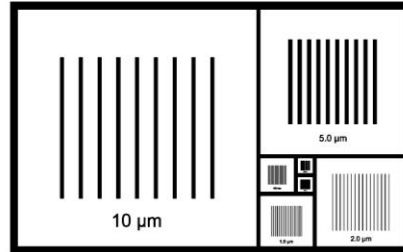
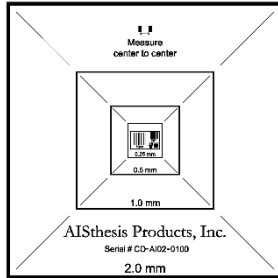


AISthesis Products

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™** 696-01 CDMS-0.1C-ISO

Product Description: 2.5x2.5mm, **Pelcotec™** 2mm-100nm Critical Dimension Magnification Standard

Product Serial Number: CD AI02 1234

As Received Condition: New

As Returned Condition: N/A

Date of Receipt: N/A

The accuracy of this product with Serial Number CD-AI02-1234 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-AI02-1234 and traceable to NIST Certified Standard CD-PG01-0211.

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	± 7.5 µm from center
<i>Sum</i>	<i>79.971 µm</i>	
Average	9.9964 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%.

Line	Number of Lines	Position of Measurement	Non-ISO 17025:2017 Compliant Measured Distance (first to last line)	Average Pitch
2.0 mm	2	$\pm 1.00\text{mm}$ from center	2.000 mm	2.000 mm
1.0 mm	2	$\pm 0.5\text{mm}$ from center	1.000 mm	1.000 mm
0.5 mm	2	$\pm 0.25\text{mm}$ from center	0.500 mm	0.500 mm
0.25 mm	2	$\pm 0.125\text{mm}$ from center	0.250 mm	0.250 mm
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
500 nm	20	$\pm 4 \mu\text{m}$ from center	9.519 μm	501.0 nm
250 nm	21	$\pm 2.5 \mu\text{m}$ from center	5.018 μm	250.9 nm
100 nm	52	$\pm 2.5 \mu\text{m}$ from center	5.119 μm	100.4 nm

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 29th, 2023

Equipment used:

Instrument	Model	Serial #	Resolution	Repeatability	Temperature	Humidity	Ref.
FE-SEM	FEI Verios 460L	9922551	0.9nm	0.030%	$23.3 \pm 0.3 \text{ }^\circ\text{C}$	$42.5 \pm 1.5\%$	CD-PG01-0211

Location: Analytical Instrumentation Facility, NC State University, Raleigh NC 27695-7531.

Notes:

D.S. Finch
Certified by

Signature

H. Haehlen
Authorized by

Signature

January 29th, 2023
Date report issued.

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Non-ISO 17025:2017 Compliant Supplemental Material.

AI02 1234

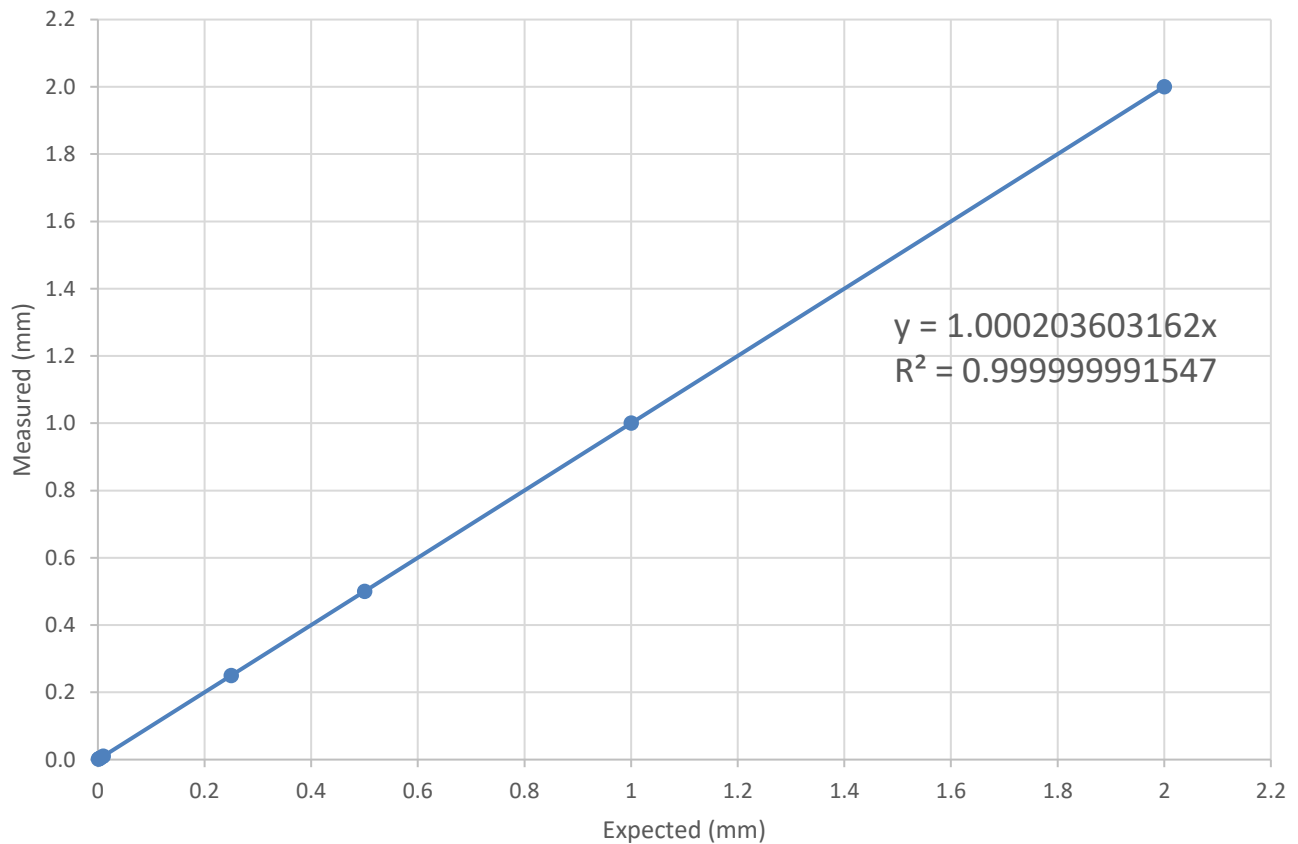


Figure 1. Expected versus actual measurements including all lines with linear regression and R² values reported.

AI02 1234

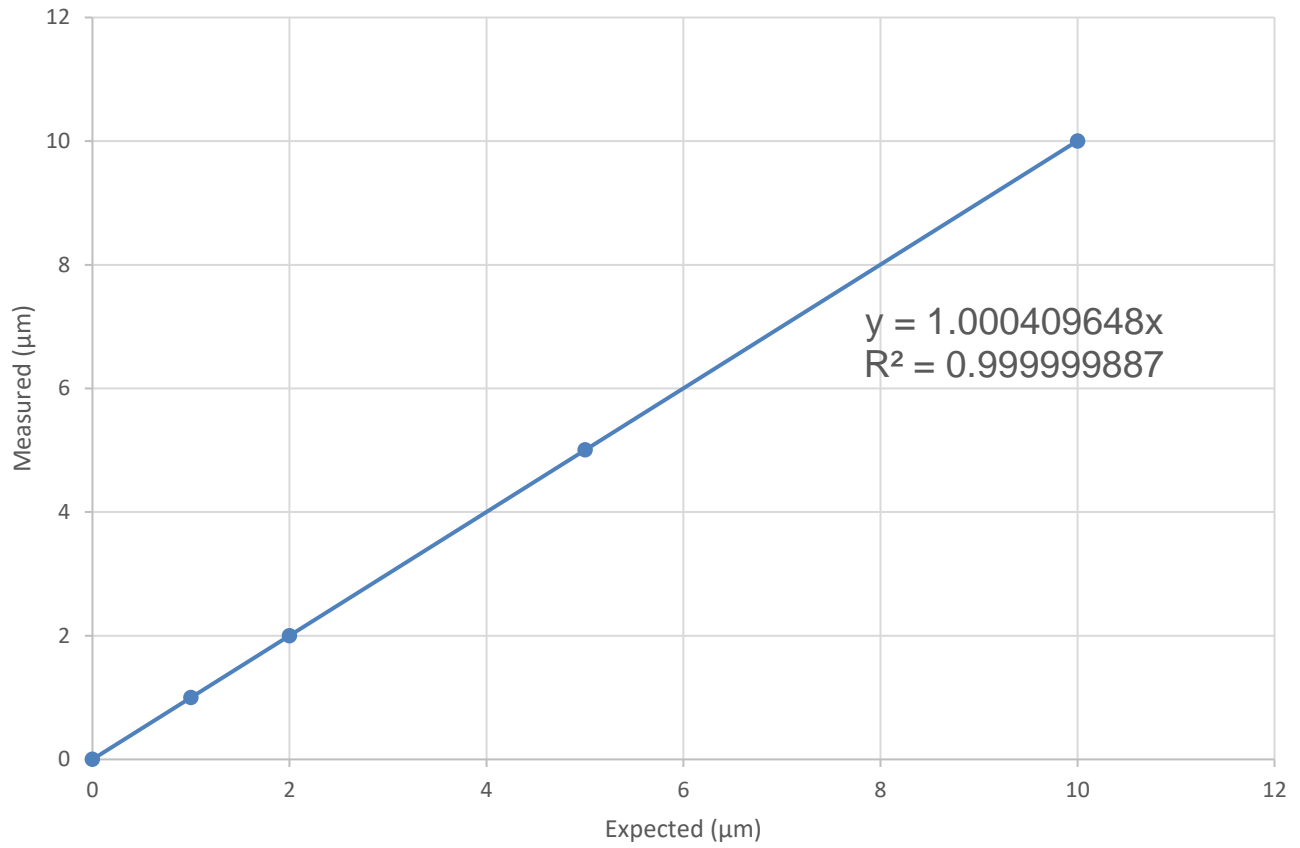


Figure 2. Expected versus actual measurements for the 10µm, 5µm, 2µm, and 1µm pitch lines with linear regression and R² values reported.

AI02 1234

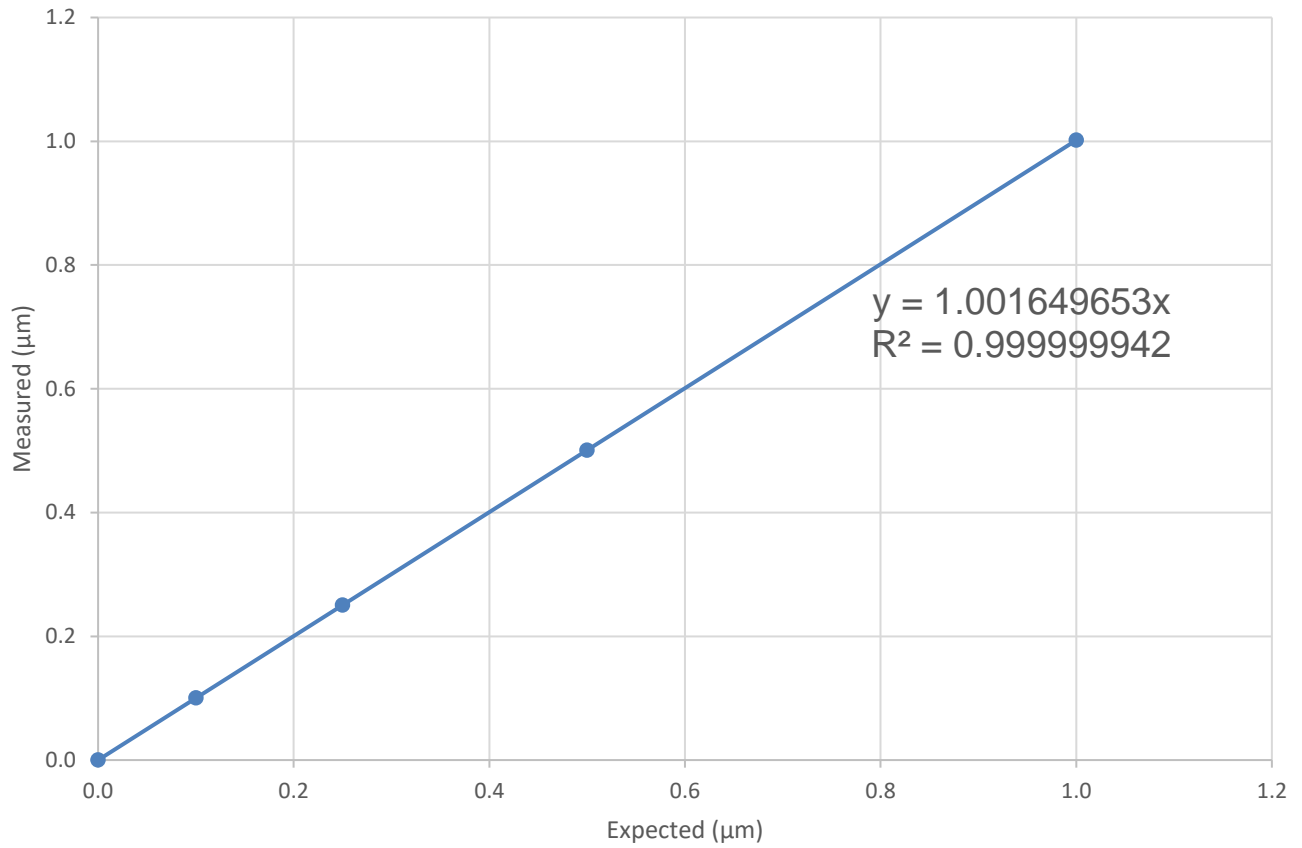


Figure 3. Expected versus actual measurements for the 1µm, 0.5µm, 0.25µm and 0.1µm pitch lines with linear regression and R² values reported.

5 µm Line	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	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

Excluding 1 st and last lines	
Average	2.0013 µm
2-Sigma *	0.0036 µm

1 µm Line	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

Excluding 1 st and last lines	
Average	1.0017 µm
2-Sigma *	0.0026 µm

0.5 μm (500nm) Line	Pitch
0-0.5 μm	0.5046 μm
0.5-1 μm	0.5015 μm
1-1.5 μm	0.4995 μm
1.5-2 μm	0.5015 μm
2-2.5 μm	0.5005 μm
2.5-3 μm	0.5005 μm
3-3.5 μm	0.5005 μm
3.5-4 μm	0.5015 μm
4-4.5 μm	0.4995 μm
4.5-5 μm	0.5026 μm
5-5.5 μm	0.4985 μm
5.5-6 μm	0.5005 μm
6-6.5 μm	0.5026 μm
6.5-7 μm	0.4985 μm
7-7.5 μm	0.5005 μm
7.5-8 μm	0.5015 μm
8-8.5 μm	0.4995 μm
8.5-9 μm	0.5026 μm
9-9.5 μm	0.5026 μm
<i>Sum</i>	<i>9.519 μm</i>
Average	0.50100 μm
2-Sigma *	0.00341 μm

Excluding 1st and last lines	
Average	0.50070 μm
2-Sigma *	0.00285 μm

0.25 μm (250nm) Line	Pitch
0-0.25 μm	0.2575 μm
0.25-0.5 μm	0.2503 μm
0.5-0.75 μm	0.2503 μm
0.75-1 μm	0.2503 μm
1-1.25 μm	0.2513 μm
1.25-1.5 μm	0.2503 μm
1.5-1.75 μm	0.2503 μm
1.75-2 μm	0.2503 μm
2-2.25 μm	0.2503 μm
2.25-2.5 μm	0.2513 μm
2.5-2.75 μm	0.2492 μm
2.75-3 μm	0.2513 μm
3-3.25 μm	0.2492 μm
3.25-3.5 μm	0.2503 μm
3.5-3.75 μm	0.2503 μm
3.75-4 μm	0.2503 μm
4-4.25 μm	0.2503 μm
4.25-4.5 μm	0.2503 μm
4.5-4.75 μm	0.2503 μm
4.75-5 μm	0.2544 μm
<i>Sum</i>	<i>5.018 μm</i>
Average	0.25088 μm
2-Sigma *	0.00401 μm

Excluding 1st and last lines	
Average	0.25031 μm
2-Sigma *	0.00119 μm

0.1 μm (100nm) Line	Pitch
0-0.1 μm	0.1081 μm
0.1-0.2 μm	0.0989 μm
0.2-0.3 μm	0.1009 μm
0.3-0.4 μm	0.0999 μm
0.4-0.5 μm	0.0999 μm
0.5-0.6 μm	0.0999 μm
0.6-0.7 μm	0.0999 μm
0.7-0.8 μm	0.1009 μm
0.8-0.9 μm	0.1009 μm
0.9-0.1 μm	0.0989 μm
1.0-1.1 μm	0.1009 μm
1.1-1.2 μm	0.0989 μm
1.2-1.3 μm	0.1009 μm
1.3-1.4 μm	0.1009 μm
1.4-1.5 μm	0.0999 μm
1.5-1.6 μm	0.0999 μm
1.6-1.7 μm	0.0989 μm
1.7-1.8 μm	0.1009 μm
1.8-1.9 μm	0.0999 μm
1.90-2.0 μm	0.0999 μm
2.0-2.1 μm	0.1009 μm
2.1-2.2 μm	0.0999 μm
2.2-2.3 μm	0.0999 μm
2.3-2.4 μm	0.1009 μm
2.4-2.5 μm	0.0999 μm
2.5-2.6 μm	0.0999 μm
2.6-2.7 μm	0.0999 μm
2.7-2.8 μm	0.0999 μm
2.8-2.9 μm	0.1009 μm
2.9-3.0 μm	0.0999 μm
3.0-3.1 μm	0.0999 μm
3.1-3.2 μm	0.0999 μm
3.2-3.3 μm	0.1009 μm
3.3-3.4 μm	0.0999 μm
3.4-3.5 μm	0.1009 μm

3.5-3.6 μm	0.0999 μm
3.6-3.7 μm	0.0989 μm
3.7-3.8 μm	0.1009 μm
3.8-3.9 μm	0.0999 μm
3.9-4.0 μm	0.0999 μm
4.0-4.1 μm	0.1009 μm
4.1-4.2 μm	0.0989 μm
4.2-4.3 μm	0.1009 μm
4.3-4.4 μm	0.0999 μm
4.4-4.5 μm	0.0999 μm
4.5-4.6 μm	0.1009 μm
4.6-4.7 μm	0.0989 μm
4.7-4.8 μm	0.1009 μm
4.8-4.9 μm	0.0999 μm
4.9-5.0 μm	0.0999 μm
5.0-5.1 μm	0.1061 μm

Sum 5.119 μm

Average	0.10038 μm
2-Sigma *	0.00317 μm

Excluding 1 st and last lines	
Average	0.10011 μm
2-Sigma *	0.00143 μm

End of report.