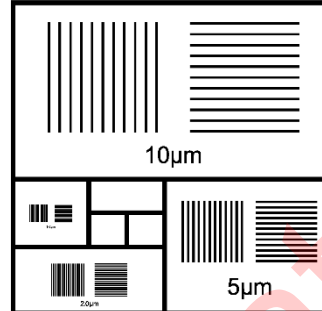
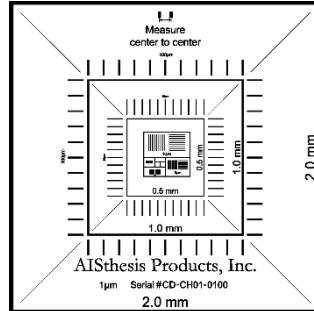


AISthesis Products

Advanced Imaging Products for Nanotechnology,
Engineering and Life Sciences
PO Box 1950, Clyde NC 28721



Certificate of Calibration for Pelcotec™ Critical Dimension Magnification Standard



Product Number: Pelcotec™ 713-1 CDMS-XY-1C-ISO-Etched

Customer name and contact information:

Product Description: 2.5x2.5mm, Pelcotec™ Etched 2mm-1µm Critical Dimension Magnification Standard.



Product Serial Number: CD-CH01-1234

As Received Condition: New

P.O. Box 492477
Redding, CA 96049-2477
Tel: 530.243.2200
www.tedpella.com

As Returned Condition: N/A

Date of Receipt: N/A

The accuracy of this product with Serial Number CD-CH01-1234 was determined using a Field Emission Scanning Electron Microscope (FE-SEM) by reference comparison to working standards traceable to the National Institute of Standards and Technology (NIST), using methods in CP 01 FE-SEM Imaging of Critical Dimension Magnification Standards (CDMS) and CP 02 Certification of Critical Dimension Magnification Standards. The data applies only to the CDMS identified in this report. All results are "as-is". Repair and/or adjustments are not possible.

Below are the ISO 17025:2017 compliant Certified 10 µm Pitch Measurements unique to Serial Number CD-CH01-1234 and traceable to NIST Certified Standard CD-PG01-0211.

X-Direction

| Line | ISO 17025:2017 Compliant Certified Pitch | Position of Measurement |
|----------|--|-------------------------|
| 0-10 µm | 9.993 µm | ± 7.5 µm from center |
| 10-20 µm | 9.980 µm | ± 7.5 µm from center |
| 20-30 µm | 9.980 µm | ± 7.5 µm from center |
| 30-40 µm | 9.999 µm | ± 7.5 µm from center |
| 40-50 µm | 10.007 µm | ± 7.5 µm from center |
| 50-60 µm | 10.014 µm | ± 7.5 µm from center |
| 60-70 µm | 9.999 µm | ± 7.5 µm from center |

| | | |
|----------------------|--|-----------------------------------|
| 70-80 μm | 9.999 μm | $\pm 7.5 \mu\text{m}$ from center |
| 80-90 μm | 9.999 μm | $\pm 7.5 \mu\text{m}$ from center |
| 90-100 μm | 9.999 μm | $\pm 7.5 \mu\text{m}$ from center |
| <i>Sum</i> | <i>99.969 μm</i> | |
| Average | 9.9969 μm | |
| 2-Sigma * | 0.0042 μm | |

* Corrected for sample size using the appropriate Student t-factor.

Y-Direction

| Line | ISO 17025:2017 Compliant Certified Pitch | Position of Measurement |
|----------------------|--|-----------------------------------|
| 0-10 μm | 9.993 μm | $\pm 7.5 \mu\text{m}$ from center |
| 10-20 μm | 9.980 μm | $\pm 7.5 \mu\text{m}$ from center |
| 20-30 μm | 9.980 μm | $\pm 7.5 \mu\text{m}$ from center |
| 30-40 μm | 9.999 μm | $\pm 7.5 \mu\text{m}$ from center |
| 40-50 μm | 10.007 μm | $\pm 7.5 \mu\text{m}$ from center |
| 50-60 μm | 10.014 μm | $\pm 7.5 \mu\text{m}$ from center |
| 60-70 μm | 9.999 μm | $\pm 7.5 \mu\text{m}$ from center |
| 70-80 μm | 9.999 μm | $\pm 7.5 \mu\text{m}$ from center |
| 80-90 μm | 9.999 μm | $\pm 7.5 \mu\text{m}$ from center |
| 90-100 μm | 9.999 μm | $\pm 7.5 \mu\text{m}$ from center |
| <i>Sum</i> | <i>99.969 μm</i> | |
| Average | 9.9969 μm | |
| 2-Sigma * | 0.0042 μm | |

* Corrected for sample size using the appropriate Student t-factor.

Measurements are reported with an uncertainty ($k=2$)** of $\pm 0.012 \mu\text{m}$. Statements of Conformity are not provided in this report. Review the results and verify that they meet the requirements for the intended use. Physical damage to or contamination of the CDMS occurring after calibration may invalidate the reported measurements. Use this product at $25^\circ\text{C} \pm 5^\circ\text{C}$ and at less than 80% RH.

** Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of $k = 2$. The reported expanded measurement uncertainty is stated as the standard measurement uncertainty multiplied by the coverage factor K such that the coverage probability corresponds to approximately 95%.

X-Direction

| Line | Number of Lines | Position of Measurement | Non-ISO 17025:2017 Compliant Measured Distance (first to last line) | Average Pitch |
|-------------------|-----------------|----------------------------------|---|-----------------------|
| 2.0mm | 2 | $\pm 1.00\text{mm}$ from center | 2.000 mm | 2.000 mm |
| 1.0mm | 2 | $\pm 0.5\text{mm}$ from center | 1.000 mm | 1.000 mm |
| 0.5mm | 2 | $\pm 0.25\text{mm}$ from center | 0.500 mm | 0.500 mm |
| 0.1mm | 11 | $\pm 50 \mu\text{m}$ from center | 1.000mm | 100.038 μm |
| 50 μm | 11 | $\pm 50 \mu\text{m}$ from center | 0.500 mm | 50.031 μm |
| 5.0 μm | 12 | $\pm 20 \mu\text{m}$ from center | 55.057 μm | 5.005 μm |
| 2.0 μm | 16 | $\pm 10 \mu\text{m}$ from center | 30.051 μm | 2.003 μm |
| 1.0 μm | 17 | $\pm 5 \mu\text{m}$ from center | 16.033 μm | 1.002 μm |

Y-Direction

| Line | Number of Lines | Position of Measurement | Non-ISO 17025:2017 Compliant Measured Distance (first to last line) | Average Pitch |
|-------|-----------------|-------------------------|---|---------------|
| 2.0mm | 2 | ± 1.00mm from center | 2.000 mm | 2.000 mm |
| 1.0mm | 2 | ± 0.5mm from center | 1.000 mm | 1.000 mm |
| 0.5mm | 2 | ± 0.25mm from center | 0.500 mm | 0.500 mm |
| 0.1mm | 11 | ± 50 µm from center | 1.000mm | 100.038 µm |
| 50µm | 11 | ± 50 µm from center | 0.500 mm | 50.031 µm |
| 5.0µm | 12 | ± 20 µm from center | 55.057 µm | 5.005 µm |
| 2.0µm | 16 | ± 10 µm from center | 30.051 µm | 2.003 µm |
| 1.0µm | 17 | ± 5 µm from center | 16.033 µm | 1.002 µm |

The average pitch is derived from the stated length that was determined using measurements (taken center-to-center) over the stated number of lines (i.e., length divided by the number of lines minus one).

Date of Analysis: January 25th, 2024

Equipment used:

| Instrument | Model | Serial # | Resolution | Repeatability | Temperature | Humidity | Ref. |
|------------|------------|----------|------------|---------------|---------------|-------------|--------------|
| FE-SEM | FEI Apreo2 | 9958357 | 0.9nm | 0.030% | 21.9 ± 0.1 °C | 33.3 ± 0.8% | CD-PG01-0211 |

Location: AISthesis Products, Inc., PO Box 1950, Clyde North Carolina 28721.

Notes:

D.S. Finch
Certified by

Signature

H. Haehlen
Authorized by

Signature

January 25th, 2024
Date report issued.

This certificate shall not be reproduced without the permission of AISthesis Products, Inc.
P.O. Box 1950, Clyde, North Carolina 28721 Tel: 828.627.6555 E-mail: CDMS@aisthesisproducts.com

CH01-1234

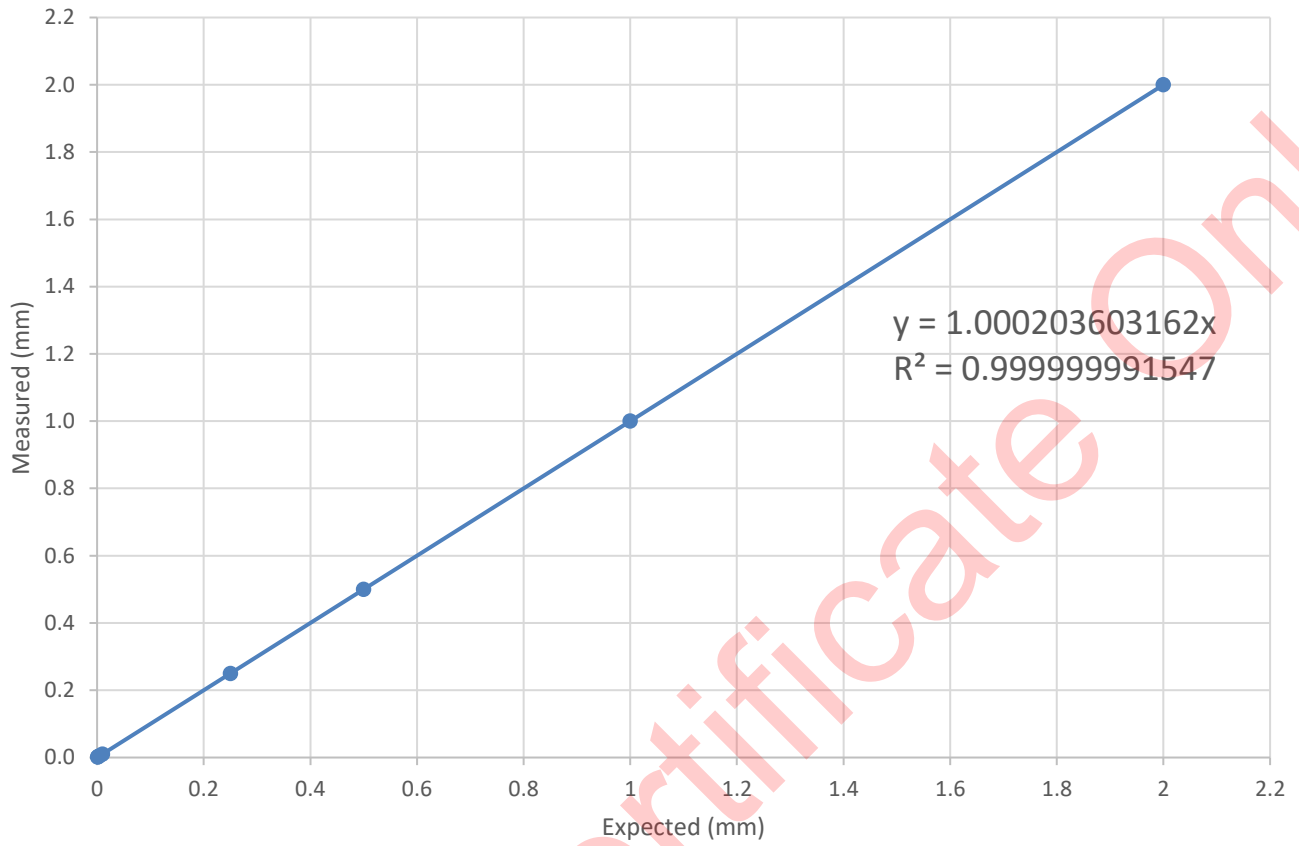


Figure 1. Expected versus actual measurements in the X direction including all lines with linear regression and R^2 values reported.

CH01-1234

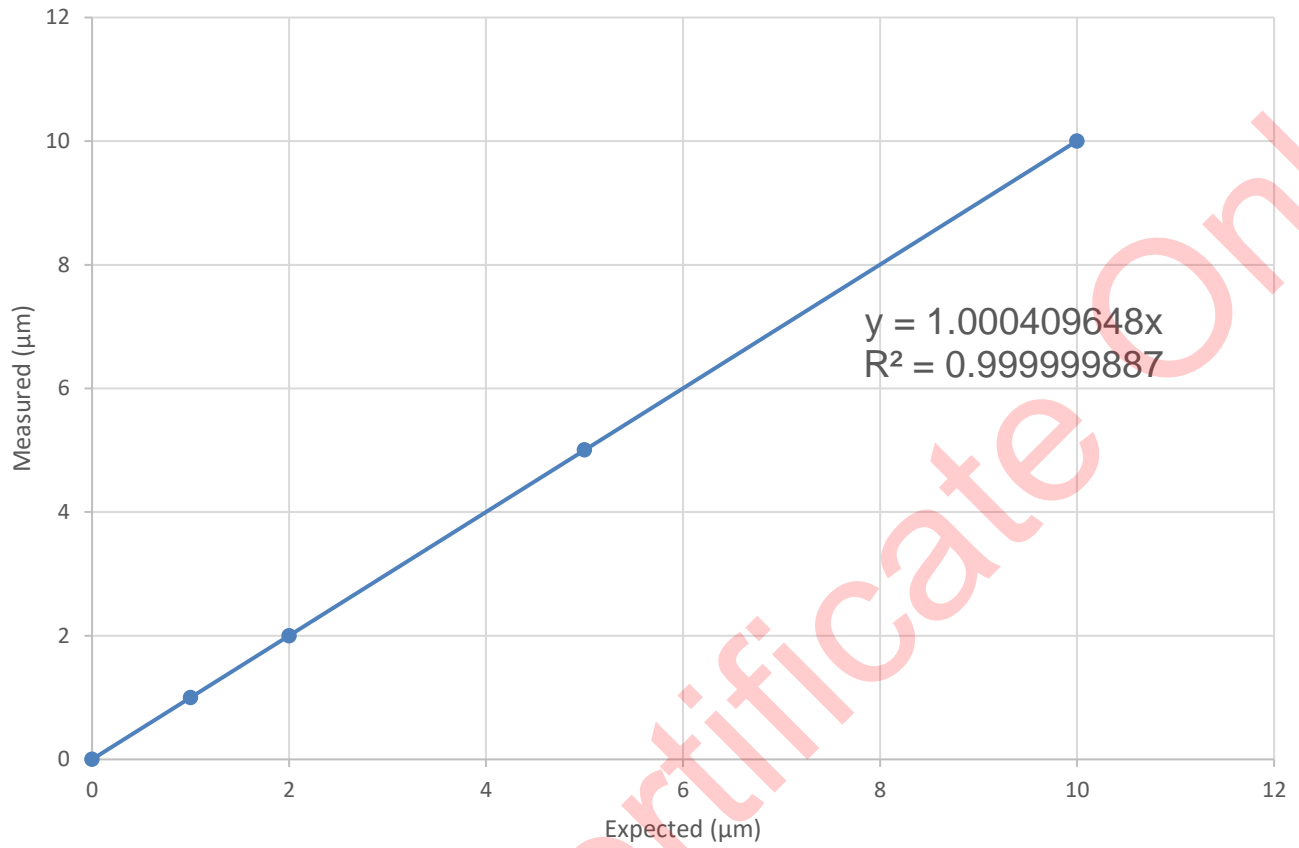


Figure 2. Expected versus actual measurements for the X-direction 10µm, 5µm, 2µm, and 1µm pitch lines with linear regression and R² values reported.

CH01-1234

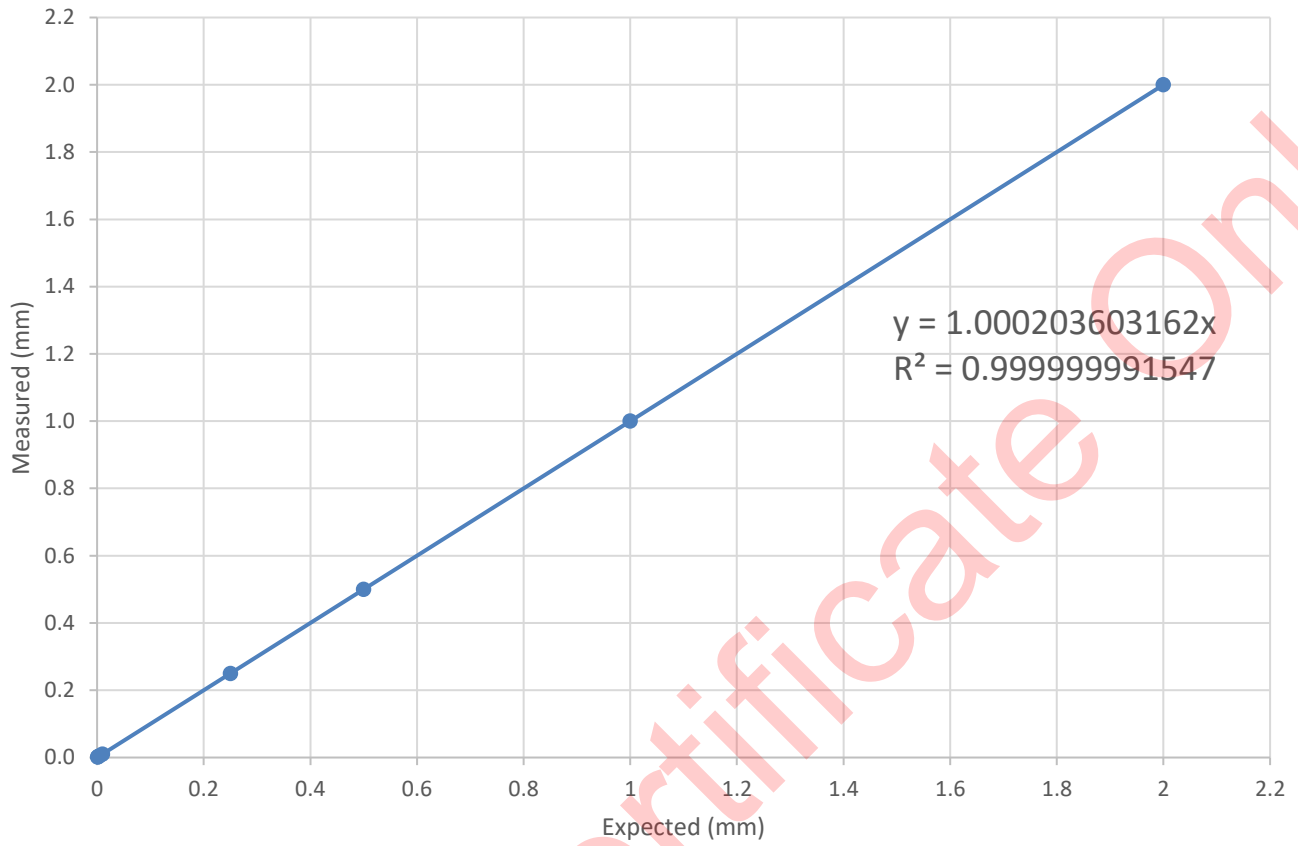


Figure 3. Expected versus actual measurements in the Y-direction including all lines with linear regression and R^2 values reported.

CH01-1234

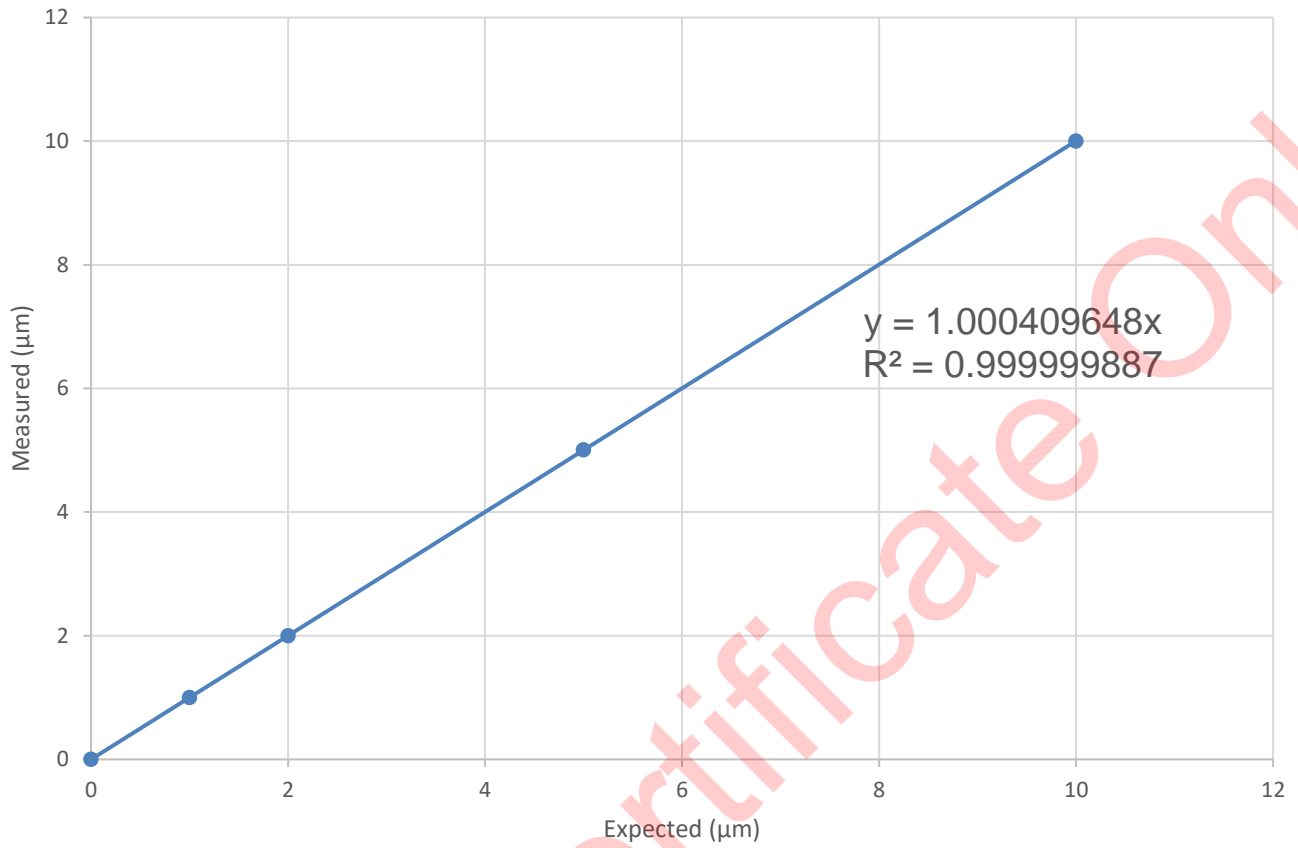


Figure 4. Expected versus actual measurements for the Y-direction 10µm, 5µm, 2µm, and 1µm pitch lines with linear regression and R² values reported.

| 5 µm Line X-direction | Pitch |
|-----------------------|------------------|
| 0-5µm | 5.005 µm |
| 5-10µm | 5.005 µm |
| 10-15µm | 5.005 µm |
| 15-20µm | 5.010 µm |
| 20-25µm | 5.010 µm |
| 25-30µm | 5.005 µm |
| 30-35µm | 5.005 µm |
| 35-40µm | 5.003 µm |
| 40-45µm | 5.000 µm |
| 45-50µm | 5.008 µm |
| 50-55µm | 5.000 µm |
| <i>Sum</i> | <i>55.057 µm</i> |
| Average | 5.0051 µm |
| 2-Sigma * | 0.0079 µm |

| 2 µm Line X-direction | Pitch |
|-----------------------|------------------|
| 0-2µm | 2.031 µm |
| 2-4µm | 2.003 µm |
| 4-6µm | 2.001 µm |
| 6-8µm | 2.003 µm |
| 8-10µm | 2.001 µm |
| 10-12µm | 2.001 µm |
| 12-14µm | 2.003 µm |
| 14-16µm | 1.998 µm |
| 16-18µm | 2.003 µm |
| 18-20µm | 2.001 µm |
| 20-22µm | 2.001 µm |
| 22-24µm | 2.001 µm |
| 24-26µm | 2.003 µm |
| 26-28µm | 2.001 µm |
| 28-30µm | 2.003 µm |
| <i>Sum</i> | <i>30.051 µm</i> |
| Average | 2.0034 µm |
| 2-Sigma * | 0.0173 µm |

| 1 µm Line X-direction | Pitch |
|-----------------------|----------|
| 0-1µm | 1.005 µm |
| 1-2µm | 1.001 µm |
| 2-3µm | 1.002 µm |
| 3-4µm | 1.002 µm |
| 4-5µm | 1.001 µm |
| 5-6µm | 1.002 µm |
| 6-7µm | 1.001 µm |
| 7-8µm | 1.001 µm |
| 8-9µm | 1.004 µm |
| 9-10µm | 1.001 µm |

| | |
|------------|------------------|
| 10-11µm | 1.000 µm |
| 11-12µm | 1.002 µm |
| 12-13µm | 1.001 µm |
| 13-14µm | 1.001 µm |
| 14-15µm | 1.004 µm |
| 15-16µm | 1.004 µm |
| <i>Sum</i> | <i>16.033 µm</i> |
| Average | 1.0021 µm |
| 2-Sigma * | 0.0032 µm |

| 5 µm Line Y-direction | Pitch |
|-----------------------|------------------|
| 0-5µm | 5.005 µm |
| 5-10µm | 5.005 µm |
| 10-15µm | 5.005 µm |
| 15-20µm | 5.010 µm |
| 20-25µm | 5.010 µm |
| 25-30µm | 5.005 µm |
| 30-35µm | 5.005 µm |
| 35-40µm | 5.003 µm |
| 40-45µm | 5.000 µm |
| 45-50µm | 5.008 µm |
| 50-55µm | 5.000 µm |
| <i>Sum</i> | <i>55.057 µm</i> |
| Average | 5.0051 µm |
| 2-Sigma * | 0.0079 µm |

| 2 µm Line Y-direction | Pitch |
|-----------------------|------------------|
| 0-2µm | 2.031 µm |
| 2-4µm | 2.003 µm |
| 4-6µm | 2.001 µm |
| 6-8µm | 2.003 µm |
| 8-10µm | 2.001 µm |
| 10-12µm | 2.001 µm |
| 12-14µm | 2.003 µm |
| 14-16µm | 1.998 µm |
| 16-18µm | 2.003 µm |
| 18-20µm | 2.001 µm |
| 20-22µm | 2.001 µm |
| 22-24µm | 2.001 µm |
| 24-26µm | 2.003 µm |
| 26-28µm | 2.001 µm |
| 28-30µm | 2.003 µm |
| <i>Sum</i> | <i>30.051 µm</i> |
| Average | 2.0034 µm |
| 2-Sigma * | 0.0173 µm |

| 1 µm Line Y-direction | Pitch |
|-----------------------|------------------|
| 0-1µm | 1.005 µm |
| 1-2µm | 1.001 µm |
| 2-3µm | 1.002 µm |
| 3-4µm | 1.002 µm |
| 4-5µm | 1.001 µm |
| 5-6µm | 1.002 µm |
| 6-7µm | 1.001 µm |
| 7-8µm | 1.001 µm |
| 8-9µm | 1.004 µm |
| 9-10µm | 1.001 µm |
| 10-11µm | 1.000 µm |
| 11-12µm | 1.002 µm |
| 12-13µm | 1.001 µm |
| 13-14µm | 1.001 µm |
| 14-15µm | 1.004 µm |
| 15-16µm | 1.004 µm |
| <i>Sum</i> | <i>16.033 µm</i> |
| Average | 1.0021 µm |
| 2-Sigma * | 0.0032 µm |

End of report.