Deutsche Akkreditierungsstelle

Annex to the Partial Accreditation Certificate D-K-15007-01-01 according to DIN EN ISO/IEC 17025:2018

Valid from: **09.11.2022**

Date of issue: 09.11.2022

This annex is a part of the accreditation certificate D-K-15007-01-00.

Holder of partial accreditation certificate:

Carl Zeiss Industrielle Messtechnik GmbH
Carl-Zeiss-Straße 22, 73447 Oberkochen

The calibration laboratory meets the minimal requirements of DIN EN ISO/IEC 17025:2018 and, if applicable, additional legal and normative requirements, including those in relevant sectoral schemes, in order to carry out the conformity assessment activities listed below.
The management system requirements of DIN EN ISO/IEC 17025 are written in the language relevant to the operations of calibration laboratories and confirm generally with the principles of DIN EN ISO 9001.

Calibrations at the locations:

Carl-Zeiss-Straße 22, 73447 Oberkochen
Willy-Messerschmitt-Straße 1, 73457 Essingen

This certificate annex is only valid together with the written accreditation certificate and reflects the status as indicated by the date of issue. The current status of any given scope of accreditation can be found in the directory of accredited bodies maintained by Deutsche Akkreditierungsstelle GmbH at https://www.dakks.de.

Calibrations in the fields:

Dimensional quantities

Length

- **Gauge blocks**
- **Diameter**
- **Form error**
- **Linear thermal expansion coefficient**

Coordinate measuring technology

- **Step gauges**
- **Virtual coordinate measuring machines**
- **Application coordinate measuring machines**

Permanent Laboratory - Oberkochen

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
Length Gauge blocks made of steel according to DIN EN ISO 3650:1999	10 mm to 2000 mm nominal size	I_DI_S_ALM_01_01_A_12: 2019/10 Measurement of the mean size with flat mirror laser interferometer with mechanical probing of the measurement surface. The wringing of both measurement surfaces must be checked using a suitable flat mirror plate.	for the mean size: 0.05 µm + 0.3 · $10^{-6} \cdot l$	l = gauge block length Measuring surface quality as stated in QMH rsp. in the work specifications.
			for the mean size: 0.05 µm + 0.25 · $10^{-6} \cdot l$	The uncertainty of measurement of the linear coefficient of thermal expansion of object to be calibrated $U(\alpha) \leq 0.1 \cdot 10^{-6}$ K^{-1}
Gauge blocks made of ceramics according to DIN EN ISO 3650:1999	10 mm to 500 mm nominal size		for the mean size: 0.05 µm + 0.4 · $10^{-6} \cdot l$	
Gauge blocks made of steel according to DIN EN ISO 3650:1999	50 mm to 500 mm nominal size	I_DI_S_ALM_01_01_A_13: 2019/10 Measurement of the mean size with a coordinate measuring machine in comparison with a gauge block made of steel of the same nominal size and determining the parallelism of the measurement	0.08 µm + 0.4 · $10^{-6} \cdot l$	l = gauge block length
Length of workpieces with plane parallel surfaces with optical measurement surface quality	10 mm to 2000 mm nominal size	I_DI_S_ALM_01_01_A_12: 2019/10 Measurement of the length with flat mirror laser interferometer with mechanical probing of the measurement surface. Measurement surface quality (planarity and parallelism), the linear coefficient of thermal expansion α and its uncertainty are considered in the measurement uncertainty.		l = measured length
			0.05 µm + 0.15 · $10^{-6} \cdot l$	material: glass ceramics or ceramics with a coefficient of linear thermal expansion $\lvert\alpha\rvert \leq 0.05 \cdot 10^{-6}$ K^{-1} and its uncertainty $U(\alpha) \leq 0.05 \cdot 10^{-6}$ K^{-1}
			0.05 µm + 0.25 · $10^{-6} \cdot l$	material: steel with an uncertainty of the coefficient of linear thermal expansion $U(\alpha) \leq 0.1 \cdot 10^{-6}$ K^{-1}
			0.05 µm + 0.3 · $10^{-6} \cdot l$	material: steel
			0.05 µm + 0.4 · $10^{-6} \cdot l$	material: ceramics

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
Thermal expansion coefficient *CTE* of workpieces and standards	Maximum dimension for the calibration object Length: 2500 mm Width: 180 mm Height: 80 mm Maximum measurable length at the calibration object: 1450 mm	I_DI_S_ALM_01_01_A_25: 2022/07 Measurement of length and temperature changes and mathematical derivation of the thermal expansion coefficient *CTE*	$U_{CTE}(t)$ = 0.02 · 10^{-6} K^{-1} + 1.5 · 10^{-3} · *CTE* + (0.027 · 10^{-6} K^{-1} m) / *L* for 10 °C ≤ t ≤ 30 °C	*L* = measured length *CTE* = thermal expansion coefficient The *CTE* is given as a model in the form of a linear component α and a quadratic component β. Example: $U_{CTE}(t)$ = 0.07 · 10^{-6} K^{-1} for steel: *L* = 1 m $U_{CTE}(t)$ = 0.09 · 10^{-6} K^{-1} for steel: *L* = 0.5 m
Step gauge blocks	to 2080 mm	I_DI_S_ALM_01_01_A_06: 2019/05 Measurement of the mean size with flat mirror laser interferometer with mechanical probing of the measurement surface. The perpendicularity deviation of the measuring surfaces must not exceed 1.5'.	unidirectional probing: 0.03 µm + 0.09 · 10^{-6} · l bidirectional probing: 0.04 µm + 0.09 · 10^{-6} · l	l = step length; material: glass ceramics or ceramics with a coefficient of linear thermal expansion $\|\alpha\|$ ≤ 0.05 · 10^{-6} K^{-1} and its uncertainty $U(\alpha)$ ≤ 0.05 · 10^{-6} K^{-1}
			unidirectional probing: 0.03 µm + 0.14 · 10^{-6} · l bidirectional probing: 0.04 µm + 0.14 · 10^{-6} · l	l = step length; material: steel with an uncertainty of the coefficient of linear thermal expansion $U(\alpha)$ ≤ 0.1 · 10^{-6} K^{-1}
			unidirectional probing: 0.03 µm + 0.18 · 10^{-6} · l bidirectional probing: 0.04 µm + 0.18 · 10^{-6} · l	material: steel

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
Step gauge blocks	to 2500 mm	I_DI_S_ALM_01_01_A_06: 2019/05 Measurement of the mean size with flat mirror laser interferometer with mechanical probing of the measurement surface. The perpendicularity deviation of the measuring surfaces must not exceed 1.5′.	unidirectional probing: $0.06\ \mu m + 0.09 \cdot 10^{-6} \cdot l$ bidirectional probing: $0.08\ \mu m + 0.09 \cdot 10^{-6} \cdot l$	material: glass ceramics or ceramics with a coefficient of linear thermal expansion $\lvert\alpha\rvert \le 0.05 \cdot 10^{-6}\ K^{-1}$ and its uncertainty $U(\alpha) \le 0.05 \cdot 10^{-6}\ K^{-1}$
	to 2500 mm	I_DI_S_ALM_01_01_A_06: 2019/05 Measurement of the mean size with flat mirror laser interferometer with mechanical probing of the measurement surface. The perpendicularity deviation of the measuring surfaces must not exceed 1.5′.	unidirectional probing: $0.06\ \mu m + 0.14 \cdot 10^{-6} \cdot l$ bidirectional probing: $0.08\ \mu m + 0.14 \cdot 10^{-6} \cdot l$	l = step length; material: steel with an uncertainty of the coefficient of linear thermal expansion $U(\alpha) \le 0.1 \cdot 10^{-6}\ K^{-1}$
			unidirectional probing: $0.06\ \mu m + 0.18 \cdot 10^{-6} \cdot l$ bidirectional probing: $0.08\ \mu m + 0.18 \cdot 10^{-6} \cdot l$	material: steel
Setting ring and plug gauges; inside and outside cylinder Diameter	3 mm to 400 mm	VDI/VDE/DGQ 2618 part 4.1:2006 Measurement of the 2-point diameter with flat mirror laser interferometer with mechanical probing of the measurement surface.	$0.08\ \mu m + 0.15 \cdot 10^{-6} \cdot d$	d = diameter material: glass ceramics or ceramics with a coefficient of linear thermal expansion $\lvert\alpha\rvert \le 0.05 \cdot 10^{-6}\ K^{-1}$ and its uncertainty $U(\alpha) \le 0.05 \cdot 10^{-6}\ K^{-1}$
Setting ring and plug gauges; inside and outside cylinder Diameter	3 mm to 400 mm	VDI/VDE/DGQ 2618 part 4.1:2006 Measurement of the 2-point diameter with flat mirror laser interferometer with mechanical probing of the measurement surface.	$0.08\ \mu m + 0.25 \cdot 10^{-6} \cdot d$	d = diameter material: steel with an uncertainty of the coefficient of linear thermal expansion $U(\alpha) \le 0.1 \cdot 10^{-6}\ K^{-1}$
			$0.08\ \mu m + 0.3 \cdot 10^{-6} \cdot d$	material: steel
			$0.08\ \mu m + 0.4 \cdot 10^{-6} \cdot d$	material: ceramics
		I_DI_S_ALM_01_01_A_08: 2017/06 Measurement with coordinate measuring machines	$0.7\ \mu m + 2 \cdot 10^{-6} \cdot d$	

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
Roundness deviation	3 mm to 400 mm	Talyrond 61 with Multiple layer procedure	0.015 µm + 7 · 10^{-2} · *RON*t	*RON*t = roundness deviation
		Single-layer procedure	0.1 µm	
Straightness deviation of surface lines	0 mm to 100 mm	I_DI_S_ALM_01_01_A_08: 2017/06	0.4 µm + 0.1 · *STR*t	*STR*t = straightness deviation
Parallelism deviation of surface lines	axial length		0.4 µm + 0.1 · *STR*t	
Straightness deviation of surface lines	> 100 mm to 500 mm		0.8 µm + 0.1 · *STR*t	
Parallelism deviation of surface lines	axial length		1.0 µm + 0.1 · *STR*t	
Setting ring and plug gauges; inside and outside cylinder		VDI/VDE/DGQ 2618 part 4.1:2006		
Diameter	16 mm, 30 mm, 50 mm nominal size	Measurement of the 2-point diameter with a coordinate measuring machine in comparison with a ring or plug of the same nominal size	0.11 µm + 0.25 · 10^{-6} · *d*	*d* = diameter
Magnification standards (cylinder with flat area; flick-standard)	flat area to 300 µm Diameter to 50 mm	I_DI_S_ALM_01_01_A_09: 2017/06 Measurement with roundness measuring machines	0.12 µm + 0.02 · *RON*t	*RON*t = roundness deviation
Balls		I_DI_S_ALM_01_01_A_07: 2021		
Diameter	2 mm to 200 mm	Measurement of the 2-point diameter with flat mirror laser interferometer with mechanical probing of the measurement surface	0.08 µm + 0.15 · 10^{-6} · *d*	*d* = diameter material: glass ceramics or ceramics with a coefficient of linear thermal expansion $\|\alpha\| \leq 0.05 \cdot 10^{-6}$ K^{-1} and its uncertainty $U(\alpha) \leq 0.05 \cdot 10^{-6}$ K^{-1}
			0.08 µm + 0.25 · 10^{-6} · *d*	*d* = diameter material: steel with an uncertainty of the coefficient of linear thermal expansion $U(\alpha) \leq 0.1 \cdot 10^{-6}$ K^{-1}
			0.08 µm + 0.3 · 10^{-6} · *d*	material: steel
			0.08 µm + 0.4 · 10^{-6} · *d*	material: ceramics
		I_DI_S_ALM_01_01_A_08: 2017/06 Measurement with coordinate measuring machines	0.7 µm + 2 · 10^{-6} · *d*	*d* = diameter

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
Roundness deviation		Talyrond 61 with Multiple layer procedure	0.015 µm + 7 · 10^{-2} · RONt	RONt = roundness deviation
		Single-layer procedure	0.1 µm	
Balls Diameter	25 mm and 30 mm nominal size	I_DI_S_ALM_01_01_A_10: 2017/06 Measurement of the 2-point diameter with a coordinate measuring machine in comparison to a ball of the same nominal size	0.09 µm + 0.35 · 10^{-6} · d	d = diameter
Coordinate measuring technology Ball and hole bar	to 2000 mm Axially distance between ball and hole center points	I_DI_S_ALM_01_01_A_14_I1: 2017/06 Measurement with flat mirror laser interferometer with mechanical probing of the measurement surface		l = distance between ball and hole center points
			0.08 µm + 0.3 · 10^{-6} · l	material: steel
			0.08 µm + 0.15 · 10^{-6} · l	material: glass ceramics or ceramics with a coefficient of linear thermal expansion $\|\alpha\| \leq 0.05 \cdot 10^{-6}$ K^{-1} and its uncertainty $U(\alpha) \leq 0.05 \cdot 10^{-6}$ K^{-1}

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
Coodinate measuring technology				
Prismatic workpieces	Coordinate measuring machine with one for the implementation of the calibration procedure specified measuring volume with the dimensions X = 1160 mm Y = 2060 mm Z = 620 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 30 mm.	Tactile measurements 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 turntable 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 stylus (zero distance between center of the probing ball and the pinole axis) maximum: U_{E0} = 0.3 µm + 2 · 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} = 0.4 µm + 2 · 10^{-6} · L The smallest applicable measurement uncertainty for bidirectional length measurements on test pieces made of steel and of length L is in the specified measuring volume: L = 20 mm U = 0.3 µm L = 1000 mm U = 1.9 µm L = 1980 mm U = 7.4 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 a 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	Remarks
Prismatic workpieces	Coordinate measuring machines with a calibrated measuring volume of: X = 1160 mm Y = 2060 mm Z = 620 mm		The measurement uncertainty for diameter and form measurements on a ball made of ceramic with nominal diameter 25 mm, measured in scanning mode and with a measuring strategy according to DIN EN ISO 10360-5: 2018 E, is in the specified measuring volume: for the determination of the form deviation (evaluation to Tschebyschew) U = 0.23 µm for the determination of the diameter (evaluation to Gauß) U = 0.34 µm	The stated measurement uncertainties for the scanning mode have been determined in consideration of an wave filter according to DIN EN ISO 16610-21: 2013 with a cut-off wavelength of 150 W/U.
Step gauge blocks	to 1100 mm	I_DI_S_ALM_01_01_A_24: 2019/11 Measurement of the mean size with a coordinate measuring machine in comparison with a step gauge block of the same nominal size	0.06 µm + 0.22 · 10^{-6} · l	l = step length
Length standards for optical metrology Distances of edges aligned in the same direction (unidirectional) and center-to-center distances of structures on flat substrates (photomasks with CR layer)	to 350 mm	I_DI_S_ALM_01_01_A_26: 2022/08 Substitution measurement with a line scale of equal nominal length using a coordinate measuring machine and optical scanning in transmitted light.	0.09 µm + 0.15 · 10^{-6} · l	l = measured length of $\lvert\alpha\rvert \leq 0.5 \cdot 10^{-6}$ K^{-1} and $U\alpha \leq 0.1 \cdot 10^{-6}$ K^{-1} The linear thermal expansion coefficient α and its uncertainty are taken into account in the measurement uncertainty.
	> 290 mm to 500 mm	With a line scale of equal nominal lengths in connection method	0.13 µm + 0.21 · 10^{-6} · l	
	to 350 mm	Measurand of arbitrary nominal lengths	0.15 µm + 0.10 · 10^{-6} · l	

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
	> 290 mm to 500 mm	Measurand of arbitrary nominal length using line scales in connection method	$0.21\ \mu m + 0.16 \cdot 10^{-6} \cdot l$	

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
Length standards for optical metrology Diameter of structures on flat substrates (photo-masks with CR layer)	0.06 mm to 10 mm	I_DI_S_ALM_01_01_A_26: 2018/04 Substitution measurement with a circular normal and the same nominal diameters using a coordinate measuring machine and optical scanning in transmitted light. Twenty-five single-points are probed according to the dot pattern of the DIN EN ISO 10360-7: 2011. For layer thickness between 30 nm and 190 nm. The calibration object is identical to the traceability standard.	0.25 µm	Diameter and form error refer to the probing points
Roundness deviation (*RON*t)			0.3 µm	
Length standards for optical measurement technology Roundness deviation (*RON*t) of structures on flat substrates (photo-masks with CR layer)	0.06 mm to 10 mm	I_DI_S_ALM_01_01_A_26: 2018-04 Measurement with a coordinate measuring machine and optical probing in transmitted light. Twenty-five single-points are probed according to the dot pattern of the DIN EN ISO 10360-7: 2011. For layer thickness between 30 nm and 190 nm.	0.6 µm	Form error refers to the probing points
Length standards for optical metrology	2D-Range: 900 mm x 1100 mm	I_DI_S_ALM_01_01_A_22: 2018/12 Measurement of center distances and X-, Y-coordinates with a calibrated coordinate measuring machine and optical probing. The measurement is performed on symmetrical 2D structures (center of a circle, middle of the line, center of a reticle).	$0.7\ \mu m + 2 \cdot 10^{-6} \cdot l$	l = measured length
	2D- Range: 1200 mm x 1980 mm		$1.4\ \mu m + 2.2 \cdot 10^{-6} \cdot l$	

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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range		Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
Two-point diameter and distances	up to	1100 mm	I_DI_S_ALM_01_01_A_28: 2018/11 Substitution measurement with a calibrated standard (ball, ring or step gauge) with a coordinate measuring machine and tactile single-point probing.	Calculation of the measurement uncertainty using the method „Virtual coordinate measuring machine“ based on ISO/TS 15530-4: 2008 taking into account the substitution effect $0.1\ \mu m + 0.4 \cdot 10^{-6} \cdot l$	l = measured length
	up to	2060 mm		$0.25\ \mu m + 0.3 \cdot 10^{-6} \cdot l$	
Balls Diameter	to	30 mm	I_DI_S_ALM_01_01_A_27: 2018/11 Substitution measurement with a ball by means of a coordinate measuring machine and tactile single-point probing. Twenty-five single-points are probed according to the dot pattern of the DIN EN ISO 10360-5:2011	Calculation of the measurement uncertainty using the method „Virtual coordinate measuring machine“ based on ISO/TS 15530-4: 2008 taking into account the substitution effect 0.1 µm	d = Diameter (measurement of the hemisphere) The best measurement uncertainty is only achieved with the same nominal dimension. Diameter and form error refer to the probing points.
Form error				0.07 µm	

Abbreviations used:

CMC	Calibration and measurement capabilities
DGQ	Deutsche Gesellschaft für Qualität e.V.
DIN	Deutsches Institut für Normung e.V. – German institute for standardization
I_DI_S	Calibration instruction of the Carl Zeiss Industrielle Messtechnik GmbH
VDE	Verband der Elektrotechnik, Elektronik und Informationstechnik e.V.
VDI	Verein Deutscher Ingenieure e.V.