

Deutsche Akkreditierungsstelle GmbH

Annex to the Accreditation Certificate D-K-19342-01-00 according to DIN EN ISO/IEC 17025:2018

Valid from: 20.05.2019

Date of issue: 20.05.2019

Holder of certificate:

Ahlborn Mess- und Regelungstechnik GmbH
Eichenfeldstraße 1-3, 83607 Holzkirchen

Calibration in the fields:

Thermodynamic quantities

Temperature quantities

- Resistance thermometers
- Thermocouples
- Temperature indicators and simulators

Humidity quantities

- Devices for relative humidity

Fluid quantities

- Velocity of gases

Electrical quantities

DC and low frequency quantities

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

Time and frequency

- Frequency

Abbreviations used: see last page

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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Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
Relative humidity Electrical hygrometers	10 % to 30 %	in 2-pressure-generators temperature range 20 °C to 30 °C AA070001:2019-01	0,4 %	Measurement uncertainty expressed in relative humidity
	> 30 % to 60 %		0,8 %	
	> 60 % to 85 %		1,0 %	
Mechanical hygrometers	10 % to 30 %	in climatic chambers air temperature: 10 °C to 95 °C AA070001:2019-01	0,7 %	Measurement uncertainty expressed in relative humidity
	> 30 % to 60 %		0,9 %	
	> 60 % to 95 %		1,1 %	
Electrical hygrometers, psychrometers	10 % to 98 %	in climatic chambers air temperature: 10 °C to 95 °C AA070001:2019-01	0,6 %	Comparison with standard psychrometer
Temperature Temperature measuring chains or temperature probes with resistance sensors ¹⁾	0,01 °C	triple point of water	2 mK	calibration at fixed point temperature
	0 °C	in ice baths DKD-R 5-1:2018	10 mK	Comparison with standard resistance thermometer
	20 °C to 30 °C	in 2-pressure-generators DKD-R 5-1:2018	0,06 K	
	-30 °C to < 0 °C	in climatic chambers DKD-R 5-1:2018	0,10 K	
	0 °C to 100 °C		0,08 K	
	> 100 °C to 150 °C		0,10 K	
	-100 °C to 200 °C	in liquid baths DKD-R 5-1:2018	10 mK	
	250 °C to 550 °C	in salt baths DKD-R 5-1:2018	20 mK	
	-100 °C to < -50 °C	in dry block calibrators DKD-R 5-1:2018	0,13 K	
	-50 °C to 250 °C		0,10 K	
	> 250 °C to 500 °C		0,15 K	
	> 500 °C to 650 °C		0,17 K	
	-100 °C to 155 °C	in dry block calibrators DKD-R 5-1:2018	0,03 K	
	> 155 °C to 250 °C		0,06 K	Only for calibration items with sensors in metal protection tubes
> 250 °C to 650 °C	0,12 K			

¹⁾ The expanded uncertainties according to EA-4/02 M:2013 are part of CMC and are the best measurement uncertainties within accreditation. They have a coverage probability of approximately 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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Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
Temperature measuring chains or temperature probes with thermocouple sensors*)	20 °C to 30 °C	in 2-pressure-generators DKD-R 5-3:2018	0,3 K	Comparison with standard resistance thermometer
	-30 °C to 150 °C	in climatic chambers DKD-R 5-3:2018	0,3 K	
	-100 °C to 250 °C	in liquid baths or dry block calibrators DKD-R 5-3:2018	0,3 K	
	> 250 °C to 650 °C		0,8 K	
	500 °C to 1100 °C	in tube furnaces DKD-R 5-3:2018	1,5 K	Comparison with standard thermocouple
	> 1100 °C to 1200 °C		2,0 K	
Temperature indicators and simulators for resistance thermometers*)	-200 °C to 661 °C	DKD-R 5-5:2018	10 mK	Comparison with reference multimeter Characteristic curve according to DIN EN 60751:2009
	> 661 °C to 850 °C		20 mK	
Temperature indicators and simulators for base metal thermocouples*)	-200 °C to 1300 °C	DKD-R 5-5:2018	0,1 K	without reference junction compensation Characteristic curve according to DIN EN 60584-01:2014
	-200 °C to 1300 °C	DKD-R 5-5:2018	0,3 K	with reference junction compensation Characteristic curve according to DIN EN 60584-01:2014
Temperature indicators and simulators for noble metal thermocouples Type S, R*)	0 °C to 1768 °C	DKD-R 5-5:2010	0,2 K	without reference junction compensation Characteristic curve according to DIN EN 60584-01:2014
Temperature indicators and simulators for noble metal thermocouples Typ S, R*)	0 °C to 1768 °C	DKD-R 5-5:2010	0,3 K	with reference junction compensation Characteristic curve according to DIN EN 60584-01:2014

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Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
Temperature indicators and simulators for noble metal thermocouples Typ B*)	500 °C to 1820 °C	DKD-R 5-5:2010	0,2 K	without reference junction compensation Characteristic curve according to DIN EN 60584-01:2014
Temperature indicators and simulators for noble metal thermocouples Typ B*)	500 °C to 1820 °C	DKD-R 5-5:2010	0,3 K	with reference junction compensation Characteristic curve according to DIN EN 60584-01:2014
Velocity of gases	0,1 m/s to 65 m/s	AA070002: 2019-01	0,5 %, but not smaller than 0,01 m/s	wind tunnel: type Göttingen nozzle: 320 mm calibration standard: laser-Doppler anemometer
DC voltage Sources	0 V to < 0,2 V 0,2 V to < 2 V 2 V to < 20 V 20 V to < 200 V 200 V to 1000 V		0,2 μV + 5 · 10 ⁻⁶ · U 0,5 μV + 5 · 10 ⁻⁶ · U 5 μV + 5 · 10 ⁻⁶ · U 50 μV + 5 · 10 ⁻⁶ · U 0,5 mV + 5 · 10 ⁻⁶ · U	U: measured value
Measuring instruments	0 V to < 0,33 V 0,33 V to < 3,3 V 3,3 V to < 33 V 33 V to < 330 V 330 V to 1020 V		0,8 μV + 22 · 10 ⁻⁶ · U 1,4 μV + 10 · 10 ⁻⁶ · U 16 · 10 ⁻⁶ · U 0,1 mV + 16 · 10 ⁻⁶ · U 1,0 mV + 16 · 10 ⁻⁶ · U	U: measured value
DC current Sources	1 μA to < 200 μA 200 μA to < 2 mA 2 mA to < 20 mA 20 mA to < 200 mA 200 mA to < 2 A 2 A to 20 A		0,4 nA + 15 · 10 ⁻⁶ · I 4,0 nA + 15 · 10 ⁻⁶ · I 40 nA + 15 · 10 ⁻⁶ · I 0,8 μA + 45 · 10 ⁻⁶ · I 16 μA + 0,17 · 10 ⁻³ · I 0,4 mA + 0,37 · 10 ⁻³ · I	I: measured value
Measuring instruments	1 μA to < 330 μA 330 μA to < 3,3 mA 3,3 mA to < 33 mA 33 mA to < 330 mA 330 mA to < 1,1 A 1,1 A to < 3 A 3 A to < 11 A 11 A to 20,5 A		20 nA + 0,1 · 10 ⁻³ · I 40 nA + 77 · 10 ⁻⁶ · I 0,22 μA + 77 · 10 ⁻⁶ · I 2,2 μA + 77 · 10 ⁻⁶ · I 30 μA + 0,16 · 10 ⁻³ · I 30 μA + 0,28 · 10 ⁻³ · I 0,3 mA + 0,40 · 10 ⁻³ · I 0,3 mA + 0,78 · 10 ⁻³ · I	I: measured value

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Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement ¹⁾	Remarks
DC resistance Sources	0,1 Ω to < 2 Ω		$4 \mu\Omega + 15 \cdot 10^{-6} \cdot R$	R: measured value
	2 Ω to < 20 Ω		$20 \mu\Omega + 9 \cdot 10^{-6} \cdot R$	
	20 Ω to < 200 Ω		$40 \mu\Omega + 8 \cdot 10^{-6} \cdot R$	
	200 Ω to < 2 kΩ		$10 \cdot 10^{-6} \cdot R$	
	2 kΩ to < 20 kΩ		$10 \cdot 10^{-6} \cdot R$	
	20 kΩ to < 200 kΩ		$10 \cdot 10^{-6} \cdot R$	
	200 kΩ to < 2 MΩ		$14 \cdot 10^{-6} \cdot R$	
	2 MΩ to < 20 MΩ		$0,1 \text{ k}\Omega + 20 \cdot 10^{-6} \cdot R$	
	20 MΩ to < 200 MΩ		$10 \text{ k}\Omega + 0,11 \cdot 10^{-3} \cdot R$	
200 MΩ to 2 GΩ		$1 \text{ M}\Omega + 0,55 \cdot 10^{-3} \cdot R$		
Measuring instruments	0 Ω to < 11 Ω		$0,75 \text{ m}\Omega + 36 \cdot 10^{-6} \cdot R$	R: measured value
	11 Ω to < 33 Ω		$1,1 \text{ m}\Omega + 24 \cdot 10^{-6} \cdot R$	
	33 Ω to < 110 Ω		$1,0 \text{ m}\Omega + 22 \cdot 10^{-6} \cdot R$	
	110 Ω to < 330 Ω		$1,4 \text{ m}\Omega + 22 \cdot 10^{-6} \cdot R$	
	330 Ω to < 1,1 kΩ		$30 \cdot 10^{-6} \cdot R$	
	1,1 kΩ to < 3,3 kΩ		$35 \cdot 10^{-6} \cdot R$	
	3,3 kΩ to < 11 kΩ		$30 \cdot 10^{-6} \cdot R$	
	11 kΩ to < 33 kΩ		$35 \cdot 10^{-6} \cdot R$	
	33 kΩ to < 110 kΩ		$30 \cdot 10^{-6} \cdot R$	
	110 kΩ to < 330 kΩ		$40 \cdot 10^{-6} \cdot R$	
	330 kΩ to < 1,1 MΩ		$30 \cdot 10^{-6} \cdot R$	
	1,1 MΩ to < 3,3 MΩ		$80 \cdot 10^{-6} \cdot R$	
	3,3 MΩ to < 11 MΩ		$0,16 \cdot 10^{-3} \cdot R$	
	11 MΩ to < 33 MΩ		$0,30 \cdot 10^{-3} \cdot R$	
	33 MΩ to < 110 MΩ		$0,60 \cdot 10^{-3} \cdot R$	
110 MΩ to < 330 MΩ	$3,5 \cdot 10^{-3} \cdot R$			
330 MΩ to 1,1 GΩ		$18 \cdot 10^{-3} \cdot R$		
AC voltage Sources	10 mV to < 200 mV	10 Hz to 40 Hz	$4 \mu\text{V} + 0,14 \cdot 10^{-3} \cdot U$	U: measured value
		> 40 Hz to 10 kHz	$4 \mu\text{V} + 0,14 \cdot 10^{-3} \cdot U$	
		> 10 kHz to 30 kHz	$25 \mu\text{V} + 0,25 \cdot 10^{-3} \cdot U$	
		> 30 kHz to 100 kHz	$0,1 \text{ mV} + 0,30 \cdot 10^{-3} \cdot U$	
	0,2 V to < 2 V	10 Hz to 40 Hz	$20 \mu\text{V} + 0,11 \cdot 10^{-3} \cdot U$	
		> 40 Hz to 10 kHz	$20 \mu\text{V} + 0,10 \cdot 10^{-3} \cdot U$	
		> 10 kHz to 30 kHz	$40 \mu\text{V} + 0,20 \cdot 10^{-3} \cdot U$	
		> 30 kHz to 100 kHz	$0,2 \text{ mV} + 0,5 \cdot 10^{-3} \cdot U$	
	2 V to < 20 V	10 Hz to 40 Hz	$0,2 \text{ mV} + 0,11 \cdot 10^{-3} \cdot U$	
		> 40 Hz to 10 kHz	$0,2 \text{ mV} + 0,10 \cdot 10^{-3} \cdot U$	
		> 10 kHz to 30 kHz	$0,4 \text{ mV} + 0,20 \cdot 10^{-3} \cdot U$	
		> 30 kHz to 100 kHz	$2 \text{ mV} + 0,50 \cdot 10^{-3} \cdot U$	
20 V to < 200 V	10 Hz to 40 Hz	$2 \text{ mV} + 0,11 \cdot 10^{-3} \cdot U$		
	> 40 Hz to 10 kHz	$2 \text{ mV} + 90 \cdot 10^{-6} \cdot U$		
	> 10 kHz to 30 kHz	$4 \text{ mV} + 0,20 \cdot 10^{-3} \cdot U$		
	> 30 kHz to 100 kHz	$20 \text{ mV} + 0,50 \cdot 10^{-3} \cdot U$		
200 V to 1050 V	40 Hz to 10 kHz	$20 \text{ mV} + 0,12 \cdot 10^{-3} \cdot U$		

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AC voltage Measuring instruments	1 mV to < 33 mV	10 Hz to 45 Hz	$5 \mu\text{V} + 0,6 \cdot 10^{-3} \cdot U$	U: measured value
		> 45 Hz to 10 kHz	$5 \mu\text{V} + 0,12 \cdot 10^{-3} \cdot U$	
		> 10 kHz to 20 kHz	$5 \mu\text{V} + 0,15 \cdot 10^{-3} \cdot U$	
		> 20 kHz to 50 kHz	$5 \mu\text{V} + 0,75 \cdot 10^{-3} \cdot U$	
		> 50 kHz to 100 kHz	$10 \mu\text{V} + 3 \cdot 10^{-3} \cdot U$	
	33 mV to < 330 mV	10 Hz to 45 Hz	$5 \mu\text{V} + 0,40 \cdot 10^{-3} \cdot U$	
		> 45 Hz to 10 kHz	$5 \mu\text{V} + 0,18 \cdot 10^{-3} \cdot U$	
		> 10 kHz to 20 kHz	$5 \mu\text{V} + 0,25 \cdot 10^{-3} \cdot U$	
		> 20 kHz to 50 kHz	$5 \mu\text{V} + 0,50 \cdot 10^{-3} \cdot U$	
		> 50 kHz to 100 kHz	$20 \mu\text{V} + 0,80 \cdot 10^{-3} \cdot U$	
	330 mV to < 3,3 V	10 Hz to 45 Hz	$35 \mu\text{V} + 0,28 \cdot 10^{-3} \cdot U$	
		> 45 Hz to 10 kHz	$25 \mu\text{V} + 0,18 \cdot 10^{-3} \cdot U$	
		> 10 kHz to 20 kHz	$45 \mu\text{V} + 0,20 \cdot 10^{-3} \cdot U$	
		> 20 kHz to 50 kHz	$25 \mu\text{V} + 0,30 \cdot 10^{-3} \cdot U$	
		> 50 kHz to 100 kHz	$0,80 \cdot 10^{-3} \cdot U$	
	3,3 V to < 33 V	10 Hz to 45 Hz	$0,30 \text{ mV} + 0,30 \cdot 10^{-3} \cdot U$	
		> 45 Hz to 10 kHz	$0,30 \text{ mV} + 0,20 \cdot 10^{-3} \cdot U$	
		> 10 kHz to 20 kHz	$0,15 \text{ mV} + 0,28 \cdot 10^{-3} \cdot U$	
		> 20 kHz to 50 kHz	$0,15 \text{ mV} + 0,35 \cdot 10^{-3} \cdot U$	
		> 50 kHz to 100 kHz	$0,15 \text{ mV} + 1,0 \cdot 10^{-3} \cdot U$	
33 V to < 330 V	45 Hz to 1 kHz	$0,2 \text{ mV} + 0,20 \cdot 10^{-3} \cdot U$		
	> 1 kHz to 10 kHz	$0,2 \text{ mV} + 0,28 \cdot 10^{-3} \cdot U$		
	> 10 kHz to 20 kHz	$0,1 \text{ mV} + 0,35 \cdot 10^{-3} \cdot U$		
	> 20 kHz to 50 kHz	$4 \text{ mV} + 0,50 \cdot 10^{-3} \cdot U$		
	> 50 kHz to 100 kHz	$30 \text{ mV} + 2,0 \cdot 10^{-3} \cdot U$		
330 V to 1020 V	45 Hz to 10 kHz	$0,25 \cdot 10^{-3} \cdot U$		
AC current Sources	1 μA to < 200 μA	1 Hz to 10 kHz	$0,03 \mu\text{A} + 0,43 \cdot 10^{-3} \cdot I$	I: measured value
	200 μA to < 2 mA	10 Hz to 10 kHz	$0,30 \mu\text{A} + 0,28 \cdot 10^{-3} \cdot I$	
	2 mA to < 20 mA	10 Hz to 10 kHz	$2,2 \mu\text{A} + 0,32 \cdot 10^{-3} \cdot I$	
	20 mA to < 200 mA	10 Hz to 10 kHz	$22 \mu\text{A} + 0,3 \cdot 10^{-3} \cdot I$	
	200 mA to < 2 A	10 Hz to 2 kHz	$0,22 \text{ mA} + 0,65 \cdot 10^{-3} \cdot I$	
	2 A to 20 A	10 Hz to 2 kHz	$2 \text{ mA} + 0,85 \cdot 10^{-3} \cdot I$	

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AC current Measuring instruments	29 µA to < 330 µA	45 Hz to 1 kHz	$0,1 \mu\text{A} + 1 \cdot 10^{-3} \cdot f$	f: measured value
		> 1 kHz to 5 kHz	$0,2 \mu\text{A} + 3 \cdot 10^{-3} \cdot f$	
		> 5 kHz to 10 kHz	$0,2 \mu\text{A} + 6 \cdot 10^{-3} \cdot f$	
	330 µA to < 3,3 mA	45 Hz to 1 kHz	$0,15 \mu\text{A} + 0,8 \cdot 10^{-3} \cdot f$	
		> 1 kHz to 5 kHz	$0,30 \mu\text{A} + 2 \cdot 10^{-3} \cdot f$	
		> 5 kHz to 10 kHz	$0,30 \mu\text{A} + 4 \cdot 10^{-3} \cdot f$	
	3,3 mA to < 33 mA	45 Hz to 1 kHz	$2 \mu\text{A} + 0,5 \cdot 10^{-3} \cdot f$	
		> 1 kHz to 5 kHz	$3 \mu\text{A} + 0,7 \cdot 10^{-3} \cdot f$	
		> 5 kHz to 10 kHz	$3 \mu\text{A} + 1,5 \cdot 10^{-3} \cdot f$	
	33 mA to < 330 mA	45 Hz to 1 kHz	$20 \mu\text{A} + 0,4 \cdot 10^{-3} \cdot f$	
		> 1 kHz to 5 kHz	$0,1 \text{ mA} + 0,8 \cdot 10^{-3} \cdot f$	
		> 5 kHz to 10 kHz	$0,1 \text{ mA} + 1,6 \cdot 10^{-3} \cdot f$	
	330 mA to < 1,1 A	45 Hz to 1 kHz	$50 \mu\text{A} + 0,45 \cdot 10^{-3} \cdot f$	
		> 1 kHz to 5 kHz	$0,7 \text{ mA} + 0,6 \cdot 10^{-3} \cdot f$	
	1,1 A to < 3 A	45 Hz to 1 kHz	$0,1 \text{ mA} + 0,6 \cdot 10^{-3} \cdot f$	
> 1 kHz to 5 kHz		$0,7 \text{ mA} + 5 \cdot 10^{-3} \cdot f$		
3 A to < 11 A	45 Hz to 100 Hz	$2 \text{ mA} + 0,6 \cdot 10^{-3} \cdot f$		
	> 100 Hz to 1 kHz	$2 \text{ mA} + 1 \cdot 10^{-3} \cdot f$		
11 A to 20,5 A	45 Hz to 100 Hz	$5 \text{ mA} + 1,2 \cdot 10^{-3} \cdot f$		
	> 100 Hz to 1 kHz	$5 \text{ mA} + 1,5 \cdot 10^{-3} \cdot f$		
Frequency Sources	10 Hz to 1,0 MHz		$20 \mu\text{Hz} + 13 \cdot 10^{-6} \cdot f$	f: measured value
Measuring instruments	0,01 Hz to < 120 Hz		$11 \text{ mHz} + 1 \cdot 10^{-6} \cdot f$	f: measured value
	120 Hz to < 1,2 kHz		$0,11 \text{ Hz} + 1 \cdot 10^{-6} \cdot f$	
	1,2 kHz to < 12 kHz		$1,1 \text{ Hz} + 1 \cdot 10^{-6} \cdot f$	
	12 kHz to < 0,12 MHz		$11 \text{ Hz} + 1 \cdot 10^{-6} \cdot f$	
	0,12 MHz to < 1,2 MHz		$0,11 \text{ kHz} + 1 \cdot 10^{-6} \cdot f$	
	1,2 MHz to 2,0 MHz		$1,1 \text{ kHz} + 1 \cdot 10^{-6} \cdot f$	

Abbreviations used:

AA	In house procedure of Ahlborn Mess- und Regelungstechnik GmbH
CMC	Calibration and measurement capabilities
DKD-R	Calibration Guideline of Deutscher Kalibrierdienst (DKD), published by Physikalisch-Technische Bundesanstalt (PTB)

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