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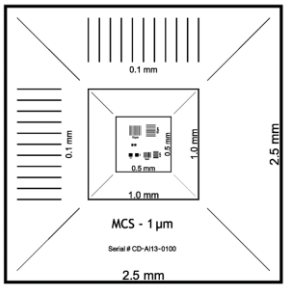
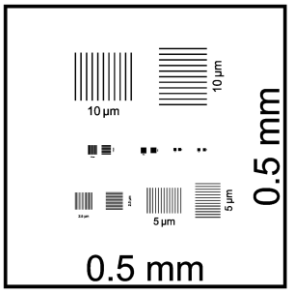
Certificate of Calibration

Certificate of Calibration for CD-AI13-1209

EM-Tec MCS-0.1 XY Magnification Calibration Standard





Product Numbers: 31-C32050-U, 31-C32050-1, 31-C32050-2, 31-C32050-6, 31-C32050-8

Product Description: EM-Tec MCS-0.1 XY Magnification Calibration Standard 2.5mm to 100 nm in both X- and Y-direction on 4x4mm chip.

Product Identifier: CD-AI13-1209

The accuracy of these products was determined by reference comparison to working standards traceable to the National Institute of Standards and Technology (NIST), Test No. 861/280822-11.

X-Direction

Line	Certified average pitch	Number of lines	Certified distance (1σ)	Between	Total expanded uncertainty (3σ)
2.5 mm	2.50 mm	2	2.50 mm ± 0.03%	First and last line	± 0.09%
1.0 mm	1.00 mm	2	1.00 mm ± 0.03%	First and last line	± 0.09%
0.5 mm	0.500 mm	2	0.500 mm ± 0.03%	First and last line	± 0.09%
0.10 mm	0.100 mm	2	0.100 mm ± 0.03%	First and second line	± 0.09%
10 µm	10.00 µm	11	99.97 µm ± 0.03%	First and last line	± 0.09%
5.0 µm	5.01 µm	13	60.07 µm ± 0.03%	First and last line	± 0.09%
2.5 µm	2.50 µm	13	30.05 µm ± 0.03%	First and last line	± 0.09%
1.0 µm	1.00 µm	17	16.03 µm ± 0.03%	First and last line	± 0.09%
500 nm	500.1 nm	20	9.50 µm ± 0.03%	First and last line	± 0.09%
250 nm	250.6 nm	21	5.01 µm ± 0.03%	First and last line	± 0.09%
100 nm	100.2 nm	52	5.11 µm ± 0.03%	First and last line	± 0.09%

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Y-Direction

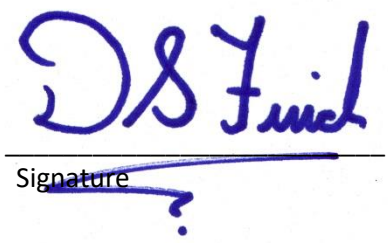
Line	Certified average pitch	Number of lines	Certified distance (1σ)	Between	Total expanded uncertainty (3σ)
2.5 mm	2.50 mm	2	2.50 mm ± 0.03%	First and last line	± 0.09%
1.0 mm	1.00 mm	2	1.00 mm ± 0.03%	First and last line	± 0.09%
0.5 mm	0.500 mm	2	0.500 mm ± 0.03%	First and last line	± 0.09%
0.10 mm	0.100 mm	2	0.100 mm ± 0.03%	First and second line	± 0.09%
10 µm	10.00 µm	11	99.95 µm ± 0.03%	First and last line	± 0.09%
5.0 µm	5.00 µm	13	60.05 µm ± 0.03%	First and last line	± 0.09%
2.5 µm	2.51 µm	13	30.06 µm ± 0.03%	First and last line	± 0.09%
1.0 µm	1.00 µm	17	16.03 µm ± 0.03%	First and last line	± 0.09%
500 nm	500.3 nm	20	9.51 µm ± 0.03%	First and last line	± 0.09%
250 nm	250.5 nm	21	5.01 µm ± 0.03%	First and last line	± 0.09%
100 nm	100.2 nm	52	5.11 µm ± 0.03%	First and last line	± 0.09%

* The 3σ uncertainty (95% confidence interval) average pitch is determined using a minimum of five die per production wafer. Each average pitch is determined using 100+ measurements on each die averaged over the stated number of lines. The total expanded uncertainty includes both Type A and Type B uncertainties corrected for sample size using an appropriate Student t-factor.

Equipment used:

Instrument	Model number	Serial #	NIST Certified CD	Resolution	Repeatability
FE-SEM	FEI Apreo 2	9958357	CD-PG01-0211	0.9nm	0.03%

Dudley S Finch
Certified by



Signature

November 24th 2023
Date

The EM-Tec MCS-1 XY traceable magnification calibration standard is manufactured on a silicon wafer with Cr and Au lines. All materials are deemed inert under normal working conditions. Under normal operation there would be no mechanical contact with the surface and the calibration features. When this calibration standard is stored and used in a clean environment, it can be used for at least 5 years.

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