

Deutsche Akkreditierungsstelle GmbH

Annex to the Accreditation Certificate D-K-15102-01-00 according to DIN EN ISO/IEC 17025:2005

Period of validity: 05.07.2017 to 04.07.2022

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Holder of certificate:

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Accredited since: 18.07.2007

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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Calibrations in the fields:

Mechanical quantities

- Mass (mass standards) ^{c)}
- Weighing instruments ^{b)}
- Pressure ^{c)}

Electrical quantities

DC and low frequency quantities

- DC voltage
- DC current
- DC resistance
- AC voltage
- AC current

Chemical analysis, reference materials

- Volume of liquids ^{c)}

Thermodynamic quantities

Temperature quantities

- Resistance thermometers
- Thermocouples
- Liquid-in glass thermometers ^{c)}
- Direct reading thermometers ^{c)}
- Mechanical thermometers ^{c)}
- Climatic chambers (temperature) ^{a)}

^{a)} on-site calibration only

^{b)} permanent laboratory and on-site calibration

^{c)} permanent laboratory and mobile laboratory

Abbreviations used: see last page

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Permanent Laboratory

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability ¹⁾	Remarks
Conventional mass *)	1 mg, 2 mg, 5 mg	OIML R 111-1:2004	0.006 mg	For weight pieces according to OIML recommendation R 111-1:2004, 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	
10 kg	16 mg			
Conventional mass *)	1 mg to 100 mg	OIML R 111-1:2004	0.05 mg	For free nominal values
	> 100 mg to 200 mg		0.06 mg	
	> 200 mg to 500 mg		0.08 mg	
	> 500 mg to 1 g		0.10 mg	
	> 1 g to 2 g		0.12 mg	
	> 2 g to 5 g		0.16 mg	
	> 5 g to 10 g		0.20 mg	
	> 10 g to 20 g		0.25 mg	
	> 20 g to 50 g		0.30 mg	
	> 50 g to 100 g		0.5 mg	
	> 100 g to 10 kg		$5 \cdot 10^{-6} \cdot m_c$	m_c : conventional mass
Non automatic weighing instruments with digital indicator *)	up to 100 g	EURAMET/cg-18/v.03, guidelines on the calibration of non-automatic weighing instruments	$2 \cdot 10^{-6}$	for weight pieces according to R 111-1:2004, Class E ₂
	up to 60 kg		$1 \cdot 10^{-5}$	for weight pieces according to R 111-1:2004, Class F 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.

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Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability ¹⁾	Remarks
Temperature Resistance thermometers *)	-80 °C to 30 °C	Alcohol bath DAkks-DKD-R 5-1:2010	20 mK	Comparison with standard resistance thermometer
	> 30 °C to 80 °C	Water bath DAkks-DKD-R 5-1:2010	30 mK	
	> 80 °C to 200 °C	Oil bath DAkks-DKD-R 5-1:2010	0.10 K	
	> 200 °C to 660 °C	Fluidized bath DAkks-DKD-R 5-1:2010	0.30 K	
Thermocouples, noble metal *)	0 °C to 200 °C	Liquid bath DAkks-DKD-R 5-3:2010	0.5 K	Comparison with resistance thermometer
	> 200 °C to 600 °C	Fluidized bath DAkks-DKD-R 5-3:2010	0.7 K	
	> 600 °C to 900 °C	Furnace DAkks-DKD-R 5-3:2010	1.1 K	Comparison with thermocouple
	> 900 °C to 1200 °C		1.5 K	
Thermocouples, base metal *)	0 °C to 200 °C	Furnace DAkks-DKD-R 5-3:2010	1.0 K	Comparison with thermocouple
	> 200 °C to 600 °C		1.0 K	
	> 600 °C to 900 °C		1.5 K	
	> 900 °C to 1200 °C		2.0 K	
Liquid-in-glass thermometers	-80 °C to 30 °C	Alcohol bath PRO-PMT/TH-004 Revision 9A	25 mK	Comparison with standard resistance thermometer
	> 30 °C to 80 °C	Water bath PRO-PMT/TH-004 Revision 9A	30 mK	
	> 80 °C to 200 °C	Oil bath PRO-PMT/TH-004 Revision 9A	0.10 K	
	> 200 °C to 360 °C	Fluidized bath PRO-PMT/TH-004 Revision 9A	0.30 K	
Direct reading electrical thermometers *)	-80 °C to 30 °C	Alcohol bath DAkks-DKD-R 5-1:2010 DAkks-DKD-R 5-3:2010	20 mK	Comparison with standard resistance thermometer
	> 30 °C to 80 °C	Water bath DAkks-DKD-R 5-1:2010 DAkks-DKD-R 5-3:2010	30 mK	
	> 80 °C to 200 °C	Oil bath DAkks-DKD-R 5-1:2010 DAkks-DKD-R 5-3:2010	0.10 K	
	> 200 °C to 660 °C	Fluidized bath DAkks-DKD-R 5-1:2010 DAkks-DKD-R 5-3:2010	0.30 K	
Mechanical (dial) thermometers	-80 °C to 80 °C	Alcohol or Water bath PRO-PMT/TH-005 Revision 9A	30 mK	Comparison with standard resistance thermometer;
	> 80 °C to 200 °C	Oil bath PRO-PMT/TH-005 Revision 9A	0.10 K	
	> 200 °C to 400 °C	Fluidized bath PRO-PMT/TH-005 Revision 9A	0.30 K	

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Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability ¹⁾	Remarks
Volume of liquids Piston operated pipettes *)	5 µL	ISO 8655:2002	0.026 µL	
	10 µL		0.04 µL	
	20 µL		0.08 µL	
	50 µL		0.14 µL	
	100 µL		0.3 µL	
	200 µL		0.6 µL	
	500 µL		1.2 µL	
	1000 µL		2.4 µL	
Volumetric burettes *)	1 mL	ISO 4787:2010	2.8 µL	
	2 mL		2.9 µL	
	5 mL		4.3 µL	
	10 mL		8.1 µL	
	25 mL		22 µL	
	50 mL		38 µL	
	100 mL		70 µL	
Volumetric pipettes *)	0.5 mL	ISO 4787:2010	1.5 µL	
	1 mL		4.4 µL	
	2 mL		5.6 µL	
	5 mL		7.4 µL	
	10 mL		8.7 µL	
	20 mL		12 µL	
	25 mL		16 µL	
	50 mL		17 µL	
	100 mL		39 µL	
200 mL	46 µL			
Volumetric flask *)	1 mL, 2 mL, 5 mL, 10 mL	ISO 4787:2010	11 µL	
	20 mL, 25 mL		19 µL	
	50 mL		30 µL	
	100 mL		41 µL	
	200 mL		59 µL	
	250 mL		59 µL	
	500 mL		85 µL	
	1000 mL		0.13 mL	
	2000 mL		0.22 mL	
5000 mL	0.39 mL			
Measuring cylinders *)	5 mL	ISO 4787:2010	35 µL	
	10 mL		61 µL	
	25 mL		93 µL	
	50 mL		0.13 mL	
	100 mL		0.20 mL	
	250 mL		0.36 mL	
	500 mL		0.58 mL	
	1000 mL		0.93 mL	
2000 mL	1.5 mL			
Provers *)	5 L	ISO 4787:2010	2.1 mL	
	10 L		3.4 mL	
	20 L		3.8 mL	

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Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability ¹⁾	Remarks
DC voltage Zener standards	10 V	Direct comparison with Zener standard	30 μ V	
Sources, fixed values	0.1 V		1.2 μ V	
	1 V		3.0 μ V	
	10 V		45 μ V	
	100 V		0.50 mV	
	1000 V		12 mV	
Measuring instruments	10 mV to 11 V		$8.0 \cdot 10^{-6} \cdot U + 6.0 \mu$ V	U: measured value
	> 11 V to 22 V		$9.0 \cdot 10^{-6} \cdot U + 4.0 \mu$ V	
	> 22 V to 275 V		$10 \cdot 10^{-6} \cdot U + 90 \mu$ V	
	> 275 V to 1 kV		$16 \cdot 10^{-6} \cdot U + 0.17$ mV	
DC current Sources, fixed values	0.1 A		$0.65 \cdot 10^{-3} \cdot I$	I: measured value
	2 A		$0.60 \cdot 10^{-3} \cdot I$	
	4 A, 6 A, 8 A, 10 A, 12 A, 14 A, 16 A, 18 A, 20 A		$0.50 \cdot 10^{-3} \cdot I$	
Measuring instruments	3.3 mA to 33 mA		$7.0 \cdot 10^{-6} \cdot I + 40 \mu$ A	I: measured value
	> 33 mA to 330 mA		$60 \cdot 10^{-6} \cdot I + 40 \mu$ A	
	> 330 mA to 1 A		$0.23 \cdot 10^{-3} \cdot I + 60 \mu$ A	
	> 1 A to 3 A		$0.45 \cdot 10^{-3} \cdot I + 50 \mu$ A	
	> 3 A to 11 A		$0.58 \cdot 10^{-3} \cdot I + 0.58$ mA	
	> 11 A to 20 A		$1.1 \cdot 10^{-3} \cdot I + 0.90$ mA	
DC resistance Resistors, fixed values	1 m Ω		$72 \cdot 10^{-6} \cdot R$	R: measured value
	10 m Ω		$28 \cdot 10^{-6} \cdot R$	
	100 m Ω		$22 \cdot 10^{-6} \cdot R$	
	1 Ω		$13 \cdot 10^{-6} \cdot R$	
	10 Ω		$13 \cdot 10^{-6} \cdot R$	
	100 Ω		$13 \cdot 10^{-6} \cdot R$	
	1 k Ω		$10 \cdot 10^{-6} \cdot R$	
	10 k Ω		$10 \cdot 10^{-6} \cdot R$	
	100 k Ω		$12 \cdot 10^{-6} \cdot R$	
	1 M Ω		$20 \cdot 10^{-6} \cdot R$	

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Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability ¹⁾	Remarks
DC resistance Measuring instruments	0.10 Ω to 11 Ω		$15 \cdot 10^{-6} \cdot R + 1.2 \text{ m}\Omega$	R: measured value
	> 11 Ω to 33 Ω		$41 \cdot 10^{-6} \cdot R + 20 \text{ m}\Omega$	
	> 33 Ω to 110 Ω		$13 \cdot 10^{-6} \cdot R + 20 \text{ m}\Omega$	
	> 110 Ω to 330 Ω		$13 \cdot 10^{-6} \cdot R + 20 \text{ m}\Omega$	
	> 330 Ω to 1.1 kΩ		$13 \cdot 10^{-6} \cdot R + 20 \text{ m}\Omega$	
	> 1.1 kΩ to 3.3 kΩ		$7.0 \cdot 10^{-6} \cdot R + 0.10 \Omega$	
	> 3.3 kΩ to 11 kΩ		$1.0 \cdot 10^{-6} \cdot R + 12 \text{ m}\Omega$	
	> 11 kΩ to 33 kΩ		$15 \cdot 10^{-6} \cdot R + 0.80 \Omega$	
	> 33 kΩ to 110 kΩ		$7.0 \cdot 10^{-6} \cdot R + 0.60 \Omega$	
	> 110 kΩ to 330 kΩ		$10 \cdot 10^{-6} \cdot R + 1.5 \Omega$	
	> 330 kΩ to 1.1 MΩ		$7.0 \cdot 10^{-6} \cdot R + 12 \Omega$	
	> 1.1 MΩ to 3.3 MΩ		$70 \cdot 10^{-6} \cdot R + 0.17 \text{ k}\Omega$	
	> 3.3 MΩ to 11 MΩ		$0.20 \cdot 10^{-3} \cdot R + 0.24 \text{ k}\Omega$	
	> 11 MΩ to 33 MΩ		$0.37 \cdot 10^{-3} \cdot R + 2.6 \text{ k}\Omega$	
	> 33 MΩ to 110 MΩ		$0.93 \cdot 10^{-3} \cdot R + 2.3 \text{ k}\Omega$	
> 110 MΩ to 330 MΩ	$3.5 \cdot 10^{-3} \cdot R + 0.12 \text{ M}\Omega$			
> 330 MΩ to 1.1 GΩ	$18 \cdot 10^{-3} \cdot R + 0.58 \text{ M}\Omega$			
AC voltage Measuring instruments	10 mV to 33 mV	40 Hz to 10 kHz	$4.0 \cdot 10^{-6} \cdot U + 0.50 \text{ mV}$	U: measured value
	> 33 mV to 0.33 V		$16 \cdot 10^{-6} \cdot U + 0.50 \text{ mV}$	
	> 0.33 V to 3.3 V		$0.12 \cdot 10^{-3} \cdot U + 0.50 \text{ mV}$	
	> 3.3 V to 33 V		$0.20 \cdot 10^{-3} \cdot U + 1.2 \text{ mV}$	
	> 33 V to 330 V	45 Hz to 10 kHz	$0.24 \cdot 10^{-3} \cdot U + 8.0 \text{ mV}$	
	> 330 V to 1000 V		$0.33 \cdot 10^{-3} \cdot U + 70 \text{ mV}$	
AC current Measuring instruments	3.3 mA to 33 mA	45 Hz to 1 kHz	$20 \cdot 10^{-6} \cdot I + 0.24 \text{ mA}$	I: measured value
	> 33 mA to 330 mA		$0.25 \cdot 10^{-3} \cdot I + 0.16 \text{ mA}$	
	> 330 mA to 1 A		$0.60 \cdot 10^{-3} \cdot I + 0.12 \text{ mA}$	
	> 1 A to 3 A		$0.70 \cdot 10^{-3} \cdot I + 0.12 \text{ mA}$	
	> 3 A to 11 A		$0.70 \cdot 10^{-3} \cdot I + 3.0 \text{ mA}$	
	> 11 A to 20 A		$1.5 \cdot 10^{-3} \cdot I + 6.0 \text{ mA}$	

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Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability ¹⁾	Remarks
Pressure Absolute pressure p_{abs} *)	0.14 bar to 1.7 bar	DKD-R 6-1:2014 EURAMET Calibration Guide No. 17 Version 3.0 DIN EN 837:1997 EURAMET /cg-3/v.01	$2.7 \cdot 10^{-5} \cdot p_{abs} + 18 \mu\text{bar}$	Pressure medium: Gas The uncertainty of the residual pressure has to be added
	> 1.7 bar to 7.0 bar		$2.8 \cdot 10^{-5} \cdot p_{abs} + 22 \mu\text{bar}$	
	> 7.0 bar to 70 bar		$3.2 \cdot 10^{-5} \cdot p_{abs} + 0.10 \text{ mbar}$	
Gauge pressure p_e *)	0 bar	DKD-R 6-1:2014 EURAMET Calibration Guide No. 17 Version 3.0 DIN EN 837:1997 EURAMET /cg-3/v.01	$2.7 \cdot 10^{-5} \cdot p_e + 18 \mu\text{bar}$	Pressure medium: Gas
	0.014 bar to 1.7 bar		$2.8 \cdot 10^{-5} \cdot p_e + 22 \mu\text{bar}$	
	> 1.7 bar to 7.0 bar		$3.2 \cdot 10^{-5} \cdot p_e + 0,10 \mu\text{bar}$	
	> 7.0 bar to 70 bar		25 mbar	
	> 70 bar to 140 bar	DKD-R 6-1:2014 EURAMET Calibration Guide No. 17 Version 3.0 DIN EN 837:1997 EURAMET /cg-3/v.01	$7.0 \cdot 10^{-5} \cdot p_e + 0.15 \text{ mbar}$	Pressure medium: Oil
	0 bar to 60 bar		$1.4 \cdot 10^{-4} \cdot p_e + 5.8 \text{ mbar}$	
> 60 bar to 1200 bar				

On-site Calibration

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability ¹⁾	Remarks
Non-automatic electronic weighing instruments with digital indicator *)	up to 100 g	EURAMET Calibration Guide No. 18, Version 4.0	$2 \cdot 10^{-6}$	with weights according to OIML R 111-1:2004, Class E ₂
	up to 60 kg		$1 \cdot 10^{-5}$	with weights according to OIML R 111-1:2004, Class F ₁
	up to 300 kg		$1 \cdot 10^{-4}$	with weights according to OIML R 111-1:2004, Class M ₁
Temperature Ovens and autoclaves (with air circulation) *)	25 °C to 400 °C	DAKKS-DKD-R 5-7:2010 EURAMET cg-20, Version 4.0	0.60 K	comparison with standard thermometers of 12 RTD, connected with one temperature measuring device and multiplexer
Climatic chambers (with air circulation) *)	-70 °C to 150 °C		0.50 K	
Calibration baths *)	-80 °C to 250 °C		0.15 K	
Calibration baths *)	-40 °C to 250 °C		0.50 K	comparison with thermocouples

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Mobile Laboratory

Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability ¹⁾	Remarks
Conventional mass ^{*)}	1 g	OIML R 111-1:2004	0.1 mg	For weight pieces according to OIML recommendation R 111-1:2004, Class F ₂
	2 g		0.12 mg	
	5 g		0.16 mg	
	10 g		0.2 mg	
	20 g		0.25 mg	
	50 g		0.3 mg	
	100 g		0.5 mg	
	200 g		1.0 mg	
	500 g		2.5 mg	
	1 kg		5.0 mg	
	2 kg		10 mg	
	5 kg		25 mg	
	10 kg		50 mg	
	20 kg		100 mg	
Gauge pressure p_e ^{*)}	0 kPa to 400 kPa	DKD-R 6-1:2014 <u>only</u> sequence B and C	0.5 kPa	Pressure medium: Oil
	> 400 kPa to 1 MPa		1.5 kPa	
	> 1MPa to 10 MPa		20 kPa	
	> 10 MPa to 25 MPa		45 kPa	
	> 25 MPa to 60 MPa		200 kPa	
Temperature Liquid-in-glass thermometers	-20 °C to 360 °C	Dry block calibrator PRO-MOB/TH-002, Version 1A	0.20 K	comparison with a standard resistance thermometer
Direct reading thermometers with resistance sensor ^{*)}	-20 °C to 660 °C	Dry block calibrator DAKKS-DKD-R 5-1:2010	0.20 K	
Direct reading thermometers with thermocouple sensor ^{*)}	-20 °C to 660 °C	Dry block calibrator DAKKS-DKD-R 5-3:2010	0.20 K	
Mechanical (dial) thermometers	-20 °C to 660 °C	Dry block calibrator PRO-MOB/TH-001, Version 1A	0.25 K	

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Measured quantity / Calibration item	Range	Measurement conditions / procedure	Best measurement capability ¹⁾	Remarks
Volume of liquids Volumetric burettes *)	10 mL	Gravimetric method ISO 4787:2010	7 µL	
	25 mL		10 µL	
	50 mL		22 µL	
	100 mL		37 µL	
Volumetric pipettes *)	10 mL	ISO 4787:2010	10 µL	
	20 mL		13 µL	
	25 mL		15 µL	
	50 mL		17 µL	
	100 mL		27 µL	
	200 mL		34 µL	
Volumetric flask *)	10 mL	ISO 4787:2010	22 µL	
	20 mL		37 µL	
	25 mL		37 µL	
	50 mL		55 µL	
	100 mL		78 µL	
	200 mL		0.14 mL	
	250 mL		0.14 mL	
	500 mL		0.21 mL	
	1000 mL		0.29 mL	
	2000 mL		0.40 mL	
	5000 mL		0.79 mL	
Measuring cylinders *)	10 mL	ISO 4787:2010	89 µL	
	25 mL		0.17 mL	
	50 mL		0.27 mL	
	100 mL		0.41 mL	
	250 mL		0.73 mL	
	500 mL		1.2 mL	
	1000 mL		1.9 mL	
	2000 mL		3.1 mL	
Provers *)	5 L	ISO 4787:2010	1.5 mL	
	10 L		2.0 mL	
	20 L		4.1 mL	

Abbreviations used:

OIML	International Organization of Legal Metrology
EURAMET	European Association of National Metrology Institutes
DKD-R	Guideline of Deutscher Kalibrierdienst (DKD)
DAkks-DKD-R	Guideline of Deutsche Akkreditierungsstelle GmbH (DAkks)
PRO-xxx	Procedure of National Metrological Institute of Ethiopia

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