CLASSIFICATION OF SERVICES IN ELECTRICITY AND MAGNETISM

Version No 11 (dated 07 03 2025)

METROLOGY AREA: ELECTRICITY AND MAGNETISM

BRANCH: DC VOLTAGE, CURRENT, AND RESISTANCE

1. **DC voltage** (up to 1100 V, for higher voltages see 8.1)
   - **1.1 DC voltage sources**
     - 1.1.1 Single values[1]: *standard cell, solid state voltage standard*
     - 1.1.2 Low value ranges (below or equal to 10 V)[#]: *DC voltage source, multifunction calibrator*
     - 1.1.3 Intermediate values (above 10 V to 1100 V)[#]: *DC voltage source, multifunction calibrator*
     - 1.1.4 Noise voltages (for noise currents see 3.1.5, for RF noise see 11.4): *DC voltage source, DC amplifier*
   - **1.2 DC voltage meters**
     - 1.2.1 Very low values (below or equal to 1 mV)[#]: *nanovoltmeter, microvoltmeter*
     - 1.2.2 Intermediate values (above 1 mV to 1100 V)[#]: *DC voltmeter, multimeter, multifunction transfer standard*
   - **1.3 DC voltage ratios** (for input voltages up to 1100 V)
     - 1.3.1 Up to 1100 V[#]: *resistive divider, ratio meter*
     - 1.3.2 Attenuation[#]: *attenuators*

2. **DC resistance**
   - **2.1 DC resistance standards and sources**
     - 2.1.1 Low values (below or equal to 1 Ω): *fixed resistor, resistance box*
     - 2.1.2 Intermediate values (above 1 Ω to 1 MΩ): *fixed resistor, resistance box*
     - 2.1.3 High values (above 1 MΩ): *fixed resistor, three terminal resistor, resistance box*
     - 2.1.4 Standards for high current: *DC shunt*
     - 2.1.5 Multiple ranges[#]: *multifunction calibrator*
     - 2.1.6 Temperature, power and pressure coefficients: *fixed resistor, three terminal resistor, resistance box, DC shunt*
   - **2.2 DC resistance meters**
     - 2.2.1 Low values (below or equal to 1 Ω)[#]: *microohmmeter, multimeter, multifunction transfer standard, resistance bridge*
     - 2.2.2 Intermediate values (above 1 Ω to 1 GΩ)[#]: *ohmmeter, multimeter, multifunction transfer standard, resistance bridge*
     - 2.2.3 High values (above 1 GΩ)[#]: *multimeter, multifunction transfer standard, teraohmmeter, resistance bridge*
   - **2.3 DC resistance ratios**
     - 2.3.1 DC resistance ratios[#]: *resistance ratio devices*

3. **DC current** (up to 100 A, for higher currents see 8.7)
   - **3.1 DC current sources**
     - 3.1.1 Low values (below or equal to 0.1 mA)[#]: *current generator, multifunction calibrator*
     - 3.1.2 Intermediate values (above 0.1 mA to 20 A)[#]: *current generator, multifunction calibrator*
     - 3.1.3 High values (above 20 A to 100 A)[#]: *current generator*
     - 3.1.4 Transconductance ratio[#]
     - 3.1.5 Noise currents (for noise voltages see 1.1.4, for RF noise see 11.4): *DC current source, DC amplifier*
   - **3.2 DC current meters**
     - 3.2.1 Low values (below or equal to 0.1 mA)[#]: *picoammeter, nanoammeter, multimeter, multifunction transfer standard*
     - 3.2.2 Intermediate values (above 0.1 mA to 20 A)[#]: *current comparator*
     - 3.2.3 High values (above 20 A to 100 A)[#]: *current transducer, dedicated equipment for heavy current*
   - **3.3 DC current ratios**

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[1] For each service, the instruments or artefacts are indicated in italic characters.

[#] Indicates services where a linearity, voltage or current coefficient calibration and measurement capability is possible

3.3.1 Ratios up to 100 A[#]: *resistive dividers, DC current comparators, current transducers*

BRANCH: IMPEDANCE UP TO THE MEGAHERTZ RANGE

4. **Impedance (up to the MHz range)**
   4.1 AC resistance
   - 4.1.1 Real component (or modulus) and imaginary component (or argument or time constant): *fixed resistor*
   - 4.1.2 AC/DC difference: *fixed resistor*
   - 4.1.3 Resistors for high current: *AC current shunt*
   - 4.1.4 Meters[#]: *LCR meter (LCR: Inductance, Capacitance, Resistance*
   - 4.1.5 AC resistance ratios[#]: *resistance ratio devices*

   4.2 Capacitance
   - 4.2.1 Capacitance and dissipation factor for low loss capacitors: *standard capacitor (sealed, dry-nitrogen or fused silica dielectric)*
   - 4.2.2 Capacitance and dissipation factor for dielectric capacitors: *fixed capacitor, switched capacitor, capacitance box*
   - 4.2.3 Capacitance and dissipation factor for transformed capacitors: *fixed capacitor, switched capacitor*
   - 4.2.4 Meters: *capacitance bridge, LCR meter (LCR: Inductance, Capacitance, Resistance)*

   4.3 Inductance
   - 4.3.1 Self inductance and equivalent series resistance, low values (lower than 1 mH): *fixed inductor, variable inductor, inductance box*
   - 4.3.2 Self inductance and equivalent series resistance, intermediate values (above or equal to 1 mH to 1 H): *fixed inductor, variable inductor, inductance box*
   - 4.3.3 Self inductance and equivalent series resistance, high values (higher than 1 H): *fixed inductor, variable inductor, inductance box*
   - 4.3.4 Mutual inductance: *fixed mutual inductor*
   - 4.3.5 Meters: *LCR meter (LCR: Inductance, Capacitance, Resistance)*
   - 4.3.6 Quality factor: *Q-standards*

BRANCH: AC VOLTAGE, AC CURRENT, AC AND DC POWER

5. **AC voltage (up to the MHz range)**
   5.1 AC/DC voltage transfer (for frequencies higher than 1 MHz see 11.7.1)
   - 5.1.1 AC/DC transfer difference at low voltages (typically below or equal to 0.5 V): *thermal converter with amplifier, micropotentiometer, AC/DC transfer standard*
   - 5.1.2 AC/DC transfer difference at medium voltages (typically above 0.5 V to 5 V): *thermal converter (directly connected), AC/DC transfer standard*
   - 5.1.3 AC/DC transfer difference at higher voltages (typically above 5 V): *thermal converter with range extender, AC/DC transfer standard*

   5.2 AC voltage up to 1100 V (for high voltage see 8.3)
   - 5.2.1 Sources[#]: *multifunction calibrator*
   - 5.2.2 Meters[#]: *AC voltmeter, multimeter, multifunction transfer standard*

   5.3 AC voltage ratio up to 1100 V (voltage transformers excluded)**, attenuation and gain** (for high voltage and voltage transformers, see 8.3)
   - 5.3.1 Real component (or modulus) and imaginary component (or argument): *inductive voltage divider, AC bridge standard, attenuator box, syncro-resolver*
   - 5.3.2 Attenuation and gain[#]: *passive device, attenuator box, inductive voltage divider*

6. **AC current**
   6.1 AC/DC current transfer
   - 6.1.1 AC/DC transfer difference: *thermal converter plus shunt, AC/DC transfer standard plus shunt*

   6.2 AC current up to 100 A (for high current see 8.6)
   - 6.2.1 Sources[#]: *multifunction calibrator, transconductance amplifier*
   - 6.2.2 Meters[#]: *AC ammeter, multimeter, multifunction transfer standard*

   6.3 AC current ratio up to 100 A (current transformers excluded, for high current and current transformers, see 8.6)
   - 6.3.1 Real component[#] (or modulus)[#] and imaginary component[#] (or argument)[#]

7. **AC and DC power**
   7.1 **AC power and energy**
      7.1.1 Single phase (frequencies below or equal to 400 Hz): *power meter, energy meter, power converter, wattmeter, power calibrator, energy calibrator*
      7.1.2 Single phase (frequencies above 400 Hz): *power meter, energy meter, power converter, wattmeter, power calibrator, energy calibrator*
      7.1.3 Three phase: *power meter, energy meter, power calibrator, energy calibrator*
   7.2 **DC power and energy**
      7.2.1 DC power meters and sources: *power meter, energy meter, power calibrator, energy calibrator*

BRANCH: HIGH VOLTAGE AND CURRENT

8. **High voltage and current**
   8.1 **High DC voltage** (for voltages lower than 1100 V see 1)
      8.1.1
      8.1.2
      8.1.3 High DC voltage ratio[#]: *DC high voltage divider, DC high voltage probe*
      8.1.4 Average value of DC voltage[#]: *DC voltage measuring system, DC voltage source, DC voltmeter*
      8.1.5 RMS value of DC voltage ripple: *DC voltage measuring system, DC voltage source, DC voltmeter*
   8.2 **High voltage impedance** (for low voltages see 4)
      8.2.1 Capacitance[#] and dissipation factor[#]: *compressed gas capacitor, capacitor for high voltage, capacitance bridge, dissipation factor standard*
      8.2.2 Inductance and loss angle: *high voltage reactor, inductance bridge*
      8.2.3 Burden: real and imaginary component (real component/imaginary component/modulus/argument[1]): *instrument transformer burden*
      8.2.4 Resistance: *high voltage resistor*
   8.3 **High AC voltage** (for voltages <= 1100 V see 5.2 and 5.3) **and voltage transformers**
      8.3.1
      8.3.2
      8.3.3 Peak value of high AC voltage: *AC peak voltage responding measuring system, AC peak voltmeter*
      8.3.4 Voltage transformers: ratio error[#] and phase displacement[#]: *voltage transformer, voltage transformer bridge, voltage divider, voltage probe*
      8.3.5 RMS value for high AC voltage[#]: *RMS responding measuring system, AC voltmeter, AC voltage source*
      8.3.6 Rectified average value of high AC voltage: *AC rectified average voltage responding measuring system, AC rectified average voltmeter*
   8.4 **Pulsed high voltage and current**
      8.4.1 Parameters for lightning impulse voltage (lightning impulse voltage peak value/test voltage value/extreme value/front time/time to half value/time to chopping/scale factor/... [add parameters as appropriate][1]) [#]: *lightning impulse voltage measuring system, impulse calibrator, digital recorder*
      8.4.2
      8.4.3 Parameters for switching impulse voltage [#] (switching impulse voltage test voltage value/scale factor/time to peak/time to half value/time to zero/time above 90%/setting time of step response/partial response time of step response/... [add parameters as appropriate][1]): *switching impulse voltage measuring system, impulse divider, impulse calibrator, digital recorder*
      8.4.4
      8.4.5 Parameters for impulse current [#] (impulse current peak value/scale factor/front time/time to half value/duration/total duration/charge/impulse energy/setting time of step response/partial response time of step response... [add parameters as appropriate][1]): *impulse current measuring system, impulse shunt/divider, digital recorder*
      8.4.6
      8.4.7
      8.4.8
      8.4.9 Parameters for other impulse voltage types (peak value/front time/time to half value/duration/total duration/charge/impulse energy/settling time of step response/partial response time of step response/... [add parameters as appropriate][1]): *other impulse measuring systems*

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[1] Select one quantity

8.5 Electric discharge

   8.5.1   Apparent charge: *partial discharge calibrator, partial discharge measuring instrument*

   8.5.2   Response: *electrostatic discharge target*

   8.5.3   Rise time of partial discharge pulse: *partial discharge calibrator*

8.6 High AC current (for currents <= 100 A see 6.2 and 6.3) and current transformers

   8.6.1

   8.6.2

   8.6.3   Current transformers: ratio error[#] and phase displacement[#]: *current transformer, current transformer bridge*

   8.6.4

   8.6.5   High AC current RMS value[#]: *AC current measuring system, AC current meter, AC current source*

   8.6.6   Other AC current parameter (average value/energy/... [add parameters as appropriate][2]): *AC current measuring system*

8.7 High DC current (for currents below or equal to 100 A see 3, for shunts see 2.1.4)

   8.7.1

   8.7.2

   8.7.3   High DC current ratio[#]: *DC current transformer*

   8.7.4   High DC current average value[#]: *DC current measuring system, DC current probe, DC source*

BRANCH: OTHER DC AND LOW FREQUENCY MEASUREMENTS

9. Other DC and low frequency measurements

9.1 Electric charge

   9.1.1   Sources: *q-source*

   9.1.2   Meters: *q-meter*

9.2 Phase angle

   9.2.1   Sources[#]: *phase source*

   9.2.2   Meters[#]: *phase meter*

   9.2.3   Phase shift: *phase shifters, phase shift measuring devices*

9.3 Current and voltage waveform

   9.3.1 Main frequency harmonics: *mains frequency harmonics analyzer*

   9.3.2 Mains frequency harmonic distortion: *mains frequency harmonic analyzer, signal generator, distortion meter, level meter*

   9.3.3

   9.3.4   Mains frequency fluctuating harmonics (non sinusoidal waveforms/harmonic measurements for voltage/current waveforms/fluctuating harmonics[2]): *mains frequency harmonics analyzer*

   9.3.5   Mains frequency voltage fluctuations, square / sine wave / other modulation (flicker severity (Pst), square/sine wave/Modulation [add modulation type as appropriate][2]): *flicker meter*

   9.3.6

   9.3.7   Mains frequency interharmonic: mains frequency analyzer

BRANCH: ELECTRIC AND MAGNETIC FIELDS

10. Electric and magnetic fields

10.1 Electric fields below 50 kHz

   10.1.1 Electrostatic field strength: *electrostatic field meter, electrostatic generator*[#]

   10.1.2 Electric field strength: *field strength probe, electric field meter*[#]

10.2 Magnetic fields below 50 kHz

   10.2.1 Magnetic flux: *flux meter, flux etalon*

   10.2.2 DC magnetic flux density and applied magnetic field strength: *magnetic flux density meter, magnetic field strength meter*

   10.2.3 AC magnetic flux density and applied magnetic field strength: *magnetic flux density meter, magnetic field strength meter*

   10.2.4 DC shielding factor (ratio of DC magnetic flux density)

   10.2.5 AC shielding factor (ratio of AC magnetic flux density)

   10.2.6 Turn area (ratio of magnetic flux and magnetic flux density): *pick up coil*

   10.2.7 Magnetic flux density or magnetic field strength per unit current: *field coils*

   10.2.8 Magnetic field gradient: *gradiometers*

10.3 Electromagnetic fields above 50 kHz

   10.3.1 Electric field strength[#]: *field probe*

   10.3.2 Magnetic field strength[#]: *field probe*

   10.3.3 Power flux density[#]: *field probe*

   10.3.4 Magnetic flux density

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[2] Select one quantity

10.3.5 Magnetic field strength per unit current
10.3.6 Turn area (ratio of magnetic flux and magnetic flux density)

BRANCH: RADIO FREQUENCY MEASUREMENTS

11. **Radio frequency measurements**
    11.1 **Radio frequency power**
        11.1.1 Absolute power in coaxial line[#]: *power meter, power source*
        11.1.2 Absolute power in waveguide[#]: *power meter, power source*
        11.1.3 Calibration factor and effective efficiency in coaxial line[#]: *thermistor, barretter and power sensor*
        11.1.4 Calibration factor and effective efficiency in waveguide[#]: *thermistor, barretter and power sensor*
        11.1.5 Non-CW power (absolute or relative) [#]: *peak power sensor, sensors with time resolution*
        11.1.6 Power measurements in balanced lines[#]: *power meter (e.g. in 150 ohm)*
    11.2 **Scalar RF reflection coefficient and attenuation** (not using a VNA or similar device) (magnitude)
        11.2.1 Reflection coefficient in coaxial line (values in linear terms): *passive device*
        11.2.2 Reflection coefficient in waveguide (values in linear terms): *passive device*
        11.2.3 Attenuation in coaxial line (values in dB): *passive device*
        11.2.4 Attenuation in waveguide (values in dB): *passive device*
        11.2.5 Directivity, effective source match: *multiports, splitter*
        11.2.6 Reflection and attenuation measurements in balanced lines
    11.3 **Scattering parameters** (vectors)
        11.3.1 Reflection coefficient (S_{ii}) in coaxial line (values in linear terms: real and imaginary or magnitude and phase): *passive device, generator*
        11.3.2 Reflection coefficient (S_{ii}) in waveguide (values in linear terms: real and imaginary or magnitude and phase): *passive device, generator*
        11.3.3 Transmission coefficient (S_{ij}) in coaxial line (values in linear or logarithmic terms: real and imaginary or magnitude and phase):
            passive devices
        11.3.4 Transmission coefficient (S_{ij}) in waveguide (values in linear or logarithmic terms: real and imaginary or magnitude and phase):
            passive devices
        11.3.5 Directivity, effective source match: *multiports, splitter*
        11.3.6 Reflection coefficient (S_{ii}) for common mode systems: *common mode absorbing devices (CMAD), coupling-decoupling network (CDN)*
        11.3.7 Transmission coefficient (S_{ij}) for common mode systems: *common mode absorbing devices (CMAD)*
        11.3.8 Reflection coefficient (Sii) in planar line systems (values in linear terms: real and imaginary or magnitude and phase): *passive device, generator*
        11.3.9 Transmission coefficient (Sij) in planar line systems (values in linear or logarithmic terms: real and imaginary or magnitude and phase): *passive devices*
    11.4 **Noise** (for LF noise voltages and currents see 1.1.4 and 3.1.5)
        11.4.1 Noise temperature or excess noise ratio in coaxial line: *noise source*
        11.4.2 Noise temperature or excess noise ratio in waveguide: *noise source*
        11.4.3 Amplifier noise parameters: *two-port amplifier, mixers*
        11.4.4 Phase noise: *oscillator, two-port device*
        11.4.5 Radio brightness temperature, spectral radiance in free space: *wide aperture noise radiometer*
    11.5 **Antenna properties**
        11.5.1 Antenna factor: *antenna dipole, loop antenna, log antenna*
        11.5.2 Antenna gain: *antenna dipole, horn antenna, log periodic*
        11.5.3 Other properties (pattern, beam width, …): *antenna dipole, horn antenna, log periodic*
    11.6 **Signal and pulse characteristics** (phase noise see 11.4.4)
        11.6.1 Pulse amplitude: *oscilloscope, pulse and function generator*
        11.6.2 Pulse time parameters: *oscilloscope, pulse and function generator*
        11.6.3 Modulation, AM and FM: *signal generator, spectrum analyser, modulation meter, jitter meter*
        11.6.4 Distortion and harmonic content: *signal generator, spectrum analyser, distortion meter*
    11.7 **Radio frequency voltage and current** (for frequencies lower than 1 MHz see 5 and 6)
        11.7.1 RF/DC difference[#]: *thermal voltage converter, AC/DC current standard*
        11.7.2 RF voltage sources[#]: *RF generator*
        11.7.3 RF voltage meters[#]: *RF voltmeter*
        11.7.4 RF current: *RF current generator*
        11.7.5 RF transfer impedance: *RF current clamp, ESD target*

11.7.6 RF voltage division factor: *burst adaptor, oscilloscope probes*

11.7.7 RF coupling factor: *coupling-decoupling network (CDN), EM current clamp, absorbing clamp*

11.7.8 Flatness of RF voltage sources: *RF voltage sources*

11.7.9 Flatness of RF voltage meters: *RF voltage meters*

11.8 Lumped impedance/admittance (using RF techniques)

11.8.1 Resistance or conductance (R, G)

11.8.2 Inductance (L)

11.8.3 Capacitance (C)

11.8.4 Quality factor (Q): *Q-standard, Q-meter*

11.9 Characteristic impedance

11.9.1 Mechanical dimensions: *coaxial airline, waveguide*

11.9.2 Electrical parameters: *coaxial airline*

BRANCH: MATERIALS

12. **Measurements on materials**

12.1 Electrical conductivity

12.1.1 Metallic materials: *metallic bar, sheet, reference material*

12.1.2 Liquids (see also subject field "Amount of Substance"): *liquid, reference material, electrolytic cell*

12.1.3 Semiconducting and similar materials: *reference wafers*

12.2 Dielectric properties

12.2.1 Relative permittivity: real and/or imaginary part: *solid materials, liquid materials*

12.2.2 Dielectric loss tangent: tan δ: *solid materials, liquid materials*

12.3 Soft magnetic sheet and powder materials

12.3.1 Specific total power loss: *Epstein, ring and single sheet sample*

12.3.2 Peak value of DC magnetic polarisation: *Epstein, ring and single sheet sample*

12.3.3 Peak value of AC magnetic polarisation: *Epstein, ring and single sheet sample*

12.3.4 Peak value of magnetic field strength: *Epstein, ring and single sheet sample*

12.3.5 RMS value of magnetic field strength: *Epstein, ring and single sheet sample*

12.3.6 Specific apparent power: *Epstein, ring and single sheet sample*

12.3.7 Relative peak permeability: *Epstein, ring and single sheet sample*

12.3.8 Complex relative permeability

12.3.9 Density: *Epstein, ring and single sheet sample*

12.3.10 Resistivity: *Epstein, ring and single sheet sample*

12.4 Soft magnetic bulk material

12.4.1 Magnetic polarisation: *rod, cylinder*

12.4.2 Magnetic field strength: *rod, cylinder*

12.4.3 Remanent magnetic flux density: *rod, cylinder*

12.4.4 Coercive magnetic field strength: *rod, cylinder*

12.4.5 Magnetic saturation polarisation: *rod, cylinder*

12.4.6 Relative permeability: *rod, cylinder*

12.5 Feebly magnetic, paramagnetic and diamagnetic material

12.5.1 DC magnetic susceptibility or relative magnetic permeability: *rod, cylinder*

12.6 Hard magnetic material

12.6.1 Remanent magnetic flux density: *cylinder, rectangular parallelepiped*

12.6.2 Coercive field strength (H_{CB}, H_{CJ}): *cylinder, rectangular parallelepiped*

12.6.3 Maximum energy product $(B.H)_{max}$: *cylinder, rectangular parallelepiped*

12.6.4 Magnetic moment: *cylinder, rectangular parallelepiped*

12.6.5 Magnetic flux density: *cylinder, rectangular parallelepiped*

12.6.6 Magnetic polarisation: *cylinder, rectangular parallelepiped*

12.6.7 Relative recoil permeability

12.7 Magnetic data storage media

12.7.1 Signal amplitude of magnetic stripes: *magnetic stripes*

12.7.2 Surface profile of magnetic stripes: *magnetic stripes*

12.7.3 Reference field of diskettes: *diskettes*

12.7.4 Signal amplitude of diskettes: *diskettes*

12.7.5 Resolution of diskettes: *diskettes*

12.7.6 Peak shift of diskettes: *diskettes*

12.7.7 Overwrite of diskettes: *diskettes*

12.7.8 Video and audio tapes