Deutsche Akkreditierungsstelle

Annex to the Accreditation Certificate D-K-15151-01-00 according to DIN EN ISO/IEC 17025:2018

Valid from: **23.08.2023**

Date of issue: 23.08.2023

Holder of accreditation certificate:

eumetron GmbH
Gartenstraße 133, 73430 Aalen

The calibration laboratory meets the requirements of DIN EN ISO/IEC 17025:2018 to carry out the conformity assessment activities listed in this annex. The calibration laboratory meets additional legal and normative requirements, if applicable, including those in relevant sectoral schemes, provided that these are explicitly confirmed below.

The management system requirements of DIN EN ISO/IEC 17025 are written in the language relevant to the operations of calibration laboratories and they conform to the general principles of DIN EN ISO 9001.

Calibrations in the fields:

Dimensional quantities

Length

- **Gauge blocks**
- **Diameter**
- **Form error**
- **Linear thermal expansion coefficient**
- **Line scales, distances**

Coordinate measuring technology

- **Virtual coordinate measuring machines**
- **Application coordinate measuring machines**
- **Step gauges**
- **Coordinate measuring machines** [a)]

[a)] also as on-site-calibration

Within the measurands/calibration items marked with *) the calibration laboratory is permitted, without being required to inform and obtain prior approval from DAkkS, to use calibration standards or equivalent calibration procedures listed here with different issue dates.

The calibration laboratory maintains a current list of all calibration standards / equivalent calibration procedures within the flexible scope of accreditation.

[1] Unless otherwise specified, the unit of a variable corresponds to the unit of the measuring range

Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement [1]	Remarks
Length				
Gauge blocks * made of steel and ceramics according to DIN EN ISO 3650:1999	10 mm to 1000 mm nominal size	VDI/VDE/DGQ 2618 part 3.1:2004 Measurement of the mean size compared with a steel step gauge	0,10 µm + 0,4 · 10^{-6} · L	L = gauge block length
		Determination of the parallelism of the measured surfaces within a diameter of 6 mm around the mean size	0,10 µm + 0,2 · 10^{-6} · L	
Setting rings and setting plugs * Inside and outside cylinder *	diameter 10 mm to 100 mm nominal size	VDI/VDE/DGQ 2618 part 4.1:2006 Measurement of the two-point diameter compared with a ring or plug and a step gauge		D = measured diameter
Diameter			0,1 µm + 0,4 · 10^{-6} · D	
Roundness error			0,1 µm	
Straightness error			0,2 µm	
Parallelism error of the surface lines			0,25 µm	
Setting rings and setting plugs Inside and outside cylinder, balls and hemispheres	diameter 3 mm to 370 mm nominal size	VA-59_V07:2021-03 VA-60_V07:2021-03 VA-61_V07:2021-03 VA-64_V07:2021-03 Rondcom 54 with Multi position measurement		
Roundness error			0,01 µm + 0,05 · 10^{-6} · RONt	RONt = roundness error
Balls	diameter 10 mm to 100 mm nominal size	VA-58_V08:2021-03 Measurement of the two-point diameter compared with a sphere and a step gauge		
Diameter			0,1 µm + 0,4 · 10^{-6} · D	
Roundness error			0,1 µm	
Taper sleeves and taper mandrels	10 mm to 150 mm nominal size	VA-62_V07:2021-03 VA-63_V07:2021-03 Measurement of the two-point diameter in two measurement heights compared with a ring or plug and a step gauge		
Diameter			0,2 µm + 0,4 · 10^{-6} · D	D = measured diameter
Taper angle			(150 mm / L) "	L = distance between the two measurement heights in mm
Roundness error			0,1 µm	
Straightness error			0,5 µm	

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement [1]	Remarks
Thermal expansion coefficient CTE of workpieces and standards	Maximum length for 1D bodies: 1650 mm maximum area for 2D bodies: 1650 mm x 650 mm	VA-54_V07:2021-03 Measurement of the linear thermal expansion coefficient CTE within a temperature range of 20 °C to 30 °C	$U_{CTE}(t) = 0{,}03 \cdot 10^{-6}\ K^{-1} + 0{,}005 \cdot CTE(t) + (0{,}025 \cdot 10^{-6}\ K^{-1}\ m) / L$ for 20 °C ≤ t ≤ 30 °C	L = measured length in m CTE is the coefficient of thermal expansion in $10^{-6}\ K^{-1}$ Example: $U = 0{,}11 \cdot 10^{-6}\ K^{-1}$ for steel: $L = 1$ m $U = 0{,}14 \cdot 10^{-6}\ K^{-1}$ for steel: $L = 0{,}5$ m The calibration certificate includes the linear term of the CTE as a constant value, or the CTE depending on the temperature. Depending on the temperature indication of the CTE, a model of linear and quadratic components of the CTE was documented.
Length standards for optical metrology	> 0 mm to 600 mm	VA-70_V10:2023-03 Optical 1D distance measurements between symmetrical 2D structures (center of a circle, middle of the line, center of a reticle) using a calibrated coordinate measuring machine via single-point probing with a video sensor in comparison with an optical scale. In case of lines, the distance is determined by the center of the line or by one edge of the line as a unidirectional distance.	$0{,}09\ \mu m + 0{,}2 \cdot 10^{-6} \cdot L$	L = measured length Materials with a coefficient of linear thermal expansion, e.g. quartz glass $\lvert\alpha\rvert \le 1{,}0 \cdot 10^{-6}\ K^{-1}$ and its uncertainty $U(\alpha) < 0{,}5 \cdot 10^{-6}\ K^{-1}$
			$0{,}09\ \mu m + 0{,}22 \cdot 10^{-6} \cdot L$	Materials with calibrated uncertainty of the coefficient of linear thermal expansion $U(\alpha) \le 0{,}04 \cdot 10^{-6}\ K^{-1} + 0{,}007 \cdot CTE + (0{,}03 \cdot 10^{-6}\ K^{-1}\ m) / L$
			$0{,}09\ \mu m + 0{,}25 \cdot 10^{-6} \cdot L$	Materials without calibration of the coefficient of linear thermal expansion

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement [1]	Remarks
Length standards for optical metrology		VA-71_V08:2021-03 Optical 1D distance measurements between symmetrical 2D structures (center of a circle, middle of the line, center of a reticle) using a calibrated coordinate measuring machine via single-point probing with a video sensor in comparison with an optical scale. In case of lines, the distance is determined by the center of the line or by one edge of the line as a unidirectional distance. For bars longer than 2150 mm, the measuring range is extended by a connection measurement with two overlapping target marks on the calibration object.		
	> 600 mm to 1180 mm	axially parallel	0,35 µm + 0,8 ·10^{-6} · L	L = measured length
	> 1180 mm to 1780 mm	axially parallel	0,35 µm + 1,0 · 10^{-6} · L	
	> 1780 mm to 2150 mm	diagonally	0,35 µm + 1,0 · 10^{-6} · L	
	> 2150 mm to 3000 mm	connection measurement	0,40 µm + 1,0 · 10^{-6} · L	
Length standards for optical metrology	up to a diagonal distance of 600 mm and a maximum aspect ratio of 2: 1	VA-72_V10:2023-03 Optische 2D Distanzmes- Optical 1D distance measureents between symmetrical 2D structures (center of a circle, middle of the line, center of a reticle) using a calibrated coordinate measuring machine via single-point probing with a video sensor in comparison with an optical scale using a multilateration procedure. For reticles the distance is measured via the crossing point of the centers of the lines.	0,09 µm + 0,2 · 10^{-6} · L	L = distance between the center of the circle or the intersection of line crosses Materials with a coefficient of linear thermal expansion, e.g. quartz glass $\lvert\alpha\rvert \leq 1{,}0 \cdot 10^{-6}$ K^{-1} and its uncertainty $U(\alpha) < 0{,}5 \cdot 10^{-6}$ K^{-1}

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement [1]	Remarks
			0,09 µm + 0,22 · 10^{-6} · L	Materials with calibrated uncertainty of the coefficient of linear thermal expansion $U(\alpha) \leq 0{,}04 \cdot 10^{-6}\ K^{-1} + 0{,}007 \cdot CTE + (0{,}03 \cdot 10^{-6}\ K^{-1}\ m) / L$
			0,09 µm + 0,25 · 10^{-6} · L	Materials without calibration of the coefficient of linear thermal expansion
Length standards for optical metrology	up to a diagonal distance of 1200 mm and a maximum aspect ratio of 2: 1	VA-73_V08:2021-03 Optical 2D distance measurements between symmetrical 2D structures (center of a circle, center of a reticle) using a calibrated coordinate measuring machine via single-point probing with a video sensor using a multilateration procedure. For reticles the distance is measured via the crossing point of the centers of the lines.	0,4 µm + 0,8 · 10^{-6} · L	L = distance between the center of the circle or the intersection of line crosses
Optical circle structure Diameter	0,02 mm to 20 mm	VA-74_V01:2023-03 Substitution measurement of the diameter with a circle standard. Determination of diameter and roundness deviation using 25 probing points in transmitted-light measurement mode according to DIN EN ISO 10360-7:2011	0,25 µm	
Roundness error ($RONt$)			0,5 µm	

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement [1]	Remarks
Coordinate measuring technology		VA-40_V20:2023-03		
Prismatic workpieces	Coordinate measuring machines with one for the implementation of the calibration procedure specified measuring volume with the dimensions: X = 1200 mm Y = 2400 mm Z = 1000 mm (the indications X, Y, Z designate the coordinate axes in manufacturer notation) Calibrations are performed with probing elements with a diameter in range 0,3 mm to 40,0 mm.	Tactile measurement using a calibrated coordinate measuring machine and determination of geometric parameters defined through control geometries (single-points, straight lines, planes, circles, balls, cylinders, tapers, toroids) using the evaluation software of the coordinate measuring machine. The measuring points can be detected by single point or scanning method. Single-point measuring can be carried out either with fixed, predefined measuring force or with extrapolation on measuring force zero. Single point measurements in the form of „Self-centering measurements" are not used within the framework of the accreditation. Excluded are evaluations of gearing parameters and free form surfaces and the use of a turntables in the measuring process. The calibration values can be determined in a substitution and multilayer method by averaging in order to reduce the measurement uncertainty.	The uncertainty of measurement is determined according to ISO/TS 15530-4: 2008 "Evaluating task specific measurement uncertainty using simulation" using the "Virtual Coordinate Measuring Machine" method. The measurement uncertainty for bidirectional length-measurements on steel artefacts in measuring positions according to DIN EN ISO 10360-2:2010 and in the specified measurement volume is for a central stylu-ses (zero distance between center of the probing ball and the pinole axis) maximum: U_{E0} = 1,5 µm + 1,5 · 10^{-6} · L and for measurements with lateral stylus (150 mm distance between center of the probing ball and the pinole axis) maximum: U_{E150} = 1,5 µm + 1,5 ·10^{-6} · L The smallest applicable measurement uncertainty for bidirectional length measure-ments on test pieces made of steel and of length L is in the specified measuring volume: L = 20 mm U = 0,5 µm L = 540 mm U = 1,0 µm L = 1060 mm U = 1,5 µm	L = measured length The measurement uncertainty is task-specific. Therefore, no smallest applicable measurement uncertainty can be specified for any measuring tasks. The here specified measurement uncertainties are exemplary for the respectively described measuring tasks. For general measuring tasks referred to the accredited scope the measuring uncertainty could be significant differently. The specified uncertainty in the calibration certificate only refers to the used measurement and evaluation strategy. This includes measuring point distribution, filtering of the measured values and outlier elimination. The measurement and evaluation strategy is explicitly documented in the calibration certificate. The dimension of a task-specific measurement uncertainty can be estimated based on the information of an inspection plan. The laboratory can do this before the real measurement starts.

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement [1]	Remarks
Prismatic workpieces (continuation)	Coordinate measuring machines with a calibrated measuring volume of: X = 1200 mm Y = 2400 mm Z = 1000 mm		The measurement uncertainty of diameter and form measurements on a ball made of ceramic with nominal diameter of 25 mm, measured in scanning mode and with a measuring strategy according to DIN EN ISO 10360-5:2020, in the specified measuring volume is: for the determination of the form deviation (Chebyshev evaluation) U = 1,3 µm for the determination of the diameter (Gauss evaluation) U = 0,8 µm	The stated measurement uncertainties for the scanning mode have been determined in consideration of a wave filter according to DIN EN ISO 16610-21:2013 with a cut-off wavelength of 150 W/U.
Two-point distance measurements of prismatic bodies	to 1540 mm	Substitution measurement on a calibrated coordinate measuring machine with tactile single-point measurement.	0,2 µm + 0,5 · 10^{-6} · L	L = measured length The substitution is performed using a DAkkS-calibrated steel step gauge of 1540 mm length. The substitution measurements refer to two-point distance measurements from direct measurements or from intersections of geometry elements.
Ball strips with internal or external balls and hole strips	to 1500 mm nominal size distance of the ball or borehole center points	VA-52_V07:2021-03 Measurement of the ball or borehole distance compared to a steel step gauge	0,12 µm + 0,4 · 10^{-6} · L	L = distance of the ball or borehole center points in µm
Ball plates with internal or external balls and hole plates	to 1150 mm nominal size diagonal distance of the ball or borehole center points and a maximum aspect ratio of 2:1	VA-55_V08:2021-03 Measurement of the ball or borehole distance compared to a steel step gauge	0,12 µm + 0,4 · 10^{-6} · L	L = distance of the ball or borehole center points
	nominal size			

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement [1]	Remarks
Step gauges	to 1540 mm nominal size	VA-51_V07:2023-03 Measurement of the mean size in comparison with a steel step gauge	0,06 µm + 0,25 · 10^{-6} · L	L = step length material: glass ceramics or ceramics with a coefficient of linear thermal expansion α with $\lvert\alpha\rvert \le 0{,}05 \cdot 10^{-6}$ K^{-1} and its uncertainty $U(\alpha) < 0{,}05 \cdot 10^{-6}$ K^{-1}
Step gauges	to 1540 mm	VA-51_V07:2023-03 Measurement of the mean size in comparison with a steel step gauge	0,06 µm + 0,3 · 10^{-6} · L	L = step length material: steel with a coefficient of linear thermal expansion α and $U(\alpha) \le 0{,}04 \cdot 10^{-6}$ K^{-1} + 0,007 · CTE + (0,03 · 10^{-6} K^{-1}m) / L
Step gauges	to 1540 mm	VA-51_V07:2023-03 Measurement of the mean size in comparison with a steel step gauge	0,06 µm + 0,35 · 10^{-6} · L	L = step length material: steel
Step gauges	to 1100 mm nominal size	VA-66_V09:2023-03 Measurement of the mean size compared with a step gauge with $\lvert\alpha\rvert \le 0{,}05 \cdot 10^{-6}$ K^{-1}	0,06 µm + 0,16 · 10^{-6} · L	L = step length material: glass ceramics or ceramics with a coefficient of linear thermal expansion α with $\lvert\alpha\rvert \le 0{,}05 \cdot 10^{-6}$ K^{-1} and its uncertainty $U(\alpha) < 0{,}05 \cdot 10^{-6}$ K^{-1}
Step gauges	to 1100 mm	VA-66_V09:2023-03 Measurement of the mean size compared with a step gauge with $\lvert\alpha\rvert \le 0{,}05 \cdot 10^{-6}$ K^{-1}	0,06 µm + 0,23 · 10^{-6} · L	L = step length material: steel with a coefficient of linear thermal expansion α and $U(\alpha) \le 0{,}04 \cdot 10^{-6}$ K^{-1} + 0,007 · CTE + (0,03 · 10^{-6} K^{-1} m) / L
Step gauges	to 1100 mm	VA-66_V09:2023-03 Measurement of the mean size compared with a step gauge with $\lvert\alpha\rvert \le 0{,}05 \cdot 10^{-6}$ K^{-1}	0,06 µm + 0,27 · 10^{-6} · L	L = step length material: steel

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Permanent Laboratory and On-Site Calibration

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement [1]	Remarks
Coordinate measuring technology Coordinate measuring machines using Software CALYPSO (Software by Fa. Carl Zeiss Industrielle Messtechnik GmbH)	Coordinate measuring machines (CMM) with a measuring volume of: X = 1200 mm Y = 2400 mm Z = 1000 mm	VA-30_V16:2023-03 Determination of the influence factors of a CMM as a requirement for the use of the method „Virtual Coordinate Measuring Machine“ (VCMM) for uncertainty evaluation		
		Reverification test of the CMM concerning the uncertainties evaluated according to the VCMM method by determining the length measurement deviations E_0 and E_{150} according to DIN EN ISO 10360-2:2010-06 using step gauges made of steel.	0,06 µm + 0,3 · 10^{-6} · L	L = measured length

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Permanent Laboratory and On-Site Calibration

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement [1]	Remarks
		Reverification test of the CMM concerning the uncertainties evaluated according to the VCMM method by determining the probing deviation according to DIN EN ISO 10360-5:2020-11 using a ring: $P_{Form.Cir.Scan:PP;Tact}$	0,05 µm	The stated uncertainties for scanning mode have been determined considering a wave filter according to DIN EN ISO 16610-21: 2013 with a cut-off wavelength of 150 W/U.
		Reverification test of the CMM concerning the uncertainties evaluated according to the VCMM method by determining the probing deviation according to DIN EN ISO 10360-5:2020-11 using a sphere: $P_{Form.Sph.Scan:PP;Tact}$ $P_{Size.Sph.Scan:PP:Tact}$	0,05 µm 0,12 µm	
		Reverification test of the CMM concerning the uncertainties evaluated according to the VCMM method by determining the multiple-stylus probing deviation according to DIN EN ISO 10360-5:2020-11 using a sphere: $P_{Form.Sph.5x25:MS:Tact}$ $P_{Size.Sph.5x25:MS:Tact}$ $P_{Dia.Sph.5x25:MS:Tact}$	0,05 µm 0,12 µm 0,05 µm	

Abbreviations used:

CMC	Calibration and measurement capabilities
DGQ	Deutsche Gesellschaft für Qualität e.V.
DIN	Deutsches Institut für Normung e.V.
VA-XX	Calibration instruction of the eumetron GmbH
VDE	Verband der Elektrotechnik, Elektronik und Informationstechnik e.V.
VDI	Verein Deutscher Ingenieure e.V.

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