Deutsche Akkreditierungsstelle

Annex to the Accreditation Certificate D-K-18351-01-00 according to DIN EN ISO/IEC 17025:2018

Valid from: **17.10.2023**

Date of issue: 17.10.2023

Holder of accreditation certificate:

ZwickRoell GmbH & Co. KG
August-Nagel-Straße 11, 89079 Ulm

Calibrations at the locations:

August-Nagel-Straße 11, 89079 Ulm

Parc Empresarial Trade Center, Avda Corts Catalanes 5-7 planta 2a Local 1, E-08173 Sant Cugat del Valles (Barcelona), Spain

18 Boon Lay Way, #06-105/106, TradeHub 21, Singapore 609966

Via Renata Bianchi, 40 (3° piano), I-16152 Genova, Italy

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 confirm generally with the principles of DIN EN ISO 9001.

Calibrations in the fields:

Mechanical quantities

Material testing machines (MTM)

- **Force (MTM)** a)
- **Extension (MTM)** a)
- **Mechanical work (MTM)** a)
- **Hardness (MTM)** a)
- **Torque (MTM)** a)
- **Angle of rotation (MTM)** a)
- **Velocity (MTM)** a)
- **Temperature (MTM)** a

Thermodynamic quantities

Temperature quantities

- **Climatic chambers (temperature)** a)
- **Direct reading thermometers** a)

a) on site calibrations

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.

August-Nagel-Straße 11, 89079 Ulm

On-site calibration Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Force (MTM) *) Force measuring devices of materials testing machines according to DIN 51220	1 N to 600 kN	DIN EN ISO 7500-1:2018 with supplementary sheet 1 to 3:1999 Supplementary sheet 4:2013 DIN EN ISO 7500-2:2007 QI-D-013:2020 DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2: 2018 DIN EN ISO 6508-2:2015 DIN EN ISO 4545-2: 2018 DIN EN ISO 2039-1:2003 DIN EN ISO 14577-2:2015 ASTM E10:2018 ASTM E92:2017 ASTM E384:2017 ASTM E18:2020 ASTM F36:2015 ASTM E4:2020 ASTM E1012:2019	0,12 %	Force transducer Class 0.5 tensile / compression
	200 N to 3000 kN		0,12 %	Force transducer Class 0.5 tensile
	200 N to 5000 kN		0,12 %	Force transducer Class 0.5 compression
	0,02 N to 200 N		0,10 %	Known masses tensile / tensile and compression
Force (MTM) Contact force of falling masses of a drop weight tester	10 N to 50 kN	QI-D-012:2021	0,12 %	Force transducer Class 0.5 compression
Extension (MTM) *) Extension measuring devices of materials testing machines according to DIN 51220	0 mm to 60 mm	DIN EN ISO 9513:2013 DIN EN ISO 6508-2:2015 DIN EN ISO 2039-1:2003 DIN EN ISO 14577-2:2015 DIN EN ISO 527-1:2019 ASTM F36:2015 ASTM E83:2023 ASTM E2309:2020	$1{,}5 \cdot 10^{-3} \cdot l$; but not < 0,5 µm	Measuring principle: incremental probe (CP60/CT6002)
	0 mm to 12 mm		$2 \cdot 10^{-3} \cdot l$; but not < 2 µm	Measuring principle: incremental probe (MT 12)
	0 mm to 12 mm		$1{,}5 \cdot 10^{-3} \cdot l$; but not < 0,5 µm	Measuring principle: incremental probe (MT 1201)
	0 mm to 205 mm		$2 \cdot 10^{-3} \cdot l$; but not < 5 µm	Measuring principle: probe on basis of magnet technology
	0 mm to 1500 mm		$2 \cdot 10^{-3} \cdot l$; but not < 4 µm	Measuring principle: Rotary encoder with incremental divide
	1,1 mm to 100 mm		$1{,}5 \cdot 10^{-3} \cdot l$; but not < 0,5 µm	Gauge blocks class 1
Extension (MTM) Extension measuring devices of cross section measuring devices	1,1 mm to 100 mm	QI-D-010:2019	$1{,}5 \cdot 10^{-3} \cdot l$; but not < 0,5 µm	Gauge blocks class 1 *l:* measured length

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On-site calibration Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Extension (MTM) Determination of the height of fall on a drop weight tester	10 mm to 5000 mm	QI-D-012:2021	$1{,}5 \cdot 10^{-3} \cdot l$	Measuring principle: Rotary encoder with incremental divide
Dimensions of the impactor and sample holder on a drop weight tester	10 mm to 300 mm	QI-D-012:2021	$1{,}5 \cdot 10^{-3} \cdot l$; but not < 0,03 mm	Calipers, outside micrometers
Optical indentation measuring devices of Hardness Testers *	0 mm to 6 mm	DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2:2018 DIN EN ISO 4545-2:2018 ASTM E10:2018 ASTM E92:2017 ASTM E384:2017	$1{,}5 \cdot 10^{-3} \cdot l$; but not < 0,5 µm	Measuring principle: Object micrometer in incident light *l:* measured length
Depth measuring device of Hardness Testers *	0 mm to 0,8 mm	DIN EN ISO 6508-2:2015 ASTM E18:2020	$1{,}5 \cdot 10^{-3} \cdot l$; but not < 0,5 µm	Measuring principle: incremental probe
Hardness (MTM) * Hardness Testers according to Brinell-, Vickers-, Rockwell-, Knoop- and Martens test procedure	100 HB to 550 HB	DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2:2018 DIN EN ISO 6508-2:2015 DIN EN ISO 4545-2:2018 DIN EN ISO 2039-1:2003 ASTM E10:2018 ASTM E92:2017 ASTM E384:2017 ASTM E18:2020 ASTM F36:2015	2 % HB	The values indicated for the measurement uncertainty are valid for the indirect verification with hardness comparison plates. The measurement uncertainty of the individual parameters of the direct verification is indicated separately. U_{CRM} = calibration uncertainty of the hardness comparison plate
	30 HV to 950 HV (Hardness scales HV5 to HV100) (Hardness scales HV0,01 to HV3)		1 % HV, but not < $1{,}5 \cdot U_{CRM}$ 2 % HV, but not < $1{,}5 \cdot U_{CRM}$	
	100 HK to 950 HK (Hardness scales HK 0,01 to HK 2)		2 % HK, but not < $1{,}5 \cdot U_{CRM}$	
	20 HRA to 65 HRA		1,0 HRA	
	66 HRA to 95 HRA		0,5 HRA	
	10 HRB to 55 HRB		1,5 HRB	
	56 HRB to 100 HRB		1,0 HRB	
	20 HRC to 55 HRC		1,0 HRC	
	56 HRC to 70 HRC		0,5 HRC	
	40 HRD to 69 HRD		1,5 HRD	
	70 HRD to 77 HRD		1,0 HRD	
	60 HRF to 100 HRF		1,0 HRF	
	20 HRN to 60 HRN		1,0 HRN	
	61 HRN to 91 HRN		0,5 HRN	
	12 HRT to 93 HRT		2,0 HRT	

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On-site calibration Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Mechanical Work (MTM) * Pendulum Impact Testers and Impact Testing Devices	0,2 J to 750 J	DIN EN-ISO 148-2:2017 DIN EN ISO 13802:2016 DIN 51222:2017 DIN 53435:2018 DIN 53512:2000 ISO 4662:2017 ASTM E23:2023a	Force: 0.12 % Pendulum length: 0.17 mm Angle: 0.03° Time: 0.02 s	The measurement uncertainty is calculated for: 1. Position of centre of percussion, 2. Potential energy, 3. Error of the indicated energy.
Torque (MTM) Torque measuring devices of materials testing machines according to DIN 51220	0,2 N·m to 2000 N·m	QI-D-005: 2018	0,30 %	With torque transducers (clockwise and counterclockwise torque)
	0,02 N·m to 20 N·m		0,30 %	Known masses tensile in combination with lever arm
Angle of rotation (MTM) Measuring devices for angle of rotation on materials testing machines according to DIN 51220	1° to 360°	QI-D-006:2018	$3 \cdot 10^{-3} \cdot W$	Measuring principle: incremental W: measured angle
Velocity (MTM) Traverse speed of materials testing machines according to DIN 51220*	0,1 mm/min to 2000 mm/min	ASTM E2658:2015	0,3 %	Measuring principle: Start/Stop-Method of distance and time using an automatically controlled stopwatch and gauge blocks
	0,1 mm/min to 500 mm/min		1,0%	Measuring principle: Start/Stop-Method of distance and time using a manually controlled stopwatch
Speed measurement of drop weight tester	1 m/s to 25 m/s	QI-D-007:2021 Procedure Chapter 3	0,3 %	Clock counter and tracible measurement of the light barrier flag

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On-site calibration Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Temperature * Measuring locations in climatic chambers with air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method C Measurement in air	0,2 K	Comparison with reference thermometer
	> −40 °C to 0 °C		0,15 K	
	> 0 °C to 100 °C		0,10 K	
	> 100 °C to 150 °C		0,15 K	
	> 150 °C to 200 °C		0,25 K	
	> 200 °C to 250 °C		0,35 K	
Climate chamber with air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method A and B Measurement in air	0,5 K	Comparison with reference thermometer
	> −40 °C to 0 °C		0,4 K	
	> 0 °C to 100 °C		0,2 K	
	> 100 °C to 150 °C		0,4 K	
	> 150 °C to 200 °C		0,6 K	
	> 200 °C to 250 °C		1,7 K	
Measuring locations in climatic chambers without air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method C Measurement in air	0,5 K	Comparison with reference thermometer
	> −40 °C to 0 °C		0,4 K	
	> 0 °C to 100 °C		0,3 K	
	> 100 °C to 150 °C		0,4 K	
	> 150 °C to 200 °C		0,5 K	
	> 200 °C to 250 °C		0,8 K	
Climate chamber without air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method A and B Measurement in air	3,0 K	Comparison with reference thermometer
	> −40 °C to 0 °C		2,0 K	
	> 0 °C to 100 °C		2,2 K	
	> 100 °C to 150 °C		3,0 K	
	> 150 °C to 200 °C		3,5 K	
	> 200 °C to 250 °C		5,0 K	
Direct reading thermometers with thermocouple sensor	150 °C to 300 °C	DKD-R 5-3: 2018 in dry block calibrator	2,8 K	Comparison with reference thermometer
	> 300 °C to 600 °C		3,5 K	
	> 600 °C to 900 °C		4,3 K	
	> 900 °C to 1200 °C		5,5 K	

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Force (MTM) Devices for determining the melt mass flow rate (MFR) and the melt volume flow rate (MVR) of thermoplastics	1 N to 2500 N	QI-D-015:2020	0,12 %	Force transducer Class 0.5 compression Devices according to DIN EN ISO 1133-1:2012 DIN EN ISO 1133-2:2012 ASTM D1238:2020
Devices for determining the Vicat softening temperature (VST) and HDT heat deflection temperature	0,1 N to 50 N	QI-D-014:2020	0,1 %	Comparative measurement using class F1 weights Devices according to DIN EN ISO 306:2014 DIN EN ISO 75-1:2020
Extension (MTM) Devices for determining the melt mass flow rate (MFR) and the melt volume flow rate (MVR) of thermoplastics	0 mm to 60 mm	QI-D-015:2020	$1{,}5 \cdot 10^{-3} \cdot l$; but not < 0,5 µm	incremental probe (CT6002) Devices according to DIN EN ISO 1133-1:2012 DIN EN ISO 1133-2:2012 ASTM D1238:2020
	1,1 mm to 50 mm		$1{,}5 \cdot 10^{-3} \cdot l$; but not < 6 µm	Gauge blocks class 1 Devices according to DIN EN ISO 1133-1:2012 DIN EN ISO 1133-2:2012 ASTM D1238:2020
Devices for determining the Vicat softening temperature (VST) and HDT heat deflection temperature	0,2 mm to 50 mm	QI-D-014:2020	$1{,}5 \cdot 10^{-3} \cdot l$; but not < 6 µm	Gauge blocks class 1 Devices according to DIN EN ISO 306:2014 DIN EN ISO 75-1:2020 *l:* measured length
Temperature (MTM) * Devices for determining the melt mass flow rate (MFR) and the melt volume flow rate (MVR) of thermoplastics	100°C to 400°C	DKD-R 5-1:2018	0,25 K	Comparison with standard thermometers
Devices for determining the Vicat softening temperature (VST) and HDT heat deflection temperature	20° C to 300 °C		0,4 K	Comparative measurement in oil baths against reference thermometer

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On-site calibration

Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range			Measurement conditions / procedure	Best measurement capability	Remarks
Force (MTM) * Force measuring devices of materials testing machines according to DIN 51220	1 N	to	600 kN	DIN EN ISO 7500-1:2018 with supplementary sheet 1 to 3:1999 Supplementary sheet 4:2013 DIN EN ISO 7500-2:2007 DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2:2018 DIN EN ISO 6508-2:2015 DIN EN ISO 4545-2:2018 DIN EN ISO 2039-1:2003 ASTM E10:2018 ASTM E92:2017 ASTM E384:2017 ASTM E18:2020 ASTM F36:2015 ASTM E4:2020	0,12 %	Force transducer Class 0.5 tensile / compression
	200 N	to	3000 kN		0,12 %	Force transducer Class 0.5 tensile
	200 N	to	5000 kN		0,12 %	Force transducer Class 0.5 compression
	0,02 N	to	200 N		0,10 %	Known masses tensile / compression
Extension (MTM) * Extension measuring devices of materials testing machines according to DIN 51220	0 mm	to	60 mm	DIN EN ISO 9513:2013 DIN EN ISO 6508-2:2015 DIN EN ISO 2039-1:2003 DIN EN ISO 527-1:2019 ASTM F36:2015 ASTM E83:2023 ASTM E2309:2020	$1,5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: incremental probe (CP60/CT6002)
	0 mm	to	12 mm		$2 \cdot 10^{-3} \cdot l$; but not <2 µm	Measuring principle: incremental probe (MT 12)
	0 mm	to	12 mm		$1,5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: incremental probe (MT 1201)
	0 mm	to	205 mm		$2 \cdot 10^{-3} \cdot l$; but not < 5 µm	Measuring principle: probe on basis of magnet technology
	0 mm	to	1500 mm		$2 \cdot 10^{-3} \cdot l$; but not <4 µm	Measuring principle: Rotary encoder with incremental divide
	1,1 mm	to	100 mm		$1,5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Gauge blocks class 1
Extension (MTM) Extension measuring devices of cross section measuring devices	1,1 mm	to	100 mm	QI-D-010:2019	1,5 · 10-3 · l; but not < 0,5 µm	Gauge blocks class 1
Optical indentation measuring devices of Hardness Testers *	0 mm	to	6 mm	DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2:2018 DIN EN ISO 4545-2:2018 ASTM E10:2018 ASTM E92:2017 ASTM E384:2017	$1,5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: Object micrometer in incident light *l:* measured length
Depth measuring device of Hardness Testers*	0 mm	to	0,8 mm	DIN EN ISO 6508-2:2015 ASTM E18:2020	$1,5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: incremental probe

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On-site calibration

Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Mechanical Work (MTM) * Pendulum Impact Testers and Impact Testing Devices	0,2 J to 750 J	DIN EN-ISO 148-2:2017 DIN EN ISO 13802:2016 DIN 51222:2017 DIN 53435:2018 DIN 53512:2000 ASTM E23:2023a	Kraft: 0,12 % Pendellänge: 0,17 mm Winkel: 0,03° Zeit: 0,02 s	The measurement uncertainty is calculated for: 1. Position of centre of percussion, 2. Potential energy, 3. Error of the indicated energy.
Velocity (MTM) * Traverse speed of materials testing machines according to DIN 51220	0,1 mm/min to 500 mm/min	ASTM E2658:2015	1,0 %	Measuring principle: Start/Stop-Method of distance and time using a manually controlled stopwatch
Hardness (MTM) * Hardness Testers according to Brinell-, Vickers-, Knoop-, and Rockwell test procedure	100 HB to 550 HB	DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2:2018 DIN EN ISO 6508-2:2015 DIN EN ISO 4545-2:2018 DIN EN ISO 2039-1:2003 ASTM E10:2018 ASTM E92:2017 ASTM E384:2017 ASTM E18:2020 ASTM F36:2015	2 % HB	The values indicated for the measurement uncertainty are valid for the indirect verification with hardness comparison plates. The measurement uncertainty of the individual parameters of the direct verification is indicated separately. U_{CRM} = calibration uncertainty of the hardness comparison plate
	30 HV to 950 HV (Hardness scales HV5 to HV100) (Hardness scales HV0,01 to HV3)		1 % HV, but not < 1,5 · U_{CRM} 2 % HV, but not < 1,5 · U_{CRM}	
	100 HK to 950 HK (Hardness scales HK 0,01 to HK 2)		2 % HK, but not < 1,5 · U_{CRM}	
	20 HRA to 65 HRA		1,0 HRA	
	66 HRA to 95 HRA		0,5 HRA	
	10 HRB to 55 HRB		1,5 HRB	
	56 HRB to 100 HRB		1,0 HRB	
	20 HRC to 55 HRC		1,0 HRC	
	56 HRC to 70 HRC		0,5 HRC	
	40 HRD to 69 HRD		1,5 HRD	
	70 HRD to 77 HRD		1,0 HRD	
	60 HRF to 100 HRF		1,0 HRF	
	20 HRN to 60 HRN		1,0 HRN	
	61 HRN to 91 HRN		0,5 HRN	
	12 HRT to 93 HRT		2,0 HRT	

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Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Temperature * Measuring locations in climatic chambers with air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method C Measurement in air	0,25 K	Comparison with reference thermometer
	> −40 °C to 0 °C		0,25 K	
	> 0 °C to 100 °C		0,20 K	
	> 100 °C to 150 °C		0,25 K	
	> 150 °C to 200 °C		0,70 K	
	> 200 °C to 250 °C		0,70 K	
Climate chamber with air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method A and B Measurement in air	0,5 K	Comparison with reference thermometer
	> −40 °C to 0 °C		0,4 K	
	> 0 °C to 100 °C		0,2 K	
	> 100 °C to 150 °C		0,4 K	
	> 150 °C to 200 °C		0,9 K	
	> 200 °C to 250 °C		1,7 K	
Measuring locations in climatic chambers without air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method C Measurement in air	0,6 K	Comparison with reference thermometer
	> −40 °C to 0 °C		0,5 K	
	> 0 °C to 100 °C		0,6 K	
	> 100 °C to 150 °C		0,8 K	
	> 150 °C to 200 °C		1,0 K	
	> 200 °C to 250 °C		1,5 K	
Climate chamber without air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method A and B Measurement in air	3,0 K	Comparison with reference thermometer
	> −40 °C to 0 °C		2,0 K	
	> 0 °C to 100 °C		2,2 K	
	> 100 °C to 150 °C		3,0 K	
	> 150 °C to 200 °C		3,5 K	
	> 200 °C to 250 °C		5,0 K	

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On-site calibration Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Force (MTM) *) Force measuring devices of materials testing machines according to DIN 51220	1 N to 600 kN	DIN EN ISO 7500-1:2018 with supplementary sheet 1 to 3:1999 Supplementary sheet 4:2013 DIN EN ISO 7500-2:2007 ASTM E4:2020 DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2:2018 DIN EN ISO 6508-2:2015 DIN EN ISO 4545-2:2018 DIN EN ISO 2039-1:2003 ASTM E10:2018 ASTM E92:2017 ASTM E384:2017 ASTM E18:2020 ASTM F36:2015	0,12 %	Force transducer Class 0.5 tensile / compression
	200 N to 3000 kN		0,12 %	Force transducer Class 0.5 tensile
	200 N to 5000 kN		0,12 %	Force transducer Class 0.5 compression
	0,02 N to 200 N		0,10 %	Known masses tensile / compression
Extension (MTM) *) Extension measuring devices of materials testing machines according to DIN 51220	0 mm to 60 mm	DIN EN ISO 9513:2013 DIN EN ISO 6508-2:2015 DIN EN ISO 2039-1:2003 DIN EN ISO 527-1:2019 ASTM E83:2023 ASTM E2309:2020 ASTM F36:2015	$1{,}5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: incremental probe (CP60/CT6002)
	0 mm to 12 mm		$2 \cdot 10^{-3} \cdot l$; but not <2 µm	Measuring principle: incremental probe (MT 12)
	0 mm to 12 mm		$1{,}5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: incremental probe (MT 1201)
	0 mm to 205 mm		$2 \cdot 10^{-3} \cdot l$; but not < 5 µm	Measuring principle: probe on basis of magnet technology
	0 mm to 1500 mm		$2 \cdot 10^{-3} \cdot l$; but not <4 µm	Measuring principle: Rotary encoder with incremental divide
	1,1 mm to 100 mm		$1{,}5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Gauge blocks class 1
Extension measuring devices of cross section measuring devices	1,1 mm to 100 mm	QI-D-010:2019	$1{,}5 \cdot 10^{-3} \cdot l$; but not < 0,5 µm	Gauge blocks class 1
Optical indentation measuring devices of Hardness Testers *	0 mm to 6 mm	DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2:2018 DIN EN ISO 4545-2:2018 ASTM E10:2018 ASTM E92:2017 ASTM E384:2017	$1{,}5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: Object micrometer in incident light *l:* measured length
Depth measuring device of Hardness Testers *	0 mm to 0,8 mm	DIN EN ISO 6508-2:2015 ASTM E18:2020	$1{,}5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: incremental probe

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On-site calibration Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Velocity (MTM) *) Traverse speed of materials testing machines according to DIN 51220	0,1 mm/min to 2000 mm/min	ASTM E2658:2015	0,3 %	Measuring principle: Start/Stop-Method of distance and time using an automatically controlled stopwatch and gauge blocks
	0,1 mm/min to 500 mm/min		1,0%	Measuring principle: Start/Stop-Method of distance and time using a manually controlled stopwatch
Mechanical Work (MTM) * Pendulum Impact Testers and Impact Testing Devices	0,2 J to 750 J	DIN EN-ISO 148-2:2017 DIN EN ISO 13802:2016 DIN 51222:2017 DIN 53435:2018 DIN 53512:2000 ISO 4662:2017 ASTM E23:2023a	Kraft: 0,12 % Pendellänge: 0,17 mm Winkel: 0,03° Zeit: 0,02 s	The measurement uncertainty is calculated for: 1. Position of centre of percussion, 2. Potential energy, 3. Error of the indicated energy.
Hardness (MTM) * Hardness Testers according to Brinell-, Vickers-, Knoop-, and Rockwell test procedure	100 HB to 550 HB	DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2:2018 DIN EN ISO 6508-2:2015 DIN EN ISO 4545-2:2018 DIN EN ISO 2039-1:2003 ASTM E10:2018 ASTM E92:2017 ASTM E384:2017 ASTM E18:2020 ASTM F36:2015	2 % HB	The values indicated for the measurement uncertainty are valid for the indirect calibration with hardness comparison plates. The measurement uncertainty of the individual parameters of the direct calibration is indicated separately. (U_{CRM} = calibration uncertainty of the hardness comparison plate)
	30 HV to 950 HV (Hardness scales HV5 to HV100) (Hardness scales HV0,01 to HV3)		1 % HV, but not < 1,5 · U_{CRM} 2 % HV, but not < 1,5 · U_{CRM}	
	100 HK to 950 HK (Hardness scales HK 0,01 to HK 2)		2 % HK, but not < 1,5 · U_{CRM}	
	20 HRA to 65 HRA		1,0 HRA	
	66 HRA to 95 HRA		0,5 HRA	
	10 HRB to 55 HRB		1,5 HRB	
	56 HRB to 100 HRB		1,0 HRB	
	20 HRC to 55 HRC		1,0 HRC	
	56 HRC to 70 HRC		0,5 HRC	
	40 HRD to 69 HRD		1,5 HRD	
	70 HRD to 77 HRD		1,0 HRD	
	60 HRF to 100 HRF		1,0 HRF	
	20 HRN to 60 HRN		1,0 HRN	
	61 HRN to 91 HRN		0,5 HRN	
	12 HRT to 93 HRT		2,0 HRT	

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On-site calibration Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Temperature * Measuring locations in climatic chambers with air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method C Measurement in air	0,2 K	Comparison with reference thermometer
	> −40 °C to 0 °C		0,15 K	
	> 0 °C to 100 °C		0,10 K	
	> 100 °C to 150 °C		0,15 K	
	> 150 °C to 200 °C		0,25 K	
	> 200 °C to 250 °C		0,35 K	
Climate chamber with air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method A and B Measurement in air	0,5 K	Comparison with reference thermometer
	> −40 °C to 0 °C		0,4 K	
	> 0 °C to 100 °C		0,2 K	
	> 100 °C to 150 °C		0,4 K	
	> 150 °C to 200 °C		0,6 K	
	> 200 °C to 250 °C		1,7 K	
Measuring locations in climatic chambers without air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method C Measurement in air	0,5 K	Comparison with reference thermometer
	> −40 °C to 0 °C		0,4 K	
	> 0 °C to 100 °C		0,3 K	
	> 100 °C to 150 °C		0,4 K	
	> 150 °C to 200 °C		0,5 K	
	> 200 °C to 250 °C		0,8 K	
Climate chamber without air circulation	−80 °C to −40 °C	DKD-R 5-7: 2018 Method A and B Measurement in air	3,0 K	Comparison with reference thermometer
	> −40 °C to 0 °C		2,0 K	
	> 0 °C to 100 °C		2,2 K	
	> 100 °C to 150 °C		3,0 K	
	> 150 °C to 200 °C		3,5 K	
	> 200 °C to 250 °C		5,0 K	
Direct reading thermometers with thermocouple sensor	150 °C to 300 °C	DKD-R 5-3: 2018 in dry block calibrator	2,8 K	Comparison with reference thermometer
	> 300 °C to 600 °C		3,5 K	
	> 600 °C to 900 °C		4,3 K	
	> 900 °C to 1200 °C		5,5 K	

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On-site calibration Calibration and measurement capabilities (CMC)

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability	Remarks
Force (MTM) * Force measuring devices of materials testing machines according to DIN 51220	1 N to 600 kN	DIN EN ISO 7500-1:2018 with supplementary sheet 1 to 3:1999 Supplementary sheet 4:2013 DIN EN ISO 7500-2:2007 ASTM E4:2020	0,12 %	Force transducer Class 0.5 tensile / compression
	200 N to 3000 kN		0,12 %	Force transducer Class 0.5 tensile
	200 N to 5000 kN		0,12 %	Force transducer Class 0.5 compression
	0,02 N to 200 N		0,10 %	Known masses tensile / compression
Extension (MTM) * Extension measuring devices of materials testing machines according to DIN 51220	0 mm to 60 mm	DIN EN ISO 9513:2013 DIN EN ISO 527-1:2019 ASTM E83:2023 ASTM E2309:2020	$1{,}5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: incremental probe (CP60/CT6002)
	0 mm to 12 mm		$2 \cdot 10^{-3} \cdot l$; but not <2 µm	Measuring principle: incremental probe (MT 12)
	0 mm to 12 mm		$1{,}5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Measuring principle: incremental probe (MT 1201)
	0 mm to 205 mm		$2 \cdot 10^{-3} \cdot l$; but not < 5 µm	Measuring principle: probe on basis of magnet technology
	0 mm to 1500 mm		$2 \cdot 10^{-3} \cdot l$; but not <4 µm	Measuring principle: Rotary encoder with incremental divide
	1,1 mm to 100 mm		$1{,}5 \cdot 10^{-3} \cdot l$; but not <0,5 µm	Gauge blocks class 1 *l:* measured length
Velocity (MTM) * Traverse speed of materials testing machines according to DIN 51220	0,1 mm/min to 500 mm/min	ASTM E2658:2015	1,0 %	Measuring principle: Start/Stop-Method of distance and time using a manually controlled stopwatch

Abbreviations used:

ASTM	ASTM American Standard for Testing and Materials
DIN	Deutsches Institut für Normung e.V. (German Institut for Standardization)
EN	European Standard
ISO	International Organisation for Standardization
QI	Quality Instruction (In house calibration procedure of ZwickRoell GmbH & Co. KG)