German Accreditation Body

Annex to the partial accreditation certificate D-K-15070-01-01 according to DIN EN ISO/IEC 17025:2018

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This document attachment is part of the accreditation certificate D-K-15070-01-00.

Partial Accreditation Certificate Holder:

Testo Industrial Services GmbH
Gewerbestraße 3, 79199 Kirchzarten,
Germany

The German original version
„Anlage zur Akkreditierungsurkunde D-K-15070-01-01 nach DIN EN ISO/IEC 17025:2018“
is valid.

The calibration laboratory meets the requirements according to DIN EN ISO/IEC 17025:2018 to perform the conformity assessment activities listed in this annex. The calibration laboratory shall comply with additional legal and normative requirements, where applicable, including those in relevant sectoral programs, provided that they are explicitly confirmed below.

The requirements for the management system in DIN EN ISO/IEC 17025 are written in a language relevant for calibration laboratories and are overall in accordance with the principles of DIN EN ISO 9001.

Other locations:

Calibration laboratory Kirchzarten, Erich-Rieder Straße 4, 79199 Kirchzarten
Calibration laboratory Munich, Nikolaus-Otto-Straße 2, 85221 Dachau
Calibration laboratory Essen, Alte Landstraße 3c, 45329 Essen
Calibration laboratory Hamburg, Meiendorfer Straße 205, 22145 Hamburg
Calibration laboratory Mörfelden-Walldorf, Kurhessenstraße 11, 64546 Mörfelden-Walldorf
Calibration laboratory Winsen, Tönnhäuser Weg 100-106, 21423 Winsen (Luhe)

This deed annex is valid only together with the deed issued in writing and reflects the status at the date of issue. The current status of valid and monitored accreditation can be found in the database of accredited bodies of the German Accreditation Body (www.dakks.de)

Electrical measurands

DC and low frequency measurands

- **DC voltage [a), b)]**
- **AC voltage [a), b)]**
- **DC current strength [a), b)]**
- **AC current strength [a), b)]**
- **AC/DC transfer**
- **Electrical power [a), b)]**
- **Phase angle**
- **DC resistance [a), b)]**
- **AC resistance**
- **Capacity [a), b)]**
- **Inductance**
- **Tension ratio [a), b)]**
- **High voltage measurands [a)]**

Time and frequency

- **Time interval [a), b)]**
- **Frequency and speed [a), b)]**

High-frequency measured variables

- **RF impedance (reflection coefficient) [a), b)]**
- **RF power [a), b)]**
- **RF attenuation [a), b)]**
- **RF noise**
- **Modulation measurands**
- **Oscilloscope measured variables [a), b)]**
- **Rise time [a), b)]**
- **Bandwidth [a), b)]**
- **Pulsed measurands [a), b)]**

Dimensional measurands

Length

- **Diameter [a), b)]**
- **Thread [a), b)]**
- **Parallel gauge blocks**
- **Linear encoders [a), b)]**
- **length measuring equipment**
- **Line dimensions, distances**

Angle

- **Inclinometers**
- **Angle of rotation**

Coordinate measuring technology

- **Coordinate measuring machines [c)]**

a) also on-site calibration
b) Mobile laboratory
c) On-site calibration only

Within themeasurands/calibration items markedwith ***)** , the calibration laboratory is permitted to apply the standards/calibration guidelines listed here with different editions without requiring prior information and approval by DAkkS. The calibration laboratory has an up-to-date list of all standards/calibration guidelines in the flexible accreditation area.

Location Calibration laboratory Kirchzarten, Erich-Rieder Straße 4, 79199 Kirchzarten

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range			Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC voltage	0 V				0.1 µV	*U* = measured value
Measuring devices	1 µV	to	220 mV		7.5 · 10^{-6} *U* 0.5 µV	
	> 220 mV	to	2,2 V		5 · 10^{-6} *U* 0.7 µV	
	> 2,2 V	to	11 V		3.5 · 10^{-6} *U* 2.5 µV	
	> 11 V	to	22 V		3.5 · 10^{-6} *U* 4 µV	
	> 22 V	to	220 V		5 · 10^{-6} *U* 40 µV	
	> 220 V	to	1000 V		6.5 · 10^{-6} *U* 0.4 mV	
Sources	0 V				0.1 µV	
	1 µV	to	200 mV		5.8 · 10^{-6} *U* 0.2 µV	
	> 200 mV	to	2 V		2.9 · 10^{-6} *U* 0.3 µV	
	> 2 V	to	20 V		2.9 · 10^{-6} *U* 0.55 µV	
	> 20 V	to	200 V		4 · 10^{-6} *U* 35 µV	
	> 200 V	to	1000 V		4.5 · 10^{-6} *U* 0.55 mV	
High Voltage	> 1 kV	to	50 kV		0.4 · 10^{-3} *U*	
Direct current strength	0 A				0.2 nA	*I* = measured value
Sources and	0.1 µA	to	< 1 µA		35 · 10^{-6} *I* 21 pA	
Measuring devices	1 µA	to	< 10 µA		50 · 10^{-6} *I* 6 pA	
	10 µA	to	< 100 µA		15 · 10^{-6} *I* 0.4 nA	
	100 µA	to	320 mA		18 · 10^{-6} *I*	
	> 320 mA	to	1 A		15 · 10^{-6} *I* 6 µA	
	> 1 A	to	10 A		0.2 · 10^{-3} *I*	
	> 10 A	to	1000 A		0.3 · 10^{-3} *I*	
Current clamps	1 mA	to	2,2 A		1 · 10^{-3} *I*	
	> 2,2 A	to	20 A		2 · 10^{-3} *I*	
	> 20 A	to	1000 A		3 · 10^{-3} *I*	
Current transformer	1 A to 120 A				0.22 · 10^{-3} *I*	
	> 120 A to 1000 A				0.25 · 10^{-3} *I*	
Direct current-resistance	0 Ω	to	< 1 mΩ		1,3 µΩ	*R* = measured value
	1 mΩ	to	10 mΩ		7 · 10^{-6} *R*	
	> 10 mΩ	to	10 MΩ		4 · 10^{-6} *R*	
	> 10 MΩ	to	100 MΩ		8 · 10^{-6} *R*	
	> 100 MΩ	to	10 GΩ		0.17 · 10^{-3} *R*	
	> 10 GΩ	to	100 GΩ		0.21 · 10^{-3} *R*	
	> 100 GΩ	to	1 TΩ		0.35 · 10^{-3} *R*	
	> 1 TΩ	to	10 TΩ		0.6 · 10^{-3} *R*	
	> 10 TΩ	to	100 TΩ		29 · 10^{-3} *R*	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range			Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC power meters	1 mW	to	< 220 W	1 mV to 0.22 V 1 A to 1000 A	$0.6 \cdot 10^{-3} P$	
	1 mW	to	320 W	0.22 V to 1000 V 0.1 mA to 0.32 A	$20 \cdot 10^{-6} P$	
	> 70 mW	to	1 kW	0.22 V to 1000 V > 0.32 A to 1 A	$35 \cdot 10^{-6} P$	
	> 0,22 W	to	10 kW	0.22 V to 1000 V > 1 A to 10 A	$0.2 \cdot 10^{-3} P$	
	> 2,2 W	to	1 MW	0.22 V to 1000 V > 10 A to 1000 A	$0.3 \cdot 10^{-3} P$	
DC power sources	1 mW	to	< 200 W	1 mV to 0.2 V 1 A to 1000 A	$0.4 \cdot 10^{-3} P$	
	1 mW	to	320 W	0.2 V to 1000 V 0.1 mA to 0.32 A	$20 \cdot 10^{-6} P$	
	> 64 mW	to	1 kW	0.2 V to 1000 V > 0.32 A to 1 A	$35 \cdot 10^{-6} P$	
	> 0,2 W	to	10 kW	0.2 V to 1000 V > 1 A to 10 A	$0.2 \cdot 10^{-3} P$	
	> 2 W	to	1 MW	0.2 V to 1000 V > 10 A to 1000 A	$0.3 \cdot 10^{-3} P$	
AC voltage Measuring devices and Sources	1 mV	to	2.2 mV	10 Hz to 20 Hz	$0.52 \cdot 10^{-3} U$	U = measured value
				> 20 Hz to 40 Hz	$0.52 \cdot 10^{-3} U$	
				> 40 Hz to 20 kHz	$0.40 \cdot 10^{-3} U$	
				> 20 kHz to 50 kHz	$0.40 \cdot 10^{-3} U$	
				> 50 kHz to 100 kHz	$0.41 \cdot 10^{-3} U$	
				> 100 kHz to 300 kHz	$0.46 \cdot 10^{-3} U$	
				> 300 kHz to 500 kHz	$0.55 \cdot 10^{-3} U$	
				> 500 kHz to 1 MHz	$0.60 \cdot 10^{-3} U$	
	> 2.2 mV	to	7 mV	10 Hz to 20 Hz	$0.22 \cdot 10^{-3} U$	
				> 20 Hz to 40 Hz	$0.22 \cdot 10^{-3} U$	
				> 40 Hz to 20 kHz	$0.16 \cdot 10^{-3} U$	
				> 20 kHz to 50 kHz	$0.16 \cdot 10^{-3} U$	
				> 50 kHz to 100 kHz	$0.20 \cdot 10^{-3} U$	
				> 100 kHz to 300 kHz	$0.22 \cdot 10^{-3} U$	
				> 300 kHz to 500 kHz	$0.33 \cdot 10^{-3} U$	
				> 500 kHz to 1 MHz	$0.45 \cdot 10^{-3} U$	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 7 mV to 22 mV	10 Hz to 20 Hz	$80 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$80 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$65 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$75 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$75 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$95 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.19 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.21 \cdot 10^{-3}\ U$	
	> 22 mV to 70 mV	10 Hz to 20 Hz	$70 \cdot 10^{-6}$ U	
		> 20 Hz to 40 Hz	$58 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$35 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$35 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$45 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$55 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.11 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 mV to 220 mV	10 Hz to 20 Hz	$39 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$35 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$25 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$25 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$28 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$42 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$85 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.1 \cdot 10^{-3}\ U$	
	> 220 mV to 700 mV	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 2 0 Hz to 40 Hz	$22 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$12 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$12 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$14 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$27 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$40 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 700 mV to 2,2 V	10 Hz to 20 Hz	$20 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$14 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$10 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$10 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$11 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$22 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$68 \cdot 10^{-6}\ U$	
	> 2,2 V to 7 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$12 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$13 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$95 \cdot 10^{-6}\ U$	
	> 7 V to 22 V	10 Hz to 20 Hz	$17 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1MHz	$0.11 \cdot 10^{-3}\ U$	
	> 22 V to 70 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$15 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$15 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$40 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 V to 220 V	10 Hz to 20 Hz	$19 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$18 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$17 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$17 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$32 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 220 V to 1000 V	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$ $27 \cdot 10^{-6}\ U$ $45 \cdot 10^{-6}\ U$ $45 \cdot 10^{-6}\ U$ $65 \cdot 10^{-6}\ U$	*U* = measured value
High Voltage	> 1 kV to 30 kV > 30 kV to 50 kV	50 Hz 50 Hz	$0.5 \cdot 10^{-3}$ U $0.6 \cdot 10^{-3}$ U	
AC power Sources and Measuring devices (areas)	100 µA to 1 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$120 \cdot 10^{-6}\ I$ $160 \cdot 10^{-6}\ I$ $60 \cdot 10^{-6}\ I$	*I* = measured value
	> 1 mA to 10 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$46 \cdot 10^{-6}\ I$	
	> 10 mA to 1 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$17 \cdot 10^{-6}\ I$	
	> 1 A to 10 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$32 \cdot 10^{-6}\ I$	
	> 10 A to 20 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$39 \cdot 10^{-6}\ I$	
	> 20 A to 100 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$69 \cdot 10^{-6}\ I$ $69 \cdot 10^{-6}\ I$ $0.17 \cdot 10^{-3}\ I$	
Current clamps	1 mA to 2,2 A > 2,2 A to 20 A > 20 A to 800 A	40 Hz to 5 kHz 40 Hz to 5 kHz 40 Hz to 65 Hz	$2 \cdot 10^{-3}\ I$ $3 \cdot 10^{-3}\ I$ $4 \cdot 10^{-3}\ I$	*I* = measured value
Current transformer	1 A to 120 A 1 A to 120 A > 120 A to 600 A > 120 A to 1000 A	40 Hz to 850 Hz > 850 Hz to 2 kHz 40 Hz to 400 Hz 40 Hz to 65 Hz	$0.16 \cdot 10^{-3}\ I$ $0.47 \cdot 10^{-3}\ I$ $0.52 \cdot 10^{-3}\ I$ $0.6 \cdot 10^{-3}\ I$	
Alternating current-resistance Areas	0,1 Ω to < 0,316 Ω	10 Hz to < 20Hz 20 Hz to 500 Hz > 500 Hz to 1 kHz	$0,2 - 10^{-3}\ R$ $50 - 10^{-6}\ R$ $0,2 - 10^{-3}\ R$	*R* = measured value
	0,316 Ω to 3,16 Ω	10 Hz to 30 Hz > 30 Hz to 55 Hz > 55 Hz to 1 kHz	$30 - 10^{-6}\ R$ $20 - 10^{-6}\ R$ $30 - 10^{-6}\ R$	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Alternating current resistor Areas	> 3,16 Ω to 10 Ω	10 Hz to 30 Hz > 30 Hz to 55 Hz > 55 Hz to 1 kHz	25 - 10^{-6} *R* 40 µΩ 9 - 10^{-6} *R* 60 µΩ 25 - 10^{-6} *R* 40 µΩ	
Cargo Charge amplifiers, Charge meters	10 pC to 10^5 pC	50 Hz to 10 kHz > 10 kHz to 20 kHz > 20 kHz to 50 kHz	0,4 % 0,6 % 1,0 %	
Phase angle Between current and voltage measuring devices	-180° to 180°	10 V to 1000 V 0.1 A to 50 A 45 Hz to 65 Hz > 65 Hz to 180 Hz > 180 Hz to 450 Hz > 450 Hz to 850 Hz > 850 Hz to 3 kHz > 3 kHz to 6 kHz	 0,0051° 0,0075° 0,018° 0,033° 0,12° 0,23°	
		10 V to 1000 V > 50 A to 80 A 45 Hz to 65 Hz > 65 Hz to 180 Hz > 180 Hz to 450 Hz > 450 Hz to 850 Hz > 850 Hz to 3 kHz	 0,0052° 0,0083° 0,025° 0,05° 0,25°	
		10 V to 1000 V > 80 A to 120 A 45 Hz to 65 Hz > 65 Hz to 180 Hz > 180 Hz to 450 Hz > 450 Hz to 850 Hz > 850 Hz to 3 kHz > 3 kHz to 6 kHz	 0,0055° 0,0091° 0,020° 0,035° 0,25° 0,5°	
Phase angle between voltages Measuring devices	-180° to 180°	10 V to 1000 V 45 Hz to 65 Hz > 65 Hz to 180 Hz > 180 Hz to 450 Hz > 450 Hz to 850 Hz > 850 Hz to 3 kHz > 3 kHz to 6 kHz	 0,006° 0,0075° 0,025° 0,043° 0,15° 0,3°	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between tensions Sources	-180° to 180	0.05 V to 2 V Measuring frequency: 40 Hz to 65 Hz 0.05 V to 0.2 V Measuring frequency: > 65 Hz to 1 kHz > 1 kHz to 2 kHz > 0.2 V to 2 V Measuring frequency: > 65 Hz to 1 kHz > 1 kHz to 2 kHz	0,015° 0,03° 0,055° 0,02° 0,035°	
Electrical power Alternating current effect-performance	5 mW up to 50 kW > 2.5 W to 120 kW	1 V to 1000 V 45 Hz to 65 Hz ±0.05 ≤ cos Φ_F ≤ ±1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ However, not smaller than 80 - 10^{-6} 0,14 - 10^{-3}	w: Uncertainty of the amplitude of the voltage fundamental w(IF): Uncertainty of the amplitude of the current fundamentals w(Φ_F): Uncertainty of the phase shift angle w(U_{rmc}): Uncertainty of the stress rms value w(I_{rmc}): Uncertainty of the current rms value
AC blind- performance	5 mvar to 50 kvar > 2.5 var up to 120 kvar	1 V to 1000 V 45 Hz to 65 Hz ±0.05 ≤ sin Φ_F ≤ ±1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ However, not smaller than 80 - 10^{-6} 0,14 - 10^{-3}	
Apparent power	0.1 VA up to 50 kVA > 50 VA to 120 kVA	1 V to 1000 V 45 Hz to 65 Hz 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ However, not smaller than 80 - 10^{-6} 0,14 - 10^{-3}	
Stress ratio	± 2 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.04 µV/V 0.05 µV/V 0.12 µV/V	Calibration of 350 Ω bridge standards and the associated indicators at discrete points In 10 % steps
	± 2 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.04 µV/V 0.04 µV/V 0.12 µV/V	
	± 5 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 4.8 kHz	 0.06 µV/V 0.22 µV/V	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Stress ratio	± 10 mV/V	Bridge voltage: 5 V		
		Measuring frequency 225 Hz	0.06 µV/V	
		Measuring frequency 4.8 kHz	0.45 µV/V	
	± 5 mV/V	Bridge voltage: 2,5 V		
		Measuring frequency 225 Hz	0.06 µV/V	
		Measuring frequency 600 Hz	0.06 µV/V	
		Measuring frequency 4.8 kHz	0.22 µV/V	
	± 10 mV/V	Bridge voltage: 2,5 V		Calibrate 350 Ω Bridge standards and the associated display devices at discrete points In 10 % steps
		Measuring frequency 225 Hz	0.06 µV/V	
		Measuring frequency 600 Hz	0.10 µV/V	
		Measuring frequency 4.8 kHz	0.45 µV/V	
	± 10 mV/V	Bridge voltage: 1 V		
		Measuring frequency 600 Hz	0.11 µV/V	
	± 20 mV/V	Bridge voltage: 1 V		
		Measuring frequency 4.8 kHz	0.6 µV/V	
	± 100 mV/V	Bridge voltage: 1 V		
		Measuring frequency 4.8 kHz	3.5 µV/V	
	± 100 mV/V	Bridge voltage: 2,5 V		
		Measuring frequency 4.8 kHz	4.0 µV/V	
Stress ratio DC voltage, bridge standards	0 mV/V	Bridge voltage: 0,5 V	2.0 µV/V	
	-2 mV/V to 2 mV/V		2.5 µV/V	
	-5 mV/V to 5 mV/V		2.5 µV/V	
	-10 mV/V to 10 mV/V		2.5 µV/V	
	-20 mV/V to 20 mV/V		2.5 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
	0 mV/V	Bridge voltage: 1 V	1.0 µV/V	
	-2 mV/V to 2 mV/V		2.0 µV/V	
	-5 mV/V to 5 mV/V		2.0 µV/V	
	-10 mV/V to 10 mV/V		2.0 µV/V	
	-20 mV/V to 20 mV/V		2.0 µV/V	
	-100 mV/V to 100 mV/V		2.0 µV/V	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Stress ratio		Bridge voltage:		
DC voltage,	0 mV/V		0.5 µV/V	
Bridge standards	-2 mV/V to 2 mV/V		0.5 µV/V	
	-5 mV/V to 5 mV/V	2,5 V	0.5 µV/V	
	-10 mV/V to 10 mV/V		0.5 µV/V	
	-20 mV/V to 20 mV/V		0.5 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
		Bridge voltage:		
	0 mV/V		0.30 µV/V	
	-2 mV/V to 2 mV/V		0.25 µV/V	
	-5 mV/V to 5 mV/V	5 V	0.25 µV/V	
	-10 mV/V to 10 mV/V		0.25 µV/V	
	-20 mV/V to 20 mV/V		0.35 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
		Bridge voltage:		
	0 mV/V		0.20 µV/V	
	-2 mV/V to 2 mV/V		0.20 µV/V	
	-5 mV/V to 5 mV/V	7,5 V	0.20 µV/V	
	-10 mV/V to 10 mV/V		0.20 µV/V	
	-20 mV/V to 20 mV/V		0.3 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
		Bridge voltage:		
	0 mV/V		0.10 µV/V	
	-2 mV/V to 2 mV/V		0.15 µV/V	
	-5 mV/V to 5 mV/V	10 V	0.15 µV/V	
	-10 mV/V to 10 mV/V		0.20 µV/V	
	-20 mV/V to 20 mV/V		0.3 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
Stress ratio		Bridge voltage:		
DC voltage	-2 mV/V to 2 mV/V		0.35 µV/V	
Bridges, gauges,	-5 mV/V to 5 mV/V		0.35 µV/V	
Measuring amplifier	-10 mV/V to 10 mV/V	0,5 V	0.40 µV/V	
	-20 mV/V to 20 mV/V		0.55 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
		Bridge voltage:		
	-2 mV/V to 2 mV/V		0.20 µV/V	
	-5 mV/V to 5 mV/V		0.20 µV/V	
	-10 mV/V to 10 mV/V	1 V	0.3 µV/V	
	-20 mV/V to 20 mV/V		0.5 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Stress ratio		Bridge voltage:		
DC voltage	-2 mV/V to 2 mV/V		0.10 µV/V	
Bridges, gauges,	-5 mV/V to 5 mV/V		0.15 µV/V	
Measuring amplifier	-10 mV/V to 10 mV/V	2.5 V; 5 V; 7.5 V; 10 V	0.25 µV/V	
	-20 mV/V to 20 mV/V		0.45 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Frequency	10 MHz	Measuring time > 30 min	$1 \cdot 10^{-11}\ f$	f = current measured value
Frequency measurement	1 mHz to 46 GHz	Measuring time > 5 min	$1 \cdot 10^{-10}\ f$	
Frequency synthesis	1 mHz to 50 GHz		$1 \cdot 10^{-10}\ f$	
Time interval	1 ns to 1000 s		$1 \cdot 10^{-10}\ f$ not smaller than 1 ns	Trigger uncertainties must be taken into account
Speed Optical	1 min^{-1} up to $2 \cdot 10^{5}$ min^{-1}	with light pulse generator	$6 \cdot 10^{-6}$ not less than 0.001 min^{-1}	
Mechanical	1 min^{-1} up to 10000 min^{-1}		$4 \cdot 10^{-4}$ not less than 0.01 min^{-1}	
Capacity Gauges	1 nF to 100 nF	50 Hz to 10 kHz	$1.0 \cdot 10^{-3}$ C	C: measured value with normal capacitances
	> 100 nF to 1000 nF	50 Hz to 1 kHz	$1.0 \cdot 10^{-3}$ C	
		> 1 kHz to 10 kHz	$2.5 \cdot 10^{-3}$ C	
	190 pF to < 400 pF	10 Hz to 10 kHz	$4 \cdot 10^{-3}$ C 8 pF	with 5520A / 5522A
	400 pF to < 1.1 nF	10 Hz to 10 kHz	$4.5 \cdot 10^{-3}$ C 8 pF	
	1.1 nF to < 3.3 nF	10 Hz to 3 kHz	$4.0 \cdot 10^{-3}$ C 8 pF	
	3.3 nF to < 11 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3}$ C 8 pF	
	11 nF to < 33 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3}$ C 80 pF	
	33 nF to < 110 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3}$ C 80 pF	
	110 nF to < 330 nF	10 Hz to 1 kHz	$4.5 \cdot 10^{-3}$ C	
	330 nF to < 1.1 µF	10 Hz to 600 Hz	$4.5 \cdot 10^{-3}$ C	
	1.1 µF to < 3.3 µF	10 Hz to 300 Hz	$4.5 \cdot 10^{-3}$ C	
	3.3 µF to < 11 µF	10 Hz to 150 Hz	$4.5 \cdot 10^{-3}$ C	
	11 µF to < 33 µF	10 Hz to 120 Hz	$6.0 \cdot 10^{-3}$ C	
	33 µF to < 110 µF	10 Hz to 80 Hz	$6.5 \cdot 10^{-3}$ C	
	110 µF to < 330 µF	DC to 50 Hz	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	DC to 20 Hz	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	DC to 6 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF	DC to 2 Hz	$6.0 \cdot 10^{-3}$ C	
	11 mF to < 33 mF	DC to 0.6 Hz	$8.0 \cdot 10^{-3}$ C	
	33 mF to 110 mF	DC to 0.2 Hz	$11 \cdot 10^{-3}$ C	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - High-frequency measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Oscilloscope measurement quantities		Square wave voltage 10 Hz to 10 kHz		
Deflection vertical	1 mV to 5V	R_i= 50 Ω	0,35 %	R_i = internal resistance
Deflection horizontal	1 mV to 120 V	R_i = 1 MΩ Time markers or sines	0,35 %	
	50 ps to < 1 µ s	< 1 V	6 ps	
	1 µs to 5 s		$1.5 \cdot 10^{-3}\, t$	
Rise time t_r	25 ps to 245 hp	500 mV	9 ps	t_r = natural rise time of the oscilloscope
	> 245 hp to 10 ms	250 mV	$35 \cdot {}^{10\text{-}3}\, t_r$	
	150 ps to 10 ms	> 250 mv to 2.5 V	$35 \cdot {}^{10\text{-}3}\, t_r$ 5 ps	
	250 ps to 10 ms		$35 \cdot {}^{10\text{-}3}\, t_r$ 8 ps	
Bandwidth B	f_c 50 MHz to 26.5 GHz	0.2 V to 2 V R_i = 50 Ω	3 % f_c	f_c = frequency -3dB point
RF attenuation	0 dB to 60 dB	300 kHz to 6 GHz	0.3 dB	Connector 50 Ω: N50
RF transmission Phase angle ϕ	-180° to 180°	300 kHz to 6 GHz	U_T - 180°/π K - f	U_T=arcsin($^{10U/2}{}^{0}$ - 1) K: 0.1°/GHz U: Uncertainty of the Attenuation in dB
RF impedance Reflection coefficient Amount $\lvert\Gamma\rvert$	0 to 1	300 kHz to 2 GHz > 2 GHz to 6 GHz	0,005 0,005 Γ^2 0,009 0,005 Γ^2	Connector 50 Ω: N50
Phase angle ϕ	-180° to 180°	0,1 <$\lvert\Gamma\rvert$< 1 300 kHz to 6 GHz	$\arcsin \frac{U_T}{T} \frac{180°}{n}$	Connector 50 Ω: N50
HF power	0.1 mW to 10 mW	9 kHz to 50 MHz > 50 MHz to 5 GHz > 5 GHz to 18 GHz > 18 GHz to 26.5 GHz	$17 \cdot 10^{-3}\, P$ $22 \cdot 10^{-3}\, P$ $30 \cdot 10^{-3}\, P$ $40 \cdot 10^{-3}\, P$	Connector 50 Ω: N50; PC-3.5
Amplitude modulation Modulation depth m	0 to 1,0	f_{MOD} < 1 MHz	0,025 m 0,004	f_{HF} = carrier frequency f_{HF} < 4 GHz f_{MOD} = modulation frequency Δf= frequency deviation
Frequency modulation Frequency deviation Δf	0 to 5 MHz		0.041 Δf 25 Hz	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - High-frequency measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase modulation Phase deviation $\Delta\Phi$	0 to (4 MHz / f_{MOD}) rad		0.041 $\Delta\Phi$ 0.025 rad	$\Delta\Phi$ = phase deviation
Total Harmonic Distortion	0 to 0,3	100 Hz to 50 kHz	0.0165 *THD* 0.0001	
THD / distortion factor	0 to 0,3	100 kHz to 2 GHz	0.0675 *THD* 0.0001	
THD_{Audio}	0 to 0,3	100 Hz to 50 kHz	0.007 $_{THDAudio}$ 0.001	
Flicker*) $\Delta U / U$	0.4 to 5	DIN EN 61000-4-15:2011	$7 \cdot 10^{-3} \Delta U / U$	
Frequency	0.0083 Hz to 40 Hz		$3 \cdot 10^{-3} \Delta U / U$	
$_{Pst}$ (Short Term)	10 minutes	(115 V, 60 Hz); (230 V 50 Hz)	0,5 %	
$_{Plt}$ (Long Term)	2 hours	(115 V, 60 Hz); (230 V 50 Hz)	1,7 %	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Length *)				
cylindrical setting standards, ring gauges:				
Diameter	1 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006	0.8 µm 2 · 10^{-6} · d	d = is the measured Diameter
Plug gauges: Diameter	1 mm to 200 mm	Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	0.8 µm 2 · 10^{-6} · d	
Test pins: Diameter	0.1 mm to 30 mm	VDI/VDE/DGQ 2618 Sheet 4.2:2007 Point 3.2.2 (Opt. 1)	0.8 µm 2 · 10^{-6} · d	
Thread gauges (single and multiple cylindrical External and internal threads with straight flanks, symmetrical profile)				
Threaded mandrels: simple Flank diameter	1.4 mm to 200 mm nominal pitch: 0.3 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.8:2006 Point 3.2.2 (Opt. 1)	3 µm 10 · 10^{-6} · d	Three-wire method d = is the measured diameter
Threaded rings: simple pitch diameter	3 mm to 200 mm nominal pitch: 0.5 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.9:2006 Point 3.2.2 (Opt. 1)	3 µm 10 · 10^{-6} · d	Two-ball method d = is the measured diameter
Threaded mandrels: simple pitch diameter	1.4 mm to 200 mm Nominal diameter	VDI/VDE/DGQ 2618 Sheet 4.8:2006	3 µm 10 · 10^{-6} · d	Scanning process d = is the measured Diameter
Outer diameter		Point 3.2.2 (Opt. 1)	2 µm	
Core diameter / Piercing diameter		to Point 3.2.6 (Opt. 5)	5 µm	
Gradient / pitch	0.5 mm to 8 mm		1.5 µm	
Thread profile angle α	> 27°		(3 1 / l_F)', but not smaller than 6'	l_F = flank length in mm
Threaded rings: simple Flank diameter	5 mm to 200 mm nominal diameter	VDI/VDE/DGQ 2618 Sheet 4.9:2006	3 µm 10 · 10^{-6} · d	Scanning process d = is the measured Diameter
Outer diameter		Point 3.2.2 (Opt. 1)	5 µm	
Core diameter / Piercing diameter		to Point 3.2.6 (Opt. 5)	2 µm	
Gradient / pitch	0.5 mm to 8 mm		1,5 µm	
Thread profile angle α	> 27°		(3 1 / l_F)', but not smaller than 6'	l_F = flank length in mm

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Length *)				
of plane-parallel,	0,01 mm to 500 mm	VDI/VDE/DGQ 2618	1.5 µm 2 · 10^{-6} · *l*	*l* is the measured
spherical or	> 500 mm to 1000 mm	Sheet 19.1:2014	2.5 µm 2 · 10^{-6} · *l*	Length
cylindrical Measuring surfaces				
Diameter	0,01 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006 Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	1.5 µm 2 · 10^{-6} · *d*	*d* is the measured Diameter
Feeler gauges	0,03 mm to 2,00 mm	DIN 2275:2014	1.5 µm 2 · 10^{-6} · *l*	*l* is the measured length
Adjustment dimensions for Outside micrometers	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm 2 · 10^{-6} · *l*	
Throat gauges	3 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.7:2005 Point 3.3.2 (Opt. 2)	0.8 µm 2 · 10^{-6} · *d*	*d* is the measured Diameter
Caliper for Exterior, interior and Depth measurements	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006		Calibration with a automatic Measuring device
Scale display			9 µm 11 · 10^{-6} · *l*	*l* is the measured
Digit display			10 µm 10 · 10^{-6} · *l*	Length
Caliper for Exterior, interior and Depth measurements	0 mm until 500 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	30 µm 30 · 10^{-6} · *l*	*l* is the measured
Depth caliper,	> 500 mm until 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006	50 µm 30 · 10^{-6} · *l*	Length
Height caliper		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
Outside micrometers	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm 10 · 10^{-6} · *l*	
Fine pointer measurement-screws	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002	3 µm 10 · 10^{-6} · *l*	
Micrometer head screws	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008	3 µm 10 · 10^{-6} · *l*	
Depth gauges	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010	3 µm 10 · 10^{-6} · *l*	
Inside micrometers	13 mm until 300 mm	VDI/VDE/DGQ 2618	3 µm 10 · 10^{-6} · *l*	
with 2-point contact on the calibration object	> 300 mm until 1000 mm	Sheet 10.7:2010	5 µm 10 · 10^{-6} · *l*	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Inside micrometers with 3-line contact on the calibration object	3 mm to 150 mm	VDI/VDE/DGQ 2618 Sheet 10.8:2002	3 µm 10 · 10^{-6} · *d*	*d* is the measured diameter
Lever gauges (quick probe) for outdoor measurements	to 200 mm	VDI/VDE/DGQ 2618 Sheet 12.1:2005	7 µm 10 · 10^{-6} · *l*	*l* is the measured length
Lever gauges (quick probe) for indoor measurements	2 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 13.1:2005	7 µm 10 · 10^{-6} · *l*	
Dial gauges	0 mm to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.1:2021	3 µm 10 · 10^{-6} · *l*	mechanical dial gauges
		VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	3 µm 10 · 10^{-6} · *l*	electronic digital dial gauges
Fine pointer	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
Feeler lever gauges	0 mm to 1,6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
electr. inductive Linear Encoders	to 100 mm	VDI/VDE/DGQ 2618 Sheet 14.1:2010	0.6 µm 1 · 10^{-6} · *l*	
electr. incremental Linear Encoders	to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	0.6 µm 1 · 10^{-6} · *l*	
Gauge blocks off Steel after DIN EN ISO 3650	0,5 mm to 150 mm	VDI/VDE/DGQ 2618 Sheet 3.1:2004 Deviation measurement of the center dimension l_c from Nominal dimension l_n through Difference measurement	For the center dimension: 0.08 µm 0.7 · 10^{-6} · *l* For f_0 and f_u: 0,07 µm	*l* is the length of the dimension For the smallest measuring Uncertainties are the pushability and Startup features of both
Gauge blocks off Ceramics after DIN EN ISO 3650	0,5 mm to 150 mm	Deviation measurement f_0 and f_u from center dimension through 5-point Difference measurement	For the center dimension: 0.1 µm 0.8 · 10^{-6} · *l* For f_0 and f_u: 0,07 µm	Measuring surfaces of the Calibration object with a suitable Flat glass plate to check
Gauge blocks off Tungsten carbide according to DIN EN ISO 3650	0,5 mm to 150 mm		For the center dimension: 0.1 µm 0.8 · 10^{-6} · *l* For f_0 and f_u: 0,07 µm	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Angle				
Perpendicularity deviation Flatness and Straightness deviation	to 30 µm	VDI/VDE/DGQ/DKD 2618 Sheet 7.1:2019 (Opt. 2)	2.5 µm $1 \cdot 10^{-6} \cdot l_z$ 4 µm $5 \cdot 10^{-6} \cdot l_z$	l_z = length of the forming or locating element up to 500 mm Leg length
Protractor				
Graduation 1°	-180° to 180°	VDI/VDE/DGQ 2618	30'	
Scale interval 5'	0° to 360°	Sheet 7.2:2008	1'	
Flat rulers				
Parallelism deviation	to 500 mm	VDI/VDE/DGQ 2618	4 µm $5 \cdot 10^{-6} \cdot l$	l is the measured
Flatness deviation		Sheet 5.1:2022	2.2 µm $3.5 \cdot 10^{-6} \cdot l$	Length
Straight edge		VDI/VDE/DGQ 2618		
Straightness deviation	to 500 mm	Sheet 5.2:2013	2.2 µm $3.5 \cdot 10^{-6} \cdot l$	l is the measured length
Tape measures and scales				
Tape measures	0 m until 100 m	4_VB_00237_EN V3	50 µm $20 \cdot 10^{-6} \cdot l$	
Standards	0 m until 3 m			
Inclinometers	-2000 µm/m to 2000 µm/m (-412") (412")	4_VB_00244_EN V3	1.7 µm/m (0,35")	max. leg length of the KG: 500 mm

Location Calibration laboratory Kirchzarten, Gewerbestraße 3, 79199 Kirchzarten

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC voltage	0 V		0.1 µV	
	10 mV		$12 \cdot 10^{-6}\ U$	U = measured value
	100 mV		$1.3 \cdot 10^{-6}\ U$	
	1 V		$0.35 \cdot 10^{-6}\ U$	
	10 V		$0.25 \cdot 10^{-6}\ U$	
	100 V		$0.4 \cdot 10^{-6}\ U$	
	1000 V		$0.9 \cdot 10^{-6}\ U$	
	1 µV up to 100 mV		$1.4 \cdot 10^{-6}\ U$ 0.15 µV	
	> 100 mV up to 100 V		$0.5 \cdot 10^{-6}\ U$	
	> 100 V up to 1000 V		$1.4 \cdot 10^{-6}\ U$	
High Voltage	> 1 kV up to 50 kV		$0.4 \cdot 10^{-3}\ U$	
Direct current strength	0 A up to 10 pA		$1.6 \cdot 10^{-3}\ I$ 2 fA	I = measured value
	> 10 pA up to 100 pA		$0.3 \cdot 10^{-3}\ I$	
	> 100 pA up to 1 nA		$0.2 \cdot 10^{-3}\ I$	
	> 1 nA up to 10 nA		$28 \cdot 10^{-6}\ I$	
	> 10 nA up to 100 nA		$10 \cdot 10^{-6}\ I$	
	> 100 nA up to 1 µA		$1.0 \cdot 10^{-6}\ I$	
	> 1 µA up to 100 mA		$0.8 \cdot 10^{-6}\ I$	
	> 100 mA up to 20 A		$1.5 \cdot 10^{-6}\ I$	
	> 20 A up to 1000 A		$9 \cdot 10^{-6}\ I$	
Direct current strength	1 mA up to 2.2 A		$1 \cdot 10^{-3}\ I$	
Current clamps	> 2,2 A up to 20 A		$2 \cdot 10^{-3}\ I$	
	> 20 A up to 1000 A		$3 \cdot 10^{-3}\ I$	
Direct current strength	1 A to 120 A		$0.22 \cdot 10^{-3}\ I$	
Current transformer	> 120 A to 1000 A		$0.25 \cdot 10^{-3}\ I$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	100 µΩ, 1 mΩ, 10 mΩ		$1.2 \cdot 10^{-6} R$	R = measured value
(discrete values)	100 mΩ		$0.5 \cdot 10^{-6} R$	
	1 Ω		$80 \cdot 10^{-9} R$	
	10 Ω		$0.12 \cdot 10^{-6} R$	
	100 Ω, 1 kΩ		$0.1 \cdot 10^{-6} R$	
	10 kΩ		$50 \cdot 10^{-9} R$	
	100 kΩ		$0.1 \cdot 10^{-6} R$	
	1 MΩ		$0.25 \cdot 10^{-6} R$	
	10 MΩ		$0.75 \cdot 10^{-6} R$	
	100 MΩ		$2.5 \cdot 10^{-6} R$	
	1 GΩ		$8 \cdot 10^{-6} R$	
	10 GΩ		$28 \cdot 10^{-6} R$	
	100 GΩ		$64 \cdot 10^{-6} R$	
DC resistance	1 TΩ		$0.12 \cdot 10^{-3} R$	R = measured value
(discrete values)	10 TΩ		$0.32 \cdot 10^{-3} R$	
	100 TΩ		$0.87 \cdot 10^{-3} R$	
DC resistance	0 µΩ to < 1 mΩ		$4 \cdot 10^{-6} R$ 1 nΩ	R = measured value
Areas	1 mΩ to < 10 mΩ		$3 \cdot 10^{-6} R$ 1 nΩ	
	10 mΩ to < 100 mΩ		$2 \cdot 10^{-6} R$ 1 nΩ	
	0,1 Ω to < 1 Ω		$0.5 \cdot 10^{-6} R$	
	1 Ω to 100 kΩ		$0.2 \cdot 10^{-6} R$	
	> 100 kΩ to 1 MΩ		$0.6 \cdot 10^{-6} R$	
	> 1 MΩ to 10 MΩ		$1.1 \cdot 10^{-6} R$	
	> 10 MΩ to 100 MΩ		$2.5 \cdot 10^{-6} R$	
	> 100 MΩ to 1 GΩ		$8 \cdot 10^{-6} R$	
	> 1 GΩ to 10 GΩ		$30 \cdot 10^{-6} R$	
	> 10 GΩ to 100 GΩ		$82 \cdot 10^{-6} R$	
	> 100 GΩ to 1 TΩ		$0.14 \cdot 10^{-3} R$	
	> 1 TΩ to 10 TΩ		$0.35 \cdot 10^{-3} R$	
	> 10 TΩ to 100 TΩ		$1.2 \cdot 10^{-3} R$	
DC power	1 mW to 2 kW	Product of U and I;	$8 \cdot 10^{-6}$	
	> 2 kW to 1000 kW	1 mV ≤ U ≤ 1000 V, 100 µA ≤ I ≤ 1000 A	$15 \cdot 10^{-6}$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC resistance Resistors (discrete values)	0,1 Ω	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz;	$25 \cdot 10^{-6} R$ $15 \cdot 10^{-6} R$ $11 \cdot 10^{-6} R$ $15 \cdot 10^{-6} R$	*R* = measured value
	1 Ω	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz;	$25 \cdot 10^{-6} R$ $11 \cdot 10^{-9} R$	
	10 Ω	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz;	$25 \cdot 10^{-6} R$ $10 \cdot 10^{-6} R$	
	100 Ω	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz 5 kHz; 10 kHz;	$12 \cdot 10^{-6} R$ $8 \cdot 10^{-6} R$ $6 \cdot 10^{-6} R$	
	1 kΩ	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz;	$35 \cdot 10^{-6} R$	
AC resistance Resistors (discrete values)	10 kΩ	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz;	$85 \cdot 10^{-6} R$ $45 \cdot 10^{-6} R$ $110 \cdot 10^{-6} R$ $65 \cdot 10^{-6} R$	
AC resistance (areas)	0,1 Ω up to 1 Ω	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 10 kHz	$35 \cdot 10^{-6} \cdot R$ $30 \cdot 10^{-6} \cdot R$ $20 \cdot 10^{-6} \cdot R$	
	1 Ω up to < 10 Ω	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 10 kHz	$35 \cdot 10^{-6} \cdot R$ $30 \cdot 10^{-6} \cdot R$ $15 \cdot 10^{-6} \cdot R$	
	10 Ω up to < 100 Ω	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 10 kHz	$35 \cdot 10^{-6} \cdot R$ $30 \cdot 10^{-6} \cdot R$ $15 \cdot 10^{-6} \cdot R$	
	100 Ω up to < 1 kΩ	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 10 kHz	$40 \cdot 10^{-6} \cdot R$ $40 \cdot 10^{-6} \cdot R$ $35 \cdot 10^{-6} \cdot R$	
	1 kΩ up to 10 kΩ	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to <400 Hz 400 Hz to 10 kHz	$90 \cdot 10^{-6} \cdot R$ $45 \cdot 10^{-6} \cdot R$ $110 \cdot 10^{-6} \cdot R$ $65 \cdot 10^{-6} \cdot R$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Cargo	1 pC to 10 000 pC	0.2 Hz to < 1 Hz	0,5 %	Calibration result: Amount of the Transmission-coefficients
Charge amplifier and		1 Hz to 10 kHz	0,4 %	
Charge meters		> 10 kHz to 20 kHz	0,6 %	
		> 20 kHz to 50 kHz	1,0 %	
AC/DC Transfer-	1 mV	10 Hz; 20 Hz; 30 Hz	$0.23 \cdot 10^{-3}\,U$	U = measured value
AC voltage-sources		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$0.11 \cdot 10^{-3}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$0.11 \cdot 10^{-3}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$0.11 \cdot 10^{-3}\,U$	
		20 kHz; 30 kHz; 50 kHz	$0.11 \cdot 10^{-3}\,U$	
		70 kHz; 100 kHz	$0.16 \cdot 10^{-3}\,U$	
		200 kHz; 300 kHz	$0.17 \cdot 10^{-3}\,U$	
		500 kHz; 700 kHz; 800 kHz	$0.25 \cdot 10^{-3}\,U$	
		1 MHz	$0.27 \cdot 10^{-3}\,U$	
	2 mV	10 Hz, 20 Hz, 30 Hz	$0.13 \cdot 10^{-3}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$0.08 \cdot 10^{-3}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$0.08 \cdot 10^{-3}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$0.08 \cdot 10^{-3}\,U$	
		20 kHz; 30 kHz; 50 kHz	$0.08 \cdot 10^{-3}\,U$	
		70 kHz; 100 kHz; 200 kHz;	$0.11 \cdot 10^{-3}\,U$	
		300 kHz	$0.11 \cdot 10^{-3}\,U$	
		500 kHz; 700 kHz; 800 kHz	$0.16 \cdot 10^{-3}\,U$	
		1 MHz	$0.18 \cdot 10^{-3}\,U$	
	6 mV	10 Hz; 20 Hz; 30 Hz	$60 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$45 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$45 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$45 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$45 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$55 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$73 \cdot 10^{-6}\,U$	
		500 kHz	$0.13 \cdot 10^{-3}\,U$	
		700 kHz; 800 kHz; 1 MHz	$0.16 \cdot 10^{-3}\,U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC/DC Transfer-	10 mV	10 Hz; 20 Hz; 30 Hz	$44 \cdot 10^{-6}\,U$	U = measured value
AC voltage-sources		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$37 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$37 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$37 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$37 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$50 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$60 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$0.14 \cdot 10^{-3}\,U$	
		1 MHz	$0.14 \cdot 10^{-3}\,U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC/DC Transfer- AC voltage- sources	20 mV	10 Hz; 20 Hz; 30 Hz	$30 \cdot 10^{-6} U$	U = measured value
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$26 \cdot 10^{-6} U$	
		300 Hz; 400 Hz; 500 Hz;	$26 \cdot 10^{-6} U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$26 \cdot 10^{-6} U$	
		20 kHz; 30 kHz; 50 kHz	$26 \cdot 10^{-6} U$	
		70 kHz; 100 kHz	$38 \cdot 10^{-6} U$	
		200 kHz; 300 kHz	$47 \cdot 10^{-6} U$	
		500 kHz; 700 kHz; 800 kHz;	$98 \cdot 10^{-6} U$	
		1 MHz	$98 \cdot 10^{-6} U$	
	40 mV	10 Hz; 20 Hz; 30 Hz	$24 \cdot 10^{-6} U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$21 \cdot 10^{-6} U$	
		300 Hz; 400 Hz; 500 Hz;	$21 \cdot 10^{-6} U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$21 \cdot 10^{-6} U$	
		20 kHz; 30 kHz; 50 kHz	$21 \cdot 10^{-6} U$	
		70 kHz; 100 kHz	$31 \cdot 10^{-6} U$	
		200 kHz; 300 kHz	$47 \cdot 10^{-6} U$	
		500 kHz; 700 kHz; 800 kHz;	$90 \cdot 10^{-6} U$	
		1 MHz	$90 \cdot 10^{-6} U$	
	60 mV	10 Hz; 20 Hz; 30 Hz	$29 \cdot 10^{-6} U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$21 \cdot 10^{-6} U$	
		300 Hz; 400 Hz	$21 \cdot 10^{-6} U$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz	$20 \cdot 10^{-6} U$	
		10 kHz; 20 kHz; 30 kHz; 50 kHz	$23 \cdot 10^{-6} U$	
		70 kHz; 100 kHz	$27 \cdot 10^{-6} U$	
		200 kHz; 300 kHz	$42 \cdot 10^{-6} U$	
		500 kHz; 700 kHz; 800 kHz;	$86 \cdot 10^{-6} U$	
		1 MHz	$86 \cdot 10^{-6} U$	
	100 mV	10 Hz; 20 Hz	$24 \cdot 10^{-6} U$	
		30 Hz	$18 \cdot 10^{-6} U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$8 \cdot 10^{-6} U$	
		300 Hz; 400 Hz; 500 Hz;	$8 \cdot 10^{-6} U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$8 \cdot 10^{-6} U$	
		20 kHz; 30 kHz; 50 kHz;	$8 \cdot 10^{-6} U$	
		70 kHz; 100 kHz	$8 \cdot 10^{-6} U$	
		200 kHz; 300 kHz	$10 \cdot 10^{-6} U$	
		500 kHz; 700 kHz;	$30 \cdot 10^{-6} U$	
		800 kHz; 1 MHz	$30 \cdot 10^{-6} U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC/DC Transfer-	200 mV	10 Hz; 20 Hz	$18 \cdot 10^{-6}\,U$	U = measured value
AC voltage-		30 Hz	$11 \cdot 10^{-6}\,U$	
sources		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$6 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$6 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$6 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$6 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz;	$8 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$8 \cdot 10^{-6}\,U$	
		500 kHz	$17 \cdot 10^{-6}\,U$	
		700 kHz	$22 \cdot 10^{-6}\,U$	
		800 kHz	$27 \cdot 10^{-6}\,U$	
		1 MHz	$28 \cdot 10^{-6}\,U$	
	300 mV	10 Hz	$14 \cdot 10^{-6}\,U$	
		20 Hz	$11 \cdot 10^{-6}\,U$	
		30 Hz	$10 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$5 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$5 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz	$5 \cdot 10^{-6}\,U$	
		5 kHz; 10 kHz; 20 kHz;	$7 \cdot 10^{-6}\,U$	
		30 kHz; 50 kHz; 70 kHz	$7 \cdot 10^{-6}\,U$	
		100 kHz; 200 kHz; 300 kHz	$8 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz;	$18 \cdot 10^{-6}\,U$	
		800 kHz; 1 MHz	$18 \cdot 10^{-6}\,U$	
	400 mV	10 Hz; 20 Hz	$10 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$5 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$5 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$5 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz;	$5 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz	$15 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz; 1MHz	$17 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC/DC Transfer-	500 mV	10 Hz	$15 \cdot 10^{-6}\,U$	U = measured value
AC voltage-		20 Hz	$9 \cdot 10^{-6}\,U$	
sources		30 Hz	$6 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$4 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz;	$4 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz;	$6 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz; 30 kHz,	$6 \cdot 10^{-6}\,U$	
		50 kHz; 70 kHz; 100 kHz;	$6 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz;	$15 \cdot 10^{-6}\,U$	
		800 kHz; 1 MHz	$15 \cdot 10^{-6}\,U$	
	600 mV	10 Hz	$14 \cdot 10^{-6}\,U$	
		20 Hz	$9 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$4 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$4 \cdot 10^{-6}\,U$	
		1kHz; 2 kHz	$4 \cdot 10^{-6}\,U$	
		5 kHz	$6 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz;	$4 \cdot 10^{-6}\,U$	
		30 kHz; 50 kHz	$4 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz;	$15 \cdot 10^{-6}\,U$	
		800 kHz; 1 MHz	$15 \cdot 10^{-6}\,U$	
	700 mV	10 Hz	$15 \cdot 10^{-6}\,U$	
		20 Hz	$9 \cdot 10^{-6}\,U$	
		30 Hz	$6 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$4 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz;	$4 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz	$4 \cdot 10^{-6}\,U$	
		2 kHz; 5 kHz; 10 kHz;	$5 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz;	$5 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz;	$6 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz;	$15 \cdot 10^{-6}\,U$	
		800 kHz; 1 MHz	$15 \cdot 10^{-6}\,U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC/DC Transfer-	1 V	10 Hz	$9 \cdot 10^{-6}\,U$	U = measured value
AC voltage sources		20 Hz	$8 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz;	$4 \cdot 10^{-6}\,U$	
		120 Hz; 300 Hz	$4 \cdot 10^{-6}\,U$	
		400 Hz; 500 Hz; 1 kHz	$2 \cdot 10^{-6}\,U$	
		2 kHz; 5 kHz	$3 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz;	$4 \cdot 10^{-6}\,U$	
		30 kHz; 50 kHz	$4 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$7 \cdot 10^{-6}\,U$	
		500 kHz	$11 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz; 1 MHz	$14 \cdot 10^{-6}\,U$	
	2 V	10 Hz; 20 Hz	$8 \cdot 10^{-6}\,U$	
		30 Hz	$5 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$2 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$2 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$2 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$2 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz	$11 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz	$14 \cdot 10^{-6}\,U$	
		1 MHz	$16 \cdot 10^{-6}\,U$	
	3 V; 4 V; 5 V;	10 Hz	$10 \cdot 10^{-6}\,U$	
	6 V; 7 V; 8 V	20 Hz	$8 \cdot 10^{-6}\,U$	
		30 Hz	$5 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$3 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$3 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$3 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$3 \cdot 10^{-6}\,U$	
		70 kHz	$4 \cdot 10^{-6}\,U$	
		100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$8 \cdot 10^{-6}\,U$	
		500 kHz	$9 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz	$12 \cdot 10^{-6}\,U$	
		1 MHz	$15 \cdot 10^{-6}\,U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC/DC Transfer-	10 V	10 Hz	$10 \cdot 10^{-6}\,U$	U = measured value
AC voltage-		20 Hz	$8 \cdot 10^{-6}\,U$	
sources		30 Hz	$5 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$4 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$4 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$4 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$4 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz	$10 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz; 1 MHz	$13 \cdot 10^{-6}\,U$	
	20 V	10 Hz; 20 Hz	$8 \cdot 10^{-6}\,U$	
		30 Hz	$5 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$3 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$3 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$3 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$3 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz	$10 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz; 1 MHz	$12 \cdot 10^{-6}\,U$	
	30 V; 40 V; 50 V; 60 V; 70 V	10 Hz; 20 Hz	$9 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$6 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$6 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$6 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$6 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$9 \cdot 10^{-6}\,U$	
	100 V	10 Hz	$10 \cdot 10^{-6}\,U$	
		20 Hz	$9 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$6 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$6 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$6 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$6 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$9 \cdot 10^{-6}\,U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / method	Extended uncertainty of measurement	Remarks
AC/DC Transfer-	200 V	10 Hz; 20 Hz	$10 \cdot 10^{-6}\,U$	U = measured value
AC voltage-		30 Hz; 40 Hz; 55 Hz;	$7 \cdot 10^{-6}\,U$	
sources		60 Hz; 120 Hz; 300 Hz;	$7 \cdot 10^{-6}\,U$	
		400 Hz; 500 Hz; 1 kHz;	$7 \cdot 10^{-6}\,U$	
		2 kHz; 5 kHz; 10 kHz;	$7 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$7 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$12 \cdot 10^{-6}\,U$	
	300 V; 400 V; 500 V; 600 V;	10 Hz; 20 Hz; 30 Hz	$9 \cdot 10^{-6}\,U$	
	700 V; 800 V; 1000 V	40 Hz; 55 Hz; 60 Hz;	$7 \cdot 10^{-6}\,U$	
		120 Hz; 300 Hz; 400 Hz;	$7 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz 2 kHz;	$7 \cdot 10^{-6}\,U$	
		5 kHz; 10 kHz; 20 kHz	$7 \cdot 10^{-6}\,U$	
		30 kHz; 50 kHz	$9 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$15 \cdot 10^{-6}\,U$	
AC/DC Transfer-	1 mV	10 Hz; 20 Hz; 30 Hz	$0.30 \cdot 10^{-3}\,U$	
AC voltage-		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$0.22 \cdot 10^{-3}\,U$	
measuring instruments		300 Hz; 400 Hz; 500 Hz;	$0.22 \cdot 10^{-3}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$0.22 \cdot 10^{-3}\,U$	
		20 kHz; 30 kHz; 50 kHz;	$0.26 \cdot 10^{-3}\,U$	
		70 kHz; 100 kHz; 200 kHz;	$0.26 \cdot 10^{-3}\,U$	
		300 kHz	$0.26 \cdot 10^{-3}\,U$	
		500 kHz; 700 kHz; 800 kHz	$0.32 \cdot 10^{-3}\,U$	
		1 MHz	$0.33 \cdot 10^{-3}\,U$	
	2 mV	10 Hz; 20 Hz; 30 Hz	$0.16 \cdot 10^{-3}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$0.13 \cdot 10^{-3}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$0.13 \cdot 10^{-3}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$0.13 \cdot 10^{-3}\,U$	
		20 kHz; 30 kHz; 50 kHz	$0.13 \cdot 10^{-3}\,U$	
		70 kHz; 100 kHz; 200 kHz;	$0.14 \cdot 10^{-3}\,U$	
		300 kHz	$0.14 \cdot 10^{-3}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$0.20 \cdot 10^{-3}\,U$	
		1 MHz	$0.20 \cdot 10^{-3}\,U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC/DC Transfer- AC voltage- measuring instruments	6 mV	10 Hz; 20 Hz; 30 Hz	$67 \cdot 10^{-6}\,U$	U = measured value
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$57 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz	$57 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$57 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$57 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$65 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$80 \cdot 10^{-6}\,U$	
		500 kHz	$0.14 \cdot 10^{-3}\,U$	
		700 kHz; 800 kHz; 1 MHz	$0.16 \cdot 10^{-3}\,U$	
	10 mV	10 Hz; 20 Hz; 30 Hz	$50 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$45 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$45 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$45 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$45 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$55 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$65 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$0.15 \cdot 10^{-3}\,U$	
		1 MHz	$0.15 \cdot 10^{-3}\,U$	
	20 mV	10 Hz	$32 \cdot 10^{-6}\,U$	
		20 Hz; 30 Hz; 40 Hz; 55 Hz;	$30 \cdot 10^{-6}\,U$	
		60 Hz; 120 Hz; 300 Hz;	$30 \cdot 10^{-6}\,U$	
		400 Hz; 500 Hz; 1 kHz; 2 kHz;	$30 \cdot 10^{-6}\,U$	
		5 kHz; 10 kHz; 20 kHz	$30 \cdot 10^{-6}\,U$	
		30 kHz; 50 kHz	$30 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$40 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$50 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$0.1 \cdot 10^{-3}\,U$	
		1 MHz	$0.1 \cdot 10^{-3}\,U$	
	40 mV	10 Hz; 20 Hz; 30 Hz	$30 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$25 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$25 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$25 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$25 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$30 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz;	$43 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$86 \cdot 10^{-6}\,U$	
		1 MHz	$86 \cdot 10^{-6}\,U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / method	Extended uncertainty of measurement	Remarks
AC/DC Transfer-	60 mV	10 Hz; 20 Hz; 30 Hz	$30 \cdot 10^{-6}\,U$	U = measured value
AC voltage-		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$25 \cdot 10^{-6}\,U$	
measuring instruments		300 Hz; 400 Hz; 500 'Hz;	$25 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$25 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$25 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$28 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$43 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$86 \cdot 10^{-6}\,U$	
		1 MHz	$86 \cdot 10^{-6}\,U$	
	100 mV	10 Hz; 20 Hz	$24 \cdot 10^{-6}\,U$	
		30 Hz	$18 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$8 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$8 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$8 \cdot 10^{-6}\,U$	
		20 kHz; 300 kHz; 50 kHz	$8 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$9 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$10 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$30 \cdot 10^{-6}\,U$	
		1 MHz	$30 \cdot 10^{-6}\,U$	
	200 mV	10 Hz; 20 Hz	$18 \cdot 10^{-6}\,U$	
		30 Hz	$11 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz,	$6 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$6 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$6 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$6 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz; 200 kHz;	$8 \cdot 10^{-6}\,U$	
		300 kHz	$8 \cdot 10^{-6}\,U$	
		500 kHz;	$17 \cdot 10^{-6}\,U$	
		700 kHz	$22 \cdot 10^{-6}\,U$	
		800 kHz; 1 MHz	$28 \cdot 10^{-6}\,U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / method	Extended uncertainty of measurement	Remarks
AC/DC Transfer-	300 mV	10 Hz; 20 Hz	$14 \cdot 10^{-6}\,U$	U = measured value
AC voltage-		30 Hz	$10 \cdot 10^{-6}\,U$	
measuring instruments		40 Hz, 55 Hz; 60 Hz; 120 Hz;	$5 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$5 \cdot 10^{-6}\,U$	
		1 kHz, 2 kHz; 5 kHz; 10 kHz;	$5 \cdot 10^{-6}\,U$	
		20 kHz	$5 \cdot 10^{-6}\,U$	
		30 kHz; 50 kHz	$7 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz; 200 kHz;	$8 \cdot 10^{-6}\,U$	
		300 kHz	$8 \cdot 10^{-6}\,U$	
		500 kHz	$15 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz; 1 MHz	$18 \cdot 10^{-6}\,U$	
	400 mV	10 Hz; 20 Hz	$10 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz, 55 Hz; 60 Hz; 120 Hz;	$5 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz	$5 \cdot 10^{-6}\,U$	
		1 kHz, 2 kHz; 5 kHz; 10 kHz;	$3 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz	$3 \cdot 10^{-6}\,U$	
		50 kHz; 70 kHz; 100 kHz;	$5 \cdot 10^{-6}\,U$	
		200 kHz	$5 \cdot 10^{-6}\,U$	
		300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz	$12 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz; 1 MHz	$17 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / method	Extended uncertainty of measurement	Remarks
AC/DC Transfer- AC voltage- measuring instruments	500 mV	10 Hz	$15 \cdot 10^{-6}\,U$	U = measured value
		20 Hz	$9 \cdot 10^{-6}\,U$	
		30 Hz	$6 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$4 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz	$4 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz;	$6 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz; 30 kHz;	$6 \cdot 10^{-6}\,U$	
		50 kHz; 70 kHz; 100 kHz;	$6 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$15 \cdot 10^{-6}\,U$	
		1 MHz	$15 \cdot 10^{-6}\,U$	
	600 mV	10 Hz	$14 \cdot 10^{-6}\,U$	
		20 Hz	$9 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$4 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$4 \cdot 10^{-6}\,U$	
		1 kHz; 2kHz	$4 \cdot 10^{-6}\,U$	
		5 kHz	$6 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz; 30 kHz;	$4 \cdot 10^{-6}\,U$	
		50 kHz	$4 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$15 \cdot 10^{-6}\,U$	
		1 MHz	$15 \cdot 10^{-6}\,U$	
	700 mV	10 Hz	$15 \cdot 10^{-6}\,U$	
		20 Hz	$9 \cdot 10^{-6}\,U$	
		30 Hz	$6 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$4 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$4 \cdot 10^{-6}\,U$	
		1 kHz	$4 \cdot 10^{-6}\,U$	
		2 kHz; 5 kHz; 10 kHz; 20 kHz;	$5 \cdot 10^{-6}\,U$	
		30 kHz; 50 kHz; 70 kHz;	$5 \cdot 10^{-6}\,U$	
		100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz;	$15 \cdot 10^{-6}\,U$	
		1 MHz	$15 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / method	Extended uncertainty of measurement	Remarks
AC/DC Transfer- AC voltage- measuring instruments	1 V	10 Hz	$9 \cdot 10^{-6}\,U$	U = measured value
		20 Hz	$8 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$4 \cdot 10^{-6}\,U$	
		300 Hz	$4 \cdot 10^{-6}\,U$	
		400 Hz; 500 Hz; 1 kHz	$2 \cdot 10^{-6}\,U$	
		2 kHz; 5 kHz	$3 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz; 30 kHz;	$4 \cdot 10^{-6}\,U$	
		50 kHz	$4 \cdot 10^{-6}\,U$	
		70 kHz, 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$7 \cdot 10^{-6}\,U$	
		500 kHz	$11 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz; 1 MHz	$14 \cdot 10^{-6}\,U$	
	2 V	10 Hz; 20 Hz	$8 \cdot 10^{-6}\,U$	
		30 Hz	$5 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz, 120 Hz;	$2 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$2 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$2 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$2 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz, 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz	$11 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz	$14 \cdot 10^{-6}\,U$	
		1 MHz	$16 \cdot 10^{-6}\,U$	
	3 V; 4 V; 5 V; 6 V; 7 V; 8 V	10 Hz	$10 \cdot 10^{-6}\,U$	
		20 Hz	$8 \cdot 10^{-6}\,U$	
		30 Hz	$5 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$3 \cdot 10^{-6}\,U$	
		300 Hz, 400 Hz; 500 Hz;	$3 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$3 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$3 \cdot 10^{-6}\,U$	
		70 kHz	$4 \cdot 10^{-6}\,U$	
		100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$8 \cdot 10^{-6}\,U$	
		500 kHz	$9 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz	$12 \cdot 10^{-6}\,U$	
		1 MHz	$15 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC/DC Transfer-	10 V	10 Hz	$10 \cdot 10^{-6}\,U$	U = measured value
AC voltage-		20 Hz	$8 \cdot 10^{-6}\,U$	
measuring instruments		30 Hz	$5 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$4 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz, 500 Hz;	$4 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$4 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$4 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz	$10 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz, 1 MHz	$13 \cdot 10^{-6}\,U$	
	20 V	10 Hz, 20 Hz	$8 \cdot 10^{-6}\,U$	
		30 Hz	$5 \cdot 10^{-6}\,U$	
		40 Hz, 55 Hz; 60 Hz, 120 Hz;	$3 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$3 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$3 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$3 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$5 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$6 \cdot 10^{-6}\,U$	
		500 kHz	$10 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz; 1 MHz	$12 \cdot 10^{-6}\,U$	
	30 V; 40 V; 50 V; 60 V; 70 V	10 Hz, 20 Hz	$9 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$6 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz,	$6 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$6 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$6 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$9 \cdot 10^{-6}\,U$	
	100 V	10 Hz	$10 \cdot 10^{-6}\,U$	
		20 Hz	$9 \cdot 10^{-6}\,U$	
		30 Hz	$7 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$6 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$6 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$6 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$6 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$9 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC/DC Transfer- AC voltage- measuring instruments	200 V	10 Hz; 20 Hz	$10 \cdot 10^{-6}\,U$	U = measured value
		30 Hz; 40 Hz; 55 Hz; 60 Hz;	$7 \cdot 10^{-6}\,U$	
		120 Hz; 300 Hz; 400 Hz;	$7 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz;	$7 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz; 30 kHz;	$7 \cdot 10^{-6}\,U$	
		50 kHz	$7 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$12 \cdot 10^{-6}\,U$	
	300 V; 400 V; 500 V; 600 V;	10 Hz; 20 Hz; 30 Hz	$9 \cdot 10^{-6}\,U$	
	700 V; 800 V; 1000 V	40 Hz; 55 Hz; 60 Hz, 120 Hz;	$7 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$7 \cdot 10^{-6}\,U$	
		1 kHz, 2 kHz; 5 kHz; 10 kHz;	$7 \cdot 10^{-6}\,U$	
		20 kHz	$7 \cdot 10^{-6}\,U$	
		30 kHz; 50 kHz	$9 \cdot 10^{-6}\,U$	
		70 kHz, 100 kHz	$15 \cdot 10^{-6}\,U$	
AC voltage Measuring devices and Sources	1 mV	10 Hz; 20 Hz; 30 Hz	$0.42 \cdot 10^{-3}\,U$	
		40 Hz; 55 Hz; 60 Hz;	$0.36 \cdot 10^{-3}\,U$	
		120 Hz; 300 Hz; 400 Hz;	$0.36 \cdot 10^{-3}\,U$	
		500 Hz; 1kHz; 2 kHz; 5 kHz;	$0.36 \cdot 10^{-3}\,U$	
		10 kHz; 20 kHz; 30 kHz;	$0.36 \cdot 10^{-3}\,U$	
		50 kHz; 70 kHz; 100 kHz	$0.36 \cdot 10^{-3}\,U$	
		200 kHz; 300 kHz	$0.43 \cdot 10^{-3}\,U$	
		500 kHz; 700 kHz; 800 kHz	$0.48 \cdot 10^{-3}\,U$	
		1 MHz	$0.53 \cdot 10^{-3}\,U$	
	2 mV	10 Hz; 20 Hz; 30 Hz	$0.18 \cdot 10^{-3}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$0.14 \cdot 10^{-3}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$0.14 \cdot 10^{-3}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$0.14 \cdot 10^{-3}\,U$	
		20 kHz; 30 kHz; 50 kHz	$0.14 \cdot 10^{-3}\,U$	
		70 kHz; 100 kHz;	$0.18 \cdot 10^{-3}\,U$	
		200 kHz; 300 kHz	$0.18 \cdot 10^{-3}\,U$	
		500 kHz; 700 kHz; 800 kHz	$0.21 \cdot 10^{-3}\,U$	
		1 MHz	$0.24 \cdot 10^{-3}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and sources	6 mV	10 Hz; 20 Hz; 30 Hz	$70 \cdot 10^{-6}\,U$	U = measured value
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$60 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$60 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$60 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$60 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$70 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$85 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz;	$0.17 \cdot 10^{-3}\,U$	
		800 kHz; 1 MHz	$0.17 \cdot 10^{-3}\,U$	
	10 mV	10 Hz; 20 Hz; 30 Hz	$53 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$47 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$47 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$47 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$47 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$57 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$70 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz;	$0.14 \cdot 10^{-3}\,U$	
		800 kHz; 1 MHz	$0.14 \cdot 10^{-3}\,U$	
	20 mV	10 Hz; 20 Hz; 30 Hz	$37 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$35 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$35 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$35 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$35 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$45 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$56 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz;	$0.11 \cdot 10^{-3}\,U$	
		800 kHz; 1 MHz	$0.11 \cdot 10^{-3}\,U$	
	40 mV	10 Hz; 20 Hz; 30 Hz	$33 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$31 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$31 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$31 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$31 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$40 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$56 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz;	$95 \cdot 10^{-6}\,U$	
		800 kHz; 1 MHz	$95 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / method	Extended uncertainty of measurement	Remarks
AC voltage	60 mV	10 Hz; 20 Hz; 30 Hz	$31 \cdot 10^{-6}\,U$	U = measured value
Measuring devices and sources		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$25 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$25 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$25 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$25 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$29 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$43 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz	$87 \cdot 10^{-6}\,U$	
		1 MHz	$98 \cdot 10^{-6}\,U$	
	100 mV	10 Hz; 20 Hz	$26 \cdot 10^{-6}\,U$	
		30 Hz	$20 \cdot 10^{-6}\,U$	
		40Hz, 55Hz; 60Hz;120Hz;	$12 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$12 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5kHz; 10 kHz;	$12 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$12 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$13 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$14 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz	$33 \cdot 10^{-6}\,U$	
		1 MHz	$53 \cdot 10^{-6}\,U$	
	200 mV	10 Hz; 20 Hz	$21 \cdot 10^{-6}\,U$	
		30 Hz	$15 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$12 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$12 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$12 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$12 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz;	$13 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$13 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz	$25 \cdot 10^{-6}\,U$	
		800 kHz; 1 MHz	$35 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage	300 mV	10 Hz; 20 Hz; 30 Hz	$17 \cdot 10^{-6}\,U$	U = measured value
Measuring devices and sources		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$12 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$12 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz;	$12 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz; 30 kHz;	$12 \cdot 10^{-6}\,U$	
		50 kHz; 70 kHz	$12 \cdot 10^{-6}\,U$	
		100 kHz; 200 kHz; 300 kHz	$13 \cdot 10^{-6}\,U$	
		500 kHz	$17 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz	$21 \cdot 10^{-6}\,U$	
		1 MHz	$28 \cdot 10^{-6}\,U$	
	500 mV; 600 mV; 700 mV	10 Hz	$18 \cdot 10^{-6}\,U$	
		20 Hz; 30 Hz	$13 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$10 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$10 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$10 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$10 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz;	$11 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$11 \cdot 10^{-6}\,U$	
		500 kHz; 700 kHz; 800 kHz	$21 \cdot 10^{-6}\,U$	
		1 MHz	$40 \cdot 10^{-6}\,U$	
	1 V	10 Hz; 20 Hz	$13 \cdot 10^{-6}\,U$	
		30 Hz	$11 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$10 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$10 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$10 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$10 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$10 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$11 \cdot 10^{-6}\,U$	
		500 kHz	$15 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz	$25 \cdot 10^{-6}\,U$	
		1 MHz	$60 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage	2 V	10 Hz; 20 Hz	$12 \cdot 10^{-6}\,U$	U = measured value
Measuring devices and		30 Hz	$10 \cdot 10^{-6}\,U$	
Sources		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$9 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$9 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$9 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$9 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz;	$10 \cdot 10^{-6}\,U$	
		200 kHz; 300 kHz	$10 \cdot 10^{-6}\,U$	
		500 kHz	$15 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz	$25 \cdot 10^{-6}\,U$	
		1 MHz	$67 \cdot 10^{-6}\,U$	
	3 V; 4 V; 5 V	10 Hz; 20 Hz	$15 \cdot 10^{-6}\,U$	
		30 Hz; 40 Hz; 55 Hz; 60 Hz;	$11 \cdot 10^{-6}\,U$	
		120 Hz; 300 Hz; 400 Hz;	$11 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz	$11 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz; 30 kHz;	$11 \cdot 10^{-6}\,U$	
		50 kHz; 70 kHz	$11 \cdot 10^{-6}\,U$	
		100 kHz; 200 kHz; 300 kHz	$11 \cdot 10^{-6}\,U$	
		500 kHz	$15 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz	$25 \cdot 10^{-6}\,U$	
		1 MHz	$67 \cdot 10^{-6}\,U$	
	6 V; 7 V; 8 V	10 Hz; 20 Hz	$15 \cdot 10^{-6}\,U$	
		30 Hz; 40 Hz; 55 Hz; 60 Hz;	$11 \cdot 10^{-6}\,U$	
		120 Hz; 300 Hz; 400 Hz;	$11 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz;	$11 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz; 30 kHz;	$11 \cdot 10^{-6}\,U$	
		50 kHz; 70 kHz	$11 \cdot 10^{-6}\,U$	
		100 kHz; 200 kHz; 300 kHz	$13 \cdot 10^{-6}\,U$	
		500 kHz	$30 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz	$60 \cdot 10^{-6}\,U$	
		1 MHz	$95 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage	10 V; 20 V	10 Hz; 20 Hz	$13 \cdot 10^{-6}\,U$	U = measured value
Measuring devices and		30 Hz; 40 Hz; 55 Hz; 60 Hz;	$11 \cdot 10^{-6}\,U$	
Sources		120 Hz; 300 Hz; 400 Hz;	$11 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz;	$11 \cdot 10^{-6}\,U$	
		10 kHz; 20 kHz; 30 kHz;	$11 \cdot 10^{-6}\,U$	
		50 kHz; 70 kHz	$11 \cdot 10^{-6}\,U$	
		100 kHz; 200 kHz;	$25 \cdot 10^{-6}\,U$	
		300 kHz; 500 kHz	$25 \cdot 10^{-6}\,U$	
		700 kHz; 800 kHz; 1 MHz	$0.11 \cdot 10^{-3}\,U$	
	30 V; 40 V; 50 V; 60 V; 70 V	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$15 \cdot 10^{-6}\,U$	
		55 Hz; 60 Hz; 120 Hz;	$15 \cdot 10^{-6}\,U$	
		300 Hz; 400 Hz; 500 Hz;	$15 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$15 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$15 \cdot 10^{-6}\,U$	
		70 kHz; 100 kHz	$20 \cdot 10^{-6}\,U$	
	100 V; 200 V	10 Hz; 20 Hz; 30 Hz	$17 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz;	$14 \cdot 10^{-6}\,U$	
		120 Hz; 300 Hz; 400 Hz;	$14 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz	$14 \cdot 10^{-6}\,U$	
		2 kHz; 5 kHz; 10 kHz;	$17 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz;	$17 \cdot 10^{-6}\,U$	
		50 kHz; 70 kHz	$17 \cdot 10^{-6}\,U$	
		100 kHz	$32 \cdot 10^{-6}\,U$	
	300 V	10 Hz; 20 Hz; 30Hz	$17 \cdot 10^{-6}\,U$	
		40 Hz; 55 Hz; 60 Hz;	$14 \cdot 10^{-6}\,U$	
		120 Hz; 300 Hz; 400 Hz;	$14 \cdot 10^{-6}\,U$	
		500 Hz; 1 kHz	$14 \cdot 10^{-6}\,U$	
		2 kHz; 5 kHz; 10 kHz; 20 kHz	$20 \cdot 10^{-6}\,U$	
		30 kHz; 50 kHz	$32 \cdot 10^{-6}\,U$	
		70 kHz	$44 \cdot 10^{-6}\,U$	
		100 kHz	$66 \cdot 10^{-6}\,U$	
	500 V; 1000 V	10 Hz; 20 Hz	$24 \cdot 10^{-6}\,U$	
		30 Hz; 40 Hz; 55 Hz;	$25 \cdot 10^{-6}\,U$	
		60 Hz; 120 Hz; 300 Hz;	$25 \cdot 10^{-6}\,U$	
		400 Hz; 500 Hz	$25 \cdot 10^{-6}\,U$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$30 \cdot 10^{-6}\,U$	
		20 kHz; 30 kHz; 50 kHz	$47 \cdot 10^{-6}\,U$	
		70 kHz	$55 \cdot 10^{-6}\,U$	
		100 kHz	$66 \cdot 10^{-6}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	1 mV to 2.2 mV	10 Hz to 20 Hz	$0.52 \cdot 10^{-3}\ U$	U = measured value
		> 20 Hz to 40 Hz	$0.52 \cdot 10^{-3}\ U$	
		> 40 Hz to 20 kHz	$0.40 \cdot 10^{-3}\ U$	
		> 20 kHz to 50 kHz	$0.40 \cdot 10^{-3}\ U$	
		> 50 kHz to 100 kHz	$0.41 \cdot 10^{-3}\ U$	
		> 100 kHz to 300 kHz	$0.46 \cdot 10^{-3}\ U$	
		> 300 kHz to 500 kHz	$0.55 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.60 \cdot 10^{-3}\ U$	
	> 2.2 mV to 7 mV	10 Hz to 20 Hz	$0.22 \cdot 10^{-3}\ U$	
		> 20 Hz to 40 Hz	$0.22 \cdot 10^{-3}\ U$	
		> 40 Hz to 20 kHz	$0.16 \cdot 10^{-3}\ U$	
		> 20 kHz to 50 kHz	$0.16 \cdot 10^{-3}\ U$	
		> 50 kHz to 100 kHz	$0.20 \cdot 10^{-3}\ U$	
		> 100 kHz to 300 kHz	$0.22 \cdot 10^{-3}\ U$	
		> 300 kHz to 500 kHz	$0.33 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.45 \cdot 10^{-3}\ U$	
	> 7 mV to 22 mV	10 Hz to 20 Hz	$80 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$80 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$65 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$75 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$75 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$95 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.19 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.21 \cdot 10^{-3}\ U$	
	> 22 mV to 70 mV	10 Hz to 20 Hz	$70 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$58 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$35 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$35 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$45 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$55 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.11 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 70 mV to 220 mV	10 Hz to 20 Hz	$39 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$35 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$25 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$25 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$28 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$42 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$85 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.1 \cdot 10^{-3}\ U$	
	> 220 mV to 700 mV	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$22 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$12 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$12 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$14 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$27 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$40 \cdot 10^{-6}\ U$	
	> 700 mV to 2.2 V	10 Hz to 20 Hz	$20 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$14 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$10 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$10 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$11 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$22 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$68 \cdot 10^{-6}\ U$	
	> 2.2 V to 7 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$12 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$13 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$95 \cdot 10^{-6}\ U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 7 V to 22 V	10 Hz to 20 Hz	$17 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1MHz	$0.11 \cdot 10^{-3}\ U$	
	> 22 V to 70 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$15 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$15 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$40 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 V to 220 V	10 Hz to 20 Hz	$19 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$18 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$17 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$17 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$32 \cdot 10^{-6}\ U$	
	> 220 V to 1000 V	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$27 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$45 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$45 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$65 \cdot 10^{-6}\ U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	0,01 V to 0,1 V	10 Hz to 40 Hz	$0.69 \cdot 10^{-3}\,U$	U = measured value
		> 40 Hz to 20 kHz	$0.53 \cdot 10^{-3}\,U$	
		> 20 kHz to 50 kHz	$0.64 \cdot 10^{-3}\,U$	
		> 50 kHz to 100 kHz	$1.1 \cdot 10^{-3}\,U$	
		> 100 kHz to 300 kHz	$2.1 \cdot 10^{-3}\,U$	
		> 300 kHz to 500 kHz	$3.6 \cdot 10^{-3}\,U$	
		> 500 kHz to 1 MHz	$5.0 \cdot 10^{-3}\,U$	
	> 0,1 V to 0,22 V	10 Hz to 40 Hz	$0.38 \cdot 10^{-3}\,U$	
		> 40 Hz to 20 kHz	$0.16 \cdot 10^{-3}\,U$	
		> 20 kHz to 50 kHz	$0.28 \cdot 10^{-3}\,U$	
		> 50 kHz to 100 kHz	$0.65 \cdot 10^{-3}\,U$	
		> 100 kHz to 300 kHz	$1.1 \cdot 10^{-3}\,U$	
		> 300 kHz to 500 kHz	$1.6 \cdot 10^{-3}\,U$	
		> 500 kHz to 1 MHz	$3.3 \cdot 10^{-3}\,U$	
	> 0,22 V to 2,2 V	10 Hz to 40 Hz	$0.49 \cdot 10^{-3}\,U$	
		> 40 Hz to 20 kHz	$0.09 \cdot 10^{-3}\,U$	
		> 20 kHz to 50 kHz	$0.14 \cdot 10^{-3}\,U$	
		> 50 kHz to 100 kHz	$0.29 \cdot 10^{-3}\,U$	
		> 100 kHz to 300 kHz	$0.85 \cdot 10^{-3}\,U$	
		> 300 kHz to 500 kHz	$2.1 \cdot 10^{-3}\,U$	
		> 500 kHz to 1 MHz	$3.3 \cdot 10^{-3}\,U$	
	> 2,2 V to 22 V	10 Hz to 40 Hz	$0.45 \cdot 10^{-3}\,U$	
		> 40 Hz to 20 kHz	$0.07 \cdot 10^{-3}\,U$	
		> 20 kHz to 50 kHz	$0.13 \cdot 10^{-3}\,U$	
		> 50 kHz to 100 kHz	$0.21 \cdot 10^{-3}\,U$	
		> 100 kHz to 300 kHz	$0.6 \cdot 10^{-3}\,U$	
		> 300 kHz to 500 kHz	$2.0 \cdot 10^{-3}\,U$	
		> 500 kHz to 1 MHz	$3.1 \cdot 10^{-3}\,U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 22 V to 220 V	10 Hz to 40 Hz	$0.47 \cdot 10^{-3}\,U$	U = measured value with Fluke 5720A (areas)
		> 40 Hz to 20 kHz	$0.09 \cdot 10^{-3}\,U$	
		> 20 kHz to 50 kHz	$0.14 \cdot 10^{-3}\,U$	
		> 50 kHz to 100 kHz	$0.29 \cdot 10^{-3}\,U$	
	> 220 V to 1000 V	50 Hz to 1 kHz	$85 \cdot 10^{-6}\,U$	
AC voltage with 50 Ω input impedance	3,2 V	10 Hz; 40 Hz; 100 Hz; 500 Hz 1 kHz; 10 kHz; 50 kHz 100 kHz; 200 kHz; 500 kHz 1 MHz; 2 MHz; 4 MHz	$0.5 \cdot 10^{-3}$	at discrete points
		5 MHz; 8 MHz	$1.1 \cdot 10^{-3}$	
		10 MHz; 15 MHz; 20 MHz	$2.0 \cdot 10^{-3}$	
		26 MHz; 30 MHz; 50 MHz	$3.2 \cdot 10^{-3}$	
	1 V; 320 mV	10 Hz; 40 Hz; 100 Hz; 500 Hz 1 kHz; 10 kHz; 50 kHz 100 kHz; 200 kHz; 500 kHz 1 MHz, 2 MHz; 4 MHz	$0.7 \cdot 10^{-3}$	
		5 MHz; 8 MHz	$1.8 \cdot 10^{-3}$	
		10 MHz; 15 MHz; 20 MHz	$3.5 \cdot 10^{-3}$	
		26 MHz; 30 MHz; 50 MHz	$5.4 \cdot 10^{-3}$	
	100 mV; 32 mV 10 mV; 3.2 mV 1 mV	10 Hz; 40 Hz; 100 Hz; 500 Hz 1 kHz; 10 kHz; 50 kHz 100 kHz; 200 kHz; 500 kHz 1 MHz, 2 MHz; 4 MHz	$1.3 \cdot 10^{-3}$	
		5 MHz; 8 MHz	$2.7 \cdot 10^{-3}$	
		10 MHz; 15 MHz; 20 MHz	$5.2 \cdot 10^{-3}$	
		26 MHz; 30 MHz; 50 MHz	$7.9 \cdot 10^{-3}$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Alternating current strength-	100 µA	10 Hz	$82 \cdot 10^{-6}\ I$	I = measured value
DC current strength-		20 Hz	$39 \cdot 10^{-6}\ I$	
Transfer		30 Hz	$31 \cdot 10^{-6}\ I$	
		40 Hz	$34 \cdot 10^{-6}\ I$	
		55 Hz	$0.11 \cdot 10^{-3}\ I$	
		400 Hz	$63 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz	$41 \cdot 10^{-6}\ I$	
		2 kHz	$39 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$31 \cdot 10^{-6}\ I$	
	300 µA	10 Hz	$37 \cdot 10^{-6}\ I$	
		20 Hz	$34 \cdot 10^{-6}\ I$	
		30 Hz; 40 Hz	$31 \cdot 10^{-6}\ I$	
		55 Hz	$41 \cdot 10\text{-}6\ I$	
		400 Hz	$35 \cdot 10\text{-}6\ I$	
		500 Hz; 1 kHz	$31 \cdot 10\text{-}6\ I$	
		2 kHz; 5 kHz; 10 kHz	$32 \cdot 10\text{-}6\ I$	
	1 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$31 \cdot 10\text{-}6\ I$	
		55 Hz; 400 Hz; 500 Hz;	$31 \cdot 10\text{-}6\ I$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$31 \cdot 10\text{-}6\ I$	
	3 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$7 \cdot 10\text{-}6\ I$	
		55 Hz; 400 Hz; 500 Hz;	$7 \cdot 10\text{-}6\ I$	
		1 kHz; 2 kHz; 5 kHz	$7 \cdot 10\text{-}6\ I$	
		10 kHz	$8 \cdot 10\text{-}6\ I$	
	5 mA	10 Hz; 20 Hz	$7 \cdot 10\text{-}6\ I$	
		30 Hz	$6 \cdot 10\text{-}6\ I$	
		40 Hz; 55 Hz	$5 \cdot 10\text{-}6\ I$	
		400 Hz; 500 Hz; 1 kHz; 2 kHz	$4 \cdot 10\text{-}6\ I$	
		5 kHz	$6 \cdot 10\text{-}6\ I$	
		10 kHz	$8 \cdot 10\text{-}6\ I$	
	10 mA	10 Hz	$6 \cdot 10^{-6}\ I$	
		20 Hz; 30 Hz	$5 \cdot 10^{-6}\ I$	
		40 Hz; 55 Hz; 400 Hz;	$4 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz;	$4 \cdot 10^{-6}\ I$	
		10 kHz	$4 \cdot 10^{-6}\ I$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Alternating current strength-	20 mA; 30 mA; 50 mA	10 Hz	$8 \cdot 10^{-6}\ I$	I = measured value
DC current strength-		20 Hz; 30 Hz; 40 Hz; 55 Hz	$5 \cdot 10^{-6}\ I$	
Transfer		400 Hz; 500 Hz; 1 kHz; 2 kHz	$4 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$5 \cdot 10^{-6}\ I$	
	100 mA	10 Hz	$8 \cdot 10^{-6}\ I$	
		20 Hz; 30 Hz; 40 Hz; 55 Hz	$5 \cdot 10^{-6}\ I$	
		400 Hz	$8 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz	$5 \cdot 10^{-6}\ I$	
		2 kHz	$8 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$5 \cdot 10^{-6}\ I$	
	200 mA	10 Hz	$7 \cdot 10^{-6}\ I$	
		20 Hz; 30 Hz; 40 Hz	$6 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz	$5 \cdot 10^{-6}\ I$	
		1 kHz	$8 \cdot 10^{-6}\ I$	
		2 kHz; 5 kHz; 10 kHz	$5 \cdot 10^{-6}\ I$	
	300 mA; 500 mA	10 Hz; 20 Hz; 30 Hz	$6 \cdot 10^{-6}\ I$	
		40 Hz; 55 Hz	$5 \cdot 10^{-6}\ I$	
		400 Hz; 500 Hz; 1 kHz; 2 kHz	$4 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$5 \cdot 10^{-6}\ I$	
	1 A	10 Hz	$7 \cdot 10^{-6}\ I$	
		20 Hz; 30 Hz	$6 \cdot 10^{-6}\ I$	
		40 Hz; 55 Hz	$7 \cdot 10^{-6}\ I$	
		400 Hz; 500 Hz;	$5 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$9 \cdot 10^{-6}\ I$	
	2 A	10 Hz	$7 \cdot 10^{-6}\ I$	
		20 Hz; 30 Hz	$8 \cdot 10^{-6}\ I$	
		40 Hz; 55 Hz; 400 Hz;	$7 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz; 2 kHz;	$7 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$7 \cdot 10^{-6}\ I$	
	3 A; 5 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$14 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$14 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$14 \cdot 10^{-6}\ I$	
	10 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$21 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$21 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$21 \cdot 10^{-6}\ I$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Alternating current strength-	20 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$26 \cdot 10^{-6}\ I$	I = measured value
DC current strength-		55 Hz; 400 Hz; 500 Hz;	$26 \cdot 10^{-6}\ I$	
Transfer		1 kHz; 2 kHz; 5 kHz;	$26 \cdot 10^{-6}\ I$	
		10 kHz	$30 \cdot 10^{-6}\ I$	
	50 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$32 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$32 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz;	$32 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$40 \cdot 10^{-6}\ I$	
	100 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$47 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$47 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz;	$47 \cdot 10^{-6}\ I$	
		10 kHz	$92 \cdot 10^{-6}\ I$	
AC power	100 µA	10 Hz	$83 \cdot 10^{-6}\ I$	
Sources		20 Hz	$40 \cdot 10^{-6}\ I$	
		30 Hz; 40 Hz	$34 \cdot 10^{-6}\ I$	
		55 Hz	$0.11 \cdot 10^{-3}\ I$	
		400 Hz	$64 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz; 2 kHz	$42 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz; 20 kHz; 30 kHz	$33 \cdot 10^{-6}\ I$	
		50 kHz	$47 \cdot 10^{-6}\ I$	
		70 kHz; 100 kHz	$77 \cdot 10^{-6}\ I$	
	300 µA	10 Hz	$38 \cdot 10^{-6}\ I$	
		20 Hz	$34 \cdot 10^{-6}\ I$	
		30 Hz; 40 Hz	$32 \cdot 10^{-6}\ I$	
		55 Hz	$42 \cdot 10^{-6}\ I$	
		400 Hz	$36 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz; 2 kHz;	$33 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz; 20 kHz;	$33 \cdot 10^{-6}\ I$	
		30 kHz; 50 kHz	$33 \cdot 10^{-6}\ I$	
		70 kHz	$52 \cdot 10^{-6}\ I$	
		100 kHz	$0.11 \cdot 10^{-3}\ I$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC power Sources	1 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$32 \cdot 10^{-6}\ I$	I = measured value
		55 Hz; 400 Hz; 500 Hz;	$32 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$32 \cdot 10^{-6}\ I$	
		20 kHz; 30 kHz; 50 kHz; 70 kHz	$32 \cdot 10^{-6}\ I$	
		100 kHz	$34 \cdot 10^{-6}\ I$	
	3 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$9 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz; 1 kHz;	$9 \cdot 10^{-6}\ I$	
		2 kHz; 5 kHz	$9 \cdot 10^{-6}\ I$	
		10 kHz	$10 \cdot 10^{-6}\ I$	
		20 kHz; 30 kHz; 50 kHz; 70 kHz	$12 \cdot 10^{-6}\ I$	
		100 kHz	$15 \cdot 10^{-6}\ I$	
	5 mA	10 Hz; 20 Hz; 30 Hz	$9 \cdot 10^{-6}\ I$	
		40 Hz; 55 Hz; 400 Hz;	$8 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz	$8 \cdot 10^{-6}\ I$	
		10 kHz	$10 \cdot 10^{-6}\ I$	
		20 kHz; 30 kHz; 50 kHz; 70 kHz	$12 \cdot 10^{-6}\ I$	
		100 kHz	$15 \cdot 10^{-6}\ I$	
	10 mA	10 Hz	$9 \cdot 10^{-6}\ I$	
		20 Hz; 30 Hz; 40 Hz; 55 Hz	$8 \cdot 10^{-6}\ I$	
		400 Hz; 500 Hz; 1 kHz; 2 kHz	$7 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz; 20 kHz; 30 kHz	$8 \cdot 10^{-6}\ I$	
		50 kHz; 70 kHz	$10 \cdot 10^{-6}\ I$	
		100 kHz	$12 \cdot 10^{-6}\ I$	
	20 mA; 30 mA;	10 Hz	$10 \cdot 10^{-6}\ I$	
	50 mA; 100 mA	20 Hz; 30 Hz; 40 Hz; 55 Hz;	$8 \cdot 10^{-6}\ I$	
		400 Hz; 500 Hz	$8 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$8 \cdot 10^{-6}\ I$	
		20 kHz; 30 kHz	$8 \cdot 10^{-6}\ I$	
		50 kHz; 70 kHz	$10 \cdot 10^{-6}\ I$	
		100 kHz	$13 \cdot 10^{-6}\ I$	
	200 mA	10 Hz	$9 \cdot 10^{-6}\ I$	
		20 Hz; 30 Hz; 40 Hz; 55 Hz;	$8 \cdot 10^{-6}\ I$	
		400 Hz; 500 Hz	$8 \cdot 10^{-6}\ I$	
		1 kHz	$10 \cdot 10^{-6}\ I$	
		2 kHz; 5 kHz; 10 kHz; 20 kHz	$9 \cdot 10^{-6}\ I$	
		30 kHz; 50 kHz;	$13 \cdot 10^{-6}\ I$	
		70 kHz; 100 kHz	$13 \cdot 10^{-6}\ I$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC power Sources	300 mA	10 Hz; 20 Hz	$9 \cdot 10^{-6}\ I$	I = measured value
		30 Hz; 40 Hz; 55 Hz; 400 Hz;	$8 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz; 2 kHz; 5 kHz;	$8 \cdot 10^{-6}\ I$	
		10 kHz; 20 kHz	$8 \cdot 10^{-6}\ I$	
		30 kHz; 50 kHz	$9 \cdot 10^{-6}\ I$	
		70 kHz; 100 kHz	$14 \cdot 10^{-6}\ I$	
	500 mA	10 Hz; 20 Hz; 30 Hz	$9 \cdot 10^{-6}\ I$	
		40 Hz; 55 Hz; 400 Hz; 500 Hz;	$8 \cdot 10^{-6}\ I$	
		1 kHz: 2 kHz; 5 kHz;	$8 \cdot 10^{-6}\ I$	
		10 kHz; 20 kHz	$8 \cdot 10^{-6}\ I$	
		30 kHz; 50 kHz	$9 \cdot 10^{-6}\ I$	
		70 kHz	$11 \cdot 10^{-6}\ I$	
		100 kHz	$14 \cdot 10^{-6}\ I$	
	1 A	10 Hz; 20 Hz; 30 Hz;	$9 \cdot 10^{-6}\ I$	
		40 Hz; 55 Hz	$9 \cdot 10^{-6}\ I$	
		400 Hz; 500 Hz	$8 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$11 \cdot 10^{-6}\ I$	
		20 kHz; 30 kHz; 50 kHz	$11 \cdot 10^{-6}\ I$	
		70 kHz	$13 \cdot 10^{-6}\ I$	
		100 kHz	$15 \cdot 10^{-6}\ I$	
	2 A	10 Hz; 20 Hz; 30 Hz	$10 \cdot 10^{-6}\ I$	
		40 Hz; 55 Hz; 400 Hz; 500 Hz	$8 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$9 \cdot 10^{-6}\ I$	
		20 kHz; 30 kHz; 50 kHz	$13 \cdot 10^{-6}\ I$	
		70 kHz	$18 \cdot 10^{-6}\ I$	
		100 kHz	$23 \cdot 10^{-6}\ I$	
	3 A	10 Hz; 20 Hz; 30 Hz	$18 \cdot 10^{-6}\ I$	
		40 Hz; 55 Hz; 400 Hz;	$17 \cdot 10^{-6}\ I$	
		500 Hz; 1k Hz; 2 kHz; 5 kHz;	$17 \cdot 10^{-6}\ I$	
		10 kHz; 20 kHz; 30 kHz	$17 \cdot 10^{-6}\ I$	
		50 kHz	$18 \cdot 10^{-6}\ I$	
		70 kHz	$27 \cdot 10^{-6}\ I$	
		100 kHz	$29 \cdot 10^{-6}\ I$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC power Sources	5 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$16 \cdot 10^{-6}\ I$	I = measured value
		55 Hz; 400 Hz; 500 Hz;	$16 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz;	$16 \cdot 10^{-6}\ I$	
		10 kHz; 20 kHz; 30 kHz	$16 \cdot 10^{-6}\ I$	
		50 kHz	$18 \cdot 10^{-6}\ I$	
		70 kHz	$27 \cdot 10^{-6}\ I$	
		100 kHz	$29 \cdot 10^{-6}\ I$	
	10 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$22 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$22 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz;	$22 \cdot 10^{-6}\ I$	
		10 kHz; 20 kHz	$22 \cdot 10^{-6}\ I$	
		30 kHz	$31 \cdot 10^{-6}\ I$	
		50 kHz	$41 \cdot 10^{-6}\ I$	
		70 kHz	$51 \cdot 10^{-6}\ I$	
		100 kHz	$76 \cdot 10^{-6}\ I$	
	20 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$27 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$27 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$27 \cdot 10^{-6}\ I$	
		20 kHz; 30 kHz	$31 \cdot 10^{-6}\ I$	
		50 kHz	$46 \cdot 10^{-6}\ I$	
		70 kHz	$0.13 \cdot 10^{-3}\ I$	
		100 kHz	$0.17 \cdot 10^{-3}\ I$	
	50 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$33 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$33 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz;	$33 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$40 \cdot 10^{-6}\ I$	
	100 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$48 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$48 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz;	$48 \cdot 10^{-6}\ I$	
		10 kHz	$93 \cdot 10^{-6}\ I$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC power Measuring devices	100 µA	10 Hz	$83 \cdot 10^{-6}\ I$	I = measured value
		20 Hz	$40 \cdot 10^{-6}\ I$	
		30 Hz; 40 Hz	$34 \cdot 10^{-6}\ I$	
		55 Hz	$0.11 \cdot 10^{-3}\ I$	
		400 Hz	$64 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz; 2 kHz;	$42 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$42 \cdot 10^{-6}\ I$	
	300 µA	10 Hz	$38 \cdot 10^{-6}\ I$	
		20 Hz	$34 \cdot 10^{-6}\ I$	
		30 Hz; 40 Hz	$32 \cdot 10^{-6}\ I$	
		55 Hz	$42 \cdot 10^{-6}\ I$	
		400 Hz	$36 \cdot 10^{-6}\ I$	
		500 Hz; 1 kHz	$32 \cdot 10^{-6}\ I$	
		2 kHz; 5 kHz; 10 kHz	$33 \cdot 10^{-6}\ I$	
	1 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$32 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz; 1 kHz;	$32 \cdot 10^{-6}\ I$	
		2 kHz; 5 kHz; 10 kHz	$32 \cdot 10^{-6}\ I$	
	3 mA; 5 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$10 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$10 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz	$10 \cdot 10^{-6}\ I$	
		10 kHz	$11 \cdot 10^{-6}\ I$	
	10 mA	10 Hz	$9 \cdot 10^{-6}\ I$	
		20 Hz; 30 Hz; 40 Hz; 55 Hz;	$8 \cdot 10^{-6}\ I$	
		400 Hz; 500 Hz; 1 kHz; 2 kHz;	$8 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$8 \cdot 10^{-6}\ I$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC power	20 mA; 30 mA;	10 Hz	$10 \cdot 10^{-6}\ I$	I = measured value
Measuring devices	50 mA; 100 mA	20 Hz; 30 Hz; 400 Hz; 55 Hz;	$8 \cdot 10^{-6}\ I$	
		400 Hz; 500 Hz; 1 kHz; 2 kHz	$8 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$9 \cdot 10^{-6}\ I$	
	200 mA; 300 mA; 500 mA	10 Hz	$10 \cdot 10^{-6}\ I$	
		20 Hz; 30 Hz; 40 Hz, 55 Hz;	$9 \cdot 10^{-6}\ I$	
		400 Hz; 500 Hz; 1 kHz; 2 kHz;	$9 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$9 \cdot 10^{-6}\ I$	
	1 A; 2 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$11 \cdot 10^{-6}\ I$	
		55 Hz, 400 Hz; 500 Hz;	$11 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5kHz; 10 kHz	$11 \cdot 10^{-6}\ I$	
	3 A; 5 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$18 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$18 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5kHz; 10 kHz	$18 \cdot 10^{-6}\ I$	
	10 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$22 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$22 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5kHz; 10 kHz	$22 \cdot 10^{-6}\ I$	
	20 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$27 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$27 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5kHz;	$27 \cdot 10^{-6}\ I$	
		10 kHz	$31 \cdot 10^{-6}\ I$	
	50 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$33 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$33 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz;	$33 \cdot 10^{-6}\ I$	
		5 kHz; 10 kHz	$40 \cdot 10^{-6}\ I$	
	100 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$48 \cdot 10^{-6}\ I$	
		55 Hz; 400 Hz; 500 Hz;	$48 \cdot 10^{-6}\ I$	
		1 kHz; 2 kHz; 5 kHz;	$48 \cdot 10^{-6}\ I$	
		10 kHz	$93 \cdot 10^{-6}\ I$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC current strength sources and measuring devices (ranges)	100 µA to 1 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	120 · 10^{-6} *I* 160 · 10^{-6} *I* 60 · 10^{-6} *I*	*I* = measured value
	> 1 mA to 10 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	46 · 10^{-6} *I*	
	> 10 mA to 1 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	17 · 10^{-6} *I*	
	> 1 A to 10 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	32 · 10^{-6} *I*	
	> 10 A to 20 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	39 · 10^{-6} *I*	
	> 20 A to 100 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	69 · 10^{-6} *I* 69 · 10^{-6} *I* 0.17 · 10^{-3} *I*	
AC current strength (ranges) Measuring devices	0.1 mA to 0.2 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.40 · 10^{-3} *I* 0.21 · 10^{-3} *I* 0.40 · 10^{-3} *I* 1.7 · 10^{-3} *I*	*I* = measured value with Fluke 5720A
	> 0.2 mA to 2.2 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.44 · 10^{-3} *I* 0.30 · 10^{-3} *I* 0.72 · 10^{-3} *I* 4.2 · 10^{-3} *I*	
	> 2.2 mA to 22 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.44 · 10^{-3} *I* 0.30 · 10^{-3} *I* 0.46 · 10^{-3} *I* 3.5 · 10^{-3} *I*	
	> 22 mA to 220 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.44 · 10^{-3} *I* 0.25 · 10^{-3} *I* 0.37 · 10^{-3} *I* 1.6 · 10^{-3} *I*	
	> 220 mA to 2.2 A	20 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.43 · 10^{-3} *I* 0.84 · 10^{-3} *I* 7.6 · 10^{-3} *I*	
	> 2.2 A to 20 A	40 Hz to 5 kHz	0.81 · 10^{-3} *I* / 1.2 mA	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC power Sources	0.1 mA to 1 A	40 Hz to 5 kHz	$2 \cdot 10^{-3}\ I$	I = measured value with HP3458A
Alternating current	1 mA to 2.2 A	40 Hz to 5 kHz	$2 \cdot 10^{-3}\ I$	I = measured value
amperage current	> 2.2 A to 20 A	40 Hz to 5 kHz	$3 \cdot 10^{-3}\ I$	
clamps	> 20 A to 800 A	40 Hz to 65 Hz	$4 \cdot 10^{-3}\ I$	
AC current strength	1 A to 120 A	40 Hz to 850 Hz	$0.16 \cdot 10^{-3}\ I$	
current transformer	1 A to 120 A	> 850 Hz to 2 kHz	$0.47 \cdot 10^{-3}\ I$	
	> 120 A to 600 A	40 Hz to 400 Hz	$0.52 \cdot 10^{-3}\ I$	
	> 120 A to 1000 A	40 Hz to 65 Hz	$0.6 \cdot 10^{-3}\ I$	
Resistance ratio AC/DC measuring bridges	0.16 to 6.3	Equal and Alternating current up to 400 Hz	$0.2 \cdot 10^{-6}$	Uncertainty of measurement denotes absolute value
Phase angle between voltages Measuring devices and sources	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 50 mV / 50 mV measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1 kHz 5 kHz; 10 kHz; 50 kHz 100 kHz	 0,005° 0,008° 0,020°	U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 0.5 V / 0.5 V 1 V / 1 V 0.8 V / 1 V 1 V / 0.5 V 10 V / 10 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz 1 kHz; 5 kHz 10 kHz 50 kHz 100 kHz	 0,005° 0,005° 0,007° 0,008° 0,009°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 100 V / 100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz 1 kHz; 5 kHz 10 kHz 50 kHz 100 kHz	 0,005° 0,005° 0,007° 0,008° 0,030°	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between tensions Measuring devices and sources	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 1 V/0.05 V 10 V/1 V 1 V /10 V 100 V/1 V 1 V/100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz 1 kHz; 5 kHz 10 kHz 50 kHz 100 kHz	 0,009° 0,009° 0,020° 0,030° 0,070°	U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
	-180° to 180	U_{REF} / U_{SIG} 0.05 V to 0.5 V Measuring frequency: 10 Hz to 1 kHz > 1 kHz to 50 kHz > 50 kHz to 100 kHz	 0,006° 0,010° 0,025°	U_{SIG}: Signal voltage U_{REF}: Reference voltage Measuring ranges
		U_{REF} / U_{SIG} > 0.5 V to 10 V Measuring frequency: 10 Hz to 5 kHz > 5 kHz to 100 kHz	 0,006° 0,015°	
		U_{REF} / U_{SIG} > 10 V to 100 V Measuring frequency: 10 Hz to 5 kHz > 5 kHz to 50 kHz > 50 kHz to 100 kHz	 0,006° 0,010° 0,035°	
		U_{REF} / U_{SIG} > 100 V to 630 V Measuring frequency: 10 Hz to 2.5 kHz > 2.5 kHz to 5 kHz > 5 kHz to 10 kHz > 10 kHz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz	 0,008° 0,03° 0,04° 0,05° 0,1° 0,2°	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between current and Voltage Sources	-180° to 180	U_{REF} / U_{SIG} 1 mA to 2 A/0.05 V to 100 V Measuring frequency:		U_{SIG}: Signal voltage U_{REF}: Reference voltage Measuring ranges
		10 Hz to 1 kHz	0,009°	
		> 1 kHz to 10 kHz	0,045°	
		> 10 kHz to 100 kHz	0,50°	
		U_{REF} / U_{SIG} > 2 A to 20 A /1 V to 100 V Measuring frequency:		
		10 Hz to 1 kHz	0,02°	
		> 1 kHz to 10 kHz	0,1°	
		> 10 kHz to 100 kHz	1,0°	
		U_{REF} / U_{SIG} > 20 A to 100 A /1 V to 100 V Measuring frequency:		
		10 Hz to 1 kHz	0,025°	
		> 1 kHz to 10 kHz	0,20°	
		> 10 kHz to 100 kHz	2,0°	
Phase angle between current and Voltage Measuring devices	-180° to 180	U_{REF} / U_{SIG} 1 mA to 2 A/0.05 V to 100 V Measuring frequency:		
		10 Hz to 1 kHz	0,009°	
		> 1 kHz to 10 kHz	0,045°	
		U_{REF} / U_{SIG} > 2 A to 20 A /1 V to 100 V Measuring frequency:		
		10 Hz to 1 kHz	0,02°	
		> 1 kHz to 10 kHz	0,1°	
		U_{REF} / U_{SIG} > 20A to 100A /1V to 100 V Measuring frequency:		
		10 Hz to 1 kHz	0,025°	
		> 1 kHz to 10 kHz	0,20°	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between current and Voltage Sources	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG}		U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
		1 mA/0.0 5V		
		1 mA/0.5 V		
		Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz	0,007°	
		5 kHz; 10 kHz	0,02°	
		50 kHz; 100 kHz	0,08°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG}		
		1 mA/1 V		
		10 mA/1 V		
		20 mA/1 V		
		50 mA/1 V		
		100 mA/1 V		
		200 mA/1 V		
		Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz	0,005°	
		5 kHz; 10 kHz	0,010°	
		50 kHz; 100 kHz	0,070°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG}		
		500 mA/1 V		
		1 A/1 V		
		2 A/1 V		
		Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz	0,006°	
		5 kHz; 10 kHz	0,040°	
		50 kHz; 100 kHz	0,40°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG}		
		5 A/1 V		
		10 A/1 V		
		20 A/1 V		
		Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz	0,010°	
		5 kHz; 10 kHz	0,090°	
		50 kHz; 100 kHz	0,90°	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between current and Voltage Sources	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 50 A/1 V 100 A/1 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz 50 kHz; 100 kHz	 0,020° 0,15° 1,5°	U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 1 mA/10 V 10 mA/10 V 20 mA/10 V 50 mA/10 V 100 mA/10 200 mA/10 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz 50 kHz; 100 kHz	 0,006° 0,020° 0,080°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 500 mA/10 V 1 A/10 V 2 A/10 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz 50 kHz; 100 kHz	 0,007° 0,040° 0,40°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 5 A/10 V 10 A/10 V 20 A/10 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz 50 kHz; 100 kHz	 0,015° 0,09° 0,90°	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between current and Voltage Sources	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 50 A/10 V 100 A/10 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz 50 kHz; 100 kHz	 0,020° 0,15° 1,5°	U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 1 mA/100 V 10 mA/100 V 20 mA/100 V 50 mA/100 V 100 mA/100 V 200 mA/100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz 50 kHz; 100 kHz	 0,008° 0,025° 0,09°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 500 mA/100 V 1 A/100 V 2 A/100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz 50 kHz; 100 kHz	 0,007° 0,04° 0,40°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 5 A/100 V 10 A/100 V 20 A/100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz 50 kHz; 100 kHz	 0,015° 0,09° 0,90°	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between current and Voltage Sources	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 50 A/100 V 100 A/100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz 50 kHz; 100 kHz	 0,020° 0,15° 1,5°	U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
Phase angle between current and Voltage Measuring devices	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 1 mA/0.05 V 1 mA/0.5 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,007° 0,02°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 1 mA/1 V 10 mA/1 V 20 mA/1 V 50 mA/1 V 100 mA/1 V 200 mA/1 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,005° 0,010°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 500 mA/1 V 1 A/1 V 2 A/1 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,006° 0,040°	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between current and Voltage Measuring devices	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 5 A/1 V 10 A/1 V 20 A/1 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,010° 0,090°	U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 50 A/1 V 100 A/1 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,020° 0,15°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 1 mA/10 V 10 mA/10 V 20 mA/10 V 50 mA/10 V 100 mA/10 V 200 mA/10 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,006° 0,020°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 500 mA/10 V 1 A/10 V 2 A/10 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,007° 0,040°	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between current and Voltage Measuring devices	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 5 A/10 V 10 A/10 V 20 A/10 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,015° 0,09°	U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 50 A/10 V 100 A/10 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,020° 0,15°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 1 mA/100 V 10 mA/100 V 20 mA/100 V 50 mA/100 V 100 mA/100 V 200 mA/100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,008° 0,025°	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase angle between current and Voltage Measuring devices	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 500 mA/100 V 1 A/100 V 2 A/100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,007° 0,04°	U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 5 A/100 V 10 A/100 V 20 A/100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,015° 0,09°	
	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 50 A/100 V 100 A/100 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz 5 kHz; 10 kHz	 0,020° 0,15°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Inductance	100 µH	1 kHz; 10 kHz	$0.3 \cdot 10^{-3}$	
Measuring devices, sources, Decadal normals	1 mH	1 kHz 10 kHz	$65 \cdot 10^{-6}$ $0.15 \cdot 10^{-3}$	
	10 mH	1 kHz 10 kHz	$55 \cdot 10^{-6}$ $0.16 \cdot 10^{-3}$	
	100 mH	1 kHz 10 kHz	$65 \cdot 10^{-6}$ $0.21 \cdot 10^{-3}$	
	1 H	100 Hz 1 kHz	$0.1 \cdot 10^{-3}$ $70 \cdot 10^{-6}$	
	10 H	100 Hz 1 kHz	$0.2 \cdot 10^{-3}$ $0.2 \cdot 10^{-3}$	
Inductance Measuring devices, Sources	0.1 mH to 1 mH	1 kHz to 10 kHz	$5.5 \cdot 10^{-3}$	
	> 1 mH to 10 mH	1 kHz to 10 kHz	$1.5 \cdot 10^{-3}$	
	> 10 mH to 100 mH	1 kHz to 10 kHz	$2.0 \cdot 10^{-3}$	
	> 0.1 H to 1 H	1 kHz	$0.4 \cdot 10^{-3}$	
	> 1 H to 10 H	100 Hz to 1 kHz	$1.5 \cdot 10^{-3}$	
Capacity gauges, Decadal normals	1 pF	50 Hz 100 Hz 1 kHz 10 kHz 400 kHz 100 kHz; 1 MHz	$6 \cdot 10^{-3}$ $2.5 \cdot 10^{-3}$ $0.3 \cdot 10^{-3}$ $0.2 \cdot 10^{-3}$ $6.1 \cdot 10^{-3}$ $3.5 \cdot 10^{-3}$	
	10 pF	50 Hz 100 Hz 1 kHz 10 kHz 100 kHz; 400 kHz 1 MHz	$0.6 \cdot 10^{-3}$ $0.4 \cdot 10^{-3}$ $35 \cdot 10^{-6}$ $40 \cdot 10^{-6}$ $75 \cdot 10^{-6}$ $110 \cdot 10^{-6}$	
	100 pF	50 Hz 100 Hz 1 kHz; 10 kHz 100 kHz 400 kHz 1 MHz	$80 \cdot 10^{-6}$ $40 \cdot 10^{-6}$ $25 \cdot 10^{-6}$ $35 \cdot 10^{-6}$ $65 \cdot 10^{-6}$ $0.35 \cdot 10^{-3}$	
	1 nF	50 Hz 100 Hz 1 kHz 10 kHz 100 kHz 400 kHz 1 MHz	$35 \cdot 10^{-6}$ $25 \cdot 10^{-6}$ $15 \cdot 10^{-6}$ $22 \cdot 10^{-6}$ $75 \cdot 10^{-6}$ $0.45 \cdot 10^{-3}$ $3 \cdot 10^{-3}$	
	10 nF	50 Hz; 100 Hz; 1 kHz 10 kHz	$35 \cdot 10^{-6}$ $55 \cdot 10^{-6}$	
	100 nF	50 Hz; 100 Hz; 1 kHz 10 kHz	$55 \cdot 10^{-6}$ $75 \cdot 10^{-6}$	
	1 µF	50 Hz 100 Hz 1 kHz 10 kHz	$55 \cdot 10^{-6}$ $70 \cdot 10^{-6}$ $55 \cdot 10^{-6}$ $110 \cdot 10^{-6}$	
	10 µF	50 Hz; 100 Hz; 1 kHz 10 kHz	$0,2 - 10^{-3}$ $0,4 - 10^{-3}$	

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Measurand/ calibration item	Measuring range			Measuring conditions / Procedures			Extended uncertainty of measurement	Remarks
Capacity	10 pF	to	100 pF	50 Hz	until	1 kHz	4.9 ? 10-3 C	C = measured value
Sources, gauges,				> 1 kHz	until	10 kHz	0.4 · 10-3 C	
Normal				> 10 kHz	until	100 kHz	3.0 · 10-3 C	
				> 100 kHz	until	400 kHz	1.6 · 10-3 C	
				> 400 kHz	to	1 MHz	2.2 · 10-3 C	
	> 100 pF	to	1 nF	50 Hz	until	1 kHz	0.2 · 10-3 C	
				> 1 kHz	until	10 kHz	2.3 · 10-3 C	
				> 10 kHz	until	100 kHz	3.5 · 10-3 C	
				> 100 kHz	until	400 kHz	1.5 · 10-3 C	
				> 400 kHz	to	1 MHz	3.6 · 10-3 C	
	> 1 nF	to	10 nF	50 Hz	to	1 kHz	2.8 · 10-3 C	
				> 1 kHz	to	10 kHz	2.4 · 10-3 C	
	> 10 nF	to	100 nF	50 Hz	to	1 kHz	4.3 · 10-3 C	
				> 1 kHz	to	10 kHz	2.0 · 10-3 C	
	> 100 nF	to	1 µF	50 Hz	to	100 Hz	0.11 · 10-3 C	
				> 100 Hz	until	1 kHz	1.0 · 10-3 C	
				> 1 kHz	until	10 kHz	0.5 · 10-3 C	
	> 1 µF	to	10 µF	50 Hz	until	100 Hz	0.58 · 10-3 C	
				> 100 Hz	until	1 kHz	0.38 · 10-3 C	
				> 1 kHz	to	10 kHz	0.43 · 10-3 C	
Capacity	190 pF	to	< 400 pF	10 Hz	to	10 kHz	4 · 10-3 C 8 pF	With 5520A / 5522A
Measuring devices	400 pF	to	< 1.1 nF	10 Hz	to	10 kHz	4.5 · 10-3 C 8 pF	
	1.1 nF	to	< 3.3 nF	10 Hz	to	3 kHz	4.0 · 10-3 C 8 pF	
	3.3 nF	to	< 11 nF	10 Hz	to	1 kHz	2.5 · 10-3 C 8 pF	
	11 nF	to	< 33 nF	10 Hz	to	1 kHz	2.5 · 10-3 C 80 pF	
	33 nF	to	< 110 nF	10 Hz	to	1 kHz	2.5 · 10-3 C 80 pF	
	110 nF	to	< 330 nF	10 Hz	to	1 kHz	4.5 · 10-3 C	
	330 nF	to	< 1.1 µF	10 Hz	to	600 Hz	4.5 · 10-3 C	
	1.1 µF	to	< 3.3 µF	10 Hz	to	300 Hz	4.5 · 10-3 C	
	3.3 µF	to	< 11 µF	10 Hz	to	150 Hz	4.5 · 10-3 C	
	11 µF	to	< 33 µF	10 Hz	to	120 Hz	6.0 · 10-3 C	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Capacity	33 µF to < 110 µF	10 Hz to 80 Hz DC to 50	6.5 · 10^{-3} *C*	*C* = measured value
Measuring devices	110 µF to < 330 µF	Hz DC to Hz DC to 6	6.0 · 10^{-3} *C*	
	330 µF to < 1.1 mF	Hz DC to 2 Hz DC to	6.0 · 10^{-3} *C*	
	1.1 mF to < 3.3 mF	200.6 Hz	6.0 · 10^{-3} *C*	
	3.3 mF to < 11 mF	DC to 0,2 Hz	6.0 · 10^{-3} *C*	
	11 mF to < 33 mF		8.0 · 10^{-3} *C*	
	33 mF to 110 mF		11 · 10^{-3} *C*	
DC capacity	1 µF to 70 µF	DC method	2.6 · 10^{-3}	
Sources, measuring devices	> 70 µF to 200 µF		0.55 · 10^{-3}	
	> 200 µF to 110 mF		0.30 · 10^{-3}	
Stress ratio	± 2 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.04 µV/V 0.05 µV/V 1.0 µV/V	Calibration of 350 Ω bridge standards and the associated indicators at discrete points in 10% steps
	± 2 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.05 µV/V 0.05 µV/V 1.0 µV/V	
	± 5 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 4.8 kHz	 0.15 µV/V 1.0 µV/V	
	± 10 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 4.8 kHz	 0.10 µV/V 0.30 µV/V	
	± 5 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.1 µV/V 0.1 µV/V 1.0 µV/V	
	± 10 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.4 µV/V 0.4 µV/V 0.4 µV/V	
	± 10 mV/V	Bridge voltage: 1 V Measuring frequency 600 Hz	 0.40 µV/V	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Stress ratio	± 20 mV/V	Bridge voltage: 1 V Measuring frequency 4.8 kHz	0.60 µV/V	Calibration of 350 Ω bridge standards and the associated indicators at discrete points in 10% steps
	± 100 mV/V	Bridge voltage: 1 V Measuring frequency 4.8 kHz	5.0 µV/V	
	± 100 mV/V	Bridge voltage: 2,5 V Measuring frequency 4.8 kHz	5.0 µV/V	
DC voltage Bridge standards	0 mV/V -2 mV/V to 2 mV/V -5 mV/V to 5 mV/V -10 mV/V to 10 mV/V -20 mV/V to 20 mV/V -100 mV/V to 100 mV/V	DC voltage Bridge voltage: 0,5 V	0.4 µV/V 0.35 µV/V 0.35 µV/V 0.35 µV/V 0.35 µV/V 0.35 µV/V	
	0 mV/V -2 mV/V to 2 mV/V -5 mV/V to 5 mV/V -10 mV/V to 10 mV/V -20 mV/V to 20 mV/V -100 mV/V to 100 mV/V	DC voltage Bridge voltage: 1,0 V	0.2 µV/V 0.15 µV/V 0.15 µV/V 0.15 µV/V 0.15 µV/V 0.25 µV/V	
	0 mV/V -2 mV/V to 2 mV/V -5 mV/V to 5 mV/V -10 mV/V to 10 mV/V -20 mV/V to 20 mV/V -100 mV/V to 100 mV/V	DC voltage Bridge voltage: 2,5 V	0.1 µV/V 0.07 µV/V 0.07 µV/V 0.07 µV/V 0.07 µV/V 0.20 µV/V	
	0 mV/V -2 mV/V to 2 mV/V -5 mV/V to 5 mV/V -10 mV/V to 10 mV/V -20 mV/V to 20 mV/V -100 mV/V to 100 mV/V	DC voltage Bridge voltage: 5,0 V	0.04 µV/V 0.035 µV/V 0.035 µV/V 0.035 µV/V 0.045 µV/V 0.15 µV/V	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Voltage ratio DC voltage bridge standards		DC voltage bridge voltage:		
	0 mV/V		0.025 µV/V	
	-2 mV/V to 2 mV/V		0.025 µV/V	
	-5 mV/V to 5 mV/V	7,5 V	0.025 µV/V	
	-10 mV/V to 10 mV/V		0.025 µV/V	
	-20 mV/V to 20 mV/V		0.04 µV/V	
	-100 mV/V to 100 mV/V		0.15 µV/V	
		DC voltage Bridge voltage:		
	0 mV/V		0.02 µV/V	
	-2 mV/V to 2 mV/V		0.015 µV/V	
	-5 mV/V to 5 mV/V	10,0 V	0.020 µV/V	
	-10 mV/V to 10 mV/V		0.025 µV/V	
	-20 mV/V to 20 mV/V		0.035 µV/V	
	-100 mV/V to 100 mV/V		0.075 µV/V	
DC voltage bridges, measuring instruments, measuring amplifiers		DC voltage bridge voltage:		With K148
	-2 mV/V to 2 mV/V		0.35 µV/V	
	-5 mV/V to 5 mV/V	0,5 V	0.35 µV/V	
	-10 mV/V to 10 mV/V		0.40 µV/V	
	-20 mV/V to 20 mV/V		0.55 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
		DC voltage Bridge voltage:		
	-2 mV/V to 2 mV/V		0.20 µV/V	
	-5 mV/V to 5 mV/V	1 V	0.20 µV/V	
	-10 mV/V to 10 mV/V		0.30 µV/V	
	-20 mV/V to 20 mV/V		0.50 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
		DC voltage Bridge voltage:		
	-2 mV/V to 2 mV/V		0.10 µV/V	
	-5 mV/V to 5 mV/V	2.5 V; 5 V; 7.5 V; 10 V	0.15 µV/V	
	-10 mV/V to 10 mV/V		0.25 µV/V	
	-20 mV/V to 20 mV/V		0.45 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		1 mA / 0.05 V // 10 Hz to 10 kHz		P = AC active power
Sources and measuring devices (discrete points)	50.0 µW	Phase angle: 0 °	0,2 - 10^{-3} P	Discrete points for Current, voltage and Phase angle
	43.3 µW	Phase angle: ±30 °	0,3 - 10^{-3} P	
	25.0 µW	Phase angle: ±60 °	0,8 - 10^{-3} P	
	12.9 µW	Phase angle: ±75 °	2,0 - 10^{-3} P	
		1 mA / 0.5 V / 10 Hz to 10 kHz		
	500 µW	Phase angle: 0 °	0,2 - 10^{-3} P	
	433 µW	Phase angle: ±30 °	0,2 - 10^{-3} P	
	250 µW	Phase angle: ±60 °	0,4 - 10^{-3} P	
	129 µW	Phase angle: ±75 °	0,7 - 10^{-3} P	
		1 mA / 1 V / 10 Hz to 10 kHz		
	1.0 mW	Phase angle: 0 °	0,1 - 10^{-3} P	
	0.9 mW	Phase angle: ±30 °	0,2 - 10^{-3} P	
	0.5 mW	Phase angle: ±60 °	0,4 - 10^{-3} P	
	0.3 mW	Phase angle: ±75 °	0,8 - 10^{-3} P	
		10 mA / 1 V / 10 Hz to 10 kHz		
	10.0 mW	Phase angle: 0 °	0,1 - 10^{-3} P	
	8.7 mW	Phase angle: ±30 °	0,2 - 10^{-3} P	
	5.0 mW	Phase angle: ±60 °	0,4 - 10^{-3} P	
	2.6 mW	Phase angle: ±75 °	0,8 - 10^{-3} P	
		20 mA / 1 V / 10 Hz to 10 kHz		
	20.0 mW	Phase angle: 0 °	50 - 10^{-6} P	
	17.3 mW	Phase angle: ±30 °	0,2 - 10^{-3} P	
	10.0 mW	Phase angle: ±60 °	0,4 - 10^{-3} P	
	5.2 mW	Phase angle: ±75 °	0,8 - 10^{-3} P	
		50 mA / 1 V / 10 Hz to 10 kHz		
	50.0 mW	Phase angle: 0 °	50 - 10^{-6} P	
	47.3 mW	Phase angle: ±30 °	0,2 - 10^{-3} P	
	25.0 mW	Phase angle: ±60 °	0,4 - 10^{-3} P	
	12.9 mW	Phase angle: ±75 °	0,8 - 10^{-3} P	
		100 mA / 1 V / 10 Hz to 10 kHz		
	100.0 mW	Phase angle: 0 °	50 - 10^{-6} P	
	86.6 mW	Phase angle: ±30 °	0,2 - 10^{-3} P	
	50.0 mW	Phase angle: ±60 °	0,4 - 10^{-3} P	
	25.9 mW	Phase angle: ±75 °	0,8 - 10^{-3} P	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		200 mA / 1 V / 10 Hz to 10 kHz		P = AC active power
Sources and measuring devices (discrete points)	200.0 mW	Phase angle: 0 °	50 - 10_{-6} P	Discrete points for Current, voltage and Phase angle
	173.2 mW	Phase angle: ±30 °	0,2 - 10_{-3} P	
	100.0 mW	Phase angle: ±60 °	0,4 - 10_{-3} P	
	51.8 mW	Phase angle: ±75 °	0,8 - 10_{-3} P	
		500 mA / 1 V / 10 Hz to 10 kHz		
	500.0 mW	Phase angle: 0 °	50 - 10_{-6} P	
	433.0 mW	Phase angle: ±30 °	0,5 - 10_{-3} P	
	250.0 mW	Phase angle: ±60 °	2,0 - 10_{-3} P	
	129.4 mW	Phase angle: ±75 °	3,0 - 10_{-3} P	
		1 A / 1 V / 10 Hz to 10 kHz		
	1,0 W	Phase angle: 0 °	50 - 10_{-6} P	
	0,9 W	Phase angle: ±30 °	0,5 - 10_{-3} P	
	0,5 W	Phase angle: ±60 °	2,0 - 10_{-3} P	
	0,3 W	Phase angle: ±75 °	3,0 - 10_{-3} P	
		2 A / 1 V / 10 Hz to 10 kHz		
	2,0 W	Phase angle: 0 °	50 - 10_{-6} P	
	1,7 W	Phase angle: ±30 °	0,5 - 10_{-3} P	
	1,0 W	Phase angle: ±60 °	2,0 - 10_{-3} P	
	0,5 W	Phase angle: ±75 °	3,0 - 10_{-3} P	
		5 A / 1 V / 10 Hz to 10 kHz		
	5,0 W	Phase angle: 0 °	50 - 10_{-6} P	
	4,3 W	Phase angle: ±30 °	1,0 - 10_{-3} P	
	2,5 W	Phase angle: ±60 °	4,0 - 10_{-3} P	
	1,3 W	Phase angle: ±75 °	8,0 - 10_{-3} P	
		10 A / 1 V / 10 Hz to 10 kHz		
	10,0 W	Phase angle: 0 °	50 - 10_{-6} P	
	8,7 W	Phase angle: ±30 °	1,0 - 10_{-3} P	
	5,0 W	Phase angle: ±60 °	4,0 - 10_{-3} P	
	2,6 W	Phase angle: ±75 °	8,0 - 10_{-3} P	
		20 A / 1 V /10 Hz to 10 kHz		
	20,0 W	Phase angle: 0 °	50 - 10_{-6} P	
	17,3 W	Phase angle: ±30 °	1,0 - 10_{-3} P	
	10,0 W	Phase angle: ±60 °	4,0 - 10_{-3} P	
	5,2 W	Phase angle: ±75 °	8,0 - 10_{-3} P	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		50 A / 1 V / 10 Hz to 10 kHz		*P* = AC active power
Sources and measuring devices (discrete points)	50,0 W	Phase angle: 0 °	0,3 - 10^{-3} *P*	Discrete points for Current, voltage and Phase angle
	43,3 W	Phase angle: ±30 °	3,0 - 10^{-3} *P*	
	25,0 W	Phase angle: ±60 °	6,0 - 10^{-3} *P*	
	12,9 W	Phase angle: ±75 °	10 - 10^{-3} *P*	
		100 A / 1 V / 10 Hz to 10 kHz		
	100,0 W	Phase angle: 0 °	0,3 - 10^{-3} *P*	
	86,6 W	Phase angle: ±30 °	3,0 - 10^{-3} *P*	
	50,0 W	Phase angle: ±60 °	6,0 - 10^{-3} *P*	
	25,9 W	Phase angle: ±75 °	10 - 10^{-3} *P*	
		1 mA / 10 V / 10 Hz to 10 kHz		
	10.0 mW	Phase angle: 0 °	0,1 - 10^{-3} *P*	
	8.7 mW	Phase angle: ±30 °	0,3 - 10^{-3} *P*	
	5.0 mW	Phase angle: ±60 °	0,7 - 10^{-3} *P*	
	2.6 mW	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		10 mA / 10 V / 10 Hz to 10 kHz		
	100.0 mW	Phase angle: 0 °	50 - 10^{-6} *P*	
	86.6 mW	Phase angle: ±30 °	0,3 - 10^{-3} *P*	
	50.0 mW	Phase angle: ±60 °	0,7 - 10^{-3} *P*	
	25.9 mW	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		20 mA / 10 V / 10 Hz to 10 kHz		
	200.0 mW	Phase angle: 0 °	50 - 10^{-6} *P*	
	173.2 mW	Phase angle: ±30 °	0,3 - 10^{-3} *P*	
	100.0 mW	Phase angle: ±60 °	0,7 - 10^{-3} *P*	
	51.8 mW	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		50 mA / 10 V / 10 Hz to 10 kHz		
	500.0 mW	Phase angle: 0 °	50 - 10^{-6} *P*	
	433.0 mW	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	250.0 mW	Phase angle: ±60 °	1,0 - 10^{-3} *P*	
	129.4 mW	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		100 mA / 10 V / 10 Hz to 10 kHz		
	1,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	0,9 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	0,5 W	Phase angle: ±60 °	1,0 - 10^{-3} *P*	
	0,3 W	Phase angle: ±75 °	2,0 - 10^{-3} *P*	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		200 mA / 10 V / 10 Hz to 10 kHz		*P* = AC active power
Sources and measuring devices	2,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	Discrete points for
(discrete points)	1,7 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	Current, voltage and
	1,0 W	Phase angle: ±60 °	1,0 - 10^{-3} *P*	Phase angle
	0,5 W	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		1 A / 10 V / 10 Hz to 10 kHz		
	10,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	8,7 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	5,0 W	Phase angle: ±60 °	2,0 - 10^{-3} *P*	
	2,6 W	Phase angle: ±75 °	3,0 - 10^{-3} *P*	
		2 A / 10 V /10 Hz to 10 kHz		
	20,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	17,3 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	10,0 W	Phase angle: ±60 °	2,0 - 10^{-3} *P*	
	5,2 W	Phase angle: ±75 °	3,0 - 10^{-3} *P*	
		5 A / 10 V /10 Hz to 10 kHz		
	50,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	43,3 W	Phase angle: ±30 °	1,0 - 10^{-3} *P*	
	25,0 W	Phase angle: ±60 °	3,0 - 10^{-3} *P*	
	12,9 W	Phase angle: ±75 °	7,0 - 10^{-3} *P*	
		10 A / 10 V / 10 Hz to 10 kHz		
	100,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	86,6 W	Phase angle: ±30 °	1,0 - 10^{-3} *P*	
	50,0 W	Phase angle: ±60 °	3,0 - 10^{-3} *P*	
	25,9 W	Phase angle: ±75 °	7,0 - 10^{-3} *P*	
		20 A / 10 V / 10 Hz to 10 kHz		
	200,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	173,2 W	Phase angle: ±30 °	1,0 - 10^{-3} *P*	
	100,0 W	Phase angle: ±60 °	3,0 - 10^{-3} *P*	
	51,8 W	Phase angle: ±75 °	7,0 - 10^{-3} *P*	
		50 A / 10 V / 10 Hz to 10 kHz		
	500,0 W	Phase angle: 0 °	0,2 - 10^{-3} *P*	
	433,0 W	Phase angle: ±30 °	2,0 - 10^{-3} *P*	
	250,0 W	Phase angle: ±60 °	5,0 - 10^{-3} *P*	
	129,4 W	Phase angle: ±75 °	1,0 - 10^{-2} *P*	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		100 A / 10 V / 10 Hz to 10 kHz		*P* = AC active power
Sources and measuring devices (discrete points)	1000,0 W	Phase angle: 0 °	0,2 - 10^{-3} *P*	Discrete points for Current, voltage and Phase angle
	866,0 W	Phase angle: ±30 °	2,0 - 10^{-3} *P*	
	500,0 W	Phase angle: ±60 °	5,0 - 10^{-3} *P*	
	258,8 W	Phase angle: ±75 °	1,0 - 10^{-2} *P*	
		1 mA / 100 V / 10 Hz to 10 kHz		
	100.0 mW	Phase angle: 0 °	50 - 10^{-6} *P*	
	86.6 mW	Phase angle: ±30 °	0,3 - 10^{-3} *P*	
	50.0 mW	Phase angle: ±60 °	0,8 - 10^{-3} *P*	
	25.9 mW	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		10 mA / 100 V / 10 Hz to 10 kHz		
	1,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	0,9 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	0,5 W	Phase angle: ±60 °	1,0 - 10^{-3} *P*	
	0,3 W	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		20 mA / 100 V / 10 Hz to 10 kHz		
	2,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	1,7 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	1,0 W	Phase angle: ±60 °	1,0 - 10^{-3} *P*	
	0,5 W	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		50 mA / 100 V / 10 Hz to 10 kHz		
	5,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	4,3 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	2,5 W	Phase angle: ±60 °	1,0 - 10^{-3} *P*	
	1,3 W	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		100 mA / 100 V / 10 Hz to 10 kHz		
	10,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	8,7 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	5,0 W	Phase angle: ±60 °	1,0 - 10^{-3} *P*	
	2,6 W	Phase angle: ±75 °	2,0 - 10^{-3} *P*	
		200 mA / 100 V / 10 Hz to 10 kHz		
	20,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	17,3 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	10,0 W	Phase angle: ±60 °	1,0 - 10^{-3} *P*	
	5,2 W	Phase angle: ±75 °	2,0 - 10^{-3} *P*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		1 A / 100 V // 10 Hz to 10 kHz		*P* = AC active power
Sources and measuring devices (discrete points)	100,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	Discrete points for Current, voltage and Phase angle
	86,6 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	50,0 W	Phase angle: ±60 °	2,0 - 10^{-3} *P*	
	25,9 W	Phase angle: ±75 °	3,0 - 10^{-3} *P*	
		2 A / 100 V // 10 Hz to 10 kHz		
	200,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	173,2 W	Phase angle: ±30 °	0,5 - 10^{-3} *P*	
	100,0 W	Phase angle: ±60 °	2,0 - 10^{-3} *P*	
	51,8 W	Phase angle: ±75 °	3,0 - 10^{-3} *P*	
		5 A / 100 V // 10 Hz to 10 kHz		
	500,0 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	433,0 W	Phase angle: ±30 °	1,0 - 10^{-3} *P*	
	250,0 W	Phase angle: ±60 °	3,0 - 10^{-3} *P*	
	129,4 W	Phase angle: ±75 °	7,0 - 10^{-3} *P*	
		10 A / 100 V // 10 Hz to 10 kHz		
	1000 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	866 W	Phase angle: ±30 °	1,0 - 10^{-3} *P*	
	500 W	Phase angle: ±60 °	3,0 - 10^{-3} *P*	
	258,8 W	Phase angle: ±75 °	7,0 - 10^{-3} *P*	
		20 A / 100 V // 10 Hz to 10 kHz		
	2000 W	Phase angle: 0 °	50 - 10^{-6} *P*	
	1732 W	Phase angle: ±30 °	1,0 - 10^{-3} *P*	
	1000 W	Phase angle: ±60 °	3,0 - 10^{-3} *P*	
	517,6 W	Phase angle: ±75 °	7,0 - 10^{-3} *P*	
		50 A / 100 V // 10 Hz to 10 kHz		
	5000 W	Phase angle: 0 °	0,2 - 10^{-3} *P*	
	4330 W	Phase angle: ±30 °	2,0 - 10^{-3} *P*	
	2500 W	Phase angle: ±60 °	5,0 - 10^{-3} *P*	
	1294 W	Phase angle: ±75 °	1,0 - 10^{-2} *P*	
		100 A / 100 V // 10 Hz to 10 kHz		
	10000 W	Phase angle: 0 °	0,2 - 10^{-3} *P*	
	8660 W	Phase angle: ±30 °	2,0 - 10^{-3} *P*	
	5000 W	Phase angle: ±60 °	5,0 - 10^{-3} *P*	
	2588 W	Phase angle: ±75 °	10 - 10^{-3} *P*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		50 A / 500 V / 40 Hz to 850 Hz		P = AC active power
Sources and measuring devices (discrete points)	25 kW	Phase angle: 0 °	$85 - 10^{-6} P$	Discrete points for Current, voltage and Phase angle
	21.7 kW	Phase angle: ±30 °	$0{,}2 - 10^{-3} P$	
	12,5 kW	Phase angle: ±60 °	$0{,}5 - 10^{-3} P$	
	6,5 kW	Phase angle: ±75 °	$1{,}0 - 10^{-3} P$	
		80 A / 500 V / 40 Hz up to 850 Hz		
	40 kW	Phase angle: 0 °	$85 - 10^{-6} P$	
	34.6 kW	Phase angle: ±30 °	$0{,}2 - 10^{-3} P$	
	20 kW	Phase angle: ±60 °	$0{,}5 - 10^{-3} P$	
	10,4 kW	Phase angle: ±75 °	$1{,}0 - 10^{-3} P$	
AC active power sources and meters (ranges)	50 µW to 500 mW	50 mV ≤ U ≤ 5 V 1 mA ≤ I ≤ 100 mA 10 Hz to 1 kHz Phase angle: 0 °	$0{,}17 - 10^{-3} P$	
		50 mV ≤ U ≤ 5 V 1 mA ≤ I ≤ 100 mA 10 Hz to 1 kHz Phase angle: 0° to ±30 °	$0{,}2 - 10^{-3} P$	
	50 µW to 500 mW	50 mV ≤ U ≤ 5 V 1 mA ≤ I ≤ 100 mA 10 Hz to 1 kHz Phase angle: 30 ° to 60 ° and -30 ° to -60 °	$0{,}3 - 10^{-3} P$	
		50 mV ≤ U ≤ 5 V 1 mA ≤ I ≤ 100 mA 10 Hz to 1 kHz Phase angle: 60 ° to 75 ° and -60 ° to -75 °	$0{,}6 - 10^{-3} P$	
	> 500 mW to 500 W	5 V ≤ U ≤ 500 V 100 mA ≤ I ≤ 1 A 16 Hz to 1 kHz Phase angle: 0 °	$0{,}1 - 10^{-3} P$	
		5 V ≤ U ≤ 500 V 100 mA ≤ I ≤ 1 A 16 Hz to 1 kHz Phase angle: 0° to ±30 °	$0{,}1 - 10^{-3} P$	
		5 V ≤ U ≤ 500 V 100 mA ≤ I ≤ 1 A 16 Hz to 1 kHz Phase angle: ±30 ° to ±60 °	$0{,}3 - 10^{-3} P$	
		5 V ≤ U ≤ 500 V 100 mA ≤ I ≤ 1 A 16 Hz to 1 kHz Phase angle: ±60 ° to ±75 °	$0{,}6 - 10^{-3} P$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power Sources and measuring devices (ranges)	> 500 W to 10 kW	25 V ≤ U ≤ 500 V 1 A ≤ I ≤ 20 A 16 Hz to 1 kHz Phase angle: 0 °	0,1 - 10^{-3} *P*	*P* = AC active power
		25 V ≤ U ≤ 500 V 1 A ≤ I ≤ 20 A 16 Hz to 1 kHz Phase angle: 0° to ±30 °	0,15 - 10^{-3} *P*	
		25 V ≤ U ≤ 500 V 1 A ≤ I ≤ 20 A 16 Hz to 1 kHz Phase angle: ±30 ° to ± 60 °	0,35 - 10^{-3} *P*	
		25 V ≤ U ≤ 500 V 1 A ≤ I ≤ 20 A 16 Hz to 1 kHz Phase angle: ±60 ° to ± 75 °	0,75 - 10^{-3} *P*	
	50 µW to 500 µW	0.05 V to 0.5 V 1 mA >1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30° to ±60° Phase angle: >±60° to ±75	0,3 - 10^{-3} *P* 0,8 - 10^{-3} *P* 7,0 - 10^{-3} *P*	
	> 0.5 mW to 200 mW	0.5 V to 1 V 1 mA to 200 mA > 1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30° to ±60° Phase angle:>±60° to ±75°	0,2 - 10^{-3} *P* 0,4 - 10^{-3} *P* 0,8 - 10^{-3} *P*	
	> 200 mW to 20 W	0.1 V to 1 V > 200 mA to 20 A > 1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30° to ±60° Phase angle:>±60° to ±75°	1,0 - 10^{-3} *P* 4,0 - 10^{-3} *P* 8,0 - 10^{-3} *P*	
	> 20 W to 100 W	0.1 V to 1 V > 20 A to 100 A >1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30° to ±60° Phase angle:>±60° to ±75°	3,0 - 10^{-3} *P* 6,0 - 10^{-3} *P* 10 - 10^{-3} *P*	
	10 mW to 200 mW	> 1 V to 10 V 1 mA to < 200 mA > 1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30 ° to ±60° Phase angle: >±60° to ±75	0,3 - 10^{-3} *P* 0,7 - 10^{-3} *P* 2,0 - 10^{-3} *P*	
	> 200 mW to 20 W	> 1 V to 10 V > 200 mA to 20 A > 1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30 ° to ±60° Phase angle:>±60° to ±75°	0,5 - 10^{-3} *P* 2,0 - 10^{-3} *P* 3,0 - 10^{-3} *P*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power Sources and measuring devices (ranges)	> 20 W to 1000 W	> 1 V to 10 V > 20 A to 100 A > 1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30° to ±60° Phase angle: >±60° to ±75	 2,0 - 10^{-3} *P* 5,0 - 10^{-3} *P* 10 - 10^{-3} *P*	*P* = AC active power
	100 mW to 20 W	> 10 V to 100 V 1 mA to 200 mA > 1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30° to ±60° Phase angle: >±60° to ±75	 0,5 - 10^{-3} *P* 1,0 - 10^{-3} *P* 2,0 - 10^{-3} *P*	
	> 20 W to 1000 W	> 10 V to 100 V > 200 mA to 10 A > 1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30° to ±60° Phase angle: >±60° to ±75	 1,5 - 10^{-3} *P* 3,0 - 10^{-3} *P* 7,0 - 10^{-3} *P*	
	> 1 kW to 10 kW	> 10 V to 100 V > 10 A to 100 A > 1 kHz to 10 kHz Phase angle: 0° to ±30° Phase angle:>±30° to ±60° Phase angle: >±60° to ±75	 2,0 - 10^{-3} *P* 5,0 - 10^{-3} *P* 10 - 10^{-3} *P*	
	> 10 kW to 80 kW	500 V ≤ U ≤ 1000 V 20 A ≤ I ≤ 80 A 40 Hz to 850 Hz Phase angle: 0 °	85 - 10^{-6} *P*	
		500 V ≤ U ≤ 1000 V 20 A ≤ I ≤ 80 A 40 Hz to 850 Hz Phase angle: 0° to ±30°	0,25 - 10^{-3} *P*	
		500 V ≤ U ≤ 1000 V 20 A ≤ I ≤ 80 A 40 Hz to 850 Hz Phase angle: 30° to 60 Phase angle: -30° to -60	0,65 - 10^{-3} *P*	
		500 V ≤ U ≤ 1000 V 20 A ≤ I ≤ 80 A 40 Hz to 850 Hz Phase angle: 60° to 75 Phase angle: -60° to -75	1,5 - 10^{-3} *P*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC reactive power Sources and measuring devices (discrete points)		1 mA / 0.05 V / 10 Hz to 10 kHz		*Q*=AC reactive power
	50.0 µVAr	Phase angle: 90 °	0,2 - 10^{-3} *Q*	Discrete points
	43.3 µVAr	Phase angle: ±60 °	0,3 - 10^{-3} *Q*	for current,
	25.0 µVAr	Phase angle: ±30 °	0,8 - 10^{-3} *Q*	voltage and
	12.9 µVAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	phase angle
		1 mA / 0.5 V / 10 Hz to 10 kHz		
	500 µVAr	Phase angle: 90 °	0,2 - 10^{-3} *Q*	
	433 µVAr	Phase angle: ±60 °	0,2 - 10^{-3} *Q*	
	250 µVAr	Phase angle: ±30 °	0,4 - 10^{-3} *Q*	
	129 µVAr	Phase angle: ±15 °	0,7 - 10^{-3} *Q*	
		1 mA / 1 V // 10 Hz to 10 kHz		
	1.0 mVAr	Phase angle: 90 °	0,1 - 10^{-3} *Q*	
	0.9 mVAr	Phase angle: ±60 °	0,2 - 10^{-3} *Q*	
	0.5 mVAr	Phase angle: ±30 °	0,4 - 10^{-3} *Q*	
	0.3 mVAr	Phase angle: ±15 °	0,8 - 10^{-3} *Q*	
		10 mA / 1 V // 10 Hz to 10 kHz		
	10.0 mVAr	Phase angle: 90 °	0,1 - 10^{-3} *Q*	
	8.7 mVAr	Phase angle: ±60 °	0,2 - 10^{-3} *Q*	
	5.0 mVAr	Phase angle: ±30 °	0,4 - 10^{-3} *Q*	
	2.6 mVAr	Phase angle: ±15 °	0,8 - 10^{-3} *Q*	
		20 mA / 1 V // 10 Hz to 10 kHz		
	20.0 mVAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	17.3 mVAr	Phase angle: ±60 °	0,2 - 10^{-3} *Q*	
	10.0 mVAr	Phase angle: ±30 °	0,4 - 10^{-3} *Q*	
	5.2 mVAr	Phase angle: ±15 °	0,8 - 10^{-3} *Q*	
		50 mA / 1 V // 10 Hz to 10 kHz		
	50.0 mVAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	47.3 mVAr	Phase angle: ±60 °	0,2 - 10^{-3} *Q*	
	25.0 mVAr	Phase angle: ±30 °	0,4 - 10^{-3} *Q*	
	12.9 mVAr	Phase angle: ±15 °	0,8 - 10^{-3} *Q*	
		100 mA / 1 V 10 Hz to 10 kHz		
	100.0 mVAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	86.6 mVAr	Phase angle: ±60 °	0,2 - 10^{-3} *Q*	
	50.0 mVAr	Phase angle: ±30 °	0,4 - 10^{-3} *Q*	
	25.9 mVAr	Phase angle: ±15 °	0,8 - 10^{-3} *Q*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC reactive power Sources and measuring devices (discrete points)		200 mA / 1 V /10 Hz to 10 kHz		*Q*=AC reactive power Discrete points for current, voltage and phase angle
	200.0 mVAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	173.2 mVAr	Phase angle: ±60 °	0,2 - 10^{-3} *Q*	
	100.0 mVAr	Phase angle: ±30 °	0,4 - 10^{-3} *Q*	
	51.8 mVAr	Phase angle: ±15 °	0,8 - 10^{-3} *Q*	
		500 mA / 1 V /10 Hz to 10 kHz		
	500.0 mVAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	433.0 mVAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	250.0 mVAr	Phase angle: ±30 °	2,0 - 10^{-3} *Q*	
	129.4 mVAr	Phase angle: ±15 °	3,0 - 10^{-3} *Q*	
		1 A / 1 V // 10 Hz to 10 kHz		
	1.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	0.9 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	0.5 VAr	Phase angle: ±30 °	2,0 - 10^{-3} *Q*	
	0.3 VAr	Phase angle: ±15 °	3,0 - 10^{-3} *Q*	
		2 A / 1 V // 10 Hz to 10 kHz		
	2.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	1.7 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	1.0 VAr	Phase angle: ±30 °	2,0 - 10^{-3} *Q*	
	0.5 VAr	Phase angle: ±15 °	3,0 - 10^{-3} *Q*	
		5 A / 1 V // 10 Hz to 10 kHz		
	5.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	4.3 VAr	Phase angle: ±60 °	1,0 - 10^{-3} *Q*	
	2.5 VAr	Phase angle: ±30 °	4,0 - 10^{-3} *Q*	
	1.3 VAr	Phase angle: ±15 °	8,0 - 10^{-3} *Q*	
		10 A / 1 V // 10 Hz to 10 kHz		
	10.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	8.7 VAr	Phase angle: ±60 °	1,0 - 10^{-3} *Q*	
	5.0 VAr	Phase angle: ±30 °	4,0 - 10^{-3} *Q*	
	2.6 VAr	Phase angle: ±15 °	8,0 - 10^{-3} *Q*	
		20 A / 1 V // 10 Hz to 10 kHz		
	20.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	17.3 VAr	Phase angle: ±60 °	1,0 - 10^{-3} *Q*	
	10.0 VAr	Phase angle: ±30 °	4,0 - 10^{-3} *Q*	
	5.2 VAr	Phase angle: ±15 °	8,0 - 10^{-3} *Q*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC reactive power Sources and measuring devices (discrete points)		50 A / 1 V // 10 Hz to 10 kHz		*Q*=AC reactive power
	50.0 VAr	Phase angle: 90 °	0,3 - 10^{-3} *Q*	Discrete points
	43.3 VAr	Phase angle: ±60 °	3,0 - 10^{-3} *Q*	for current,
	25.0 VAr	Phase angle: ±30 °	6,0 - 10^{-3} *Q*	voltage and
	12.9 VAr	Phase angle: ±15 °	10 - 10^{-3} *Q*	phase angle
		100 A / 1 V // 10 Hz to 10 kHz		
	100.0 VAr	Phase angle: 90 °	0,3 - 10^{-3} *Q*	
	86.6 VAr	Phase angle: ±60 °	3,0 - 10^{-3} *Q*	
	50.0 VAr	Phase angle: ±30 °	6,0 - 10^{-3} *Q*	
	25.9 VAr	Phase angle: ±15 °	10 - 10^{-3} *Q*	
		1 mA / 10 V // 10 Hz to 10 kHz		
	10.0 mVAr	Phase angle: 90 °	0,1 - 10^{-3} *Q*	
	8.7 mVAr	Phase angle: ±60 °	0,3 - 10^{-3} *Q*	
	5.0 mVAr	Phase angle: ±30 °	0,7 - 10^{-3} *Q*	
	2.6 mVAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	
		10 mA / 10 V /10 Hz to 10 kHz		
	100.0 mVAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	86.6 mVAr	Phase angle: ±60 °	0,3 - 10^{-3} *Q*	
	50.0 mVAr	Phase angle: ±30 °	0,7 - 10^{-3} *Q*	
	25.9 mVAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	
		20 mA / 10 V /10 Hz to 10 kHz		
	200.0 mVAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	173.2 mVAr	Phase angle: ±60 °	0,3 - 10^{-3} *Q*	
	100.0 mVAr	Phase angle: ±30 °	0,7 - 10^{-3} *Q*	
	51.8 mVAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	
		50 mA / 10 V /10 Hz to 10 kHz		
	500.0 mVAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	433.0 mVAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	250.0 mVAr	Phase angle: ±30 °	1,0 - 10^{-3} *Q*	
	129.4 mVAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	
		100 mA / 10 V / 10 Hz to 10 kHz		
	1.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	0.9 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	0.5 VAr	Phase angle: ±30 °	1,0 - 10^{-3} *Q*	
	0.3 VAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC reactive power Sources and measuring devices (discrete points)		200 mA / 10 V / 10 Hz to 10 kHz		*Q*=AC reactive power
	2.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	Discrete points
	1.7 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	for current,
	1.0 VAr	Phase angle: ±30 °	1,0 - 10^{-3} *Q*	voltage and
	0.5 VAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	phase angle
		1 A / 10 V // 10 Hz to 10 kHz		
	10.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	8.7 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	5.0 VAr	Phase angle: ±30 °	2,0 - 10^{-3} *Q*	
	2.6 VAr	Phase angle: ±15 °	3,0 - 10^{-3} *Q*	
		2 A / 10 V // 10 Hz to 10 kHz		
	20.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	17.3 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	10.0 VAr	Phase angle: ±30 °	2,0 - 10^{-3} *Q*	
	5.2 VAr	Phase angle: ±15 °	3,0 - 10^{-3} *Q*	
		5 A / 10 V // 10 Hz to 10 kHz		
	50.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	43.3 VAr	Phase angle: ±60 °	1,0 - 10^{-3} *Q*	
	25.0 VAr	Phase angle: ±30 °	3,0 - 10^{-3} *Q*	
	12.9 VAr	Phase angle: ±15 °	7,0 - 10^{-3} *Q*	
		10 A / 10 V // 10 Hz to 10 kHz		
	100.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	86.6 VAr	Phase angle: ±60 °	1,0 - 10^{-3} *Q*	
	50.0 VAr	Phase angle: ±30 °	3,0 - 10^{-3} *Q*	
	25.9 VAr	Phase angle: ±15 °	7,0 - 10^{-3} *Q*	
		20 A / 10 V // 10 Hz to 10 kHz		
	200.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	173.2 VAr	Phase angle: ±60 °	1,0 - 10^{-3} *Q*	
	100.0 VAr	Phase angle: ±30 °	3,0 - 10^{-3} *Q*	
	51.8 VAr	Phase angle: ±15 °	7,0 - 10^{-3} *Q*	
		50 A / 10 V // 10 Hz to 10 kHz		
	500.0 VAr	Phase angle: 90 °	0,2 - 10^{-3} *Q*	
	433.0 VAr	Phase angle: ±60 °	2,0 - 10^{-2} *Q*	
	250.0 VAr	Phase angle: ±30 °	2,0 - 10^{-2} *Q*	
	129.4 VAr	Phase angle: ±15 °	1,0 - 10^{-2} *Q*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC reactive power Sources and measuring devices (discrete points)		100 A / 10 V 10 Hz to 10 kHz		*Q*=AC reactive power
	1000.0 VAr	Phase angle: 90 °	0,2 - 10^{-3} *Q*	Discrete points
	866.0 VAr	Phase angle: ±60 °	2,0 - 10^{-2} *Q*	for current,
	500.0 VAr	Phase angle: ±30 °	2,0 - 10^{-2} *Q*	voltage and
	258.8 VAr	Phase angle: ±15 °	1,0 - 10^{-2} *Q*	phase angle
		1 mA / 100 V // 10 Hz to 10 kHz		
	100.0 m VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	86.6 m VAr	Phase angle: ±60 °	0,3 - 10^{-3} *Q*	
	50.0 m VAr	Phase angle: ±30 °	0,8 - 10^{-3} *Q*	
	25.9 m VAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	
		10 mA /100 V // 10 Hz to 10 kHz		
	1.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	0.9 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	0.5 VAr	Phase angle: ±30 °	1,0 - 10^{-3} *Q*	
	0.3 VAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	
		20 mA /100 V // 10 Hz to 10 kHz		
	2.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	1.7 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	1.0 VAr	Phase angle: ±30 °	1,0 - 10^{-3} *Q*	
	0.5 VAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	
		50 mA / 100 V// 10 Hz to 10 kHz		
	5.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	4.3 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	2.5 VAr	Phase angle: ±30 °	1,0 - 10^{-3} *Q*	
	1.3 VAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	
		100 mA /100 V// 10 Hz to 10 kHz		
	10.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	8.7 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	5.0 VAr	Phase angle: ±30 °	1,0 - 10^{-3} *Q*	
	2.6 VAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	
		200 mA/100 V// 0 Hz to 10 kHz		
	20.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	
	17.3 VAr	Phase angle: ±60 °	0,5 - 10^{-3} *Q*	
	10.0 VAr	Phase angle: ±30 °	1,0 - 10^{-3} *Q*	
	5.2 VAr	Phase angle: ±15 °	2,0 - 10^{-3} *Q*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC reactive power Sources and measuring devices (discrete points)		1 A / 100 V // 10 Hz to 10 kHz		Q=AC reactive power
	100.0 VAr	Phase angle: 90 °	50 - 10^{-6} Q	Discrete points for current, voltage and phase angle
	86.6 VAr	Phase angle: ±60 °	0,5 - 10^{-3} Q	
	50.0 VAr	Phase angle: ±30 °	2,0 - 10^{-3} Q	
	25.9 VAr	Phase angle: ±15 °	3,0 - 10^{-3} Q	
		2 A / 100 V // 10 Hz to 10 kHz		
	200.0 VAr	Phase angle: 90 °	50 - 10^{-6} Q	
	173.2 VAr	Phase angle: ±60 °	0,5 - 10^{-3} Q	
	100.0 VAr	Phase angle: ±30 °	2,0 - 10^{-3} Q	
	51.8 VAr	Phase angle: ±15 °	3,0 - 10^{-3} Q	
		5 A / 100 V // 10 Hz to 10 kHz		
	500.0 VAr	Phase angle: 90 °	50 - 10^{-6} Q	
	433.0 VAr	Phase angle: ±60 °	1,0 - 10^{-3} Q	
	250.0 VAr	Phase angle: ±30 °	3,0 - 10^{-3} Q	
	129.4 VAr	Phase angle: ±15 °	7,0 - 10^{-3} Q	
		10 A / 100 V // 10 Hz to 10 kHz		
	1000 VAr	Phase angle: 90 °	50 - 10^{-6} Q	
	866 VAr	Phase angle: ±60 °	1,0 - 10^{-3} Q	
	500 VAr	Phase angle: ±30 °	3,0 - 10^{-3} Q	
	258.8 VAr	Phase angle: ±15 °	7,0 - 10^{-3} Q	
		20 A / 100 V // 10 Hz to 10 kHz		
	2000 VAr	Phase angle: 90 °	50 - 10^{-6} Q	
	1732 VAr	Phase angle: ±60 °	1,0 - 10^{-3} Q	
	1000 VAr	Phase angle: ±30 °	3,0 - 10^{-3} Q	
	517.6 VAr	Phase angle: ±15 °	7,0 - 10^{-3} Q	
		50 A / 100 V // 10 Hz to 10 kHz		
	5000 VAr	Phase angle: 90 °	0,2 - 10^{-3} Q	
	4330 VAr	Phase angle: ±60 °	2,0 - 10^{-3} Q	
	2500 VAr	Phase angle: ±30 °	5,0 - 10^{-3} Q	
	1294 VAr	Phase angle: ±15 °	1,0 - 10^{-2} Q	
		100 A / 100 V // 10 Hz to 10 kHz		
	10000 VAr	Phase angle: 90 °	0,2 - 10^{-3} Q	
	8660 VAr	Phase angle: ±60 °	2,0 - 10^{-3} Q	
	5000 VAr	Phase angle: ±30 °	5,0 - 10^{-3} Q	
	2588 VAr	Phase angle: ±15 °	1,0 - 10^{-3} Q	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC reactive power Sources and measuring devices (discrete points)		50 A / 500 V // 40 Hz to 850 Hz		Q= AC reactive power
	25 kVAr	Phase angle: 90 °	85 - 10^{-6} Q	Discrete points
	21.7 kVAr	Phase angle: ±60 °	0,2 - 10^{-3} Q	for current,
	12.5 kVAr	Phase angle: ±30 °	0,5 - 10^{-3} Q	voltage and
	6.5 kVAr	Phase angle: ±15 °	1,0 - 10^{-3} Q	phase angle
		80 A / 500 V // 40 Hz to 850 Hz		
	40 kVAr	Phase angle: 90 °	85 - 10^{-6} Q	
	34.6 kVAr	Phase angle: ±60 °	0,2 - 10^{-3} Q	
	20 kVAr	Phase angle: ±30 °	0,5 - 10^{-3} Q	
	10.4 kVAr	Phase angle: ±15 °	1,0 - 10^{-3} Q	
AC reactive power Sources and measuring devices (areas)	50 µVAr to 500 mVAr	50 mV ≤ U ≤ 5 V 1 mA ≤ I ≤ 100 mA 10 Hz to 1 kHz Phase angle: ±90 °	0,17 - 10^{-3} Q	Q=AC reactive power
		50 mV ≤ U ≤ 5 V 1 mA ≤ I ≤ 100 mA 10 Hz to 1 kHz Phase angle: 90 ° to 60 Phase angle: -90 ° to -60 °	0,2 - 10^{-3} Q	
		50 mV ≤ U ≤ 5 V 1 mA ≤ I ≤ 100 mA 10 Hz to 1 kHz Phase angle: 60 ° to 30 ° Phase angle: -60 ° to -30 °	0,3 - 10^{-3} Q	
		50 mV ≤ U ≤ 5 V 1 mA ≤ I ≤ 100 mA 10 Hz to 1 kHz Phase angle: 30 ° to 15 ° Phase angle: -30 ° to -15 °	0,6 - 10^{-3} Q	
	> 500 mVAr to 500 VAr	5 V ≤ U ≤ 500 V 100 mA ≤ I ≤ 1 A 16 Hz to 1 kHz Phase angle: 90 °	0,1 - 10^{-3} Q	
		5 V ≤ U ≤ 500 V 100 mA ≤ I ≤ 1 A 16 Hz to 1 kHz Phase angle: 90 ° to 60 ° Phase angle: -90 ° to -60 °	0,1 - 10^{-3} Q	
		5 V ≤ U ≤ 500 V 100 mA ≤ I ≤ 1 A 16 Hz to 1 kHz Phase angle: 60 ° to 30 ° Phase angle: -60 ° to -30 °	0,3 - 10^{-3} Q	
		5 V ≤ U ≤ 500 V 100 mA ≤ I ≤ 1 A 16 Hz to 1 kHz Phase angle: 30 ° to 15 ° Phase angle: -30 ° to -15 °	0,6 - 10^{-3} Q	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC reactive power Sources and measuring devices (ranges)	> 500 VAr to 10 kVAr	25 V ≤ U ≤ 500 V 1 A ≤ I ≤ 20 A 16 Hz to 1 kHz Phase angle: 90 °	0,1 - 10^{-3} *Q*	*Q*=AC reactive power
		25 V ≤ U ≤ 500 V 1 A ≤ I ≤ 20 A 16 Hz to 1 kHz Phase angle:90 ° to 60 ° Phase angle: -90 ° to -60 °	0,15 - 10^{-3} *Q*	
		25 V ≤ U ≤ 500 V 1 A ≤ I ≤ 20 A 16 Hz to 1 kHz Phase angle: 60 ° to 30 ° Phase angle: -60 ° to -30 °	0,35 - 10^{-3} *Q*	
		25 V ≤ U ≤ 500 V 1 A ≤ I ≤ 20 A 16 Hz to 1 kHz Phase angle: 30 ° to 15 ° Phase angle: -30 ° to -15 °	0,75 - 10^{-3} *Q*	
	50 µVAr to 500 µVAr	0.05 V to 0.5 V 1 mA > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle:<±60° to ±30° Phase angle: <±30° to ±15	0,3 - 10^{-3} *Q* 0,8 - 10^{-3} *Q* 7,0 - 10^{-3} *Q*	
	> 0.5 mVAr to 200 mVAr	0.5 V to 1 V 1 mA to < 200 mA > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle:<±60° to ±30° Phase angle: <±30° to ±15	0,2 - 10^{-3} *Q* 0,4 - 10^{-3} *Q* 0,8 - 10^{-3} *Q*	
	> 200 mVAr to 20 VAr	> 0.1 V to 1 V > 200 mA to 20 A > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle:<±60° to ±30° Phase angle:<±30° to ±15°	1,0 - 10^{-3} *Q* 4,0 - 10^{-3} *Q* 8,0 - 10^{-3} *Q*	
	> 20 VAr to 100 VAr	> 0.1 V to 1 V > 20 A to 100 A > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle:<±60° to ±30° Phase angle:<±30° to ±15°	3,0 - 10^{-3} *Q* 6,0 - 10^{-3} *Q* 10,0 - 10^{-3} *Q*	
	10 mVAr to 200 mVAr	> 1 V to 10 V 1 mA to < 200 mA > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle: < ±60 ° to ±30° Phase angle: < ±30° to ±15	0,3 - 10^{-3} *Q* 0,7 - 10^{-3} *Q* 2,0 - 10^{-3} *Q*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC reactive power Sources and measuring devices (ranges)	> 200 mVAr to 20 VAr	> 1 V to 10 V > 200 mA to 20 A > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle:<±60° to ±30° Phase angle:<±30° to ±15°	 0,3 - 10^{-3} *Q* 0,7 - 10^{-3} *Q* 2,0 - 10^{-3} *Q*	*Q*=AC reactive power
	> 20 VAr to 1000 VAr	> 1 V to 10 V > 20 A to 100 A > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle:<±60° to ±30° Phase angle:<±30° to ±15°	 2,0 - 10^{-3} *Q* 5,0 - 10^{-3} *Q* 10 - 10^{-3} *Q*	
	100 mVAr to 20 VAr	> 10 V to 100 V 1 mA to 200 mA > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle:<±60° to ±30° Phase angle:<±30° to ±15°	 0,5 - 10^{-3} *Q* 1,0 - 10^{-3} *Q* 2,0 - 10^{-3} *Q*	
	> 20 VAr to 1000 VAr	> 10 V to 100 V > 200 mA to 10 A > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle:<±60° to ±30° Phase angle:<±30° to ±15°	 1,5 - 10^{-3} *Q* 3,0 - 10^{-3} *Q* 7,0 - 10^{-3} *Q*	
	> 1 kVAr to 10 kVAr	> 10 V to 100 V > 10 A to 100 A > 1 kHz to 10 kHz Phase angle: ±90° to ±60 Phase angle:<±60° to ±30° Phase angle: <±30° to ±15	 2,0 - 10^{-3} *Q* 5,0 - 10^{-3} *Q* 10,0 - 10^{-3} *Q*	
	> 10 kVAr to 80 kVAr	500 V ≤ U ≤ 1000 V 20 A ≤ I ≤ 80 A 40 Hz to 850 Hz Phase angle:± 90 °	85 - 10^{-6} *Q*	
		500 V ≤ U ≤ 1000 V 20 A ≤ I ≤ 80 A 40 Hz to 850 Hz Phase angle: 90 ° to 60 ° Phase angle: -90 ° to -60 °	0,25 - 10^{-3} *Q*	
		500 V ≤ U ≤ 1000 V 20 A ≤ I ≤ 80 A 40 Hz to 850 Hz Phase angle: 60 ° to 30 ° Phase angle: -60 ° to -30 °	0,65 - 10^{-3} *Q*	
		500 V ≤ U ≤ 1000 V 20 A ≤ I ≤ 80 A 40 Hz to 850 Hz Phase angle: 30 ° to 15 ° Phase angle: -30 ° to -15 °	1,5 - 10^{-3} *Q*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC apparent power Sources and measuring devices (ranges)	50 µVA to 500 µVA	50 mV ≤ U ≤ 500 mV I = 1 mA 10 Hz to 10 kHz	0,17 - 10^{-3} *S*	*S* = AC apparent power
	500 µVA up to 5 mVA	U = 500 mV 10 mA ≤ I ≤ 100 mA 10 Hz to 10 kHz	0,16 - 10^{-3} *S*	
	5 mVA to 50 mVA	U = 500 mV 10 mA ≤ I ≤ 100 mA 10 Hz to 10 kHz	55 - 10^{-6} *S*	
	50 mVA to 500 mVA	500 mV ≤ U ≤ 5 V I = 100 mA 10 Hz to 10 kHz	30 - 10^{-6} *S*	
	500 mVA up to 5 VA	5 V ≤ U ≤ 50 V I = 100 mA 16 Hz to 10 kHz	25 - 10^{-6} *S*	
	5 VA to 500 VA	50 V ≤ U ≤ 500 V 100 mA ≤ I ≤ 1 A 16 Hz to 10 kHz	50 - 10^{-6} *S*	
	500 VA to 5 kVA	U = 500 V 1 A ≤ I ≤ 10 A 16 Hz to 5 kHz	60 - 10^{-6} *S*	
	5 kVA to 10 kVA	U = 500 V 1 A ≤ I ≤ 20 A 16 Hz to 5 kHz	60 - 10^{-6} *S*	
	10 kVA to 80 kVA	500 V ≤ U ≤ 1000 V 20 A ≤ I ≤ 80 A 40 Hz to 850 Hz	85 - 10^{-6} *S*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Harmonic voltage Measuring devices	 1 V to 1000 V 1 V to 180 V	 40 Hz to 850 Hz > 850 Hz to 5 kHz	 $0.5 \cdot 10^{-3}$ $0.8 \cdot 10^{-3}$	Maximum up to the 100th harmonic
Sources	1 V to 1000 V 1 V to 180 V	40 Hz to 850 Hz > 850 Hz to 5 kHz	$0.4 \cdot 10^{-3}$ $0.4 \cdot 10^{-3}$	
Power Measuring devices	 0.01 A to 80 A 0.01 A to 20 A	 40 Hz to 850 Hz > 850 Hz to 5 kHz	 $4.0 \cdot 10^{-3}$ 3,0 %	
Sources	0.01 A to 80 A 0.01 A to 20 A	40 Hz to 850 Hz > 850 Hz to 5 kHz	$4.0 \cdot 10^{-3}$ 3,0 %	
Frequency	10 MHz	Measuring time > 30 min	$1 \cdot 10^{-11} f$	f = current measured value
Frequency measurement	1 mHz to 46 GHz	Measuring time > 5 min	$\sqrt{(1 \cdot 10^{-10} \cdot f)^2 + U^2}$ $_{Tf}$	At low frequencies are possible trigger uncertainties U_{Tf} or U_{Tt} must be taken into account.
Frequency synthesis	1 mHz to 50 GHz		$1 \cdot 10^{-10} f$	
Time interval	1 ns to 1000 s		$\sqrt{(1 \cdot 10^{-10} \cdot t)^2 + U^2 + 1ns^2}$ $_{Tt}$	
Speed optical	1 min^{-1} up to $2 \cdot 10^5$ min^{-1}	with light pulse generator	$6 \cdot 10^{-6}$ but not smaller than 0.001 min^{-1}	
mechanical	1 min^{-1} up to 10000 min^{-1}		$4 \cdot 10^{-4}$ but not smaller than 0.01 min^{-1}	
Oscilloscope calibrators Deflection vertical	 1 mV to 5 V	Square wave voltage 10 Hz to 10 kHz Ri= 50 Ω	$20 \cdot 10^{-6}$ 1 µV	
	1 mV to 200 V	Ri= 1 MΩ		
Deflection horizontal	1 ns to 1 s > 1 s to 5 s	Time stamps Measuring time > 5 min Ri= 1 MΩ, 50 Ω	$\sqrt{(1 \cdot 10^{-10} \cdot t)^2 + U^2}$ $_{Tt}$ $\sqrt{(5 \cdot 10^{-10} \cdot t)^2 + U^2}$ $_{Tt}$	t = current measured value Trigger uncertainty U_{Tt} to consider
Rise time t_r	18 hp to 100 hp > 100 ps to 10 ms	20 mV to 1 V	8 ps $4.5 \cdot ^{10\text{-}2} \cdot t_r$ 3 ps	External trigger signal required

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Oscilloscope measurement		Square wave voltage 10 Hz to 10 kHz		
Deflection vertical	1 mV to 5V	Ri = 50 Ω	0,35 %	Ri Internal resistance
	1 mV to 120 V	Ri = 1 MΩ	0,35 %	
Deflection horizontal	50 ps to < 1 µs	Time stamps or sine	6 ps	t = current measured value
	1 µs to 5 s	< 1 V	$1.5 \cdot 10^{-3} \cdot t$	
Rise time t_r	180 hp to 450 hp	250 mV	40 ps	t_r = current rise time
	> 450 ps to 10 ms	250 mV to 1 V	$4.5 \cdot {}^{10\text{-}2} \cdot t_r$	
Bandwidth B		0.2 V to 2 V		f_c = frequency at which -3dB point f_{Ref} = 5% f_c $\lvert\Gamma_{oszi}\rvert$: Reflection factor osci
	f_c	Ri= 50 Ω		
	50 MHz to 26.5 GHz	$\lvert\Gamma_{oszi}\rvert \le 0{,}05$	12 MHz	
		$\lvert\Gamma_{oszi}\rvert \le 0{,}1$	13 MHz	
		$\lvert\Gamma_{oszi}\rvert \le 0{,}15$	14 MHz	
		$\lvert\Gamma_{oszi}\rvert \le 0{,}2$	15 MHz	
Total Harmonic Distortion	0 to 0.3	100 Hz to 50 kHz	0,0001 0,0165 · *THD*	
THD / distortion	0 to 0.3	100 kHz to 2 GHz	0,0001 0,0675 · *THD*	
factor$_{THDAudio}$	0 to 0.3	100 Hz to 50 kHz	0.001 0.007 · $_{THDAudio}$	
Flicker*)				
$\Delta U / U$	0.4 to 5	DIN EN 61000-4-15:2011	$7 \cdot 10^{-3} \cdot \Delta U / U$	
Frequency	0.0083 Hz to 40 Hz		$3 \cdot 10^{-3} \cdot \Delta U / U$	
$_{Pst}$ (Short Term)		(115 V, 60 Hz);(230 V 50 Hz)	0,5 %	
$_{Plt}$ (Long Term)	10 minutes	(115 V, 60 Hz);(230 V 50 Hz)	1,7%	
	2 hours			
Current transformer transformation ratio	40 A to 400 A (primary) 10 mA to 5 A (secondary)	DC	20 - 10^{-6}	
	> 400 A to 4000 A (primary) 100 mA to 5 A (secondary)		24 - 10^{-6}	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - High-frequency measurands

Calibration and measurement capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
HF power Power meters	> 1 pW to 0.1 mW	2.5 MHz to 2 GHz	(0.025 0.14 -/Γ/) - *P*	Connector system: N, PC-3.5 ; 50 Ω; |Γ| KG ≤ 0.2
		> 2 GHz to 18 GHz	(0.049 0.21 -/Γ/) - *P*	
		> 18 GHz to 26.5 GHz	(0.071 0.32 -/Γ/) - *P*	Connector system: PC-3.5 ; 50 Ω; |Γ| KG ≤ 0.2
HF power Signal generators	> 1 pW to 0.1 mW	2.5 MHz to 2 GHz	(0.035 0.13 - |Γ|) - *P*	Connector system: N, PC-3.5 ; 50 Ω; |Γ| KG ≤ 0.2
		> 2 GHz to 18 GHz	(0.053 0.2 - |Γ|) - *P*	
		> 18 GHz to 26.5 GHz	(0.074 0.31 - |Γ|) - *P*	Connector: PC-3.5; 50 Ω, |Γ| KG ≤ 0.2
	0.1 mW to 10 mW	9 kHz to <0.1 MHz	17 · 10^{-3} - *P*	N connector; 50 Ω
		0.1 MHz to 50 MHz	10 · 10^{-3} - *P*	| Γ | ≤ 0,3
		>50 MHz to 6 GHz	15 · 10^{-3} - *P*	
		>6 GHz to 18 GHz	20 · 10^{-3} - *P*	
		0.1 MHz to 50 MHz	20 · 10^{-3} - *P*	| Γ | ≤ 0,5
		> 50 MHz to 6 GHz	30 · 10^{-3} - *P*	
		> 6 GHz to 18 GHz	40 · 10^{-3} - *P*	
	10 mW to 50 W	0.1 MHz to 2 GHz	48 · 10^{-3} - *P*	| *Γ* | of the KG ≤ 0.1
		0.1 MHz to 2 GHz	63 · 10^{-3} - *P*	| *Γ* | of the KG ≤ 0.3
		0.1 MHz to 2 GHz	123 · 10^{-3} - *P*	| *Γ* | of the KG ≤ 0.5
				N connector; PC-3.5 3)
	0.1 mW to 10 mW	10 MHz to 1 GHz	20 · 10^{-3} - *P*	Connector PC-3.5; 50 Ω3)
		> 1 GHz to 10 GHz	30 · 10^{-3} - *P*	| Γ | ≤ 0,3
		> 10 GHz to 18 GHz	40 · 10^{-3} - *P*	
		> 18 GHz to 26.5 GHz	45 · 10^{-3} - *P*	
		10 MHz to 1 GHz	40 · 10^{-3} - *P*	| Γ | ≤ 0,5
		> 1 GHz to 10 GHz	80 · 10^{-3} - *P*	
		> 10 GHz to 18 GHz	100 · 10^{-3} - *P*	
		> 18 GHz to 26.5 GHz	110 · 10^{-3} - *P*	

3) When using other connector systems, the measurement uncertainty increases.

Permanent laboratory Kirchzarten, Gewerbestraße 3 - High-frequency measurands

Calibration and measurement capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
HF power Power meters	0.1 mW to 10 mW	9 kHz to < 0.1 MHz	$17 \cdot 10^{-3} \cdot P$	N connector; 50 Ω3) $\lvert \Gamma \rvert \leq 0{,}3$
		0.1 MHz to 50 MHz	$6.0 \cdot 10^{-3} \cdot P$	
		> 50 MHz to 6 GHz	$12 \cdot 10^{-3} \cdot P$	
		> 6 GHz to 18 GHz	$20 \cdot 10^{-3} \cdot P$	
	> 10 mW to 50 W	32 MHz to 1 GHz	$20 \cdot 10^{-3} \cdot P$	
	0.1 mW to 10 mW	10 MHz to 1 GHz	$10 \cdot 10^{-3} \cdot P$	Connector PC-3.5; 50 Ω3) $\lvert \Gamma \rvert \leq 0{,}3$
		> 1 GHz to 10 GHz	$15 \cdot 10^{-3} \cdot P$	
		> 10 GHz to 18 GHz	$20 \cdot 10^{-3} \cdot P$	
		> 18 GHz to 26.5 GHz	$25 \cdot 10^{-3} \cdot P$	
Phase noise Signal generators	Phase noise related to carrier amplitude in dBc/Hz	Offset frequency referred to carrier frequency		Carrier frequency: 100 MHz - 1 GHz
	> -87 dBc/Hz	100 Hz	2.5 dB	
	> -99 dBc/Hz	1 kHz	2.5 dB	
	> -104 dBc/Hz	10 kHz	2.5 dB	
	> -111 dBc/Hz	100 kHz	2.5 dB	
	> -131 dBc/Hz	1 MHz	2.5 dB	
	> -137 dBc/Hz	10 MHz	2.5 dB	
	> -80 dBc/Hz	100 Hz	2.5 dB	> 1 MHz - 3 GHz
	> -96 dBc/Hz	1 kHz	2.5 dB	
	> -101 dBc/Hz	10 kHz	2.5 dB	
	> -109 dBc/Hz	100 kHz	2.5 dB	
	> -126 dBc/Hz	1 MHz	2.5 dB	
	> -136 dBc/Hz	10 MHz	2.5 dB	
	> -72 dBc/Hz	100 Hz	2.5 dB	> 3 GHz - 6 GHz
	> -93 dBc/Hz	1 kHz	2.5 dB	
	> -98 dBc/Hz	10 kHz	2.5 dB	
	> -106 dBc/Hz	100 kHz	2.5 dB	
	> -120 dBc/Hz	1 MHz	2.5 dB	
	> -135 dBc/Hz	10 MHz	2.5 dB	
HF noise display Receiver / Measuring devices	10 Hz to 50 GHz	-165 to 0 dBm/Hz dbm/Hz	1 dB	
Signal level difference Measuring devices / sources	0 dBc to 90 dBc	9 kHz to 7 GHz	1.5 dB	SNR > 20 dB
		> 7 GHz to 13.6 GHz	2.3 dB	
		> 13.6 GHz to 26.5 GHz	3 dB	
	> 90 dBc to 100 dBc	9 kHz to 7 GHz	4.5 dB	SNR > 20 dB
		> 7 GHz to 13.6 GHz	4.8 dB	
		> 13.6 GHz to 26.5 GHz	5.3 dB	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - High-frequency measurands

Calibration and measurement capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Filter bandwidth Measuring devices	1 Hz to 40 MHz		1 %	SNR > 70 dB
Form factor Measuring devices	1:1 bis 4:1 > 4:1 to 10:1 > 10:1 bis 18:1		5,5 % 7 % 8,5 %	SNR > 20 dB
Amplitude modulation: Modulation depth *m*	0.0 to ≤ 1.0	f_{MOD} < 1 MHz	0,004 0,025 · m	f_{HF} = carrier frequency f_{HF} < 4 GHz f_{MOD} = modulation freq. Absolute measuremen t uncertainty
Frequency modulation Frequency deviation Δf	0 Hz to 5 MHz	f_{MOD} < 1 MHz	0.041 ·Δf 25 Hz	f_{HF} = Carrier frequency f_{HF} < 4 GHz f_{MOD} = Modulation frequency Δf = frequency deviation Absolute measuremen t uncertainty
Phase modulation Phase deviation $\Delta\Phi$	0 to (4 MHz /$_{fMOD}$) rad	f_{MOD} < 1 MHz	0.025 rad 0.041 · ΔΦ	f_{HF} = Carrier frequency f_{HF} < 4 GHz f_{MOD} = *Modulation frequency* $\Delta\Phi$ = phase deviation Absolute measuremen t uncertainty
Distortion factor k	> 0.0001 to 0.01 > 0.01 to 0.1 > 0.1 to 0.2	AM- Demodulation method f_{HF}: 150 kHz to 2 GHz f_{MOD} = 1kHz P_{HF} = 0 dBm	0,030 0,029 0,025	*fHF*= Carrier frequency f_{MOD} = Modulation frequency P_{HF} = Carrier level
	> 0.0001 to 0.01 > 0.01 to 0.1 > 0.1 to 0.2	FM & PM- Demodulation method f_{HF}:150 kHz to 2 GHz f_{MOD} = 1kHz P_{HF} = 0 dBm Δf ≤ 50 kHz	0,09	Absolute measurement uncertainty

Permanent laboratory Kirchzarten, Gewerbestraße 3 - High-frequency measurands

Calibration and measurement capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Pulsed measurands *) Spectral voltage amplitude density (Measure/ Display)	S_0 = 13.5 µVs	DIN EN 55016-1-1:2020 CISPR 16-1-1:2019 CISPR Band A 9 kHz to 0.15 MHz	0.30 dB	Pulse frequency 1 Hz to 100 Hz $\Gamma_G, \Gamma_L \leq 0.05$ (represent)
	S_0 = 0.316 µVs	CISPR Band B > 0.15 MHz to 30 MHz	0.30 dB	Pulse frequency 1 Hz to 1000 Hz $\Gamma_G, \Gamma_L \leq 0.07$ (represent)
	S_0 = 0.0044 µVs	CISPR Band C > 30 MHz to 300 MHz	0.36 dB	Pulse frequency 1 Hz to 1000 Hz $\Gamma_G, \Gamma_L \leq 0.12$ (represent)
	S_0 = 0.0044 µVs	CISPR Band D > 300 MHz to 1 GHz	0.40 dB	
HF current transformer clamp *) Transfer light resistance dB(Ω)	9 kHz to 100 MHz > 100 MHz to 400 MHz > 400 MHz to 1 GHz	DIN EN 55016-1-2:2019 4.4 mA	0.3 dB 0.5 dB 0.8 dB	
HF Bulk Current Injection Transducer Clamp*) Insertion loss dB	9 kHz to 100 MHz > 100 MHz to 400 MHz > 400 MHz to 1 GHz	DIN EN 61000-4-6:2014 4.4 mA	0.3 dB 0.5 dB 1.5 dB	
Burst generators *) Voltage pulse	100 V to 4400 V	DIN EN 61000-4-4:2013 under load (RL) at R_L =50 Ω at R_L =1 kΩ	2,2 %	R_L = load resistance
Rise time and Pulse width	3 ns to 1 µs		2,5 %	
Burst duration and Burst period	100 ns to 1 s		0,25 %	
Surge generators *) Measure and display voltage amplitude	250 V to 7000 V	DIN EN 61000-4-5:2019 with or without Coupling and	3,5 %	
Current amplitude	5 A to 5 kA	Decoupling network	3,5 %	
Rise time and Pulse width	400 ns to 1 ms		3,5 %	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - High-frequency measurands

Calibration and measurement capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
RF attenuation	0 dB to 60 dB	9 kHz to 26.5 GHz > 26.5 GHz to 40 GHz > 40 GHz to 50 GHz	0.06 dB 0.09 dB 0.11 dB	Connector 50 Ω: N50; PC-3.5; PC-2.4[3]
	> 60 dB to 90 dB	9 kHz to 26.5 GHz	0.12 dB	
HF reflection coefficient	0 to 1	9 kHz to 10 GHz > 10 GHz to 18 GHz > 18 GHz to 26.5 GHz > 26.5 GHz to 50 GHz	0,003 0,0035/|Γ| 0,004 0,0040/|Γ| 0,004 0,0045/|Γ| 0,007 0,0060/|Γ|	Connector 50 Ω: N50; PC-3.5; PC-2.4[3] |Γ|: Amount of the complex Reflection factor
RF attenuation Phase angle ϕ	-180° to 180°	9 kHz to 50 GHz	$_{US}$ - 180°/π K - f	$_{US}$ = arcsin(U(|Γ|)/|Γ|) K = 0.025°/GHz Connector 50 Ω: N50; PC-3.5; PC-2.4[3]
RF transmission phase Phase angle φ	-180° to 180°	9 kHz to 50 GHz	U_T - 180°/π K - f 0.3°	U_T=arcsin($^{10U/20}$ - 1) K: 0.05°/GHz U: Uncertainty of the Attenuation in dB
Electrostatic Discharge (ESD) Current pulse I_P Support values current pulse I_{30} Current pulse I_{60} Rise time $_{tr}$ DC voltage U_L	 1 A to 120 A 1 A until 120 A 1 A until 120 A 0.6 ns until 1 µs 1 kV to 30 kV	DIN EN61000-4-2	 3,0 % 3,5 % 3,5 % 5,0 % 0,5 %	I_P = first discharge current peak I_{30} = current at 30 ns I_{60} = current at 60 ns

3) When using other connector systems, the measurement uncertainty increases.

On-site calibration - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Length *) Cylindrical setting standards, ring gauges: Diameter	1 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006 Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	0.8 µm $2 \cdot 10^{-6} \cdot d$	d = is the measured Diameter
Plug gauges: Diameter	1 mm to 200 mm		0.8 µm $2 \cdot 10^{-6} \cdot d$	
Test pins: Diameter	0,1 mm to 30 mm	VDI/VDE/DGQ 2618 Sheet 4.2:2007 Point 3.2.2 (Opt. 1)	0.8 µm $2 \cdot 10^{-6} \cdot d$	
Thread gauges (one and multi-start cylindrical male and female threads with straight flanks, symmetrical profile) Threaded mandrels: simple Flank diameter	1.4 mm to 200 mm nominal pitch: 0.3 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.8:2006 Point 3.2.2 (Opt. 1)	3 µm $10 \cdot 10^{-6} \cdot d$	Three-wire method d = is the measured diameter
Threaded rings: simpler Flank diameter	3 mm to 200 mm nominal pitch: 0.5 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.9:2006 Point 3.2.2 (Opt. 1)	3 µm $10 \cdot 10^{-6} \cdot d$	Two-ball method d = is the measured Diameter
Length of plane-parallel, spherical or cylindrical measuring surfaces	0,01 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 19.1:2014	1.5 µm $2 \cdot 10^{-6} \cdot l$	l is the measured length
Diameter	0,01 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006 Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	1.5 µm $2 \cdot 10^{-6} \cdot d$	d is the measured diameter
Feeler gauges	0,03 mm to 2,00 mm	DIN 2275:2014	1.5 µm $2 \cdot 10^{-6} \cdot l$	l is the measured length
Adjustment dimensions for Outside micrometers	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm $2 \cdot 10^{-6} \cdot l$	

On-site calibration - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Throat gauges	3 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.7:2005 Point 3.3.2 (Opt. 2)	0.8 µm $2 \cdot 10^{-6} \cdot d$	*d* is the measured Diameter
Caliper for Exterior, interior and Depth measurements	0 mm until 500 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	30 µm $30 \cdot 10^{-6} \cdot l$	*l* is the measured Length
Depth caliper,	> 500 mm until 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006	50 µm $30 \cdot 10^{-6} \cdot l$	
Height caliper		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
Outside micrometers	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm $10 \cdot 10^{-6} \cdot l$	
Precision micrometers	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002	3 µm $10 \cdot 10^{-6} \cdot l$	
Micrometer head screws	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008	3 µm $10 \cdot 10^{-6} \cdot l$	
Depth gauges	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010	3 µm $10 \cdot 10^{-6} \cdot l$	
Inside micrometers with 2-point contact on the calibration object	13 mm until 300 mm > 300 mm until 500 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	3 µm $10 \cdot 10^{-6} \cdot l$ 5 µm $10 \cdot 10^{-6} \cdot l$	
Inside micrometers with 3-line contact on the calibration object	3 mm to 150 mm	VDI/VDE/DGQ 2618 Sheet 10.8:2002	3 µm $10 \cdot 10^{-6} \cdot d$	*d* is the measured diameter
Lever gauges (quick probe) for outdoor measurements	to 200 mm	VDI/VDE/DGQ 2618 Sheet 12.1:2005	7 µm $10 \cdot 10^{-6} \cdot l$	*l* is the measured length
Lever gauges (quick probes) for Internal measurements	2 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 13.1:2005	7 µm $10 \cdot 10^{-6} \cdot l$	
Dial gauges	0 mm to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.1:2021	3 µm $10 \cdot 10^{-6} \cdot l$	mechanical dial gauges
		VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	3 µm $10 \cdot 10^{-6} \cdot l$	electronic digital dial gauges
Fine pointer	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
Feeler lever gauges	0 mm to 1,6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
Electr. inductive Linear Encoders	to 100 mm	VDI/VDE/DGQ 2618 Sheet 14.1:2010	0.6 µm $1 \cdot 10^{-6} \cdot l$	
Electr. incremental Linear Encoders	to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	0.6 µm $1 \cdot 10^{-6} \cdot l$	

On-site calibration - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Coordinate measuring technology Coordinate measuring machines with optical probing Measuring projectors, Measuring microscopes	Devices with one measuring level with a Area diagonals ≤ 450 mm	Calibration of the metrological Properties according to DKD-R 4-3 Sheet 18.1:2018, and the below mentioned Standards and guidelines DIN EN ISO 10360 VDI/VDE 2617		Measuring systems with visual probing or electronic Edge detection
		Determination of the Probing deviation P_{SX}, P_{SY} and P_{S2D} by means of a Circle standard according to VDI/VDE 2617 Sheet 6.1:2021	0,5 µm	
		Determination of the Probing deviation of the Image processing system P_{SVX}, P_{SVY} and P_{SV2D} by means of a Circle standard according to VDI/VDE 2617 Sheet 6.1:2021	0,5 µm	
		Determination of the Length measurement deviation E_{UXY}, E_{UX} and E_{UY} by means of a Line scale or Circle matrix according to DIN EN ISO 10360-7:2011	0.5 µm 0.7 · 10_{-6} · l	l is the measured Length

On-site calibration - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Coordinate measuring technology Coordinate measuring machines with optical probing Measuring projectors, measuring microscopes		Determination of the length measurement deviation of the image processing system E_{UV} by means of a line scale or circle matrix according to DIN EN ISO 10360-7:2011	0,5 µm	
	to 100 mm to 100 µm	Determination of the length measurement deviation E_{UZ} by means of gauge blocks or depth setting standard according to DIN EN ISO 10360-7:2011	0.5 µm 0.7 ·10^{-6} · *l* 0.25 µm	*l* is the measured length

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC voltage	0 V		0.1 µV	*U* = set value
Measuring devices	1 mV to 2,2 V		7 · 10^{-6} *U* 1 µV	
	> 2,2 V to 11 V		9 · 10^{-6} *U*	
	> 11 V to 22 V		8 · 10^{-6} *U*	
	> 22 V to 220 V		12 · 10^{-6} *U*	
	> 220 V to 1000 V		12 · 10^{-6} *U*	
DC voltage	0 V		0.1 µV	*U* = measured value
Sources	1 mV to 100 mV		8 · 10^{-6} *U* 1 µV	
	> 100 V to 1 V		11 · 10^{-6} *U*	
	> 1 V to 10 V		9 · 10^{-6} *U*	
	> 10 V to 100 V		13 · 10^{-6} *U*	
	> 100 V to 1000 V		16 · 10^{-6} *U*	
High Voltage	> 1 kV to 10 kV		2.5 · 10^{-3} *U* 2.5 V	*U* = measured value
DC current strength	0 A	Precision Open	0.2 nA	*I* = set value
meters and sources	0.1 µA until < 1 µA	Normal resistance and voltmeter	35 - 10^{-6} *I* 21 pA	
	1 µA until < 10 µA		50 - 10^{-6} *I* 6 pA	
	10 µA until < 100 µA		15 - 10^{-6} *I* 0.4 nA	
	100 µA until 320 mA		18 - 10^{-6} *I*	
	> 320 mA until 1 A		15 - 10^{-6} *I* 6 µA	
	> 1 A to 10 A		0,2 - 10^{-3} *I*	
	> 10 A > 150 A		0,3 - 10^{-3} *I*	
	150 A to 2000 A	Current transformer	0,3 - 10^{-3} *I*	
Direct current strength	1 mA to 2,2 A		1 · 10^{-3} *I*	
Current clamps	> 2,2 A to 20 A		2 · 10^{-3} *I*	
	> 20 A to 1000 A		3 · 10^{-3} *I*	

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	0 Ω		50 µ Ω	*R* = set value
	1 Ω; 1.9 Ω		95 · 10^{-6} *R*	Fluke 5700A
	10 Ω		28 · 10^{-6} *R*	
	19 Ω		27 · 10^{-6} *R*	
	100 Ω; 190 Ω		17 · 10^{-6} *R*	
	1 kΩ		13 · 10^{-6} *R*	
	1.9 kΩ		13 · 10^{-6} *R*	
	10 kΩ		12 · 10^{-6} *R*	
	19 kΩ		12 · 10^{-6} *R*	
	100 kΩ		14 · 10^{-6} *R*	
	190 kΩ		14 · 10^{-6} *R*	
	1 MΩ		20 · 10^{-6} *R*	
	1.9 MΩ		21 · 10^{-6} *R*	
	10 MΩ		40 · 10^{-6} *R*	
	19 MΩ		48 · 10^{-6} *R*	
	100 MΩ		110 · 10^{-6} *R*	
	0 Ω		100 µΩ	*R* = measured value
	1 Ω to 10 Ω		16 · 10^{-6} *R* 50 µΩ	HP 3458A
	> 10 Ω to 100 Ω		12 · 10^{-6} *R* 500 µΩ	
	> 100 Ω to 1 kΩ		15 · 10^{-6} *R*	
	> 1 kΩ to 10 kΩ		15 · 10^{-6} *R*	
	> 10 kΩ to 100 kΩ		15 · 10^{-6} *R*	
	> 100 kΩ to 1 MΩ		35 · 10^{-6} *R*	
	> 1 MΩ to 10 MΩ		150 · 10^{-6} *R*	
	> 10 MΩ to 100 MΩ		600 · 10^{-6} *R*	
	> 100 MΩ to 1 GΩ		5 · 10^{-3} *R*	
	0,001 Ω to 0,1 Ω	Substitution procedure	50 · 10^{-6} *R*	
	> 0,1 Ω to 1 MΩ	with normal resistance	20 · 10^{-6} *R*	
	> 1 MΩ to 100 MΩ		30 · 10^{-6} *R*	

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3} R$	R = set value
(areas)	11 Ω to < 33 Ω		$33 \cdot 10^{-6} R$	Fluke 5520A /5522A
Measuring devices	33 Ω to < 110 Ω		$29 \cdot 10^{-6} R$	
	110 Ω to < 330 Ω		$28 \cdot 10^{-6} R$	
	330 Ω to < 1.1 kΩ		$28 \cdot 10^{-6} R$	
	1.1 kΩ to < 3.3 kΩ		$28 \cdot 10^{-6} R$	
	3.3 kΩ to < 11 kΩ		$28 \cdot 10^{-6} R$	
	11 kΩ to < 33 kΩ		$28 \cdot 10^{-6} R$	
	33 kΩ to < 110 kΩ		$28 \cdot 10^{-6} R$	
	110 kΩ to < 330 kΩ		$32 \cdot 10^{-6} R$	
	330 kΩ to < 1.1 MΩ		$33 \cdot 10^{-6} R$	
	1.1 MΩ to < 3.3 MΩ		$62 \cdot 10^{-6} R$	
	3.3 MΩ to < 11 MΩ		$0.13 \cdot 10^{-3} R$	
	11 MΩ to < 33 MΩ		$0.25 \cdot 10^{-3} R$	
	33 MΩ to < 110 MΩ		$0.5 \cdot 10^{-3} R$	
	110 MΩ to < 330 MΩ		$3 \cdot 10^{-3} R$	
	330 MΩ to < 1.1 GΩ		$15 \cdot 10^{-3} R$	
AC voltage	1 mV to 2.2 mV	10 Hz to 20 Hz	$0.52 \cdot 10^{-3} U$	U = measured value
Measuring devices and		> 20 Hz to 40 Hz	$0.52 \cdot 10^{-3} U$	
Sources		> 40 Hz to 20 kHz	$0.40 \cdot 10^{-3} U$	
		> 20 kHz to 50 kHz	$0.40 \cdot 10^{-3} U$	
		> 50 kHz to 100 kHz	$0.41 \cdot 10^{-3} U$	
		> 100 kHz to 300 kHz	$0.46 \cdot 10^{-3} U$	
		> 300 kHz to 500 kHz	$0.55 \cdot 10^{-3} U$	
		> 500 kHz to 1 MHz	$0.60 \cdot 10^{-3} U$	
	> 2.2 mV to 7 mV	10 Hz to 20 Hz	$0.22 \cdot 10^{-3} U$	
		> 20 Hz to 40 Hz	$0.22 \cdot 10^{-3} U$	
		> 40 Hz to 20 kHz	$0.16 \cdot 10^{-3} U$	
		> 20 kHz to 50 kHz	$0.16 \cdot 10^{-3} U$	
		> 50 kHz to 100 kHz	$0.20 \cdot 10^{-3} U$	
		> 100 kHz to 300 kHz	$0.22 \cdot 10^{-3} U$	
		> 300 kHz to 500 kHz	$0.33 \cdot 10^{-3} U$	
		> 500 kHz to 1 MHz	$0.45 \cdot 10^{-3} U$	

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 7 mV to 22 mV	10 Hz to 20 Hz	$80 \cdot 10^{-6}\,U$	U = measured value
		> 20 Hz to 40 Hz	$80 \cdot 10^{-6}\,U$	
		> 40 Hz to 20 kHz	$65 \cdot 10^{-6}\,U$	
		> 20 kHz to 50 kHz	$75 \cdot 10^{-6}\,U$	
		> 50 kHz to 100 kHz	$75 \cdot 10^{-6}\,U$	
		> 100 kHz to 300 kHz	$95 \cdot 10^{-6}\,U$	
		> 300 kHz to 500 kHz	$0.19 \cdot 10^{-3}\,U$	
		> 500 kHz to 1 MHz	$0.21 \cdot 10^{-3}\,U$	
	> 22 mV to 70 mV	10 Hz to 20 Hz	$70 \cdot 10^{-6}\,U$	
		> 20 Hz to 40 Hz	$58 \cdot 10^{-6}\,U$	
		> 40 Hz to 20 kHz	$35 \cdot 10^{-6}\,U$	
		> 20 kHz to 50 kHz	$35 \cdot 10^{-6}\,U$	
		> 50 kHz to 100 kHz	$45 \cdot 10^{-6}\,U$	
		> 100 kHz to 300 kHz	$55 \cdot 10^{-6}\,U$	
		> 300 kHz to 500 kHz	$0.11 \cdot 10^{-3}\,U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\,U$	

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 70 mV to 220 mV	10 Hz to 20 Hz	$39 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$35 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$25 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$25 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$28 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$42 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$85 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.1 \cdot 10^{-3}\ U$	
	> 220 mV to 700 mV	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$22 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$12 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$12 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$14 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$27 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$40 \cdot 10^{-6}\ U$	
	> 700 mV to 2.2 V	10 Hz to 20 Hz	$20 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$14 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$10 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$10 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$11 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$22 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$68 \cdot 10^{-6}\ U$	
	> 2.2 V to 7 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$12 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$13 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$95 \cdot 10^{-6}\ U$	

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 7 V to 22 V	10 Hz to 20 Hz	$17 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1MHz	$0.11 \cdot 10^{-3}\ U$	
	> 22 V to 70 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$15 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$15 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$40 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 V to 220 V	10 Hz to 20 Hz	$19 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$18 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$17 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$17 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$32 \cdot 10^{-6}\ U$	
	> 220 V to 1000 V	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$27 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$45 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$45 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$65 \cdot 10^{-6}\ U$	
High Voltage	> 0.7 kV to 1 kV	50 Hz	$2.5 \cdot 10^{-3}\ U$ 0.25 V	
	> 1 kV to 7 kV		$3.5 \cdot 10^{-3}\ U$ 2.0 V	
Alternating current strength sources and measuring devices	100 µA to 1 mA	10 Hz to 40 Hz	$120 \cdot 10^{-6}\ I$	I = measured value
		> 40 Hz to 1 kHz;	$160 \cdot 10^{-6}\ I$	
		> 1 kHz to 10 kHz;	$60 \cdot 10^{-6}\ I$	
	> 1 mA to 10 mA	10 Hz to 40 Hz	$46 \cdot 10^{-6} I$	
		> 40 Hz to 1 kHz;		
		> 1 kHz to 10 kHz;		

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Alternating current strength sources and measuring devices	> 10 mA to 1 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	17 · 10^{-6} *I*	*I* = measured value
	> 1 A to 10 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	32 · 10^{-6} *I*	
	> 10 A to 20 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	39 · 10^{-6} *I*	
	> 20 A to 100 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	69 · 10^{-6} *I* 69 · 10^{-6} *I* 0.17 · 10^{-3} *I*	
Sources	100 A to 2000 A	50 Hz	3.0 · 10^{-3} · *I*	Current transformer
Current clamps	1 mA to 2.2 A > 2.2 A to 20 A > 20 A to 800 A	40 Hz to 5 kHz 40 Hz to 5 kHz 40 Hz to 65 Hz	2 · 10^{-3} *I* 3 · 10^{-3} *I* 4 · 10^{-3} *I*	*I* = measured value
Capacity gauges	190 pF to < 400 pF 400 pF to < 1.1 nF 1.1 nF to < 3.3 nF 3.3 nF to < 11 nF 11 nF to < 33 nF 33 nF to < 110 nF 110 nF to < 330 nF 330 nF to < 1.1 µF 1.1 µF to < 3.3 µF 3.3 µF to < 11 µF 11 µF to < 33 µF 33 µF to < 110 µF 110 µF to < 330 µF 330 µF to < 1.1 mF 1.1 mF to < 3.3 mF 3.3 mF to < 11 mF 11 mF to < 33 mF 33 mF to 110 mF	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 600 Hz 10 Hz to 300 Hz 10 Hz to 150 Hz 10 Hz to 120 Hz 10 Hz to 80 Hz DC to 50 Hz DC to Hz DC to 6 Hz DC to 2 Hz DC to 200.6 Hz DC to 0,2 Hz	4 · 10^{-3} C 8 pF 4.5 · 10^{-3} C 8 pF 4.0 · 10^{-3} C 8 pF 2.5 · 10^{-3} C 8 pF 2.5 · 10^{-3} C 80 pF 2.5 · 10^{-3} C 80 pF 4.5 · 10^{-3} C 4.5 · 10^{-3} C 4.5 · 10^{-3} C 4.5 · 10^{-3} C 6.0 · 10^{-3} C 6.5 · 10^{-3} C 6.0 · 10^{-3} C 6.0 · 10^{-3} C 6.0 · 10^{-3} C 6.0 · 10^{-3} C 8.0 · 10^{-3} C 11 · 10^{-3} C	With 5520A / 5522A
	1 nF to 100 nF > 100 nF to 1000 nF	50 Hz to 10 kHz 50 Hz to 1 kHz > 1 kHz to 10 kHz	1,0 - 10^{-3} *C* 1,0 - 10^{-3} *C* 2,5 - 10^{-3} *C*	*C*: measured value with normal capacitances

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Frequency	1 mHz to 46 GHz		$2 \cdot 10^{-9} \cdot f_{UTf}$	f = current measured value $_{UTf}$ =Trigger uncertainty
Time interval	1 µs to 1000 s		$2 \cdot 10^{-9} \cdot t$ 2 ns	t = current measured value
Speed optical	1 min^{-1} up to 100.000 min^{-1}	with light pulse generator	$8 \cdot 10^{-6}$ but not less than 0.006 min^{-1}	
AC active power measuring devices	109 µW to < 11kW	33 mV to 1000 V 45 Hz to 65 kHz *PF* = 1 33 mA to < 11 A	$1.4 \cdot 10^{-3} P$	*P* = set value with Fluke 5520A/5522A *PF:* Power factor
	363 mW up to 20 kW	11 A to 20 A	$2.0 \cdot 10^{-3} P$	
DC power Measuring devices	1 mW to 300 W > 300 W to 20 kW		$0.5 \cdot 10^{-3} P$ $1.0 \cdot 10^{-3} P$	
Sources	1 mW to 300 W > 300 W to 1 kW > 1 kW to 1 MW	Product of U and I 1 mV ≤ U ≤ 1000 V 100 µA ≤ I ≤ 2000 A	30 - $10^{-6} P$ 200 - $10^{-6} P$ 300 - $10^{-6} P$	*P* Calculated power
AC active power	5 mW up to 50 kW > 2.5 W to 120 kW	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than 80 - 10^{-6} not smaller than 0.14 - 10^{-3}	$w(_{UF})$ Uncertainty of the amplitude of the voltage fundamental $w(_{IF})$ Uncertainty of amplitude of Current fundamental $w(_{\Phi F})$ Uncertainty of the phase shift angle $w(U_{rmc})$ Uncertainty of the voltage rms value $w(I_{rmc})$ Uncertainty of the rms current value
	5 mvar to 50 kvar > 2.5 var up to 120 kvar	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than 80 - 10^{-6} not smaller than 0.14 - 10^{-3}	
Apparent power	0.1 VA up to 50 kVA > 50 VA to 120 kVA	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than 80 - 10^{-6} not smaller than 0.14 - 10^{-3}	

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Stress ratio	± 2 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.04 µV/V 0.05 µV/V 1.0 µV/V	Calibration of 350 Ω bridge standards and the associated indicators at discrete points in 10% steps
	± 2 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.05 µV/V 0.05 µV/V 1.0 µV/V	
	± 5 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 4.8 kHz	 0.15 µV/V 1.0 µV/V	
	± 10 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 4.8 kHz	 0.10 µV/V 0.30 µV/V	
	± 5 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.1 µV/V 0.1 µV/V 1.0 µV/V	
	± 10 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.4 µV/V 0.4 µV/V 0.4 µV/V	Calibration of 350 Ω bridge standards and the associated indicators at discrete points in 10% steps
	± 10 mV/V	Bridge voltage: 1 V Measuring frequency 600 Hz	 0.40 µV/V	
	± 20 mV/V	Bridge voltage: 1 V Measuring frequency 4.8 kHz	 0.60 µV/V	
	± 100 mV/V	Bridge voltage: 1 V Measuring frequency 4.8 kHz	 5.0 µV/V	
	± 100 mV/V	Bridge voltage: 2,5 V Measuring frequency 4.8 kHz	 5.0 µV/V	

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Voltage ratio DC voltage bridge standards		Bridge voltage:		
	0 mV/V		2.0 µV/V	
	-2 mV/V to 2 mV/V		2.5 µV/V	
	-5 mV/V to 5 mV/V	0,5 V	2.5 µV/V	
	-10 mV/V to 10 mV/V		2.5 µV/V	
	-20 mV/V to 20 mV/V		2.5 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
		Bridge voltage:		
	0 mV/V		1.0 µV/V	
	-2 mV/V to 2 mV/V		2.0 µV/V	
	-5 mV/V to 5 mV/V	1,0 V	2.0 µV/V	
	-10 mV/V to 10 mV/V		2.0 µV/V	
	-20 mV/V to 20 mV/V		2.0 µV/V	
	-100 mV/V to 100 mV/V		2.0 µV/V	
		Bridge voltage:		
	0 mV/V		0.5 µV/V	
	-2 mV/V to 2 mV/V		0.5 µV/V	
	-5 mV/V to 5 mV/V	2,5 V	0.5 µV/V	
	-10 mV/V to 10 mV/V		0.5 µV/V	
	-20 mV/V to 20 mV/V		0.5 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
		Bridge voltage:		
	0 mV/V		0.3 µV/V	
	-2 mV/V to 2 mV/V		0.25 µV/V	
	-5 mV/V to 5 mV/V	5,0 V	0.25 µV/V	
	-10 mV/V to 10 mV/V		0.25 µV/V	
	-20 mV/V to 20 mV/V		0.35 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
		Bridge voltage:		
	0 mV/V		0.2 µV/V	
	-2 mV/V to 2 mV/V		0.2 µV/V	
	-5 mV/V to 5 mV/V	7,5 V	0.2 µV/V	
	-10 mV/V to 10 mV/V		0.2 µV/V	
	-20 mV/V to 20 mV/V		0.3 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
		Bridge voltage:		
	0 mV/V		0.1 µV/V	
	-2 mV/V to 2 mV/V		0.15 µV/V	
	-5 mV/V to 5 mV/V	10,0 V	0.15 µV/V	
	-10 mV/V to 10 mV/V		0.2 µV/V	
	-20 mV/V to 20 mV/V		0.3 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	

On-site calibration - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Voltage ratio DC voltage bridges, measuring instruments, measuring amplifier	-2 mV/V to 2 mV/V	Bridge voltage: 0,5 V	0.35 µV/V	With K148
	-5 mV/V to 5 mV/V		0.35 µV/V	
	-10 mV/V to 10 mV/V		0.40 µV/V	
	-20 mV/V to 20 mV/V		0.55 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
	-2 mV/V to 2 mV/V	Bridge voltage: 1 V	0.20 µV/V	
	-5 mV/V to 5 mV/V		0.20 µV/V	
	-10 mV/V to 10 mV/V		0.30 µV/V	
	-20 mV/V to 20 mV/V		0.50 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
	-2 mV/V to 2 mV/V	Bridge voltage: 2.5 V; 5 V; 7.5 V; 10 V	0.10 µV/V	
	-5 mV/V to 5 mV/V		0.15 µV/V	
	-10 mV/V to 10 mV/V		0.25 µV/V	
	-20 mV/V to 20 mV/V		0.45 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	

On-site calibration - high-frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Oscilloscope measured variables				
Vertical deflection	5 mV to 5 V	R_i = 50 Ω	3.5 · 10^{-3} U 35 µV	Square wave voltage
	5 mV to 120 V	R_i = 1 MΩ	2.4 · 10^{-3} U 40 µV	10 Hz to 10 kHz
Horizontal deflection	5 ns to 520 ms		3 · 10^{-6} t 1 ns	t: current time
	> 20 ms to 5 s		30 · 10^{-6} t 1.2 · 10^{-3} t^2	
Rise time	150 ps to 10 ms	250 mV	35 - $^{10-3}$ - t_r 5 ps	t_r = intrinsic rise time
	250 ps to 10 ms	> 250 mV to 2.5 V R_i = 50 Ω	35 - $^{10-3}$ - t_r 8 ps	of the oscilloscope
RF impedance (reflection factor) Single measurement |S11| Amount $\|\Gamma\|$	0,0 to 1,0	45 MHz to 5 GHz	0,01 0,01 $\|\Gamma\|$	Connector; PC-7; 50 Ω3)
		> 5 GHz to 18 GHz	0,015 0,01 $\|\Gamma\|$	
		9 kHz to 5 GHz	0,01 0,01 $\|\Gamma\|$	N connector; 50 Ω3)
		> 5 GHz to 18 GHz	0,015 0,01 $\|\Gamma\|$	
		45 MHz to 5 GHz	0,01 0,005 $\|\Gamma\|$	Connector; PC-3.5; 50 Ω3)
		> 5 GHz to 18 GHz	0,015 0,01 $\|\Gamma\|$	
		> 18 GHz to 26.5 GHz	0,02 0,02 $\|\Gamma\|$	
Phase φ		9 kHz to 18 GHz 0,1 ≤ $\|\Gamma\|$ ≤ 1	—	N connector; 50 Ω.
	-180° to 180°	45 MHz to 18 GHz 0,1 ≤ $\|\Gamma\|$ ≤ 1	$\arcsin\frac{U(\|\Gamma\|)}{\|\Gamma\|}\bullet\frac{180°}{\pi}$	PC-7; 50 Ω
		45 MHz to 26.5 GHz 0,1 ≤ $\|\Gamma\|$ ≤ 1		PC-3.5

On-site calibration - high-frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
RF impedance (reflection factor)	0.0 to 1.0	45 MHz to 5 GHz > 5 GHz to 18 GHz	0,015 0,01 |Γ| 0,02 0,01 |Γ|	PC-7; 50 Ω3)
Two-port measurement|S11|&amp |S22| Amount |Γ|		9 kHz to 5 GHz > 5 GHz to 18 GHz	0,015 0,01 |Γ| 0,02 0,01 |Γ|	N connector; 50 Ω. 3)
		45 MHz to 5 GHz > 5 GHz to 18 GHz > 18 GHz to 26.5 GHz	0,01 0,005 |Γ| 0,015 0,01 |Γ| 0,02 0,02 |Γ|	PC-3,53)
Phase φ	-180° to 180	9 kHz to 18 GHz 0,1 ≤ |Γ| ≤ 1 45 MHz to 18 GHz 0,1 ≤ |Γ| ≤ 1 45 MHz to 26.5 GHz 0,1 ≤ |Γ| ≤ 1	$\arcsin\frac{U(\lvert\Gamma\rvert)}{\lvert\Gamma\rvert}\bullet\frac{180°}{\pi}$	N connector; 50 Ω. PC-7; 50 Ω PC-3.5
HF - Attenuation Switchable-Attenuators,	0 dB to 60 dB	9 kHz to 18 GHz	0.3 dB	Connector system: N; 50 Ω |Γ|≤ 0.1
Fixed attenuators	> 60 dB to 90 dB		0.3 dB	
Absolute attenuation values	0 dB to 60 dB	45 MHz to 20 GHz > 20 GHz to 26.5 GHz	0.3 dB 0.5 dB	Connector system PC-3.5; 50 Ω 45 MHz to 20 GHz |Γ|≤ 0.1 < 20 GHz to 26.5 GHz |Γ|≤ 0.15
	> 60 dB to 90 dB	45 MHz to 20 GHz > 20 GHz to 26.5 GHz	0.3 dB 0.5 dB	
HF power Power meters	> 1 pW to 0.1 mW	2.5 MHz to 2 GHz > 2 GHz to 18 GHz > 18 GHz to 26.5GHz	(0.025 0.14 -|Γ|) - P (0.049 0.21 -|Γ|) - P (0.071 0.32 -|Γ|) - P	Connector system: N, PC-3.5 ; 50 Ω; | Γ|/KG ≤ 0.2
HF power Signal generators	> 1 pW to 0.1 mW	2.5 MHz to 2 GHz > 2 GHz to 18 GHz > 18 GHz to 26.5GHz	(0.035 0.13 -|Γ|) - P (0.053 0.2 -|Γ|) - P (0.074 0.31 -|Γ|) - P	Connector system: N, PC-3.5 ; 50 Ω;|Γ| KG ≤ 0.2
	0.1 mW to 10 mW	9 kHz to 50 MHz > 50 MHz to 5 GHz > 5 GHz to 18 GHz	17 · 10-3 - P 22 · 10-3 - P 30 · 10-3 - P	N connector; 50 Ω3) |Γ| ≤ 0,3
	0.1 mW to 10 mW	50 MHz to 5 GHz > 5 GHz to 18 GHz > 18 GHz to 26.5 GHz	22 · 10-3 - P 32 · 10-3 - P 40 · 10-3 - P	Connector PC-3.5; 50 Ω3) |Γ| ≤ 0,3

On-site calibration - high-frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
HF power	0.1 mW to 10 mW	9 kHz to 50 MHz	$17 \cdot 10^{-3} \cdot P$	N connector; 50 Ω[3]
Power meters		> 50 MHz until 5 GHz	$21 \cdot 10^{-3} \cdot P$	$\lvert \Gamma \rvert \leq 0{,}3$
		> 5 GHz until 18 GHz	$28 \cdot 10^{-3} \cdot P$	
	0.1 mW to 10 mW	50 MHz to 5 GHz	$22 \cdot 10^{-3} \cdot P$	Connector PC-3.5; 50 Ω[3]
		> 5 GHz to 18 GHz	$32 \cdot 10^{-3} \cdot P$	$\lvert \Gamma \rvert \leq 0{,}3$
		> 18 GHz to 26.5 GHz	$40 \cdot 10^{-3} \cdot P$	
Signal level difference	0 dBc to 90 dBc	9 kHz to 7 GHz	1.5 dB	SNR > 20 dB
Measuring devices /		> 7 GHz to 13,6 GHz	2.3 dB	
sources		> 13.6 GHz to 26,5 GHz	3 dB	
	> 90 dBc to 100 dBc	9 kHz to 7 GHz	4.5 dB	SNR > 20 dB
		> 7 GHz to 13,6 GHz	4.8 dB	
		> 13.6 GHz to 26,5 GHz	5.3 dB	
Filter bandwidth	1 Hz to 40 MHz		1 %	SNR > 70 dB
Measuring devices				
HF noise display	10 Hz to 50 GHz	-165 dbm/Hz to 0 dBm/Hz	1 dB	
Receiver / Measuring devices				
Form factor	1:1 to 4:1		5,5 %	SNR > 20 dB
Measuring devices	> 4:1 to 10:1		7 %	
	> 10:1 to 18:1		8,5 %	

3) When using other connector systems, the measurement uncertainty increases.

On-site calibration - high-frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Amplitude modulation: Modulation depth *m*	0.0 to ≤ 1.0	f_{HF} < 4 GHz f_{MOD} < 1 MHz	0,004 0,025 · *m*	f_{HF} = carrier frequency f_{MOD} = Modulation freq.
Frequency modulation Frequency deviation *Δf*	0 Hz to 5 MHz	f_{HF} < 4 GHz f_{MOD} < 1 MHz	0.041 · Δf 25 Hz	f_{HF} = Carrier frequency f_{MOD} = Modulation freq.
Phase modulation Phase deviation *ΔΦ*	0 to (4 MHz / f_{MOD}) rad	f_{HF} < 4 GHz f_{MOD} < 1 MHz	0.025 rad 0.041 · *ΔΦ*	f_{HF} = Carrier frequency f_{MOD} = Modulation freq.
Distortion factor k	> 0.0001 to 0.01 > 0.01 to 0.1 > 0.1 to 0.2	AM demodulation method f_{HF}: 150 kHz to 2 GHz f_{MOD} = 1kHz P_{HF} = 0 dBm	0,030 0,029 0,025	*fHF*= Carrier frequency f_{MOD} = Modulation freq. P_{HF} = Carrier level
	> 0.0001 to 0.01 > 0.01 to 0.1 > 0.1 to 0.2	FM & PM-Demodulation method f_{HF}:150 kHz to 2 GHz f_{MOD} = 1kHz P_{HF} = 0 dBm *Δf* ≤ 50 kHz	0,09	Absolute measurement uncertainty
Pulsed measurands*) Spectral voltage amplitude density (Measure/ Display)	S_0 = 13.5 µVs	DIN EN 55016-1-1:2020 CISPR 16-1-1:2019 CISPR Band A 9 kHz to 0.15 MHz	0.50 dB	Pulse frequency 1 Hz to 100 Hz Γ_G, Γ_L ≤ 0.05 (represent)
	S_0 = 0.316 µVs	CISPR Band B > 0.15 MHz to 30 MHz	0.50 dB	Pulse frequency 1 Hz to 1000 Hz Γ_G, Γ_L ≤ 0.07 (represent)
	S_0 = 0.0044 µVs	CISPR Band C > 30 MHz to 300 MHz	0.6 dB	Pulse frequency 1 Hz to 1000 Hz Γ_G, Γ_L ≤ 0.12 (represent)
	S_0 = 0.0044 µVs	CISPR Band D > 300 MHz to 1 GHz	0.6 dB	Pulse frequency 1 Hz to 1000 Hz Γ_G, Γ_L ≤ 0.12 (represent)
HF current transformer clamp*) Transfer resistance dB(Ω)	9 kHz to 100 MHz > 100 MHz to 400 MHz > 400 MHz to 1 GHz	DIN EN 55016-1-2:2019 4.4 mA	0.3 dB 0.5 dB 0.8 dB	
HF Bulk Current Injection Transducer Clamp Insertion Loss dB	9 kHz to 100 MHz > 100 MHz to 400 MHz > 400 MHz to 1 GHz	DIN EN 61000-4-6:2014 4.4 mA	0.3 dB 0.5 dB 1.5 dB	

On-site calibration - high-frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase noise	Phase noise related to carrier amplitude in dBc/Hz	Offset frequency referred to carrier frequency		Carrier frequency:
Signal generators	> -87 dBc/Hz	100 Hz	2.5 dB	100 MHz - 1 GHz
	> -99 dBc/Hz	1 kHz	2.5 dB	
	> -104 dBc/Hz	10 kHz	2.5 dB	
	> -111 dBc/Hz	100 kHz	2.5 dB	
	> -131 dBc/Hz	1 MHz	2.5 dB	
	> -137 dBc/Hz	10 MHz	2.5 dB	
	> -80 dBc/Hz	100 Hz	2.5 dB	> 1 MHz - 3 GHz
	> -96 dBc/Hz	1 kHz	2.5 dB	
	> -101 dBc/Hz	10 kHz	2.5 dB	
	> -109 dBc/Hz	100 kHz	2.5 dB	
	> -126 dBc/Hz	1 MHz	2.5 dB	
	> -136 dBc/Hz	10 MHz	2.5 dB	
	> -72 dBc/Hz	100 Hz	2.5 dB	> 3 GHz - 6 GHz
	> -93 dBc/Hz	1 kHz	2.5 dB	
	> -98 dBc/Hz	10 kHz	2.5 dB	
	> -106 dBc/Hz	100 kHz	2.5 dB	
	> -120 dBc/Hz	1 MHz	2.5 dB	
	> -135 dBc/Hz	10 MHz	2.5 dB	
Burst generators voltage pulse	100 V to 4400 V	DIN EN 61000-4-4:2013 under load ($_{RL}$) at$_{RL}$ = 50 Ω at$_{RL}$ = 1 kΩ	2,2 %	$_{RL}$ = load resistance
Rise time and pulse width	3 ns to 1 µs		2,5 %	
Burst duration and burst period	100 ns to 1 s		0,25 %	
Surge generators voltage amplitude	250 V to 7000 V	DIN EN 61000-4-5:2019 with or without coupling and decoupling network	3,5 %	
Current amplitude	5 A to 5 kA		3,5 %	
Rise time and pulse width	400 ns to 1 ms		3,5 %	

Mobile laboratory - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC voltage	0 V		0.1 µV	U = set value
Measuring devices	1 mV to 2,2 V		$7 \cdot 10^{-6} U$ 1 µV	
	> 2,2 V to 11 V		$9 \cdot 10^{-6} U$	
	> 11 V to 22 V		$8 \cdot 10^{-6} U$	
	> 22 V to 220 V		$12 \cdot 10^{-6} U$	
	> 220 V to 1000 V		$12 \cdot 10^{-6} U$	
DC voltage	0 V		0.1 µV	U = measured value
Sources	1 mV to 100 mV		$8 \cdot 10^{-6} U$ 1 µV	
	> 100 V to 1 V		$11 \cdot 10^{-6} U$	
	> 1 V to 10 V		$9 \cdot 10^{-6} U$	
	> 10 V to 100 V		$13 \cdot 10^{-6} U$	
	> 100 V to 1000 V		$16 \cdot 10^{-6} U$	
High Voltage	> 1 kV to 10 kV		2.5 · $10^{-3} U$ 2.5 V	U = measured value
Direct current strength	0 A	Precision Open	0.2 nA	I = set value
Measuring devices and sources	0.1 µA to < 1 µA	Normal resistance and Voltmeter	35 - $10^{-6} I$ 21 pA	
	1 µA to < 10 µA		50 - $10^{-6} I$ 6 pA	
	10 µA to < 100 µA		15 - $10^{-6} I$ 0.4 nA	
	100 µA to 320 mA		18 - $10^{-6} I$	
	> 320 mA to 1 A		15 - $10^{-6} I$ 6 µA	
	> 1 A to 10 A		0,2 - $10^{-3} I$	
	> 10 A to > 150 A		0,3 - $10^{-3} I$	
	150 A to 2000 A	Current transformer	0,3 - $10^{-3} I$	
Direct current strength	1 mA to 2,2 A		$1 \cdot 10^{-3} I$	
Current clamps	> 2,2 A to 20 A		$2 \cdot 10^{-3} I$	
	> 20 A to 1000 A		$3 \cdot 10^{-3} I$	

Mobile laboratory - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	0 Ω		50 µ Ω	*R* = set value
	1 Ω; 1.9 Ω		95 · 10^{-6} *R*	Fluke 5700A
	10 Ω		28 · 10^{-6} *R*	
	19 Ω		27 · 10^{-6} *R*	
	100 Ω; 190 Ω		17 · 10^{-6} *R*	
	1 kΩ		13 · 10^{-6} *R*	
	1.9 kΩ		13 · 10^{-6} *R*	
	10 kΩ		12 · 10^{-6} *R*	
	19 kΩ		12 · 10^{-6} *R*	
	100 kΩ		14 · 10^{-6} *R*	
	190 kΩ		14 · 10^{-6} *R*	
	1 MΩ		20 · 10^{-6} *R*	
	1.9 MΩ		21 · 10^{-6} *R*	
	10 MΩ		40 · 10^{-6} *R*	
	19 MΩ		48 · 10^{-6} *R*	
	100 MΩ		110 · 10^{-6} *R*	
	0 Ω		100 µΩ	*R* = measured value
	1 Ω to 10 Ω		16 · 10^{-6} *R* 50 µΩ	HP 3458A
	> 10 Ω to 100 Ω		12 · 10^{-6} *R* 500 µΩ	
	> 100 Ω to 1 kΩ		15 · 10^{-6} *R*	
	> 1 kΩ to 10 kΩ		15 · 10^{-6} *R*	
	> 10 kΩ to 100 kΩ		15 · 10^{-6} *R*	
	> 100 kΩ to 1 MΩ		35 · 10^{-6} *R*	
	> 1 MΩ to 10 MΩ		150 · 10^{-6} *R*	
	> 10 MΩ to 100 MΩ		600 · 10^{-6} *R*	
	> 100 MΩ to 1 GΩ		5 · 10^{-3} *R*	
	0.001 Ω to 0.1 Ω	Substitution procedure	50 · 10^{-6} *R*	
	> 0.1 Ω to 1 MΩ	with normal resistance	20 · 10^{-6} *R*	
	> 1 MΩ to 100 MΩ		30 · 10^{-6} *R*	

Mobile laboratory - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3}\,R$	R = set value
(areas)	11 Ω to < 33 Ω		$33 \cdot 10^{-6}\,R$	Fluke 5520A /5522A
Measuring devices	33 Ω to < 110 Ω		$29 \cdot 10^{-6}\,R$	
	110 Ω to < 330 Ω		$28 \cdot 10^{-6}\,R$	
	330 Ω to < 1.1 kΩ		$28 \cdot 10^{-6}\,R$	
	1.1 kΩ to < 3.3 kΩ		$28 \cdot 10^{-6}\,R$	
	3.3 kΩ to < 11 kΩ		$28 \cdot 10^{-6}\,R$	
	11 kΩ to < 33 kΩ		$28 \cdot 10^{-6}\,R$	
	33 kΩ to < 110 kΩ		$28 \cdot 10^{-6}\,R$	
	110 kΩ to < 330 kΩ		$32 \cdot 10^{-6}\,R$	
	330 kΩ to < 1.1 MΩ		$33 \cdot 10^{-6}\,R$	
	1.1 MΩ to < 3.3 MΩ		$62 \cdot 10^{-6}\,R$	
	3.3 MΩ to < 11 MΩ		$0.13 \cdot 10^{-3}\,R$	
	11 MΩ to < 33 MΩ		$0.25 \cdot 10^{-3}\,R$	
	33 MΩ to < 110 MΩ		$0.5 \cdot 10^{-3}\,R$	
	110 MΩ to < 330 MΩ		$3 \cdot 10^{-3}\,R$	
	330 MΩ to < 1.1 GΩ		$15 \cdot 10^{-3}\,R$	
AC voltage	1 mV to 2.2 mV	10 Hz to 20 Hz	$0.52 \cdot 10^{-3}\,U$	U = measured value
Measuring devices and		> 20 Hz to 40 Hz	$0.52 \cdot 10^{-3}\,U$	
Sources		> 40 Hz to 20 kHz	$0.40 \cdot 10^{-3}\,U$	
		> 20 kHz to 50 kHz	$0.40 \cdot 10^{-3}\,U$	
		> 50 kHz to 100 kHz	$0.41 \cdot 10^{-3}\,U$	
		> 100 kHz to 300 kHz	$0.46 \cdot 10^{-3}\,U$	
		> 300 kHz to 500 kHz	$0.55 \cdot 10^{-3}\,U$	
		> 500 kHz to 1 MHz	$0.60 \cdot 10^{-3}\,U$	
	> 2.2 mV to 7 mV	10 Hz to 20 Hz	$0.22 \cdot 10^{-3}\,U$	
		> 20 Hz to 40 Hz	$0.22 \cdot 10^{-3}\,U$	
		> 40 Hz to 20 kHz	$0.16 \cdot 10^{-3}\,U$	
		> 20 kHz to 50 kHz	$0.16 \cdot 10^{-3}\,U$	
		> 50 kHz to 100 kHz	$0.20 \cdot 10^{-3}\,U$	
		> 100 kHz to 300 kHz	$0.22 \cdot 10^{-3}\,U$	
		> 300 kHz to 500 kHz	$0.33 \cdot 10^{-3}\,U$	
		> 500 kHz to 1 MHz	$0.45 \cdot 10^{-3}\,U$	

Mobile laboratory - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 7 mV to 22 mV	10 Hz to 20 Hz	$80 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$80 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$65 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$75 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$75 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$95 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.19 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.21 \cdot 10^{-3}\ U$	
	> 22 mV to 70 mV	10 Hz to 20 Hz	$70 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$58 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$35 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$35 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$45 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$55 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.11 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 mV to 220 mV	10 Hz to 20 Hz	$39 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$35 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$25 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$25 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$28 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$42 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$85 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.1 \cdot 10^{-3}\ U$	
	> 220 mV to 700 mV	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$22 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$12 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$12 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$14 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$27 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$40 \cdot 10^{-6}\ U$	

Mobile laboratory - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 700 mV to 2.2 V	10 Hz to 20 Hz	$20 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$14 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$10 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$10 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$11 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$22 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$68 \cdot 10^{-6}\ U$	
	> 2.2 V to 7 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$12 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$13 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$95 \cdot 10^{-6}\ U$	
	> 7 V to 22 V	10 Hz to 20 Hz	$17 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1MHz	$0.11 \cdot 10^{-3}\ U$	
	> 22 V to 70 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$15 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$15 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$40 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 V to 220 V	10 Hz to 20 Hz	$19 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$18 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$17 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$17 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$32 \cdot 10^{-6}\ U$	

Mobile laboratory - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 220 V to 1000 V	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$ $27 \cdot 10^{-6}\ U$ $45 \cdot 10^{-6}\ U$ $45 \cdot 10^{-6}\ U$ $65 \cdot 10^{-6}\ U$	*U* = measured value
High Voltage	> 0.7 kV to 1 kV > 1 kV to 7 kV	50 Hz	$2.5 \cdot 10^{-3}\ U$ 0.25 V $3.5 \cdot 10^{-3}\ U$ 2.0 V	
Alternating current strength sources and measuring devices	100 µA to 1 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$120 \cdot 10^{-6}\ I$ $160 \cdot 10^{-6}\ I$ $60 \cdot 10^{-6}\ I$	*I* = measured value
	> 1 mA to 10 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$46 \cdot 10^{-6}\ I$	
	> 10 mA to 1 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$17 \cdot 10^{-6}\ I$	*I* = measured value
	> 1 A to 10 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$32 \cdot 10^{-6}\ I$	
	> 10 A to 20 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$39 \cdot 10^{-6}\ I$	
	> 20 A to 100 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$69 \cdot 10^{-6}\ I$ $69 \cdot 10^{-6}\ I$ $0.17 \cdot 10^{-3}\ I$	
Current clamps	1 mA to 2.2 A > 2.2 A to 20 A > 20 A to 800 A	40 Hz to 5 kHz 40 Hz to 5 kHz 40 Hz to 65 Hz	$2 \cdot 10^{-3}\ I$ $3 \cdot 10^{-3}\ I$ $4 \cdot 10^{-3}\ I$	*I* = measured value
Capacity gauges	190 pF to < 400 pF 400 pF to < 1.1 nF 1.1 nF to < 3.3 nF 3.3 nF to < 11 nF 11 nF to < 33 nF 33 nF to < 110 nF 110 nF to < 330 nF 330 nF to < 1.1 µF 1.1 µF to < 3.3 µF 3.3 µF to < 11 µF	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 600 Hz 10 Hz to 300 Hz 10 Hz to 150 Hz	$4 \cdot 10^{-3}\ C$ 8 pF $4.5 \cdot 10^{-3}\ C$ 8 pF $4.0 \cdot 10^{-3}\ C$ 8 pF $2.5 \cdot 10^{-3}\ C$ 8 pF $2.5 \cdot 10^{-3}\ C$ 80 pF $2.5 \cdot 10^{-3}\ C$ 80 pF $4.5 \cdot 10^{-3}\ C$ $4.5 \cdot 10^{-3}\ C$ $4.5 \cdot 10^{-3}\ C$ $4.5 \cdot 10^{-3}\ C$	With 5520A / 5522A

Mobile laboratory - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Capacity gauges	11 µF to < 33 µF	10 Hz to 120 Hz	$6.0 \cdot 10^{-3}$ C	With 5520A / 5522A
	33 µF to < 110 µF	10 Hz to 80 Hz	$6.5 \cdot 10^{-3}$ C	
	110 µF to < 330 µF	DC to 50 Hz	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	DC to Hz	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	DC to 6 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF	DC to 2 Hz	$6.0 \cdot 10^{-3}$ C	
	11 mF to < 33 mF	DC to 200.6 Hz	$8.0 \cdot 10^{-3}$ C	
	33 mF to 110 mF	DC to 0,2 Hz	$11 \cdot 10^{-3}$ C	
	1 nF to 100 nF	50 Hz to 10 kHz	$1{,}0 - 10^{-3}$ *C*	*C*: measured value with normal capacitances
	> 100 nF to 1000 nF	50 z to 1 kHz	$1{,}0 - 10^{-3}$ *C*	
		>1 kHz to 10 kHz	$2{,}5 - 10^{-3}$ *C*	
Frequency	1 mHz to 46 GHz		$2 \cdot 10^{-9} \cdot f_{UTf}$	*f* = current measured value $_{UTf}$ =Trigger uncertainty
Time interval	1 µs to 1000 s		$2 \cdot 10^{-9} \cdot t$ 2 ns	*t* = current measured value
Speed optical	1 min^{-1} to 100.000 min^{-1}	with light pulse generator	$8 \cdot 10^{-6}$ but not less than 0.006 min^{-1}	
AC active power measuring devices		33 mV to 1000 V 45 Hz to 65 kHz *PF* = 1		*P* = set value with Fluke 5520A/5522A *PF:* Power factor
	109 µW to < 11kW	33 mA to < 11 A	$1.4 \cdot 10^{-3} P$	
	363 mW up to 20 kW	11 A to 20 A	$2.0 \cdot 10^{-3} P$	
DC power Measuring devices	1 mW to 300 W		$0.5 \cdot 10^{-3} P$	
	> 300 W to 20 kW		$1.0 \cdot 10^{-3} P$	
Sources	1 mW to 300 W	Product of *U and I*	$30 - 10^{-6} P$	P: calculated power
	> 300 W to 1 kW	1 mV ≤ U ≤ 1000 V	$200 - 10^{-6} P$	
	> 1 kW to 1 MW	100 µA ≤ I ≤ 2000 A	$300 - 10^{-6} P$	
AC active power	5 mW to 50 kW > 2.5 W to 120 kW	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than $80 - 10^{-6}$ not smaller than $0.14 - 10^{-3}$	$w(_{UF})$ . .Uncertainty of the amplitude of the voltage fundamental $w(_{IF})$ . .Uncertainty of the amplitude of the current fundamentals $w(\Phi_F)$ ... Uncertainty of the phase shift angle $w(U_{rmc})$ ... uncertainty of the stress rms value $w(I_{rmc})$ ... Uncertainty of the rms current value
AC reactive power	5 mvar to 50 kvar > 2.5 var to 120 kvar	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than $80 - 10^{-6}$ not smaller than $0.14 - 10^{-3}$	

Mobile laboratory - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Apparent power		1 V to 1000 V 45 Hz to 65 Hz $0.05 \leq \cos \varphi \leq 1$	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	
	0.1 VA until 50 kVA	0.1 A to 50 A	not less than $80 \cdot 10^{-6}$	
	> 50 VA until 120 kVA	> 50 A to 120 A	not smaller than $0.14 \cdot 10^{-3}$	

Mobile laboratory - high frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Oscilloscope measured variables				
Vertical deflection	5 mV to 5 V	R_i = 50 Ω	3.5 · 10^{-3} U 35 µV	Square wave voltage
	5 mV to 120 V	R_i = 1 MΩ	2.4 · 10^{-3} U 40 µV	10 Hz to 10 kHz
Horizontal deflection	5 ns to 520 ms		3 · 10^{-6} t 1 ns	t: current time
	> 20 ms to 5 s		30 · 10^{-6} t 1.2 · 10^{-3} t^2	
Rise time	150 ps until 10 ms	250 mV	35 - $^{10-3}$ - t_r 5 ps	t_r = natural rise time
	250 ps until 10 ms	> 250 mV to 2.5 V R_i = 50 Ω	35 - $^{10-3}$ - t_r 8 ps	of the oscilloscope
RF impedance (reflection coefficient) Single measurement $_{\|S11\|}$A mount $\|\Gamma\|$	0,0 to 1,0	45 MHz to 5 GHz	0,01 0,01 $\|\Gamma\|$	Connector; PC-7; 50 Ω[3]
		> 5 GHz to 18 GHz	0,015 0,01 $\|\Gamma\|$	
		9 kHz to 5 GHz	0,01 0,01 $\|\Gamma\|$	N connector; 50 Ω[3]
		> 5 GHz to 18 GHz	0,015 0,01 $\|\Gamma\|$	
		45 MHz until 5 GHz	0,01 0,005 $\|\Gamma\|$	Connector; PC-3.5; 50 Ω[3]
		> 5 GHz until 18 GHz	0,015 0,01 $\|\Gamma\|$	
		> 18 GHz to 26.5 GHz	0,02 0,02 $\|\Gamma\|$	
Phase φ		9 kHz to 18 GHz 0,1 ≤ $\|\Gamma\|$ ≤ 1	—	N connector; 50 Ω.
	-180° to 180°	45 MHz to 18 GHz 0,1 ≤ $\|\Gamma\|$ ≤ 1	$\arcsin\frac{U(\|\Gamma\|)}{\|\Gamma\|}\bullet\frac{180°}{\pi}$	PC-7; 50 Ω
		45 MHz to 26.5 GHz 0,1 ≤ $\|\Gamma\|$ ≤ 1		PC-3.5

Mobile laboratory - high frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
RF impedance (reflection factor)	0,0 to 1,0	45 MHz to 5 GHz > 5 GHz to 18 GHz	0,015 0,01 |Γ| 0,02 0,01 |Γ|	PC-7; 50 Ω3)
Two-port measurement|S11|&amp |S22| Amount |Γ|		9 kHz to 5 GHz > 5 GHz to 18 GHz	0,015 0,01 |Γ| 0,02 0,01 |Γ|	N connector; 50 Ω. 3)
		45 MHz to 5 GHz > 5 GHz to 18 GHz > 18 GHz to 26.5 GHz	0,01 0,005 |Γ| 0,015 0,01 |Γ| 0,02 0,02 |Γ|	PC-3,53)
Phase φ	-180° to 180°	9 kHz to 18 GHz 0,1 ≤ |Γ| ≤ 1 45 MHz to 18 GHz 0,1 ≤ |Γ| ≤ 1 45 MHz to 26.5 GHz 0,1 ≤ |Γ| ≤ 1	$\arcsin\frac{U(\lvert\Gamma\rvert)}{\lvert\Gamma\rvert}\bullet\frac{180°}{\pi}$	N connector; 50 Ω. PC-7; 50 Ω PC-3.5
HF - Attenuation Switchable-Attenuators,	0 dB to 60 dB	9 kHz to 18 GHz	0.3 dB	Connector system: N; 50 Ω |Γ|≤ 0.1
Fixed attenuators	> 60 dB to 90 dB		0.3 dB	
Absolute Damping values	0 dB to 60 dB	45 MHz to 20 GHz > 20 GHz to 26.5 GHz	0.3 dB 0.5 dB	Connector system PC-3.5; 50 Ω 45 MHz to 20 GHz |Γ|≤ 0.1 <20 GHz to 26.5 GHz |Γ|≤ 0.15
	> 60 dB to 90 dB	45 MHz to 20 GHz > 20 GHz to 26.5 GHz	0.3 dB 0.5 dB	
HF power Power meters	> 1 pW to 0.1 mW	2.5 MHz to 2 GHz > 2 GHz to 18 GHz > 18 GHz to 26.5GHz	(0.025 0.14 -|Γ|) - P (0.049 0.21 -|Γ|) - P (0.071 0.32 -|Γ|) - P	Connector system: N, PC-3.5 ; 50 Ω; |Γ|KG ≤ 0.2
HF power Signal generators	> 1 pW to 0.1 mW	2.5 MHz to 2 GHz > 2 GHz to 18 GHz > 18 GHz to 26.5GHz	(0.035 0.13 -|Γ|) - P (0.053 0.2 -|Γ|) - P (0.074 0.31 -|Γ|) - P	Connector system: N, PC-3.5 ; 50 Ω; |Γ| KG≤ 0.2
	0.1 mW to 10 mW	9 kHz to 50 MHz > 50 MHz until 5 GHz > 5 GHz until 18 GHz	17 · 10-3 - P 22 · 10-3 - P 30 · 10-3 - P	N connector; 50 Ω3) |Γ| ≤ 0,3
	0.1 mW to 10 mW	50 MHz to 5 GHz > 5 GHz to 18 GHz > 18 GHz to 26.5 GHz	22 · 10-3 - P 32 · 10-3 - P 40 · 10-3 - P	Connector PC-3.5; 50 Ω3) |Γ| ≤ 0,3

Mobile laboratory - high frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
HF power	0.1 mW to 10 mW	9 kHz to 50 MHz	$17 \cdot 10^{-3} \cdot P$	N connector; 50 Ω[3]
Power meters		> 50 MHz until 5 GHz	$21 \cdot 10^{-3} \cdot P$	$\lvert \Gamma \rvert \leq 0{,}3$
		> 5 GHz until 18 GHz	$28 \cdot 10^{-3} \cdot P$	
	0.1 mW to 10 mW	50 MHz to 5 GHz	$22 \cdot 10^{-3} \cdot P$	Connector PC-3.5; 50 Ω[3]
		> 5 GHz to 18 GHz	$32 \cdot 10^{-3} \cdot P$	$\lvert \Gamma \rvert \leq 0{,}3$
		> 18 GHz to 26.5 GHz	$40 \cdot 10^{-3} \cdot P$	
Signal level difference	0 dBc to 90 dBc	9 kHz until 7 GHz	1.5 dB	SNR > 20 dB
Measuring devices /		> 7 GHz until 13.6 GHz	2.3 dB	
sources		> 13.6 GHz until 26.5 GHz	3 dB	
	> 90 dBc to 100 dBc	9 kHz until 7 GHz	4.5 dB	SNR > 20 dB
		> 7 GHz until 13.6 GHz	4.8 dB	
		> 13.6 GHz to 26.5 GHz	5.3 dB	
Filter bandwidth	1 Hz to 40 MHz		1 %	SNR > 70 dB
Measuring devices				
HF noise display	10 Hz to 50 GHz	-165 dbm/Hz to 0 dBm/Hz	1 dB	
Receiver / Measuring devices				
Form factor	1:1 to 4:1		5,5 %	SNR > 20 dB
Measuring devices	> 4:1 to 10:1		7 %	
	> 10:1 to 18:1		8,5 %	

3) When using other connector systems, the measurement uncertainty increases.

Mobile laboratory - high frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Amplitude modulation: Modulation depth *m*	0.0 to ≤ 1.0	f_{HF} < 4 GHz f_{MOD} < 1 MHz	0,004 0,025 · *m*	f_{HF} = carrier frequency f_{MOD} = modulation freq.
Frequency modulation Frequency deviation *Δf*	0 Hz to 5 MHz	f_{HF} < 4 GHz f_{MOD} < 1 MHz	0.041 · Δf 25 Hz	f_{HF} = Carrier frequency f_{MOD} = Modulation freq.
Phase modulation Phase deviation *ΔΦ*	0 to (4 MHz / f_{MOD}) rad	f_{HF} < 4 GHz f_{MOD} < 1 MHz	0.025 rad 0.041 · ΔΦ	f_{HF} = Carrier frequency f_{MOD} = Modulation freq.
Distortion factor k	> 0.0001 to 0.01 > 0.01 to 0.1 > 0.1 to 0.2	AM demodulation method f_{HF}: 150 kHz to 2 GHz f_{MOD} = 1kHz P_{HF} = 0 dBm	0,030 0,029 0,025	*fHF*= Carrier frequency f_{MOD} = Modulation freq. P_{HF} = Carrier level
	> 0.0001 to 0.01 > 0.01 to 0.1 > 0.1 to 0.2	FM & PM-Demodulation method f_{HF}:150 kHz to 2 GHz f_{MOD} = 1kHz P_{HF} = 0 dBm *Δf* ≤ 50 kHz	0,09	Absolute measurement uncertainty
Pulsed measurands*) Spectral voltage amplitude density (Measure/ Display)	S_0 = 13.5 µVs	*DIN EN 55016-1-1:2020* CISPR 16-1-1:2019 CISPR Band A 9 kHz to 0.15 MHz	0.50 dB	Pulse frequency 1 Hz to 100 Hz $\Gamma_G, \Gamma_L \leq 0.05$ (represent)
	S_0 = 0.316 µVs	CISPR Band B > 0.15 MHz to 30 MHz	0.50 dB	Pulse frequency 1 Hz to 1000 Hz $\Gamma_G, \Gamma_L \leq 0.07$ (represent)
	S_0 = 0.0044 µVs	CISPR Band C > 30 MHz to 300 MHz	0.6 dB	Pulse frequency 1 Hz to 1000 Hz $\Gamma_G, \Gamma_L \leq 0.12$ (represent)
	S_0 = 0.0044 µVs	CISPR Band D > 300 MHz to 1 GHz	0.6 dB	Pulse frequency 1 Hz to 1000 Hz $\Gamma_G, \Gamma_L \leq 0.12$ (represent)
HF current transformer clamp*) Transfer resistance dB(Ω)	9 kHz to 100 MHz > 100 MHz to 400 MHz > 400 MHz to 1 GHz	DIN EN 55016-1-2:2019 4.4 mA	0.3 dB 0.5 dB 0.8 dB	
HF Bulk Current Injection*) Transducer clamp insertion loss dB	9 kHz to 100 MHz > 100 MHz to 400 MHz > 400 MHz to 1 GHz	DIN EN 61000-4-6:2014 4.4 mA	0.3 dB 0.5 dB 1.5 dB	

Mobile laboratory - high frequency and radiation measurement quantities

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Phase noise	Phase noise related to carrier amplitude in dBc/Hz	Offset frequency referred to carrier frequency		Carrier frequency:
Signal generators	> -87 dBc/Hz	100 Hz	2.5 dB	100 MHz - 1 GHz
	> -99 dBc/Hz	1 kHz	2.5 dB	
	> -104 dBc/Hz	10 kHz	2.5 dB	
	> -111 dBc/Hz	100 kHz	2.5 dB	
	> -131 dBc/Hz	1 MHz	2.5 dB	
	> -137 dBc/Hz	10 MHz	2.5 dB	
	> -80 dBc/Hz	100 Hz	2.5 dB	> 1 MHz - 3 GHz
	> -96 dBc/Hz	1 kHz	2.5 dB	
	> -101 dBc/Hz	10 kHz	2.5 dB	
	> -109 dBc/Hz	100 kHz	2.5 dB	
	> -126 dBc/Hz	1 MHz	2.5 dB	
	> -136 dBc/Hz	10 MHz	2.5 dB	
	> -72 dBc/Hz	100 Hz	2.5 dB	> 3 GHz - 6 GHz
	> -93 dBc/Hz	1 kHz	2.5 dB	
	> -98 dBc/Hz	10 kHz	2.5 dB	
	> -106 dBc/Hz	100 kHz	2.5 dB	
	> -120 dBc/Hz	1 MHz	2.5 dB	
	> -135 dBc/Hz	10 MHz	2.5 dB	
Burst generators				
voltage pulse	100 V to 4400 V	DIN EN 61000-4-4 under load ($_{RL}$) at$_{RL}$ = 50 Ω at$_{RL}$ = 1 kΩ	2,2 %	$_{RL}$ = load resistance
Rise time and pulse width	3 ns to 1 µs		2,5 %	
Burst duration and burst period	100 ns to 1 s		0,25 %	
Surge generators voltage amplitude	250 V to 7000 V	DIN EN 61000-4-5 with or without coupling and decoupling network	3,5 %	
Current amplitude	5 A to 5 kA		3,5 %	
Rise time and pulse width	400 ns to 1 ms		3,5 %	

Mobile laboratory - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Length *) Cylindrical setting standards, ring gauges: Diameter	1 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006	0.8 µm $2 \cdot 10^{-6} \cdot d$	d = is the measured Diameter
Plug gauges: Diameter	1 mm to 200 mm	Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	0.8 µm $2 \cdot 10^{-6} \cdot d$	
Test pins: Diameter	0,1 mm to 30 mm	VDI/VDE/DGQ 2618 Sheet 4.2:2007 Point 3.2.2 (Opt. 1)	0.8 µm $2 \cdot 10^{-6} \cdot d$	
Thread gauges (one and multi-start cylindrical male and female threads with straight flanks, symmetrical profile) Threaded mandrels: simple Flank diameter	1.4 mm to 200 mm nominal pitch: 0.3 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.8:2006 Point 3.2.2 (Opt. 1)	3 µm $10 \cdot 10^{-6} \cdot d$	Three-wire method d = is the measured diameter
Threaded rings: simple pitch diameter	3 mm to 200 mm nominal pitch: 0.5 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.9:2006 Point 3.2.2 (Opt. 1)	3 µm $10 \cdot 10^{-6} \cdot d$	Two-ball method d = is the measured diameter
Length of plane-parallel, spherical or cylindrical measuring surfaces	0,01 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 19.1:2014	1.5 µm $2 \cdot 10^{-6} \cdot l$	l is the measured length
Diameter	0,01 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006 Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	1.5 µm $2 \cdot 10^{-6} \cdot d$	d is the measured diameter
Feeler gauges	0,03 mm to 2,00 mm	DIN 2275:2014	1.5 µm $2 \cdot 10^{-6} \cdot l$	l is the measured length
Adjustment dimensions for Outside micrometers	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm $2 \cdot 10^{-6} \cdot l$	

Mobile laboratory - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Throat gauges	3 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.7:2005 Point 3.3.2 (Opt. 2)	0.8 µm 2 · 10^{-6} · *d*	*d* is the measured Diameter
Caliper for Exterior, interior and Depth measurements	0 mm until 500 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	30 µm 30 · 10^{-6} · *l*	*l* is the measured Length
Depth caliper,	> 500 mm until 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006	50 µm 30 · 10^{-6} · *l*	
Height caliper		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
Outside micrometers	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm 10 · 10^{-6} · *l*	
Fine pointer measurement-screws	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002	3 µm 10 · 10^{-6} · *l*	
Micrometer head screws	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008	3 µm 10 · 10^{-6} · *l*	
Depth gauges	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010	3 µm 10 · 10^{-6} · *l*	
Inside micrometers with 2-point contact on the calibration object	13 mm to 300 mm > 300 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	3 µm 10 · 10^{-6} · *l* 5 µm 10 · 10^{-6} · *l*	
Inside micrometers with 3-line contact on the calibration object	3 mm to 150 mm	VDI/VDE/DGQ 2618 Sheet 10.8:2002	3 µm 10 · 10^{-6} · *d*	*d* is the measured diameter
Lever gauges (quick probes) for External measurements	to 200 mm	VDI/VDE/DGQ 2618 Sheet 12.1:2005	7 µm 10 · 10^{-6} · *l*	*l* is the measured length
Lever gauges (quick probes) for Internal measurements	2 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 13.1:2005	7 µm 10 · 10^{-6} · *l*	
Dial gauges	0 mm to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.1:2021	3 µm 10 · 10^{-6} · *l*	mechanical dial gauges
		VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	3 µm 10 · 10^{-6} · *l*	electronic digital dial gauges
Fine pointer	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
Feeler lever gauges	0 mm to 1,6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
electr. inductive Linear Encoders	to 100 mm	VDI/VDE/DGQ 2618 Sheet 14.1:2010	0.6 µm 1 · 10^{-6} · *l*	
electr. incremental Linear Encoders	to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	0.6 µm 1 · 10^{-6} · *l*	

Location Calibration Laboratory Munich, Nikolaus-Otto-Straße 2, 85221 Dachau

Permanent Laboratory Munich - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC voltage	0 V		0.1 µV	U = set value
Measuring devices	1 mV to 2,2 V		$7 \cdot 10^{-6} U$ 1 µV	
	> 2,2 V to 11 V		$9 \cdot 10^{-6} U$	
	> 11 V to 22 V		$8 \cdot 10^{-6} U$	
	> 22 V to 220 V		$12 \cdot 10^{-6} U$	
	> 220 V to 1000 V		$12 \cdot 10^{-6} U$	
DC voltage	0 V		0.1 µV	U = measured value
Sources	1 mV to 100 mV		$8 \cdot 10^{-6} U$ 1 µV	
	> 100 V to 1 V		$11 \cdot 10^{-6} U$	
	> 1 V to 10 V		$9 \cdot 10^{-6} U$	
	> 10 V to 100 V		$13 \cdot 10^{-6} U$	
	> 100 V to 1000 V		$16 \cdot 10^{-6} U$	
High Voltage	> 1 kV to 10 kV		$2.5 \cdot 10^{-3} U$ 2.5 V	U = measured value
DC current strength	0 A	Precision Open	0.2 nA	I = set value
meters and sources	0.1 µA until < 1 µA	Normal resistance and voltmeter	35 - 10^{-6} / 21 pA	
	1 µA until < 10 µA		50 - 10^{-6} / 6 pA	
	10 µA until < 100 µA		15 - 10^{-6} / 0.4 nA	
	100 µA until 320 mA		18 - 10^{-6} /	
	> 320 mA until 1 A		15 - 10^{-6} / 6 µA	
	> 1 A to 10 A		0,2 - 10^{-3} /	
	> 10 A > 150 A		0,3 - 10^{-3} /	
	150 A to 2000 A	Current transformer	0,3 - 10^{-3} /	
Direct current strength	1 mA to 2,2 A		$1 \cdot 10^{-3}$ /	
Current clamps	> 2,2 A to 20 A		$2 \cdot 10^{-3}$ /	
	> 20 A to 1000 A		$3 \cdot 10^{-3}$ /	

Permanent Laboratory Munich - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	0 Ω		50 µ Ω	*R* = set value
	1 Ω; 1.9 Ω		95 · 10^{-6} *R*	Fluke 5700A
	10 Ω		28 · 10^{-6} *R*	
	19 Ω		27 · 10^{-6} *R*	
	100 Ω; 190 Ω		17 · 10^{-6} *R*	
	1 kΩ		13 · 10^{-6} *R*	
	1.9 kΩ		13 · 10^{-6} *R*	
	10 kΩ		12 · 10^{-6} *R*	
	19 kΩ		12 · 10^{-6} *R*	
	100 kΩ		14 · 10^{-6} *R*	
	190 kΩ		14 · 10^{-6} *R*	
	1 MΩ		20 · 10^{-6} *R*	
	1.9 MΩ		21 · 10^{-6} *R*	
	10 MΩ		40 · 10^{-6} *R*	
	19 MΩ		48 · 10^{-6} *R*	
	100 MΩ		110 · 10^{-6} *R*	
	0 Ω		100 µΩ	*R* = measured value
	1 Ω to 10 Ω		16 · 10^{-6} *R* 50 µΩ	HP 3458A
	> 10 Ω to 100 Ω		12 · 10^{-6} *R* 500 µΩ	
	> 100 Ω to 1 kΩ		15 · 10^{-6} *R*	
	> 1 kΩ to 10 kΩ		15 · 10^{-6} *R*	
	> 10 kΩ to 100 kΩ		15 · 10^{-6} *R*	
	> 100 kΩ to 1 MΩ		35 · 10^{-6} *R*	
	> 1 MΩ to 10 MΩ		150 · 10^{-6} *R*	
	> 10 MΩ to 100 MΩ		600 · 10^{-6} *R*	
	> 100 MΩ to 1 GΩ		5 · 10^{-3} *R*	
	0,001 Ω to 0,1 Ω	Substitution procedure	50 · 10^{-6} *R*	
	> 0,1 Ω to 1 MΩ	with normal resistance	20 · 10^{-6} *R*	
	> 1 MΩ to 100 MΩ		30 · 10^{-6} *R*	

Permanent Laboratory Munich - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range			Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	1 Ω	to	< 11 Ω		$0.12 \cdot 10^{-3} R$	R = set value
(areas)	11 Ω	to	< 33 Ω		$33 \cdot 10^{-6} R$	Fluke 5520A /5522A
Measuring devices	33 Ω	to	< 110 Ω		$29 \cdot 10^{-6} R$	
	110 Ω	to	< 330 Ω		$28 \cdot 10^{-6} R$	
	330 Ω	to	< 1.1 kΩ		$28 \cdot 10^{-6} R$	
	1.1 kΩ	to	< 3.3 kΩ		$28 \cdot 10^{-6} R$	
	3.3 kΩ	to	< 11 kΩ		$28 \cdot 10^{-6} R$	
	11 kΩ	to	< 33 kΩ		$28 \cdot 10^{-6} R$	
	33 kΩ	to	< 110 kΩ		$28 \cdot 10^{-6} R$	
	110 kΩ	to	< 330 kΩ		$32 \cdot 10^{-6} R$	
	330 kΩ	to	< 1.1 MΩ		$33 \cdot 10^{-6} R$	
	1.1 MΩ	to	< 3.3 MΩ		$62 \cdot 10^{-6} R$	
	3.3 MΩ	to	< 11 MΩ		$0.13 \cdot 10^{-3} R$	
	11 MΩ	to	< 33 MΩ		$0.25 \cdot 10^{-3} R$	
	33 MΩ	to	< 110 MΩ		$0.5 \cdot 10^{-3} R$	
	110 MΩ	to	< 330 MΩ		$3 \cdot 10^{-3} R$	
	330 MΩ	to	< 1.1 GΩ		$15 \cdot 10^{-3} R$	
AC resistance	0,1 Ω	to	2 Ω	50 Hz to 400 Hz	$10 - 10^{-3} - R$	

Permanent Laboratory Munich - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	1 mV to 2.2 mV	10 Hz to 20 Hz	$0.52 \cdot 10^{-3}\ U$	U = measured value
		> 20 Hz to 40 Hz	$0.52 \cdot 10^{-3}\ U$	
		> 40 Hz to 20 kHz	$0.40 \cdot 10^{-3}\ U$	
		> 20 kHz to 50 kHz	$0.40 \cdot 10^{-3}\ U$	
		> 50 kHz to 100 kHz	$0.41 \cdot 10^{-3}\ U$	
		> 100 kHz to 300 kHz	$0.46 \cdot 10^{-3}\ U$	
		> 300 kHz to 500 kHz	$0.55 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.60 \cdot 10^{-3}\ U$	
	> 2.2 mV to 7 mV	10 Hz to 20 Hz	$0.22 \cdot 10^{-3}\ U$	
		> 20 Hz to 40 Hz	$0.22 \cdot 10^{-3}\ U$	
		> 40 Hz to 20 kHz	$0.16 \cdot 10^{-3}\ U$	
		> 20 kHz to 50 kHz	$0.16 \cdot 10^{-3}\ U$	
		> 50 kHz to 100 kHz	$0.20 \cdot 10^{-3}\ U$	
		> 100 kHz to 300 kHz	$0.22 \cdot 10^{-3}\ U$	
		> 300 kHz to 500 kHz	$0.33 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.45 \cdot 10^{-3}\ U$	
	> 7 mV to 22 mV	10 Hz to 20 Hz	$80 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$80 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$65 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$75 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$75 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$95 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.19 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.21 \cdot 10^{-3}\ U$	
	> 22 mV to 70 mV	10 Hz to 20 Hz	$70 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$58 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$35 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$35 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$45 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$55 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.11 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	> 70 mV to 220 mV	10 Hz to 20 Hz	$39 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$35 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$25 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$25 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$28 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$42 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$85 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.1 \cdot 10^{-3}\ U$	
	> 220 mV to 700 mV	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$22 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$12 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$12 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$14 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$27 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$40 \cdot 10^{-6}\ U$	
	> 700 mV to 2.2 V	10 Hz to 20 Hz	$20 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$14 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$10 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$10 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$11 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$22 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$68 \cdot 10^{-6}\ U$	
	> 2.2 V to 7 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$12 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$13 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$95 \cdot 10^{-6}\ U$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	> 7 V to 22 V	10 Hz to 20 Hz	$17 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1MHz	$0.11 \cdot 10^{-3}\ U$	
	> 22 V to 70 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$15 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$15 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$40 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 V to 220 V	10 Hz to 20 Hz	$19 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$18 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$17 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$17 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$32 \cdot 10^{-6}\ U$	
	> 220 V to 1000 V	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$27 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$45 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$45 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$65 \cdot 10^{-6}\ U$	
High Voltage	> 0.7 kV to 1 kV	50 Hz	$2.5 \cdot 10^{-3}\ U$ 0.25 V	
	> 1 kV to 7 kV		$3.5 \cdot 10^{-3}\ U$ 2.0 V	

Permanent Laboratory Munich - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC power Sources and measuring devices	100 µA to 1 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$120 \cdot 10^{-6}\ I$ $160 \cdot 10^{-6}\ I$ $60 \cdot 10^{-6}\ I$	*I* = measured value
	> 1 mA to 10 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$46 \cdot 10^{-6}\ I$	
	> 10 mA to 1 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$17 \cdot 10^{-6}\ I$	
	> 1 A to 10 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$32 \cdot 10^{-6}\ I$	
	> 10 A to 20 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$39 \cdot 10^{-6}\ I$	
Current clamps	1 mA to 2,2 A > 2,2 A to 20 A > 20 A to 800 A	40 Hz to 5 kHz 40 Hz to 5 kHz 40 Hz to 65 Hz	$2 \cdot 10^{-3}\ I$ $3 \cdot 10^{-3}\ I$ $4 \cdot 10^{-3}\ I$	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Capacity gauges	190 pF to < 400 pF	10 Hz to 10 kHz	$4 \cdot 10^{-3}$ C 8 pF	With 5520A / 5522A
	400 pF to < 1.1 nF	10 Hz to 10 kHz	$4.5 \cdot 10^{-3}$ C 8 pF	
	1.1 nF to < 3.3 nF	10 Hz to kHz	$4.0 \cdot 10^{-3}$ C 8 pF	
	3.3 nF to < 11 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3}$ C 8 pF	
	11 nF to < 33 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3}$ C 80 pF	
	33 nF to < 110 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3}$ C 80 pF	
	110 nF to < 330 nF	10 Hz to 1 kHz	$4.5 \cdot 10^{-3}$ C	
	330 nF to < 1.1 µF	10 Hz to 600 Hz	$4.5 \cdot 10^{-3}$ C	
	1.1 µF to < 3.3 µF	10 Hz to 300 Hz	$4.5 \cdot 10^{-3}$ C	
	3.3 µF to < 11 µF	10 Hz to 150 Hz	$4.5 \cdot 10^{-3}$ C	
	11 µF to < 33 µF	10 Hz to 120 Hz	$6.0 \cdot 10^{-3}$ C	
	33 µF to < 110 µF	10 Hz to 80 Hz	$6.5 \cdot 10^{-3}$ C	
	110 µF to < 330 µF	DC to 50 Hz	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	DC to Hz	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	DC to 6 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF	DC to 2 Hz	$6.0 \cdot 10^{-3}$ C	
	11 mF to < 33 mF	DC to 200.6 Hz	$8.0 \cdot 10^{-3}$ C	
	33 mF to 110 mF	DC to 0,2 Hz	$11 \cdot 10^{-3}$ C	
	1 nF to 100 nF	50 Hz to 10 kHz	1,0 - 10^{-3} *C*	*C*: measured value with normal capacitances
	> 100 nF to 1000 nF	50 Hz to 1 kHz	1,0 - 10^{-3} *C*	
		> 1kHz to 10 kHz	2,5 - 10^{-3} *C*	
Frequency	1 mHz to 1 GHz		$2 \cdot {}^{10\text{-}9} \cdot f_{UTf}$	*f* = current measured value $_{UTf}$ =Trigger uncertainty
Time interval	1 µs to 1000 s		$2 \cdot 10^{-9} \cdot t$ 2 ns	*t* = current measured value
Speed optical	1 min^{-1} up to 100.000 min^{-1}	with light pulse generator	$8 \cdot 10^{-6}$ but not less than 0.006 min^{-1}	
AC active power measuring devices		33 mV to 1000 V 45 Hz to 65 kHz *PF* = 1		*P* = set value with Fluke 5520A/5522A *PF:* Power factor
	109 µW to < 11kW	33 mA to < 11 A	$1.4 \cdot 10^{-3} P$	
	363 mW up to 20 kW	11 A to 20 A	$2.0 \cdot 10^{-3} P$	
DC power Measuring devices	1 mW to 300 W		$0.5 \cdot 10^{-3} P$	
	> 300 W to 20 kW		$1.0 \cdot 10^{-3} P$	
Sources	1 mW to 300 W	Product of U and I 1 mV ≤	30 - 10^{-6} *P*	*P* Calculated power
	> 300 W to 1 kW	U ≤ 1000 V	200 - $10^{-6} P$	
	> 1 kW to 1 MW	100 µA ≤ I ≤ 2000 A	300 - $10^{-6} P$	

Permanent Laboratory Munich - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power	5 mW to 50 kW > 2,5 W to 120 kW	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than 80 - 10_{-6} not smaller than 0.14 - 10_{-3}	$w(_{UF})$ . .Uncertainty of the amplitude of the voltage fundamental $w(_{IF})$ . .Uncertainty of the amplitude Current fundamental $w(_{\Phi F})$ ...Uncertainty of the phase shift angle $w(U_{rmc})$ ... Uncertainty of the voltage rms value $w(I_{rmc})$ ... uncertainty of the rms current value
AC reactive power	5 mvar to 50 kvar > 2,5 var to 120 kvar	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than 80 - 10_{-6} not smaller than 0.14 - 10_{-3}	
Apparent power	0.1 VA to 50 kVA > 50 VA to 120 kVA	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than 80 - 10_{-6} not smaller than 0.14 - 10_{-3}	

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Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Stress ratio	± 2 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.04 µV/V 0.05 µV/V 0.12 µV/V	Calibration of 350 Ω bridge standards and the associated indicators at discrete points In 10 % steps
	± 2 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.04 µV/V 0.04 µV/V 0.12 µV/V	
	± 5 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 4.8 kHz	 0.06 µV/V 0.22 µV/V	
	± 10 mV/V	Bridge voltage: 5 V Measuring frequency 225 Hz Measuring frequency 4.8 kHz	 0.06 µV/V 0.45 µV/V	
	± 5 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.06 µV/V 0.06 µV/V 0.22 µV/V	
	± 10 mV/V	Bridge voltage: 2,5 V Measuring frequency 225 Hz Measuring frequency 600 Hz Measuring frequency 4.8 kHz	 0.06 µV/V 0.10 µV/V 0.45 µV/V	
	± 10 mV/V	Bridge voltage: 1 V Measuring frequency 600 Hz	 0.11 µV/V	
	± 20 mV/V	Bridge voltage: 1 V Measuring frequency 4.8 kHz	 0.6 µV/V	
	± 100 mV/V	Bridge voltage: 1 V Measuring frequency 4.8 kHz	 3.5 µV/V	
	± 100 mV/V	Bridge voltage: 2,5 V Measuring frequency 4.8 kHz	 4.0 µV/V	

Permanent Laboratory Munich - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Voltage ratio DC voltage bridge standards		Bridge voltage:		
	0 mV/V		2.0 µV/V	
	-2 mV/V to 2 mV/V		2.5 µV/V	
	-5 mV/V to 5 mV/V	0,5 V	2.5 µV/V	
	-10 mV/V to 10 mV/V		2.5 µV/V	
	-20 mV/V to 20 mV/V		2.5 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
		Bridge voltage:		
	0 mV/V		1.0 µV/V	
	-2 mV/V to 2 mV/V		2.0 µV/V	
	-5 mV/V to 5 mV/V	1 V	2.0 µV/V	
	-10 mV/V to 10 mV/V		2.0 µV/V	
	-20 mV/V to 20 mV/V		2.0 µV/V	
	-100 mV/V to 100 mV/V		2.0 µV/V	
		Bridge voltage:		
	0 mV/V		0.5 µV/V	
	-2 mV/V to 2 mV/V		0.5 µV/V	
	-5 mV/V to 5 mV/V	2,5 V	0.5 µV/V	
	-10 mV/V to 10 mV/V		0.5 µV/V	
	-20 mV/V to 20 mV/V		0.5 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
		Bridge voltage:		
	0 mV/V		0.30 µV/V	
	-2 mV/V to 2 mV/V		0.25 µV/V	
	-5 mV/V to 5 mV/V	5 V	0.25 µV/V	
	-10 mV/V to 10 mV/V		0.25 µV/V	
	-20 mV/V to 20 mV/V		0.35 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
		Bridge voltage:		
	0 mV/V		0.20 µV/V	
	-2 mV/V to 2 mV/V		0.20 µV/V	
	-5 mV/V to 5 mV/V	7,5 V	0.20 µV/V	
	-10 mV/V to 10 mV/V		0.20 µV/V	
	-20 mV/V to 20 mV/V		0.3 µV/V	
	-100 mV/V to 100 mV/V		1.5 µV/V	
		Bridge voltage:		
	0 mV/V		0.10 µV/V	
	-2 mV/V to 2 mV/V		0.15 µV/V	
	-5 mV/V to 5 mV/V	10 V	0.15 µV/V	

Permanent Laboratory Munich - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Voltage ratio DC	-10 mV/V to 10 mV/V		0.20 µV/V	
voltage	-20 mV/V to 20 mV/V		0.3 µV/V	
Bridge standards	-100 mV/V to 100 mV/V		1.5 µV/V	
Voltage ratio DC		Bridge voltage:		
voltage bridges,	-2 mV/V to 2 mV/V		0.35 µV/V	
measuring	-5 mV/V to 5 mV/V		0.35 µV/V	
instruments,	-10 mV/V to 10 mV/V	0,5 V	0.40 µV/V	
measuring amplifiers	-20 mV/V to 20 mV/V		0.55 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
		Bridge voltage:		
	-2 mV/V to 2 mV/V		0.20 µV/V	
	-5 mV/V to 5 mV/V		0.20 µV/V	
	-10 mV/V to 10 mV/V	1 V	0.3 µV/V	
	-20 mV/V to 20 mV/V		0.5 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
		Bridge voltage:		
	-2 mV/V to 2 mV/V		0.10 µV/V	
	-5 mV/V to 5 mV/V		0.15 µV/V	
	-10 mV/V to 10 mV/V	2.5 V; 5 V; 7.5 V; 10 V	0.25 µV/V	
	-20 mV/V to 20 mV/V		0.45 µV/V	
	-100 mV/V to 100 mV/V		2.5 µV/V	
Charge charge	1 pC to 10_4 pC	0.2 Hz to < 1 Hz	0,5 %	
amplifiers, charge		1 Hz to 10 kHz	0,4 %	
meters		> 10 kHz to 20 kHz	0,6 %	
		> 20 kHz to 50 kHz	1,0 %	
Oscilloscope measured variables				*U* - measured value
Vertical deflection	5 mV to 5 V	R_i = 50 Ω	$3.5 \cdot 10_{-3}$ *U* 35 µV	Square wave voltage
	5 mV to 120 V	R_i = 1 MΩ	$2.4 \cdot 10_{-3}$ *U* 40 µV	10 Hz to 10 kHz
Horizontal deflection	5 ns to 520 ms		$3 \cdot 10_{-6}$ *T* 1 ns	
	> 20 ms to 5 s		$30 \cdot 10_{-6}$ *T* $1.2 \cdot 10_{-4}$ T^2	
Rise time	150 ps to 10 ms	250 mV	35 $-^{10-3}$ - t_r 5 ps	t_r = intrinsic rise time
	250 ps to 10 ms	> 250 mV to 2.5 V	35 $-^{10-3}$ - t_r 8 ps	of the oscilloscope

Permanent Laboratory Munich - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Length *) Cylindrical setting standards, ring gauges: Diameter	1 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006	0.8 µm 2 · 10^{-6} · *d*	*d* = is the measured Diameter
Plug gauges: Diameter	1 mm to 200 mm	Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	0.8 µm 2 · 10^{-6} · *d*	
Test pins: Diameter	0.1 mm to 30 mm	VDI/VDE/DGQ 2618 Sheet 4.2:2007 Point 3.2.2 (Opt. 1)	0.8 µm 2 · 10^{-6} · *d*	
Thread gauges (one and multi-start cylindrical male and female threads with straight flanks, symmetrical profile) Threaded mandrels: simple Flank diameter	1.4 mm to 200 mm Nominal slope: 0.3 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.8:2006 Point 3.2.2 (Opt. 1)	3 µm 10 · 10^{-6} · *d*	Three-wire method *d* = is the measured diameter
Threaded rings: simpler Flank diameter	3 mm to 200 mm nominal pitch: 0.5 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.9:2006 Point 3.2.2 (Opt. 1)	3 µm 10 · 10^{-6} · *d*	Two-ball method *d* = is the measured Diameter
Length of plane-parallel, spherical or cylindrical Measuring surfaces	0.01 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 19.1:2014	1.5 µm 2 · 10^{-6} · *l*	*l* is the measured Length
Diameter	0.01 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006 Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	1.5 µm 2 · 10^{-6} · *d*	*d* is the measured Diameter
Feeler gauges	0.03 mm to 2.00 mm	DIN 2275:2014	1.5 µm 2 · 10^{-6} · *l*	*l* is the measured length
Adjustment dimensions for Outside micrometers	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm 2 · 10^{-6} · *l*	

Permanent Laboratory Munich - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Throat gauges	3 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.7:2005 Point 3.3.2 (Opt. 2)	0.8 µm 2 · 10^{-6} · *d*	*d* is the measured Diameter
Caliper for Exterior, interior and Depth measurements	0 mm until 500 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	30 µm 30 · 10^{-6} · *l*	*l* is the measured Length
Depth caliper,	> 500 mm until 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006	50 µm 30 · 10^{-6} · *l*	
Height caliper		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
Outside micrometers	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm 10 · 10^{-6} · *l*	
Fine pointer measurement-screws	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002	3 µm 10 · 10^{-6} · *l*	
Micrometer head screws	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008	3 µm 10 · 10^{-6} · *l*	
Depth gauges	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010	3 µm 10 · 10^{-6} · *l*	
Inside micrometers with 2-point contact on the calibration object	13 mm to 300 mm > 300 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	3 µm 10 · 10^{-6} · *l* 5 µm 10 · 10^{-6} · *l*	
Inside micrometers with 3-line contact on the calibration object	3 mm to 100 mm	VDI/VDE/DGQ 2618 Sheet 10.8:2002	3 µm 10 · 10^{-6} · *d*	*d* is the measured diameter
Lever gauges (quick probes) for External measurements	to 200 mm	VDI/VDE/DGQ 2618 Sheet 12.1:2005	7 µm 10 · 10^{-6} · *l*	*l* is the measured length
Lever gauges (quick probes) for Internal measurements	2 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 13.1:2005	7 µm 10 · 10^{-6} · *l*	
Dial gauges	0 mm to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.1:2021	3 µm 10 · 10^{-6} · *l*	mechanical dial gauges
		VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	3 µm 10 · 10^{-6} · *l*	electronic digital dial gauges
Fine pointer	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
Feeler lever gauges	0 mm to 1,6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
Rotation angle Direct rotary encoders	0 ° to 360 °	VDI/VDE 2648 Sheet 1	0,06 °	
Indirect rotary encoders	0 ° to 360 °	VDI/VDE 2648 Sheet 2 Rotation speed > 0.21/min Rotation speed < 0.21/min	0,5 ° 1,0 °	

Location Calibration Laboratory Essen, Alte Landstraße 3c, 45329 Essen, Germany

Permanent Laboratory Essen - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC voltage	0 V		0.1 µV	U = set value
Measuring devices	1 mV to 2,2 V		$7 \cdot 10^{-6} U$ 1 µV	
	> 2,2 V to 11 V		$9 \cdot 10^{-6} U$	
	> 11 V to 22 V		$8 \cdot 10^{-6} U$	
	> 22 V to 220 V		$12 \cdot 10^{-6} U$	
	> 220 V to 1000 V		$12 \cdot 10^{-6} U$	
DC voltage	0 V		0.1 µV	U = measured value
Sources	1 mV to 100 mV		$8 \cdot 10^{-6} U$ 1 µV	
	> 100 V to 1 V		$11 \cdot 10^{-6} U$	
	> 1 V to 10 V		$9 \cdot 10^{-6} U$	
	> 10 V to 100 V		$13 \cdot 10^{-6} U$	
	> 100 V to 1000 V		$16 \cdot 10^{-6} U$	
High Voltage	> 1 kV to 10 kV		$2.5 \cdot 10^{-3} U$ 2.5 V	U = measured value
DC current strength	0 A	Precision Open	0.2 nA	I = set value
meters and sources	0.1 µA until < 1 µA	Normal resistance and voltmeter	$35 - 10^{-6} I$ 21 pA	
	1 µA until < 10 µA		$50 - 10^{-6} I$ 6 pA	
	10 µA until < 100 µA		$15 - 10^{-6} I$ 0.4 nA	
	100 µA until 320 mA		$18 - 10^{-6} I$	
	> 320 mA until 1 A		$15 - 10^{-6} I$ 6 µA	
	> 1 A to 10 A		$0,2 - 10^{-3} I$	
	> 10 A > 150 A		$0,3 - 10^{-3} I$	
	150 A to 2000 A	Current transformer	$0,3 - 10^{-3} I$	
Direct current strength	1 mA to 2,2 A		$1 \cdot 10^{-3} I$	
Current clamps	> 2,2 A to 20 A		$2 \cdot 10^{-3} I$	
	> 20 A to 1000 A		$3 \cdot 10^{-3} I$	

Permanent Laboratory Essen - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	0 Ω		50 µ Ω	R = set value
	1 Ω; 1.9 Ω		95 · 10^{-6} R	Fluke 5700A
	10 Ω		28 · 10^{-6} R	
	19 Ω		27 · 10^{-6} R	
	100 Ω; 190 Ω		17 · 10^{-6} R	
	1 kΩ		13 · 10^{-6} R	
	1.9 kΩ		13 · 10^{-6} R	
	10 kΩ		12 · 10^{-6} R	
	19 kΩ		12 · 10^{-6} R	
	100 kΩ		14 · 10^{-6} R	
	190 kΩ		14 · 10^{-6} R	
	1 MΩ		20 · 10^{-6} R	
	1.9 MΩ		21 · 10^{-6} R	
	10 MΩ		40 · 10^{-6} R	
	19 MΩ		48 · 10^{-6} R	
	100 MΩ		110 · 10^{-6} R	
	0 Ω		100 µΩ	R = measured value
	1 Ω to 10 Ω		16 · 10^{-6} R 50 µΩ	HP 3458A
	> 10 Ω to 100 Ω		12 · 10^{-6} R 500 µΩ	
	> 100 Ω to 1 kΩ		15 · 10^{-6} R	
	> 1 kΩ to 10 kΩ		15 · 10^{-6} R	
	> 10 kΩ to 100 kΩ		15 · 10^{-6} R	
	> 100 kΩ to 1 MΩ		35 · 10^{-6} R	
	> 1 MΩ to 10 MΩ		150 · 10^{-6} R	
	> 10 MΩ to 100 MΩ		600 · 10^{-6} R	
	> 100 MΩ to 1 GΩ		5 · 10^{-3} R	
	0,001 Ω to 0,1 Ω	Substitution procedure	50 · 10^{-6} R	
	> 0,1 Ω to 1 MΩ	with normal resistance	20 · 10^{-6} R	
	> 1 MΩ to 100 MΩ		30 · 10^{-6} R	

Permanent Laboratory Essen - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range			suring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	1 Ω	to	< 11 Ω		$0.12 \cdot 10^{-3} R$	R = set value
(areas)	11 Ω	to	< 33 Ω		$33 \cdot 10^{-6} R$	Fluke 5520A /5522A
Measuring devices	33 Ω	to	< 110 Ω		$29 \cdot 10^{-6} R$	
	110 Ω	to	< 330 Ω		$28 \cdot 10^{-6} R$	
	330 Ω	to	< 1.1 kΩ		$28 \cdot 10^{-6} R$	
	1.1 kΩ	to	< 3.3 kΩ		$28 \cdot 10^{-6} R$	
	3.3 kΩ	to	< 11 kΩ		$28 \cdot 10^{-6} R$	
	11 kΩ	to	< 33 kΩ		$28 \cdot 10^{-6} R$	
	33 kΩ	to	< 110 kΩ		$28 \cdot 10^{-6} R$	
	110 kΩ	to	< 330 kΩ		$32 \cdot 10^{-6} R$	
	330 kΩ	to	< 1.1 MΩ		$33 \cdot 10^{-6} R$	
	1.1 MΩ	to	< 3.3 MΩ		$62 \cdot 10^{-6} R$	
	3.3 MΩ	to	< 11 MΩ		$0.13 \cdot 10^{-3} R$	
	11 MΩ	to	< 33 MΩ		$0.25 \cdot 10^{-3} R$	
	33 MΩ	to	< 110 MΩ		$0.5 \cdot 10^{-3} R$	
	110 MΩ	to	< 330 MΩ		$3 \cdot 10^{-3} R$	
	330 MΩ	to	< 1.1 GΩ		$15 \cdot 10^{-3} R$	
AC resistance	0,1 Ω	to	2 Ω	50 Hz to 400 Hz	$10 - 10^{-3} - R$	

Permanent Laboratory Essen - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC power Sources and measuring devices	1 mV to 2.2 mV	10 Hz to 20 Hz	$0.52 \cdot 10^{-3}\ U$	U = measured value
		> 20 Hz to 40 Hz	$0.52 \cdot 10^{-3}\ U$	
		> 40 Hz to 20 kHz	$0.40 \cdot 10^{-3}\ U$	
		> 20 kHz to 50 kHz	$0.40 \cdot 10^{-3}\ U$	
		> 50 kHz to 100 kHz	$0.41 \cdot 10^{-3}\ U$	
		> 100 kHz to 300 kHz	$0.46 \cdot 10^{-3}\ U$	
		> 300 kHz to 500 kHz	$0.55 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.60 \cdot 10^{-3}\ U$	
	> 2.2 mV to 7 mV	10 Hz to 20 Hz	$0.22 \cdot 10^{-3}\ U$	
		> 20 Hz to 40 Hz	$0.22 \cdot 10^{-3}\ U$	
		> 40 Hz to 20 kHz	$0.16 \cdot 10^{-3}\ U$	
		> 20 kHz to 50 kHz	$0.16 \cdot 10^{-3}\ U$	
		> 50 kHz to 100 kHz	$0.20 \cdot 10^{-3}\ U$	
		> 100 kHz to 300 kHz	$0.22 \cdot 10^{-3}\ U$	
		> 300 kHz to 500 kHz	$0.33 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.45 \cdot 10^{-3}\ U$	
	> 7 mV to 22 mV	10 Hz to 20 Hz	$80 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$80 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$65 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$75 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$75 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$95 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.19 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.21 \cdot 10^{-3}\ U$	
	> 22 mV to 70 mV	10 Hz to 20 Hz	$70 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$58 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$35 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$35 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$45 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$55 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.11 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	

Permanent Laboratory Essen - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	> 70 mV to 220 mV	10 Hz to 20 Hz	$39 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$35 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$25 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$25 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$28 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$42 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$85 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.1 \cdot 10^{-3}\ U$	
	> 220 mV to 700 mV	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$22 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$12 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$12 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$14 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$27 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$40 \cdot 10^{-6}\ U$	
	> 700 mV to 2.2 V	10 Hz to 20 Hz	$20 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$14 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$10 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$10 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$11 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$22 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$68 \cdot 10^{-6}\ U$	
	> 2.2 V to 7 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$12 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$13 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$95 \cdot 10^{-6}\ U$	

Permanent Laboratory Essen - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	> 7 V to 22 V	10 Hz to 20 Hz	$17 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1MHz	$0.11 \cdot 10^{-3}\ U$	
	> 22 V to 70 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$15 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$15 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$40 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 V to 220 V	10 Hz to 20 Hz	$19 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$18 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$17 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$17 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$32 \cdot 10^{-6}\ U$	
	> 220 V to 1000 V	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$27 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$45 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$45 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$65 \cdot 10^{-6}\ U$	
High Voltage	> 0.7 kV to 1 kV	50 Hz	$2.5 \cdot 10^{-3}\ U$ 0.25 V	
	> 1 kV to 7 kV		$3.5 \cdot 10^{-3}\ U$ 2.0 V	

Permanent Laboratory Essen - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC power Sources and measuring devices	100 µA to 1 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	120 · 10^{-6} *I* 160 · 10^{-6} *I* 60 · 10^{-6} *I*	*I* = measured value
	> 1 mA to 10 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	46 · 10^{-6} *I*	
	> 10 mA to 1 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	17 · 10^{-6} *I*	
	> 1 A to 10 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	32 · 10^{-6} *I*	
	> 10 A to 20 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	39 · 10^{-6} *I*	
Current clamps	1 mA to 2.2 A > 2.2 A to 20 A > 20 A to 800 A	40 Hz to 5 kHz 40 Hz to 5 kHz 40 Hz to 65 Hz	2 · 10^{-3} *I* 3 · 10^{-3} *I* 4 · 10^{-3} *I*	*I* = measured value
Capacity gauges	190 pF to < 400 pF 400 pF to < 1.1 nF 1.1 nF to < 3.3 nF 3.3 nF to < 11 nF 11 nF to < 33 nF 33 nF to < 110 nF 110 nF to < 330 nF 330 nF to < 1.1 µF 1.1 µF to < 3.3 µF	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 600 Hz 10 Hz to 300 Hz	4 · 10^{-3} C 8 pF 4.5 · 10^{-3} C 8 pF 4.0 · 10^{-3} C 8 pF 2.5 · 10^{-3} C 8 pF 2.5 · 10^{-3} C 80 pF 2.5 · 10^{-3} C 80 pF 4.5 · 10^{-3} C 4.5 · 10^{-3} C 4.5 · 10^{-3} C	With 5520A / 5522A

Permanent Laboratory Essen - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Capacity gauges	3.3 µF to < 11 µF	10 Hz to 150 Hz	4.5 · 10^{-3} C	With 5520A / 5522A
	11 µF to < 33 µF	10 Hz to 120 Hz	6.0 · 10^{-3} C	
	33 µF to < 110 µF	10 Hz to 80 Hz	6.5 · 10^{-3} C	
	110 µF to < 330 µF	DC to 50 Hz	6.0 · 10^{-3} C	
	330 µF to < 1.1 mF	DC to 20 Hz	6.0 · 10^{-3} C	
	1.1 mF to < 3.3 mF	DC to 6 Hz	6.0 · 10^{-3} C	
	3.3 mF to < 11 mF	DC to 2 Hz	6.0 · 10^{-3} C	
	11 mF to < 33 mF	DC to 0.6 Hz	8.0 · 10^{-3} C	
	33 mF to 110 mF	DC to 0.2 Hz	11 · 10^{-3} C	
	1 nF to 100 nF	50 Hz to 10 kHz	1,0 - 10^{-3} *C*	*C*: measured value with normal capacitances
	> 100 nF to 1000 nF	50 Hz to 1 kHz	1,0 - 10^{-3} *C*	
		> 1 kHz to 10 kHz	2,5 - 10^{-3} *C*	
Frequency	1 mHz to 1 GHz		2 · 10^{-9} · f $_{UTf}$	*f* = current measured value $_{UTf}$ =Trigger uncertainty
Time interval	1 µs to 1000 s		2 · 10^{-9} · *t* 2 ns	*t* = current measured value
Speed optical	1 min^{-1} up to 100.000 min^{-1}	with light pulse generator	8 · 10^{-6} but not less than 0.006 min^{-1}	
AC active power measuring devices		33 mV to 1000 V 45 Hz to 65 kHz *PF* = 1		*P* = set value with Fluke 5520A/5522A *PF:* Power factor
	109 µW to < 11kW	33 mA to < 11 A	1.4 · 10^{-3} *P*	
	363 mW up to 20 kW	11 A to 20 A	2.0 · 10^{-3} *P*	
DC power Measuring devices	1 mW to 300 W		0.5 · 10^{-3} *P*	
	> 300 W to 20 kW		1.0 · 10^{-3} *P*	
Sources	1 mW to 300 W	Product of U and I 1	30 - 10^{-6} *P*	*P* Calculated power
	>300 W to 1 kW	mV ≤ U ≤ 1000 V	200 - 10^{-6} *P*	
	>1 kW to 1 MW	100 µA ≤ I ≤ 2000 A	300 - 10^{-6} *P*	

Permanent Laboratory Essen - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	$w(_{UF})$ . .Uncertainty of the amplitude of the voltage fundamental $w(_{IF})$ . .Uncertainty of the amplitude of the Current fundamental $w(_{\Phi F})$ ...Uncertainty of the phase shift angle $w(U_{rmc})$ ... Uncertainty of the voltage rms value $w(I_{rmc})$ ... uncertainty of the rms current value
	5 mW to 50 kW	0.1 A to 50 A	not less than 80 - 10^{-6}	
	> 2,5 W to 120 kW	> 50 A to 120 A	not smaller than 0.14 - 10^{-3}	
AC reactive power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	
	5 mvar to 50 kvar	0.1 A to 50 A	not less than 80 - 10^{-6}	
	> 2,5 var to 120 kvar	> 50 A to 120 A	not smaller than 0.14 - 10^{-3}	
Apparent power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	
	0.1 VA to 50 kVA	0.1 A to 50 A	not less than 80 - 10^{-6}	
	> 50 VA to 120 kVA	> 50 A to 120 A	not smaller than 0.14 - 10^{-3}	
Oscilloscopes				*U* - measured value
Vertical deflection	5 mV to 5 V	R_i = 50 Ω	3.5 · 10^{-3} *U* 35 µV	Square wave voltage
	5 mV to 120 V	R_i = 1 MΩ	2.4 · 10^{-3} *U* 40 µV	10 Hz to 10 kHz
Horizontal deflection	5 ns to 520 ms		3 · 10^{-6} *T* 1 ns	
	> 20 ms to 5 s		30 · 10^{-6} *T* 1.2 · 10^{-4} T^2	
Rise time	150 ps to 10 ms	250 mV	35 - $^{10-3}$ - $_{tr}$ 5 ps	t_r = intrinsic rise time
	250 ps to 10 ms	> 250 mV to 2.5 V	35 - $^{10-3}$ - $_{tr}$ 8 ps	of the oscilloscope

Permanent Laboratory Essen - Dimensional Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Length *)				
Cylindrical setting standards, ring gauges: Diameter *)	1 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006	0.8 µm 2 · 10-6 · *d*	*d* = is the measured Diameter
Plug gauges: Diameter *)	1 mm to 200 mm	Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	0.8 µm 2 · 10-6 · *d*	
Test pins: Diameter *)	0.1 mm to 30 mm	VDI/VDE/DGQ 2618 Sheet 4.2:2007 Point 3.2.2 (Opt. 1)	0.8 µm 2 · 10-6 · *d*	
Thread gauges (one and multi-start cylindrical male and female threads with straight flanks, symmetrical profile)				
Threaded mandrels: simple Flank diameter	1.4 mm to 200 mm nominal pitch: 0.3 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.8:2006 Point 3.2.2 (Opt. 1)	3 µm 10 · 10-6 · *d*	Three-wire method *d* = is the measured diameter
Threaded rings: simpler Flank diameter	3 mm to 200 mm nominal pitch: 0.5 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.9:2006 Point 3.2.2 (Opt. 1)	3 µm 10 · 10-6 · *d*	Two-ball method *d* = is the measured Diameter
Threaded mandrels: simple pitch diameter	1.4 mm to 200 mm Nominal diameter	VDI/VDE/DGQ 2618 Sheet 4.8:2006	3 µm 10 · 10-6 · *d*	Scanning process *d* = is the measured
Outer diameter		Point 3.2.2 (Opt. 1)	2 µm	Diameter
Core diameter / Piercing diameter		to Point 3.2.6 (Opt. 5)	5 µm	
Gradient / pitch	0.5 mm to 8 mm		1.5 µm	
Thread profile angle α	> 27°		(3 1 / l_F)', but not smaller than 6'	l_F = flank length in mm
Threaded rings: simple pitch diameter	5 mm to 200 mm Nominal diameter	VDI/VDE/DGQ 2618 Sheet 4.9:2006	3 µm 10 · 10-6 · *d*	Scanning process *d* = is the measured
Outer diameter		Point 3.2.2 (Opt. 1)	5 µm	Diameter
Core diameter / Piercing diameter		to Point 3.2.6 (Opt. 5)	2 µm	
Gradient / pitch	0.5 mm to 8 mm		1,5 µm	
Thread profile angle α	> 27°		(3 1 / l_F)', but not smaller than 6'	l_F = flank length in mm

Permanent Laboratory Essen - Dimensional Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Length*)				
of plane-parallel, spherical or cylindrical measuring surfaces	0,01 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 19.1:2014	1.5 µm 2 · 10-6 · *l*	*l* is the measured length
Diameter	0,01 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006 Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	1.5 µm 2 · 10-6 · *d*	*d* is the measured diameter
Feeler gauges	0,03 mm to 2,00 mm	DIN 2275:2014	1.5 µm 2 · 10-6 · *l*	*l* is the measured length
Adjustment dimensions for Outside micrometers	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm 2 · 10-6 · *l*	
Throat gauges	3 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.7:2005 Point 3.3.2 (Opt. 2)	0.8 µm 2 · 10-6 · *d*	*d* is the measured Diameter
Caliper for Exterior, interior and Depth measurements	0 mm until 500 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	30 µm 30 · 10-6 · *l*	*l* is the measured Length
Depth caliper,	> 500 mm until 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006	50 µm 30 · 10-6 · *l*	
Height caliper		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
Outside micrometers	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm 10 · 10-6 · *l*	
Fine pointer measurement-screws	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002	3 µm 10 · 10-6 · *l*	
Micrometer head screws	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008	3 µm 10 · 10-6 · l	
Depth gauges	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010	3 µm 10 · 10-6 · *l*	
Inside micrometers with 2-point contact on the calibration object	13 mm to 300 mm > 300 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	3 µm 10 · 10-6 · *l* 5 µm 10 · 10-6 · *l*	
Inside micrometers with 3-line contact on the calibration object	3 mm to 100 mm	VDI/VDE/DGQ 2618 Sheet 10.8:2002	3 µm 10 · 10-6 · *d*	*d* is the measured diameter
Lever gauges (quick probes) for External measurements	to 200 mm	VDI/VDE/DGQ 2618 Sheet 12.1:2005	7 µm 10 · 10-6 · *l*	*l* is the measured length

Permanent Laboratory Essen - Dimensional Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Lever gauges (quick probe) for indoor measurements	2 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 13.1:2005	7 µm 10 · 10^{-6} · *l*	*l* is the measured length
Dial gauges	0 mm to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.1:2021	3 µm 10 · 10^{-6} · *l*	mechanical dial gauges
		VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	3 µm 10 · 10^{-6} · *l*	electronic digital dial gauges
Fine pointer	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
Feeler lever gauges	0 mm to 1,6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
electr. inductive Linear Encoders	to 100 mm	VDI/VDE/DGQ 2618 Sheet 14.1:2010	0.6 µm 1 · 10^{-6} · *l*	
electr. incremental Linear Encoders	to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	0.6 µm 1 · 10^{-6} · *l*	
Angle Squareness-deviation Flatness and Straightness deviation	to 30 µm	VDI/VDE/DGQ/DKD 2618 Sheet 7.1:2019 Point 3.2.2.2 (Opt. 2)	2.5 µm 1 · $^{10\text{-}6}$ · l_z 4 µm 5 · $^{10\text{-}6}$ · l_z	l_z = length of the forming or locating element up to 500 mm Leg length
Protractor Graduation 1° Scale interval 5'	-180° to 180° 0° to 360°	VDI/VDE/DGQ 2618 Sheet 7.2:2008	30' 1'	
Flat rulers Parallelism deviation Flatness deviation	to 500 mm	VDI/VDE/DGQ 2618 Sheet 5.1:2022	4 µm 5 · 10^{-6} · *l* 2.2 µm 3.5 · 10^{-6} · *l*	*l* is the measured Length
Straight edge Straightness deviation	to 500 mm	VDI/VDE/DGQ 2618 Sheet 5.2:2013	2.2 µm 3.5 · 10^{-6} · *l*	*l* is the measured Length
Inclinometers	-2000 µm/m (-412") to 2000 µm/m (412")	4_VB_00244_EN V1	1.7 µm/m (0,35")	Max. Leg length of the KG: 500 mm

Location Calibration Laboratory Hamburg, Meiendorfer Straße 205, 22145 Hamburg, Germany

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC voltage	0 V		0.1 µV	*U* = set value
Measuring devices	1 mV to 2,2 V		7 · 10^{-6} *U* 1 µV	
	> 2,2 V to 11 V		9 · 10^{-6} *U*	
	> 11 V to 22 V		8 · 10^{-6} *U*	
	> 22 V to 220 V		12 · 10^{-6} *U*	
	> 220 V to 1000 V		12 · 10^{-6} *U*	
DC voltage	0 V		0.1 µV	*U* = measured value
Sources	1 mV to 100 mV		8 · 10^{-6} *U* 1 µV	
	> 100 V to 1 V		11 · 10^{-6} *U*	
	> 1 V to 10 V		9 · 10^{-6} *U*	
	> 10 V to 100 V		13 · 10^{-6} *U*	
	> 100 V to 1000 V		16 · 10^{-6} *U*	
High Voltage	> 1 kV to 10 kV		2.5 · 10^{-3} *U* 2.5 V	*U* = measured value
DC current strength	0 A	Precision Open	0.2 nA	*I* = set value
meters and sources	0.1 µA until < 1 µA	Normal resistance and voltmeter	35 - 10^{-6} *I* 21 pA	
	1 µA until < 10 µA		50 - 10^{-6} *I* 6 pA	
	10 µA until < 100 µA		15 - 10^{-6} *I* 0.4 nA	
	100 µA until 320 mA		18 - 10^{-6} *I*	
	> 320 mA until 1 A		15 - 10^{-6} *I* 6 µA	
	> 1 A to 10 A		0,2 - 10^{-3} *I*	
	> 10 A > 150 A		0,3 - 10^{-3} *I*	
	150 A to 2000 A	Current transformer	0,3 - 10^{-3} *I*	
Direct current strength	1 mA to 2,2 A		1 · 10^{-3} *I*	
Current clamps	> 2,2 A to 20 A		2 · 10^{-3} *I*	
	> 20 A to 1000 A		3 · 10^{-3} *I*	

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	0 Ω		50 µ Ω	R = set value
	1 Ω; 1.9 Ω		95 · 10^{-6} R	Fluke 5700A
	10 Ω		28 · 10^{-6} R	
	19 Ω		27 · 10^{-6} R	
	100 Ω; 190 Ω		17 · 10^{-6} R	
	1 kΩ		13 · 10^{-6} R	
	1.9 kΩ		13 · 10^{-6} R	
	10 kΩ		12 · 10^{-6} R	
	19 kΩ		12 · 10^{-6} R	
	100 kΩ		14 · 10^{-6} R	
	190 kΩ		14 · 10^{-6} R	
	1 MΩ		20 · 10^{-6} R	
	1.9 MΩ		21 · 10^{-6} R	
	10 MΩ		40 · 10^{-6} R	
	19 MΩ		48 · 10^{-6} R	
	100 MΩ		110 · 10^{-6} R	
	0 Ω		100 µΩ	R = measured value
	1 Ω to 10 Ω		16 · 10^{-6} R 50 µΩ	HP 3458A
	> 10 Ω to 100 Ω		12 · 10^{-6} R 500 µΩ	
	> 100 Ω to 1 kΩ		15 · 10^{-6} R	
	> 1 kΩ to 10 kΩ		15 · 10^{-6} R	
	> 10 kΩ to 100 kΩ		15 · 10^{-6} R	
	> 100 kΩ to 1 MΩ		35 · 10^{-6} R	
	> 1 MΩ to 10 MΩ		150 · 10^{-6} R	
	> 10 MΩ to 100 MΩ		600 · 10^{-6} R	
	> 100 MΩ to 1 GΩ		5 · 10^{-3} R	
	0,001 Ω to 0,1 Ω	Substitution procedure	50 · 10^{-6} R	
	> 0,1 Ω to 1 MΩ	with normal resistance	20 · 10^{-6} R	
	> 1 MΩ to 100 MΩ		30 · 10^{-6} R	
DC resistance	1 mΩ		0.1 · 10^{-3} · R	
	10 mΩ		30 · 10^{-6} · R	
	100 mΩ		30 · 10^{-6} · R	
	1 Ω		30 · 10^{-6} · R	
	1 mΩ until 10 mΩ	Substitution procedure	0.1 · 10^{-3} · R	
	> 10 mΩ until 1 Ω	Substitution procedure	30 · 10^{-6} · R	
	0,1 Ω to 2 Ω	Direct procedure	50 · 10^{-6} · R	

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range			Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	1 Ω	to	< 11 Ω		$0.12 \cdot 10^{-3}\,R$	R = set value
(areas)	11 Ω	to	< 33 Ω		$33 \cdot 10^{-6}\,R$	Fluke 5520A /5522A
Measuring devices	33 Ω	to	< 110 Ω		$29 \cdot 10^{-6}\,R$	
	110 Ω	to	< 330 Ω		$28 \cdot 10^{-6}\,R$	
	330 Ω	to	< 1.1 kΩ		$28 \cdot 10^{-6}\,R$	
	1.1 kΩ	to	< 3.3 kΩ		$28 \cdot 10^{-6}\,R$	
	3.3 kΩ	to	< 11 kΩ		$28 \cdot 10^{-6}\,R$	
	11 kΩ	to	< 33 kΩ		$28 \cdot 10^{-6}\,R$	
	33 kΩ	to	< 110 kΩ		$28 \cdot 10^{-6}\,R$	
	110 kΩ	to	< 330 kΩ		$32 \cdot 10^{-6}\,R$	
	330 kΩ	to	< 1.1 MΩ		$33 \cdot 10^{-6}\,R$	
	1.1 MΩ	to	< 3.3 MΩ		$62 \cdot 10^{-6}\,R$	
	3.3 MΩ	to	< 11 MΩ		$0.13 \cdot 10^{-3}\,R$	
	11 MΩ	to	< 33 MΩ		$0.25 \cdot 10^{-3}\,R$	
	33 MΩ	to	< 110 MΩ		$0.5 \cdot 10^{-3}\,R$	
	110 MΩ	to	< 330 MΩ		$3 \cdot 10^{-3}\,R$	
	330 MΩ	to	< 1.1 GΩ		$15 \cdot 10^{-3}\,R$	
AC resistance	0,1 Ω	to	2 Ω	50 Hz to 400 Hz	$10 - 10^{-3} - R$	
	> 2 Ω	to	5 Ω	50 Hz	$9 - 10^{-3} - R$	
	> 5 Ω	to	20 Ω	50 Hz	$5 - 10^{-3} - R$	
	> 20 Ω	to	200 Ω	50 Hz	$5 - 10^{-3} - R$	

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	1 mV to 2.2 mV	10 Hz to 20 Hz	$0.52 \cdot 10^{-3}\ U$	U = measured value
		> 20 Hz to 40 Hz	$0.52 \cdot 10^{-3}\ U$	
		> 40 Hz to 20 kHz	$0.40 \cdot 10^{-3}\ U$	
		> 20 kHz to 50 kHz	$0.40 \cdot 10^{-3}\ U$	
		> 50 kHz to 100 kHz	$0.41 \cdot 10^{-3}\ U$	
		> 100 kHz to 300 kHz	$0.46 \cdot 10^{-3}\ U$	
		> 300 kHz to 500 kHz	$0.55 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.60 \cdot 10^{-3}\ U$	
	> 2.2 mV to 7 mV	10 Hz to 20 Hz	$0.22 \cdot 10^{-3}\ U$	
		> 20 Hz to 40 Hz	$0.22 \cdot 10^{-3}\ U$	
		> 40 Hz to 20 kHz	$0.16 \cdot 10^{-3}\ U$	
		> 20 kHz to 50 kHz	$0.16 \cdot 10^{-3}\ U$	
		> 50 kHz to 100 kHz	$0.20 \cdot 10^{-3}\ U$	
		> 100 kHz to 300 kHz	$0.22 \cdot 10^{-3}\ U$	
		> 300 kHz to 500 kHz	$0.33 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.45 \cdot 10^{-3}\ U$	
	> 7 mV to 22 mV	10 Hz to 20 Hz	$80 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$80 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$65 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$75 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$75 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$95 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.19 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.21 \cdot 10^{-3}\ U$	
	> 22 mV to 70 mV	10 Hz to20 Hz	$70 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$58 \cdot 10^{-6}\ U$	
		> 40 Hz to20 kHz	$35 \cdot 10^{-6}\ U$	
		> 20 kHz to50 kHz	$35 \cdot 10^{-6}\ U$	
		> 50 kHz to100 kHz	$45 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$55 \cdot 10^{-6}\ U$	
		> 300 kHz to500 kHz	$0{,}11 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0{,}13 \cdot 10^{-3}\ U$	

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	> 70 mV to220 mV	10 Hz to20 Hz	$39 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to40 Hz	$35 \cdot 10^{-6}\ U$	
		> 40 Hz to20 kHz	$25 \cdot 10^{-6}\ U$	
		> 20 kHz to50 kHz	$25 \cdot 10^{-6}\ U$	
		> 50 kHz to100 kHz	$28 \cdot 10^{-6}\ U$	
		> 100 kHz to300 kHz	$42 \cdot 10^{-6}\ U$	
		> 300 kHz to500 kHz	$85 \cdot 10^{-6}\ U$	
		> 500 kHz to1 MHz	$0{,}1 \cdot 10^{-3}\ U$	
	> 220 mV to700 mV	10 Hz to20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to40 Hz	$22 \cdot 10^{-6}\ U$	
		> 40 Hz to20 kHz	$12 \cdot 10^{-6}\ U$	
		> 20 kHz to50 kHz	$12 \cdot 10^{-6}\ U$	
		> 50 kHz to100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to300 kHz	$14 \cdot 10^{-6}\ U$	
		> 300 kHz to500 kHz	$27 \cdot 10^{-6}\ U$	
		> 500 kHz to1 MHz	$40 \cdot 10^{-6}\ U$	
	> 700 mV to2,2 V	10 Hz to20 Hz	$20 \cdot 10^{-6}\ U$	
		> 20 Hz to40 Hz	$14 \cdot 10^{-6}\ U$	
		> 40 Hz to20 kHz	$10 \cdot 10^{-6}\ U$	
		> 20 kHz to50 kHz	$10 \cdot 10^{-6}\ U$	
		> 50 kHz to100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to300 kHz	$11 \cdot 10^{-6}\ U$	
		> 300 kHz to500 kHz	$22 \cdot 10^{-6}\ U$	
		> 500 kHz to1 MHz	$68 \cdot 10^{-6}\ U$	
	> 2,2 V to7 V	10 Hz to20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to40 Hz	$12 \cdot 10^{-6}\ U$	
		> 40 Hz to20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to300 kHz	$13 \cdot 10^{-6}\ U$	
		> 300 kHz to500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to1 MHz	$95 \cdot 10^{-6}\ U$	

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	> 7 V to22 V	10 Hz to20 Hz	$17 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to1MHz	$0{,}11 \cdot 10^{-3}\ U$	
	> 22 V to70 V	10 Hz to20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to20 kHz	$15 \cdot 10^{-6}\ U$	
		> 20 kHz to50 kHz	$15 \cdot 10^{-6}\ U$	
		> 50 kHz to100 kHz	$25 \cdot 10^{-6}\ U$	
		> 100 kHz to300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to500 kHz	$40 \cdot 10^{-6}\ U$	
		> 500 kHz to1 MHz	$0{,}13 \cdot 10^{-3}\ U$	
	> 70 V to220 V	10 Hz to20 Hz	$19 \cdot 10^{-6}\ U$	
		> 20 Hz to40 Hz	$18 \cdot 10^{-6}\ U$	
		> 40 Hz to20 kHz	$17 \cdot 10^{-6}\ U$	
		> 20 kHz to50 kHz	$17 \cdot 10^{-6}\ U$	
		> 50 kHz to100 kHz	$32 \cdot 10^{-6}\ U$	
	> 220 V to1000 V	10 Hz to20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to40 Hz	$27 \cdot 10^{-6}\ U$	
		> 40 Hz to20 kHz	$45 \cdot 10^{-6}\ U$	
		> 20 kHz to50 kHz	$45 \cdot 10^{-6}\ U$	
		> 50 kHz to100 kHz	$65 \cdot 10^{-6}\ U$	
High voltage	> 0,7 kV to1 kV	50 Hz	$2{,}5 \cdot 10^{-3}\ U + 0{,}25$ V	
	> 1 kV to7 kV		$3{,}5 \cdot 10^{-3}\ U + 2{,}0$ V	

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	100 µA to1 mA	10 Hz to40 Hz > 40 Hz to1 kHz; > 1 kHz to10 kHz;	120 · 10^{-6} / 160 · 10^{-6} / 60 · 10^{-6} /	/ = measured value
	> 1 mA to10 mA	10 Hz to40 Hz > 40 Hz to1 kHz; > 1 kHz to10 kHz;	46 · 10^{-6} /	
	> 10 mA to1 A	10 Hz to40 Hz > 40 Hz to1 kHz; > 1 kHz to10 kHz;	17 · 10^{-6} /	
	> 1 A to10 A	10 Hz to40 Hz > 40 Hz to1 kHz; > 1 kHz to10 kHz;	32 · 10^{-6} /	
	> 10 A to20 A	10 Hz to40 Hz > 40 Hz to1 kHz; > 1 kHz to10 kHz;	39 · 10^{-6} /	
Current clamps	1 mA to 2,2 A > 2,2 A to 20 A > 20 A to 800 A	40 Hz to 5 kHz 40 Hz to 5 kHz 40 Hz to 65 Hz	2 · 10^{-3} / 3 · 10^{-3} / 4 · 10^{-3} /	/ = measured value rt

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Capacity	190 pF to < 400 pF	10 Hz to 10 kHz	$4 \cdot 10^{-3} C + 8$ pF	With 5520A / 5522A
Measuring devices	400 pF to < 1,1 nF	10 Hz to 10 kHz	$4{,}5 \cdot 10^{-3} C + 8$ pF	
	1,1 nF to < 3,3 nF	10 Hz to 3 kHz	$4{,}0 \cdot 10^{-3} C + 8$ pF	
	3,3 nF to < 11 nF	10 Hz to 1 kHz	$2{,}5 \cdot 10^{-3} C + 8$ pF	
	11 nF to < 33 nF	10 Hz to 1 kHz	$2{,}5 \cdot 10^{-3} C + 80$ pF	
	33 nF to < 110 nF	10 Hz to 1 kHz	$2{,}5 \cdot 10^{-3} C + 80$ pF	
	110 nF to < 330 nF	10 Hz to 1 kHz	$4{,}5 \cdot 10^{-3} C$	
	330 nF to < 1,1 µF	10 Hz to 600 Hz	$4{,}5 \cdot 10^{-3} C$	
	1,1 µF to < 3,3 µF	10 Hz to 300 Hz	$4{,}5 \cdot 10^{-3} C$	
	3,3 µF to < 11 µF	10 Hz to 150 Hz	$4{,}5 \cdot 10^{-3} C$	
	11 µF to < 33 µF	10 Hz to 120 Hz	$6{,}0 \cdot 10^{-3} C$	
	33 µF to < 110 µF	10 Hz to 80 Hz	$6{,}5 \cdot 10^{-3} C$	
	110 µF to < 330 µF	DC to 50 Hz	$6{,}0 \cdot 10^{-3} C$	
	330 µF to < 1,1 mF	DC to 20 Hz	$6{,}0 \cdot 10^{-3} C$	
	1,1 mF to < 3,3 mF	DC to 6 Hz	$6{,}0 \cdot 10^{-3} C$	
	3,3 mF to < 11 mF	DC to 2 Hz	$6{,}0 \cdot 10^{-3} C$	
	11 mF to < 33 mF	DC to 0.6 Hz	$8.0 \cdot 10^{-3} C$	
	33 mF to 110 mF	DC to 0.2 Hz	$11 \cdot 10^{-3} C$	
	1 nF to 100 nF	50 Hz until 10 kHz	$1{,}0 - 10^{-3}\ C$	*C*: measured value with normal capacitances
	> 100 nF to 1000 nF	50 Hz until 1 kHz	$1{,}0 - 10^{-3}\ C$	
		> 1 kHz to 10 kHz	$2{,}5 - 10^{-3} C$	

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Frequency	1 mHz to 1 GHz		$2 \cdot 10^{-9} \cdot f_{UTf}$	f = current measured value $_{UTf}$ =Trigger uncertainty
Time interval	1 µs to 1000 s		$2 \cdot 10^{-9} \cdot t$ 2 ns	t = current measured value
Speed optical	1 min^{-1} up to 100.000 min^{-1}	with light pulse generator	$8 \cdot 10^{-6}$ but not less than 0.006 min^{-1}	
AC active power measuring devices		33 mV to 1000 V 45 Hz to 65 kHz *PF* = 1		*P* = set value with Fluke 5520A/5522A *PF:* Power factor
	109 µW to < 11kW	33 mA to < 11 A	$1.4 \cdot 10^{-3} P$	
	363 mW up to 20 kW	11 A to 20 A	$2.0 \cdot 10^{-3} P$	
DC power Measuring devices	1 mW to 300 W > 300 W to 20 kW		$0.5 \cdot 10^{-3} P$ $1.0 \cdot 10^{-3} P$	
Sources	1 mW to 300 W > 300 W to 1 kW >1 kW up to 1 MW	Product of U and I 1 mV ≤ U ≤ 1000 V 100 µA ≤ I ≤ 2000 A	$30 - 10^{-6} P$ $200 - 10^{-6} P$ $300 - 10^{-6} P$	*P* Calculated power

Permanent Laboratory Hamburg - Electrical Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power	5 mW up to 50 kW > 2.5 W to 120 kW	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than 80 - 10_{-6} not smaller than 0.14 - 10_{-3}	$w(_{UF})$ . .Uncertainty of the amplitude of the voltage fundamental $w(_{IF})$ . .Uncertainty of the amplitude of the Current fundamental $w(_{\Phi F})$ ...Uncertainty of the phase shift angle $w(U_{rmc})$ ... Uncertainty of the voltage rms value $w(I_{rmc})$ ... uncertainty of the rms current value
AC reactive power	5 mvar to 50 kvar > 2.5 var up to 120 kvar	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than 80 - 10_{-6} not smaller than 0.14 - 10_{-3}	
Apparent power	0.1 VA up to 50 kVA > 50 VA to 120 kVA	1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1 0.1 A to 50 A > 50 A to 120 A	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$ not less than 80 - 10_{-6} not smaller than 0.14 - 10_{-3}	
Oscilloscopes				*U* - measured value
Vertical deflection	5 mV to 5 V 5 mV to 120 V	R_i = 50 Ω R_i = 1 MΩ	3.5 · 10_{-3} *U* 35 µV 2.4 · 10_{-3} *U* 40 µV	Square wave voltage 10 Hz to 10 kHz
Horizontal deflection	5 ns to 520 ms > 20 ms to 5 s		3 · 10_{-6} *T* 1 ns 30 · 10_{-6} *T* 1.2 · 10_{-4} T^2	
Rise time	150 ps to 10 ms 250 ps to 10 ms	250 mV > 250 mV to 2.5 V	35 - $^{10-3}$ - $_{tr}$ 5 ps 35 - $^{10-3}$ - $_{tr}$ 8 ps	$_{tr}$ = intrinsic rise time of the oscilloscope

Location Calibration laboratory Mörfelden-Walldorf, Kurhessenstraße 11, 64546 Mörfelden-Walldorf

Permanent Laboratory Mörfelden-Walldorf - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC voltage	0 V		0.1 µV	U = set value
Measuring devices	1 mV to 2,2 V		$7 \cdot 10^{-6} U$ 1 µV	
	> 2,2 V to 11 V		$9 \cdot 10^{-6} U$	
	> 11 V to 22 V		$8 \cdot 10^{-6} U$	
	> 22 V to 220 V		$12 \cdot 10^{-6} U$	
	> 220 V to 1000 V		$12 \cdot 10^{-6} U$	
DC voltage	0 V		0.1 µV	U = measured value
Sources	1 mV to 100 mV		$8 \cdot 10^{-6} U$ 1 µV	
	> 100 V to 1 V		$11 \cdot 10^{-6} U$	
	> 1 V to 10 V		$9 \cdot 10^{-6} U$	
	> 10 V to 100 V		$13 \cdot 10^{-6} U$	
	> 100 V to 1000 V		$16 \cdot 10^{-6} U$	
High Voltage	> 1 kV to 10 kV		$2.5 \cdot 10^{-3} U$ 2.5 V	U = measured value
DC current strength	0 A	Precision Open	0.2 nA	I = set value
meters and sources	0.1 µA until < 1 µA	Normal resistance and voltmeter	$35 - 10^{-6} I$ 21 pA	
	1 µA until < 10 µA		$50 - 10^{-6} I$ 6 pA	
	10 µA until < 100 µA		$15 - 10^{-6} I$ 0.4 nA	
	100 µA until 320 mA		$18 - 10^{-6} I$	
	> 320 mA until 1 A		$15 - 10^{-6} I$ 6 µA	
	> 1 A to 10 A		$0,2 - 10^{-3} I$	
	> 10 A > 150 A		$0,3 - 10^{-3} I$	
	150 A to 2000 A	Current transformer	$0,3 - 10^{-3} I$	
Direct current strength	1 mA to 2,2 A		$1 \cdot 10^{-3} I$	
Current clamps	> 2,2 A to 20 A		$2 \cdot 10^{-3} I$	
	> 20 A to 1000 A		$3 \cdot 10^{-3} I$	

Permanent Laboratory Mörfelden-Walldorf - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	0 Ω		50 µ Ω	R = set value
Measuring devices	1 Ω; 1.9 Ω		95 · 10^{-6} R	Fluke 5700A
	10 Ω		28 · 10^{-6} R	
	19 Ω		27 · 10^{-6} R	
	100 Ω; 190 Ω		17 · 10^{-6} R	
	1 kΩ		13 · 10^{-6} R	
	1.9 kΩ		13 · 10^{-6} R	
	10 kΩ		12 · 10^{-6} R	
	19 kΩ		12 · 10^{-6} R	
	100 kΩ		14 · 10^{-6} R	
	190 kΩ		14 · 10^{-6} R	
	1 MΩ		20 · 10^{-6} R	
	1.9 MΩ		21 · 10^{-6} R	
	10 MΩ		40 · 10^{-6} R	
	19 MΩ		48 · 10^{-6} R	
	100 MΩ		110 · 10^{-6} R	
Sources	0 Ω		100 µΩ	R = measured value
	1 Ω to 10 Ω		16 · 10^{-6} R 50 µΩ	HP 3458A
	> 10 Ω to 100 Ω		12 · 10^{-6} R 500 µΩ	
	> 100 Ω to 1 kΩ		15 · 10^{-6} R	
	> 1 kΩ to 10 kΩ		15 · 10^{-6} R	
	> 10 kΩ to 100 kΩ		15 · 10^{-6} R	
	> 100 kΩ to 1 MΩ		35 · 10^{-6} R	
	> 1 MΩ to 10 MΩ		150 · 10^{-6} R	
	> 10 MΩ to 100 MΩ		600 · 10^{-6} R	
	> 100 MΩ to 1 GΩ		5 · 10^{-3} R	
	0,001 Ω to 0,1 Ω	Substitution procedure	50 · 10^{-6} R	
	> 0,1 Ω to 1 MΩ	with normal resistance	20 · 10^{-6} R	
	> 1 MΩ to 100 MΩ		30 · 10^{-6} R	

Permanent Laboratory Mörfelden-Walldorf - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	1 Ω to < 11 Ω		0.12 · 10^{-3} *R*	*R* = set value
Measuring devices	11 Ω to < 33 Ω		33 · 10^{-6} *R*	Fluke 5520A /5522A
	33 Ω to < 110 Ω		29 · 10^{-6} *R*	
	110 Ω to < 330 Ω		28 · 10^{-6} *R*	
	330 Ω to < 1.1 kΩ		28 · 10^{-6} *R*	
	1.1 kΩ to < 3.3 kΩ		28 · 10^{-6} *R*	
	3.3 kΩ to < 11 kΩ		28 · 10^{-6} *R*	
	11 kΩ to < 33 kΩ		28 · 10^{-6} *R*	
	33 kΩ to < 110 kΩ		28 · 10^{-6} *R*	
	110 kΩ to < 330 kΩ		32 · 10^{-6} *R*	
	330 kΩ to < 1.1 MΩ		33 · 10^{-6} *R*	
	1.1 MΩ to < 3.3 MΩ		62 · 10^{-6} *R*	
	3.3 MΩ to < 11 MΩ		0.13 · 10^{-3} *R*	
	11 MΩ to < 33 MΩ		0.25 · 10^{-3} *R*	
	33 MΩ to < 110 MΩ		0.5 · 10^{-3} *R*	
	110 MΩ to < 330 MΩ		3 · 10^{-3} *R*	
	330 MΩ to < 1.1 GΩ		15 · 10^{-3} *R*	
AC resistance	0,1 Ω to 2 Ω	50 Hz to 400 Hz	10 - 10^{-3} - *R*	
AC voltage	1 mV to 2.2 mV	10 Hz to 20 Hz	0.52 · 10^{-3} *U*	*U* = measured value
Measuring devices and		> 20 Hz to 40 Hz	0.52 · 10^{-3} *U*	
Sources		> 40 Hz to 20 kHz	0.40 · 10^{-3} *U*	
		> 20 kHz to 50 kHz	0.40 · 10^{-3} *U*	
		> 50 kHz to 100 kHz	0.41 · 10^{-3} *U*	
		> 100 kHz to 300 kHz	0.46 · 10^{-3} *U*	
		> 300 kHz to 500 kHz	0.55 · 10^{-3} *U*	
		> 500 kHz to 1 MHz	0.60 · 10^{-3} *U*	
	> 2.2 mV to 7 mV	10 Hz to 20 Hz	0.22 · 10^{-3} *U*	
		> 20 Hz to 40 Hz	0.22 · 10^{-3} *U*	
		> 40 Hz to 20 kHz	0.16 · 10^{-3} *U*	
		> 20 kHz to 50 kHz	0.16 · 10^{-3} *U*	
		> 50 kHz to 100 kHz	0.20 · 10^{-3} *U*	
		> 100 kHz to 300 kHz	0.22 · 10^{-3} *U*	
		> 300 kHz to 500 kHz	0.33 · 10^{-3} *U*	
		> 500 kHz to 1 MHz	0.45 · 10^{-3} *U*	

Permanent Laboratory Mörfelden-Walldorf - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	> 7 mV to 22 mV	10 Hz to 20 Hz	$80 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$80 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$65 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$75 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$75 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$95 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.19 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.21 \cdot 10^{-3}\ U$	
	> 22 mV to 70 mV	10 Hz to 20 Hz	$70 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$58 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$35 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$35 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$45 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$55 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.11 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 mV to 220 mV	10 Hz to 20 Hz	$39 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$35 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$25 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$25 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$28 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$42 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$85 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.1 \cdot 10^{-3}\ U$	
	> 220 mV to 700 mV	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$22 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$12 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$12 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$14 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$27 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$40 \cdot 10^{-6}\ U$	

Permanent Laboratory Mörfelden-Walldorf - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	> 700 mV to 2.2 V	10 Hz to 20 Hz	$20 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$14 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$10 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$10 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$11 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$22 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$68 \cdot 10^{-6}\ U$	
	> 2.2 V to 7 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$12 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$13 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$95 \cdot 10^{-6}\ U$	
	> 7 V to 22 V	10 Hz to 20 Hz	$17 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1MHz	$0.11 \cdot 10^{-3}\ U$	
	> 22 V to 70 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$15 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$15 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$40 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 V to 220 V	10 Hz to 20 Hz	$19 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$18 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$17 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$17 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$32 \cdot 10^{-6}\ U$	

Permanent Laboratory Mörfelden-Walldorf - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage meters and sources	> 220 V to 1000 V	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$ $27 \cdot 10^{-6}\ U$ $45 \cdot 10^{-6}\ U$ $45 \cdot 10^{-6}\ U$ $65 \cdot 10^{-6}\ U$	U = measured value
High Voltage	> 0.7 kV to 1 kV > 1 kV to 7 kV	50 Hz	$2.5 \cdot 10^{-3}\ U$ 0.25 V $3.5 \cdot 10^{-3}\ U$ 2.0 V	
Alternating current strength sources and measuring devices	100 µA to 1 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$120 \cdot 10^{-6}\ I$ $160 \cdot 10^{-6}\ I$ $60 \cdot 10^{-6}\ I$	I = measured value
	> 1 mA to 10 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$46 \cdot 10^{-6}\ I$	
	> 10 mA to 1 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$17 \cdot 10^{-6}\ I$	
	> 1 A to 10 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$32 \cdot 10^{-6}\ I$	
	> 10 A to 20 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$39 \cdot 10^{-6}\ I$	
Current clamps	1 mA to 2.2 A > 2.2 A to 20 A > 20 A to 800 A	40 Hz to 5 kHz 40 Hz to 5 kHz 40 Hz to 65 Hz	$2 \cdot 10^{-3}\ I$ $3 \cdot 10^{-3}\ I$ $4 \cdot 10^{-3}\ I$	I = measured value

Permanent Laboratory Mörfelden-Walldorf - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Capacity gauges	190 pF to < 400 pF	10 Hz to 10 kHz	$4 \cdot 10^{-3}$ C 8 pF	With 5520A / 5522A
	400 pF to < 1.1 nF	10 Hz to 10 kHz	$4.5 \cdot 10^{-3}$ C 8 pF	
	1.1 nF to < 3.3 nF	10 Hz to kHz	$4.0 \cdot 10^{-3}$ C 8 pF	
	3.3 nF to < 11 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3}$ C 8 pF	
	11 nF to < 33 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3}$ C 80 pF	
	33 nF to < 110 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3}$ C 80 pF	
	110 nF to < 330 nF	10 Hz to 1 kHz	$4.5 \cdot 10^{-3}$ C	
	330 nF to < 1.1 µF	10 Hz to 600 Hz	$4.5 \cdot 10^{-3}$ C	
	1.1 µF to < 3.3 µF	10 Hz to 300 Hz	$4.5 \cdot 10^{-3}$ C	
	3.3 µF to < 11 µF	10 Hz to 150 Hz	$4.5 \cdot 10^{-3}$ C	
	11 µF to < 33 µF	10 Hz to 120 Hz	$6.0 \cdot 10^{-3}$ C	
	33 µF to < 110 µF	10 Hz to 80 Hz DC to	$6.5 \cdot 10^{-3}$ C	
	110 µF to < 330 µF	50 Hz DC to Hz DC	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	to 6 Hz DC to 2 Hz	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	DC to 200.6 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF	DC to 0,2 Hz	$6.0 \cdot 10^{-3}$ C	
	11 mF to < 33 mF		$8.0 \cdot 10^{-3}$ C	
	33 mF to 110 mF		$11 \cdot 10^{-3}$ C	
	1 nF to 100 nF	50 Hz to 10 kHz	1,0 - 10^{-3} *C*	*C*: measured value
	> 100 nF to 1000 nF	50 Hz to 1 kHz	1,0 - 10^{-3} *C*	with normal
		> 1 kHz to 10 kHz	2,5 - 10^{-3} *C*	capacitances
Frequency	1 mHz to 1 GHz		$2 \cdot 10^{-9} \cdot f_{UTf}$	*f* = current measured value $_{UTf}$ =Trigger uncertainty
Time interval	1 µs to 1000 s		$2 \cdot 10^{-9} \cdot t$ 2 ns	*t* = current measured value
Speed optical	1 min^{-1} up to 100.000 min^{-1}	with light pulse generator	$8 \cdot 10^{-6}$ but not less than 0.006 min^{-1}	
AC active power measuring devices		33 mV to 1000 V 45 Hz to 65 kHz *PF* = 1		*P* = set value with Fluke 5520A/5522A *PF:* Power factor
	109 µW to < 11kW	33 mA to < 11 A	$1.4 \cdot 10^{-3} P$	
	363 mW up to 20 kW	11 A to 20 A	$2.0 \cdot 10^{-3} P$	
DC power Measuring devices	1 mW to 300 W		$0.5 \cdot 10^{-3} P$	
	> 300 W to 20 kW		$1.0 \cdot 10^{-3} P$	
Sources	1 mW to 300 W	Product of U and I 1 mV	30 - 10^{-6} *P*	*P*
	> 300 W to 1 kW	≤ U ≤ 1000 V	200 - 10^{-6} *P*	Calculated
	> 1 kW to 1 MW	100 µA ≤ I ≤ 2000 A	300 - 10^{-6} *P*	power

Permanent Laboratory Mörfelden-Walldorf - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	$w(_{UF})$ . .Uncertainty of the amplitude of the voltage fundamental $w(_{IF})$ . .Uncertainty of the amplitude of the Current fundamental $w(_{\Phi F})$ ...Uncertainty of the phase shift angle $w(U_{rmc})$ ... Uncertainty of the voltage rms value $w(I_{rmc})$ ... uncertainty of the rms current value
	5 mW up to 50 kW	0.1 A to 50 A	not smaller than 80 - 10^{-6}	
	> 2.5 W to 120 kW	> 50 A to 120 A	not smaller than 0,14 - 10^{-3}	
AC reactive power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	
	5 mvar to 50 kvar	0.1 A to 50 A	not smaller than 80 - 10^{-6}	
	> 2.5 var up to 120 kvar	> 50 A to 120 A	not smaller than 0,14 - 10^{-3}	
Apparent power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	
	0.1 VA up to 50 kVA	0.1 A to 50 A	not less than 80 - 10^{-6}	
	> 50 VA to 120 kVA	> 50 A to 120 A	not smaller than 0.14 - 10^{-3}	
Oscilloscopes				*U* - measured value
Vertical deflection	5 mV to 5 V	R_i = 50 Ω	3.5 · 10^{-3} *U* 35 µV	Square wave voltage
	5 mV to 120 V	R_i = 1 MΩ	2.4 · 10^{-3} *U* 40 µV	10 Hz to 10 kHz
Horizontal deflection	5 ns to 520 ms		3 · 10^{-6} *T* 1 ns	
	> 20 ms to 5 s		30 · 10^{-6} *T* 1.2 · 10^{-4} T^2	
Rise time	150 ps to 10 ms	250 mV	35 - $^{10-3}$ - $_{tr}$ 5 ps	$_{tr}$ = intrinsic rise time
	250 ps to 10 ms	> 250 mV to 2.5 V	35 - $^{10-3}$ - $_{tr}$ 8 ps	of the oscilloscope

Location Calibration Laboratory Winsen, Tönnhäuser Weg 100-106, 21423 Winsen (Luhe)

Permanent Laboratory Winsen - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC voltage	0 V		0.1 µV	*U* = set value
Measuring devices	1 mV to 2,2 V		7 · 10^{-6} *U* 1 µV	
	> 2,2 V to 11 V		9 · 10^{-6} *U*	
	> 11 V to 22 V		8 · 10^{-6} *U*	
	> 22 V to 220 V		12 · 10^{-6} *U*	
	> 220 V to 1000 V		12 · 10^{-6} *U*	
DC voltage	0 V		0.1 µV	*U* = measured value
Sources	1 mV to 100 mV		8 · 10^{-6} *U* 1 µV	
	> 100 V to 1 V		11 · 10^{-6} *U*	
	> 1 V to 10 V		9 · 10^{-6} *U*	
	> 10 V to 100 V		13 · 10^{-6} *U*	
	> 100 V to 1000 V		16 · 10^{-6} *U*	
High Voltage	> 1 kV to 10 kV		2.5 · 10^{-3} *U* 2.5 V	*U* = measured value
DC current strength	0 A	Precision Open	0.2 nA	*I* = set value
meters and sources	0.1 µA until < 1 µA	Normal resistance and voltmeter	35 - 10^{-6} *I* 21 pA	
	1 µA until < 10 µA		50 - 10^{-6} *I* 6 pA	
	10 µA until < 100 µA		15 - 10^{-6} *I* 0.4 nA	
	100 µA until 320 mA		18 - 10^{-6} *I*	
	> 320 mA until 1 A		15 - 10^{-6} *I* 6 µA	
	> 1 A to 10 A		0,2 - 10^{-3} *I*	
	> 10 A > 150 A		0,3 - 10^{-3} *I*	
	150 A to 2000 A	Current transformer	0,3 - 10^{-3} *I*	
Direct current strength	1 mA to 2,2 A		1 · 10^{-3} *I*	
Current clamps	> 2,2 A to 20 A		2 · 10^{-3} *I*	
	> 20 A to 1000 A		3 · 10^{-3} *I*	

Permanent Laboratory Winsen - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	0 Ω		50 µ Ω	R = set value
Measuring devices	1 Ω; 1.9 Ω		95 · 10^{-6} R	Fluke 5700A
	10 Ω		28 · 10^{-6} R	
	19 Ω		27 · 10^{-6} R	
	100 Ω; 190 Ω		17 · 10^{-6} R	
	1 kΩ		13 · 10^{-6} R	
	1.9 kΩ		13 · 10^{-6} R	
	10 kΩ		12 · 10^{-6} R	
	19 kΩ		12 · 10^{-6} R	
	100 kΩ		14 · 10^{-6} R	
	190 kΩ		14 · 10^{-6} R	
	1 MΩ		20 · 10^{-6} R	
	1.9 MΩ		21 · 10^{-6} R	
	10 MΩ		40 · 10^{-6} R	
	19 MΩ		48 · 10^{-6} R	
	100 MΩ		110 · 10^{-6} R	
Sources	0 Ω		100 µΩ	R = measured value
	1 Ω to 10 Ω		16 · 10^{-6} R 50 µΩ	HP 3458A
	> 10 Ω to 100 Ω		12 · 10^{-6} R 500 µΩ	
	> 100 Ω to 1 kΩ		15 · 10^{-6} R	
	> 1 kΩ to 10 kΩ		15 · 10^{-6} R	
	> 10 kΩ to 100 kΩ		15 · 10^{-6} R	
	> 100 kΩ to 1 MΩ		35 · 10^{-6} R	
	> 1 MΩ to 10 MΩ		150 · 10^{-6} R	
	> 10 MΩ to 100 MΩ		600 · 10^{-6} R	
	> 100 MΩ to 1 GΩ		5 · 10^{-3} R	
	0,001 Ω to 0,1 Ω	Substitution procedure	50 · 10^{-6} R	
	> 0,1 Ω to 1 MΩ	with normal resistance	20 · 10^{-6} R	
	> 1 MΩ to 100 MΩ		30 · 10^{-6} R	

Permanent Laboratory Winsen - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
DC resistance	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3} R$	R = set value
Measuring devices	11 Ω to < 33 Ω		$33 \cdot 10^{-6} R$	Fluke 5520A /5522A
	33 Ω to < 110 Ω		$29 \cdot 10^{-6} R$	
	110 Ω to < 330 Ω		$28 \cdot 10^{-6} R$	
	330 Ω to < 1.1 kΩ		$28 \cdot 10^{-6} R$	
	1.1 kΩ to < 3.3 kΩ		$28 \cdot 10^{-6} R$	
	3.3 kΩ to < 11 kΩ		$28 \cdot 10^{-6} R$	
	11 kΩ to < 33 kΩ		$28 \cdot 10^{-6} R$	
	33 kΩ to < 110 kΩ		$28 \cdot 10^{-6} R$	
	110 kΩ to < 330 kΩ		$32 \cdot 10^{-6} R$	
	330 kΩ to < 1.1 MΩ		$33 \cdot 10^{-6} R$	
	1.1 MΩ to < 3.3 MΩ		$62 \cdot 10^{-6} R$	
	3.3 MΩ to < 11 MΩ		$0.13 \cdot 10^{-3} R$	
	11 MΩ to < 33 MΩ		$0.25 \cdot 10^{-3} R$	
	33 MΩ to < 110 MΩ		$0.5 \cdot 10^{-3} R$	
	110 MΩ to < 330 MΩ		$3 \cdot 10^{-3} R$	
	330 MΩ to < 1.1 GΩ		$15 \cdot 10^{-3} R$	
AC resistance	0,1 Ω to 2 Ω	50 Hz to 400 Hz	$10 - 10^{-3} - R$	
AC voltage	1 mV to 2.2 mV	10 Hz to 20 Hz	$0.52 \cdot 10^{-3} U$	U = measured value
Measuring devices and		> 20 Hz to 40 Hz	$0.52 \cdot 10^{-3} U$	
Sources		> 40 Hz to 20 kHz	$0.40 \cdot 10^{-3} U$	
		> 20 kHz to 50 kHz	$0.40 \cdot 10^{-3} U$	
		> 50 kHz to 100 kHz	$0.41 \cdot 10^{-3} U$	
		> 100 kHz to 300 kHz	$0.46 \cdot 10^{-3} U$	
		> 300 kHz to 500 kHz	$0.55 \cdot 10^{-3} U$	
		> 500 kHz to 1 MHz	$0.60 \cdot 10^{-3} U$	
	> 2.2 mV to 7 mV	10 Hz to 20 Hz	$0.22 \cdot 10^{-3} U$	
		> 20 Hz to 40 Hz	$0.22 \cdot 10^{-3} U$	
		> 40 Hz to 20 kHz	$0.16 \cdot 10^{-3} U$	
		> 20 kHz to 50 kHz	$0.16 \cdot 10^{-3} U$	
		> 50 kHz to 100 kHz	$0.20 \cdot 10^{-3} U$	
		> 100 kHz to 300 kHz	$0.22 \cdot 10^{-3} U$	
		> 300 kHz to 500 kHz	$0.33 \cdot 10^{-3} U$	
		> 500 kHz to 1 MHz	$0.45 \cdot 10^{-3} U$	

Permanent Laboratory Winsen - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 7 mV to 22 mV	10 Hz to 20 Hz	$80 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$80 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$65 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$75 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$75 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$95 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.19 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.21 \cdot 10^{-3}\ U$	
	> 22 mV to 70 mV	10 Hz to 20 Hz	$70 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$58 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$35 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$35 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$45 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$55 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$0.11 \cdot 10^{-3}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 mV to 220 mV	10 Hz to 20 Hz	$39 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$35 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$25 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$25 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$28 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$42 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$85 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.1 \cdot 10^{-3}\ U$	
	> 220 mV to 700 mV	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$22 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$12 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$12 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$14 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$27 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$40 \cdot 10^{-6}\ U$	

Permanent Laboratory Winsen - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 700 mV to 2.2 V	10 Hz to 20 Hz	$20 \cdot 10^{-6}\ U$	U = measured value
		> 20 Hz to 40 Hz	$14 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$10 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$10 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$11 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$22 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$68 \cdot 10^{-6}\ U$	
	> 2.2 V to 7 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$12 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$13 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$13 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$95 \cdot 10^{-6}\ U$	
	> 7 V to 22 V	10 Hz to 20 Hz	$17 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$11 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$11 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$11 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$30 \cdot 10^{-6}\ U$	
		> 500 kHz to 1MHz	$0.11 \cdot 10^{-3}\ U$	
	> 22 V to 70 V	10 Hz to 20 Hz	$18 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$15 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$15 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$	
		> 100 kHz to 300 kHz	$25 \cdot 10^{-6}\ U$	
		> 300 kHz to 500 kHz	$40 \cdot 10^{-6}\ U$	
		> 500 kHz to 1 MHz	$0.13 \cdot 10^{-3}\ U$	
	> 70 V to 220 V	10 Hz to 20 Hz	$19 \cdot 10^{-6}\ U$	
		> 20 Hz to 40 Hz	$18 \cdot 10^{-6}\ U$	
		> 40 Hz to 20 kHz	$17 \cdot 10^{-6}\ U$	
		> 20 kHz to 50 kHz	$17 \cdot 10^{-6}\ U$	
		> 50 kHz to 100 kHz	$32 \cdot 10^{-6}\ U$	

Permanent Laboratory Winsen - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC voltage Measuring devices and Sources	> 220 V to 1000 V	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz	$25 \cdot 10^{-6}\ U$ $27 \cdot 10^{-6}\ U$ $45 \cdot 10^{-6}\ U$ $45 \cdot 10^{-6}\ U$ $65 \cdot 10^{-6}\ U$	U = measured value
High Voltage	> 0.7 kV to 1 kV > 1 kV to 7 kV	50 Hz	$2.5 \cdot 10^{-3}\ U$ 0.25 V $3.5 \cdot 10^{-3}\ U$ 2.0 V	
Alternating current strength sources and measuring devices	100 µA to 1 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$120 \cdot 10^{-6}\ I$ $160 \cdot 10^{-6}\ I$ $60 \cdot 10^{-6}\ I$	I = measured value
	> 1 mA to 10 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$46 \cdot 10^{-6}\ I$	
	> 10 mA to 1 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$17 \cdot 10^{-6}\ I$	
	> 1 A to 10 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$32 \cdot 10^{-6}\ I$	
	> 10 A to 20 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	$39 \cdot 10^{-6}\ I$	
Current clamps	1 mA to 2.2 A > 2.2 A to 20 A > 20 A to 800 A	40 Hz to 5 kHz 40 Hz to 5 kHz 40 Hz to 65 Hz	$2 \cdot 10^{-3}\ I$ $3 \cdot 10^{-3}\ I$ $4 \cdot 10^{-3}\ I$	I = measured value

Permanent Laboratory Winsen - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Capacity gauges	190 pF to < 400 pF	10 Hz to 10 kHz	$4 \cdot 10^{-3} C$ 8 pF	With 5520A / 5522A
	400 pF to < 1.1 nF	10 Hz to 10 kHz	$4.5 \cdot 10^{-3} C$ 8 pF	
	1.1 nF to < 3.3 nF	10 Hz to kHz	$4.0 \cdot 10^{-3} C$ 8 pF	
	3.3 nF to < 11 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3} C$ 8 pF	
	11 nF to < 33 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3} C$ 80 pF	
	33 nF to < 110 nF	10 Hz to 1 kHz	$2.5 \cdot 10^{-3} C$ 80 pF	
	110 nF to < 330 nF	10 Hz to 1 kHz	$4.5 \cdot 10^{-3} C$	
	330 nF to < 1.1 µF	10 Hz to 600 Hz	$4.5 \cdot 10^{-3} C$	
	1.1 µF to < 3.3 µF	10 Hz to 300 Hz	$4.5 \cdot 10^{-3} C$	
	3.3 µF to < 11 µF	10 Hz to 150 Hz	$4.5 \cdot 10^{-3} C$	
	11 µF to < 33 µF	10 Hz to 120 Hz	$6.0 \cdot 10^{-3} C$	
	33 µF to < 110 µF	10 Hz to 80 Hz	$6.5 \cdot 10^{-3} C$	
	110 µF to < 330 µF	DC to 50 Hz	$6.0 \cdot 10^{-3} C$	
	330 µF to < 1.1 mF	DC to Hz	$6.0 \cdot 10^{-3} C$	
	1.1 mF to < 3.3 mF	DC to 6 Hz	$6.0 \cdot 10^{-3} C$	
	3.3 mF to < 11 mF	DC to 2 Hz	$6.0 \cdot 10^{-3} C$	
	11 mF to < 33 mF	DC to 200.6 Hz	$8.0 \cdot 10^{-3} C$	
	33 mF to 110 mF	DC to 0,2 Hz	$11 \cdot 10^{-3} C$	
	1 nF to 100 nF	50 Hz to 10 kHz	$1{,}0 - 10^{-3} C$	*C*: measured value
	> 100 nF to 1000 nF	50 Hz to 1 kHz	$1{,}0 - 10^{-3} C$	with normal
		> 1 kHz to 10 kHz	$2{,}5 - 10^{-3} C$	capacitances
Frequency	1 mHz to 1 GHz		$2 \cdot 10^{-9} \cdot f_{UTf}$	*f* = current measured value $_{UTf}$ =Trigger uncertainty
Time interval	1 µs to 1000 s		$2 \cdot 10^{-9} \cdot t$ 2 ns	*t* = current measured value
Speed optical	1 min^{-1} up to 100.000 min^{-1}	with light pulse generator	$8 \cdot 10^{-6}$ but not less than 0.006 min^{-1}	
AC active power measuring devices		33 mV to 1000 V 45 Hz to 65 kHz *PF* = 1		*P* = set value with Fluke 5520A/5522A *PF:* Power factor
	109 µW to < 11kW	33 mA to < 11 A	$1.4 \cdot 10^{-3} P$	
	363 mW up to 20 kW	11 A to 20 A	$2.0 \cdot 10^{-3} P$	
DC power Measuring devices	1 mW to 300 W		$0.5 \cdot 10^{-3} P$	
	> 300 W to 20 kW		$1.0 \cdot 10^{-3} P$	
Sources	1 mW to 300 W	Product of *U and I*	$30 - 10^{-6} P$	*P*:
	> 300 W to 1 kW	1 mV ≤ U ≤ 1000 V	$200 - 10^{-6} P$	calculated
	> 1 kW to 1 MW	100 µA ≤ I ≤ 2000 A	$300 - 10^{-6} P$	power

Permanent Laboratory Winsen - Electrical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
AC active power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	$w(_{UF})$ . .Uncertainty of the amplitude of the voltage fundamental $w(_{IF})$ . .Uncertainty of the amplitude of the Current fundamental $w(_{\Phi F})$ ...Uncertainty of the phase shift angle $w(U_{rmc})$ ... Uncertainty of the voltage rms value $w(I_{rmc})$ ... uncertainty of the rms current value
	5 mW to 50 kW	0.1 A to 50 A	not less than 80 - 10^{-6}	
	> 2,5 W to 120 kW	> 50 A to 120 A	not smaller than 0.14 - 10^{-3}	
AC reactive power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	
	5 mvar to 50 kvar	0.1 A to 50 A	not less than 80 - 10^{-6}	
	> 2,5 var to 120 kvar	> 50 A to 120 A	not smaller than 0.14 - 10^{-3}	
Apparent power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	
	0.1 VA to 50 kVA	0.1 A to 50 A	not less than 80 - 10^{-6}	
	> 50 VA to 120 kVA	> 50 A to 120 A	not smaller than 0.14 - 10^{-3}	
Oscilloscopes				*U* - measured value
Vertical deflection	5 mV to 5 V	R_i = 50 Ω	3.5 · 10^{-3} *U* 35 µV	Square wave voltage
	5 mV to 120 V	R_i = 1 MΩ	2.4 · 10^{-3} *U* 40 µV	10 Hz to 10 kHz
Horizontal deflection	5 ns to 520 ms		3 · 10^{-6} *T* 1 ns	
	> 20 ms to 5 s		30 · 10^{-6} *T* 1.2 · 10^{-4} T^2	
Rise time	150 ps to 10 ms	250 mV	35 - $^{10-3}$ - $_{tr}$ 5 ps	$_{tr}$ = intrinsic rise time
	250 ps to 10 ms	> 250 mV to 2.5 V	35 - $^{10-3}$ - $_{tr}$ 8 ps	of the oscilloscope

Permanent Laboratory Winsen - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Length *) Cylindrical setting standards, ring gauges: Diameter	1 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006	0.8 µm $2 \cdot 10^{-6} \cdot d$	d = is the measured
Plug gauges: Diameter	1 mm to 200 mm	Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	0.8 µm $2 \cdot 10^{-6} \cdot d$	Diameter
Test pins: Diameter	0,1 mm to 30 mm	VDI/VDE/DGQ 2618 Sheet 4.2:2007 Point 3.2.2 (Opt. 1)	0.8 µm $2 \cdot 10^{-6} \cdot d$	
Thread gauges (one and multi-start cylindrical male and female threads with straight flanks, symmetrical profile) Threaded mandrels: simple Flank diameter	1.4 mm to 200 mm nominal pitch: 0.3 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.8:2006 Point 3.2.2 (Opt. 1)	3 µm $10 \cdot 10^{-6} \cdot d$	Three-wire method d = is the measured diameter
Threaded rings: simpler Flank diameter	3 mm to 200 mm nominal pitch: 0.5 mm to 6 mm	VDI/VDE/DGQ 2618 Sheet 4.9:2006 Point 3.2.2 (Opt. 1)	3 µm $10 \cdot 10^{-6} \cdot d$	Two-ball method d = is the measured Diameter
Length of plane-parallel, spherical or cylindrical Measuring surfaces	0,01 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 19.1:2014	1.5 µm $2 \cdot 10^{-6} \cdot l$	l is the measured Length
Diameter	0,01 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006 Point 3.3.4 (Opt. 3), Point 3.3.5 (Opt. 4)	1.5 µm $2 \cdot 10^{-6} \cdot d$	d is the measured Diameter
Feeler gauges	0,03 mm to 2,00 mm	DIN 2275:2014	1.5 µm $2 \cdot 10^{-6} \cdot l$	l is the measured length
Adjustment dimensions for Outside micrometers	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm $2 \cdot 10^{-6} \cdot l$	

Permanent Laboratory Winsen - Dimensional measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Throat gauges	3 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.7:2005 Point 3.3.2 (Opt. 2)	0.8 µm 2 · 10^{-6} · *d*	*d* is the measured Diameter
Caliper for outside, inside and Depth measurements	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	30 µm 30 · 10^{-6} · *l*	*l* is the measured length
Depth caliper,	>500mm to 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006	50 µm 30 · 10^{-6} · *l*	
Height caliper		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
Outside micrometers	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm 10 · 10^{-6} · *l*	
Fine pointer measuring screws	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002	3 µm 10 · 10^{-6} · *l*	
Micrometer head screws	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008	3 µm 10 · 10^{-6} · *l*	
Depth gauges	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010	3 µm 10 · 10^{-6} · *l*	
Inside micrometers with 2-point contact on the calibration object	13 mm until 300 mm >300mm until 500 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	3 µm 10 · 10^{-6} · *l* 5 µm 10 · 10^{-6} · *l*	
Inside micrometers with 3-line contact on the calibration object	3 mm to 100 mm	VDI/VDE/DGQ 2618 Sheet 10.8:2002	3 µm 10 · 10^{-6} · *d*	*d* is the measured diameter
Lever gauges (quick probes) for External measurements	to 200 mm	VDI/VDE/DGQ 2618 Sheet 12.1:2005	7 µm 10 · 10^{-6} · *l*	*l* is the measured length
Lever gauges (quick probe) for indoor measurements	2 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 13.1:2005	7 µm 10 · 10^{-6} · *l*	
Dial gauges	0 mm to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.1:2021	3 µm 10 · 10^{-6} · *l*	mechanical dial gauges
		VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	3 µm 10 · 10^{-6} · *l*	electronic digital dial gauges
Fine pointer	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
Feeler lever gauges	0 mm to 1,6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
Tape measures and scales Tape measures Standards	 0 m until 100 m 0 m until 3 m	4_VB_00237_EN V1	50 µm 20 · 10^{-6} · *l*	*l* is the measured length

Abbreviations used:

CMC	Calibration and measurement capabilities
DIN	German Institute for Standardization R.A.
DKD	Guideline of the German Calibration Service (DKD), published by the Federal Physical-Technical Institute (PTB)
DKD-R	Guideline of the German Calibration Service (DKD), published by the Federal Physical-Technical Institute (PTB)
DGQ	German Society for Quality R.A.
VDE	Association for Electrical, Electronic & Information Technologies R.A.
VDI	Association of German Engineers R.A.
VDI/VDE/DGQ 2618	VDI guideline series for test equipment monitoring
VB	Self-developed calibration method of the laboratory

German Accreditation Body

Annex to the partial accreditation certificate D-K-15070-01-02 according to DIN EN ISO/IEC 17025:2018

Valid from: **30.05.2023**

Date of issue: 30.05.2023

This document attachment is part of the accreditation certificate D-K-15070-01-00.

Partial Accreditation Certificate Holder:

Testo Industrial Services GmbH
Gewerbestraße 3, 79199 Kirchzarten,
Germany

The German original version
„Anlage zur Akkreditierungsurkunde D-K-15070-01-02 nach DIN EN ISO/IEC 17025:2018“
is valid.

The calibration laboratory meets the requirements according to DIN EN ISO/IEC 17025:2018 to perform the conformity assessment activities listed in this annex. The calibration laboratory shall comply with additional legal and normative requirements, where applicable, including those in relevant sectoral programs, provided that they are explicitly confirmed below.

The requirements for the management system in DIN EN ISO/IEC 17025 are written in a language relevant for calibration laboratories and are overall in accordance with the principles of DIN EN ISO 9001.

Calibrations at the sites:

Calibration laboratory Kirchzarten, Gewerbestraße 3, 79199 Kirchzarten
Calibration laboratory Kirchzarten, Erich-Rieder Straße 4, 79199 Kirchzarten
Calibration laboratory Munich, Nikolaus-Otto-Straße 2, 85221 Dachau
Calibration laboratory Essen, Alte Landstraße 3c, 45329 Essen
Calibration laboratory Hamburg, Meiendorfer Straße 205, 22145 Hamburg
Calibration laboratory Mörfelden-Walldorf, Kurhessenstraße 11,
64546 Mörfelden-Walldorf
Calibration laboratory Winsen, Tönnhäuser Weg 100-106, 21423 Winsen (Luhe)

This deed annex is valid only together with the deed issued in writing and reflects the status at the date of issue. The current status of valid and monitored accreditation can be found in the database of accredited bodies of the German Accreditation Body (www.dakks.de)

Calibration in the fields:

Thermodynamic measurands

Temperature measurands

- **Resistance thermometer** [a)]
- **Thermocouples, thermocouples** [a)]
- **Radiation Thermometer**
- **Temperature fixed point cells**
- **Temperature block calibrators** [a)]
- **Temperature indicators and simulators** [a), b)]
- **Climate cabinets (temperature)** [c)]
- **Temperature transmitter, data logger** [a)]

Humidity measurement variables

- **Measuring instruments for relative humidity** [a)]
- **Measuring instruments for absolute humidity** [a)]
- **Climate cabinets (humidity)** [c)]

Chemical and medical measurands Chemical analyses and reference materials

- **Measuring instruments for electrolytic Conductivity**
- **pH value**
- **Gas mixtures**

Mechanical measured variables

- **Force**
- **Scales** [c)]
- **Pressure** [a)]
- **Torque** [a)]
- **Acceleration flow measurement variables**
- **Flow velocity of gases**
- **Volume of flowing gases**
- **Mass of flowing gases**
- **Volume of flowing liquids**
- **Mass of flowing liquids Acoustic measurands**

a) also on-site calibration
b) also mobile laboratory
c) On-site calibration only

Within the measurands/calibration items marked with [*)] , the calibration laboratory is permitted to apply the standards/calibration guidelines listed here with different editions without requiring prior information and approval by DAkkS. The calibration laboratory has an up-to-date list of all standards/calibration guidelines in the flexible accreditation area.

Calibration and measurement capabilities

Location Calibration laboratory Gewerbestraße 3, 79199 Kirchzarten

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Mechanical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Acceleration vibration transducer, vibration measuring device	0.1 m/s² to 20 m/s²	Sinus excitation DKD-R 3-1 Sheet 3:2020		Complex transfer coefficient (magnitude / phase). Transducer mass up to 0.9 kg, displacement amplitude up to 100 mm
		0.2 Hz to < 0.4 Hz	2,5 % / 1,6 °	
		0.4 Hz to < 1 Hz	1,5 % / 1,6 °	
		1 Hz to < 16 Hz	0,8 % / 0,8 °	
		16 Hz	0,55 % / 0,6 °	
		> 16 Hz to 63 Hz	0,8 % / 0,8 °	
		> 63 Hz to 160 Hz	1,0 % / 1,1 °	
	1 m/s² to 200 m/s²	Sinus excitation DKD-R 3-1 Sheet 3:2020		Complex transfer coefficient (magnitude / phase). Transducer mass up to 0.2 kg, displacement amplitude up to 8 mm
		5 Hz to < 10 Hz	1,5 % / 1,5 °	
		10 Hz to < 20 Hz	0,8 % / 0,8 °	
		20 Hz to 1 kHz	0,6 % / 0,6 °	
		> 1 kHz to 5 kHz	0,8 % / 0,8 °	
		> 5 kHz to 10 kHz	2,0 % / 1,5 °	
		> 10 kHz to 15 kHz	2,5 % / 2,5 °	
		> 15 kHz to 20 kHz	3,0 % / 3,0 °	
	1 m/s² to 500 m/s²	Sinus excitation DKD-R 3-1 Sheet 3:2020		Complex transfer coefficient (magnitude / phase). Transducer mass up to 0.5 kg, displacement amplitude up to 10 mm
		3 Hz to < 5 Hz	1,6 % / 1,1°	
		5 Hz to < 20 Hz	1,1 % / 1,1°	
		20 Hz to < 80 Hz	0,8 % / 0,8°	
		80 Hz	0,55 % / 0,6 °	
		> 80 Hz to 1 kHz	0,8 % / 0,8°	
		> 1 kHz to 5 kHz	1,3 % / 1,1°	
		> 5 kHz to 10 kHz	2,3 % / 1,1°	
Vibration calibrator	0.1 m/s² to 100 m/s²	Sinus excitation DIN ISO 16063-44:2019		
		10 Hz to < 20 Hz	0,8 %	
		20 Hz to 1 kHz	0,6 %	
		> 1 kHz to 5 kHz	0,8 %	
		> 5 kHz to 10 kHz	2,0 %	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Mechanical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Print *) Negative and positive overpressure p_e	-1 bar to -0.03 bar	DKD-R 6-1: 2014	10 µbar$^{5\text{-}10\text{-}5}$ - p_e	p_e = measured value pressure medium: Gas
	> -0.03 bar to < -1 mbar		50 µbar$^{1\text{-}10\text{-}4}$ - p_e	
	-1 mbar to < 0 mbar		4 µbar	
	0 bar		0.6 µbar	
	> 0 mbar to < 0.2 mbar		4 µbar	
	0.2 mbar to 3.6 mbar		0.7 µbar	
	> 3.6 mbar to 0.2 bar		2 µbar$^{1\text{-}10\text{-}4}$ - p_e	
	> 0.2 bar to 2 bar		30 µbar 2.$^{5\text{-}10\text{-}5}$ - p_e	
	> 2 bar to 20 bar		0.05 mbar 2.$^{5\text{-}10\text{-}5}$ - p_e	
	> 20 bar to 100 bar		0.5 mbar 2.$^{5\text{-}10\text{-}5}$ - p_e	
	> 100 bar to 400 bar		6 mbar 3.$^{5\text{-}10\text{-}5}$ - p_e	
	0 bar		$^{7\text{-}10\text{-}5}$ - p_e at least 7.5 mbar	Print medium: Oil
	2 bar to 1200 bar			
Absolute pressure p_{abs}	0.01 bar to 2 bar	DKD-R 6-1: 2014 $p_{abs} = p_e \; p_{amb}$	15 µbar 2.$^{5\text{-}10\text{-}5}$ - p_{abs}	p_{abs} = measured value pressure medium gas The measurement uncertainty of the residual gas measurement must be taken into account. The measurement uncertainty of the barometer must be taken into account
	> 2 bar to 20 bar		170 µbar 2.$^{5\text{-}10\text{-}5}$ - p_{abs}	
	> 20 bar to 101 bar		0.6 mbar 2.$^{5\text{-}10\text{-}5}$ - p_{abs}	
	> 101 bar to 401 bar		7 mbar 3.$^{5\text{-}10\text{-}5}$ - p_{abs}	
	1 bar		$^{7\text{-}10\text{-}5}$ - p_{abs} at least 7.5 mbar	p_{abs} = measured value pressure medium: Oil Measurement uncertainty of the barometer must be taken into account
	3 bar to 1201 bar			

Permanent Laboratory Calibration Laboratory Gewerbestraße 3 - Acoustics

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Acoustics Measuring microphone/ Free-field open-circuit or free-field operating transmission dimension	-60 dB to 20 dB (referred to 1 V/Pa)	DIN EN 61094-8:2013 Substitution process in a low-reflection chamber with ½''- reference microphone. 125 Hz to 8 kHz > 8 kHz to 20 kHz	0.35 dB 0.50 dB	
Measuring microphone/ Pressure-idle or pressure-operating transmission dimension	-60 dB to 20 dB (referred to 1 V/Pa) 250 Hz / 114 dB	DIN EN IEC 60942:2018 Calibration with reference standard Pistonphone	0.2 dB	
	1000 Hz / 94 dB	Calibrator		
	1000 Hz / 114 dB	Calibrator		
	-60 dB to 20 dB (referred to 1 V/Pa)	DIN EN 61094-5:2016 Comparative measurement with SQ-4.2 electro-acoustic coupler 31.5 Hz to 5 kHz > 5 kHz to 16 kHz	0.25 dB 0.50 dB	Only 1/2'' - microphones
Sound level meter/ Sound pressure level display (free field)	250 Hz / 114 dB 1000 Hz / 94 dB 1000 Hz / 114 dB	DIN EN 61672-3:2017 Calibration with reference standard Pistonfon calibrator Calibrator	0.2 dB	
		DIN EN 61672-3:2017 Comparative measurement with SQ-4.2 electro-acoustic coupler 31.5 Hz to 10 kHz > 10 kHz to 16 kHz	0.35 dB 0.60 dB	Only 1/2'' - microphones
	74 dB to 94 dB (referred to 20 µPa)	DIN EN 61672-3:2017 Substitution process in a low-reflection chamber with ½''- Reference microphone 125 Hz to < 250 Hz 250 Hz to 8 kHz > 8 kHz to 20 kHz	0.50 dB 0.40 dB 0.60 dB	
Sound calibrator/ sound pressure level	70 dB to 130 dB	DIN EN IEC 60942:2018 Calibration with ½'' reference microphone 250 Hz or 1 kHz	0.15 dB	
	Frequency: 250 Hz or 1 kHz		0.1 Hz	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature Fixed point cells	-189,3442 °C	G-ITS-90, Part 2.3:2021 Argon triple point	4.0 mK	Comparison with reference fixed-point cell using normal resistance thermometers
	-38,8344 °C	G-ITS-90, Part 2.4:2021 Mercury triple point	1.0 mK	
	0,01 °C	G-ITS-90, Part 2.2:2018 Water triple point	0.5 mK	
	29,7646 °C	G-ITS-90, Part 2.4:2021 Gallium melting point	0.8 mK	
	156,5985 °C	G-ITS-90, Part 2.4:2021 Indium solidification point	2.5 mK	
	231,928 °C	G-ITS-90, Part 2.4:2021 Tin solidification point	1.5 mK	
	419,527 °C	G-ITS-90, Part 2.4:2021 Zinc solidification point	2.0 mK	
	660,323 °C	G-ITS-90, Part 2.4:2021 Aluminum-solidification point	7.0 mK	
Standard platinum resistance thermometers (SPRT), direct reading thermometers and temperature transmitters with resistance sensor (SPRT)	-196 °C to -189.3442 °C	EURAMET Technical Guide No. 1:2017	8.0 mK	Extrapolation
	-189,3442 °C	G-ITS-90, Part 2.3:2021 Argon triple point	4.0 mK	Calibration at temperature fixed points
	-38,8344 °C	G-ITS-90, Part 2.4:2021 Mercury triple point	1.5 mK	
	0,01 °C	G-ITS-90, Part 2.2:2018 Water triple point	0.5 mK	
	29,7646 °C	G-ITS-90, Part 2.4:2021 Gallium melting point	1.0 mK	
	156,5985 °C	G-ITS-90, Part 2.4:2021 Indium solidification point	2.5 mK	
	231,928 °C	G-ITS-90, Part 2.4:2021 Tin solidification point	2.5 mK	
	419,527 °C	G-ITS-90, Part 2.4:2021 Zinc solidification point	2.5 mK	
	660,323 °C	G-ITS-90, Part 2.4:2021 Aluminum-solidification point	7.0 mK	
	-189,3442 °C to 0.01 °C	G-ITS-90, Part 5:2021 Fixed points: Ar, Hg, TPW	6.0 mK	Calibration at fixed temperature points with characteristic curve determination according to ITS-90 The measurement uncertainty refers to the characteristic curve in the specified range
	-38.8344 °C to 29.7646 °C	G-ITS-90, Part 5:2021 Fixed points: Hg, TPW, Ga	2.0 mK	
	0 °C to 156,5985 °C	G-ITS-90, Part 5:2021 Fixed points: TPW, In	3.5 mK	
	0 °C to 231.928 °C	G-ITS-90, Part 5:2021 Fixed points: TPW, In, Sn	3.5 mK	
	0 °C to 419.527 °C	G-ITS-90, Part 5:2021 Fixed points: TPW, Sn, Zn	4.0 mK	
	0 °C to 660.323 °C	G-ITS-90, Part 5:2021 Fixpkte.: TPW, Sn, Zn, Al	8.0 mK	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Resistance thermometers, direct reading thermometers with resistance sensor *)	-196 °C	DKD-R 5-1:2018 in liquid nitrogen	15 mK	Comparison with standard resistance thermometers
	0,00 °C	DKD-R 5-1:2018 Ice Point	5.0 mK	
	-120 °C to 200 °C	DKD-R 5-1:2018 in liquid bath	10 mK	
	> 200 °C to 300 °C		15 mK	
	> 300 °C to 420 °C		20 mK	
	> 420 °C to 500 °C		50 mK	
	> 500 °C to 660 °C	DKD-R 5-1:2018 in the tube furnace	0,20 K	
Temperature transmitter with resistance sensor *)	-40 °C to 200 °C	DKD-R 5-1:2018 in liquid bath	15 mK	Comparison with standard resistance thermometers
	> 200 °C to 500 °C		25 mK	
direct reading thermometers, temperature transmitters and data loggers with resistance sensor *)	-40 °C to < 0 °C	DKD-R 5-1:2018 in the climatic chamber	0,30 K	Comparison with standard resistance thermometers
	0 °C to 50 °C		0,15 K	
	> 50 °C to 80 °C		0,25 K	
	> 80 °C to 120 °C		0,40 K	
	> 120 °C to 180 °C		0,90 K	
Precious metal thermocouples *)	0,01 °C	DKD-R 5-3 Water triple point	0,4 K	Calibration at temperature fixed points of the ITS 90
	231,928 °C	DKD-R 5-3 Tin solidification point	0,4 K	
	419,527 °C	DKD-R 5-3 Zinc solidification point	0,4 K	
	660,323 °C	DKD-R 5-3 Aluminum solidification point	0,4 K	
	961,78 °C	DKD-R 5-3 Silver solidification point	0,5 K	
	0 °C to 1000 °C	DKD-R 5-3 with DKD-R 5-6 at temperature fixed points	0,6 K	Calibration at fixed temperature points with characteristic curve determination The measurement uncertainty refers to the characteristic curve in the specified range
Precious metal thermocouples, direct reading thermometers with attached precious metal thermocouple sensor *)	-40 °C to 500 °C	DKD-R 5-3:2018 in liquid bath	0,5 K	Comparison with standard resistance thermometers
	> 500 °C to 1000 °C	DKD-R 5-3:2018 in the tube furnace	0,8 K	Comparison with standard thermocouples
	> 1000 °C to 1200 °C	DKD-R 5-3:2018 in the ball furnace	1,6 K	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Non-precious metal thermocouples, direct reading with connected non-precious metal thermocouple sensor *)	-196 °C	DKD-R 5-3:2018 in liquid nitrogen	0,5 K	Comparison with standard resistance thermometers
	-80 °C to 200 °C	DKD-R 5-3:2018 in liquid bath	0,2 K	
	200 °C to 400 °C		0,4 K	
	> 400 °C to 500 °C		0,5 K	
	> 500 °C to 1000 °C	DKD-R 5-3:2018 in the tube furnace	1,0 K	Comparison with standard thermocouples
Temperature transmitter and data logger with thermocouple sensor *)	-80 °C to 200 °C	DKD-R 5-3:2018 Liquid bath	0,5 K	Comparison with standard resistance thermometers
	> 200 °C to 500 °C		1,0 K	
	> 500 °C to 1000 °C	DKD-R 5-3:2018 Tube furnace	2,0 K	Comparison with standard thermocouples
Liquid glass thermometer *)	-80 °C to < 0 °C	PTB test rule volume 2:2003	20 mK	Comparison with standard resistance thermometers
	0 °C to 200 °C		10 mK	
Circulated thermostats and baths	-80 °C to < 200 °C	3-APD-0-0155-EN: 2023-01	10 mK	Comparison with standard resistance thermometers
	200 °C to 300 °C		15 mK	
Temperature block calibrators *)	-90 °C to 125 °C	DKD-R 5-4:2018	0,04 K	Comparison with standard resistance thermometers
	> 125 °C 150 °C		0,05 K	
	> 150 °C to 300 °C		0,25 K	
	> 300 °C to 650 °C		0,50 K	
	> 650 °C to 800 °C		2,5 K	Comparison with standard thermocouples
	> 800 °C to 1000 °C		4 K	
Surface temperature sensor	50 °C to 100 °C	3-APD-0-0016-EN: 2023-01	0,8 K	t = measured value in °C
	> 100 °C to 500 °C		0.008 K - t / °C	
Radiation thermometer	-18 °C to 60 °C	3-APD-0-0018-EN: 2023-01 Spectral range: 8 µm to 14 µm	0,6 K	Calibration with liquid flushed cavity radiator
	> 60 °C to 100 °C		0,9 K	
	> 100 °C to 350 °C		1,2 K	
Temperature simulators for resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,016 K	Characteristic according to DIN EN 60751:2009
Temperature display devices for resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,03 K	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature indicators and simulators for Precious metal thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature indicators and simulators for Non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	
Frost and dew point temperature Dew point mirror, -transmitter, -hygrometer	-32 °C to < -25 °C	3-APD-0-0036-EN: 2023-01 1-Temperature 2-Pressure Humidity Generator	90 mK	
	-25 °C to < 0 °C	3-APD-0-0035-EN: 2023-01 1-Temp. 1/ 2-Pressure Humidity Generator	35 mK	Primary generator
	0 °C to < 70 °C		30 mK	
	70 °C to < 90 °C		40 mK	
	90 °C to 95°C		45 mK	
	-20 °C to 50 °C	3-APD-0-0037-EN: 2023-01 in the climatic chamber	0,2 K	Comparison with dew point hygrometer
	> 50 °C to 70 °C		0,25 K	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Relative humidity Dew point mirror	2 % to 98 %	3-APD-0-0035-EN: 2023-01 1-Temp.- 1-/ 2-Pressure-Humidity generator with temperature chamber 3 °C to 98 °C Frost point ≥ -25 °C	0.1 % 0.003 - *rH*	*rH* = measured value Uncertainty of measurement expressed as absolute value of relative humidity
Electrical psychrometer	2 % to 98 %		0.3 % 0.007 - *rH*	
Hygrometers, data loggers, transmitters *)	2 % to 98 %	DKD-R 5-8:2019 1-Temp.- 1-/ 2-Pressure-Humidity generator with temperature chamber 3 °C to 98 °C Frost point ≥ -25 °C	0.2 % 0.003 - *rH*	
	5 % to 30 %	DKD-R 5-8:2019 in the climatic chamber temperature range: -18 °C to 0 °C Frost point ≥ -32 °C	2,0 %	References: Dew point mirror and resistance thermometer Uncertainty of measurement expressed as absolute value of relative humidity
	> 30 % to 60 %		3,9 %	
	> 60% to 95%		6,2 %	
	5 % to 30 %	DKD-R 5-8:2019 in the climatic chamber temperature range: > 0 °C to 25 ° Frost point ≥ -32 °C	1,0 %	
	> 30 % to 60 %		1,8 %	
	> 60% to 95%		3,3 %	
	5 % to 30 %	DKD-R 5-8:2019 in the climatic chamber temperature range: > 25 °C to 50 °C Frost point ≥ -32 °C	0,6 %	
	> 30 % to 60 %		1,1 %	
	> 60% to 95%		1,8 %	
	5 % to 30 %	DKD-R 5-8:2019 in the climatic chamber temperature range: > 50 °C to 80 °C Frost point ≥ -32 °C	0,8 %	
	> 30 % to 60 %		1,5 %	
	> 60% to 95%		2,4 %	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Flow measured variables

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Gas flow rate Flow velocity from Gases	0.1 m/s to 68 m/s	Measurement with low-turbulence free jet	0.5 %; but not less than 0.01 m/s	
Volume flow rate *dV/dt* of flowing gases	15 m³/h to 2000 m³/h	3-APD-0-0055-EN: 2023-01 Air under ambient conditions	1.5 %; but not less than 0.3 m³/h	
Mass flow rate *dm/dt* of flowing gases	15 kg/h to 2000 kg/h		1.5 %; but not less than 0.3 m³/h	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Chemical and medical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Electrolytic conductivity conductivity meters and facilities	1.3 µS/cm up < 5 µS/cm	3-APD-0-0265-EN: 2023-01	1,5 %	discrete values
	5 µS/cm to < 100 µS/cm		0,7 %	
	100 µS/cm to < 706 µS/cm		0,5 %	
	706 µS/cm up 100 mS/cm		0,3 %	
pH - value pH meters and facilities	1.68 pH to 10 pH	3-APD-0-0266-EN: 2023-01	0.03 pH	
Exhaust gas / flue gas measuring instruments Gas concentration Oxygen $_{O2}$	0,0 % vol 1,4 % vol 2,5 % vol 5,0 % vol	3-APD-0-0169-EN: 2023-01	0,02 % vol 0.035 % vol 0.060 % vol 0,12 % vol	ppm vol = 10^{-6} - m_3/m_3 % vol = 10^{-2} - m_3/m_3
Carbon monoxide CO	80 ppm vol 100 ppm vol 300 ppm vol 400 ppm vol 700 ppm vol 5000 ppm vol		3 ppm vol 3 ppm vol 7.5 ppm vol 10 ppm vol 17.5 ppm vol 125 ppm vol	
Carbon dioxide $_{CO2}$	0,0 % vol 0,1 % vol 0,5 % vol 17 % vol 38,5 % vol		0,03 % vol 0,03 % vol 0,03 % vol 0,41 % vol 0,9 % vol	
Nitric Oxide NO	150 ppm 300 ppm		3.8 ppm vol 7.5 ppm vol	
Nitrogen dioxide $_{NO2}$	100 ppm		3.0 ppm vol	
Sulfur dioxide $_{SO2}$	100 ppm		3.0 ppm vol	
Sulfur-hydrogenH2S	200 ppm		7.0 ppm vol	
Methane $_{CH4}$	5000 ppm		120 ppm vol	

On-site calibration

On-site calibration - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature resistance thermometers, direct reading thermometers with resistance sensor *)	0,00 °C	DKD-R 5-1:2018 Ice Point	10 mK	Comparison with standard resistance thermometers
	-80 °C to 200 °C	DKD-R 5-1:2018 in liquid bath	10 mK	
	> 200 °C to 300 °C	DKD-R 5-1:2018 in the block calibrator	0,5 K	
	> 300 °C to 660 °C	DKD-R 5-1:2018 in the calibration furnace	3,0 K	Comparison with standard thermocouples
Temperature trans-mitter and data logger with resistance sensor *)	-80 °C to 200 °C	DKD-R 5-1:2018 in liquid bath	25 mK	Comparison with standard resistance thermometers
	> 200 °C to 300 °C		0,5 K	
	> 300 °C to 500 °C	DKD-R 5-1:2018 in the block calibrator	3,0 K	
direct reading thermometers, temperature transmitters and data loggers with resistance sensor *)	-40 °C to < 0 °C	DKD-R 5-1:2018 in the climatic chamber	0,30 K	Comparison with standard resistance thermometers
	0 °C to 50 °C		0,15 K	
	> 50 °C to 80 °C		0,25 K	
	> 80 °C to 120 °C		0,40 K	
	> 120 °C to 180 °C		0,90 K	
	0 °C to 70 °C	DKD-R 5-1:2018 1-temperature 2-pressure humidity generator with temperature chamber	0,05 K	Comparison with resistance thermometer
Non-precious metal thermocouples, direct reading thermometers with non-precious metal thermocouple sensor *)	-80 °C to 200 °C	DKD-R 5-3:2018 in liquid bath	0,2 K	Comparison with standard resistance thermometers
	> 200 °C to 300 °C	DKD-R 5-3:2018 in the block calibrator	0,5 K	
	> 300 °C to 1000 °C	DKD-R 5-3:2018 in the calibration furnace	3,0 K	Comparison with standard thermocouples
Temperature trans-mitter with thermo- element sensor *)	-80 °C to 200 °C	DKD-R 5-3:2018 in liquid bath	0,3 K	Comparison with standard resistance thermometers
	> 200 °C to 1000 °C	DKD-R 5-3:2018 in the calibration furnace	3,5 K	Comparison with standard thermocouples
Circulating thermostats, precision baths	-80 °C to < 200 °C	3-APD-0-0155-EN: 2023-01	10 mK	Comparison with standard resistanc thermometers
	200 °C to 300 °C		15 mK	

On-site calibration - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Block calibrators *)	-90 °C to 125 °C	DKD-R 5-4:2018	0,04 K	Comparison with standard resistance thermometers
	> 125 °C to 150 °C		0,05 K	
	> 150 °C to 300 °C		0,25 K	
	> 300 °C to 650 °C		0,5	
	> 650 °C to 800 °C		2,5 K	Comparison with standard thermocouples
	> 800 °C to 1000 °C		4 K	
Temperature simula- tors for resistance-thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,016 K	Characteristic according to DIN EN 60751:2009
Temperature display devices for resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,03 K	
Temperature indicators and simulators for precious metal thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature indicators and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	
Measuring locations in climatic chambers with circulating air *)	-90 °C to 0 °C	DKD-R 5-7:2018 Method C	0,3 K	Measuring medium: Air Comparison with resistance thermometers
	> 0 °C to 100 °C		0,2 K	
	> 100 °C to 200 °C		0,3 K	
	> 200 °C to 350 °C		0,5 K	
Measuring locations in climatic chambers without circulating air *)	-90 °C to 0 °C		0,5 K	
	> 0 °C to 100 °C		0,3 K	
	> 100 °C to 200 °C		0,5 K	
	> 200 °C to 350 °C		0,8 K	
Air conditioners with circulating air *)	-90 °C to 0 °C	DKD-R 5-7:2018 Method A and B	0,5 K	Measuring medium: Air Comparison with resistance thermometers
	> 0 °C to 100 °C		0,3 K	
	> 100 °C to 200 °C		0,5 K	
	> 200 °C to 350 °C		0,8 K	
Air conditioners without recirculation *)	-90 °C to 0 °C		0,8 K	
	> 0 °C to 100 °C		0,5 K	
	> 100 °C to 200 °C		0,8 K	
	> 200 °C to 350 °C		1,2 K	

On-site calibration - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Dew point temperature Dew point meters, -hygrometer	-25 °C to 70 °C	3-APD-0-0164-EN: 2023-01 1-Temperature 2-Pressure Humidity Generator	0,09 K	Comparison with c point mirror
Relative humidity measuring points in climatic chambers with circulating air *)	5 % to 30 %	DKD-R 5-7:2018 Method C Temperature range: -10 °C to 95 °C	0,3 %	Measuring mediun Humidity referenc calculated from de point and air temperature Uncertainty of measurement expressed as absol value of relative humidity
	> 30 % to 60 %		0,4 %	
	> 60% to 98%		0,6 %	
Air conditioners with circulating air *)	5 % to 30 %	DKD-R 5-7:2018 Method A and B Temperature range: -10 °C to 95 °C	0,4 %	
	> 30 % to 60 %		0,6 %	
	> 60% to 98%		0,8 %	
Relative humidity hygrometers, data loggers, transmitters *)	10 % to 95 %	DKD-R 5-8:2019 1-Temperature 2-Pressure Humidity Generator Chamber temperature: 0 °C to 70 °C	0,6 %	References: Dew p mirror and resistar thermo- meter Uncertainty of measurement expressed as absol value of relative humidity
Hygrometers, data loggers, transmitters *)	10 % to 95 %	DKD-R 5-8:2019 Humidity generator with limited useful volume Chamber temperature: 0 °C to 40 °C	0,9 %	References: Dew p mirror and resistar thermo- meter Uncertainty of measurement expressed as absol value of relative humidity
	10 % to 95 %	DKD-R 5-8:2019 Humidity generator with limited useful volume Chamber temperature: > 40 °C to 70 °C	2,0 %	

On-site calibration - Mechanical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Scales *) non-automatic electronic scales	0 kg to 10 kg	EURAMET cg-18 Version 4.0 Calibration at the installation site	1 - 10^{-6}	with weights of class $_{E2}$
	> 10 kg up to 80 kg		5 - 10^{-6}	
Torque *) Calibration equipment	0,2 N-m to 1000 N-m	DKD-R 10-8:2020	2 - 10^{-3}	
Torque - transducer, - sensors, - measuring chains	0.4 N-m to < 10 N-m	DIN 51309:20225		
	10 N-m to 5000 N-m		0,5 - 10^{-3}	
Hand operated torque screwing tools	10 N-m to 1000 N-m	DIN EN ISO 6789-2:2017	1 %	
Print *) Negative and positive overpressure p_e	-1 bar to -0.03 bar	DKD-R 6-1: 2014	12 µbar 5.$^{2\text{-}10\text{-}5}$ - p_e	p_e = measured value pressure medium: Gas
	> -0.03 bar to < -1 mbar		50 µbar$^{1\text{-}10\text{-}4}$ - p_e	
	-1 mbar to < 0 mbar		4 µbar	
	0 bar		2 µbar	
	> 0 mbar to < 0.2 mbar		4 µbar	
	0.2 mbar to 3.6 mbar		0.7 µbar	
	> 3.6 mbar to 0.2 bar		2 µbar$^{1\text{-}10\text{-}4}$ - p_e	
	> 0.2 bar to 2 bar		30 µbar 2.$^{7\text{-}10\text{-}5}$ - p_e	
	> 2 bar to 20 bar		75 µbar 2.$^{7\text{-}10\text{-}5}$ - p_e	
	> 20 bar to 100 bar		0.5 mbar 3.$^{0\text{-}10\text{-}5}$ - p_e	
	> 100 bar to 400 bar		7 mbar 3.$^{5\text{-}10\text{-}5}$ - p_e	
	0 bar		7,2 - $^{10\text{-}5}$ - p_e at least 7.5 mbar	Print medium: Oil
	2 bar to 1200 bar			

On-site calibration - Mechanical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Absolute pressure p_{abs}	0,01 bar to 2 bar	DKD-R 6-1: 2014 $p_{abs} = p_e \; p_{amb}$	17 µbar $2.^{7\text{-}10\text{-}5}$ - p_{abs}	p_{abs} = measured value pressure medium gas The measurement uncertainty of the residual gas measurement must be taken into account. The measurement uncertainty of the barometer must be taken into account
	> 2 bar to 20 bar		180 µbar $2.^{7\text{-}10\text{-}5}$ - p_{abs}	
	> 20 bar to 101 bar		0.5 mbar $3.^{0\text{-}10\text{-}5}$ - p_{abs}	
	> 101 bar to 401 bar		7 mbar $3.^{5\text{-}10\text{-}5}$ - p_{abs}	
	1 bar		$^{7\text{-}10\text{-}5}$ - p_{abs} at least 7.5 mbar	p_{abs} = measured value Print medium: Oil Measurement uncertainty of the barometer must be taken into account
	3 bar to 1201 bar			

On-site calibration - flow measured variables

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Flow rate of liquids Volume flow *dV/dt* of flowing liquids	0.01 L/min to 250 L/min	3-APD-0-0251-EN: 2023-01 Volumetric comparison measurement (references: Turbines, gear counters, Coriolis; MID,...) Density from 700 kg/m³ to 1100 kg/m³ Viscosity from 0.8 mm²/s to 1600 mm²/s	0,15 %	Measuring instruments with analog output, frequency output and visual display
Mass flow rate *dm/dt* of flowing liquids	0.01 kg/min up to 250 kg/min		0,20 %	
Gas flow rate Volume flow *dV/dt* of flowing gases	0.001 L/min to 250 L/min	3-APD-0-0251-EN: 2023-01 Volumetric comparison measurement (references: Coriolis, piston calibrator,...) Calibration medium: Compressed air (with compressed air qualities according to DIN ISO 8573-1; clean and oil-free air with max. 55 % rH) at room temperature up to max. 10 bar overpressure	0,50 %	Measuring instruments with analog output, frequency output, visual display in the standard state P_N =1013.25 mbar T_N = 0 °C
Mass flow rate *dm/dt* of flowing gases	1.3 mg/min up to 312 g/min		0,50 %	
Volume flow *dV/dt* from streaming Gases	5 mL/min up to 250 L/min	3-APD-0-0251-EN: 2023-01 Volumetric comparison measurement (References: Coriolis, piston calibrator, ...) Calibration medium: $_{N2}$,$_{CO2}$, Ar,$_{CH4}$,He (purity > 99.99 % by volume); Room temperature up to max. 10 bar overpressure	0,50 %	Measuring instruments with analog output, frequency output, visual display In the standard state: p_N = 1013.25 mbar T_N = 0 °C and ρ_{NN2} = 1.250 kg/m3 ρ_{NCO2} = 1.976 kg/m3 ρ_{NAr}= 1.783 kg/m3 ρ_{NCH4} = 0.717 kg/m3 ρ_{NHe}= 0.1785 kg/m3

Mobile laboratory

Mobile laboratory - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature measurement variables Temperature simulators for Resistance-thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,016 K	Characteristic according to DIN EN 60751:2009
Temperature display devices for resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,03 K	
Temperature indicators and simulators for Precious metal-thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature-display devices and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

Mobile laboratory - Mechanical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Print *) Negative and positive overpressure p_e	-1 bar to -0.03 bar	DKD-R 6-1: 2014	12 µbar $5.^{2\text{-}10\text{-}5}$ - p_e	p_e = measured value pressure medium: Gas
	> -0.03 bar to < -1 mbar		50 µbar$^{1\text{-}10\text{-}4}$ - p_e	
	-1 mbar to < 0 mbar		4 µbar	
	0 bar		2 µbar	
	> 0 mbar to < 0.2 mbar		4 µbar	
	0.2 mbar to 3.6 mbar		1 µbar	
	> 3.6 mbar to 0.2 bar		2 µbar$^{1\text{-}10\text{-}4}$ - p_e	
	> 0.2 bar to 2 bar		30 µbar $2.^{7\text{-}10\text{-}5}$ - p_e	
	> 2 bar to 20 bar		75 µbar $2.^{7\text{-}10\text{-}5}$ - p_e	
	> 20 bar to 100 bar		0.5 mbar $3.^{0\text{-}10\text{-}5}$ - p_e	
	> 100 bar to 400 bar		7 mbar $3.^{5\text{-}10\text{-}5}$ - p_e	
	0 bar		7,2 - $^{10\text{-}5}$ - p_e at least 7.5 mbar	Print medium: Oil
	2 bar to 1200 bar			
Absolute pressure p_{abs}	0.01 bar to 2 bar	DKD-R 6-1: 2014 $p_{abs} = p_e$ p_{amb}	17 µbar $2.^{7\text{-}10\text{-}5}$ - p_{abs}	p_{abs} = measured value pressure medium gas The measurement uncertainty of the residual gas measurement must be taken into account. The measurement uncertainty of the barometer must be taken into account
	> 2 bar to 20 bar		180 µbar $2.^{7\text{-}10\text{-}5}$ - p_{abs}	
	> 20 bar to 101 bar		0.5 mbar $3.^{0\text{-}10\text{-}5}$ - p_{abs}	
	> 101 bar to 401 bar		7 mbar $3.5\ ^{\text{-}10\text{-}5}$ - p_{abs}	
	1 bar		7 -$^{10\text{-}5}$ - p_{abs} at least 7.5 mbar	p_{abs} = measured value pressure medium: Oil Measurement uncertainty of the barometer must be taken into account
	3 bar to 1201 bar			

Location Calibration laboratory Kirchzarten, Erich-Rieder Straße 4, 79199 Kirchzarten

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature measurement variables Temperature simulators for Resistance-thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,016 K	Characteristic according to DIN EN 60751:2009
Temperature display-devices for resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,03 K	
Temperature indicators and simulators for Precious metal-thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature indicators and simulators for Base metal-thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Mechanical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Torque *) manually operated Torque Screwdriving tools	0.01 N-m to 0.2 Nm	DIN EN ISO 6789-2:2017	1 - 10^{-2}	
		DIN EN ISO 6789-2:2017		
indicating rotary moment wrenches Calibra-for torque tools	> 0.2 N-m to 1 kNm	DKD-R 3-7:2018	2 - 10^{-3}	
		DKD-R 10-8:2020		
Torque - transducer, - sensors, - measuring chains	10 N-m to 5 kNm	DIN 51309:2022	0,5 - 10^{-3}	
Force *) Force gauges, -transducer	10 N to 250 kN	DKD-R 3-3:2018 DIN EN ISO 376:2011	5 - 10^{-4}	

Calibration Laboratory Munich, Nikolaus-Otto-Strasse 2, 85221 Dachau

Permanent Laboratory Munich - Mechanical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Acceleration *) Vibration transducer, vibration measuring device	0.1 m/s² to 20 m/s²	Sinus excitation DKD-R 3-1 Sheet 3:2020		Complex transfer coefficient (magnitude / phase). Transducer mass up to 0.9 kg, displacement amplitude up to 100 mm
		0.2 Hz to < 0.4 Hz	2,5 % / 1,6 °	
		0.4 Hz to < 1 Hz	1,5 % / 1,6 °	
		1 Hz to < 16 Hz	0,8 % / 0,8 °	
		16 Hz	0,55 % / 0,6 °	
		> 16 Hz to 63 Hz	0,8 % / 0,8 °	
		> 63 Hz to 160 Hz	1,0 % / 1,1 °	
	1 m/s² to 200 m/s²	Sinus excitation DKD-R 3-1 Sheet 3:2020		Complex transfer coefficient (magnitude / phase). Transducer mass up to 0.2 kg, displacement amplitude up to 8 mm
		5 Hz to < 10 Hz	1,5 % / 1,5 °	
		10 Hz to < 20 Hz	0,8 % / 0,8 °	
		20 Hz to 1 kHz	0,6 % / 0,6 °	
		> 1 kHz to 5 kHz	0,8 % / 0,8 °	
		> 5 kHz to 10 kHz	2,0 % / 1,5 °	
		> 10 kHz to 15 kHz	2,5 % / 2,5 °	
		> 15 kHz to 20 kHz	3,0 % / 3,0 °	
Vibration calibrator	1 m/s² to 100 m/s²	Sine excitation DIN ISO 16063-44:2019		
		10 Hz to < 20 Hz	0,8 %	
		20 Hz to 1 kHz	0,6 %	
		> 1 kHz to 5 kHz	0,8 %	
		> 5 kHz to 10 kHz	2,0 %	
Torque *) hand operated torque screwing tools	0,2 N-m to 1000 Nm	DIN EN ISO 6789-2:2017	2 - 10^{-3}	
indicating rotary moment wrenches		DKD-R 3-7:2018		
Calibration equipment for turning moment tools		DKD-R 10-8:2020		
Torque transducers, torque meters		DIN 51309:2005		
Force *) Tensile force, compressive force, force gauges, force transducers	10 N to 100 kN	DKD-R 3-3:2018	1 - 10^{-3}	

Permanent Laboratory Munich - Mechanical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Print *) Positive and negative overpressure p_e	-1 bar to < -0.1 bar	DKD-R 6-1:2014	0.2 mbar $1 \cdot 10^{-4} \cdot p_e$	p_e = measured value pressure medium gas
	-0.1 bar to < 0 bar		50 µbar $1 \cdot 10^{-4} \cdot p_e$	
	0 bar		10 µbar	
	> 0 bar to 0.1 bar		50 µbar $1 \cdot 10^{-4} \cdot p_e$	
	> 0.1 bar to 10 bar		0.2 mbar $1 \cdot 10^{-4} \cdot p_e$	
	> 10 bar to 250 bar		$2 \cdot 10^{-4} \cdot p_e$	
Absolute pressure p_{abs}	0.03 bar to 10 bar	DKD-R 6-1:2014 $p_{abs} = p_e\, p_{amb}$	0.2 mbar $1 \cdot 10^{-4} \cdot p_{abs}$	p_{abs} = measured value pressure medium: Gas The measurement uncertainty of the barometer must be taken into account
	> 10 bar to 251 bar		$2 \cdot 10^{-4} \cdot p_{abs}$	

Permanent Laboratory Munich - Flow measurement variables

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Flow rate of liquids Volume flow rate dV/dt of flowing liquids	1,2 m_3/h to 340 m_3/h	Comparative measurement with reference flow meters	0,1 %	
Mass flow rate*dm/dtof* flowing Liquids	1200 kg/h to 3.4 - 10_5 kg/h	Calibration medium: Water 3-APD-0-0171-EN: 2023-06		
Volume flow *dV/dt of* flowing Liquids	0.1 mL/min to 15 mL/min	Volumetric measurement Piston calibrator	0,08 %	Measuring instruments with analog output, frequency output, visual display
	0.8 mL/min to 40 L/min			
	10 mL/min to 300 L/min			
	1 L/min to 1200 L/min	Liquids with a Density from 700kg/m³ to 1100kg/m³	0,05 %	
Mass flow rate*dm/dt* of flowing liquids	0.1 g/min to 15 kg/min			
	0.6 g/min to 32 kg/min	Viscosity from 0.3 mm²/s to 1600 mm²/s	0,12 %	
	8 g/min up to 240 kg/min	3-APD-0-0090-EN: 2023-05		
	0.8 kg/min to 1000 kg/min		0,09 %	

Permanent Laboratory Munich - Flow measurement variables

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Volume *V from* streaming Liquids	25 mL to 2,5 L	3-APD-0-0090-EN: 2023-05 Flow rates not less than 0.5 mL/min	0,08 %	Measuring instruments with analog output, frequency output, visual display
	190 mL to 19 L	3-APD-0-0090-EN: 2023-05 Flow rates not less than 1 mL/min		
	410 mL to 41 L	3-APD-0-0090-EN: 2023-05 Flow rates not less than 10 mL/min		
Gas flow rate Volume flow *dV/dt of* flowing Gases	1 mL/min to < 3mL/min	3-APD-0-0088-EN: 2023-01 Laminar flow elements dry air (dew point < -15°C)	0,40 %	Measuring instruments with analog output, frequency output, visual display In normal condition $_{pN}$ =1013.25 mbar T_N = 0 °C
	3 mL/min to 1000 L/min		0,33 %	
	8 L/min to 15000 L/min	3-APD-0-0088-EN: 2023-01 Critical nozzles dry air (dew point < -15°C)	0,24 %	
Volume flow rate *dV/dt* of flowing gases	5 mL/min to 250 L/min	3-APD-0-0251-EN: 2023-01 Volumetric comparison measurement (References: Coriolis, piston calibrator, ...) Calibration medium: $_{N2}$,$_{CO2}$, Ar,$_{CH4}$,He (purity > 99.99 vol. %); Room temperature up to max. 10 bar overpressure	0,50 %	Measuring instruments with analog output, frequency output, visual display In the standard state:$_{pN}$ = 1013.25 mbar$_{TN}$ = 0 °C and $_{\rho NN2}$ = 1.250$^{kg/m3}$ $_{\rho NCO2}$ = 1.976$^{kg/m3}$ $_{\rho NAr}$= 1.783$^{kg/m3}$ $_{\rho NCH4}$ = 0.717$^{kg/m3}$ $_{\rho NHe}$= 0.1785$^{kg/m3}$
Mass flow rate*dm/dt* of flowing gases	1.3 g/min to < 3.9 g/min	3-APD-0-0088-EN: 2023-01 Laminar flow elements dry air (dew point < -15°C)	0,42 %	
	3.9 g/min to < 1300 g/min		0,36 %	
	10 g/min to 15000 g/min	3-APD-0-0088-EN: 2023-01 Critical nozzles dry air (dew point < -15°C)	0,24 %	

Permanent Laboratory Munich - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature measurement variables Temperature simulators for Resistance-thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,016 K	Characteristic according to DIN EN 60751:2009
Temperature display-devices for Resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,03 K	
Temperature indicators and simulators for Precious metal thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature indicators and simulators for Base metal-thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

Calibration Laboratory Essen, Alte Landstraße 3c, 45329 Essen, Germany

Permanent Laboratory Essen - Thermodynamic Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature measurement variables Temperature simulators for Resistance-thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,016 K	Characteristic according to DIN EN 60751:2009
Temperature display devices for resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,03 K	
Temperature indicators and simulators for Precious metal-thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature-display devices and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

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Permanent Laboratory Hamburg - Thermodynamic Measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature measurement variables Temperature simulators for resistive thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,016 K	Characteristic according to DIN EN 60751:2009
Temperature display devices for resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,03 K	
Temperature indicators and simulators for precious metal thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature indicators and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

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Permanent Laboratory Mörfelden-Walldorf - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature measurement variables Resistance thermometers, direct reading thermometers with resistance sensor *)	-40 °C to 200 °C	DKD-R 5-1:2018 in liquid bath	10 mK	Comparison with standard resistance thermometers
Temperature transmitter and data logger with resistance sensor *)	-40 °C to 200 °C	DKD-R 5-1:2018 in liquid bath	15 mK	
direct reading thermometers, temperature transmitters and data loggers with resistance sensor *)	-40 °C to < 0 °C	DKD-R 5-1:2018 in the climatic chamber	0,30 K	
	0 °C to 50 °C		0,15 K	
	> 50 °C to 80 °C		0,25 K	
	> 80 °C to 120 °C		0,40 K	
	> 120 °C to 180 °C		0,90 K	
Precious metal- Thermocouples, direct reading Thermometer with Precious metal-Thermocouple sensor *)	-40 °C to 200 °C	DKD-R 5-3:2018 in liquid bath	0,5 K	Comparison with normal Resistance-thermometers
Base metal-Thermocouples, direct reading Thermometer with Base metal-Thermocouple sensor *)	-40 °C to 200 °C	DKD-R 5-3:2018 in liquid bath	0,2 K	
Temperature trans-mitter and data logger with thermocouple sensor *)	-40 °C to 200 °C	DKD-R 5-3:2018 in liquid bath	0,3 K	Comparison with standard resistance thermometers
Circulating thermostats, precision baths	-40 °C to 200 °C	3-APD-0-0155-EN: 2023-01	10 mK	Comparison with standard resistance thermometers
Temperature block calibrators *)	-40 °C to 150 °C	DKD-R 5-4:2018	0,05 K	Comparison with standard resistance thermometers

Permanent Laboratory Mörfelden-Walldorf - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Radiation thermometer	-18 °C to 60 °C	3-APD-0-0018-EN: 2023-01 Spectral range: 8 µm to 14 µm	0,6 K	Calibration with liquid flushed cavity radiator
	> 60 °C to 100 °C		0,9 K	
	> 100 °C to 350 °C		1,2 K	
Temperature simulators for resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,016 K	Characteristic according to DIN EN 60751:2009
Temperature display-devices for resistance thermometers *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,03 K	
Temperature indicators and simulators for Precious metal-thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature-display devices and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	
Frost / Dew point temperature Dew point mirror, -transmitter, -hygrometer	-32 °C to -25 °C	3-APD-0-0036-EN: 2023-01 1-temperature 2-pressure humidity generator	90 mK	
	> -25 °C to -10 °C		60 mK	
	> -10 °C to 40 °C		90 mK	
	> 40 °C to 70 °C		0,12 K	
Relative humidity Hygrometer, Transmitter	10 % to 20 %	DKD-R 5-8:2019 1-Temp.- 2-Pressure Humidity generator -10 °C to < 0°C	0,7 %	Measurement uncertainty as Absolute value of the relative humidity
	> 20 % to 40 %		1,3 %	
	> 40 % to 85 %		2,1 %	
	10 % to 40 %	DKD-R 5-8:2019 1-temp. 2-pressure humidity generator 0 °C to 20 °C	0,3 %	
	> 40 % to 80 %		0,6 %	
	> 80 % to 95 %		0,7 %	
	10 % to 40 %	DKD-R 5-8:2019 1-Temp.- 2-Pressure Humidity generator > 20 °C to 70 °C	0,3 %	
	> 40 % to 80 %		0,5 %	
	> 80 % to 95 %		0,6 %	

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Permanent Laboratory Winsen - Thermodynamic measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Temperature measurement variables Temperature simulators for Resistance-thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,016 K	Characteristic according to DIN EN 60751:2009
Temperature display devices for resistance thermometer *)	-200 °C to 850 °C	DKD-R 5-5:2018	0,03 K	
Temperature indicators and simulators for Precious metal-thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature-display devices and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

Permanent Laboratory Winsen - Mechanical measurands

Calibration and Measurement Capabilities (CMC)

Measurand/ calibration item	Measuring range	Measuring conditions / Procedures	Extended uncertainty of measurement	Remarks
Print *) Positive and negative Overpressure p_e	-1 bar to 10 bar	DKD-R 6-1:2014	0.2 mbar $1 \cdot 10^{-4} \cdot p_e$	p_e = measured value Pressure medium gas
	> 10 bar to 250 bar		$2 \cdot 10^{-4} \cdot p_e$	
Absolute pressure p_{abs}	0,03 bar to 11 bar	DKD-R 6-1:2014 $p_{abs} = p_e\, p_{amb}$	0.2 mbar $1 \cdot 10^{-4} \cdot p_{abs}$	p_{abs} = measured value pressure medium: Gas The measurement uncertainty of the barometer must be taken into account
	> 11 bar to 251 bar		$2 \cdot 10^{-4} \cdot p_{abs}$	

Abbreviations used

APD	In-house developed calibration procedure by Testo Industrial Services GmbH
CMC	Calibration and measurement capabilities
DIN	German Institute for Standardization R.A.
DKD-R	Guideline of the German Calibration Service (DKD), published by the Federal Physical-Technical Institute (PTB)
EURAMET	European Association of National Metrology Institutes
G-ITS-90, Part 2.2	BIPM-Guide to the Realization of the ITS-90, Triple Point of Water
G-ITS-90, Part 2.3	BIPM-Guide to the Realization of the ITS-90, Cryogenic Fixed Points
G-ITS-90, Part 2.4	BIPM-Guide to the Realization of the ITS-90, Metal Fixed Points for Contact Thermometry
G-ITS-90, Part 5	BIPM-Guide to the Realization of the ITS-90, Platinum Resistance Thermometry