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 annex to the certificate is part of the accreditation certificate D-K-15070-01-00.

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

Holder of the partial accreditation certificate:

Testo Industrial Services GmbH
Gewerbestraße 3, 79199 Kirchzarten

with the locations

Testo Industrial Services GmbH
Calibration laboratory Kirchzarten
Gewerbestraße 3, 79199 Kirchzarten

Testo Industrial Services GmbH Calibration laboratory Kirchzarten
Erich-Rieder-Straße 4, 79199 Kirchzarten

Testo Industrial Services GmbH Calibration laboratory Munich
Nikolaus-Otto-Straße 2, 85221 Dachau

Testo Industrial Services GmbH Calibration laboratory Essen
Hermann-Drescher-Weg 4 a-d, 45329 Essen

Testo Industrial Services GmbH Calibration laboratory Hamburg
Meiendorfer Straße 205, 22145 Hamburg

Testo Industrial Services GmbH Calibration laboratory Mörfelden-Walldorf
Kurhessenstraße 11, 64546 Mörfelden-Walldorf

Testo Industrial Services GmbH Calibration laboratory Winsen
Tönnhäuser Weg 100-106, 21423 Winsen (Luhe)

Testo Industrial Services GmbH Calibration laboratory Heidenheim
Alexanderstraße 18, 89522 Heidenheim an der Brenz

The calibration laboratory fulfils the requirements according to DIN EN ISO/IEC 17025:2018 to perform the conformity assessment activities listed in this annex. The calibration laboratory complies with additional legal and normative requirements, including those in relevant sectoral programs, where applicable, provided these 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 generally in accordance with the principles of DIN EN ISO 9001.

Electrical measurands

Direct current and low frequency measurands

- **Direct voltage** [a), b)]
- **AC voltage** [a), b)]
- **Direct current** [a), b)]
- **Actuating current** [a), b)]
- **AC/DC transfer**
- **Electrical power** [a), b)]
- **Phase angle**
- **Direct current resistance** [a), b)]
- **Actuating current resistance**
- **Capacity** [a), b)]
- **Inductance**
- **Voltage ratio** [a), b)]
- **High-voltage measured variables** [a)]

Time and frequency

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

High-frequency measured variables

- **HF impedance (reflection factor)** [a), b)]
- **HF power** [a), b)]
- **HF attenuation** [a), b)]
- **HF noise**
- **Modulation parameters**
- **Oscilloscope measured variables** [a), b)]
- **Rise time** [a), b)]
- **Bandwidth** [a), b)]
- **Pulse-shaped measured variables** [a), b)]

Dimensional measurands

Length

- **Diameter** [a), b)]
- **Thread** [a), b)]
- **Parallel end dimensions**
- **Length measures** [a), b)]
- **Length measuring device**
- **Dimensions, distances**

Angle

- **Inclinometers**
- **Rotation angle**

Coordinate metrology

- **Application of coordinate measuring machines**

[a)] **also on-site calibration**
[b)] **Mobile laboratory**

Within the measurands/calibration items marked with *), the calibration laboratory is permitted to use the standards/calibration guidelines listed here with different issue statuses without the need for 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / Measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC voltage measures	0 V		0.1 µV	U = measured value
	1 µV to 220 mV		$7.5 \cdot 10^{-6}\ U + 0.5$ µV	
	> 220 mV to 2.2 V		$5 \cdot 10^{-6}\ U + 0.7$ µV	
	> 2.2 V to 11 V		$3.5 \cdot 10^{-6}\ U + 2.5$ µV	
	> 11 V to 22 V		$3.5 \cdot 10^{-6}\ U + 4$ µV	
	> 22 V to 220 V		$5 \cdot 10^{-6}\ U + 40$ µV	
	> 220 V to 1000 V		$6.5 \cdot 10^{-6}\ U + 0.4$ mV	
sources	0 V		0.1 µV	
	1 µV to 200 mV		$5.8 \cdot 10^{-6}\ U + 0.2$ µV	
	> 200 mV to 2 V		$2.9 \cdot 10^{-6}\ U + 0.3$ µV	
	> 2 V to 20 V		$2.9 \cdot 10^{-6}\ U + 0.55$ µV	
	> 20 V to 200 V		$4 \cdot 10^{-6}\ U + 35$ µV	
	> 200 V to 1000 V		$4.5 \cdot 10^{-6}\ U + 0.55$ mV	
High voltage	> 1 kV to 50 kV		$0.4 \cdot 10^{-3}\ U$	
Direct current sources and measures	0 A		0.2 nA	I = measured value
	0.1 µA to < 1 µA		$35 \cdot 10^{-6}\ I + 21$ pA	
	1 µA to < 10 µA		$50 \cdot 10^{-6}\ I + 6$ pA	
	10 µA to < 100 µA		$15 \cdot 10^{-6}\ I + 0.4$ nA	
	100 µA to 320 mA		$18 \cdot 10^{-6}\ I$	
	> 320 mA to 1 A		$15 \cdot 10^{-6}\ I + 6$ µA	
	> 1 A to 10 A		$0.2 \cdot 10^{-3}\ I$	
	> 10 A to 1000 A		$0.3 \cdot 10^{-3}\ I$	
Current clamps	1 mA to 2.2 A		$1 \cdot 10^{-3}\ I$	
	> 2.2 A to 20 A		$2 \cdot 10^{-3}\ I$	
	> 20 A to 1000 A		$3 \cdot 10^{-3}\ I$	
Current transformer	1 A to 120 A		$0.22 \cdot 10^{-3}\ I$	
	> 120 A to 1000 A		$0.25 \cdot 10^{-3}\ I$	
DC resistance	0 Ω up to < 1 mΩ		1.3 µΩ	R = measured value
	1 mΩ up to 10 mΩ		$7 \cdot 10^{-6}\ R$	
	> 10 mΩ to 10 MΩ		$4 \cdot 10^{-6}\ R$	
	> 10 MΩ to 100 MΩ		$8 \cdot 10^{-6}\ R$	
	> 100 MΩ to 10 GΩ		$0.17 \cdot 10^{-3}\ R$	
	> 10 GΩ to 100 GΩ		$0.21 \cdot 10^{-3}\ R$	
	> 100 GΩ to 1 TΩ		$0.35 \cdot 10^{-3}\ R$	
	> 1 TΩ to 10 TΩ		$0.6 \cdot 10^{-3}\ R$	
	> 10 TΩ to 100 TΩ		$29 \cdot 10^{-3}\ R$	

Permanent laboratory Kirchzarten, Erich-Rieder-Straße 4 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC power measures	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 up 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	$0.3 \cdot 10^{-3}\ P$	
Direct current 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 measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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	
Alternating current sources and measures (ranges)	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	$0.16 \cdot 10^{-3}\ I$ $0.47 \cdot 10^{-3}\ I$ $0.52 \cdot 10^{-3}\ I$ $0.6 \cdot 10^{-3}\ I$	
AC resistance Areas	0.1 Ω to < 0.316 Ω	10 Hz to < 20 Hz 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	$30 - 10^{-6}\ R$ $20 - 10^{-6}\ R$ $30 - 10^{-6}\ R$	
Alternating current		10 Hz to 30 Hz	$25 - 10^{-6}\ R$ + 40 µΩ	

Permanent laboratory Kirchzarten, Erich-Rieder-Straße 4 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
resistance	> 3.16 Ω to 10 Ω	> 30 Hz to 55 Hz	9 - 10^{-6} *R* + 60 µΩ	
Areas		> 55 Hz to 1 kHz	25 - 10^{-6} *R* + 40 µΩ	
Load	10 pC to 10^5 pC	50 Hz to 10 kHz	0,4 %	
Charge amplifiers,		> 10 kHz to 20 kHz	0,6 %	
charge meters		> 20 kHz to 50 kHz	1,0 %	
Phase angle		10 V to 1000 V 0.1 A to 50 A		
between current		45 Hz to 65 Hz	0,0051°	
and voltage	-180° to 180°	> 65 Hz to 180 Hz	0,0075°	
Measures		> 180 Hz to 450 Hz	0,018°	
		> 450 Hz to 850 Hz	0,033°	
		> 850 Hz to 3 kHz	0,12°	
		> 3 kHz to 6 kHz	0,23°	
		10 V to 1000 V > 50 A to 80 A		
		45 Hz to 65 Hz	0,0052°	
		> 65 Hz to 180 Hz	0,0083°	
		> 180 Hz to 450 Hz	0,025°	
		> 450 Hz to 850 Hz	0,05°	
		> 850 Hz to 3 kHz	0,25°	
		10 V to 1000 V > 80 A to 120 A		
		45 Hz to 65 Hz	0,0055°	
		> 65 Hz to 180 Hz	0,0091°	
		> 180 Hz to 450 Hz	0,020°	
		> 450 Hz to 850 Hz	0,035°	
		> 850 Hz to 3 kHz	0,25°	
		> 3 kHz to 6 kHz	0,5°	
Phase angle between		10 V to 1000 V		
voltages		45 Hz to 65 Hz	0,006°	
Measures	-180° to 180°	> 65 Hz to 180 Hz	0,0075°	
		> 180 Hz to 450 Hz	0,025°	
		> 450 Hz to 850 Hz	0,043°	
		> 850 Hz to 3 kHz	0,15°	
		> 3 kHz to 6 kHz	0,3°	

Permanent laboratory Kirchzarten, Erich-Rieder-Straße 4 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between voltages 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 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_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(/F): Uncertainty of the amplitude of the current fundamental w(Φ_F): Uncertainty of the phase shift angle w(U_{rms}): Uncertainty of the effective voltage value w(/rms): Uncertainty of the effective 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 ≤ 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 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}	
Tension 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 display devices at discrete points In 10 % increments
	± 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Tension 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		Calibration of 350 Ω bridge standards and the associated display devices at discrete points In 10 % increments
		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	
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	

Permanent laboratory Kirchzarten, Erich-Rieder-Straße 4 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Voltage ratio DC voltage, bridge standards		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	
	-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	
Voltage ratio DC voltage Bridges, measures, measuring amplifiers		Bridge voltage:		
	-2 mV/V to +2 mV/V		0.35 µV/V	
	-5 mV/V to +5 mV/V		0.35 µV/V	
	-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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Voltage ratio DC voltage Bridges, measures, measuring amplifiers	-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	

Permanent laboratory Kirchzarten, Erich-Rieder-Straße 4 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 less than 1 ns	Trigger uncertainties must be taken into account
Optical speed	1 min^{-1} 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} to 10000 min^{-1}		$4 \cdot 10^{-4}$ not less than 0.01 min^{-1}	
Capacity measures	1 nF to 100 nF	50 Hz to 10 kHz	$1.0 \cdot 10^{-3}$ C	C: measured value with standard capacities
	> 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 up to 50 Hz	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	DC up to 20 Hz	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	DC up to 6 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF	DC up to 2 Hz	$6.0 \cdot 10^{-3}$ C	
	11 mF to < 33 mF	DC up to 0.6 Hz	$8.0 \cdot 10^{-3}$ C	
	33 mF to 110 mF	DC up to 0.2 Hz	$11 \cdot 10^{-3}$ C	

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

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Oscilloscope measured variables Vertical deflection	1 mV to 5V	Rectangular voltage 10 Hz to 10 kHz R_i = 50 Ω	0,35 %	R_i = Innenwiderstand
	1 mV to 120 V	R_i = 1 MΩ	0,35 %	
Horizontal deflection	50 ps to < 1 µ s	Time stamps or sine < 1 V	6 ps	
	1 µs to 5 s		$1.5 \cdot 10^{-3}\ t$	
rise time t_r	25 hp to 245 hp	500 mV	9 ps	t_r = Intrinsic rise time of the oscilloscope
	> 245 ps to 10 ms		$35 \cdot 10^{-3}\ t_r$	
	150 ps to 10 ms	250 mV	$35 \cdot 10^{-3}\ t_r$ + 5 ps	
	250 ps to 10 ms	> 250 mv to 2.5 V	$35 \cdot 10^{-3}\ t_r$ + 8 ps	
bandwith 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
HF attenuation	0 dB to 60 dB	300 kHz to 6 GHz	0.3 dB	Connector 50 Ω: N50
HF transmission phase angle ϕ	-180° to 180°	300 kHz to 6 GHz	U_T - 180°/π + K - f	U_T=arcsin($10^{U/20}$ - 1) K: 0.1°/GHz U: Uncertainty of the Attenuation in dB
HF impedance Reflection factor Amount $\|\Gamma\|$	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 < $\|\Gamma\|$ < 1 300 kHz to 6 GHz	$\arcsin \frac{U\|\Gamma'\|\ 180°}{\|\Gamma'\|\ rr}$	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
Frequencymodulation Frequenzhub Δf	0 to 5 MHz		0.041 Δf + 25 Hz	

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

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase modulation Phasenhub $\Delta\Phi$	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 THD_{Audio} + 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		$3 \cdot 10^{-3}$ $\Delta U / U$	
P_{st} (Short Term)	10 minutes	(115 V, 60 Hz); (230 V 50 Hz)	0,5 %	
P_{lt} (Long Term)	2 hours	(115 V, 60 Hz); (230 V 50 Hz)	1,7 %	

Permanent laboratory Kirchzarten, Erich-Rieder-Straße 4 - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration	Measuring range /	Measuring conditions /	Expanded measurement	Remarks
Length Cylindrical setting standards, ring gauges:	1 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006	0.8 µm + 2 · 10^{-6} · *d*	
diameter *)	> 200mm to 300 mm	Point 3.3.4 (Opt. 3)	1.5 µm + 2 · 10^{-6} · *d*	*d* is the measured Diameter
Plug gauges: diameter *)	1 mm to 200 mm	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 multi-course cylindrical External and internal threads with straight flanks, symmetrical profile)		VDI/VDE/DGQ 2618 Sheet 4.8:2006		
Threaded mandrels: simple pitch diameter *)	1.4 mm to 200 mm nominal pitch: 0.3 mm to 6 mm	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
		Point 3.2.2 (Opt. 1) to Point 3.2.6 (Opt. 5)	2 µm	
Core diameter / Puncture diameter *)			5 µm	
Slope / 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 Diameter
outside diameter *)		Point 3.2.2 (Opt. 1) to Point 3.2.6 (Opt. 5)	5 µm	
Core diameter / puncture diameter *)			2 µm	
Slope / 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Length of plane-parallel, spherical or cylindrical measuring surface diameter *)	0.01 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 19.1:2014	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	l is the measured length
	>500mm to 1000 mm		$2.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	
	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)	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot d$	d is the measured diameter
feeler *)	0.03 mm to 2.00 mm	DIN 2275:2014	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	l is the measured length
Adjustment dimensions for micrometer *)	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	
Snap gauge *)	3 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.7:2005 Point 3.3.2 (Opt. 2)	$0.8\ \mu m + 2 \cdot 10^{-6} \cdot d$	d is the measured Diameter
Caliper for external, internal and depth measurements: scale indication *)	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	$9\ \mu m + 11 \cdot 10^{-6} \cdot l$	Automated measuring system l is the measured length
numerical display *)			$10\ \mu m + 10 \cdot 10^{-6} \cdot l$	
Calipers for external, internal and depth measurements *)	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	$30\ \mu m + 30 \cdot 10^{-6} \cdot l$	l is the measured length
Depth caliper / height caliper*)	> 500mm to 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006	$50\ \mu m + 30 \cdot 10^{-6} \cdot l$	
		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
micrometer *)	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	$3\ \mu m + 10 \cdot 10^{-6} \cdot l$	
Precision pointer micrometers *)	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002		
micrometer head *)	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008		
depth micrometers *)	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010		
Inside micrometers with 2-point contact at the calibration object *)	13 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	$3\ \mu m + 10 \cdot 10^{-6} \cdot l$	
	> 300mm to 1000 mm		$5\ \mu m + 10 \cdot 10^{-6} \cdot l$	

Permanent laboratory Kirchzarten, Erich-Rieder-Straße 4 - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Inside micrometers with 3-line contact am 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
Inside micrometers with 2-line contact on the calibration object	5 mm to 100 mm	3-APD-0-0025-EN 2023-07	3 µm + 10 · 10^{-6} · d	d is the measured diameter
Lever gauges (quick probe) for external measurements *)	up to 200 mm	VDI/VDE/DGQ 2618 Sheet 12.1:2005	7 µm + 10 · 10^{-6} · l	l is the measured length
Lever gauges (rapid probe) for inner measures *)	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
precision indicator *)	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
lever gauges *)	0 mm to 1.6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
electr. inductive lenght measures *)	up to 100 mm	VDI/VDE/DGQ 2618 Sheet 14.1:2010	0.6 µm + 1 · 10^{-6} · l	
electr. incremental Length measures	up to 100 mm	3-APD-0-0027-EN 2023-08		
Parallel gauge blocks made of steel according to DIN EN ISO 3650 *)	0.5 mm to 150 mm	VDI/VDE/DGQ 2618 Sheet 3.1:2004 Measuresment of the deviation of the central dimension l_c from Nominal dimension l_n by difference measurement	For the center dimension: 0.08 µm + 0.7 · 10^{-6} · l	l is the length of the dimension
			Für f_0 und f_u: 0.07 µm	For the smallest measuring Uncertainties are the pushability and push features of both measuring surfaces of the Calibration item to be tested with a suitable flat glass plate
Parallel gauge blocks made of ceramic according to DIN EN ISO 3650 *)	0.5 mm to 150 mm	Measuresment of deviations f_0 and f_u from the center dimension by 5-point difference measurement	For the center dimension: 0.1 µm + 0.8 · 10^{-6} · l	
			Für f_0 und f_u: 0.07 µm	
Parallel gauge blocks made of 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	
			Für f_0 und f_u: 0.07 µm	

Permanent laboratory Kirchzarten, Erich-Rieder-Straße 4 - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Angle Perpendicularity deviation Flatness and straightness deviation*)	up to 30 µm	VDI/VDE/DGQ/DKD 2618 Sheet 7.1:2019 (Opt. 2)	2.5 µm + 1 · 10^{-6} · l_z 4 µm + 5 · 10^{-6} · l_z	l_z : Length of the mold u. Positioning bracing up to 500 mm side length
protractor scale graduation 1° *)	-180° to 180°	VDI/VDE/DGQ 2618 Sheet 7.2:2008	30'	
scale graduation value 5'*)	0° to 360°		1'	
Flat rulers deviation of parallelism*) flatness deviation *)	up 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 sraightness deviation*)	up to 500 mm	VDI/VDE/DGQ 2618 Sheet 5.2:2013	2.2 µm + 3.5 · 10^{-6} · l	l is the measured length
Tape measuress and scales Tape measuress	0 m to 100 m	VDI/VDE/DGQ 2618 Sheet 8.2:2023	50 µm + 20 · 10^{-6} · l	
Scales	0 m to 3 m			
Inclinometers	-2000 to 2000 µm/m µm/m (-412") (412")	3-APD-0-0244-EN 2023-01	1.7 µm/m (0,35")	Max. leg length of coordinate machine: 500 mm

Location Calibration laboratory Kirchzarten, Gewerbestraße 3, 79199 Kirchzarten

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / Procedure	Expanded measurement uncertainty	Remarks
Coordinate measuring technology Prismatic, conical and spherical workpieces	Coordinate measuring machine with a calibrated measuring volume of: X = 3000 mm Y = 1200 mm Z = 900 mm	3-APD-0-0292-EN: 2023-01 Tactile measurement in the form of single-point probing with a coordinate measuring machine and determination of control geometries determined by geometric parameters (single points, straight lines, planes, circles, spheres, cylinders, tori) with the evaluation software of the CMM. Single-point probing is performed with a fixed, predetermined measuring force or with extrapolation to zero measuring force. Single-point probing as "self-centering probing" is used in the context of the Accreditation not used. To ensure traceability, a comparable standard is calibrated. In addition, the following restrictions must be observed: Measuring points must can be evenly distributed over mold elements; Covering at least 50% of the surface of molded elements; Evaluation of medium form elements	The measurement uncertainty is determined using a measurement uncertainty balance based on the VDI/VDE 2617 Part 11:2011 guideline. It is task-specific and is specified for a coverage probability of 95% (extension factor k = 2). Example of measurement uncertainty for a measurement task: Parallel gauge block with two nominal dimensions, a laterally projecting probe with a length of 150 mm was used, the expanded measurement uncertainty of the test characteristic "distance" was determined: L = 50 mm, U = 1.8 µm L = 3000 mm, U = 26 µm	The determined measurement uncertainty can differ significantly from the uncertainty given as an example for simple measurement tasks.

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 to 100 mV		$1.4 \cdot 10^{-6}\ U$ + 0.15 µV	
	> 100 mV to 100 V		$0.5 \cdot 10^{-6}\ U$	
	> 100 V to 1000 V		$1.4 \cdot 10^{-6}\ U$	
High voltage	> 1 kV to 50 kV		$0.4 \cdot 10^{-3}\ U$	
Direct current intensity	0 A to 10 pA		$1.6 \cdot 10^{-3}\ I$ + 2 fA	I = measured value
	> 10 pA to 100 pA		$0.3 \cdot 10^{-3}\ I$	
	> 100 pA to 1 nA		$0.2 \cdot 10^{-3}\ I$	
	> 1 nA to 10 nA		$28 \cdot 10^{-6}\ I$	
	> 10 nA to 100 nA		$10 \cdot 10^{-6}\ I$	
	> 100 nA to 1 µA		$1.0 \cdot 10^{-6}\ I$	
	> 1 µA to 100 mA		$0.8 \cdot 10^{-6}\ I$	
	> 100 mA to 20 A		$1.5 \cdot 10^{-6}\ I$	
	> 20 A to 1000 A		$9 \cdot 10^{-6}\ I$	
Direct current current clamps	1 mA to 2.2 A		$1 \cdot 10^{-3}\ I$	
	> 2.2 A to 20 A		$2 \cdot 10^{-3}\ I$	
	> 20 A to 1000 A		$3 \cdot 10^{-3}\ I$	
Direct current intensity Current transformer	1 A to 120 A		$0.22 \cdot 10^{-3}\ I$	
	> 120 A to 1000 A		$0.25 \cdot 10^{-3}\ I$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance (discrete values)	100 µΩ, 1 mΩ, 10 mΩ		$1.2 \cdot 10^{-6}\ R$	R = measured value
	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 (discrete values)	1 TΩ		$0.12 \cdot 10^{-3}\ R$	R = measured value
	10 TΩ		$0.32 \cdot 10^{-3}\ R$	
	100 TΩ		$0.87 \cdot 10^{-3}\ R$	
DC resistance ranges	0 µΩ to < 1 mΩ		$4 \cdot 10^{-6}\ R$ + 1 nΩ	R = measured value
	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 up 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		$1.2 \cdot 10^{-3}\ R$	
Direct current 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current resistance	0.1 Ω	10 Hz; 20 Hz; 30 Hz;	$25 \cdot 10^{-6}\ R$	R = measured value
Resistors		40 Hz; 55 Hz;	$15 \cdot 10^{-6}\ R$	
(discrete values)		400 Hz; 500 Hz;	$11 \cdot 10^{-6}\ R$	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$15 \cdot 10^{-6}\ R$	
	1 Ω	10 Hz; 20 Hz; 30 Hz;	$25 \cdot 10^{-6}\ R$	
		40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz;	$11 \cdot 10^{-9}\ R$	
	10 Ω	10 Hz; 20 Hz; 30 Hz;	$25 \cdot 10^{-6}\ R$	
		40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz;	$10 \cdot 10^{-6}\ R$	
	100 Ω	10 Hz; 20 Hz; 30 Hz;	$12 \cdot 10^{-6}\ R$	
		40 Hz; 55 Hz;	$8 \cdot 10^{-6}\ R$	
		400 Hz; 500 Hz; 1 kHz; 2 kHz 5 kHz; 10 kHz;	$6 \cdot 10^{-6}\ R$	
	1 kΩ	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz;	$35 \cdot 10^{-6}\ R$	
Alternating current resistance	10 kΩ	10 Hz;	$85 \cdot 10^{-6}\ R$	
Resistors		20 Hz; 30 Hz; 40 Hz;	$45 \cdot 10^{-6}\ R$	
(discrete values)		55 Hz;	$110 \cdot 10^{-6}\ R$	
		400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz;	$65 \cdot 10^{-6}\ R$	
Alternating current resistance	0.1 Ω to 1 Ω	10 Hz to 20 Hz	$35 \cdot 10^{-6} \cdot R$	
(ranges)		>20 Hz to 40 Hz	$30 \cdot 10^{-6} \cdot R$	
		> 40 Hz to 10 kHz	$20 \cdot 10^{-6} \cdot R$	
	1 Ω to < 10 Ω	10 Hz to 20 Hz	$35 \cdot 10^{-6} \cdot R$	
		>20 Hz to 40 Hz	$30 \cdot 10^{-6} \cdot R$	
		> 40 Hz to 10 kHz	$15 \cdot 10^{-6} \cdot R$	
	10 Ω to < 100 Ω	10 Hz to 20 Hz	$35 \cdot 10^{-6} \cdot R$	
		>20 Hz to 40 Hz	$30 \cdot 10^{-6} \cdot R$	
		> 40 Hz to 10 kHz	$15 \cdot 10^{-6} \cdot R$	
	100 Ω to < 1 kΩ	10 Hz to 20 Hz	$40 \cdot 10^{-6} \cdot R$	
		>20 Hz to 40 Hz	$40 \cdot 10^{-6} \cdot R$	
		> 40 Hz to 10 kHz	$35 \cdot 10^{-6} \cdot R$	
	1 kΩ to 10 kΩ	10 Hz to 20 Hz	$90 \cdot 10^{-6} \cdot R$	
		>20 Hz to 40 Hz	$45 \cdot 10^{-6} \cdot R$	
		>40 Hz to <400 Hz	$110 \cdot 10^{-6} \cdot R$	
		400 Hz to 10 kHz	$65 \cdot 10^{-6} \cdot R$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Load Charge amplifiers and charge meters	1 pC to 10 000 pC	0.2 Hz to < 1 Hz	0,5 %	Calibration result: Amount of the transfer coefficient
		1 Hz to 10 kHz	0,4 %	
		> 10 kHz to 20 kHz	0,6 %	
		> 20 kHz to 50 kHz	1,0 %	
AC/DC transfer AC voltage sources	1 mV	10 Hz; 20 Hz; 30 Hz	$0.23 \cdot 10^{-3}\ U$	U = measured value
		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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer AC voltage sources	10 mV	10 Hz; 20 Hz; 30 Hz	$44 \cdot 10^{-6}\ U$	U = measured value
		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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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	$30 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibrier and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer AC voltage sources	200 mV	10 Hz; 20 Hz	$18 \cdot 10^{-6}\ U$	U = measured value
		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;	$8 \cdot 10^{-6}\ U$	
		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	$17 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer AC voltage sources	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;	$15 \cdot 10^{-6}\ U$	
		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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer AC voltage sources	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;	$4 \cdot 10^{-6}\ U$	
		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; 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	$15 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer AC voltage sources	10 V	10 Hz	$10 \cdot 10^{-6}\ U$	U = measured value
		20 Hz	$8 \cdot 10^{-6}\ U$	
		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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer AC voltage sources	200 V	10 Hz; 20 Hz	$10 \cdot 10^{-6}\ U$	U = measured value
		30 Hz; 40 Hz; 55 Hz;	$7 \cdot 10^{-6}\ U$	
		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; 700 V; 800 V; 1000 V	10 Hz; 20 Hz; 30 Hz	$9 \cdot 10^{-6}\ U$	
		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 alternating voltage measures	1 mV	10 Hz; 20 Hz; 30 Hz	$0.30 \cdot 10^{-3}\ U$	
		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$0.22 \cdot 10^{-3}\ U$	
		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 measured variables

Calibrier and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer alternating voltage measures	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 measured variables

Calibrier and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer alternating voltage measures	60 mV	10 Hz; 20 Hz; 30 Hz	$30 \cdot 10^{-6}\ U$	U = measured value
		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	$28 \cdot 10^{-6}\ U$	
		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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer alternating voltage measures	300 mV	10 Hz; 20 Hz	$14 \cdot 10^{-6}\ U$	U = measured value
		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 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	$17 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer alternating voltage measures	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	$15 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibrier and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer alternating voltage measures	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	$15 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer alternating voltage measures	10 V	10 Hz	$10 \cdot 10^{-6}\ U$	U = measured value
		20 Hz	$8 \cdot 10^{-6}\ U$	
		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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC/DC transfer alternating voltage measures	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; 700 V; 800 V; 1000 V	10 Hz; 20 Hz; 30 Hz	$9 \cdot 10^{-6}\ U$	
		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 measures 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	$0.24 \cdot 10^{-3}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage	6 mV	10 Hz; 20 Hz; 30 Hz	$70 \cdot 10^{-6}\ U$	U = measured value
measures and		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$60 \cdot 10^{-6}\ U$	
sources		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	$95 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage	60 mV	10 Hz; 20 Hz; 30 Hz	$31 \cdot 10^{-6}\ U$	U = measured value
measures and		40 Hz; 55 Hz; 60 Hz; 120 Hz;	$25 \cdot 10^{-6}\ U$	
sources		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	$20 \cdot 10^{-6}\ U$	
		40 Hz, 55 Hz; 60 Hz; 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	$35 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibrier and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures and sources	300 mV	10 Hz; 20 Hz; 30 Hz	$17 \cdot 10^{-6}\ U$	U = measured value
		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	$60 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures and sources	2 V	10 Hz; 20 Hz	$12 \cdot 10^{-6}\ U$	U = measured value
		30 Hz	$10 \cdot 10^{-6}\ U$	
		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	$95 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures and sources	10 V; 20 V	10 Hz; 20 Hz	$13 \cdot 10^{-6}\ U$	U = measured value
		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;	$25 \cdot 10^{-6}\ U$	
		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	$66 \cdot 10^{-6}\ U$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage	1 mV to 2.2 mV	10 Hz to 20 Hz	$0.52 \cdot 10^{-3}\ U$	U = measured value
measures 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	$0.45 \cdot 10^{-3}\ U$	
	> 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 Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures	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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures	> 22 V to 220 V	10 Hz to 40 Hz	$0.47 \cdot 10^{-3}\ U$	U = measured value with Fluke 5720A (ranges)
		> 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	$85 \cdot 10^{-6}\ U$	
Alternating 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current - direct current - transfer	100 µA	10 Hz	$82 \cdot 10^{-6}$	*I* = measured value
		20 Hz	$39 \cdot 10^{-6}$ *I*	
		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 · 10-6 *I*	
		400 Hz	35 · 10-6 *I*	
		500 Hz; 1 kHz	31 · 10-6 *I*	
		2 kHz; 5 kHz; 10 kHz	32 · 10-6 *I*	
	1 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	31 · 10-6 *I*	
		55 Hz; 400 Hz; 500 Hz;	31 · 10-6 *I*	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	31 · 10-6 *I*	
	3 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	7 · 10-6 *I*	
		55 Hz; 400 Hz; 500 Hz;	7 · 10-6 *I*	
		1 kHz; 2 kHz; 5 kHz	7 · 10-6 *I*	
		10 kHz	8 · 10-6 *I*	
	5 mA	10 Hz; 20 Hz	7 · 10-6 *I*	
		30 Hz	6 · 10-6 *I*	
		40 Hz; 55 Hz	5 · 10-6 *I*	
		400 Hz; 500 Hz; 1 kHz; 2 kHz	4 · 10-6 *I*	
		5 kHz	6 · 10-6 *I*	
		10 kHz	8 · 10-6 *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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current - direct current - transfer	20 mA; 30 mA; 50 mA	10 Hz	$8 \cdot 10^{-6}$ /	/ = measured value
		20 Hz; 30 Hz; 40 Hz; 55 Hz	$5 \cdot 10^{-6}$ /	
		400 Hz; 500 Hz; 1 kHz; 2 kHz	$4 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz	$5 \cdot 10^{-6}$ /	
	100 mA	10 Hz	$8 \cdot 10^{-6}$ /	
		20 Hz; 30 Hz; 40 Hz; 55 Hz	$5 \cdot 10^{-6}$ /	
		400 Hz	$8 \cdot 10^{-6}$ /	
		500 Hz; 1 kHz	$5 \cdot 10^{-6}$ /	
		2 kHz	$8 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz	$5 \cdot 10^{-6}$ /	
	200 mA	10 Hz	$7 \cdot 10^{-6}$ /	
		20 Hz; 30 Hz; 40 Hz	$6 \cdot 10^{-6}$ /	
		55 Hz; 400 Hz; 500 Hz	$5 \cdot 10^{-6}$ /	
		1 kHz	$8 \cdot 10^{-6}$ /	
		2 kHz; 5 kHz; 10 kHz	$5 \cdot 10^{-6}$ /	
	300 mA; 500 mA	10 Hz; 20 Hz; 30 Hz	$6 \cdot 10^{-6}$ /	
		40 Hz; 55 Hz	$5 \cdot 10^{-6}$ /	
		400 Hz; 500 Hz; 1 kHz; 2 kHz	$4 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz	$5 \cdot 10^{-6}$ /	
	1 A	10 Hz	$7 \cdot 10^{-6}$ /	
		20 Hz; 30 Hz	$6 \cdot 10^{-6}$ /	
		40 Hz; 55 Hz	$7 \cdot 10^{-6}$ /	
		400 Hz; 500 Hz;	$5 \cdot 10^{-6}$ /	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$9 \cdot 10^{-6}$ /	
	2 A	10 Hz	$7 \cdot 10^{-6}$ /	
		20 Hz; 30 Hz	$8 \cdot 10^{-6}$ /	
		40 Hz; 55 Hz; 400 Hz;	$7 \cdot 10^{-6}$ /	
		500 Hz; 1 kHz; 2 kHz;	$7 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz	$7 \cdot 10^{-6}$ /	
	3 A; 5 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$14 \cdot 10^{-6}$ /	
		55 Hz; 400 Hz; 500 Hz;	$14 \cdot 10^{-6}$ /	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$14 \cdot 10^{-6}$ /	
	10 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$21 \cdot 10^{-6}$ /	
		55 Hz; 400 Hz; 500 Hz;	$21 \cdot 10^{-6}$ /	
		1 kHz; 2 kHz; 5 kHz; 10 kHz	$21 \cdot 10^{-6}$ /	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current - direct current - transfer	20 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$26 \cdot 10^{-6}$ /	/ = measured value
		55 Hz; 400 Hz; 500 Hz;	$26 \cdot 10^{-6}$ /	
		1 kHz; 2 kHz; 5 kHz;	$26 \cdot 10^{-6}$ /	
		10 kHz	$30 \cdot 10^{-6}$ /	
	50 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$32 \cdot 10^{-6}$ /	
		55 Hz; 400 Hz; 500 Hz;	$32 \cdot 10^{-6}$ /	
		1 kHz; 2 kHz;	$32 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz	$40 \cdot 10^{-6}$ /	
	100 A	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$47 \cdot 10^{-6}$ /	
		55 Hz; 400 Hz; 500 Hz;	$47 \cdot 10^{-6}$ /	
		1 kHz; 2 kHz; 5 kHz;	$47 \cdot 10^{-6}$ /	
		10 kHz	$92 \cdot 10^{-6}$ /	
AC power sources	100 µA	10 Hz	$83 \cdot 10^{-6}$ /	
		20 Hz	$40 \cdot 10^{-6}$ /	
		30 Hz; 40 Hz	$34 \cdot 10^{-6}$ /	
		55 Hz	$0.11 \cdot 10^{-3}$ /	
		400 Hz	$64 \cdot 10^{-6}$ /	
		500 Hz; 1 kHz; 2 kHz	$42 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz; 20 kHz; 30 kHz	$33 \cdot 10^{-6}$ /	
		50 kHz	$47 \cdot 10^{-6}$ /	
		70 kHz; 100 kHz	$77 \cdot 10^{-6}$ /	
	300 µA	10 Hz	$38 \cdot 10^{-6}$ /	
		20 Hz	$34 \cdot 10^{-6}$ /	
		30 Hz; 40 Hz	$32 \cdot 10^{-6}$ /	
		55 Hz	$42 \cdot 10^{-6}$ /	
		400 Hz	$36 \cdot 10^{-6}$ /	
		500 Hz; 1 kHz; 2 kHz;	$33 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz; 20 kHz;	$33 \cdot 10^{-6}$ /	
		30 kHz; 50 kHz	$33 \cdot 10^{-6}$ /	
		70 kHz	$52 \cdot 10^{-6}$ /	
		100 kHz	$0.11 \cdot 10^{-3}$ /	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC power sources	1 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$32 \cdot 10^{-6}$ /	/ = measured value
		55 Hz; 400 Hz; 500 Hz;	$32 \cdot 10^{-6}$ /	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$32 \cdot 10^{-6}$ /	
		20 kHz; 30 kHz; 50 kHz; 70 kHz	$32 \cdot 10^{-6}$ /	
		100 kHz	$34 \cdot 10^{-6}$ /	
	3 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$9 \cdot 10^{-6}$ /	
		55 Hz; 400 Hz; 500 Hz; 1 kHz;	$9 \cdot 10^{-6}$ /	
		2 kHz; 5 kHz	$9 \cdot 10^{-6}$ /	
		10 kHz	$10 \cdot 10^{-6}$ /	
		20 kHz; 30 kHz; 50 kHz; 70 kHz	$12 \cdot 10^{-6}$ /	
		100 kHz	$15 \cdot 10^{-6}$ /	
	5 mA	10 Hz; 20 Hz; 30 Hz	$9 \cdot 10^{-6}$ /	
		40 Hz; 55 Hz; 400 Hz;	$8 \cdot 10^{-6}$ /	
		500 Hz; 1 kHz; 2 kHz; 5 kHz	$8 \cdot 10^{-6}$ /	
		10 kHz	$10 \cdot 10^{-6}$ /	
		20 kHz; 30 kHz; 50 kHz; 70 kHz	$12 \cdot 10^{-6}$ /	
		100 kHz	$15 \cdot 10^{-6}$ /	
	10 mA	10 Hz	$9 \cdot 10^{-6}$ /	
		20 Hz; 30 Hz; 40 Hz; 55 Hz	$8 \cdot 10^{-6}$ /	
		400 Hz; 500 Hz; 1 kHz; 2 kHz	$7 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz; 20 kHz; 30 kHz	$8 \cdot 10^{-6}$ /	
		50 kHz; 70 kHz	$10 \cdot 10^{-6}$ /	
		100 kHz	$12 \cdot 10^{-6}$ /	
	20 mA; 30 mA;	10 Hz	$10 \cdot 10^{-6}$ /	
	50 mA; 100 mA	20 Hz; 30 Hz; 40 Hz; 55 Hz;	$8 \cdot 10^{-6}$ /	
		400 Hz; 500 Hz	$8 \cdot 10^{-6}$ /	
		1 kHz; 2 kHz; 5 kHz; 10 kHz;	$8 \cdot 10^{-6}$ /	
		20 kHz; 30 kHz	$8 \cdot 10^{-6}$ /	
		50 kHz; 70 kHz	$10 \cdot 10^{-6}$ /	
		100 kHz	$13 \cdot 10^{-6}$ /	
	200 mA	10 Hz	$9 \cdot 10^{-6}$ /	
		20 Hz; 30 Hz; 40 Hz; 55 Hz;	$8 \cdot 10^{-6}$ /	
		400 Hz; 500 Hz	$8 \cdot 10^{-6}$ /	
		1 kHz	$10 \cdot 10^{-6}$ /	
		2 kHz; 5 kHz; 10 kHz; 20 kHz	$9 \cdot 10^{-6}$ /	
		30 kHz; 50 kHz;	$13 \cdot 10^{-6}$ /	
		70 kHz; 100 kHz	$13 \cdot 10^{-6}$ /	

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Calibration and measurement opportunities

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

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

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

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current meters	100 µA	10 Hz	$83 \cdot 10^{-6}$ /	/ = measured value
		20 Hz	$40 \cdot 10^{-6}$ /	
		30 Hz; 40 Hz	$34 \cdot 10^{-6}$ /	
		55 Hz	$0.11 \cdot 10^{-3}$ /	
		400 Hz	$64 \cdot 10^{-6}$ /	
		500 Hz; 1 kHz; 2 kHz;	$42 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz	$42 \cdot 10^{-6}$ /	
	300 µA	10 Hz	$38 \cdot 10^{-6}$ /	
		20 Hz	$34 \cdot 10^{-6}$ /	
		30 Hz; 40 Hz	$32 \cdot 10^{-6}$ /	
		55 Hz	$42 \cdot 10^{-6}$ /	
		400 Hz	$36 \cdot 10^{-6}$ /	
		500 Hz; 1 kHz	$32 \cdot 10^{-6}$ /	
		2 kHz; 5 kHz; 10 kHz	$33 \cdot 10^{-6}$ /	
	1 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$32 \cdot 10^{-6}$ /	
		55 Hz; 400 Hz; 500 Hz; 1 kHz;	$32 \cdot 10^{-6}$ /	
		2 kHz; 5 kHz; 10 kHz	$32 \cdot 10^{-6}$ /	
	3 mA; 5 mA	10 Hz; 20 Hz; 30 Hz; 40 Hz;	$10 \cdot 10^{-6}$ /	
		55 Hz; 400 Hz; 500 Hz;	$10 \cdot 10^{-6}$ /	
		1 kHz; 2 kHz; 5 kHz	$10 \cdot 10^{-6}$ /	
		10 kHz	$11 \cdot 10^{-6}$ /	
	10 mA	10 Hz	$9 \cdot 10^{-6}$ /	
		20 Hz; 30 Hz; 40 Hz; 55 Hz;	$8 \cdot 10^{-6}$ /	
		400 Hz; 500 Hz; 1 kHz; 2 kHz;	$8 \cdot 10^{-6}$ /	
		5 kHz; 10 kHz	$8 \cdot 10^{-6}$ /	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current meters	20 mA; 30 mA; 50 mA; 100 mA	10 Hz 20 Hz; 30 Hz; 400 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz 5 kHz; 10 kHz	$10 \cdot 10^{-6}$ / $8 \cdot 10^{-6}$ / $8 \cdot 10^{-6}$ / $9 \cdot 10^{-6}$ /	/ = measured value
	200 mA; 300 mA; 500 mA	10 Hz 20 Hz; 30 Hz; 40 Hz, 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz	$10 \cdot 10^{-6}$ / $9 \cdot 10^{-6}$ / $9 \cdot 10^{-6}$ / $9 \cdot 10^{-6}$ /	
	1 A; 2 A	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz, 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5kHz; 10 kHz	$11 \cdot 10^{-6}$ / $11 \cdot 10^{-6}$ / $11 \cdot 10^{-6}$ /	
	3 A; 5 A	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5kHz; 10 kHz	$18 \cdot 10^{-6}$ / $18 \cdot 10^{-6}$ / $18 \cdot 10^{-6}$ /	
	10 A	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5kHz; 10 kHz	$22 \cdot 10^{-6}$ / $22 \cdot 10^{-6}$ / $22 \cdot 10^{-6}$ /	
	20 A	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5kHz; 10 kHz	$27 \cdot 10^{-6}$ / $27 \cdot 10^{-6}$ / $27 \cdot 10^{-6}$ / $31 \cdot 10^{-6}$ /	
	50 A	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz	$33 \cdot 10^{-6}$ / $33 \cdot 10^{-6}$ / $33 \cdot 10^{-6}$ / $40 \cdot 10^{-6}$ /	
	100 A	10 Hz; 20 Hz; 30 Hz; 40 Hz; 55 Hz; 400 Hz; 500 Hz; 1 kHz; 2 kHz; 5 kHz; 10 kHz	$48 \cdot 10^{-6}$ / $48 \cdot 10^{-6}$ / $48 \cdot 10^{-6}$ / $93 \cdot 10^{-6}$ /	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current sources and measures (ranges)	100 µA to 1 mA	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	120 · 10^{-6} / 160 · 10^{-6} / 60 · 10^{-6} /	/ = 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} /	
	> 10 mA to 1 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	17 · 10^{-6} /	
	> 1 A to 10 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	32 · 10^{-6} /	
	> 10 A to 20 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	39 · 10^{-6} /	
	> 20 A to 100 A	10 Hz to 40 Hz > 40 Hz to 1 kHz; > 1 kHz to 10 kHz;	69 · 10^{-6} / 69 · 10^{-6} / 0.17 · 10^{-3} /	
Alternating current intensity (ranges) Measures	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} / 0.21 · 10^{-3} / 0.40 · 10^{-3} / 1.7 · 10^{-3} /	/ = measured value 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} / 0.30 · 10^{-3} / 0.72 · 10^{-3} / 4.2 · 10^{-3} /	
	> 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} / 0.30 · 10^{-3} / 0.46 · 10^{-3} / 3.5 · 10^{-3} /	
	> 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} / 0.25 · 10^{-3} / 0.37 · 10^{-3} / 1.6 · 10^{-3} /	
	> 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} / 0.84 · 10^{-3} / 7.6 · 10^{-3} /	
	> 2,2 A to 20 A	40 Hz to 5 kHz	0.81 · 10^{-3} / + 1.2 mA	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current intensity	0.1 mA to 1 A	40 Hz to 5 kHz	$2 \cdot 10^{-3}$ /	/ = measured value
sources				with HP3458A
Alternating current	1 mA to 2,2 A	40 Hz to 5 kHz	$2 \cdot 10^{-3}$ /	/ = measured value
current clamps	> 2,2 A to 20 A	40 Hz to 5 kHz	$3 \cdot 10^{-3}$ /	
	> 20 A to 800 A	40 Hz to 65 Hz	$4 \cdot 10^{-3}$ /	
Alternating current intensity	1 A to 120 A	40 Hz to 850 Hz	$0.16 \cdot 10^{-3}$ /	
Current transformer	1 A to 120 A	>850 Hz to 2 kHz	$0.47 \cdot 10^{-3}$ /	
	> 120 A to 600 A	40 Hz to 400 Hz	$0.52 \cdot 10^{-3}$ /	
	> 120 A to 1000 A	40 Hz to 65 Hz	$0.6 \cdot 10^{-3}$ /	
Resistance ratio	0,16 to 6,3	Equal and	$0,2 \cdot 10^{-6}$	Measuresment uncertainty
AC/DC measuring bridges		Alternating current up to 400 Hz		denotes absolute value
Phase angle	0°; 30°; 60°; 75°; 90°; 150°;	U_{REF} / U_{SIG}		U_{SIG}: Signal voltage
between tensions	180°; 270°; 300°	50 mV / 50 mV		U_{REF}: Reference voltage
Measures and sources		Measuring frequency:		
		10 Hz; 40 Hz; 55 Hz; 400 Hz; 1 kHz	0,005°	For discrete measured values
		5 kHz; 10 kHz; 50 kHz	0,008°	and frequencies
		100 kHz	0,020°	
	0°; 30°; 60°; 75°; 90°; 150°;	U_{REF} / U_{SIG}		
	180°; 270°; 300°	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	0,005°	
		1 kHz; 5 kHz	0,005°	
		10 kHz	0,007°	
		50 kHz	0,008°	
		100 kHz	0,009°	
	0°; 30°; 60°; 75°; 90°; 150°;	U_{REF} / U_{SIG}		
	180°; 270°; 300°	100 V / 100 V		
		Measuring frequency:		
		10 Hz; 40 Hz; 55 Hz; 400 Hz	0,005°	
		1 kHz; 5 kHz	0,005°	
		10 kHz	0,007°	
		50 kHz	0,008°	
		100 kHz	0,030°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between tensions measures 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°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between electricity and tension sources	-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 > 1 kHz to 10 kHz > 10 kHz to 100 kHz	 0,009° 0,045° 0,50°	U_{SIG}: Signal voltage U_{REF}: Reference voltage Measuring ranges
		U_{REF} / U_{SIG} > 2 A to 20 A /1 V to 100 V Measuring frequency: 10 Hz to 1 kHz > 1 kHz to 10 kHz > 10 kHz to 100 kHz	 0,02° 0,1° 1,0°	
		U_{REF} / U_{SIG} > 20 A to 100 A /1 V to 100 V Measuring frequency: 10 Hz to 1 kHz > 1 kHz to 10 kHz > 10 kHz to 100 kHz	 0,025° 0,20° 2,0°	
Phase angle between electricity and Tension Measures	-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 > 1 kHz to 10 kHz	 0,009° 0,045°	
		U_{REF} / U_{SIG} > 2 A to 20 A /1 V to 100 V Measuring frequency: 10 Hz to 1 kHz > 1 kHz to 10 kHz	 0,02° 0,1°	
		U_{REF} / U_{SIG} > 20A to 100A /1V to 100 V Measuring frequency: 10 Hz to 1 kHz > 1 kHz to 10 kHz	 0,025° 0,20°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between electricity and Tension sources	0°; 30°; 60°; 75°; 90°; 150°; 180°; 270°; 300°	U_{REF} / U_{SIG} 1 mA/0.0 5V 1 mA/0.5 V Measuring frequency: 10 Hz; 40 Hz; 55 Hz; 400 Hz; 1kHz	0,007°	U_{SIG}: Signal voltage U_{REF}: Reference voltage For discrete measured values and frequencies
		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°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between electricity and tension 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°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between electricity and Tension 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°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between electricity and Tension 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 electricity and Tension Measures	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°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between electricity and Tension Measures	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°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between electricity and Tension Measures	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°	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase angle between electricity and Tension Measures	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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Inductance Measures, sources, Decadic normal	100 µH	1 kHz; 10 kHz	$0{,}3 \cdot 10^{-3}$	
	1 mH	1 kHz	$65 \cdot 10^{-6}$	
		10 kHz	$0{,}15 \cdot 10^{-3}$	
	10 mH	1 kHz	$55 \cdot 10^{-6}$	
		10 kHz	$0{,}16 \cdot 10^{-3}$	
	100 mH	1 kHz	$65 \cdot 10^{-6}$	
		10 kHz	$0{,}21 \cdot 10^{-3}$	
	1 H	100 Hz	$0{,}1 \cdot 10^{-3}$	
		1 kHz	$70 \cdot 10^{-6}$	
	10 H	100 Hz	$0{,}2 \cdot 10^{-3}$	
		1 kHz	$0{,}2 \cdot 10^{-3}$	
Inductance Measures, 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 measures, Decadic normal	1 pF	50 Hz	$6 \cdot 10^{-3}$	
		100 Hz	$2{,}5 \cdot 10^{-3}$	
		1 kHz	$0{,}3 \cdot 10^{-3}$	
		10 kHz	$0{,}2 \cdot 10^{-3}$	
		400 kHz	$6{,}1 \cdot 10^{-3}$	
		100 kHz; 1 MHz	$3{,}5 \cdot 10^{-3}$	
	10 pF	50 Hz	$0{,}6 \cdot 10^{-3}$	
		100 Hz	$0{,}4 \cdot 10^{-3}$	
		1 kHz	$35 \cdot 10^{-6}$	
		10 kHz	$40 \cdot 10^{-6}$	
		100 kHz; 400 kHz	$75 \cdot 10^{-6}$	
		1 MHz	$110 \cdot 10^{-6}$	
	100 pF	50 Hz	$80 \cdot 10^{-6}$	
		100 Hz	$40 \cdot 10^{-6}$	
		1 kHz; 10 kHz	$25 \cdot 10^{-6}$	
		100 kHz	$35 \cdot 10^{-6}$	
		400 kHz	$65 \cdot 10^{-6}$	
		1 MHz	$0{,}35 \cdot 10^{-3}$	
	1 nF	50 Hz	$35 \cdot 10^{-6}$	
		100 Hz	$25 \cdot 10^{-6}$	
		1 kHz	$15 \cdot 10^{-6}$	
		10 kHz	$22 \cdot 10^{-6}$	
		100 kHz	$75 \cdot 10^{-6}$	
		400 kHz	$0{,}45 \cdot 10^{-3}$	
		1 MHz	$3 \cdot 10^{-3}$	
	10 nF	50 Hz; 100 Hz; 1 kHz	$35 \cdot 10^{-6}$	
		10 kHz	$55 \cdot 10^{-6}$	
	100 nF	50 Hz; 100 Hz; 1 kHz	$55 \cdot 10^{-6}$	
		10 kHz	$75 \cdot 10^{-6}$	
	1 µF	50 Hz	$55 \cdot 10^{-6}$	
		100 Hz	$70 \cdot 10^{-6}$	
		1 kHz	$55 \cdot 10^{-6}$	
		10 kHz	$110 \cdot 10^{-6}$	
	10 µF	50 Hz; 100 Hz; 1 kHz	$0.2 - 10^{-3}$	
		10 kHz	$0.4 - 10^{-3}$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Capacity	10 pF to 100 pF	50 Hz to 1 kHz	$4.9 \cdot 10^{-3}\ C$	C = measured value
sources, measures,		> 1 kHz to 10 kHz	$0.4 \cdot 10^{-3}\ C$	
standards		> 10 kHz to 100 kHz	$3.0 \cdot 10^{-3}\ C$	
		> 100 kHz to 400 kHz	$1.6 \cdot 10^{-3}\ C$	
		> 400 kHz to 1 MHz	$2.2 \cdot 10^{-3}\ C$	
	> 100 pF to 1 nF	50 Hz to 1 kHz	$0.2 \cdot 10^{-3}\ C$	
		> 1 kHz to 10 kHz	$2.3 \cdot 10^{-3}\ C$	
		> 10 kHz to 100 kHz	$3.5 \cdot 10^{-3}\ C$	
		> 100 kHz to 400 kHz	$1.5 \cdot 10^{-3}\ C$	
		> 400 kHz to 1 MHz	$3.6 \cdot 10^{-3}\ C$	
	> 1 nF to 10 nF	50 Hz to 1 kHz	$2.8 \cdot 10^{-3}\ C$	
		> 1 kHz to 10 kHz	$2.4 \cdot 10^{-3}\ C$	
	> 10 nF to 100 nF	50 Hz to 1 kHz	$4.3 \cdot 10^{-3}\ C$	
		> 1 kHz to 10 kHz	$2.0 \cdot 10^{-3}\ C$	
	> 100 nF to 1 µF	50 Hz to 100 Hz	$0.11 \cdot 10^{-3}\ C$	
		> 100 Hz to 1 kHz	$1.0 \cdot 10^{-3}\ C$	
		> 1 kHz to 10 kHz	$0.5 \cdot 10^{-3}\ C$	
	> 1 µF to 10 µF	50 Hz to 100 Hz	$0.58 \cdot 10^{-3}\ C$	
		> 100 Hz to 1 kHz	$0.38 \cdot 10^{-3}\ C$	
		> 1 kHz to 10 kHz	$0.43 \cdot 10^{-3}\ C$	
Capacity	190 pF to < 400 pF	10 Hz to 10 kHz	$4 \cdot 10^{-3}\ C + 8$ pF	With 5520A / 5522A
measures	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	$6.0 \cdot 10^{-3}\ C$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Capacity measures	33 µF to < 110 µF	10 Hz to 80 Hz	$6.5 \cdot 10^{-3}\ C$	C = measured value
	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 up to 0.2 Hz	$11 \cdot 10^{-3}\ C$	
DC capacity sources, measures	1 µF to 70 µF	DC method	$2{,}6 \cdot 10^{-3}$	
	> 70 µF to 200 µF		$0{,}55 \cdot 10^{-3}$	
	> 200 µF to 110 mF		$0{,}30 \cdot 10^{-3}$	
Tension ratio	± 2 mV/V	Bridge voltage: 5 V		Calibration of 350 Ω bridge standards and the associated display devices at discrete points in 10% steps
		Measuring frequency 225 Hz	0.04 µV/V	
		Measuring frequency 600 Hz	0.05 µV/V	
		Measuring frequency 4.8 kHz	1.0 µV/V	
	± 2 mV/V	Bridge voltage: 2,5 V		
		Measuring frequency 225 Hz	0.05 µV/V	
		Measuring frequency 600 Hz	0.05 µV/V	
		Measuring frequency 4.8 kHz	1.0 µV/V	
	± 5 mV/V	Bridge voltage: 5 V		
		Measuring frequency 225 Hz	0.15 µV/V	
		Measuring frequency 4.8 kHz	1.0 µV/V	
	± 10 mV/V	Bridge voltage: 5 V		
		Measuring frequency 225 Hz	0.10 µV/V	
		Measuring frequency 4.8 kHz	0.30 µV/V	
	± 5 mV/V	Bridge voltage: 2,5 V		
		Measuring frequency 225 Hz	0.1 µV/V	
		Measuring frequency 600 Hz	0.1 µV/V	
		Measuring frequency 4.8 kHz	1.0 µV/V	
	± 10 mV/V	Bridge voltage: 2,5 V		
		Measuring frequency 225 Hz	0.4 µV/V	
		Measuring frequency 600 Hz	0.4 µV/V	
		Measuring frequency 4.8 kHz	0.4 µV/V	
	± 10 mV/V	Bridge voltage: 1 V		
		Measuring frequency 600 Hz	0.40 µV/V	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Tension 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 display devices 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		DC voltage Bridge voltage:		
	0 mV/V		0.4 µV/V	
	-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		0.35 µV/V	
	-20 mV/V to +20 mV/V		0.35 µV/V	
	-100 mV/V to +100 mV/V		0.35 µV/V	
		DC voltage Bridge voltage:		
	0 mV/V		0.2 µV/V	
	-2 mV/V to +2 mV/V		0.15 µV/V	
	-5 mV/V to +5 mV/V	1,0 V	0.15 µV/V	
	-10 mV/V to +10 mV/V		0.15 µV/V	
	-20 mV/V to +20 mV/V		0.15 µV/V	
	-100 mV/V to +100 mV/V		0.25 µV/V	
		DC voltage Bridge voltage:		
	0 mV/V		0.1 µV/V	
	-2 mV/V to +2 mV/V		0.07 µV/V	
	-5 mV/V to +5 mV/V	2,5 V	0.07 µV/V	
	-10 mV/V to +10 mV/V		0.07 µV/V	
	-20 mV/V to +20 mV/V		0.07 µV/V	
	-100 mV/V to +100 mV/V		0.20 µV/V	
		DC voltage Bridge voltage:		
	0 mV/V		0.04 µV/V	
	-2 mV/V to +2 mV/V		0.035 µV/V	
	-5 mV/V to +5 mV/V	5,0 V	0.035 µV/V	
	-10 mV/V to +10 mV/V		0.035 µV/V	
	-20 mV/V to +20 mV/V		0.045 µV/V	
	-100 mV/V to +100 mV/V		0.15 µV/V	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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, measures, 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	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power sources and measures (discrete points)		1 mA / 0.05 V // 10 Hz to 10 kHz		*P* = AC active power
		Phase angle: 0 °		
	50.0 µW	Phase angle: ±30 °	0.2 - 10^{-3} *P*	Discrete points for current, voltage and phase angle
	43.3 µW	Phase angle: ±60 °	0.3 - 10^{-3} *P*	
	25.0 µW	Phase angle: ±75 °	0.8 - 10^{-3} *P*	
	12.9 µW		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*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power sources and measures (discrete points)		200 mA / 1 V / 10 Hz to 10 kHz		P = AC active power
	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	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power sources and measures (discrete points)		50 A / 1 V / 10 Hz to 10 kHz		*P* = AC active power
	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*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power sources and measures (discrete points)		200 mA / 10 V / 10 Hz to 10 kHz		P = AC active power
	2,0 W	Phase angle: 0 °	50 - 10^{-6} P	Discrete points for current, voltage and phase angle
	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	
		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	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power sources and measures (discrete points)		100 A / 10 V / 10 Hz to 10 kHz		P = AC active power
	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 measured variables

Calibrar and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power sources and measures (discrete points)		1 A / 100 V // 10 Hz to 10 kHz		*P* = AC active power
	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		
		Phase angle: 0 °		
	1000 W	Phase angle: ±30 °	50 - 10^{-6} *P*	
	866 W	Phase angle: ±60 °	1.0 - 10^{-3} *P*	
	500 W	Phase angle: ±75 °	3.0 - 10^{-3} *P*	
	258,8 W		7.0 - 10^{-3} *P*	
		20 A / 100 V // 10 Hz to 10 kHz		
		Phase angle: 0 °		
	2000 W	Phase angle: ±30 °	50 - 10^{-6} *P*	
	1732 W	Phase angle: ±60 °	1.0 - 10^{-3} *P*	
	1000 W	Phase angle: ±75 °	3.0 - 10^{-3} *P*	
	517,6 W		7.0 - 10^{-3} *P*	
		50 A / 100 V // 10 Hz to 10 kHz		
		Phase angle: 0 °		
	5000 W	Phase angle: ±30 °	0.2 - 10^{-3} *P*	
	4330 W	Phase angle: ±60 °	2.0 - 10^{-3} *P*	
	2500 W	Phase angle: ±75 °	5.0 - 10^{-3} *P*	
	1294 W		1.0 - 10^{-2} *P*	
		100 A / 100 V // 10 Hz to 10 kHz		
		Phase angle: 0 °		
	10000 W	Phase angle: ±30 °	0.2 - 10^{-3} *P*	
	8660 W	Phase angle: ±60 °	2.0 - 10^{-3} *P*	
	5000 W	Phase angle: ±75 °	5.0 - 10^{-3} *P*	
	2588 W		10 - 10^{-3} *P*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power sources and measures (discrete points)	25 kW 21.7 kW 12.5 kW 6.5 kW	50 A / 500 V / 40 Hz to 850 Hz Phase angle: 0 ° Phase angle: ±30 ° Phase angle: ±60 ° Phase angle: ±75 °	85 - 10^{-6} *P* 0.2 - 10^{-3} *P* 0.5 - 10^{-3} *P* 1.0 - 10^{-3} *P*	*P* = AC active power Discrete points for current, voltage and phase angle
	40 kW 34.6 kW 20 kW 10.4 kW	80 A / 500 V / 40 Hz to 850 Hz Phase angle: 0 ° Phase angle: ±30 ° Phase angle: ±60 ° Phase angle: ±75 °	85 - 10^{-6} *P* 0.2 - 10^{-3} *P* 0.5 - 10^{-3} *P* 1.0 - 10^{-3} *P*	
AC active power sources and measures (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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power sources and measures (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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power sources and measures (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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current reactive power		1 mA / 0.05 V / 10 Hz to 10 kHz		*Q*= AC-Reactive power
sources and measures	50.0 µVAr	Phase angle: 90 °	0.2 - 10^{-3} *Q*	Discrete points for
(discrete points)	43.3 µVAr	Phase angle: ±60 °	0.3 - 10^{-3} *Q*	current, voltage and
	25.0 µVAr	Phase angle: ±30 °	0.8 - 10^{-3} *Q*	phase angle
	12.9 µVAr	Phase angle: ±15 °	2.0 - 10^{-3} *Q*	
		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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current reactive power sources and measures (discrete points)		200 mA / 1 V /10 Hz to 10 kHz		*Q*= AC-Reactive power
		Phase angle: 90 °		
	200.0 mVAr	Phase angle: ±60 °	50 - 10^{-6} *Q*	Discrete points for current, voltage and phase angle
	173.2 mVAr	Phase angle: ±30 °	0.2 - 10^{-3} *Q*	
	100.0 mVAr	Phase angle: ±15 °	0.4 - 10^{-3} *Q*	
	51.8 mVAr		0.8 - 10^{-3} *Q*	
		500 mA / 1 V /10 Hz to 10 kHz		
		Phase angle: 90 °		
	500.0 mVAr	Phase angle: ±60 °	50 - 10^{-6} *Q*	
	433.0 mVAr	Phase angle: ±30 °	0.5 - 10^{-3} *Q*	
	250.0 mVAr	Phase angle: ±15 °	2.0 - 10^{-3} *Q*	
	129.4 mVAr		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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current reactive power		50 A / 1 V // 10 Hz to 10 kHz		*Q*= AC-Reactive power
sources and measures	50.0 VAr	Phase angle: 90 °	0.3 - 10^{-3} *Q*	Discrete points for
(discrete points)	43.3 VAr	Phase angle: ±60 °	3.0 - 10^{-3} *Q*	current, voltage
	25.0 VAr	Phase angle: ±30 °	6.0 - 10^{-3} *Q*	and phase angle
	12.9 VAr	Phase angle: ±15 °	10 - 10^{-3} *Q*	
		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		
		Phase angle: 90 °		
	10.0 mVAr	Phase angle: ±60 °	0.1 - 10^{-3} *Q*	
	8.7 mVAr	Phase angle: ±30 °	0.3 - 10^{-3} *Q*	
	5.0 mVAr	Phase angle: ±15 °	0.7 - 10^{-3} *Q*	
	2.6 mVAr		2.0 - 10^{-3} *Q*	
		10 mA / 10 V / 10 Hz to 10 kHz		
		Phase angle: 90 °		
	100.0 mVAr	Phase angle: ±60 °	50 - 10^{-6} *Q*	
	86.6 mVAr	Phase angle: ±30 °	0.3 - 10^{-3} *Q*	
	50.0 mVAr	Phase angle: ±15 °	0.7 - 10^{-3} *Q*	
	25.9 mVAr		2.0 - 10^{-3} *Q*	
		20 mA / 10 V / 10 Hz to 10 kHz		
		Phase angle: 90 °		
	200.0 mVAr	Phase angle: ±60 °	50 - 10^{-6} *Q*	
	173.2 mVAr	Phase angle: ±30 °	0.3 - 10^{-3} *Q*	
	100.0 mVAr	Phase angle: ±15 °	0.7 - 10^{-3} *Q*	
	51.8 mVAr		2.0 - 10^{-3} *Q*	
		50 mA / 10 V / 10 Hz to 10 kHz		
		Phase angle: 90 °		
	500.0 mVAr	Phase angle: ±60 °	50 - 10^{-6} *Q*	
	433.0 mVAr	Phase angle: ±30 °	0.5 - 10^{-3} *Q*	
	250.0 mVAr	Phase angle: ±15 °	1.0 - 10^{-3} *Q*	
	129.4 mVAr		2.0 - 10^{-3} *Q*	
		100 mA / 10 V / 10 Hz to 10 kHz		
		Phase angle: 90 °		
	1.0 VAr	Phase angle: ±60 °	50 - 10^{-6} *Q*	
	0.9 VAr	Phase angle: ±30 °	0.5 - 10^{-3} *Q*	
	0.5 VAr	Phase angle: ±15 °	1.0 - 10^{-3} *Q*	
	0.3 VAr		2.0 - 10^{-3} *Q*	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current reactive power		200 mA / 10 V / 10 Hz to 10 kHz		*Q*= AC-Reactive power
sources and measures	2.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	Discrete points for
(discrete points)	1.7 VAr	Phase angle: ±60 °	0.5 - 10^{-3} *Q*	current, voltage and
	1.0 VAr	Phase angle: ±30 °	1.0 - 10^{-3} *Q*	phase angle
	0.5 VAr	Phase angle: ±15 °	2.0 - 10^{-3} *Q*	
		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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current reactive power		100 A / 10 V 10 Hz to 10 kHz		*Q*= AC-Reactive power
sources and measures	1000.0 VAr	Phase angle: 90 °	0.2 - 10^{-3} *Q*	Discrete points for
(discrete points)	866.0 VAr	Phase angle: ±60 °	2.0 - 10^{-2} *Q*	current, voltage and
	500.0 VAr	Phase angle: ±30 °	2.0 - 10^{-2} *Q*	phase angle
	258.8 VAr	Phase angle: ±15 °	1.0 - 10^{-2} *Q*	
		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 // 1 0 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current reactive power		1 A / 100 V // 10 Hz to 10 kHz		*Q*= AC-Reactive power
sources and measures	100.0 VAr	Phase angle: 90 °	50 - 10^{-6} *Q*	Discrete points for
(discrete points)	86.6 VAr	Phase angle: ±60 °	0.5 - 10^{-3} *Q*	current, voltage and
	50.0 VAr	Phase angle: ±30 °	2.0 - 10^{-3} *Q*	phase angle
	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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current reactive power sources and measures (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 for current, voltage and phase angle
	21.7 kVAr	Phase angle: ±60 °	0.2 - 10^{-3} *Q*	
	12.5 kVAr	Phase angle: ±30 °	0.5 - 10^{-3} *Q*	
	6.5 kVAr	Phase angle: ±15 °	1.0 - 10^{-3} *Q*	
		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*	
Alternating current reactive power sources and measures (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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current reactive power sources and measures (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 measured variables

Calibrar and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current reactive power sources and measures (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 measured variables

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC apparent power sources and measures (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 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Harmonic voltage				Maximum up to the 100th harmonic
Measures				
	1 V to 1000 V	40 Hz to 850 Hz	$0{,}5 \cdot 10^{-3}$	
	1 V to 180 V	>850 Hz to 5 kHz	$0{,}8 \cdot 10^{-3}$	
sources	1 V to 1000 V	40 Hz to 850 Hz	$0{,}4 \cdot 10^{-3}$	
	1 V to 180 V	>850 Hz to 5 kHz	$0{,}4 \cdot 10^{-3}$	
Strom				
Measures	0.01 A to 80 A	40 Hz to 850 Hz	$4{,}0 \cdot 10^{-3}$	
	0.01 A to 20 A	>850 Hz to 5 kHz	3,0 %	
sources	0.01 A to 80 A	40 Hz to 850 Hz	$4{,}0 \cdot 10^{-3}$	
	0.01 A to 20 A	>850 Hz to 5 kHz	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	$\sqrt{(1 \cdot 10^{-10} \cdot f)^2 + U_{Tf}^2}$	At low frequencies possible trigger uncertainties $U_{T\uparrow}$ or $U_{T\downarrow}$ must be taken into account..
Frequency synthesis	1 mHz to 50 GHz		$1 \cdot 10^{-10}\, f$	
Time interval	1 ns to 1000 s		$\sqrt{(1 \cdot 10^{-10} \cdot t)^2 + U_{Tt}^2 + 1ns^2}$	
Speed	1 min^{-1} -> to $2 \cdot 10^5$ min^{-1}	with light pulse generator	$6 \cdot 10^{-6}$	
optical			but not less than 0.001 min^{-1}	
mechanical	1 min^{-1} -> to 10000 min^{-1}		$4 \cdot 10^{-4}$	
			but not less than 0.01 min^{-1}	
Oscilloscopcalibrators		Rectangular voltage 10 Hz to 10 kHz		
Vertical deflection	1 mV to 5 V	R_i = 50 Ω	$20 \cdot 10^{-6}$ + 1 µV	
	1 mV to 200 V	R_i = 1 MΩ		
Horizontal deflection	1 ns to 1 s	Time marks	$\sqrt{(1 \cdot 10^{-10} \cdot t)^2 + U_{Tt}^2}$	t = current measured value
	> 1 s to 5 s	Measuring time > 5 min	$\sqrt{(5 \cdot 10^{-10} \cdot t)^2 + U_{Tt}^2}$	Trigger uncertainty $U_{T\downarrow}$ zu berücksichtigen
		R_i = 1 MΩ, 50 Ω		
rise time t_r	18 hp to 100 hp	20 mV to 1 V	8 ps	External trigger signal
	> 100 ps to 10 ms		$4.5 \cdot 10^{-2} \cdot t_r$ + 3 ps	required

Permanent laboratory Kirchzarten, Gewerbestraße 3 - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Oscilloscope measured variables		Rectangular voltage 10 Hz to 10 kHz		
Vertical deflection	1 mV to 5V 1 mV to 120 V	Ri = 50 Ω Ri = 1 MΩ	0,35 % 0,35 %	Ri Innenwiderstand
Horizontal deflection	50 ps to < 1 µs 1 µs to 5 s	Time stamps or sine < 1 V	6 ps $1.5 \cdot 10^{-3} \cdot t$	t = current measured value
rise time t_r	180 hp to 450 hp > 450 ps to 10 ms	250 mV 250 mV to 1 V	40 hp $4,5 \cdot 10^{-2} \cdot t_r$	t_r = current rise time
bandwith B	f_c 50 MHz to 26.5 GHz	0.2 V to 2 V R_i = 50 Ω $\lvert\Gamma_{OSZI}\rvert \le 0,05$ $\lvert\Gamma_{OSZI}\rvert \le 0,1$ $\lvert\Gamma_{OSZI}\rvert \le 0,15$ $\lvert\Gamma_{OSZI}\rvert \le 0,2$	12 MHz 13 MHz 14 MHz 15 MHz	f_c = frequency at the -3dB point f_{Ref} = 5% f_c $\lvert\Gamma_{OSZI}\rvert$: Reflection factor Oszi
Total Harmonic Distortion	0 to 0.3	100 Hz to 50 kHz	0.0001 + 0.0165 · *THD*	
THD / THD distortion	0 to 0.3	100 kHz to 2 GHz	0.0001 + 0.0675 · *THD*	
factor$_{Audio}$	0 to 0.3	100 Hz to 50 kHz	0.001 + 0.007 · THD_{Audio}	
Flicker*) $\Delta U / U$ Frequency	0.4 to 5 0.0083 Hz to 40 Hz	DIN EN 61000-4-15:2011	$7 \cdot 10^{-3} \cdot \Delta U / U$ $3 \cdot 10^{-3} \cdot \Delta U / U$	
P_{st} (Short Term) P_{lt} (Long Term)	10 minutes 2 hours	(115 V, 60 Hz);(230 V 50 Hz) (115 V, 60 Hz);(230 V 50 Hz)	0,5 % 1,7%	
Transformation ratio of current transformers	40 A to 400 A (primary) 10 mA to 5 A (secondary) > 400 A to 4000 A (primary) 100 mA to 5 A (secondary)	DC	$20 - 10^{-6}$ $24 - 10^{-6}$	

Permanent laboratory Kirchzarten, Gewerbestraße 3 - High-frequency measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
HF power Power meters	> 1 pW to 0.1 mW			connector system: N, PC-3.5 ;
		2.5 MHz to 2 GHz	(0.025 + 0.14 - |Γ|) - *P*	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 ;
		> 2 GHz to 18 GHz	(0.053 + 0.2 - |Γ|) - *P*	50 Ω; |Γ| KG ≤ 0.2
		> 18 GHz to 26.5 GHz	(0.074 + 0.31 - |Γ|) - *P*	Connector: PC-3.5; 50 Ω, |KG ≤ 0.2
	0.1 mW to 10 mW	9 kHz to <0.1 MHz	$17 \cdot 10^{-3}$ - *P*	N connector; 50 Ω
		0.1 MHz to 50 MHz	$10 \cdot 10^{-3}$ - *P*	| Γ | ≤ 0,3
		>50 MHz to 6 GHz	$15 \cdot 10^{-3}$ - *P*	
		>6 GHz to 18 GHz	$20 \cdot 10^{-3}$ - *P*	
		0.1 MHz to 50 MHz	$20 \cdot 10^{-3}$ - *P*	| Γ | ≤ 0,5
		> 50 MHz to 6 GHz	$30 \cdot 10^{-3}$ - *P*	
		> 6 GHz to 18 GHz	$40 \cdot 10^{-3}$ - *P*	
	10 mW to 50 W	0.1 MHz to 2 GHz	$48 \cdot 10^{-3}$ - *P*	| *Γ* | of the KG ≤ 0.1
		0.1 MHz to 2 GHz	$63 \cdot 10^{-3}$ - *P*	| *Γ* | of the KG ≤ 0.3
		0.1 MHz to 2 GHz	$123 \cdot 10^{-3}$ - *P*	| *Γ* | of the KG ≤ 0.5
				N connector; PC-3.5 [3)]
	0.1 mW to 10 mW	10 MHz to 1 GHz	$20 \cdot 10^{-3}$ - *P*	Connector PC-3.5; 50 Ω[3)]
		> 1 GHz to 10 GHz	$30 \cdot 10^{-3}$ - *P*	| Γ | ≤ 0,3
		>10 GHz to 18 GHz	$40 \cdot 10^{-3}$ - *P*	
		>18 GHz to 26.5 GHz	$45 \cdot 10^{-3}$ - *P*	
		10 MHz to 1 GHz	$40 \cdot 10^{-3}$ - *P*	| Γ | ≤ 0,5
		> 1 GHz to 10 GHz	$80 \cdot 10^{-3}$ - *P*	
		>10 GHz to 18 GHz	$100 \cdot 10^{-3}$ - *P*	
		>18 GHz to 26.5 GHz	$110 \cdot 10^{-3}$ - *P*	

3) The measurement uncertainty increases when other connector systems are used.

Permanent laboratory Kirchzarten, Gewerbestraße 3 - High-frequency measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
HF power Power meters	0.1 mW to 10 mW	9 kHz to < 0.1 MHz	$17 \cdot 10^{-3} - P$	N connector; 50 Ω[3)] $\lvert \Gamma \rvert \leq 0.3$
		0.1 MHz to 50 MHz	$6.0 \cdot 10^{-3} - P$	
		> 50 MHz to 6 GHz	$12 \cdot 10^{-3} - P$	
		> 6 GHz to 18 GHz	$20 \cdot 10^{-3} - P$	
	> 10 mW to 50 W	32 MHz to 1 GHz	$20 \cdot 10^{-3} - P$	
	0.1 mW to 10 mW	10 MHz to 1 GHz	$10 \cdot 10^{-3} - P$	Connector PC-3.5; 50 Ω[3)] $\lvert \Gamma \rvert \leq 0,3$
		> 1 GHz to 10 GHz	$15 \cdot 10^{-3} - P$	
		> 10 GHz to 18 GHz	$20 \cdot 10^{-3} - P$	
		> 18 GHz to 26.5 GHz	$25 \cdot 10^{-3} - P$	
Phase noise Signal generators	Phase noise related to carrier amplitude in dBc/Hz	Offset frequency related 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 / measures	10 Hz to 50 GHz	-165 to 0 dBm/Hz dbm/Hz	1 dB	
Signal level difference Measures / 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Filter bandwidth Measures	1 Hz to 40 MHz		1 %	SNR > 70 dB
Form factor Measures	1:1 to 4:1 > 4:1 to 10:1 > 10:1 to 18:1		5,5 % 7 % 8,5 %	SNR > 20 dB
Amplitude modulation: Modulationsgrad *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 measurement 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 measurement uncertainty
Phase modulation Phase deviation $\Delta\Phi$	0 to (4 MHz / f_{MOD}) 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 measurement 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	f_{HF} = 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Pulsed measures *) Spectral voltage Amplitude density (Measures/ 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 rate 1 Hz to 100 Hz $\Gamma_G, \Gamma_L \leq 0,05$ (act)
	S_0 = 0,316 µVs	CISPR Band B > 0.15 MHz to 30 MHz	0.30 dB	Pulse rate 1 Hz to 1000 Hz $\Gamma_G, \Gamma_L \leq 0,07$ (act)
	S_0 = 0,0044 µVs	CISPR Band C > 30 MHz to 300 MHz	0.36 dB	Pulse rate 1 Hz to 1000 Hz $\Gamma_G, \Gamma_L \leq 0,12$ (act)
	S_0 = 0,0044 µVs	CISPR Band D > 300 MHz to 1 GHz	0.40 dB	
HF current transformer clamp *) Transfer certificate 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 transformer 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 an 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 *) Voltage amplitude measurement and display	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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
HF 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 factor	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 $\|\Gamma\|$ 0.004 + 0.0040 $\|\Gamma\|$ 0.004 + 0.0045 $\|\Gamma\|$ 0.007 + 0.0060 $\|\Gamma\|$	Connector 50 Ω: N50; PC-3,5; PC-2,4[3)] $\|\Gamma\|$: Amount of the complex Reflection factor
HF attenuation phase angle ϕ	-180° to 180°	9 kHz to 50 GHz	U_S - 180°/π + K - f	U_S = arcsin(U($\|\Gamma\|$)/$\|\Gamma\|$) K = 0.025°/GHz Connector 50 Ω: N50; PC-3,5; PC-2,4[3)]
HF transmission phase Phase angle φ	-180° to 180°	9 kHz to 50 GHz	U_T - 180°/π + K - f + 0.3°	U_T=arcsin($10^{U/20}$ - 1) K: 0.05°/GHz U: Uncertainty of the Attenuation in dB
Electrostatic discharge (ESD) current pulse I_P values	1 A to 120 A	DIN EN61000-4-2	3,0 %	I_P = first discharge peak I_{30} = Current at 30 ns I_{60} = Current at 60 ns
current pulse I_{30}	1 A to 120 A		3,5 %	
current pulse I_{60}	1 A to 120 A		3,5 %	
rise time t_r	0.6 ns to 1 µs		5,0 %	
DCU_L	1 kV to 30 kV		0,5 %	

3) If other connector systems are used, the measurement uncertainty increases.

On-site calibration - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Length Cylindrical setting standards, ring gauges: diameter *)	1 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006	$0.8\ \mu m + 2 \cdot 10^{-6} \cdot d$	*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)	$0.8\ \mu m + 2 \cdot 10^{-6} \cdot d$	
Test pins: diameter*)	0.1 mm to 30 mm	VDI/VDE/DGQ 2618 Sheet 4.2:2007 Point 3.2.2 (Opt. 1)	$0.8\ \mu m + 2 \cdot 10^{-6} \cdot d$	
Thread gauges (one and multi-start cylindrical external and internal threads with straight flanks, symmetrical profile)				
Threaded mandrels: simple pitch 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)	$3\ \mu m + 10 \cdot 10^{-6} \cdot d$	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)	$3\ \mu m + 10 \cdot 10^{-6} \cdot d$	Two-ball method *d* is the measured Diameter
Lenght *) of plan parallel, spherical or cylindrical measuring surface *)	0.01 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 19.1:2014	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	*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)	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot d$	*d* is the measured diameter
feeler*)	0.03 mm to 2.00 mm	DIN 2275:2014	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	*l* is the measured length
Adjustment dimensions for micrometer *)	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	

On-site calibration - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Snap gauge *)	3 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.7:2005 Point 3.3.2 (Opt. 2)	$0.8\ \mu m + 2 \cdot 10^{-6} \cdot d$	*d* is the measured Diameter
Calipers for external, internal and depth measurements *)	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	$30\ \mu m + 30 \cdot 10^{-6} \cdot l$	*l* is the measured length
	> 500 mm to 1000 mm			
Depth caliper / height caliper *)		VDI/VDE/DGQ 2618 Sheet 9.2:2006	$50\ \mu m + 30 \cdot 10^{-6} \cdot l$	
		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
micrometer *)	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	$3\ \mu m + 10 \cdot 10^{-6} \cdot l$	
Precision micrometers*)	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002		
micrometer head *)	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008		
depth micrometers *)	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010		
Inside micrometers with 2-point contact on the calibration item *)	13 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	$3\ \mu m + 10 \cdot 10^{-6} \cdot l$	
	> 300 mm to 500 mm		$5\ \mu m + 10 \cdot 10^{-6} \cdot l$	
Inside micrometers with 2-line contact on the calibration item	5 mm to 100 mm	3-APD-0-0025-EN 2023:07	$3\ \mu m + 10 \cdot 10^{-6} \cdot d$	*d* is the measured diameter
Inside micrometers with 3-line contact on the calibration item *)	3 mm to 150 mm	VDI/VDE/DGQ 2618 Sheet 10.8:2002	$3\ \mu m + 10 \cdot 10^{-6} \cdot d$	*d* is the measured diameter
Lever gauges (quick probe) for external measurements *)	up to 200 mm	VDI/VDE/DGQ 2618 Sheet 12.1:2005	$7\ \mu m + 10 \cdot 10^{-6} \cdot l$	*l* is the measured length
Lever gauges (quick probe) for internal measurements *)	2 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 13.1:2005	$7\ \mu m + 10 \cdot 10^{-6} \cdot l$	
dial gauges *)	0 mm to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.1:2021	$3\ \mu m + 10 \cdot 10^{-6} \cdot l$	Mechanical dial gauges
		VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020	$3\ \mu m + 10 \cdot 10^{-6} \cdot l$	Electronic digital dial gauges
precision indicator *)	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
lever gauges *)	0 mm to 1.6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
electr. inductive lenght measures *)	up to 100 mm	VDI/VDE/DGQ 2618 Sheet 14.1:2010	$0.6\ \mu m + 1 \cdot 10^{-6} \cdot l$	
electr. incremental Length measures	up to 100 mm	3-APD-0-0027-EN 2023-08	$0.6\ \mu m + 1 \cdot 10^{-6} \cdot l$	

On-site calibration - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Coordinate metrology Coordinate measuring machines with optical probing Measuring projectors, measuring microscopes *)	Devices with a measuring level with a Area diagonals ≤ 450 mm	Calibration of metrological properties according to DKD-R 4-3 Sheet 18.1:2018, as well as the standards and guidelines DIN EN ISO 10360 listed below VDI/VDE 2617		Measuring systems with visual probing or electronic edge detection
		Determination oft he probing deviation P_{SX}, P_{SY} and P_{S2D} by means of a circular 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} und P_{SV2D} by means of a circular standard according to VDI/VDE 2617 Sheet 6.1:2021	0.5 µm	
		Determination of the length measurement deviation E_{UXY}, E_{UX} und 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Coordinate metrology Coordinate measuring machines with optical probing		Determination of the length measurement deviation of the image processing system E_{UV} with a line scale or a circular matrix according to DIN EN ISO 10360-7:2011	0.5 µm	
Measuring projectors, measuring microscopes *)	up to 100 mm	Determination of the length measurement deviation E_{UZ} with gauge block or with depth setting normal according to DIN EN ISO 10360-7:2011	0.5 µm + 0.7 ·10^{-6} · l	l is the measured length
	up to 100 µm		0.25 µm	

On-site calibration - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC voltage measures	0 V		0.1 µV	U = set value
	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 sources	0 V		0.1 µV	U = measured value
	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
Direct current meters and sources	0 A	Precision Open	0.2 nA	I = set value
	0.1 µA to < 1 µA	Standard 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 current clamps	1 mA to 2.2 A		$1 \cdot 10^{-3}\ I$	
	> 2.2 A to 20 A		$2 \cdot 10^{-3}\ I$	
	> 20 A to 1000 A		$3 \cdot 10^{-3}\ I$	

On-site calibration - Electrical measured variables

Calibration and measurement opportunities

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

On-site calibration - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance (ranges) Measures	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3}\ R$	R = set value Fluke 5520A /5522A
	11 Ω to < 33 Ω		$33 \cdot 10^{-6}\ R$	
	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 measures 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	$0.45 \cdot 10^{-3}\ U$	

On-site calibration - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 sources and measures	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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current sources and measures	> 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*	
sources	100 A to 2000 A	50 Hz	$3.0 \cdot 10^{-3} \cdot I$	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	$2 \cdot 10^{-3}$ *I* $3 \cdot 10^{-3}$ *I* $4 \cdot 10^{-3}$ *I*	*I* = measured value
Capacity measures	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 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 10 Hz to 150 Hz 10 Hz to 120 Hz 10 Hz to 80 Hz DC to 50 Hz DC to 20 Hz DC to 6 Hz DC to 2 Hz DC to 0.6 Hz DC up to 0.2 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 $6.0 \cdot 10^{-3}$ C $6.5 \cdot 10^{-3}$ C $6.0 \cdot 10^{-3}$ C $6.0 \cdot 10^{-3}$ C $6.0 \cdot 10^{-3}$ C $6.0 \cdot 10^{-3}$ C $8.0 \cdot 10^{-3}$ C $11 \cdot 10^{-3}$ 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 standard capacities

On-site calibration - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Frequency	1 mHz to 46 GHz		$2 \cdot 10^{-9} \cdot f + U_{Tf}$	f = current measured value U_{Tf} =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 measures		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	$2.0 \cdot 10^{-3} P$	
Direct current power Measures	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 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 smaller than 80 - 10^{-6} not smaller than 0.14 - 10^{-3}	$w(U_F)$ Uncertainty of the amplitude of the voltage fundamental $w(I_F)$ Incertainty of the amplitude of the Current fundamental $w(\Phi_F)$ Uncertainty of the phase displacement angle <tg183837 displacement angle $w(U_{rms})$ Uncertainty of the effective voltage value $w(I_{rms})$ Uncertainty of the effective current value
	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 smaller 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 smaller than 80 - 10^{-6} not smaller than 0.14 - 10^{-3}	

On-site calibration - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Tension 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 display devices 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 display devices 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 measured variables

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Voltage ratio DC voltage bridges, measures, measuring amplifiers		Bridge voltage: 0,5 V		With K148
	-2 mV/V to +2 mV/V		0.35 µV/V	
	-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	
		Bridge voltage: 1 V		
	-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		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	
		Bridge voltage: 2.5 V; 5		
	-2 mV/V to +2 mV/V		0.10 µV/V	
	-5 mV/V to +5 mV/V	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	

On-site calibration - high-frequency and radiation measurands

Calibrierandmanagementcompanies (CMC)

Measuresd variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measuresment uncertainty	Remarks
Oscilloscope measuresd variables				
Vertical deflection	5 mV to 5 V	R_i = 50 Ω	$3.5 \cdot 10^{-3}\ U + 35$ µV	Rectangular 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	t: current time
	> 20 ms to 5 s		$30 \cdot 10^{-6}\ t + 1.2 \cdot 10^{-3}\ t^2$	
Rise time	150 ps to 10 ms	250 mV	$35 - 10^{-3} - t_r + 5$ ps	t_r = self rise time
	250 hp to 10 ms	> 250 mV to 2.5 V R_i = 50 Ω	$35 - 10^{-3} - t_r + 8$ ps	of the oscilloscope
HF impedance	0,0 to 1,0	45 MHz to 5 GHz	0.01 + 0.01 |Γ|	Connector; PC-7; 50 Ω[3]
(reflection factor)		>5 GHz to 18 GHz	0.015 + 0.01 |Γ|	
Single-port measurement		>9kHz to 5 GHz	0,01 + 0,1 |Γ|	N-Connector; 50 Ω[3]
Amount |Γ|		>5 GHz to 18 GHz	0,015 + 0,1 |Γ|	
		45 MHz to 5 GHz	0,01 + 0,005 |Γ|	Connektor; PC-3,5; 50 Ω3)
		>5 GHz to 18 GHz	0,015 + 0,01 |⍰|	
		>18GHz to 26.5 GHz	0,02 + 0,02|⍰|	
Phase φ		9 kHz to 18 GHz	$\arcsin\frac{U(\lvert\Gamma\rvert)}{\lvert\Gamma\rvert}\bullet\frac{180°}{\pi}$	N-Connector; 50 Ω
		0,1 ≤ |Γ| ≤ 1		
	-180°C to 180°	45 MHz to 18 GHz		PC-7; 50 Ω
		0,1 ≤ |Γ| ≤ 1		
		45 MHz to 26.5 GHz		PC-3.5
		0,1 ≤ |Γ| ≤ 1		

On-site calibration - high-frequency and radiation measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
HF impedance (reflection factor) Double-port measurement $\|S_{11}\|$ & $\|S_{22}\|$ Amount $\|\Gamma\|$	0.0 to 1.0	45 MHz to 5 GHz > 5 GHz to 18 GHz	0.015 + 0.01 $\|\Gamma\|$ 0.02 + 0.01 $\|\Gamma\|$	PC-7; 50 Ω[3)]
		9 kHz to 5 GHz > 5 GHz to 18 GHz	0.015 + 0.01 $\|\Gamma\|$ 0.02 + 0.01 $\|\Gamma\|$	N connector; 50 Ω. [3)]
		45 MHz to 5 GHz > 5 GHz to 18 GHz >18 to 26.5 GHz GHz	0.01 + 0.005 $\|\Gamma\|$ 0.015 + 0.01 $\|\Gamma\|$ 0.02 + 0.02 $\|\Gamma\|$	PC-3,5[3)]
Phase ϕ	-180° to 180°	9 kHz to 18 GHz 0.1 ≤ $\|\Gamma\|$ ≤ 1 45 MHz to 18 GHz 0.1 ≤ $\|\Gamma\|$ ≤ 1 45 MHz to 26.5 GHz 0.1 ≤ $\|\Gamma\|$ ≤ 1	$\arcsin \frac{U(\|\Gamma\|)}{\|\Gamma\|} \bullet \frac{180°}{\pi}$	N connector; 50 Ω. PC-7; 50 Ω PC-3.5
HF - Attenuation Switchable-Attenuators, Fixed attenuators	0 dB to 60 dB	9 kHz to 18 GHz	0.3 dB	connector system: N; 50 Ω IΓI ≤ 0.1
	>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 IΓI ≤ 0.1 < 20 GHz to 26.5 GHz IΓI ≤ 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 26.5 GHz	(0.025 + 0.14 - $\|\Gamma\|$) - *P* (0.049 + 0.21 - $\|\Gamma\|$) - *P* (0.071 + 0.32 - $\|\Gamma\|$) - *P*	connector system: N, PC-3.5 ; 50 Ω; $\|\Gamma\|$ 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 26.5 GHz	(0.035 + 0.13 - $\|\Gamma\|$) - *P* (0.053 + 0.2 - $\|\Gamma\|$) - *P* (0.074 + 0.31 - $\|\Gamma\|$) - *P*	connector system: N, PC-3.5 ; 50 Ω; $\|\Gamma\|_{KG}$ ≤ 0.2
	0.1 mW to 10 mW	9 kHz to 50 MHz > 50 to 5 GHz MHz > 5 GHz to 18 GHz	$17 \cdot 10^{-3}$ - *P* $22 \cdot 10^{-3}$ - *P* $30 \cdot 10^{-3}$ - *P*	N connector; 50 Ω[3)] $\|\Gamma\|$ ≤ 0,3
	0.1 mW to 10 mW	50 MHz to 5 GHz > 5 GHz to 18 GHz >18 to 26.5 GHz GHz	$22 \cdot 10^{-3}$ - *P* $32 \cdot 10^{-3}$ - *P* $40 \cdot 10^{-3}$ - *P*	Connector PC-3.5; 50 Ω[3)] $\|\Gamma\|$ ≤ 0,3

On-site calibration - high-frequency and radiation measurands

Calibration and measurement opportunities

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

3) The measurement uncertainty increases when other connector systems are used.

On-site calibration - high-frequency and radiation measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Amplitude modulation: Modulationsgrad 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} = Modulationsfreq.
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} = Modulationsfreq.
Phase modulation Phase deviation $\Delta\Phi$	0 to (4 MHz / f_{MOD}) rad	f_{HF} < 4 GHz f_{MOD} < 1 MHz	0.025 rad + 0.041 · $\Delta\Phi$	f_{HF} = carrier frequency f_{MOD} = Modulationsfreq.
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	f_{HF} = carrier frequency f_{MOD} = Modulationsfreq. 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
Pulse-shaped measured variables*) Spectral voltage Amplitude density (Measures/ 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 rate 1 Hz to 100 Hz Γ_G, Γ_L ≤ 0,05 (act)
	S_0 = 0,316 µVs	CISPR Band B > 0.15 MHz to 30 MHz	0.50 dB	Pulse rate 1 Hz to 1000 Hz Γ_G, Γ_L ≤ 0,07 (act)
	S_0 = 0,0044 µVs	CISPR Band C > 30 MHz to 300 MHz	0.6 dB	Pulse rate 1 Hz to 1000 Hz Γ_G, Γ_L ≤ 0,12 (act)
	S_0 = 0,0044 µVs	CISPR Band D > 300 MHz to 1 GHz	0.6 dB	Pulse rate 1 Hz to 1000 Hz Γ_G, Γ_L ≤ 0,12 (act)
HF current transformer clamp*) Transmission certificate-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 transformer 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 measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Phase noise	Phase noise related to carrier amplitude in	Offset frequency related 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 unter Last (R_L) at R_L = 50 Ω on 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 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	400 ns to 1 ms		3,5 %	

Mobile laboratory - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC voltage measures	0 V		0.1 µV	U = set value
	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 sources	0 V		0.1 µV	U = measured value
	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
Direct current intensity Measures and sources	0 A	Precision Open	0.2 nA	I = set value
	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 current clamps	1 mA to 2.2 A		$1 \cdot 10^{-3}\ I$	
	> 2.2 A to 20 A		$2 \cdot 10^{-3}\ I$	
	>20 A to 1000 A		$3 \cdot 10^{-3}\ I$	

Mobile laboratory - Electrical measured variables

Calibriarandmeasures (CMC)

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

Mobile laboratory - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance (ranges) Measures	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3}\ R$	R = set value Fluke 5520A /5522A
	11 Ω to < 33 Ω		$33 \cdot 10^{-6}\ R$	
	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 measures 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	$0.45 \cdot 10^{-3}\ U$	

Mobile laboratory - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibrar and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures and sources	> 220 V to 1000 V	10 Hz to 20 Hz	$25 \cdot 10^{-6}\ U$	U = measured value
		> 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 sources and measures	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;		
	> 10 mA to 1 A	10 Hz to 40 Hz	$17 \cdot 10^{-6}\ I$	I = measured value
		> 40 Hz to 1 kHz;		
		> 1 kHz to 10 kHz;		
	> 1 A to 10 A	10 Hz to 40 Hz	$32 \cdot 10^{-6}\ I$	
		> 40 Hz to 1 kHz;		
		> 1 kHz to 10 kHz;		
	> 10 A to 20 A	10 Hz to 40 Hz	$39 \cdot 10^{-6}\ I$	
		> 40 Hz to 1 kHz;		
		> 1 kHz to 10 kHz;		
	> 20 A to 100 A	10 Hz to 40 Hz	$69 \cdot 10^{-6}\ I$	
		> 40 Hz to 1 kHz;	$69 \cdot 10^{-6}\ I$	
		> 1 kHz to 10 kHz;	$0{,}17 \cdot 10^{-3}\ I$	
Current clamps	1 mA to 2.2 A	40 Hz to 5 kHz	$2 \cdot 10^{-3}\ I$	I = measured value
	> 2.2 A to 20 A	40 Hz to 5 kHz	$3 \cdot 10^{-3}\ I$	
	> 20 A to 800 A	40 Hz to 65 Hz	$4 \cdot 10^{-3}\ I$	
Capacity measures	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	

Mobile laboratory - Electrical measured variables

Calibrier- und Messmittel (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Capacity	11 µF to < 33 µF	10 Hz to 120 Hz	$6.0 \cdot 10^{-3}$ C	With 5520A / 5522A
measures	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 20 Hz	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	DC to 6 Hz DC to 2	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	Hz DC to 0.6 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 with standard capacities
	> 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 46 GHz		$2 \cdot 10^{-9} \cdot f + U_{Tf}$	f = current measured value U_{Tf} =Trigger uncertainty
Time interval	1 µs to 1000 s		$2 \cdot 10^{-9} \cdot t$ + 2 ns	t = current measured value
Speed	1 min^{-1} to 100,000 , min^{-1}	with light pulse generator	$8 \cdot 10^{-6}$	
optical			but not less than 0.006 min^{-1}	
AC active power measures		33 mV to 1000 V		*P* = set value with Fluke 5520A/5522A *PF*: Power factor
		45 Hz to 65 kHz		
		PF = 1		
	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	$2.0 \cdot 10^{-3} P$	
Direct current power	1 mW to 300 W		$0.5 \cdot 10^{-3} P$	
Measures	> 300 W to 20 kW		$1,0 \cdot 10^{-3} P$	
sources	1 mW to 300 W	Produkt aus *U* und *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				$w(U_F)$ ... Incertainty of the amplitude of the voltage fundamental $w(I_F)$ ... Incertainty of the amplitude of the current fundamental $w(\Phi_F)$ ... Uncertainty of the phase shift angle $w(U_{rms})$ ... Uncertainty of the voltage RMS value $w(I_{rms})$ ... Uncertainty of the current RMS value
		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 mW 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 to 120 kvar	>50 A to 120 A	not smaller than 0.14 - 10^{-3}	

Mobile laboratory - Electrical measured variables

Kalibrier- und Messmöglichkeiten (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 to 50 kVA	0.1 A to 50 A	not smaller than $80 \cdot 10^{-6}$	
	>50 VA to 120 kVA	>50 A to 120 A	not smaller than $0.14 \cdot 10^{-3}$	

Mobiles Laboratorium - Hochfrequenz- und Strahlungsmessgrößen

Calibration and measurement opportunities

measured variable / calibration object	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Oscilloscope measured variables Vertical deflection	5 mV to 5 V 5 mV to 120 V	R_i = 50 Ω R_i = 1 MΩ	$3.5 \cdot 10^{-3}\ U + 35$ µV $2.4 \cdot 10^{-3}\ U + 40$ µV	Rectangular voltage 10 Hz to 10 kHz
Horizontal deflection	5 ns to 520 ms > 20 ms to 5 s		$3 \cdot 10^{-6}\ t + 1$ ns $30 \cdot 10^{-6}\ t + 1.2 \cdot 10^{-3}\ t^2$	t: actual time
Rise time	150 ps to 10 ms 250 ps to 10 ms	250 mV > 250 mV to 2.5 V R_i = 50 Ω	$35 - 10^{-3} - t_r + 5$ ps $35 - 10^{-3} - t_r + 8$ ps	t_r = Self-rise time of the oscilloscope
HF impedance (reflection factor) One-port measurement $\|S_{11}\|$ Amount $\|\Gamma\|$	0.0 to 1.0	45 MHz to 5 GHz >5 GHz to 18 GHz	0.01 + 0.01 $\|\Gamma\|$ 0.015 + 0.01 $\|\Gamma\|$	Connector; PC-7; 50 Ω[3]
		9 kHz to 5 GHz >5 GHz to 18 GHz	0.01 + 0.01 $\|\Gamma\|$ 0.015 + 0.01 $\|\Gamma\|$	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 $\|\Gamma\|$ 0,015 + 0,01 $\|\Gamma\|$ 0.02 + 0.02 $\|\Gamma\|$	Connektor;PC-3,5; 50 Ω[3]
Phase ϕ	-180° to 180°	9 kHz to 18 GHz $0.1 \le \|\Gamma\| \le 1$ 45 MHz to 18 GHz $0.1 \le \|\Gamma\| \le 1$ 45 MHz to 26.5 GHz $0.1 \le \|\Gamma\| \le 1$	$\arcsin \frac{\|U\|(\Gamma)\ 180°}{\|\|\Gamma \bullet \pi}$	N connector; 50 Ω. PC-7; 50 Ω PC-3.5

Mobiles Laboratorium - Hochfrequenz- und Strahlungsmessgrößen

Kalibrier- und Messmöglichkeiten (CMC)

measured variable / calibration object	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
HF impedance (reflection factor) Double-port measurement $\|S_{11}\|$ & $\|S_{22}\|$ Amount $\|\Gamma\|$	0,0 to 1,0	45 MHz to 5 GHz	0.015 + 0.01 $\|\Gamma\|$	PC-7; 50 Ω[3)]
		> 5 GHz to 18 GHz	0.02 + 0.01 $\|\Gamma\|$	
		9 kHz to 5 GHz	0.015 + 0.01 $\|\Gamma\|$	N connector; 50 Ω. [3)]
		> 5 GHz to 18 GHz	0.02 + 0.01 $\|\Gamma\|$	
		45 MHz to 5 GHz	0.01 + 0.005 $\|\Gamma\|$	PC-3,5[3)]
		> 5 GHz to 18 GHz	0,015 + 0,01 $\|\Gamma\|$	
		> 18 GHz to 26.5 GHz	0.02 + 0.02 $\|\Gamma\|$	
Phase ϕ	-180° to 180°	9 kHz to 18 GHz 0.1 ≤ $\|\Gamma\|$ ≤ 1		N connector; 50 Ω.
		45 MHz to 18 GHz 0.1 ≤ $\|\Gamma\|$ ≤ 1	$\frac{\psi(\Gamma)}{\|\Gamma\|}$ $\frac{}{\pi}$	PC-7; 50 Ω
		45 MHz to 26.5 GHz 0.1 ≤ $\|\Gamma\|$ ≤ 1		PC-3.5
HF - Attenuation Switchable-Attenuators, Fixed attenuators	0 dB to 60 dB	9 kHz to 18 GHz	0,3 dB	connector system: N; 50 Ω IΓI ≤ 0.1
	>60 dB to 90 dB		0.3 dB	
Absolute Attenuation values	0 dB to 60 dB	45 MHz to 20 GHz	0.3 dB	Connector system PC-3,5; 50 Ω 45 MHz to 20 GHz IΓI ≤ 0,1 <20 GHz to 26.5 GHz IΓI ≤ 0,15
		>20 GHz to 26.5 GHz	0.5 dB	
	>60 dB to 90 dB	45 MHz to 20 GHz	0.3 dB	
		>20 GHz to 26.5 GHz	0.5 dB	
HF power Power meters	> 1 pW to 0.1 mW	2.5 MHz to 2 GHz	(0.025 + 0.14 - $\|\Gamma\|$) - *P*	Connector system: N, PC-3.5 ; 50 Ω; $\|\Gamma\|$ KG ≤ 0.2
		>2 GHz to 18 GHz	(0.049 + 0.21 - $\|\Gamma\|$) - *P*	
		> 18 GHz to 26.5GHz	(0.071 + 0.32 - $\|\Gamma\|$) - *P*	
HF power Signal generators	> 1 pW to 0.1 mW	2,5 MHz to 2 GHz	(0.035 + 0.13 - $\|\Gamma\|$) - *P*	connector system: N, PC-3.5 ; 50 Ω; $\|\Gamma\|_{KG}$ ≤ 0.2
		>2 GHz to 18 GHz	(0.053 + 0.2 - $\|\Gamma\|$) - *P*	
		> 18 GHz to 26.5GHz	(0.074 + 0.31 - $\|\Gamma\|$) - *P*	
	0.1 mW to 10 mW	9 kHz to 50 MHz	17 · 10^{-3} - *P*	N connector; 50 Ω[3)] $\|\Gamma\|$ ≤ 0,3
		> 50 MHz to 5 GHz	22 · 10^{-3} - *P*	
		> 5 GHz to 18 GHz	30 · 10^{-3} - *P*	
	0.1 mW to 10 mW	50 MHz to 5 GHz	22 · 10^{-3} - *P*	Connector PC-3.5; 50 Ω[3)] $\|\Gamma\|$ ≤ 0,3
		> 5 GHz until 18 GHz	32 · 10^{-3} - *P*	
		> 18 GHz until 26.5 GHz	40 · 10^{-3} - *P*	

Mobile laboratory - high-frequency and radiation measurements

Kalibrier- und Messmöglichkeiten (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
HF power Power meters	0.1 mW to 10 mW	9 kHz to 50 MHz	$17 \cdot 10^{-3}$ - P	N connector; 50 Ω[3]
		> 50 MHz to 5 GHz	$21 \cdot 10^{-3}$ - P	$\|\Gamma\| \leq 0{,}3$
		> 5 GHz to 18 GHz	$28 \cdot 10^{-3}$ - 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	$32 \cdot 10^{-3}$ - P	$\|\Gamma\| \leq 0{,}3$
		> 18 GHz to 26.5 GHz	$40 \cdot 10^{-3}$ - P	
Signal level difference Measures / 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	
Filter bandwidth Measures	1 Hz to 40 MHz		1 %	SNR > 70 dB
HF noise display receiver / measures	10 Hz to 50 GHz	-165 dbm/Hz to 0 dBm/Hz	1 dB	
Form factor Measures	1:1 to 4:1		5,5 %	SNR > 20 dB
	> 4:1 to 10:1		7 %	
	> 10:1 to 18:1		8,5 %	

3) The measurement uncertainty increases when other connector systems are used.

Mobile laboratory - high-frequency and radiation measurements

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Amplitude modulation: grade of modulation 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 $\Delta\Phi$	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	f_{HF} = 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
Pulse-shaped measurement variabes*) Spectral voltage Amplitude density (Measures/ Display)	S_0 = 13,5 µVs	*DIN EN 55016-1-1:2020* CISPR 16-1-1:2019 CISPR Volume A 9 kHz to 0.15 MHz	0.50 dB	Pulse rate 1 Hz to 100 Hz Γ_G, Γ_L ≤ 0,05 (act)
	S_0 = 0,316 µVs	CISPR Band B > 0.15 MHz to 30 MHz	0.50 dB	Pulse rate 1 Hz to 1000 Hz Γ_G, Γ_L ≤ 0,07 (act)
	S_0 = 0,0044 µVs	CISPR Band C > 30 MHz to 300 MHz	0.6 dB	Pulse rate 1 Hz to 1000 Hz Γ_G, Γ_L ≤ 0,12 (act)
	S_0 = 0,0044 µVs	CISPR Band D > 300 MHz to 1 GHz	0.6 dB	Pulse rate 1 Hz to 1000 Hz Γ_G, Γ_L ≤ 0,12 (act)
HF current transformer clamp*) Transmission impedance 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 measurements

Calibration and measurement opportunities

Measured variable / calibration	Measuring range /	Measuring conditions /	Expanded measurement	Remarks
Phase noise	Phase noise related to carrier amplitude in dBc/Hz	Offset frequency related 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		DIN EN 61000-4-4 under load (R_L)		R_L = load resistance
Rise time and pulse width	3 ns to 1 µs	at R_L = 50 Ω at R_L = 1 kΩ	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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 · 10^{-6} · *d*	*d* is the measured Diameter
Plug gauges: diameter *)	1 mm to 200 mm		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 external and internal threads with straight flanks, symmetrical profile) Threaded mandrels: simple pitch 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
Länge *) of plane-parallel, spherical or cylindrical measuring surface *)	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 *)	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 micrometer *)	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm + 2 · 10^{-6} · *l*	

Mobile laboratory - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Snap gauge *)	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
Calipers for external, internal 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
	> 500 mm to 1000 mm			
Depth caliper / height caliper *)		VDI/VDE/DGQ 2618 Sheet 9.2:2006	50 µm + 30 · 10^{-6} · *l*	
		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
micrometer *)	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm + 10 · 10^{-6} · *l*	
Precision indicator measuring head *)	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002		
micrometer head *)	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008		
depth micrometers *)	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010		
Inside micrometers with 2-point contact am calibration object *)	13 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	3 µm + 10 · 10^{-6} · *l*	
	> 300 mm to 500 mm		5 µm + 10 · 10^{-6} · *l*	
Inside micrometers with 2-line contact on the calibration item	5 mm to 100 mm	3-APD-0-0025-EN 2023:07	3 µm + 10 · 10^{-6} · *d*	*d* is the measured diameter
Inside micrometers with 3-line contact am 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 (rapid probe) for outside measures *)	up 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 button) for internal measurements *)	2 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 13.1:2005	7 µm + 10 · 10^{-6} · *l*	

Mobile laboratory - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
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		Electronic digital dial gauges
precision indicator *)	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
lever gauges *)	0 mm to 1.6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
electr. inductive lenght measures *)	up to 100 mm	VDI/VDE/DGQ 2618 Sheet 14.1:2010	0.6 µm + 1 · 10^{-6} · *l*	
electr. incremental Length measures	up to 100 mm	3-APD-0-0027-EN 2023-08	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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC voltage measures	0 V		0.1 µV	U = set value
	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 sources	0 V		0.1 µV	U = measured value
	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
Direct current meters and sources	0 A	Precision Open	0.2 nA	I = set value
	0.1 µA to < 1 µA	Standard 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 current clamps	1 mA to 2.2 A		$1 \cdot 10^{-3}\ I$	
	> 2.2 A to 20 A		$2 \cdot 10^{-3}\ I$	
	> 20 A to 1000 A		$3 \cdot 10^{-3}\ I$	

Permanent Laboratory Munich - Electrical measurands

Calibration and measurement opportunities

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

Permanent Laboratory Munich - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance (ranges)	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3}$ *R*	*R* = set value Fluke
Measures	11 Ω to < 33 Ω		$33 \cdot 10^{-6}$ *R*	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*	
Alternating current resistance	0.1 Ω to 2 Ω	50 Hz to 400 Hz	$10 - 10^{-3}$ - *R*	

Permanent Laboratory Munich - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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	$0.13 \cdot 10^{-3}\ U$	

Permanent Laboratory Munich - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 Munich - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage	> 7 V to 22 V	10 Hz to 20 Hz	$17 \cdot 10^{-6}\ U$	U = measured value
measures and		> 20 Hz to 40 Hz	$16 \cdot 10^{-6}\ U$	
sources		> 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current sources and measures	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	

Permanent Laboratory Munich - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Capacity	190 pF to < 400 pF	10 Hz to 10 kHz	$4 \cdot 10^{-3}$ C + 8 pF	With 5520A / 5522A
measures	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 DC to 50	$6.5 \cdot 10^{-3}$ C	
	110 µF to < 330 µF	Hz DC to 20 Hz DC to	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	6 Hz DC to 2 Hz DC to	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	0.6 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF	DC up 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 with standard capacities
	> 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		$2 \cdot 10^{-9} \cdot f + U_{Tf}$	*f* = current measured value U_{Tf} =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 measures		33 mV to 1000 V 45 Hz to 65 kHz *PF* = 1		*P* = set value with Fluke 5520A/5522A
	109 µW to < 11kW	33 mA to < 11 A	1.4 · 10^{-3} *P*	*PF*: Power factor
	363 mW up to 20 kW	11 A to 20 A	2.0 · 10^{-3} *P*	
Direct current power Measures	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 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	$w(U_F)$ ... Incertainty of the amplitude of the voltage fundamental $w(/_F)$ ... Incertainty of the amplitude of the Current fundamental $w(\Phi_F)$ ... Uncertainty of the phase shift angle $w(U_{rms})$ ... Uncertainty of the effective voltage value $w(/_{rms})$ ... Uncertainty of the effective current value
	5 mW 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 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 smaller than 80 - 10^{-6}	
	> 50 VA to 120 kVA	>50 A to 120 A	not smaller than 0.14 - 10^{-3}	

Permanent Laboratory Munich - Electrical measurands

Calibrier- und Messmöglichkeiten (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Tension 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 display devices
	± 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	at discrete points In 10 % increments
	± 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	
Tension ratio		Bridge voltage:		

Permanent Laboratory Munich - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC voltage	0 mV/V		2.0 µV/V	
Bridge standards	-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	
Tension ratio	-10 mV/V to +10 mV/V		0.20 µV/V	
DC voltage	-20 mV/V to +20 mV/V		0.3 µV/V	

Permanent Laboratory Munich - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Bridge standards	-100 mV/V to +100 mV/V		1.5 µV/V	
Voltage ratio		Bridge voltage:		
DC voltage	-2 mV/V to +2 mV/V		0.35 µV/V	
Bridges, measures, measuring amplifiers	-5 mV/V to +5 mV/V		0.35 µV/V	
	-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	
		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	1 pC to 10^4 pC	0.2 Hz to < 1 Hz	0,5 %	
Charge amplifiers, charge meters		1 Hz to 10 kHz	0,4 %	
		> 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 10 Hz to 10 kHz
	5 mV to 120 V	R_i = 1 MΩ	$2.4 \cdot 10^{-3}\ U + 40$ µV	
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 = Self-rise time of the oscilloscope
	250 ps to 10 ms	> 250 mV to 2.5 V	$35 - 10^{-3} - t_r + 8$ ps	

Permanent Laboratory Munich - Dimensional Measurands

Calibrar and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Length Cylindrical setting standards, ring gauges: diameter *)	1 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.1:2006	$0.8\ \mu m + 2 \cdot 10^{-6} \cdot d$	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)	$0.8\ \mu m + 2 \cdot 10^{-6} \cdot d$	
Test pins: diameter *)	0.1 mm to 30 mm	VDI/VDE/DGQ 2618 Sheet 4.2:2007 Point 3.2.2 (Opt. 1)	$0.8\ \mu m + 2 \cdot 10^{-6} \cdot d$	
Thread gauges (one and multi-start cylindrical external and internal threads with straight flanks, symmetrical profile) Threaded mandrels: simple pitch 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)	$3\ \mu m + 10 \cdot 10^{-6} \cdot d$	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)	$3\ \mu m + 10 \cdot 10^{-6} \cdot d$	Two-ball method d is the measured Diameter
Length of plane-parallel, spherical or cylindrical measuring surface *)	0.01 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 19.1:2014	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	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)	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot d$	d is the measured diameter
feeler *)	0.03 mm to 2.00 mm	DIN 2275:2014	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	l is the measured length
Adjustment dimensions for micrometer *)	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	$1.5\ \mu m + 2 \cdot 10^{-6} \cdot l$	

Permanent Laboratory Munich - Dimensional Measurands

Calibrar and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Snap gauge *)	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 500 mm	VDI/VDE/DGQ 2618 Sheet 9.1:2006	30 µm + 30 · 10^{-6} · *l*	*l* is the measured Length
Depth caliper / height caliper *)	> 500 mm to 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006 VDI/VDE/DGQ 2618 Sheet 9.3:2006	50 µm + 30 · 10^{-6} · *l*	
micrometer *)	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm + 10 · 10^{-6} · *l*	
Precision indicator measuring screws*)	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002		
micrometer head *)	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008		
depth micrometers *)	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010		
Inside micrometers with 2-point contact on the calibration item *)	13 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	3 µm + 10 · 10^{-6} · *l*	
	> 300 mm to 500 mm		5 µm + 10 · 10^{-6} · *l*	
Inside micrometers with 2-line contact on the calibration item	5 mm to 100 mm	3-APD-0-0025-EN 2023:07	3 µm + 10 · 10^{-6} · *d*	*d* is the measured Diameter
Inside micrometers with 3-line contact on the calibration item *)	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 probe) 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 internal measurements *)	2 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 13.1:2005	7 µm + 10 · 10^{-6} · *l*	

Permanent Laboratory Munich - Dimensional Measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
dial gauges *)	0 mm to 100 mm	VDI/VDE/DGQ/DKD 2618 Sheet 11.1:2021	3 µm + 10 · 10^{-6} · /	Mechanical dial gauges
		VDI/VDE/DGQ/DKD 2618 Sheet 11.4:2020		Electronic digital dial gauges
precision indicator *)	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
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*		VDI/VDE 2648 Sheet 2 Rotational speed > 0.21/min Rotational speed < 0.21/min	0,5 ° 1,0 °	

Location Calibration laboratory Essen, Hermann-Drescher-Weg 4 a-d, 45329 Essen

Permanent Laboratory Essen - Electrical measurands

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC voltage measures	0 V		0.1 µV	*U* = set value
	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 sources	0 V		0.1 µV	*U* = measured value
	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
Direct current meters and sources	0 A	Precision Open	0.2 nA	*I* = set value
	0.1 µA to < 1 µA	Standard resistor 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 current clamps	1 mA to 2.2 A		$1 \cdot 10^{-3}$ *I*	
	> 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 opportunities

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

Permanent Laboratory Essen - Electrical measurands

Calibrar and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance (ranges)	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3}\ R$	R = set value Fluke
Measures	11 Ω to < 33 Ω		$33 \cdot 10^{-6}\ R$	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		$15 \cdot 10^{-3}\ R$	
Alternating current resistance	0.1 Ω to 2 Ω	50 Hz to 400 Hz	$10 - 10^{-3} - R$	

Permanent Laboratory Essen - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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	$0.13 \cdot 10^{-3}\ U$	

Permanent Laboratory Essen - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current sources and measures	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
Capacity measures	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	$4 \cdot 10^{-3}$ 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	With 5520A / 5522A

Permanent Laboratory Essen - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Capacity measures	3.3 µF to < 11 µF	10 Hz to 150 Hz	$4.5 \cdot 10^{-3}$ C	With 5520A / 5522A
	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 50 Hz	$6.5 \cdot 10^{-3}$ C	
	110 µF to < 330 µF		$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	DC up to 20 Hz	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	DC up to 6 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF	DC up to 2 Hz	$6.0 \cdot 10^{-3}$ C	
	11 mF to < 33 mF	DC up to 0.6 Hz	$8.0 \cdot 10^{-3}$ C	
	33 mF to 110 mF	DC up 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 standard capacities
	> 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		$2 \cdot 10^{-9} \cdot f + U_{Tf}$	*f* = current measured value U_{Tf} =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 measures	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*	
Direct current power Measures	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 up 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 Essen - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	$w(U_F)$ ... Uncertainty of the amplitude of the voltage fundamental $w(/_F)$ ... Incertainty of the amplitude of the Current fundamental $w(\Phi_F)$ ... Uncertainty of the phase shift angle $w(U_{rms})$ ... Uncertainty of the effective voltage value $w(/_{rms})$ ... Uncertainty of the effective current value
	5 mW 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 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 smaller than 80 - 10^{-6}	
	>50 VA to 120 kVA	>50 A to 120 A	not smaller than 0.14 - 10^{-3}	
Oscilloscopes Vertical deflection	5 mV to 5 V	R_i = 50 Ω	3.5 · 10^{-3} U + 35 µV	U - measured value Rectangular voltage 10 Hz to 10 kHz
	5 mV to 120 V	R_i = 1 MΩ	2.4 · 10^{-3} U + 40 µV	
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} - t_r + 5 ps	t_r = Self-rise time of the oscilloscope
	250 ps to 10 ms	> 250 mV to 2.5 V	35 - 10^{-3} - t_r + 8 ps	

Permanent Laboratory Essen - Dimensional Measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 · 10^{-6} · *d*	*d* is the measured diameter
Plug gauges: diameter *)	1 mm to 200 mm		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 external and internal threads with straight flanks, symmetrical profile) Threaded mandrels: simple pitch 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: single flank diameter *)	1.4 mm to 200 mm nominal diameter	VDI/VDE/DGQ 2618 Sheet 4.8:2006 Point 3.2.2 (Opt. 1) to Point 3.2.6 (Opt. 5)	3 µm + 10 · 10^{-6} · *d*	Scanning method *d* is the measured diameter
outside diameter *)			2 µm	
Core diameter / puncture diameter *)			5 µm	
Pitch / Pitch	0.5 mm to 8 mm		1.5 µm	
Threaded 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 Point 3.2.2 (Opt. 1) to Point 3.2.6 (Opt. 5)	3 µm + 10 · 10^{-6} · *d*	Scanning method *d* is the measured diameter
Outer diameter			5 µm	
Core diameter / puncture diameter c			2 µm	
Pitch / Pitch	0.5 mm to 8 mm		1.5 µm	
Threaded profile bracket 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Length				
plan parallel, spherical or cylindrical measuring surface *)	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 *)	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 micrometer *)	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm + 2 · 10^{-6} · *l*	
Snap gauge *)	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
Calipers for external, internal 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 / height caliper *)	> 500 mm to 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006	50 µm + 30 · 10^{-6} · *l*	
		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
micrometer *)	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm + 10 · 10^{-6} · *l*	
Precision indicator measuring screws *)	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002		
micrometer head *)	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008		
depth micrometers *)	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 item *)	13 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	3 µm + 10 · 10^{-6} · *l*	
	> 300 mm to 500 mm		5 µm + 10 · 10^{-6} · *l*	
Inside micrometers with 2-line contact on the calibration item	5 mm to 100 mm	3-APD-0-0025-EN 2023:07	3 µm + 10 · 10^{-6} · *d*	*d* is the measured diameter
Inside micrometers with 3-line contact on the calibration item *)	3 mm to 100 mm	VDI/VDE/DGQ 2618 Sheet 10.8:2002	3 µm + 10 · 10^{-6} · *d*	*d* is the measured diameter

Permanent Laboratory Essen - Dimensional Measurands

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Lever gauges (quick probe) for external	up 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 test) for internal 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
precision indicator *)	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
lever gauges *)	0 mm to 1.6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	
electr. inductive lenght measures *)	up to 100 mm	VDI/VDE/DGQ 2618 Sheet 14.1:2010	0.6 µm + 1 · 10^{-6} · l	
electr. incremental Length measures	up to 100 mm	3-APD-0-0027-EN 2023-08	0.6 µm + 1 · 10^{-6} · l	
Angle Perpendicularity deviation *)	up to 30 µm	VDI/VDE/DGQ/DKD 2618 Sheet 7.1:2019 Section 3.2.2.2 (Opt. 2)	2.5 µm + 1 · 10^{-6} · l_z	l_z : Length of the form and positional scaffolding up to 500 mm leg length
Flatness and sraightness deviation *)			4 µm + 5 · 10^{-6} · l_z	
Protractor Graduation value 1° *)	-180° to 180°	VDI/VDE/DGQ 2618 Sheet 7.2:2008	30'	
scale graduation value 5'*)	0° to 360°		1'	
Flat-line parallelism deviation *)	up to 500 mm	VDI/VDE/DGQ 2618 Sheet 5.1:2022	4 µm + 5 · 10^{-6} · l	l is the measured
flatness deviation *)			2.2 µm + 3.5 · 10^{-6} · l	
Straight edge sraightness deviation *)	up 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 to 2000 µm/m µm/m (-412") (412")	APD-0-0244-EN 2023-01	1.7 µm/m (0,35")	max. leg length of the KG: 500 mm
Tape dimensions and scales		VDI/VDE/DGQ 2618 Sheet 8.2:2023	50 µm + 20 · 10^{-6} · l	l is the measured length
Belt dimensions	0 m to 100 m			
Scales	0 m to 3 m			

Location Calibration laboratory Hamburg, Meiendorfer Straße 205, 22145 Hamburg

Permanent Laboratory Hamburg - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC voltage measures	0 V		0.1 µV	U = set value
	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 sources	0 V		0.1 µV	U = measured value
	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
Direct current meters and sources	0 A	Precision Open	0.2 nA	I = set value
	0.1 µA to < 1 µA	Standard 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 current clamps	1 mA to 2.2 A		$1 \cdot 10^{-3}\ I$	
	> 2.2 A to 20 A		$2 \cdot 10^{-3}\ I$	
	> 20 A to 1000 A		$3 \cdot 10^{-3}\ I$	

Permanent Laboratory Hamburg - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance	0 Ω		50 µ Ω	R = set value Fluke
	1 Ω; 1.9 Ω		$95 \cdot 10^{-6}\ R$	5700A
	10 Ω		$28 \cdot 10^{-6}\ R$	
	19 Ω		$27 \cdot 10^{-6}\ R$	
	100 Ω; 190 Ω		$17 \cdot 10^{-6}\ R$	
	1 kΩ		$13 \cdot 10^{-6}\ R$	
	1.9 kΩ		$13 \cdot 10^{-6}\ R$	
	10 kΩ		$12 \cdot 10^{-6}\ R$	
	19 kΩ		$12 \cdot 10^{-6}\ R$	
	100 kΩ		$14 \cdot 10^{-6}\ R$	
	190 kΩ		$14 \cdot 10^{-6}\ R$	
	1 MΩ		$20 \cdot 10^{-6}\ R$	
	1.9 MΩ		$21 \cdot 10^{-6}\ R$	
	10 MΩ		$40 \cdot 10^{-6}\ R$	
	19 MΩ		$48 \cdot 10^{-6}\ R$	
	100 MΩ		$110 \cdot 10^{-6}\ R$	
	0 Ω		100 µΩ	R = measured
	1 Ω to 10 Ω		$16 \cdot 10^{-6}\ R$ + 50 µΩ	value HP 3458A
	> 10 Ω to 100 Ω		$12 \cdot 10^{-6}\ R$ + 500 µΩ	
	> 100 Ω to 1 kΩ		$15 \cdot 10^{-6}\ R$	
	> 1 kΩ to 10 kΩ		$15 \cdot 10^{-6}\ R$	
	> 10 kΩ to 100 kΩ		$15 \cdot 10^{-6}\ R$	
	> 100 kΩ to 1 MΩ		$35 \cdot 10^{-6}\ R$	
	> 1 MΩ to 10 MΩ		$150 \cdot 10^{-6}\ R$	
	> 10 MΩ to 100 MΩ		$600 \cdot 10^{-6}\ R$	
	> 100 MΩ to 1 GΩ		$5 \cdot 10^{-3}\ R$	
	0.001 Ω to 0.1 Ω	Substitution method with	$50 \cdot 10^{-6}\ R$	
	> 0.1 Ω to 1 MΩ	normal resistance	$20 \cdot 10^{-6}\ R$	
	> 1 MΩ to 100 MΩ		$30 \cdot 10^{-6}\ R$	
DC resistance	1 mΩ		$0.1 \cdot 10^{-3} \cdot R$	
	10 mΩ		$30 \cdot 10^{-6} \cdot R$	
	100 mΩ		$30 \cdot 10^{-6} \cdot R$	
	1 Ω		$30 \cdot 10^{-6} \cdot R$	
	1 mΩ to 10 mΩ	Substitution procedure	$0.1 \cdot 10^{-3} \cdot R$	
	> 10 mΩ to 1 Ω	Substitution procedure	$30 \cdot 10^{-6} \cdot R$	
	0.1 Ω to 2 Ω	Direct procedure	$50 \cdot 10^{-6} \cdot R$	

Permanent Laboratory Hamburg - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance (ranges)	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3}\ R$	R = set value Fluke
Measures	11 Ω to < 33 Ω		$33 \cdot 10^{-6}\ R$	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		$15 \cdot 10^{-3}\ R$	
Alternating current 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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	$0.13 \cdot 10^{-3}\ U$	

Permanent Laboratory Hamburg - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 Hamburg - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 Hamburg - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Alternating current sources and measures	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 Hamburg - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Capacity measures	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 DC to 50	$6.5 \cdot 10^{-3}$ C	
	110 µF to < 330 µF	Hz DC to 20 Hz DC	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	to 6 Hz	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	DC up to 2 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF	DC up to 0.6 Hz DC	$6.0 \cdot 10^{-3}$ C	
	11 mF to < 33 mF	up to 0.2 Hz	$8.0 \cdot 10^{-3}$ 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 with standard capacities
	> 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*	

Permanent Laboratory Hamburg - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Frequency	1 mHz to 1 GHz		$2 \cdot 10^{-9} \cdot f + U_{Tf}$	f = current measured value U_{Tf} =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 measures		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	$2.0 \cdot 10^{-3} P$	
Direct current power Measures	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

Permanent Laboratory Hamburg - Electrical measurands

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	$w(U_F)$ ... Incertainty of the amplitude of the voltage fundamental $w(/_F)$ ... Incertainty of the amplitude of the Current fundamental $w(\Phi_F)$ ... Uncertainty of the phase shift angle $w(U_{rms})$ ... Uncertainty of the effective voltage value $w(/_{rms})$ ... Uncertainty of the effective current value
	5 mW 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 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 smaller than 80 - 10^{-6}	
	> 50 VA to 120 kVA	> 50 A to 120 A	not smaller than 0.14 - 10^{-3}	
Oscilloscopes Vertical deflection	5 mV to 5 V	R_i = 50 Ω	3.5 · 10^{-3} U + 35 µV	U - measured value square wave voltage 10 Hz to 10 kHz
	5 mV to 120 V	R_i = 1 MΩ	2.4 · 10^{-3} U + 40 µV	
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} - t_r + 5 ps	t_r = Self-rise time of the oscilloscope
	250 ps to 10 ms	> 250 mV to 2.5 V	35 - 10^{-3} - t_r + 8 ps	

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

Permanent laboratory Mörfelden-Walldorf - Electrical measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC voltage measures	0 V		0.1 µV	U = set value
	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 sources	0 V		0.1 µV	U = measured value
	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
Direct current meters and sources	0 A	Precision Open	0.2 nA	I = set value
	0.1 µA to < 1 µA	Standard 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 current clamps	1 mA to 2.2 A		$1 \cdot 10^{-3}\ I$	
	> 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance meters	0 Ω		50 µ Ω	R = set value
	1 Ω; 1.9 Ω		$95 \cdot 10^{-6}\ R$	Fluke 5700A
	10 Ω		$28 \cdot 10^{-6}\ R$	
	19 Ω		$27 \cdot 10^{-6}\ R$	
	100 Ω; 190 Ω		$17 \cdot 10^{-6}\ R$	
	1 kΩ		$13 \cdot 10^{-6}\ R$	
	1.9 kΩ		$13 \cdot 10^{-6}\ R$	
	10 kΩ		$12 \cdot 10^{-6}\ R$	
	19 kΩ		$12 \cdot 10^{-6}\ R$	
	100 kΩ		$14 \cdot 10^{-6}\ R$	
	190 kΩ		$14 \cdot 10^{-6}\ R$	
	1 MΩ		$20 \cdot 10^{-6}\ R$	
	1.9 MΩ		$21 \cdot 10^{-6}\ R$	
	10 MΩ		$40 \cdot 10^{-6}\ R$	
	19 MΩ		$48 \cdot 10^{-6}\ R$	
	100 MΩ		$110 \cdot 10^{-6}\ R$	
sources	0 Ω		100 µΩ	R = measured
	1 Ω to 10 Ω		$16 \cdot 10^{-6}\ R$ + 50 µΩ	value HP 3458A
	> 10 Ω to 100 Ω		$12 \cdot 10^{-6}\ R$ + 500 µΩ	
	> 100 Ω to 1 kΩ		$15 \cdot 10^{-6}\ R$	
	> 1 kΩ to 10 kΩ		$15 \cdot 10^{-6}\ R$	
	> 10 kΩ to 100 kΩ		$15 \cdot 10^{-6}\ R$	
	> 100 kΩ to 1 MΩ		$35 \cdot 10^{-6}\ R$	
	> 1 MΩ to 10 MΩ		$150 \cdot 10^{-6}\ R$	
	> 10 MΩ to 100 MΩ		$600 \cdot 10^{-6}\ R$	
	> 100 MΩ to 1 GΩ		$5 \cdot 10^{-3}\ R$	
	0.001 Ω to 0.1 Ω	Substitution method with	$50 \cdot 10^{-6}\ R$	
	> 0.1 Ω to 1 MΩ	normal resistance	$20 \cdot 10^{-6}\ R$	
	> 1 MΩ to 100 MΩ		$30 \cdot 10^{-6}\ R$	

Permanent Laboratory Mörfelden-Walldorf - Electrical measured variables

Calibrar and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance meters	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3}\ R$	R = set value
	11 Ω to < 33 Ω		$33 \cdot 10^{-6}\ R$	Fluke 5520A
	33 Ω to < 110 Ω		$29 \cdot 10^{-6}\ R$	/5522A
	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		$15 \cdot 10^{-3}\ R$	
Alternating current resistance	0.1 Ω to 2 Ω	50 Hz to 400 Hz	$10 - 10^{-3} - R$	
AC voltage measures 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 Mörfelden-Walldorf - Electrical measured variables

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 sources and measures	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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Capacity measures	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 DC to 50 Hz	$6.5 \cdot 10^{-3}$ C	
	110 µF to < 330 µF	DC to 20 Hz DC to 6 Hz DC	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	to 2 Hz DC to 0.6 Hz	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	DC up to 0.2 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF		$6.0 \cdot 10^{-3}$ 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 standard
		> 1 kHz to 10 kHz	$2.5 - 10^{-3}$ *C*	capacities
Frequency	1 mHz to 1 GHz		$2 \cdot 10^{-9} \cdot f + U_{Tf}$	*f* = current measured value U_{Tf} =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 measures	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*	
Direct current power Measures	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 ≤ U	$30 - 10^{-6}$ *P*	*P* calculated
	> 300 W to 1 kW	≤ 1000 V	$200 - 10^{-6}$ *P*	power
	> 1 kW to 1 MW	100 µA ≤ I ≤ 2000 A	$300 - 10^{-6}$ *P*	

Permanent Laboratory Mörfelden-Walldorf - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC active power		1 V to 1000 V 45 Hz to 65 Hz 0.05 ≤ cos φ ≤ 1	$2\sqrt{w(U_F)^2 + w(I_F)^2 + w(\Phi_F)^2}$	$w(U_F)$ ... Uncertainty of the amplitude of the voltage fundamental $w(I_F)$ ... Incertainty of the amplitude of the Current fundamental $w(\Phi_F)$ ... Uncertainty of the phase shift angle $w(U_{rms})$ ... Uncertainty of the effective voltage value $w(I_{rms})$ ... Uncertainty of the effective current value
	5 mW 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 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 smaller than 80 - 10^{-6}	
	> 50 VA to 120 kVA	>50 A to 120 A	not smaller than 0.14 - 10^{-3}	
Oscilloscopes Vertical deflection	5 mV to 5 V	R_i = 50 Ω	3.5 · 10^{-3} U + 35 µV	U - measured value square wave voltage 10 Hz to 10 kHz
	5 mV to 120 V	R_i = 1 MΩ	2.4 · 10^{-3} U + 40 µV	
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} - t_r + 5 ps	t_r = Self-rise time of the oscilloscope
	250 ps to 10 ms	> 250 mV to 2.5 V	35 - 10^{-3} - t_r + 8 ps	

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

Permanent Laboratory Winsen - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC voltage measures	0 V		0.1 µV	U = set value
	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 sources	0 V		0.1 µV	U = measured value
	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
Direct current meters and sources	0 A	Precision Open	0.2 nA	I = set value
	0.1 µA to < 1 µA	Standard 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 current clamps	1 mA to 2.2 A		$1 \cdot 10^{-3}\ I$	
	> 2.2 A to 20 A		$2 \cdot 10^{-3}\ I$	
	> 20 A to 1000 A		$3 \cdot 10^{-3}\ I$	

Permanent Laboratory Winsen - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance meters	0 Ω		50 µ Ω	R = set value
	1 Ω; 1.9 Ω		$95 \cdot 10^{-6}\ R$	Fluke 5700A
	10 Ω		$28 \cdot 10^{-6}\ R$	
	19 Ω		$27 \cdot 10^{-6}\ R$	
	100 Ω; 190 Ω		$17 \cdot 10^{-6}\ R$	
	1 kΩ		$13 \cdot 10^{-6}\ R$	
	1.9 kΩ		$13 \cdot 10^{-6}\ R$	
	10 kΩ		$12 \cdot 10^{-6}\ R$	
	19 kΩ		$12 \cdot 10^{-6}\ R$	
	100 kΩ		$14 \cdot 10^{-6}\ R$	
	190 kΩ		$14 \cdot 10^{-6}\ R$	
	1 MΩ		$20 \cdot 10^{-6}\ R$	
	1.9 MΩ		$21 \cdot 10^{-6}\ R$	
	10 MΩ		$40 \cdot 10^{-6}\ R$	
	19 MΩ		$48 \cdot 10^{-6}\ R$	
	100 MΩ		$110 \cdot 10^{-6}\ R$	
sources	0 Ω		100 µΩ	R = measured
	1 Ω to 10 Ω		$16 \cdot 10^{-6}\ R$ + 50 µΩ	value
	> 10 Ω to 100 Ω		$12 \cdot 10^{-6}\ R$ + 500 µΩ	HP 3458A
	> 100 Ω to 1 kΩ		$15 \cdot 10^{-6}\ R$	
	> 1 kΩ to 10 kΩ		$15 \cdot 10^{-6}\ R$	
	> 10 kΩ to 100 kΩ		$15 \cdot 10^{-6}\ R$	
	> 100 kΩ to 1 MΩ		$35 \cdot 10^{-6}\ R$	
	> 1 MΩ to 10 MΩ		$150 \cdot 10^{-6}\ R$	
	>10 MΩ to 100 MΩ		$600 \cdot 10^{-6}\ R$	
	> 100 MΩ to 1 GΩ		$5 \cdot 10^{-3}\ R$	
	0.001 Ω to 0.1 Ω	Substitution method with	$50 \cdot 10^{-6}\ R$	
	> 0.1 Ω to 1 MΩ	normal resistance	$20 \cdot 10^{-6}\ R$	
	> 1 MΩ to 100 MΩ		$30 \cdot 10^{-6}\ R$	

Permanent Laboratory Winsen - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
DC resistance meters	1 Ω to < 11 Ω		$0.12 \cdot 10^{-3}\ R$	R = set value Fluke 5520A / 5522A
	11 Ω to < 33 Ω		$33 \cdot 10^{-6}\ R$	
	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		$15 \cdot 10^{-3}\ R$	
Alternating current resistance	0.1 Ω to 2 Ω	50 Hz to 400 Hz	$10 - 10^{-3} - R$	
AC voltage measures 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 Winsen - Electrical measured variables

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
AC voltage measures 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 sources and measures	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 measured variables

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Capacity measures	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 DC to 50	$6.5 \cdot 10^{-3}$ C	
	110 µF to < 330 µF	Hz DC to 20 Hz DC to	$6.0 \cdot 10^{-3}$ C	
	330 µF to < 1.1 mF	6 Hz DC to 2 Hz DC to	$6.0 \cdot 10^{-3}$ C	
	1.1 mF to < 3.3 mF	0.6 Hz	$6.0 \cdot 10^{-3}$ C	
	3.3 mF to < 11 mF	DC up 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 standard
		> 1 kHz to 10 kHz	$2.5 - 10^{-3}$ *C*	capacities
Frequency	1 mHz to 1 GHz		$2 \cdot 10^{-9} \cdot f + U_{Tf}$	f = current measured value U_{Tf} =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 measures		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*	
Direct current power Measures	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
	> 300 W to 1 kW	1 mV ≤ U ≤ 1000 V	$200 - 10^{-6}$ *P*	power
	> 1 kW to 1 MW	100 µA ≤ I ≤ 2000 A	$300 - 10^{-6}$ *P*	

Permanent Laboratory Winsen - Electrical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 smaller than 80 - 10^{-6} not smaller than 0.14 - 10^{-3}	w(U_F) ... Incertainty of the amplitude of the voltage fundamental w($/_F$) ... Incertainty of the amplitude of the Current fundamental w(Φ_F) ... Uncertainty of the phase shift angle w(U_{rms}) ... Uncertainty of the effective voltage value w($/_{rms}$) ... Uncertainty of the effective 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 smaller 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 smaller than 80 - 10^{-6} not smaller than 0.14 - 10^{-3}	
Oscilloscopes 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	U : measured value Rectangular 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} - t_r + 5 ps 35 - 10^{-3} - t_r + 8 ps	t_r : Self-rise time of the oscilloscope

Permanent Laboratory Winsen - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / Procedure	Expanded measurement uncertainty	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 · 10^{-6} · *d*	*d* is the measured Diameter
Plug gauges: diameter *)	1 mm to 200 mm		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 external and internal threads with straight flanks, symmetrical profile) Threaded mandrels: simple pitch 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
Length of plane-parallel, spherical or cylindrical measuring surface *)	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 *)	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 micrometer *)	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm + 2 · 10^{-6} · *l*	

Permanent Laboratory Winsen - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / Procedure	Expanded measurement uncertainty	Remarks
Snap gauge *)	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
Calipers for external, internal 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 / height caliper *)	> 500mm to 1000 mm	VDI/VDE/DGQ 2618 Sheet 9.2:2006	50 µm + 30 · 10^{-6} · *l*	
		VDI/VDE/DGQ 2618 Sheet 9.3:2006		
micrometer *)	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm + 10 · 10^{-6} · *l*	
Precision indicator measuring screws *)	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002		
micrometer head *)	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008		
depth micrometers *)	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010		
Inside micrometers with 2-point contact on the calibration item *)	13 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.7:2010	3 µm + 10 · 10^{-6} · *l*	
	> 300mm to 500 mm		5 µm + 10 · 10^{-6} · *l*	
Inside micrometers with 2-line contact on the calibration item	5 mm to 100 mm	3-APD-0-0025-EN 2023:07	3 µm + 10 · 10^{-6} · *d*	*d* is the measured diameter
Inside micrometers with 3-line contact on the calibration item *)	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 probe) for external measurements *)	up to 200 mm	VDI/VDE/DGQ 2618 Sheet 12.1:2005	7 µm + 10 · 10^{-6} · *l*	*l* is the measured length
Lever gauges (rapid probe) for Innenmessungen *)	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		Electronic digital dial gauges
precision indicator *)	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
lever gauges *)	0 mm to 1.6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	

Permanent Laboratory Winsen - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / Procedure	Expanded measurement uncertainty	Remarks
Tape dimensions and scales				
Belt dimensions	0 m to 100 m	VDI/VDE/DGQ 2618 Sheet 8.2:2023	50 µm + 20 · 10^{-6} · /	/ is the measured length
Scales	0 m to 3 m			

Permanent Laboratory Heidenheim - Dimensional measured variables

Calibration and measures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 multi-start cylindrical Exterior and interior thread with straight flanks, symmetrical profile)				
threaded mandrels: simple Flank diameter	Nominal diameter 1.4 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.8:2006 Point 3.2.2 (Opt. 1) to Point 3.2.6 (Opt. 5)	3 µm + 10 · 10^{-6} · d	d = is the measured diameter
outside diameter *)			2 µm	
Core diameter resp. puncture diameter *)			5 µm	
Gradient or pitch *)	0.5 mm to 8 mm		1.5 µm	
Threaded profile bracket α *)	> 27°		(3 + 1 / l_F)', but not smaller than 6'	l_F = flank length in mm
Threaded rings: simple pitch diameter *)	Nominal diameter: 5 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 4.9:2006 Point 3.2.2 (Opt. 1) to Point 3.2.6 (Opt. 5)	3 µm + 10 · 10^{-6} · d	d = is the measured diameter
outside diameter *)			5 µm	
Core diameter resp. puncture diameter *)			2 µm	
Gradient or pitch *)	0.5 mm to 8 mm		1.5 µm	
Threaded profile bracket α *)	> 27°		(3 + 1 / l_F)', but not smaller than 6'	l_F = flank length in mm

Permanent Laboratory Heidenheim - Dimensional measured variables

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Length				
plan parallel, spherical oder cylindrical measuring surface *)	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 *)	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 micrometer *)	25 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 4.4:2009	1.5 µm + 2 · 10^{-6} · *l*	
Snap gauge *)	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
Calipers for external, internal 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
	> 500 mm to 1000 mm		50 µm + 30 · 10^{-6} · *l*	
deph caliper *)		VDI/VDE/DGQ 2618 Sheet 9.2:2006		
height caliper *)		VDI/VDE/DGQ 2618 Sheet 9.3:2006		

Permanent Laboratory Heidenheim - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
micrometer *)	0 mm to 500 mm	VDI/VDE/DGQ 2618 Sheet 10.1:2001	3 µm + 10 · 10^{-6} · *l*	
precision indicatormess-head *)	0 mm to 200 mm	VDI/VDE/DGQ 2618 Sheet 10.3:2002	3 µm + 10 · 10^{-6} · *l*	
micrometer head *)	0 mm to 50 mm	VDI/VDE/DGQ 2618 Sheet 10.4:2008	3 µm + 10 · 10^{-6} · *l*	
depth micrometers *)	0 mm to 300 mm	VDI/VDE/DGQ 2618 Sheet 10.5:2010	3 µm + 10 · 10^{-6} · *l*	
Inside micrometers with 2-line contact on the calibration object	5 mm to 100 mm	3-APD-0-0025-EN 2023:07	3 µm + 10 · 10^{-6} · *d*	*d* is the measured diameter
Inside micrometers with 3-line contact on the calibration item *)	3 mm to 150 mm	VDI/VDE/DGQ/DKD 2618 Sheet 10.8:2024	3 µm + 10 · 10^{-6} · *d*	*d* is the measured diameter
Lever gauges (rapid test) for Outsidde measures *)	up 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 button) 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
precision indicator *)	0 mm to 3 mm	VDI/VDE/DGQ 2618 Sheet 11.2:2002	0.6 µm	
lever gauges *)	0 mm to 1.6 mm	VDI/VDE/DGQ 2618 Sheet 11.3:2002	1.0 µm	

Permanent Laboratory Heidenheim - Dimensional measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Coordinate measuring technology Prismatic, conical and spherical workpieces	Coordinate measuring machine with a calibrated measuring volume of: X = 700 mm Y = 1400 mm Z = 500 mm	3-APD-0-0292-EN: 2024-07 Tactile measurement in the form of single-point probing with a coordinate measuring machine and determination of control geometries determined by geometric parameters (single points, straight lines, planes, circles, spheres, cylinders, tori) with the evaluation software of the CMM. Single-point probing is performed with a fixed, predefined measuring force or with extrapolation to zero measuring force. Single-point probes as "self-centering probes" are not used within the scope of accreditation. To ensure traceability, a comparable standard is calibrated. In addition, the following restrictions must be observed: It must be possible to distribute measuring points evenly over form elements; Covering at least 50% of the surface of molded elements; Evaluation of medium form elements	The measurement uncertainty is determined by a measurement uncertainty balance based on the guideline VDI/VDE 2617 Sheet 11:2011. It is task-specific and is used for a coverage probability of 95 % (increase factor k = 2). Example of measurement uncertainty for a measurement task: Parallel gauge block with two nominal dimensions, a laterally projecting probe with a length of 150 mm was used, the expanded measurement uncertainty of the test characteristic "distance" was determined: L = 50 mm, U = 2.3 µm L = 1400 mm, U = 13.7 µm	The determined measurement uncertainty can differ significantly from the uncertainty given as an example for simple measurement tasks.

Abbreviations used:

CMC Calibration and measurement capabilities DIN Deutsches Institut für Normung e.V. (German Institute for Standardization)
DKD-R Guideline of the German Calibration Service (DKD), published by the Physikalisch-Technische Bundesanstalt
DGQ German Society for Quality e.V.
VDE Association for Electrical, Electronic & Information Technologies
VDI Association of German Engineers
VDI/VDE/DGQ 2618 VDI guideline series for test equipment monitoring
APD Self-developed calibration procedure 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: 31.05.2024

Date of issue: 31.05.2024

This annex to the certificate is part of the accreditation certificate D-K-15070-01-00.

Holder of the partial accreditation certificate:

Testo Industrial Services GmbH
Gewerbestraße 3, 79199 Kirchzarten

with the locations

Testo Industrial Services GmbH
Calibration laboratory Kirchzarten
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Testo Industrial Services GmbH Calibration laboratory Hamburg
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Testo Industrial Services GmbH Calibration laboratory Mörfelden-Walldorf
Kurhessenstraße 11, 64546 Mörfelden-Walldorf

Testo Industrial Services GmbH Calibration laboratory Winsen
Tönnhäuser Weg 100-106, 21423 Winsen (Luhe)

The calibration laboratory fulfils the requirements according to DIN EN ISO/IEC 17025:2018 to perform the conformity assessment activities listed in this annex. The calibration laboratory complies with additional legal and normative requirements, including those in relevant sectoral programs, where applicable, provided these 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 generally in accordance with the principles of DIN EN ISO 9001.

Calibration in the areas:

Thermodynamic measurements

Temperature measurements

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

Moisture measurements

- **Measures for relative humidity** [a)]
- **Measures for absolute humidity** [a)]
- **Climate chambers (humidity)** [c)]

Chemical and medical parameters

Chemical analyses and reference materials

- **Measures for electrolytic conductivity**
- **pH value**
- **Gas mixtures**

Mechanical measurements

- **Power**
- **Scales** [c)]
- **Print** [a)]
- **Drehmoment** [a)]
- **Acceleration**

Flow measurements

- **Flow velocity of gases**
- **Volume of flowing gases**
- **Mass of flowing gases**
- **Volume of flowing liquids**
- **Mass of flowing liquids**

Acoustic measurements

[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 use the standards/calibration guidelines listed here with different issue statuses without being required to inform and obtain prior approval from DAkkS. The calibration laboratory has an up-to-date list of all standards/calibration guidelines in the flexible accreditation area.

Calibration and measurement options

Location calibration laboratory Gewerbestraße 3, 79199 Kirchzarten

Permanent laboratory calibration laboratory Gewerbestraße 3 - Mechanical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 (amount / phase). Pick-up mass up to 0.9 kg, travel 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 (amount / phase). Pick-up mass up to 0.2 kg, travel 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 (amount / phase). Pick-up mass up to 0.5 kg, travel 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

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Pressure *) Negative and positive overprint p_e	-1 bar to -0.03 bar	DKD-R 6-1: 2014	10 µbar + 5-10^{-5} - p_e	p_e = measured value pressure medium: Gas
	> -0.03 bar to < -1 mbar		50 µbar + 1-10^{-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 + 1-10^{-4} - p_e	
	> 0.2 bar to 2 bar		30 µbar + 2.5-10^{-5} - p_e	
	> 2 bar to 20 bar		0.05 mbar + 2.5-10^{-5} - p_e	
	> 20 bar to 100 bar		0.5 mbar + 2.5-10^{-5} - p_e	
	> 100 bar to 400 bar		6 mbar + 3.5-10^{-5} - p_e	
	0 bar		$7 \cdot 10^{-5} \cdot p_e$ at least 7.5 mbar	Print medium: Oil
	2 bar to 1200 bar			
Absolutdruck p_{abs}	0.01 bar to 2 bar	DKD-R 6-1: 2014 $p_{abs} = p_e + p_{amb}$	15 µbar + 2.5-10^{-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 + 2.5-10^{-5} - p_{abs}	
	> 20 bar to 101 bar		0.6 mbar + 2.5-10^{-5} - p_{abs}	
	> 101 bar to 401 bar		7 mbar + 3.5-10^{-5} - p_{abs}	
	1 bar 3 bar to 1201 bar		$7 \cdot 10^{-5} \cdot p_{abs}$ at least 7.5 mbar	p_{abs} = Messwert Print medium: Oil Measuresment uncertainty of the barometer must be taken into account

Permanent laboratory calibration laboratory Gewerbestraße 3 - Acoustics

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Akustik *)				
Measuring microphone /	Transmission dimension: -60 dB to + 20 dB (referred to 1 V/Pa)	DIN EN 61094-8:2013		
Sound pressure level (free field) Free-field idle or free-field operating transmission -measures	125 Hz to < 250 Hz	Substitution process in a low-reflection chamber with ½''- Normal at sound pressure level 74 dB up to 94 dB	0.35 dB	
	250 Hz to 8 kHz		0.30 dB	
	> 8 kHz to 10 kHz		0.40 dB	
	> 10 kHz to 20 kHz		0.45 dB	
Measuring microphone /	Transmission dimension: -60 dB to + 20 dB (referred to 1 V/Pa)	DIN EN IEC 60942:2018		
Sound pressure level (pressure) Pressure idle or pressure operating transfer -measures	250 Hz / 124 dB	Calibration with reference standard	0.15 dB	
	1000 Hz / 94 dB	Pistonphon	0.15 dB	
	1000 Hz / 114 dB	e calibrator	0.15 dB	
		Calibrator		
	Transmission dimension: -60 dB to + 20 dB (referred to 1 V/Pa)	DIN EN 61094-5:2016		1/2'' microphones only
	31.5 Hz to 5 kHz	Calibration with reference standard	0.20 dB	
	> 5 kHz to 10 kHz	Comparative measurement with electro-acoustic coupler (SQ-4.2) at 64 dB to 94 dB	0.25 dB	
	> 10 kHz to 16 kHz		0.50 dB	
Sound level meter /	Display deviation in the frequency range:	DIN EN 61672-3:2017		
Sound pressure level display (free field)	125 Hz to < 250 Hz	Substitution process in a low-reflection chamber with ½''- Normal at sound pressure level 74 dB up to 94 dB	0,50 dB	
	250 Hz to 8 kHz		0.40 dB	
	> 8 kHz to 10 kHz		0.50 dB	
	> 10 kHz to 20 kHz		0.60 dB	
Sound level meter /	Display deviation at the reference point:	DIN EN 61672-3:2017		
Sound pressure level display (pressure)		Calibration with reference standard		
	250 Hz / 124 dB	Pistonphone	0.15 dB	
	1 kHz / 94 dB	Calibrator	0.15 dB	
	1 kHz / 114 dB	Calibrator	0.15 dB	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Acoustics

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Sound level calibrator Sound pressure level (Print)	Sound pressure level: 74 dB to 130 dB (based on 20 µPa) 250 Hz / 124 dB 1000 Hz / 94 dB 1000 Hz / 114 dB	DIN EN IEC 60942:2018 Substitution method with recycled Calibrators	0.15 dB	
Frequency	250 Hz / 1000 Hz		0.1 Hz	

Permanent laboratory calibration laboratory Gewerbestraße 3 - Thermodynamic measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 standard 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 fixed temperature 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 up 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 Fixed points: TPW, Sn, Zn, Al	8.0 mK	
Resistance thermometer,	-196 °C	DKD-R 5-1:2018 in liquid nitrogen	15 mK	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Thermodynamic measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
direct reading thermometers with resistance sensor *)	0,00 °C	DKD-R 5-1:2018 Ice point	5.0 mK	Comparison with standard resistance thermometers
	-120 °C to 200 °C	DKD-R 5-1:2018 in the 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 the 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 climate cabinet	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 metall-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 fixed temperature 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 connected precious metal thermocouple sensor *)	-40 °C to 500 °C	DKD-R 5-3:2018 in the 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 oven	1,6 K	
Non-precious metal thermocouples, direct reading with	-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	0,2 K	

Permanent laboratory Calibration laboratory Gewerbestraße 3 - Thermodynamic measurands

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
connected non-precious metal thermocouple sensor *)	200 °C to 400 °C	in the liquid bath	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-in-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	
Block-temperature thermometer *)	-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 radiators
	> 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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Temperature display units and simulators for Precious metall-thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature display units and simulators for Non-precious metal thermos elements- *)	-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 climate cabinet	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 opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 Measuresment uncertainty expressed as absolute value of relative humidity
Electrical psychrometers	2 % to 98 %		0.3 % + 0.007 - *rH*	
Hygrometer, data logger, measuring transducer *)	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 Measuresment uncertainty 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 rate measured variables

Calibrierandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Flow of gases Flow velocity from Gases	0.1 m/s to 68 m/s	Measuresment with low-turbulence free jet	0.5 %; but not less than 0.01 m/s	
Volumetric 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Electrolytic conductivity Conductivity measures and facilities	1.3 µS/cm to < 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 to 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	
Flue gas / flue gas measures Gaskonzentration Sauerstoff O_2	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	
Kohlenstoffdioxid CO_2	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.	
Nitrogen monoxide NO	150 ppm 300 ppm		3.8 ppm vol 7.5 ppm vol	
Stickstoffdioxid NO_2	100 ppm		3.0 ppm vol	
Schwefeldioxid SO_2	100 ppm		3.0 ppm vol	
Sulphur wasserstoff H_2S	200 ppm		7.0 ppm vol	
Methan CH_4	5000 ppm		120 ppm vol	

On-site calibration

On-site calibration - Thermodynamic measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 the 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 the 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 climate cabinet	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 the 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 thermocouple sensor *)	-80 °C to 200 °C	DKD-R 5-3:2018 in the 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 resistance thermometers
	200 °C to 300 °C		15 mK	

On-site calibration - Thermodynamic measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Dry-well *)	-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 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 display units 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 units and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	
Measuresment type in climate 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 climate chambers without air circulation *)	-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	
Airconditioning cabinets with recirculating 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 conditioning cabinets 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Dew point temperature Dew point measures, -hygrometer	-25 °C to 70 °C	3-APD-0-0164-EN: 2023-01 1-Temperature 2-Pressure-Humidity generator	0,09 K	Comparison with dew point mirror
Relative humidity Measuresment location in climate chambers with circulating air *)	5 % to 30 %	DKD-R 5-7:2018 Method C Temperature range: -10 °C to 95 °C	0,3 %	Measuring medium air Humidity reference is calculated from dew point and air temperature Measuresment uncertainty expressed as absolute value of relative humidity
	> 30 % to 60 %		0,4 %	
	> 60 % to 98 %		0,6 %	
Air conditioning cabinets with recirculating 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 Hygrometer, data logger, transmitter *)	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 point mirror and resistance thermometer Measuresment uncertainty expressed as absolute value of relative humidity
Hygrometer, data logger, measuring transducer *)	10 % to 95 %	DKD-R 5-8:2019 Humidity generator with limited usable volume Chamber temperature: 0 °C to 40 °C	0,9 %	References: Dew point mirror and resistance thermometer Measuresment uncertainty expressed as absolute value of relative humidity
	10 % to 95 %	DKD-R 5-8:2019 Humidity generator with limited usable volume Chamber temperature: > 40 °C to 70 °C	2,0 %	

On-site calibration - mechanical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
scales *) non-automatic electronic weighing instruments	0 kg to 10 kg	EURAMET cg-18 Version 4.0 Calibration at the installation site	$1 \cdot 10^{-6}$	with class E weights[2]
	> 10 kg to 80 kg		$5 \cdot 10^{-6}$	
Drehmoment *) Calibration equipment	0,2 N·m to 1000 N·m	DKD-R 10-8:2020	$2 \cdot 10^{-3}$	
Torque - transducer, - sensors, - electrodes	0.4 N-m to < 10 N-m	DIN 51309:2022		
	10 N-m to 5000 N-m		$0.5 \cdot 10^{-3}$	
Hand-operated torque screwdriving tools	1 N-m to 1000 N-m	DIN EN ISO 6789-2:2017	1 %	
Pressure *) Negative and positive overprint p_e	-1 bar to -0.03 bar	DKD-R 6-1: 2014	12 µbar + $5.2 \cdot 10^{-5}$ - p_e	p_e = measured value pressure medium: Gas
	> -0.03 bar to < -1 mbar		50 µbar + $1 \cdot 10^{-4}$ - 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 + $1 \cdot 10^{-4}$ - p_e	
	> 0.2 bar to 2 bar		30 µbar + $2.7 \cdot 10^{-5}$ - p_e	
	> 2 bar to 20 bar		75 µbar + $2.7 \cdot 10^{-5}$ - p_e	
	> 20 bar to 100 bar		0.5 mbar + $3.0 \cdot 10^{-5}$ - p_e	
	> 100 bar to 400 bar		7 mbar + $3.5 \cdot 10^{-5}$ - p_e	
	0 bar		$7.2 \cdot 10^{-5}$ - p_e at least 7.5 mbar	Print medium: Oil
	2 bar to 1200 bar			

On-site calibration - Mechanical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Absolute pressure p_{abs}	0.01 bar to 2 bar	DKD-R 6-1: 2014 $p_{abs} = p_e + p_{amb}$	17 µbar + 2.7-10^{-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 + 2.7-10^{-5} - p_{abs}	
	> 20 bar to 101 bar		0.5 mbar + 3.0-10^{-5} - p_{abs}	
	> 101 bar to 401 bar		7 mbar + 3.5-10^{-5} - p_{abs}	
	1 bar		$7 \cdot 10^{-5} \cdot p_{abs}$ at least 7.5 mbar	p_{abs} = Messwert Druckmedium: Oil Measuresment uncertainty of the barometer must be taken into account
	3 bar to 1201 bar			

On-site calibration - flow rate measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Flow rate of liquids Volume flow rate *dV/dt* of flowing liquids	0.01 L/min to 250 L/min	3-APD-0-0251-EN: 2023-01 Volumetric comparative measurement (references: Turbines, gear meters, Coriolis; MID,...) Density from 700 kg/m³ to 1100 kg/m³ Viscosity from 0.8 mm²/s to 1600 mm²/s	0,15 %	Measures 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 %	
Flow of gases Volume flow rate *dV/dt* of flowing gases	0.001 L/min to 250 L/min	3-APD-0-0251-EN: 2023-01 Volumetric comparative 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 %	Measures with analog output, frequency output, visual display in 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 rate *dV/dt* of flowing gases	5 mL/min to 250 L/min	3-APD-0-0251-EN: 2023-01 Volumetric comparative measurement (references: Coriolis, piston calibrator, ...) Calibration medium: N_2, CO_2, Ar, CH_4, He (purity > 99.99 % by volume); room temperature up to max. 10 bar overpressure	0,50 %	Measures with analog output, frequency output, visual display In the standard state: p_N = 1013.25 mbar T_N = 0 °C and $\rho_N N_2$ = 1,250 kg/m³ $\rho_N CO_2$ = 1,976 kg/m³ ρ_NAr = 1.783 kg/m³ $\rho_N CH_4$ = 0,717 kg/m³ ρ_NHe = 0.1785 kg/m³

Mobiles Laboratorium

Mobile laboratory - Thermodynamic measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 display units and simulators for Precious metall-thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature display units and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

Mobile laboratory - Mechanical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Pressure *) Negative and positive overprint p_e	-1 bar to -0.03 bar	DKD-R 6-1: 2014	12 µbar + 5.2-10^{-5} - p_e	p_e = measured value pressure medium: Gas
	> -0.03 bar to < -1 mbar		50 µbar + 1-10^{-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 + 1-10^{-4} - p_e	
	> 0.2 bar to 2 bar		30 µbar + 2.7-10^{-5} - p_e	
	> 2 bar to 20 bar		75 µbar + 2.7-10^{-5} - p_e	
	> 20 bar to 100 bar		0.5 mbar + 3.0-10^{-5} - p_e	
	> 100 bar to 400 bar		7 mbar + 3.5-10^{-5} - p_e	
	0 bar		7.2 - 10^{-5} - p_e at least 7.5 mbar	Print medium: Oil
	2 bar to 1200 bar			
Absolutdruck p_{abs}	0.01 bar to 2 bar	DKD-R 6-1: 2014 $p_{abs} = p_e + p_{amb}$	17 µbar + 2.7-10^{-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 + 2.7-10^{-5} - p_{abs}	
	> 20 bar to 101 bar		0.5 mbar + 3.0-10^{-5} - p_{abs}	
	> 101 bar to 401 bar		7 mbar + 3.5 - 10^{-5} - p_{abs}	
	1 bar		7 - 10^{-5} - p_{abs} at least 7.5 mbar	p_{abs} = Messwert Druckmedium: Oil Measuresment 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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 display units 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 units and simulators for precious metal – thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

Permanent laboratory Kirchzarten, Erich-Rieder Straße 4 - Mechanical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Drehmoment *) manually operated Torque Screwing tools	0.01 N-m to 0.2 N-m	DIN EN ISO 6789-2:2017 DIN EN ISO 6789-2:2017	1 - 10^{-2}	
Indicating torque wrench Calibration equipment for torque tools	> 0.2 N-m to 1 kN-m	DKD-R 3-7:2018 DKD-R 10-8:2020	2 - 10^{-3}	
Torque - transducer, - sensors, - electrodes	10 N-m to 5 kN-m	DIN 51309:2022	0.5 - 10^{-3}	
Force *) Force measures, -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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Acceleration *) Vibration transducer, vibration measuring device	0.1 m/s² to 20 m/s²	Sinusoidal excitation DKD-R 3-1 Sheet 3:2020		Complex transfer coefficient (amount / phase). Pick-up mass up to 0.9 kg, travel 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	Sinusoidal excitation DKD-R 3-1 Sheet 3:2020		Complex transfer coefficient (amount / phase). Pick-up mass up to 0.2 kg, travel 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	Sinusoidal 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 *) manually operated torque application tools	0,2 N·m to 1000 N·m	DIN EN ISO 6789-2:2017	$2 \cdot 10^{-3}$	
Indicating torque wrench		DKD-R 3-7:2018		
Calibration devices for turning torque tools		DKD-R 10-8:2020		
Torque transducers, torque measures		DIN 51309:2022		
Force *) Tensile force, compressive force, force measures, force transducers	10 N to 100 kN	DKD-R 3-3:2018	$1 \cdot 10^{-3}$	

Permanent Laboratory Munich - Mechanical measurands

Calibrierandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Pressure *) Positive and negative overprint p_e	-1 bar to < -0.1 bar	DKD-R 6-1:2014	0.2 mbar + 1 - 10^{-4} - p_e	p_e = measured value pressure medium gas
	-0.1 bar to < 0 bar		50 µbar + 1 - 10^{-4} - p_e	
	0 bar		10 µbar	
	> 0 bar to 0.1 bar		50 µbar + 1 - 10^{-4} - p_e	
	> 0.1 bar to 10 bar		0.2 mbar + 1 - 10^{-4} - p_e	
	> 10 bar to 250 bar		2 - 10^{-4} - p_e	
Absolutdruck p_{abs}	0.03 bar to 10 bar	DKD-R 6-1:2014 $p_{abs} = p_e + p_{amb}$	0.2 mbar + 1 - 10^{-4} - 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 - 10^{-4} - p_{abs}	

Permanent Laboratory Munich - Flow rate measured variables

Calibration and measurement opportunities

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

Permanent Laboratory Munich - Flow measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Volume *V* of flowing 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 %	Measures 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		
Flow of gases Volumetric flow rate *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 %	Measures with analog output, frequency output, visual display
	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 %	In the normal state p_N = 1013.25 mbar T_N = 0 °C
Volumetric flow rate *dV/dt* of flowing gases	5 mL/min to 250 L/min	3-APD-0-0251-EN: 2023-01 Volumetric comparative measurement (references: Coriolis, piston calibrator, ...) Calibration medium: N_2, CO_2, Ar, CH_4, He (purity > 99.99 % by volume); room temperature up to max. 10 bar overpressure	0,50 %	Measures with analog output, frequency output, visual display In the standard state: p_N = 1013.25 mbar T_N = 0 °C and $\rho_N N_2$ = 1.250 kg/m3 $\rho_N CO_2$ = 1,976 kg/m3 ρ_NAr = 1,783 kg/m3 $\rho_N CH_4$ = 0,717 kg/m3 ρ_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 measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 display units 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 units and simulators for Nichtprecious metall-thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

Calibration laboratory Essen, Hermann-Drescher-Weg 4a-d, 45329 Essen

Permanent Laboratory Essen - Thermodynamic measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 metals 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	

Kalibrierlabor Hamburg, Meiendorfer Straße 205, 22145 Hamburg

Permanent Laboratory Hamburg - Thermodynamic measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 display units 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 units and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

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

Permanent Laboratory Mörfelden-Walldorf - Thermodynamic measured variables

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement	Remarks
Temperature measured Resistance thermometers, direct reading Thermometer with resistance sensor *)	-40 °C to 200 °C	DKD-R 5-1:2018 in the liquid bath	10 mK	Comparison with Resistance thermometers
Temperature Transmitter and data logger with resistance sensor *)	-40 °C to 200 °C	DKD-R 5-1:2018 in the liquid bath	15 mK	
direct reading Thermometer, Temperature Transmitter and Data logger with resistance sensor *)	-40 °C to < 0 °C	DKD-R 5-1:2018 in the climate cabinet	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 thermometers with precious metal thermocouple sensor *)	-40 °C to 200 °C	DKD-R 5-3:2018 in the liquid bath	0,5 K	Comparison with standard resistance thermometers
Non-precious metal thermocouples, direct-reading thermometers with non-precious metal thermocouple sensor *)	-40 °C to 200 °C	DKD-R 5-3:2018 in the 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 the 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
Dry-well calibrator *)	-40 °C to 150 °C	DKD-R 5-4:2018	0,05 K	Comparison with standard resistance thermometers

Permanent Laboratory Mörfelden-Walldorf - Thermodynamic measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 radiators
	> 60 °C to 100 °C		0,9 K	
	> 100 °C to 350 °C		1,2 K	
Temperature simulators for resistance thermometers *)	-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 display units 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 units 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 %	Measuresment 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 %	

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

Permanent Laboratory Winsen - Thermodynamic measured variables

Calibriarandmeasures (CMC)

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	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 display units and simulators for Precious metall-thermocouples *)	-200 °C to 1750 °C	DKD-R 5-5: 2018	0,1 K	Characteristic according to DIN EN 60584-1:2014
Temperature display units and simulators for non-precious metal thermocouples *)	-200 °C to 1300 °C	DKD-R 5-5: 2018	0,05 K	

Permanent Laboratory Winsen - Mechanical measured variables

Calibration and measurement opportunities

Measured variable / calibration item	Measuring range / measuring span	Measuring conditions / procedure	Expanded measurement uncertainty	Remarks
Pressure *) Positive and negative overpressure p_e	-1 bar to 10 bar	DKD-R 6-1:2014	0.2 mbar + 1 - 10^{-4} - p_e	p_e = measured value Gas pressure medium
	> 10 bar to 250 bar		2 - 10^{-4} - 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 - 10^{-4} - p_{abs}	p_{abs} = Messwert pressure medium: Gas The measurement uncertainty of the barometer is to take into account
	> 11 bar to 251 bar		2 - 10^{-4} - p_{abs}	

Verwendete Abkürzungen

APD	Calibration procedure developed by Testo Industrial Services GmbH
CMC	Calibration and measurement capabilities
DIN	Deutsches Institut für Normung e.V. (German Institute for Standardization)
DKD-R	Guideline of the German Calibration Service (DKD), published by the Physikalisch Technische Bundesanstalt
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