

3.1 Calibration and Measurement Capabilities

The Calibration and Measurement Capabilities (CMCs) of the division 2 are based on the Appendix C of the BIPM database. They are being reviewed in a two-step process whereas in the first step a 100 percent review by the members of EURAMET takes place followed by a statistical check by Regional Metrology Organizations (RMOs) under the supervision of the *Joint Committees of the BIPM and the Regions (JCRB)* of the CIPM. The CMC entries can be viewed in the following list. Each entry is directly linked to the corresponding entry of the BIPM database.

Calibration services outside of the CIPM MRA (without CMC entries in the BIPM database) are only offered as [additional services](#) to a certain extent by the division 2. Furthermore, internal calibration services in the field of Electricity, Temperature and Humidity are provided for all divisions of the PTB.

The CMC entries listed in Appendix C of the BIPM database are divided into the following chapters:

Chapter	Title	Remarks
1 DC voltage	1.1 DC voltage sources	-
	1.2 DC voltage meters	-
	1.3 DC voltage ratios	-
2 DC resistance	2.1 DC resistance standards and sources	-
	2.2 DC resistance meters	-
	2.3 DC resistance ratios	no records
3 DC current	3.1 DC current sources	-
	3.2 DC current meters	-
	3.3 DC current ratios	no records
4 Impedance (up to the MHz range)	4.1 AC resistance	-
	4.2 Capacitance	-
	4.3 Inductance	-
5 AC voltage (up to the MHz range)	5.1 AC/DC voltage transfer	-
	5.2 AC voltage up to 1100 V	-
	5.3 AC voltage ratio up to 1100 V, attenuation and gain	-
6 AC current	6.1 AC/DC current transfer	-
	6.2 AC current up to 100 A	-
	6.3 AC current ratio up to 100 A	no records

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7 AC power	7.1 AC power and energy	-
8 High voltage and current	8.1 High DC voltage	-
	8.2 High voltage impedance	-
	8.3 AC high voltage and voltage transformers	-
	8.4 Pulsed high voltage and current	-
	8.5 Electric discharge	-
	8.6 High AC current and current transformers	-
	8.7 High DC current	no records
9 Other DC and low frequency measurements	9.1 Electric charge	no records
	9.2 Phase angle	-
	9.3 Current and voltage waveform	no records
10 Electric and magnetic fields	10.1 Electric fields below 50 kHz	-
	10.2 Magnetic fields below 50 kHz	-
	10.3 Electromagnetic fields above 50 kHz	-
	10.4 EMC, Immunity	only PTB in-house
	10.5 EMC, Emission	only PTB in-house
	10.6 EMC, Test Procedures	only PTB in-house
11 Radio frequency measurements	11.1 Radio frequency power	-
	11.2 Scalar RF reflection coefficient and attenuation	-
	11.3 Scattering parameters	-
	11.4 Noise	no records
	11.5 Antenna properties	no records
	11.6 Signal and pulse characteristics	-
	11.7 Radio frequency voltage and current	-
	11.8 Lumped impedance/admittance (using RF techniques)	no records
	11.9 Characteristic impedance	-

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12 Measurements on materials	12.1 Electrical conductivity	-
	12.2 Dielectric properties	no records
	12.3 Soft magnetic sheet and powder materials	-
	12.4 Soft magnetic bulk material	-
	12.5 Feebly magnetic, paramagnetic and diamagnetic material	-
	12.6 Hard magnetic material	-
	12.7 Magnetic data storage media	no records

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Additional Services

Quantity	Instrument or Artifact	Method of Measurement	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage Factor	Level of Confidence	Is the expanded uncertainty a relative one?
DC current: Current ratio	Ultrastable Low-noise Current Amplifier	Calibration with cryogenic current comparator (14-bit)	1000:1	1000:1		Temperature	19 °C to 26 °C	2E-8		2	95%	Yes
DC resistance: Transresistance	Ultrastable Low-noise Current Amplifier	Calibration with cryogenic current comparator (14-bit) and standard resistor	1E6	1E6	Ω	Temperature	19 °C to 26 °C	20	nOhm/ Ohm	2	95%	Yes
Phase angle	Power meter	Sampling System	$-\pi$	$+\pi$	rad	Voltage, current, frequency	30V – 240V 0,005A – 100A 16,7Hz – 1000Hz	20 - 400	μrad	2	95%	Yes
Signal and pulse characteristics: step response	Electrical pulse-generator or optical photodiode	70 GHz sampling oscilloscope, femtosecond laser (only for photodiode)	-0.1 (multivariate quantity)	1.5 (multivariate quantity)	Voltage versus time	Bandwidth	1 GHz – 5 GHz	0.005 – 0.1 (multivariate quantity)	Voltage versus time	2	95 %	No

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Signal and pulse characteristics: step response	50 GHz, 70 GHz, and 100 GHz sampling oscilloscopes	Optoelectronic time-domain measurements based on femtosecond lasers	-0.1 (multivariate quantity)	1.5 (multivariate quantity)	Voltage versus time	Type of coaxial connector	1.85 mm or 1.0 mm	Typically between 0.005 - 0.3 (multivariate quantity, depends on MC simulations)	Voltage versus time	2	95%	No
DC-Power	Power meter		1,5W	100kW	Watt	Voltage, current,	30V – 1000V 0,05A – 100A	50	μW/W	2	95%	Yes
Signal and pulse characteristics: step response	Ultrafast photodiode	Optoelectronic time-domain measurements based on femtosecond lasers	-0.1 (multivariate quantity)	1.5 (multivariate quantity)		Nominal bandwidth, type of coaxial connector, excitation wavelength	70 GHz or 100 GHz, 1.85 mm or 1.0 mm, 1550 nm	Typically between 0.005 - 0.3 (multivariate quantity, depends on MC simulations)		2	95%	No

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Hard magnetic material: Remanent magnetic flux density B_r, remanent magnetic polarisation J_r	Permanent magnetic material cylinder	Electromagnet, coil system, Fluxmeter	0,1	2	T			0,001 – 0,02		2	95%	Yes
Hard magnetic material: Coercivity H_{cB}	Permanent magnetic material cylinder	Electromagnet, coil system, Fluxmeter	1	1000	kA/m			0,003 – 0,01		2	95%	Yes
Hard magnetic material: Coercivity H_{cJ}	Permanent magnetic material cylinder	Electromagnet, coil system, Fluxmeter	1	2300	kA/m			0,003 – 0,01		2	95%	Yes
Hard magnetic material: Maximum Energy product ($B \cdot H$)_{max}	Permanent magnetic material cylinder	Electromagnet, coil system, Fluxmeter	5	500	kJ/m³			0,005 – 0,02		2	95%	Yes
Antenna gain	Antenna	Vector Network Analyzer	10	316	Connector: N (50 Ohm) PC 2.4 (50 Ohm) Waveguide Waveguide	1 – 18 GHz 1 – 50 GHz 50 – 75 GHz 75 – 110 GHz	0,035 0,035 0,072 1,12		2	95%	No	

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Quality Management Manual

Division 2

Scattering parameters: transmission coefficient (S_{ij}) on coaxials and waveguides, real and imaginary	Passive two-port devices	Vector Network Analyzer	-1	1		Connector: N (50 Ohm) PC 2.4 (50 Ohm) Waveguide	10 – 50 GHz 50 – 110 GHz	0,05		2	95%	No
Power density	Security scanner	Spectrum analyzer	1E-8	10	mW/c m²	Frequency	75 – 110 GHz	0,32		2	95%	Yes

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