Deutsche Akkreditierungsstelle GmbH

Annex to the Accreditation Certificate D-K-15007-01-00 according to DIN EN ISO/IEC 17025:2005

Period of validity: 16.08.2018 to 10.01.2021 Date of issue: 18.08.2018

Holder of certificate:

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

with its calibration laboratory

Carl Zeiss Industrielle Messtechnik GmbH
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Accredited as calibration laboratory since: 18.03.1987

Calibration in the fields:

Dimensional quantities

Length

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

Coordinate measuring technology

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

Thermodynamic quantities

Temperature quantities

- **Resistance thermometers**
- **Thermocouples**
- **Direct reading thermometers**

[a)] on permanent laboratory and on-site calibration

Abbreviations used: see last page

Permanent Laboratory

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability [1)]	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: 2018/04 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: $0.05\ \mu m + 0.3 \cdot 10^{-6} \cdot l$	l = gauge block length Measuring surface quality as stated in QMH rsp. in the test specifications.
			for the mean size: $0.05\ \mu m + 0.25 \cdot 10^{-6} \cdot l$	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		for the mean size: $0.05\ \mu m + 0.4 \cdot 10^{-6} \cdot l$	
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: 2017/06 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	$0.08\ \mu m + 0.4 \cdot 10^{-6} \cdot l$	l = gauge block length
Length of workpieces with planeparallel surfaces with optical measurement surface quality	10 mm to 2080 mm nominal size	I_DI_S_ALM_01_01_A_12: 2018/04 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
			$0.05\ \mu m + 0.15 \cdot 10^{-6} \cdot l$	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 $U(\alpha) \leq 0.05 \cdot 10^{-6}\ K^{-1}$
			$0.05\ \mu m + 0.25 \cdot 10^{-6} \cdot l$	material: steel with an uncertainty of the coefficient of linear thermal expansion $U(\alpha) \leq 0.1 \cdot 10^{-6}\ K^{-1}$
			$0.05\ \mu m + 0.3 \cdot 10^{-6} \cdot l$	material: steel
			$0.05\ \mu m + 0.4 \cdot 10^{-6} \cdot l$	material: ceramics

[1)] The best measurement capabilities are stated according to EA-4/02. These are expanded uncertainties of measurement with a coverage probability of 95% and have a coverage factor of k = 2 unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability [1]	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 lenght at the calibration object: 1450 mm	I_DI_S_ALM_01_01_A_25: 2018/04 Measurement of length and temperature changes and mathematical derivation of the thermal expansion coefficient CTE	$U_{CTE}(t) = 0.02 \cdot 10^{-6}\ K^{-1} + 1.5 \cdot 10^{-3} \cdot CTE + (0.027 \cdot 10^{-6}\ K^{-1}\ m) / L$ 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: $U_{CTE}(t) = 0.07 \cdot 10^{-6}\ K^{-1}$ for steel: L = 1 m $U_{CTE}(t) = 0.09 \cdot 10^{-6}\ K^{-1}$ for steel: L = 0.5 m
Step gauge blocks	to 2080 mm	I_DI_S_ALM_01_01_A_06: 2018/03 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: $0.03\ \mu m + 0.09 \cdot 10^{-6} \cdot l$ bidirectional probing: $0.04\ \mu m + 0.09 \cdot 10^{-6} \cdot l$	l = step length; 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 2080 mm	I_DI_S_ALM_01_01_A_06: 2018/03 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: $0.03\ \mu m + 0.14 \cdot 10^{-6} \cdot l$ bidirectional probing: $0.04\ \mu m + 0.14 \cdot 10^{-6} \cdot l$	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: $0.03\ \mu m + 0.18 \cdot 10^{-6} \cdot l$ bidirectional probing: $0.04\ \mu m + 0.18 \cdot 10^{-6} \cdot l$	material: steel
	to 2500 mm	I_DI_S_ALM_01_01_A_06: 2018/03 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 $U(\alpha) \le 0.05 \cdot 10^{-6}\ K^{-1}$

[1] The best measurement capabilities are stated according to EA-4/02. These are expanded uncertainties of measurement with a coverage probability of 95% and have a coverage factor of k = 2 unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability [1]	Remarks
Step gauge blocks	to 2500 mm	I_DI_S_ALM_01_01_A_06: 2018/03 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 $U(\alpha) \leq 0.1 \cdot 10^{-6}\ K^{-1}$
			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
	to 1100 mm	I_DI_S_ALM_01_01_A_24: 2017/12 Measurement of the mean size with a coordinate measuring machine in comparison with a step gauge block of the same nominal size	$0.1\ \mu m + 0.4 \cdot 10^{-6} \cdot l$	l = step length
Setting ring and plug gauges; inside and outside cylinder Diameter	3 mm to 400 mm	I_DI_S_ALM_01_01_A_07: 2017/06 and DAkkS-DKD-R 4-3 part 4.1:2010 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 $\lvert\alpha\rvert \leq 0.05 \cdot 10^{-6}\ K^{-1}$ and its uncertainty $U(\alpha) \leq 0.05 \cdot 10^{-6}\ K^{-1}$
Setting ring and plug gauges; inside and outside cylinder Diameter	3 mm to 400 mm	I_DI_S_ALM_01_01_A_07: 2017/06 and DAkkS-DKD-R 4-3 part 4.1:2010 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 $U(\alpha) \leq 0.1 \cdot 10^{-6}\ K^{-1}$
			$0.08\ \mu m + 0.3 \cdot 10^{-6} \cdot d$	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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Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability [1]	Remarks
Roundness deviation	3 mm to 400 mm	Talyrond 61 with Multiple layer procedure	0.015 µm + 7 · 10^{-2} · RONt	RONt = 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 · STRt	STRt = straightness deviation
Parallelism deviation of surface lines	axial lenght		0.4 µm + 0.1 · STRt	
Straightness deviation of surface lines	> 100 mm to 500 mm		0.8 µm + 0.1 · STRt	
Parallelism deviation of surface lines	axial lenght		1.0 µm + 0.1 · STRt	
Setting ring and plug gauges; inside and outside cylinder		I_DI_S_ALM_01_01_A_11: 2018/03 and DAkkS-DKD-R 4-3 part 4.1:2010		
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 · RONt	RONt = roundness deviation
Balls		I_DI_S_ALM_01_01_A_07: 2017/06		d = diameter
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	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 $U(\alpha) \le 0.05 \cdot 10^{-6}\ K^{-1}$
Balls		I_DI_S_ALM_01_01_A_07: 2017/06		d = diameter
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 + 0.25 · 10^{-6} · d	material: steel with an uncertainty of the coefficient of linear thermal expansion $U(\alpha) \le 0.1 \cdot 10^{-6}\ K^{-1}$
			0.08 µm + 0.3 · 10^{-6} · d	material: steel
			0.08 µm + 0.4 · 10^{-6} · d	material: ceramics

[1] The best measurement capabilities are stated according to EA-4/02. These are expanded uncertainties of measurement with a coverage probability of 95% and have a coverage factor of k = 2 unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability [1]	Remarks
Balls Diameter	2 mm to 200 mm	I_DI_S_ALM_01_01_A_08: 2017/06 Measurement with coordinate measuring machines	0.7 µm + 2 · 10^{-6} · d	d = diameter
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 plates and hole plates	to 800 mm Axially distance between ball and hole center points	I_DI_S_ALM_01_01_A_14: 2017/06		l = distance between ball and hole center points
		Comparison with ball bar made of steel	0.65 µm + 1.1 · 10^{-6} · l	material: steel
		Comparison with ball bar made of zerodur	0.65 µm + 0.9 · 10^{-6} · l	material: steel
			0.65 µm + 0.4 · 10^{-6} · 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}
		Comparison with flat mirror laser interferometer	0.5 µm + 0.9 · 10^{-6} · l	material: steel
			0.5 µm + 0.5 · 10^{-6} · l	material: invar
			0.5 µm + 0.4 · 10^{-6} · 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}

[1] The best measurement capabilities are stated according to EA-4/02. These are expanded uncertainties of measurement with a coverage probability of 95% and have a coverage factor of k = 2 unless stated otherwise. Uncertainties without unit are relative uncertainties referring to the measurement value unless stated otherwise.

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability [1)]	Remarks
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		l = distance between ball and hole center points
		Measurement with flat mirror laser interferometer with mechanical probing of the measurement surface	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 $\lvert\alpha\rvert \leq 0.05 \cdot 10^{-6}\ K^{-1}$ and its uncertainty $U(\alpha) \leq 0.05 \cdot 10^{-6}\ K^{-1}$
Temperature quantities Resistance thermometers (SPRT only), as a measuring chain with display	0.01 °C	I_DI_S_ALM_01_01_A_19: 2017/06 Triple point of water	2 mK	Calibration at temperature fixed points of ITS-90
	29.7646 °C	I_DI_S_ALM_01_01_A_18: 2017/06 Melting point of gallium	2 mK	
Resistance thermometers (Pt-100), as a measuring chain with display	0.01 °C	I_DI_S_ALM_01_01_A_19: 2017/06 Triple point of water	5 mK	Calibration at temperature fixed points of ITS-90
	29.7646 °C	I_DI_S_ALM_01_01_A_18: 2017/06 Melting point of gallium	5 mK	
Resistance thermometers (Pt-100 and SPRT), as a measuring chain with display (Precision thermometer)	0 °C to 45 °C	I_DI_S_ALM_01_01_A_17: 2017/06 and DAkkS-DKD-R 5-1:2010	10 mK	Comparison with standard resistance thermometers in thermostatic bathes
Resistance thermometers with connected evaluation electronics (portable measuring instrument)	3 °C to 45 °C	I_DI_S_ALM_01_01_A_16: 2017/06 and DAkkS-DKD-R 5-3:2010	0.1 K	Comparison with resistance thermometers in thermostatic bathes
Thermocouples with connected evaluation electronics (portable measuring instrument)	3 °C to 45 °C	I_DI_S_ALM_01_01_A_16: 2017/06 and DAkkS-DKD-R 5-3:2010	0.3 K	

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Permanent laboratory and On-side calibration

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability [1)]	Remarks
Coordinate measuring technology Coordinate measuring machines using a contacting probing system and control software CALYPSO, CMM-OS and UMESS UX (Software of Carl Zeiss Industrielle Messtechnik GmbH)	Coordinate measureing machines featuring a measuring volume with a space diagonal ≤ 3750 mm	I_DI_S_ALM_01_01_A_15: 2017/06 Calibration of metrological characteristics according to guideline: DAkkS-DKD-R 4-3: part 18.1:2010 DIN EN ISO 10360 VDI/VDE 2617 Probing error P and error of indication for size measurement E for tactile discrete-point probing are determined.		
		The error of indication of size measurement E_0 and E_{150} is determined using steel or glass ceramics step gauges according to DIN EN ISO 10360-2:2010	for l to 2000 mm 0.08 µm + 0.15 · 10^{-6} · l	
		Determination of repeatability range R_0 using steel or glass ceramics step gauges according to DIN EN ISO 10360-2:2010	0.06 µm	
		Determination of probing error P_{FTU} on a reference ball according to DIN EN ISO 10360-5:2011	0.08 µm	Measurement of a reference ball made of ceramics with a diameter of 25 mm
		Determination of the radial 4-axis deviation FR, of the tangential 4-axis deviation FT of two ball standards according DIN EN ISO 10360-3:2000	0.36 µm	The distance between ball and axis of rotary table is 206 mm
		Determination of the of the axial 4-axis deviation FA of two ball standards according	0.44 µm	
		Determination of scanning probing error THP and scanning-test time τ on a reference ball according to DIN EN ISO 10360-4:2003	0.08 µm 0.9 s	Measurement of a reference ball made of ceramics with a diameter of 25 mm

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Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability [1)]	Remarks
Coordinate measuring machines using a contacting probing system and control software Calypso, CMM-OS and UMESS UX (Software of Carl Zeiss Industrielle Messtechnik GmbH)	Coordinate measuring machines featuring a measuring volume with a space diagonal ≤ 3750 mm	Determination of multiple stylus form error P_{FTM} on a reference ball according to DIN EN ISO 10360-5:2011	0.08 µm	Measurement of a reference ball made of ceramics with a diameter of 25 mm
		Determination of multiple stylus size error P_{STM} on a reference ball according to DIN EN ISO 10360-5:2011	0.1 µm	
		Determination of multiple stylus location error P_{LTM} on a reference ball according to DIN EN ISO 10360-5:2011	0.08 µm	

Abbreviations used:

DAkkS-DKD-R	Guideline of Deutsche Akkreditierungsstelle GmbH
VDI/VDE 2617	Guideline: Accuracy of coordinate measuring machines
I_DI_S	Calibration instruction of the Carl Zeiss Industrielle Messtechnik GmbH

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