CH-3003 Bern-Wabern, 1 March 2016

Measurement Services
DC and Low Frequency Laboratory

Valid from: 1 March 2016

The DC and Low frequency laboratory performs high accuracy calibrations of your standards and measuring instruments in the field of DC and low frequency electrical quantities. Our measurement results are traceable to national standards and thus to internationally supported realizations of the SI units.

The services listed in this catalogue correspond to our standard measurement capabilities. Other services, with e.g. reduced measurement uncertainty or an extended measurement range, are possible and may be discussed directly with the responsible expert. In addition, our lab team with its considerable specialist knowledge is available for consultation and assisting in finding solutions to demanding metrological tasks in the field of electrical measurements.

Measurement uncertainty

The measurement uncertainties are indicated for information only and can only be evaluated after the measurements have been completed. They contain contributions originating from the measurement standard, the calibration method, the environmental conditions and the device under test. The indicated measurement uncertainty is stated as the combined standard uncertainty multiplied by a coverage factor $k = 2$. The measured value (y) and the associated uncertainty (U) represent the interval ($y \pm U$) which contains the value of the measured quantity with a probability of approximately 95 %. The uncertainty is estimated following the guidelines of the ISO.

Quotation

Calibration services are quoted upon request by the interested party. The service includes a calibration certificate.

„METAS General Terms and Conditions" are applied to all services of METAS. They are available at www.metas.ch. Amendments, subsidiary agreements and supplements shall always have to be made in writing.

Federal Institute of Metrology METAS
Lindenweg 50, 3003 Bern-Wabern, Suisse
Phone +41 58 387 01 11, www.metas.ch
info@metas.ch

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DC resistance standards and resistance meters

Type	Quantity	Uncertainty	Parameters	Comparison procedure
Standard	100 μΩ - <1 Ω	1 ppm – 3 ppm	Current 15 °C – 30 °C	Reference standard + current comparator bridge with range extender
	0.1 Ω – 10 kΩ	1 ppm		
	>10 kΩ – 100 MΩ	2 ppm – 6 ppm	Voltage 15 °C – 30 °C	Reference standard + potentiometer
	>100 MΩ – 1 TΩ	10 ppm – 160 ppm		Reference standard + modified Wheatstone bridge
	>1 TΩ - 100 TΩ	160 ppm – 500 ppm		
	>100 TΩ - 10 PΩ	> 0.2%	Voltage ≥ 1000 V 15 °C – 30 °C	
	1 Ω - 13 kΩ	0.005 ppm	1 Ω, 10 Ω, 100 Ω, 1000 Ω 6453 Ω, 10 Ω, 12096 Ω Current 15 °C – 30 °C	Quantum Hall effect (QHE) primary reference standard + cryogenic current comparator (CCC) bridge
	1 Ω - 100 MΩ	≥ 10 ppm	15 °C – 30 °C	Reference standard + digital multimeter
Decade	1 Ω - 100 MΩ	≥ 1 ppm		Reference standard + ohmmeter
		≥ 20 ppm		Ohmmeter
	>100 MΩ – 100 TΩ	≥ 10 ppm		Reference standard
Calibrator	1 Ω - 100 MΩ	≥ 1 ppm		Reference standard + digital multimeter
Current comparator resistance bridge	1 Ω - 10 kΩ	≥ 10^{-8} (depending on DUT)	20 °C or 23 °C	Measurement of reference resistor sets
				Quantum Hall effect (QHE) primary reference standard + 1 kΩ resistor
Micro-ohmmeter	1 μΩ - 10 μΩ	≥ 0.001 μΩ		Reference standards

Contact person : Thomas Pulfer - +41 58 387 05 71 – thomas.pulfer@metas.ch

Impedance standards and impedance meters

Type	Quantity	Uncertainty	Parameters	Comparison procedure
Capacitance				
Standard	1 pF – 100 nF	1 ppm	1 kHz	Reference standard
	1 pF – 1 μF	≥ 7 ppm	50 Hz – 20 kHz	Capacitance bridge
	Temperature coefficient			
	tan δ : 0 – 0.1	≥ 5×10^{-6}		
Decade	1 pF – 1 μF	≥ 7 ppm		
Loss factor	tan δ : 0 – 0.1	≥ 5×10^{-6}		
Inductance				
Standard	1 μH - 10 H	≥ 200 ppm	50 Hz, 20 kHz	Reference standard
Decade			50 Hz, 100 Hz, 400 Hz, 1 kHz, 5 kHz	
Pont ou instrument de mesure				
Capacitance	1 pF – 1 μF	≥ 7 ppm	50 Hz, 20 kHz	Reference standard
Inductance	1 μH – 10 H	≥ 200 ppm		
AC resistance	1 Ω – 1 MΩ	≥ 10 ppm		

Contact person : David Corminboeuf - +41 58 387 06 42 – david.corminboeuf@metas.ch

DC voltage standards and voltmeters

<table>
<tr><th>Type</th><th>Quantity</th><th>Uncertainty</th><th>Parameters</th><th>Comparison procedure</th></tr>
<tr><td>Zener reference</td><td>10 V, 1.018 V</td><td>0.2 ppm</td><td rowspan="2">23 ºC ± 0.5 ºC</td><td>Group of 4 reference standards</td></tr>
<tr><td>Voltage reference</td><td>1 V – 10 V</td><td>Best precision TBD</td><td>Josephson primary standard</td></tr>
<tr><td>Voltage calibrator</td><td>10 μV – 1000 V</td><td colspan="3">See multifunction instruments : multifunction calibrator</td></tr>
<tr><td>Digital voltmeter</td><td>100 mV – 10 V</td><td>TBD</td><td>23 ºC ± 0.5 ºC</td><td>Josephson primary standard</td></tr>
<tr><td>Voltage divider</td><td>1:10 – 1:100</td><td>0.5 ppm</td><td>Tension d’entrée → 1000 V</td><td>Reference divider</td></tr>
<tr><td>High voltage divider</td><td>1:10000 – 1:100</td><td rowspan="3">≥ 55 ppm</td><td rowspan="3">23 ºC</td><td rowspan="3">Reference divider</td></tr>
<tr><td>High voltage probe</td><td rowspan="2">1 kV – 100 kV</td></tr>
<tr><td>High voltage source</td></tr>
</table>

Contact person : Thomas Pulfer - +41 58 387 05 71 – thomas.pulfer@metas.ch

DC current sources and ammeters

Type	Quantity	Uncertainty	Parameters	Comparison procedure
Electrometer	10 fA – 1000 pA	1000 ppm – 200 ppm	23 ºC	Voltage ramp and standard capacitor
	100 pA – 1 μA	200 ppm – 8 ppm		Reference source and reference resistor
	1 μA – 100 mA	2 ppm		Voltage drop across reference resistor
Ammeter	2 μA – 2 A	See multifunction instruments : digital multimeter		
	2 A – 100 A	2 ppm		Reference current comparator
Current comparator, shunt	1 A – 100 A	≥ 2 ppm	Voltage output 0.1 V – 10 V 23 ºC	Reference current comparator
	100 A – 2 kA	≥ 10 ppm		
	2 kA – 10 kA	≥ 30 ppm		
Current calibrator	2 μA – 2 A	See multifunction instruments : multifunction calibrator		
Current source	10 fA – 100 pA	1000 ppm – 200 ppm	23 ºC	
High current source	1 A – 100 A	≥ 2 ppm	23 ºC	Reference current comparator
	100 A – 10 kA	≥ 15 ppm	On-site calibration possible	
Electronic load	1 A – 60 A	200 ppm		

Contact person : Thomas Pulfer - +41 58 387 05 71 – thomas.pulfer@metas.ch

AC measurement instruments : voltage and current

<table>
<tr><th>Type</th><th>Quantity</th><th>Uncertainty</th><th>Parameters</th><th>Comparison procedure</th></tr>
<tr><td>AC/DC voltage transfer standard</td><td rowspan="2">AC/DC difference
2 mV – 1000 V</td><td rowspan="3">≥ 2 ppm</td><td rowspan="3">10 Hz – 1 MHz
23 °C</td><td rowspan="2">Reference AC/DC transfer standard</td></tr>
<tr><td>AC/DC voltage transfer standard, model Fluke 792A</td></tr>
<tr><td rowspan="2">AC/DC voltage transfer standard, model Fluke 5790</td><td>AC/DC difference
10 mV – 1000 V</td><td rowspan="2">Comparison of UUT DC reference with reference DMM and computation of the AC-V function characteristics</td></tr>
<tr><td>AC-V calibration
10 mV – 1000 V</td></tr>
<tr><td>HF AC/DC voltage transfer standard</td><td>AC/DC difference
500 mV – 30 V</td><td>≥ 40 ppm</td><td>1 MHz – 100 MHz
23 °C</td><td>Reference AC/DC transfer standard</td></tr>
<tr><td>Shunt pour transfert AC/DC, model Fluke A40</td><td rowspan="2">AC/DC difference
10 mA – 20 A</td><td>≥ 45 ppm</td><td rowspan="2">20 Hz – 10 kHz</td><td rowspan="2">Reference AC/DC transfer standard</td></tr>
<tr><td>Shunt pour transfert AC/DC, model Fluke Y5020</td><td>≥ 100 ppm</td></tr>
<tr><td>AC voltmeter</td><td rowspan="2">100 mV – 1000 V</td><td colspan="3">See multifunction instruments : digital multimeter</td></tr>
<tr><td>AC voltage calibrator</td><td colspan="3">See multifunction instruments : multifunction calibrator</td></tr>
<tr><td>AC ammeter</td><td rowspan="2">10 mA – 20 A</td><td colspan="3">See multifunction instruments : digital multimeter</td></tr>
<tr><td>AC current calibrator</td><td colspan="3">See multifunction instruments : multifunction calibrator</td></tr>
<tr><td>Inductive divider</td><td>$1:10^{-7}$ – 1:1.1</td><td>≥ 0.5 ppm</td><td>40 Hz – 5 kHz
2 V – 30 V</td><td>Reference divider</td></tr>
</table>

Contact person : Alessandro Mortara - +41 58 387 03 28 – alessandro.mortara@metas.ch

Multifunction instruments

<table>
<tr><th rowspan="2">Type</th><th rowspan="2">Quantity</th><th rowspan="2">Uncertainty</th><th rowspan="2">Parameters</th><th colspan="2">Comparison procedure</th></tr>
<tr><th>Digital multimeter</th><th>Multifunction calibrator</th></tr>
<tr><td>DC voltage</td><td>10 μV – 1000 V</td><td rowspan="2">≥ 2 ppm</td><td rowspan="2">23 °C</td><td rowspan="4">Reference source</td><td rowspan="2">Reference multimeter</td></tr>
<tr><td>DC current</td><td>2 μA – 2 A</td></tr>
<tr><td>AC voltage</td><td>100 mV – 1000 V</td><td>11 ppm – 2300 ppm</td><td>10 Hz – 1 MHz
23 °C</td><td>AC/DC transfer</td></tr>
<tr><td>AC current</td><td>10 mA – 20 A</td><td>50 ppm – 135 ppm</td><td>20 Hz – 10 kHz
23 °C</td><td rowspan="2">Reference multimeter</td></tr>
<tr><td>Resistance</td><td>100 mΩ – 100 MΩ</td><td>≥ 1 ppm</td><td>23 °C</td><td>Reference standards</td></tr>
<tr><td>DC adjustment</td><td></td><td></td><td>Adjustement by means of external references</td><td>Reference voltage source and resistance standard</td><td></td></tr>
</table>

Contact person : Thomas Pulfer - +41 58 387 05 71 – thomas.pulfer@metas.ch

Temperature bridges and simulators

Type	Quantity	Uncertainty	Parameters	Procedure
Temperature simulator	-100°C – 1200°C	0.1°C	Thermocouple, type K, with cold-junction compensation	Voltage measurement
	0°C – 1500°C	0.3°C – 0.12°C	Thermocouple, type S, with cold-junction compensation	
	-100°C – 500°C	0.004°C – 0.02°C		Resistance measurement
DC resistance thermometer bridge	10 Ω – 500 Ω	2 ppm	Function Pt-25, Pt-100 Display of resistance value	Reference standards
AC resistance thermometer bridge	1:0 – 1:1	10^{-6}		Comparison with inductive reference divider

Contact person : Thomas Pulfer - +41 58 387 05 71 – thomas.pulfer@metas.ch

Other instruments and standards

Type	Quantity	Uncertainty	Parameters	Procedure
Phasemeter	Phase difference phase 0° - 360°	≥ 0.02°	23°C 50 Hz – 30 kHz 0.5 V – 3 V	Phase difference generator
Flicker source	Modulation depth 0.4 % - 10 %	0.05 % - 1 %	Modulation frequency 8 mHz – 33 Hz	

Contact person : Alessandro Mortara - +41 58 387 03 28 – alessandro.mortara@metas.ch

Magnetic field

Type	Quantity	Uncertainty	Parameters	Comparison procedure
DC measuring instrument	0.043 T – 2.1 T	≥ 20 ppm	23°C	Reference teslameter
Magnet or DC electromagnet				

Contact person : David Corminboeuf - +41 58 387 06 42 – david.corminboeuf@metas.ch

Electric charge

Type	Quantity	Comparison procedure
Charge amplifier or Coulombmeter	10 pC – 1 μC	Calibrated charge source
Charge calibrator		

Contact person : Alessandro Mortara - +41 58 387 03 28 – alessandro.mortara@metas.ch