

Length, United States, NIST (National Institute of Standards and Technology)

Note: Approval dates are shown only for the CMCs published after 24 May 2004

Calibration or Measurement Services			Measurand Level or Range			Measurement Conditions/Independent variables		Expanded Uncertainty					Comments	NMI Service Identifier
Class	Instrument or artifact	Instrument Type or Method	Minimum value	Maximum value	units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?		
Laser radiations	Other stabilized laser: vacuum wavelength	Optical beat frequency	633	633	nm			4E-10		2	95%	Yes		1
Length instruments	Laser interferometer system: error of indicated displacement L	Comparison to master length interferometer	0.001	5	m			$Q[0.05, 0.1L]$, L in m	μm	2	95%	No		2
End standards	Gauge block: central length L	Interferometry, exact fractions	0.1	100	mm			$(18 + 0.15L)$, L in mm, values range from 18 nm to 33 nm	nm	2	95%	No		3
End standards	Length bar: central length L	Interferometry, exact fractions	100	500	mm			$(18 + 0.15L)$, L in mm, values range from 33 nm to 93 nm	nm	2	95%	No		3b
End standards	Gauge block: central length L	Mechanical comparison to gauge block	0.1	101.6	mm			$(25 + 0.35L)$, L in mm, values range from 25 nm to 61 nm	nm	2	95%	No		4
End standards	Length bar: central length L	Mechanical comparison to length bar	101.6	508	mm			$(31 + 0.26L)$, L in mm, values range from 58 nm to 163 nm	nm	2	95%	No		5
End standards	Length bar: central length L	Line scale interferometer with wrung graduated gage blocks	100	1000	mm			$(30 + 0.09L)$, L in mm	nm	2	95%	No		6
End standards	Step gauge: face spacing L	CMM	20	1200	mm			$(0.35 + 0.0001L)$, L in mm	μm	2	95%	No		7
Line standards	Precision line scale: line spacing, L	Line scale interferometer	0.002	1000	mm	Illumination	reflection only	$(3 + 0.1L)$	nm	2	95%	No	Approved on 14 June 2004	8

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Line standards	Stage micrometer: line spacing, L	Line scale interferometer	0.002	100	mm	Illumination	reflection only	$(3 + 0.1L)$	nm	2	95%	No	Approved on 14 June 2004	9
Line standards	1-D grating: pitch P	Atomic force microscope & laser displacement interferometer scale	0.1	10	μm			$Q[0.003, 0.002P]$, P in μm , values range from 0.003 μm to 0.02 μm	μm	2	95%	No		11
Diameter standards	External cylinder (plug, piston, pin, wire): diameter L	Mechanical stylus & laser displacement interferometer scale	0.01	100	mm			$(35 + 1L)$, L in mm, values range from 35 nm to 135 nm	nm	2	95%	No		16
Diameter standards	External cylinder (plug, piston, pin, wire): diameter	Mechanical comparison	0.1	25	mm			0.125	μm	2	95%	No		17
Diameter standards	Internal cylinder (ring): diameter L	Mechanical comparison	2	100	mm			$(85 + 0.4L)$, L in mm, values range from 86 nm to 125 nm	nm	2	95%	No		18
Diameter standards	Sphere (ball): diameter L	Mechanical stylus & laser displacement interferometer scale	1	30	mm			$Q[21, 0.5L]$, L in mm, values range from 21 nm to 26 nm	nm	2	95%	No		19
Diameter standards	Sphere (ball): diameter L	Mechanical comparison	1	100	mm			$(0.1 + 0.00057L)$, L in mm	μm	2	95%	No		21
Angle by circle-dividers	Optical polygon: face angle	Index table and autocollimator	5	120	$^\circ$	Number of faces	3 to 72 with nominally equal, integer angles between sides	0.14	"	2	95%	No		22
Angle by circle-dividers	Index table: index angle	Index table and autocollimator	$360/n$ ($n = 24$)	$360/n$ ($n = 3$)	$^\circ$	Number of divisions	$n = 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20$ and 24	0.14	"	2	95%	No		23

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Angle artefacts	Angle block: included angle	Indexing table and autocollimator	0.000278	45	°			0.14	"	2	95%	No		24
Angle artefacts	Angle block: included angle	Indexing table and autocollimator or two autocollimators	0.000278	45	°			0.18	"	2	95%	No		25
Angle prisms	Optical wedge: deviation angle	Autocollimator	0	60	"			0.1	"	2	95%	No		27
Roundness standards	External cylinder (plug): roundness	Spindle-based roundness measuring instrument	0	0.5	µm			12	nm	2	95%	No		29
Roundness standards	Internal cylinder (ring): roundness	Spindle-based roundness measuring instrument	0	0.5	µm			12	nm	2	95%	No		30
Roundness standards	Sphere or hemisphere: roundness	Spindle-based roundness measuring instrument	0	0.5	µm	Sphere diameter	5 mm to 100 mm	12	nm	2	95%	No		31
Surface texture	Groove or step-height standard: step height <i>H</i>	Stylus instrument	0.007	25	µm			Q[1, 7H], <i>H</i> in µm, values range from 1 nm to 175 nm	nm	2	95%	No		35
Surface texture	Roughness standard: ISO parameters <i>R_a</i> , <i>R_q</i> , <i>R_z</i>	Stylus instrument	0.3	10	µm			Q[0.01, 0.013R], <i>R</i> in µm	µm	2	95%	No		37
Screw standards	Thread plug, plain: pitch diameter	3-wire method	1	500	mm			1.25	µm	2	95%	No		38
Screw standards	Threaded plug, tapered: pitch diameter	3-wire method	1	500	mm			1.25	µm	2	95%	No		42
CMM artefacts	Ball bar: ball spacing	CMM	300	1500	mm	Kinematically supported		(0.25 + 0.0005L), <i>L</i> in mm	µm	2	95%	No		60

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Miscellaneous complex geometry	Hardness indenter: radius	Stylus instrument	180	220	µm			0.4	µm	2	95%	No		61
Reference materials	SEM magnification standard (high keV SRM 484/2070): line spacing	SEM with HeNe laser displacement interferometer	0.5	5	µm			0.034 to 0.051	µm	2	95%	No		68
Reference materials	Sinusoidal roughness standard, SRM 2071: Ra	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	0.3 Ra (period = 100)	0.3 Ra (period = 100)	µm			0.015	µm	2	95%	No		69
Reference materials	Sinusoidal roughness standard, SRM 2071: period	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	0.3 Ra (period = 100)	0.3 Ra (period = 100)	µm			0.31	µm	2	95%	No		70
Reference materials	Sinusoidal roughness standard, SRM 2072: Ra	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	1 Ra (period = 100)	1 Ra (period = 100)	µm			0.027	µm	2	95%	No		71

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Reference materials	Sinusoidal roughness standard, SRM 2072: period	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	1 Ra (period = 100)	1 Ra (period = 100)	µm			0.24	µm	2	95%	No		72
Reference materials	Sinusoidal roughness standard, SRM 2073: Ra	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	3 Ra (period = 100)	3 Ra (period = 100)	µm			0.08	µm	2	95%	No		73
Reference materials	Sinusoidal roughness standard, SRM 2073: period	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	3 Ra (period = 100)	3 Ra (period = 100)	µm			0.12	µm	2	95%	No		74
Reference materials	Sinusoidal roughness standard, SRM 2074: Ra	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	1 Ra (period = 40)	1 Ra (period = 40)	µm			0.02	µm	2	95%	No		75

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Reference materials	Sinusoidal roughness standard, SRM 2074: period	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	1 Ra (period = 40)	1 Ra (period = 40)	µm			0.06	µm	2	95%	No		76
Reference materials	Sinusoidal roughness standard, SRM 2075: Ra	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	1 Ra (period = 800)	1 Ra (period = 800)	µm			0.012	µm	2	95%	No		77
Reference materials	Sinusoidal roughness standard, SRM 2075: period	Stylus instrument with calibrated step heights for Z, HeNe laser displacement interferometer for X	1 Ra (period = 800)	1 Ra (period = 800)	µm			0.47	µm	2	95%	No		78
Reference materials	Linewidth, photomask - SRM 473: linewidth	Optical microscopy & laser displacement interferometer scale	0.5	30	µm			37	nm	2	95%	No		79
Reference materials	Pitch, photomask (magnification standard) - SRM 473: pitch	Optical microscopy & laser displacement interferometer scale	2	60	µm			10	nm	2	95%	No		80

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Reference materials	Pitch, microscope (magnification standard) - SRM 2800: pitch	Optical microscopy & laser displacement interferometer scale	1	10000	µm			10	nm	2	95%	No		81
Reference materials	Pin gage for optical fiber ferrules (SRM 2522): diameter	Micrometer with laser displacement interferometer scale	125	125	µm			0.05	µm	2	95%	No		82
Reference materials	Optical fiber ferrule geometry (SRM 2523): diameter	Micrometer with laser displacement interferometer scale	2.49	2.49	mm			0.065	µm	2	95%	No		83
Reference materials	Optical fiber coating standard (SRM 2553): diameter	Micrometer with laser displacement interferometer scale	244	244	µm			0.258	µm	2	95%	No		84
Reference materials	Optical fiber coating standard (SRM 2554): diameter	Micrometer with laser displacement interferometer scale	242	242	µm			0.114	µm	2	95%	No		85
Reference materials	Optical fiber coating standard (SRM 2555): diameter	Micrometer with laser displacement interferometer scale	238	238	µm			0.058	µm	2	95%	No		86