

of **Mitutoyo Nederland B.V.**
Service Department, Calibration Service and Technical Department
Veenendaal

Valid from: **10-04-2009** to **30-09-2010**

Replaces annex dated: **29-04-2008**

Premises: **N.A.**

HCS code	Measured quantity, Instrument, Gauge	Range	Best measurement capabilities ($k=2$)	Remarks
DM 0 0	DIMENSIONAL QUANTITIES			
DM 1 0	Length gauges			Performed by: Calibration Service
	Small rectangular gauge blocks			l = measured length (m)
	- steel and ceramic - hard metal (tungsten carbide)	(0,1 - 100) mm (0,1 - 100) mm	$0,05 \mu\text{m} + 0,7 \cdot 10^{-6} \cdot l$ $0,05 \mu\text{m} + 1,7 \cdot 10^{-6} \cdot l$	automatic comparator automatic comparator (Mitutoyo GBCD-100A)
	- variation in length	(0,1 - 100) mm	0,04 μm	automatic comparator (Mitutoyo GBCD-100A)
	Square gauge blocks			
	- steel - hard metal (tungsten carbide)	(0,1 - 100) mm (0,1 - 100) mm	$0,05 \mu\text{m} + 0,7 \cdot 10^{-6} \cdot l$ $0,05 \mu\text{m} + 1,7 \cdot 10^{-6} \cdot l$	automatic comparator automatic comparator (Mitutoyo GBCD-100A)
	- variation in length	(0,1 - 100) mm	0,04 μm	automatic comparator (Mitutoyo GBCD-100A)
	Long rectangular gauge blocks			

This annex has been approved by:

Ir. J.C. van der Poel
Chief Executive

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HCS code	Measured quantity, Instrument, Gauge	Range	Best measurement capabilities ($k=2$)	Remarks
	- steel and ceramic - zero-glass	(100 - 1510) mm (100 - 1510) mm	$0,10 \mu\text{m} + 0,34 \cdot 10^{-6} \cdot l$ $0,10 \mu\text{m} + 0,20 \cdot 10^{-6} \cdot l$	laser interferometer + CMM laser interferometer + CMM
	- variation in length	(100 - 1510) mm	0,22 μm	laser interferometer + CMM
	Long square gauge blocks			
	- steel - hard metal (tungsten carbide)	(100 - 500) mm (100 - 500) mm	$0,10 \mu\text{m} + 0,34 \cdot 10^{-6} \cdot l$ $0,10 \mu\text{m} + 0,40 \cdot 10^{-6} \cdot l$	laser interferometer + CMM laser interferometer + CMM
	- variation in length	(100 - 500) mm	0,14 μm	laser interferometer + CMM
	Micrometer-standards			
	- length	till 1510 mm	$0,10 \mu\text{m} + 0,50 \cdot 10^{-6} \cdot l$	laser interferometer + CMM
	- variation in length	till 1510 mm	0,04 μm	laser interferometer + CMM
	Step gauges (check-masters)			l_s = measurement position (m) l_t = total length (m)
	- length	till 1510 mm	$0,12 \mu\text{m} + 0,34 \cdot 10^{-6} \cdot l_s + 0,12 \cdot 10^{-6} \cdot l_t$	laser interferometer + CMM
	- variation in length	till 1510 mm	0,06 μm	laser interferometer + CMM

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HCS code	Measured quantity, Instrument, Gauge	Range	Best measurement capabilities ($k=2$)	Remarks
DM 2 0	Line scales, Distances			Performed by: Calibration Service & Technical Department
	Deviations of translations			r = rotation, t = straightness deviation l = length of translation (m)
	- linear displacements	till 20 m till 20 m	$0,20 \mu\text{m} + 0,7 \cdot 10^{-6} \cdot l$ $0,20 \mu\text{m} + 2,3 \cdot 10^{-6} \cdot l$	(1) laser interferometer (1) laser interferometer, with thermal compensation for the object
	- straightness deviation	till 1,5 mm till 1,5 mm	$0,8 \mu\text{m} + 0,8 \cdot 10^{-3} \cdot t + 0,4 \cdot 10^{-6} \cdot l$ $2,5 \mu\text{m} + 8,0 \cdot 10^{-3} \cdot t + 0,4 \cdot 10^{-6} \cdot l$	(1) laser with straightness optics $l \leq 3 \text{ m}$ $l \leq 20 \text{ m}$
	- rotation around horizontal axis with translation (pitch, roll)	-100" tot 100" -100" tot 100"	$0,2" + 2,0 \cdot 10^{-2} \cdot r + 3,5 \cdot 10^{-2} \cdot (l/m)"$ $1,5" + 2,0 \cdot 10^{-2} \cdot r$	(1) laser with rotation optics, $l \leq 20 \text{ m}$ (1) electronic levels
	- rotation around vertical axis with translation (yaw)	-100" tot 100"	$0,2" + 2,0 \cdot 10^{-2} \cdot r + 3,5 \cdot 10^{-2} \cdot (l/m)"$	(1) laser with rotation optics, $l \leq 20 \text{ m}$
	Deviations of combined displacements			
	- squareness of guides	-300" tot 300"	1,2" ($\approx 6 \mu\text{m/m}$)	(1) laser with squareness optics, with length per guide $\leq 20 \text{ m}$
	Line standards			
	- zero-glass - normal glass	till 400 mm	$0,08 \mu\text{m} + 0,50 \cdot 10^{-6} \cdot l$ $0,08 \mu\text{m} + 1,00 \cdot 10^{-6} \cdot l$	laser interferometer + Vision system
	- zero-glass - normal glass	till 600 mm	$0,08 \mu\text{m} + 0,52 \cdot 10^{-6} \cdot l$ $0,08 \mu\text{m} + 1,02 \cdot 10^{-6} \cdot l$	

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	Line scales			
	- normal glass	till 400 mm till 600 mm	$0,40 \mu\text{m} + 1,00 \cdot 10^{-6} /$ $0,40 \mu\text{m} + 1,06 \cdot 10^{-6} /$	laser interferometer + Vision system
	Calibration charts			
	- normal glass	till 10 mm	$0,24 \mu\text{m}$	laser interferometer + Vision system
	2-D Grids (zero-glass)			
	- distance between 2 points - linearity - straightness - squareness - rotation	till 200x200 mm	$0,8 \mu\text{m} + 0,5 \cdot 10^{-6} /$ $0,2 \mu\text{m} + 0,5 \cdot 10^{-6} /$ $0,2''$ $0,4''$	laser interferometer + Vision system

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HCS code	Measured quantity, Instrument, Gauge	Range	Best measurement capabilities ($k=2$)	Remarks
DM 3 0	Length measuring instruments			Performed by: Technical Department l = measured length (m) d = measured diameter (m)
	Calipers			
	- steel and carbon	(0 - 1500) mm (0 - 1500) mm	$8,4 \mu\text{m} + 4,5 \cdot 10^{-6} \cdot l$ $9,6 \mu\text{m} + 4,2 \cdot 10^{-6} \cdot l$	analog (dial caliper) digital
	- plastic	(0 - 150) mm	0,1 mm	digital (gauge blocks)
	- build-in types	(0 - 1000) mm	$9,6 \mu\text{m} + 4,2 \cdot 10^{-6} \cdot l$	digital
	- depth- types	(0 - 1000) mm (0 - 1000) mm	$8,4 \mu\text{m} + 4,5 \cdot 10^{-6} \cdot l$ $9,6 \mu\text{m} + 4,2 \cdot 10^{-6} \cdot l$	analog (dial caliper) digital
	- tire thread depth gauge	(0 - 25) mm	8 μm	digital
	- dial caliper gauge for outside measurements	(0 - 50) mm (0 - 50) mm	1,0 μm 4,1 μm	analog (gauge blocks) digital (gauge blocks)
	- dial caliper gauge for inside measurements	(0 - 200) mm (0 - 200) mm	3,1 μm 5,1 μm	analog (ring gauges) digital (ring gauges)
	Micrometers			
	- outside	(0 - 1000) mm (0 - 1000) mm	$1,2 \mu\text{m} + 6,6 \cdot 10^{-6} \cdot l$ $1,3 \mu\text{m} + 6,5 \cdot 10^{-6} \cdot l$	analog (gauge blocks) digital (gauge blocks)
	- mini holtest (2-point)	(2 - 6) mm	1,8 μm	analog (ring gauges)
	- inside (3-point)	(0 - 300) mm (0 - 300) mm	$1,7 \mu\text{m} + 9,8 \cdot 10^{-6} \cdot d$ $2,2 \mu\text{m} + 9,0 \cdot 10^{-6} \cdot d$	analog (ring gauges) digital (ring gauges)
	- caliper type inside micrometer	(0 - 300) mm (0 - 300) mm	$2,2 \mu\text{m} + 4,2 \cdot 10^{-6} \cdot d$ $2,3 \mu\text{m} + 3,9 \cdot 10^{-6} \cdot d$	analog (ring gauges) digital (ring gauges)
	- tubular inside	(0 - 300) mm	$3,1 \mu\text{m} + 6,8 \cdot 10^{-6} \cdot d$	analog (ring gauges)

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	micrometers	(0 - 300) mm	$2,8 \mu\text{m} + 7,2 \cdot 10^{-6} \cdot d$	digital (ring gauges)
	- heads	(0 - 50) mm (0 - 50) mm	$1,3 \mu\text{m} + 1,3 \cdot 10^{-6} \cdot l$ $1,2 \mu\text{m} + 1,3 \cdot 10^{-6} \cdot l$	analog (gauge blocks) digital (gauge blocks)
	- with dial indicator	(0 - 50) mm	$1,9 \mu\text{m}$	analog (gauge blocks)
	- dial snap	(0 - 100) mm	$1,0 \mu\text{m}$	analog (gauge blocks)
	- indicating	(0 - 100) mm	$0,9 \mu\text{m}$	analog (gauge blocks)
	Linear gauges	(0 - 100) mm	$0,3 \mu\text{m} + 4,8 \cdot 10^{-6} \cdot l$	Mitutoyo i-Checker
	Indicators			
	- dial	(0 - 100) mm (0 - 100) mm	$0,3 \mu\text{m} + 5,2 \cdot 10^{-6} \cdot l$ $0,3 \mu\text{m} + 4,8 \cdot 10^{-6} \cdot l$	analog (Mitutoyo i-Checker) digital (Mitutoyo i-Checker)
	- test	(0 - 1,6) mm	$0,6 \mu\text{m}$	Mitutoyo i-Checker
	- thickness gauge	(0 - 25) mm (0 - 25) mm	$1,7 \mu\text{m}$ $0,9 \mu\text{m}$	analog (gauge blocks) digital (gauge blocks)
	Indicator testers			
	- i-Checker	(0 - 100) mm	$0,10 \mu\text{m} + 2,2 \cdot 10^{-6} \cdot l$ $0,06 \mu\text{m} + 0,8 \cdot 10^{-6} \cdot l$	digital (gauge blocks) (1) digital (laser interferometer)
	- tester 170-102	(0 - 25) mm	$0,4 \mu\text{m}$	analog (gauge blocks)
	- tester 521-105	(0 - 5) mm	$0,3 \mu\text{m}$ $0,9 \mu\text{m}$	analog (gauge blocks) (1) analog (laser interferometer)
	- tester 521-103	(0 - 1) mm	$0,3 \mu\text{m}$ $4,5 \mu\text{m}$	analog (gauge blocks) (1) analog (laser interferometer)

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	Height gauges	(0 - 1000) mm (0 - 1000) mm (0 - 1000) mm (0 - 1000) mm	$9,8 \mu\text{m} + 1,8 \cdot 10^{-6} /$ $9,8 \mu\text{m} + 1,9 \cdot 10^{-6} /$ $9,6 \mu\text{m} + 1,8 \cdot 10^{-6} /$ $9,6 \mu\text{m} + 1,9 \cdot 10^{-6} /$	analog (square column) analog (two column) digital (square column) digital (two column)
	Low-force height gauges	<u>VL-50 / VL-50A /</u> <u>Elecont- type</u> (0 - 50) mm	0,9 μm	digital (gauge blocks)
	Linear heights			
	- linear displacements	(0 - 1000) mm	$1,2 \mu\text{m} + 2,9 \cdot 10^{-6} /$ $0,2 \mu\text{m} + 2,3 \cdot 10^{-6} /$	(1) steel step gauge (1) laser interferometer, with thermal compensation for the object. See DM 2 0 In combination with calibration of granite plate.
	- squareness		7,0 μm	(1) precision square
	- straightness		1,6 μm	(1) longest leg of precision square
	Profile projectors	<u>PJ / PV / PH-type</u> (0 - 50) mm (0 - 300) mm Magnification error	$1,5 \mu\text{m} + 2,4 \cdot 10^{-6} /$ $1,4 \mu\text{m} + 6,6 \cdot 10^{-6} /$ 0,02%	(1) (1)
	Measurement microscopes	<u>TM-type</u> (0 - 50) mm <u>MF-type</u> (0 - 50) mm (0 - 300) mm	$2,0 \mu\text{m} + 3,2 \cdot 10^{-6} /$ $0,9 \mu\text{m} + 3,6 \cdot 10^{-6} /$ $0,9 \mu\text{m} + 7,9 \cdot 10^{-6} /$	(1) (1) (1)

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	Vision systems			
	- 3-D: normal glass	<u>QV-type</u> (0 – 200) mm (0 – 400) mm (0 – 1000) mm (0 – 100) mm (0 – 250) mm	$0,3 \mu\text{m} + 2,5 \cdot 10^{-6} /$ $0,3 \mu\text{m} + 2,9 \cdot 10^{-6} /$ $0,3 \mu\text{m} + 3,0 \cdot 10^{-6} /$ $0,4 \mu\text{m} + 2,8 \cdot 10^{-6} /$ $0,5 \mu\text{m} + 3,5 \cdot 10^{-6} /$	(1) X- and Y-axis (1) X- and Y-axis (1) X- and Y-axis (1) Z-axis (1) Z-axis
	zero glass	(0 – 400) mm (0 – 100) mm (0 – 250) mm	$0,2 \mu\text{m} + 0,4 \cdot 10^{-6} /$ $0,1 \mu\text{m} + 12 \cdot 10^{-6} /$ $0,2 \mu\text{m} + 13 \cdot 10^{-6} /$	(1) X- and Y-axis (1) Z-axis (1) Z-axis
	- 2-D & 3-D:	<u>QS-type</u> (0 – 200) mm (0 – 400) mm (0 – 100) mm (0 – 250) mm	$0,7 \mu\text{m} + 7,5 \cdot 10^{-6} /$ $0,7 \mu\text{m} + 8,6 \cdot 10^{-6} /$ $1,4 \mu\text{m} + 2,6 \cdot 10^{-6} /$ $1,4 \mu\text{m} + 2,0 \cdot 10^{-6} /$	(1) X- and Y-axis (1) X- and Y-axis (1) Z-axis (1) Z-axis
	- 2-D:	<u>QI-type</u> (0 – 200) mm (0 – 400) mm	$0,7 \mu\text{m} + 7,5 \cdot 10^{-6} /$ $0,7 \mu\text{m} + 8,5 \cdot 10^{-6} /$	(1) X- and Y-axis (1) X- and Y-axis

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DM 4 0	Diameter			Performed by: Calibration Service d = measured diameter (m)
	Ring gauges			
	- diameter - roundness	(30 – 300) mm (4 – 50) mm <i>RONt</i> : (0 – 12) μm	1,0 μm + $1,0 \cdot 10^{-6} \cdot d$ 0,2 μm 0,10 μm + 10 % <i>RONt</i>	1-D bench + laser laser interferometer + CMM With Roundness machine conform ISO 12181:2003 guideline -at middle See DM 5 0
	Spheres (master ball)			
	- diameter - roundness	(0 – 30) mm (0 – 30) mm <i>RONt</i> : (0 – 1) μm	0,3 μm 0,2 μm 0,10 μm + 10 % <i>RONt</i>	1-D bench + laser laser interferometer + CMM With Roundness machine conform ISO 12181:2003 guideline -at equator See DM 5 0

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DM 5 0	Form error			Performed by: Calibration Service
	Measurement equipment for form			
	- straightness of straight edges	(0 - 2) mm	1,5 μm	With CMM: Straight edges till 1000 mm
	- straightness of knife edge straight edges	(0 - 2) mm	1,5 μm	With CMM: Straight edges till 1000 mm
	- flatness of surface plates	till (3 x 3) m	0,2 μm + 0,7 $\cdot 10^{-6} / l$	(1) Electronic levels, without temperature correction / = diagonal
	Roundness	d till 300 mm		With Roundness machine conform ISO 12181:2003 guideline
	- in- & outside ring - sphere (master ball)	ROMt: (0 – 12) μm (0 – 1) μm	0,10 μm + 10 % ROMt 0,10 μm + 10 % ROMt	-at middle -at equator

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HCS code	Measured quantity, Instrument, Gauge	Range	Best measurement capabilities ($k=2$)	Remarks
DM 8 0	Co-ordinate Measuring Machines			Performed by: Calibration Service & Technical Department
	- touch-trigger probe systems			
	1-Dimensional (1D) 2-Dimensional (2D) 3-Dimensional (3D)		0,04 μm 0,10 μm 0,10 μm	(1) VDI/VDE 2617, part 3 (1) VDI/VDE 2617, part 3 (1) VDI/VDE 2617, part 3 & ISO 10360-5:2004
	- 1D, 2D and 3D measuring machines	(0 - 1,5) m		VDI/VDE 2617, part 2.1 & ISO 10360-2:2001
			0,7 $\mu\text{m} + 3,4 \cdot 10^{-6} /$	(1) manual CMM – steel step gauge Meas. room (20 \pm 1) °C
			0,1 $\mu\text{m} + 3,8 \cdot 10^{-6} /$ 0,5 $\mu\text{m} + 3,6 \cdot 10^{-6} /$	(1) CNC CMM – steel gauge block (1) CNC CMM – steel step gauge meas. room (20 \pm 1) °C
			0,1 $\mu\text{m} + 0,4 \cdot 10^{-6} /$ 0,1 $\mu\text{m} + 1,3 \cdot 10^{-6} /$ 0,5 $\mu\text{m} + 0,9 \cdot 10^{-6} /$	(1) CNC CMM with thermal compensation and zero-glass scales – zero-glass gauge block (1) CNC CMM with thermal compensation – steel gauge block (1) CNC CMM with thermal compensation – steel step gauge Meas. room (20 \pm 2) °C
	CMM components: -linear displacements -straightness -rotation and squareness	(0 - 20) m	See DM 1 0	VDI/VDE 2617, part 3 (1) Assessment by laser, $l \leq 20$ m.

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HCS code	Measured quantity, Instrument, Gauge	Range	Best measurement capabilities ($k=2$)	Remarks
DM 9 0	Angle			Performed by: Calibration Service With CMM: / = distance on longest leg (m) L = length shortest leg (m)
	Angle gauges Blade type squares 90° (stock support squares)			
	- angle deviation	$\pm 0,5^\circ$	$(0,5 \cdot m/L)'' \approx 2,4 \mu\text{m}/L$	length of legs till (700 x 1000) mm
	- straightness	(0 - 2) mm	1,5 μm	length of legs till 700 mm
	- form deviation of longest leg	± 1 mm	$(1,5 + 1,0 \cdot l/L) \mu\text{m}$	length of legs till (700 x 1000) mm
	Spirit levels	$\pm 0,1$ mm/m $\pm 0,25$ mm/m $\pm 0,5$ mm/m	0,01 mm/m ($\approx 2''$) 0,02 mm/m ($\approx 4''$) 0,05 mm/m ($\approx 10''$)	With sine bar 500 mm and class 00 gauge blocks 0,02 mm/m resolution 0,05 mm/m resolution 0,1 mm/m resolution
	Electronic levels	± 2000 $\mu\text{m}/\text{m}$	2,0 $\mu\text{m}/\text{m}$ ($\approx 0,4''$) 10 $\mu\text{m}/\text{m}$ ($\approx 2''$) 1 $\mu\text{m}/\text{m}$ ($\approx 0,2''$)	With sine bar 500 mm and class 00 gauge blocks 1 $\mu\text{m}/\text{m}$ resolution 10 $\mu\text{m}/\text{m}$ resolution With sine bar 1800 mm and linear gauge

Annex to ISO/IEC 17025 Accreditation
with number: **K 086**

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Remarks:

The ambient temperature during the calibration within the laboratory is nominal 20 °C.

Best measurement capability: The highest achievable accuracy for a given measuring point or measuring range, expressed as the total positive and negative measurement uncertainty.

The measurement uncertainty is calculated according to EA-4/02 "Expression of the Uncertainty of Measurement in Calibration".

The "variation in length (v)" is defined conform the standard ISO 3650:1998.

(1) These calibrations are carried out at customer site or at Mitutoyo Nederland