

Deutsche Akkreditierungsstelle

Annex to the Partial Accreditation Certificate D-K-15015-01-02 according to DIN EN ISO/IEC 17025:2018

Valid from: 22.04.2024

Date of issue: 22.04.2024

This annex is a part of the accreditation certificate D-K-15015-01-00.

Holder of partial accreditation certificate:

Trescal GmbH
Borsigstraße 11, 64291 Darmstadt

with the locations

Trescal GmbH
Borsigstraße 11, 64291 Darmstadt

Trescal GmbH
Niederlassung Neustadt
Ernst-Abbe-Straße 18, 01844 Neustadt

Trescal GmbH
Niederlassung Esslingen
Limburgstraße 6, 73734 Esslingen

Trescal GmbH
Niederlassung Halver
Oststraße 7, 58553 Halver

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>.

Abbreviations used: see last page

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**Trescal GmbH
Niederlassung Braunschweig
Weinbergweg 36, 38106 Braunschweig**

**Trescal GmbH
Niederlassung Wetzlar
Friedenstraße 26, 35578 Wetzlar**

**Trescal GmbH
Niederlassung Ruhla
Bahnhofstraße 25, 99842 Ruhla**

**Trescal GmbH
Niederlassung Nürnberg
Poststraße 15a, 90471 Nürnberg**

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 principles of DIN EN ISO 9001.

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Calibration in the fields:

Thermodynamic quantities

Temperature quantities

- Temperature indicators and simulators ^{a)}
- Direct reading thermometers ^{a)}
- Resistance thermometers ^{a)}
- Thermocouples ^{a)}
- Temperature transmitters, data loggers
- Temperature block calibrators
- Climatic chambers (temperature) ^{b)}

Humidity quantities

- Devices for relative humidity
- Climatic chambers (humidity) ^{b)}

Mechanical quantities

- Force ^{a)}
- Pressure ^{a)}
- Acceleration
- Torque ^{a)}
- Weighing instruments ^{a)}
- Mass (mass standards)

Material testing machines (MTM)

- Hardness (MTM) ^{a)}
- Force (MTM) ^{b)}
- Extension (MTM) ^{b)}
- Velocity (MTM) ^{b)}
- Mechanical work (MTM) ^{b)}

Acoustical quantities

^{a)} also as on-site Calibration

^{b)} only 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.

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Darmstadt

Permanent Laboratory - Darmstadt

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|----------------------|---|-------------------------------------|---|
| Temperature quantities Temperature indicators for thermocouples * Type K and Type N | -200 °C to -100 °C | DKD-R 5-5:2018 with internal reference junction | 0.4 K | Characteristic curve according to DIN EN 60584-4:2014 |
| | > -100 °C to 120 °C | | 0.25 K | |
| | > 120 °C to 1000 °C | | 0.35 K | |
| | > 1000 °C to 1370 °C | | 0.5 K | |
| Type J | -210 °C to -100 °C | | 0.35 K | |
| | > -100 °C to 760 °C | | 0.25 K | |
| | > 760 °C to 1200 °C | | 0.3 K | |

On-Site Calibration – Darmstadt

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|----------------------|---|-------------------------------------|---|
| Temperature quantities Temperature indicators for thermocouples * Type K and Type N | -200 °C to -100 °C | DKD-R 5-5:2018 with internal reference junction | 0.4 K | Characteristic curve according to DIN EN 60584-4:2014 |
| | > -100 °C to 120 °C | | 0.25 K | |
| | > 120 °C to 1000 °C | | 0.35 K | |
| | > 1000 °C to 1370 °C | | 0.5 K | |
| Type J | -210 °C to -100 °C | | 0.35 K | |
| | > -100 °C to 760 °C | | 0.25 K | |
| | > 760 °C to 1200 °C | | 0.3 K | |

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Neustadt

Permanent Laboratory - Neustadt

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|------------------------|------------------------------------|-------------------------------------|--|
| Hardness (MTM) * for hardness scale | | DIN ISO 48-9:2021 | | direct measurement with reference standards for distance and force |
| Shore A | 0 Shore to 100 Shore | | 1 Shore | |
| Measuring range | 0 mm to 2.5 mm | | 2 μm | |
| Elastic force | 0 mN to 8050 mN | | 2 mN | |
| Bore diameter of pressure plate d_1 | 2.9 mm to 3.1 mm | | 5 μm | |
| Shaft diameter of indenter d_2 | 1.1 mm to 1.4 mm | | 5 μm | |
| Upper truncated diameter of truncated cone d_3 | 0.78 mm to 0.8 mm | | 3 μm | |
| Diameter of pressure plate D | 17.5 mm to 18.5 mm | | 10 μm | |
| Taper angle of indenter α | 34° 45' to 35° 15' | | 4' | |
| Shore D | 10 Shore to 100 Shore | | 1 Shore | |
| Measuring range | 0 mm to 2.5 mm | | 2 μm | |
| Elastic force | 0 mN to 44500 mN | | 3 mN | |
| Bore diameter of pressure plate d_1 | 2.9 mm to 3.1 mm | | 5 μm | |
| Shaft diameter of indenter d_2 | 1.1 mm to 1.4 mm | | 5 μm | |
| Radius of indenter r | 0.09 mm to 0.11 mm | | 3 μm | |
| Diameter of pressure plate D | 17.5 mm to 18.5 mm | | 10 μm | |
| Taper angle of indenter α | 29° 45' to 30° 15' | | 4' | |
| IRHD - N | 30 IRHD-N to 95 IRHD-N | | 1 IRHD - N | |
| Measuring range | 0 mm to 1.8 mm | | 2 μm | |
| Bore diameter of pressure plate d_1 | 5 mm to 7 mm | | 10 μm | |
| Ball diameter of indenter d_2 | 2.49 mm to 2.51 mm | | 3 μm | |
| Diameter of pressure plate D | 19 mm to 21 mm | | 20 μm | |
| Pre-load of indenter F_c | 0.28 N to 0.32 N | | 3 mN | |

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Permanent Laboratory - Neustadt

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|------------------------|---|---|--|
| IRHD - N | | DIN ISO 48-9:2021 | | direct measurement with reference standards for distance and force |
| Total force on indenter F_t | 5.67 N to 5.73 N | | 3 mN | |
| Force on pressure plate F_f | 6.8 N to 9.8 N | | 3 mN | |
| IRHD - L | 10 IRHD-L to 35 IRHD-L | | 1 IRHD - L | |
| Measuring range | 0 mm to 3.2 mm | | 2 μ m | |
| Bore diameter of pressure plate d_1 | 9 mm to 11 mm | | 10 μ m | |
| Ball diameter of indenter d_2 | 4.99 mm to 5.01 mm | | 3 μ m | |
| Diameter of pressure plate D | 21 mm to 23 mm | | 20 μ m | |
| Pre-load on indenter F_c | 0.28 N to 0.32 N | | 3 mN | |
| Total force on indenter F_t | 5.67 N to 5.73 N | | 3 mN | |
| Force on pressure plate F_f | 6.8 N to 9.8 N | | 3 mN | |
| IRHD - M | 30 IRHD-M to 95 IRHD-M | | 4.5 IRHD - M | |
| Measuring range | 0 mm to 0.3 mm | | 2 μ m | |
| Bore diameter of pressure plate d_1 | 0.85 mm to 1.15 mm | | 5 μ m | |
| Ball diameter of indenter d_2 | 0.39 mm to 0.4 mm | 3 μ m | | |
| Diameter of pressure plate D | 3.2 mm to 3.5 mm | 10 μ m | | |
| Pre-load on indenter F_c | 7.8 mN to 8.8 mN | 0.3 mN | | |
| Total force on indenter F_t | 152.3 mN to 154.3 mN | 0.3 mN | | |
| Force on pressure plate F_f | 205 mN to 265 mN | 0.3 mN | | |
| Pressure * | | | | |
| Absolute pressure p_{abs} | 0 bar to 2 bar | DKD-R 6-1:2014 | 0.15 mbar | Pressure medium: gas The uncertainty of the barometer has to be taken into account. |
| | > 2 bar to 121 bar | Method of calibration up to 2 bar: $p_{abs} = p_e + p_{amb}$ | $6.3 \cdot 10^{-5} \cdot p_{abs} + 0.45$ mbar | |
| | 1 bar; to 2 bar | DKD-R 6-1:2014 | $6.8 \cdot 10^{-5} \cdot p_{abs} + 0.35$ mbar | Pressure medium: oil The uncertainty of the barometer has to be taken into account. |
| | > 61 bar to 1201 bar | Method of calibration: $p_{abs} = p_e + p_{amb}$ | $9.7 \cdot 10^{-5} \cdot p_{abs} + 5.8$ mbar | |

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Permanent Laboratory - Neustadt

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|----------------------|------------------------------------|---|---|
| Negative and positive gauge pressure p_e | -1 bar to 1 bar | DKD-R 6-1:2014 | 0.11 mbar | Pressure medium: gas |
| | > 1 bar to 120 bar | | $6.3 \cdot 10^{-5} \cdot p_e + 0.45$ mbar | |
| Positive gauge pressure p_e | > 1 bar to 60 bar | | $6.8 \cdot 10^{-5} \cdot p_e + 0.35$ mbar | Pressure medium: oil |
| | > 60 bar to 1200 bar | | $9.7 \cdot 10^{-5} \cdot p_e + 5.8$ mbar | |
| Weighing instruments * Nonautomatic electronic weighing instruments | to 600 g | EURAMET/cg-18/v.4.0:2015 | $2 \cdot 10^{-6}$ | with weights according to OIML R 111-1:2004, class E ₂ |
| | to 180 kg | | $2 \cdot 10^{-5}$ | with weights according to OIML R 111-1:2004, class F ₁ |

On-Site Calibration - Neustadt

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|-----------|------------------------------------|-------------------------------------|---|
| Weighing instruments * Non automatic electronic weighing instruments | to 600 g | EURAMET/cg-18/v. 4.0:2015 | $2 \cdot 10^{-6}$ | with weights according to OIML R 111-1:2004, class E ₂ |
| | to 180 kg | | $2 \cdot 10^{-5}$ | with weights according to OIML R 111-1:2004, class F ₁ |

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Esslingen
Permanent Laboratory - Esslingen
Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|--|--|--|---|
| Pressure * Gauge pressure p_e | 0 bar to 1.6 bar > 1.6 bar to 10 bar > 10 bar to 172 bar > 172 bar to 500 bar | DKD-R 6-1:2014 | 0.18 mbar 1.8 mbar 18 mbar $2 \cdot 10^{-4} \cdot p_e$ | Pressure medium: gas |
| Absolute pressure p_{abs} | 1 bar to 1.6 bar > 1.6 bar to 10 bar > 10 bar to 172 bar | | 0.18 mbar 1.8 mbar 18 mbar | Pressure medium: gas The uncertainty of the barometer has to be taken into account. |
| Acceleration | For sinusoidal excitation and narrow-band evaluation methods (sine approximation), the amplitudes of vibration acceleration, vibration velocity and vibration displacement are unambiguously linked to one another by the vibration frequency. This is why vibration velocity sensors and vibration displacement sensors can be calibrated using the measurand acceleration as stated in the table in ranges of velocity and displacement - converted accordingly for the stated frequency ranges. | | | |
| Acceleration * | 0.1 m/s ² to 10 m/s ² | DKD-R 3-1: part 3:2020 Sinusoidal excitation 0.4 Hz to 160 Hz | 1 % / 1.4° | Sensor weight up to 1 kg Displacement amplitude up to 150 mm pk-pk Calibration result: - complex transfer coefficient (magnitude/phase) |
| | 10 m/s ² to 500 m/s ² | 10 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz | 1 % / 1° 1.5 % / 1.5° 2.5 % / 2° | Sensor weight up to 0.3 kg Displacement amplitude up to 10 mm pk-pk Calibration result: - complex transfer coefficient (magnitude /phase) |
| Measurement Amplifier * Charge amplifier transfer coefficient | Input charge 1 pC to 10 nC | DKD-R 3-2:2019 0.2 Hz to < 1 Hz 1 Hz to 5 kHz > 5 kHz to 10 kHz > 10 kHz to 20 kHz > 20 kHz to 50 kHz | 0.5 % / 0.7° 0.4 % / 0.5° 0.4 % / 1° 0.6 % / 2° 1 % / 5° | Complex amplification coefficient (magnitude /phase) |

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Permanent Laboratory - Esslingen

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|--|--|--|--|
| Voltage and IEPE amplifier transfer coefficient | 0.001 V/V to 1000 V/V | 0.2 Hz to 1 Hz > 1 Hz to 20 kHz > 20 kHz to 50 kHz | 0.4 % / 0.7° 0.3 % / 0.5° 1 % / 5° | |
| Vibration calibrator * | | | | |
| Acceleration amplitude for frequency range of 20 Hz – 1 kHz | 1 m/s ² to 20 m/s ² | DIN ISO 16063-44:2019 | 1.1 % | Magnitude |
| Frequency | 20 Hz to 1 kHz | | 5 · 10 ⁻⁴ · f, but not less than 0.1 Hz | f = measured frequency |
| Harmonic distortion | 20 Hz to 1 kHz | | 10 % (THD) | THD: Total Harmonic Distortion |
| Torque * | | | | |
| Hand torque assembly tools, triggering / indicating | 1 N·m to 1000 N·m | DIN EN ISO 6789-2:2017 | 1 · 10 ⁻² | |
| Force * | | | | |
| Force sensors Force measuring devices | 50 N to 250 kN | DIN EN ISO 376:2011, DKD-R 3-3:2018 | 9 · 10 ⁻⁴ | Compression and tension force, 50 kN- and 250-kN-K-BNME with reference sensors 500 N, 2 kN, 10 kN, 50 kN, 250 kN |
| Hand force measuring devices | 50 N to 1000 N | DKD-R 3-3:2018 Method C | 0.5 % | Compression and tension force, 50-kN- and 250-kN-K-BNME with reference force sensors 500 N, 2 kN |
| Acoustical quantities* | | | | |
| Free field effective sensitivity level of ¼" and ½" measuring microphones | 125 Hz to < 250 Hz 250 Hz to 8 kHz > 8 kHz to 10 kHz > 10 kHz to 20 kHz | DIN EN 61094-8:2013 Substitution method in an anechoic chamber with ½" standard microphone at sound pressure level 74 dB to 94 dB | 0.35 dB 0.35 dB 0.45 dB 0.50 dB | |
| Free field frequency response of sound calibrators | 125 Hz to < 250 Hz 250 Hz to 8 kHz > 8 kHz to 10 kHz > 10 kHz to 20 kHz | DIN EN 61672-3:2017 respectively DIN EN 62585:2013 Substitution method in an anechoic chamber with ½" standard microphone at sound pressure level 74 dB to 94 dB | 0.50 dB 0.40 dB 0.50 dB 0.60 dB | |

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Permanent Laboratory - Esslingen

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|---|---|-------------------------------------|---------|
| Pressure sensitivity level of ½" measuring microphones | 31.5 Hz to 5 kHz > 5 kHz to 10 kHz > 10 kHz to 16 kHz | DIN EN 61094-5:2016 Comparative measurement in an electro-acoustical coupler | 0.25 dB 0.40 dB 0.50 dB | |
| Sound pressure level of sound calibrators | 250 Hz; 1 kHz | DIN EN IEC 60942:2018 94 dB; 114 dB; 124 dB | 0.15 dB | |

On-Site Calibration - Esslingen

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|-------------------|------------------------------------|-------------------------------------|---------|
| Torque * Hand torque assembly tools, triggering / indicating | 1 N·m to 1000 N·m | DIN EN ISO 6789-2:2017 | 1 · 10 ⁻² | |

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Halver

Permanent Laboratory - Halver

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|----------------------|--|---|--|
| Torque * Hand torque assembly tools | 2 N·m to 3 kN·m | DIN EN ISO 6789-2:2017 | $1 \cdot 10^{-2}$ | |
| Force * Force measuring devices | 10 N to 50 kN | DKD-R 3-3:2018 | 0.24 % | With force measuring devices in direction of compression and tension |
| Hand force measuring devices | 1 N to 600 N | VDI/VDE 2624 part 2.1:2008 | 0.2 % | with mass stacks in direction of compression and tension |
| | 10 N to 5 kN | | 0.2 % | With force measuring devices in direction of compression and tension |
| Hardness (MTM) * Shore A, D | 0 Shore to 100 Shore | DIN ISO 48-9:2021 ASTM D 2240:2015 | 1.5 Shore | R = measured radius D = measured diameter |
| Radius | to 0.1 mm | | $1.5 \cdot 10^{-5} \cdot R + 2.6 \mu\text{m}$ | |
| Diameter | 0.35 mm to 22 mm | | $1.5 \cdot 10^{-5} \cdot D + 2.6 \mu\text{m}$ | |
| Angle | 29° to 36° | | 0.1° | |
| Measuring range | 0 mm to 3 mm | | 0.15 %; but not less than 0.5 μm | |
| Elastic force | 0.55 N to 8.05 N | | 0.2 %; but not less than 2 mN | |
| | 4.45 N to 44.5 N | | 0.2 %; but not less than 8 mN | |
| Mass on pressure plate | 0.1 kg to 5 kg | | 0.2 %; but not less than 1 g | |
| Temperature quantities * direct reading thermometers with resistance sensor | -35 °C to 150 °C | DKD-R 5-1:2018 in liquid baths | 0.6 K | Comparison with reference thermometer |
| | 50 °C to 600 °C | DKD-R 5-1:2018 in dry block calibrator | 3.1 K | |
| direct reading thermometers with thermocouple sensor | -35 °C to 150 °C | DKD-R 5-3:2018 in liquid baths | 1.0 K | Comparison with reference thermometer |
| | 50 °C to 600 °C | DKD-R 5-3:2018 in dry block calibrator | 4.5 K | |

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Permanent Laboratory - Halver

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|--------------------|--|-------------------------------------|---|
| Temperature indicators for thermocouples | | DKD-R 5-5:2018 without internal reference junction | | Characteristic curve according to DIN EN 60584-1:2014 |
| Type J | -200 °C to 1200 °C | | 0.5 K | |
| Type K | -200 °C to 1200 °C | | 0.6 K | |
| Type N | -200 °C to 1200 °C | | 0.6 K | |
| Type T | -200 °C to 400 °C | | 0.6 K | |
| Type E | -200 °C to 1000 °C | | 0.6 K | |
| Type C | 0 °C to 1200 °C | | 0.6 K | |
| Type R | 0 °C to 1200 °C | | 0.6 K | |
| Type S | 0 °C to 1200 °C | | 0.6 K | |
| Type B | 0 °C to 1200 °C | 0.6 K | | |

On-Site Calibration - Halver

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|-----------------|--|-------------------------------------|--|
| Force * Hand force measuring devices | 1 N to 600 N | VDI/VDE 2624 part 2.1:2008 | 0.2 % | with mass stacks in direction of compression and tension |
| Extension (MTM) * Extensometer systems of material testing machines according to DIN 51220:2003 | 0 mm to 60 mm | DIN EN ISO 9513:2013 ASTM E 83:2016 | 0.15 %; but not less than 0.5 µm | Measuring principle: incremental |
| | 0 mm to 1500 mm | ASTM E 399:2020 ASTM E 2309/ E 2309M:2020 | 0.3 %; but not less than 3 µm | |
| Indentation measuring devices of hardness testing machines | 0 mm to 20 mm | ISO 6506-2:2017 DIN EN ISO 6506-2:2018 ASTM E 10:2018 ISO 6507-2:2018 DIN EN ISO 6507-2:2018 ASTM E 384:2017 ASTM E 92:2017 ISO 6508-02:2015 DIN EN ISO 6508-2:2015 ASTM E 18:2022 DIN EN ISO 2039-1:2003 DIN EN ISO 2039-2:2000 ASTM F 36:2015 ASTM D 785:2008 | 0.15 %; but not less than 0.5 µm | Measuring principle: Stage micrometer in reflected light |

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On-Site Calibration - Halver

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|-------------------------|--|---|--|
| Depth measuring devices of hardness testing machines | 0 mm to 1 mm | DIN EN ISO 6508-2:2015 ASTM E 18:2022 | 0.3 µm | Measuring principle: incremental, DMS |
| Force (MTM) * Force measuring devices of material testing machines | 10 N to 600 kN | ISO 7500-1:2018 DIN EN ISO 7500-1:2018 DIN EN ISO 7500-1 Supplement 1:2022 Supplement 2:2022 Supplement 3:1999 Supplement 4:2013 | 0.12 % | with force measurement for direction of tension |
| | 1 N to 1000 kN | ISO 7500-2:2006 DIN EN ISO 7500-2:2007 ASTM E 4:2021 ISO 6506-2:2017 DIN EN ISO 6506-2:2019 ASTM E 10:2018 ISO 6507-2:2018 DIN EN ISO 6507-2:2018 ASTM E 384:2017 ASTM E 92:2017 ISO 6508-2:2015 DIN EN ISO 6508-2:2015 ASTM E 18:2022 DIN EN ISO 2039-1:2003 DIN EN ISO 2039-2:2000 ASTM F 36:2015 ASTM D 785:2008 ASTM E 1012:2019 ASTM E 467:2021 ISO 23788:2012 | 0.12 % | with force measurement for direction of compression |
| | 0.1 N to 100 N | | 0.10 % | with mass stacks in direction of compression and tension |
| Velocity (MTM) * Traverse speed | 0.1 mm/min to 20 mm/min | ASTM E 2658:2015 | 1.5 % | Measuring principle: Start/stop method of distance and time |
| Mechanical work (MTM) * pendulum impact testing machines and impact devices | 0.2 J to 750 J | DIN EN ISO 148-2:2017 DIN 51222:2017 | Force: 0.12 % Pendulum length: 0.3 mm Angle: 0.05° Time: 0.2 s | The uncertainty is calculated for: 1. position of the oscillation center 2. potential energy 3. Deviation of the indicated energy 4. Indirect calibration with reference samples |

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On-Site Calibration - Halver

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|--|--|--|--|
| Hardness (MTM) * Hardness testing machines according to Brinell, Vickers and Rockwell methods | 60 HBW to 650 HBW | DIN EN ISO 6506-2:2019 ASTM E 10:2018 | 2 % HBW | The specified values of uncertainty apply to indirect calibration with hardness reference plates. Uncertainty of individual parameters from direct measurement is listed separately. U_{CRM} = Calibration uncertainty of hardness reference plate |
| | 100 HV to 1000 HV (Hardness scales HV5 to HV100) (Hardness scales HV0,01 to HV3) | ISO 6507-2:2018 DIN EN ISO 6507-2:2018 ASTM E 384:2017 ASTM E 92:2017 | 1 % HV, but not < $1.5 \cdot U_{CRM}$ 2 % HV, but not < $1.5 \cdot U_{CRM}$ | |
| | 20 HRA to 93 HRA | ISO 6508-2:2015 | 0.5 HRA | |
| | 20 HRB to 115 HRB | DIN EN ISO 6508-2:2015 ASTM E 18:2022 | 0.8 HRB | |
| | 10 HRC to 70 HRC | | 0.5 HRC | |
| | 70 HR15N to 94 HR15N | | 0.6 HR15N | |
| | 42 HR30N to 86 HR30N | | 0.6 HR30N | |
| | 20 HR45N to 77 HR45N | | 0.6 HR45N | |
| | 67 HR15T to 93 HR15T | | 1.2 HR15T | |
| | 29 HR30T to 82 HR30T | | 1.2 HR30T | |
| | 15 HR45T to 72 HR45T | | 1.2 HR45T | |
| Temperature quantities * Temperature indicators for thermocouples | | DKD-R 5-5:2018 without internal reference junction | | Characteristic curve according to DIN EN 60584-1:2014 |
| Type J | -200 °C to 1200 °C | | 0.5 K | |
| Type K | -200 °C to 1200 °C | | 0.6 K | |
| Type N | -200 °C to 1200 °C | | 0.6 K | |
| Type T | -200 °C to 400 °C | | 0.6 K | |
| Type E | -200 °C to 1000 °C | | 0.6 K | |
| Type C | 0 °C to 1200 °C | | 0.9 K | |
| Type R | 0 °C to 1200 °C | | 0.6 K | |
| Type S | 0 °C to 1200 °C | | 0.6 K | |
| Type B | 0 °C to 1200 °C | | 0.6 K | |

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Braunschweig

Permanent Laboratory - Braunschweig

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|----------------------|---|-------------------------------------|---|
| Temperature quantities Resistance thermometers, direct reading thermometers and transmitters with resistance sensors | 0.01 °C | Trescal BS KA20a 01.1/2021 Triple point of water | 15 mK | Calibration at fixed point temperatures |
| | 29.7646 °C | Trescal BS KA20b 01.1/2021 Fixed point of gallium | 15 mK | |
| Resistance thermometers, direct reading thermometers and transmitters with resistance sensors * | -100 °C to -20 °C | DKD-R 5-1:2018 in dry block calibrator | 0.25 K | Comparison with reference thermometer |
| | > -20 °C to 140 °C | | 0.05 K | |
| | > 140 °C to 300 °C | | 0.2 K | |
| | > 300 °C to 660 °C | | 0.7 K | |
| Direct reading thermometers with base metal thermocouple sensors * | -40 °C to 150 °C | DKD-R 5-1:2018 in climatic chamber | 0.4 K | Comparison with reference thermometer |
| | -100 °C to 140 °C | DKD-R 5-3:2018 in dry block calibrator | 0.5 K | |
| | > 140 °C to 300 °C | | 0.5 K | |
| | > 300 °C to 660 °C | | 0.9 K | |
| | 500 °C to 900 °C | DKD-R 5-3:2018 in tube furnace | 1.6 K | |
| | > 900 °C to 1100 °C | | 2.0 K | |
| | > 1100 °C to 1200 °C | | 3.0 K | |
| Base metal thermocouples and transmitters with base metal thermocouple sensors * | -40 °C to 150 °C | DKD-R 5-3:2018 in climatic chamber | 0.5 K | Comparison with reference thermometer |
| | -100 °C to 140 °C | DKD-R 5-3:2018 in dry block calibrator | 1.0 K | |
| | 140 °C to 300 °C | | 1.0 K | |
| | > 300 °C to 660 °C | | 1.4 K | |
| | 500 °C to 700 °C | DKD-R 5-3:2018 in tube furnace | 2.3 K | |
| | > 700 °C to 900 °C | | 2.4 K | |
| | > 900 °C to 1100 °C | | 2.7 K | |
| > 1100 °C to 1200 °C | 3.5 K | | | |

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Permanent Laboratory - Braunschweig

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|----------------------|---|-------------------------------------|---|
| Noble metal thermocouples, direct reading thermometers with noble metal thermocouple sensors and transmitters with thermocouple sensors type S and type R * | 200 °C to 300 °C | DKD-R 5-3:2018 in dry block calibrator | 0.5 K | Comparison with reference thermometer |
| | > 300 °C to 660 °C | | 0.9 K | |
| | 500 °C to 700 °C | DKD-R 5-3:2018 in tube furnace | 1.2 K | |
| | > 700 °C to 900 °C | | 1.3 K | |
| | > 900 °C to 1100 °C | | 1.8 K | |
| | > 1100 °C to 1200 °C | | 2.9 K | |
| Dry block calibrators * | -100 °C to 300 °C | DKD-R 5-4:2018 | 0.35 K | Comparison with reference thermometer |
| | > 300 °C to 660 °C | | 0.65 K | |
| | > 660 °C to 800 °C | | 2.5 K | |
| | > 800 °C to 1000 °C | | 4.0 K | |
| | > 1000 °C to 1200 °C | | 5.0 K | |
| Thermo-hygrographs | 10 °C to 40 °C | Trescal BS KA24 01.1/2021 in climatic chamber | 1.2 K | Comparison with reference thermometer |
| Humidity quantities Relative humidity Hygrometers for direct logging of relative humidity in air * | 20 % to 50 % | DKD-R 5-8:2019 in climatic chamber temperature range: 20 °C to 80 °C | 1.5 % | Comparison with dew point hygrometer |
| | > 50 % to 80 % | | 2.0 % | |
| | > 80 % to 90 % | | 2.6 % | |
| | 20 % to 50 % | DKD-R 5-8:2019 in humidity generator at 23 °C | 1.0 % | Measurement uncertainty expressed as an absolute value of relative humidity |
| | > 50 % to 90 % | | 1.5 % | |
| Thermo-hygrographs * | 20 % to 90 % | DKD-R 5-8:2019 in climatic chamber temperature range: 20 °C to 80 °C | 5.0 % | |

On-Site Calibration - Braunschweig

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|--------------------|---|-------------------------------------|---------------------------------------|
| Temperature quantities Resistance thermometers, direct reading thermometers and transmitters with resistance sensor * | -100 °C to -20 °C | DKD-R 5-1:2018 in dry block calibrator | 0.5 K | Comparison with reference thermometer |
| | > -20 °C to 140 °C | | 0.1 K | |
| | > 140 °C to 300 °C | | 0.4 K | |
| | > 300 °C to 660 °C | | 1.4 K | |

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On-Site Calibration - Braunschweig

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|--------------------|---|-------------------------------------|--|
| Direct reading thermometers and transmitters with thermocouple sensors * | -100 °C to 140 °C | DKD-R 5-3:2018 in dry block calibrator | 1.0 K | Comparison with reference thermometer |
| | > 140 °C to 300 °C | | 1.0 K | |
| | > 300 °C to 660 °C | | 1.8 K | |
| Climatic chamber with air circulation * | -90 °C to 10 °C | DKD-R 5-7:2018 method A or B | 1.7 K | Comparison with reference thermometer |
| | > 10 °C to 40 °C | | 1.0 K | |
| | > 40 °C to 250 °C | | 1.7 K | |
| Climatic chamber without air circulation * | -90 °C to 10 °C | DKD-R 5-7:2018 method A or B | 3.0 K | Comparison with reference thermometer |
| | > 10 °C to 40 °C | | 2.2 K | |
| | > 40 °C to 250 °C | | 5.0 K | |
| Measuring locations in climatic chambers with air circulation * | -90 °C to 10 °C | DKD-R 5-7:2018 method C | 1.7 K | Comparison with reference thermometer |
| | > 10 °C to 40 °C | | 1.0 K | |
| | > 40 °C to 250 °C | | 1.7 K | |
| Measuring locations in climatic chambers without air circulation * | -90 °C to 10 °C | DKD-R 5-7:2018 method C | 1.7 K | Comparison with reference thermometer |
| | > 10 °C to 40 °C | | 1.0 K | |
| | > 40 °C to 250 °C | | 1.7 K | |
| Humidity quantities Climatic chambers with air circulation * | 20 % to 90 % | DKD-R 5-7:2018 method A or B Air temperature: 10 °C to 20 °C | 3.5 % | Comparison with capacitive humidity sensor |
| | 10 % to 90 % | DKD-R 5-7:2018 method A or B Air temperature: 20 °C to 90 °C | 3.5 % | Measurement uncertainty expressed as absolute value of relative humidity |
| Measuring locations in climatic chambers with air circulation * | 20 % to 90 % | DKD-R 5-7:2018 method C Air temperature: 10 °C to 20 °C | 3.5 % | |
| | 10 % to 90 % | DKD-R 5-7:2018 method C Air temperature: 20 °C to 90 °C | 3.5 % | |

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Wetzlar
Permanent Laboratory - Wetzlar
Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks | | |
|--|---------------------|---|-------------------------------------|---|--|--|
| Temperature quantities Resistance thermometers, direct reading thermometers with resistance sensor * | -50 °C to 250 °C | DKD-R 5-1:2018 in oil baths | 50 mK | Comparison with reference thermometer | | |
| | -80 °C to -45 °C | DKD-R 5-1:2018 in dry block calibrator | 0.3 K | | | |
| | > -45 °C to 100 °C | | 0.1 K | | | |
| | > 100 °C to 650 °C | | 0.2 K | | | |
| Thermocouples, direct reading thermometers with thermocouple sensor * | -50 °C to 250 °C | DKD-R 5-3:2018 in oil baths | 0.3 K | Comparison with reference thermometer | | |
| | -80 °C to -45 °C | DKD-R 5-3:2018 in dry block calibrator | 0.5 K | | | |
| | > -45 °C to 100 °C | | 0.4 K | | | |
| | > 100 °C to 650 °C | | 0.5 K | | | |
| Temperature indicators for resistance thermometers * | -200 °C to 850 °C | DKD-R 5-5:2018 | 30 mK | Characteristic curve according to DIN EN 60751:2009 | | |
| Simulators for resistance thermometers * | -200 °C to 850 °C | | 25 mK | | | |
| Temperature indicators for thermocouples * Type J, T, E, K, N | -200 °C to -50 °C | DKD-R 5-5:2018 without internal reference junction | 0.2 K | Characteristic curve according to DIN EN 60584:2014 | | |
| | > -50 °C to 1300 °C | | 0.15 K | | | |
| | Type R, S | | 0 °C to 100 °C | | 0.6 K | |
| | | | > 100 °C to 400 °C | | 0.5 K | |
| Type B | > 400 °C to 1760 °C | | 0.3 K | | | |
| | 600 °C to 700 °C | | 0.6 K | | | |
| | > 700 °C to 1100 °C | | 0.4 K | | | |
| > 1100 °C to 1800 °C | 0.3 K | | | | | |
| Temperature indicators for thermocouples * Type J, T, E, K, N | -200 °C to 1300 °C | DKD-R 5-5:2018 with internal reference junction | 0.35 K | Characteristic curve according to DIN EN 60584:2014 | | |
| | Type R, S | | 0 °C to 100 °C | | 0.7 K | |
| | | | > 100 °C to 1800 °C | | 0.5 K | |
| | Type B | | 600 °C to 700 °C | | 0.6 K | |
| > 700 °C to 1200 °C | | | 0.5 K | | | |
| > 1200 °C to 1800 °C | | | 0.4 K | | | |
| Pressure * Positive gauge pressure | 0 bar to 14 bar | | DKD-R 6-1:2014 | | $0.8 \text{ mbar} + 1.0 \cdot 10^{-4} \cdot p_e$ | p_e = measured value Pressure medium: gas |

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On-Site Calibration – Wetzlar
Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|---------------------|---|--|---|
| Temperature quantities Resistance thermometers, direct reading thermometers with resistance sensor * | -30 °C to 150 °C | DKD-R 5-1:2018 in micro baths | 0.1 K | Comparison with reference thermometer |
| | > 150 °C to 250 °C | | 0.15 K | |
| Thermocouples, direct reading thermometers with thermocouple sensor * | -30 °C to 250 °C | DKD-R 5-3:2018 in micro baths | 0.5 K | |
| Temperature indicators for resistance thermometers * | -200 °C to 850 °C | DKD-R 5-5:2018 | 40 mK | Characteristic curve according to DIN EN 60751:2009 |
| Simulators for resistance thermometers * | -200 °C to 850 °C | | 30 mK | |
| Temperature indicators for thermocouples: * Type K, J, E, N, T | -200 °C to -50 °C | DKD-R 5-5:2018 without internal reference junction | 0.5 K | Characteristic curve according to DIN EN 60584:2014 |
| | > -50 °C to 900 °C | | 0.3 K | |
| | > 900 °C to 1300 °C | | 0.4 K | |
| Type R, S | 0 °C to 100 °C | | 1.5 K | |
| | > 100 °C to 1800 °C | | 1.0 K | |
| Type B | 600 °C to 800 °C | | 1.5 K | |
| | > 800 °C to 1800 °C | 1.0 K | | |
| Pressure * Positive gauge pressure | 0 bar to 14 bar | DKD-R 6-1:2014 | 0.8 mbar + $1.0 \cdot 10^{-4} \cdot p_e$ | p_e = measured value Pressure medium: gas |

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Ruhla

On-Site Calibration - Ruhla

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|---|--|--|--|
| Hardness (MTM) * Calibration of Hardness testing machines according to Brinell, Vickers and Rockwell methods | 60 HBW to 650 HBW | DIN EN ISO 6506-2:2019 | 2 % HBW | Determination of uncertainty with direct and indirect calibration of hardness testing machine U_{CRM} = Calibration uncertainty of hardness reference plate |
| | 50 HV To 1500 HV (Hardness scales HV5 to HV100) (Hardness scales HV0,01 to HV3) | DIN EN ISO 6507-2:2018 DIN EN ISO 6508-2:2015 | 1 % HV, but not less than $1.5 \cdot U_{CRM}$ 2 % HV, but not less than $1.5 \cdot U_{CRM}$ | |
| | 20 HRA to 95 HRA | | 0.6 HRA | |
| | 10 HRBW to 100 HRBW | | 1.0 HRBW | |
| | 10 HRC to 70 HRC | | 0.6 HRC | |
| | 20 HRN to 94 HRN | | 1.0 HRN | |
| | 10 HRTW to 93 HRTW | | 1.6 HRTW | |
| | 60 HRFW to 100 HRFW | | 1.0 HRFW | |
| Calibration of depth measuring device of Rockwell hardness testing machines * | 0 mm to 0.25 mm | DIN EN ISO 6508-2:2015 | 0.6 μ m | direct calibration with depth measuring device |
| Calibration of indentation measuring device of hardness testing machines * | 0.01 mm to 6 mm | DIN EN ISO 6506-2:2019 DIN EN ISO 6507-2:2013 | 0.15 μ m | Measuring principle: Stage micrometer in reflected light |
| Calibration of force measuring device of hardness testing machines * | 2.5 N to 50 kN | DIN EN ISO 6506-2:2019 | 0.24 % | with force sensors (class 1) in compression direction |
| | 0.1 N to 100 N | DIN EN ISO 6507-2:2018 DIN EN ISO 6508-2:2015 | 0.10 % | |

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Nürnberg

Permanent Laboratory - Nürnberg

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|--|--------------------|------------------------------------|-------------------------------------|--|
| Torque * Hand torque assembly tools, triggering / indicating | 1 N·m to 1000 N·m | DIN EN ISO 6789-2:2017 | $1 \cdot 10^{-2}$ | |
| Mass * Mass or conventional mass | 1 mg | OIML R 111-1:2004 | 0.006 mg | for fixed nominal values |
| | 2 mg | | 0.006 mg | |
| | 5 mg | | 0.006 mg | for weights according to OIML R111-1: 2004 according to class F ₁ |
| | 10 mg | | 0.008 mg | |
| | 20 mg | | 0.010 mg | |
| | 50 mg | | 0.012 mg | |
| | 100 mg | | 0.016 mg | |
| | 200 mg | | 0.020 mg | |
| | 500 mg | | 0.025 mg | |
| | 1 g | | 0.03 mg | |
| | 2 g | | 0.04 mg | |
| | 5 g | | 0.05 mg | |
| | 10 g | | 0.06 mg | |
| | 20 g | | 0.08 mg | |
| | 50 g | | 0.10 mg | |
| | 100 g | | 0.16 mg | |
| | 200 g | | 0.3 mg | |
| | 500 g | | 0.8 mg | |
| | 1 kg | | 1.6 mg | |
| 2 kg | 3.0 mg | | | |
| 5 kg | 8.0 mg | | | |
| Temperature quantities * Resistance thermometers and direct reading thermometers with resistance sensors | -10 °C to 140 °C | DKD-R 5-1:2018 in liquid baths | 0.3 K | Comparison with reference thermometer |
| Thermocouples and direct reading thermometers with thermocouple sensors | -10 °C to 140 °C | DKD-R 5-3:2018 in liquid baths | 1 K | Comparison with reference thermometer |
| Temperature indicators for thermocouples | -200 °C to 1200 °C | DKD-R 5-5:2018 | 0.6 K | Characteristic curve according to DIN EN 60584-1:2014 |

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Permanent Laboratory - Nürnberg

Calibration and Measurement Capabilities (CMC)

| Measurement quantity / Calibration item | Range | Measurement conditions / Procedure | Expanded measurement of uncertainty | Remarks |
|---|--------------|---|-------------------------------------|--|
| Humidity quantities * measuring instruments for relative humidity - hygrometers | 25 % to 75 % | DKD-R 5-8:2019 in climate chamber air temperature 25 °C | 2 % | Comparison with capacitive humidity sensors Measurement uncertainty expressed as an absolute value of relative humidity |

Abbreviations used:

| | |
|---------------|---|
| ASTM | American Society for Testing and Materials |
| CMC | Calibration and measurement capabilities |
| DIN | Deutsches Institut für Normung e.V. |
| DKD-R | Guideline of Deutscher Kalibrierdienst (DKD), published by Physikalisch-Technische Bundesanstalt |
| EURAMET | European Association of National Metrology Institutes |
| OIML R | International Recommendation of International Organization of Legal Metrology |
| Trescal BS KA | Calibration Guide of Trescal GmbH |
| VDE | Verband der Elektrotechnik, Elektronik und Informationstechnik e.V. |
| VDI | Verein Deutscher Ingenieure e.V. |

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