (µm)</b>      | <b>0.41</b> | <b>0.29</b> |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>0.59</b> | <b>0.72</b> |
| <b>PASS OR FAIL</b>                | <b>PASS</b> | <b>PASS</b> |

**ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS**

|                                    |              |              |
|------------------------------------|--------------|--------------|
| NOMINAL DISTANCE (mm)              | 0.20046      | 1.00121      |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.00</b>  | <b>1.01</b>  |
| 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       |
| <b>MEASURED ACCURACY (µm)</b>      | <b>2.84</b>  | <b>6.62</b>  |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>-1.84</b> | <b>-5.62</b> |
| <b>PASS OR FAIL</b>                | <b>FAIL</b>  | <b>FAIL</b>  |

**ACCURACY VALIDATION RESULTS AFTER CORRECTIONS**

|                                    |             |             |
|------------------------------------|-------------|-------------|
| NOMINAL DISTANCE (mm)              | 0.20046     | 1.00121     |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.00</b> | <b>1.01</b> |
| 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      |
| <b>MEASURED ACCURACY (µm)</b>      | <b>0.54</b> | <b>0.46</b> |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>0.46</b> | <b>0.55</b> |
| <b>PASS OR FAIL</b>                | <b>PASS</b> | <b>PASS</b> |



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**ACCURACY VALIDATION RESULTS BEFORE CORRECTIONS**

|                                    |              |              |
|------------------------------------|--------------|--------------|
| NOMINAL DISTANCE (mm)              | 0.20046      | 1.00121      |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.00</b>  | <b>1.01</b>  |
| 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       |
| <b>MEASURED ACCURACY (µm)</b>      | <b>4.81</b>  | <b>8.79</b>  |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>-3.81</b> | <b>-7.78</b> |
| <b>PASS OR FAIL</b>                | <b>FAIL</b>  | <b>FAIL</b>  |

**ACCURACY VALIDATION RESULTS AFTER CORRECTIONS**

|                                    |             |             |
|------------------------------------|-------------|-------------|
| NOMINAL DISTANCE (mm)              | 0.20046     | 1.00121     |
| <b>ACCURACY SPECIFICATION (µm)</b> | <b>1.00</b> | <b>1.01</b> |
| 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      |
| <b>MEASURED ACCURACY (µm)</b>      | <b>0.11</b> | <b>0.26</b> |
| <b>REMAINING TOLERANCE (µm)</b>    | <b>0.89</b> | <b>0.75</b> |
| <b>PASS OR FAIL</b>                | <b>PASS</b> | <b>PASS</b> |

**ACCURACY VALIDATION RESULTS BEFORE CALIBRATION**

|                                 |             |              |               |               |               |
|---------------------------------|-------------|--------------|---------------|---------------|---------------|
| NOMINAL DISTANCE (mm)           | 25.0000     | 50.0000      | 75.0000       | 100.0000      | 125.0000      |
| <b>SPECIFICATION (µm)</b>       | <b>2.63</b> | <b>2.75</b>  | <b>2.88</b>   | <b>3.00</b>   | <b>3.13</b>   |
| 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      |
| <b>MEASURED ACCURACY (µm)</b>   | <b>0.37</b> | <b>10.70</b> | <b>17.03</b>  | <b>20.00</b>  | <b>24.47</b>  |
| <b>REMAINING TOLERANCE (µm)</b> | <b>2.26</b> | <b>-7.95</b> | <b>-14.16</b> | <b>-17.00</b> | <b>-21.34</b> |
| <b>PASS OR FAIL</b>             | <b>PASS</b> | <b>FAIL</b>  | <b>FAIL</b>   | <b>FAIL</b>   | <b>FAIL</b>   |

**ACCURACY VALIDATION RESULTS AFTER CALIBRATION**

|                                 |             |             |             |             |             |
|---------------------------------|-------------|-------------|-------------|-------------|-------------|
| NOMINAL DISTANCE (mm)           | 25.0000     | 50.0000     | 75.0000     | 100.0000    | 125.0000    |
| <b>SPECIFICATION (µm)</b>       | <b>2.63</b> | <b>2.75</b> | <b>2.88</b> | <b>3.00</b> | <b>3.13</b> |
| 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     | 75.0004     | 99.9990     | 125.0020    |
| AVERAGE (mm)                    | 24.9997     | 49.9992     | 75.0000     | 99.9989     | 125.0020    |
| <b>MEASURED ACCURACY (µm)</b>   | <b>0.30</b> | <b>0.77</b> | <b>0.00</b> | <b>1.10</b> | <b>1.97</b> |
| <b>REMAINING TOLERANCE (µm)</b> | <b>2.33</b> | <b>1.98</b> | <b>2.88</b> | <b>1.90</b> | <b>1.16</b> |
| <b>PASS OR FAIL</b>             | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> |

**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    |
| <b>ACCURACY SPECIFICATION (μm)</b> | <b>2.03</b> | <b>2.15</b> | <b>2.28</b> | <b>2.40</b> | <b>2.53</b> | <b>2.65</b> | <b>2.78</b> | <b>2.90</b> | <b>3.03</b> | <b>3.15</b> | <b>3.28</b> | <b>3.40</b> |

## 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    |
| <b>MEASURED ACCURACY (μm)</b>   | <b>0.40</b> | <b>0.60</b> | <b>0.70</b> | <b>0.90</b> | <b>1.00</b> | <b>1.20</b> | <b>1.20</b> | <b>1.30</b> | <b>2.00</b> | <b>3.10</b> | <b>3.60</b>  | <b>3.30</b> |
| <b>REMAINING TOLERANCE (μm)</b> | <b>1.63</b> | <b>1.55</b> | <b>1.58</b> | <b>1.50</b> | <b>1.52</b> | <b>1.45</b> | <b>1.57</b> | <b>1.60</b> | <b>1.02</b> | <b>0.05</b> | <b>-0.33</b> | <b>0.10</b> |
| <b>PASS OR FAIL</b>             | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>FAIL</b>  | <b>PASS</b> |

## 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     |
| <b>MEASURED ACCURACY (μm)</b>   | <b>0.70</b> | <b>0.80</b> | <b>2.20</b> | <b>3.50</b>  | <b>3.80</b>  | <b>3.10</b>  | <b>4.00</b>  | <b>4.00</b>  |
| <b>REMAINING TOLERANCE (μm)</b> | <b>1.33</b> | <b>1.35</b> | <b>0.07</b> | <b>-1.10</b> | <b>-1.27</b> | <b>-0.45</b> | <b>-1.22</b> | <b>-1.10</b> |
| <b>PASS OR FAIL</b>             | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>FAIL</b>  | <b>FAIL</b>  | <b>FAIL</b>  | <b>FAIL</b>  | <b>FAIL</b>  |

**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    |
| <b>ACCURACY SPECIFICATION (μm)</b> | <b>2.03</b> | <b>2.15</b> | <b>2.28</b> | <b>2.40</b> | <b>2.53</b> | <b>2.65</b> | <b>2.78</b> | <b>2.90</b> | <b>3.03</b> | <b>3.15</b> | <b>3.28</b> | <b>3.40</b> |

## 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    |
| <b>MEASURED ACCURACY (μm)</b>   | <b>0.10</b> | <b>0.10</b> | <b>0.30</b> | <b>0.50</b> | <b>0.40</b> | <b>0.40</b> | <b>0.30</b> | <b>0.30</b> | <b>0.40</b> | <b>0.40</b> | <b>0.00</b> | <b>0.00</b> |
| <b>REMAINING TOLERANCE (μm)</b> | <b>1.93</b> | <b>2.05</b> | <b>1.98</b> | <b>1.90</b> | <b>2.13</b> | <b>2.25</b> | <b>2.47</b> | <b>2.60</b> | <b>2.62</b> | <b>2.75</b> | <b>3.28</b> | <b>3.40</b> |
| <b>PASS OR FAIL</b>             | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> |

## 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    |
| <b>MEASURED ACCURACY (μm)</b>   | <b>0.00</b> | <b>0.00</b> | <b>0.10</b> | <b>0.00</b> | <b>0.00</b> | <b>0.00</b> | <b>0.10</b> | <b>0.00</b> |
| <b>REMAINING TOLERANCE (μm)</b> | <b>2.03</b> | <b>2.15</b> | <b>2.17</b> | <b>2.40</b> | <b>2.53</b> | <b>2.65</b> | <b>2.67</b> | <b>2.90</b> |
| <b>PASS OR FAIL</b>             | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> | <b>PASS</b> |