

CATALOGUE OF CALIBRATION AND MEASUREMENT SERVICES

Year 2025

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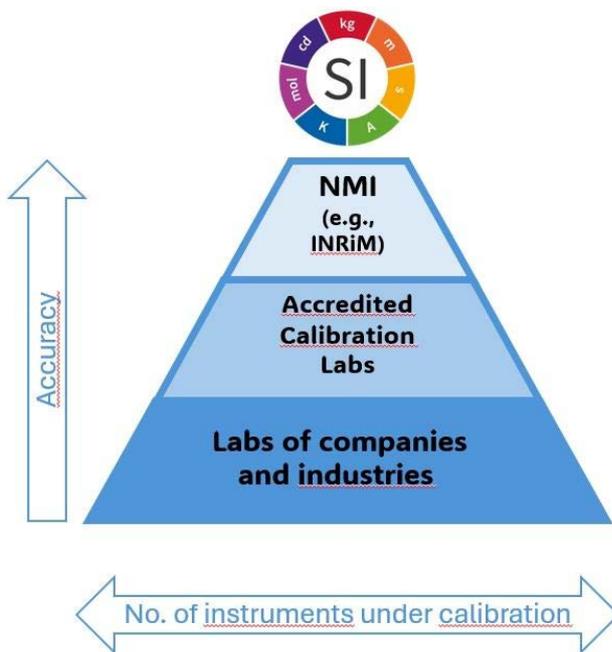
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METROLOGICAL OFFER AND DISSEMINATION OF SI UNITS BY INRiM

The National Institute for Metrological Research (INRiM) is a national public body established by the Legislative Decree no. 38 of January 21st, 2004, through the merger of the Metrology Institute Gustavo Colonnetti (IMGC) originally within the CNR (National Research Council) and the Istituto Elettrotecnico Nazionale Galileo Ferraris (IENGF).

INRiM is the place where a large part of the measurement's science in Italy is studied and applied, and, according to Law no. 273 of August 11th, 1991, it acts as a Metrology Primary Institute (alias NMI – National Metrological Institute). Performing this role, the Institute realises, maintains and



develops the national reference standards of the basic units of the International System (SI) - metre, kilogram, second, ampere, kelvin, mole and candela - and the respective derived units and disseminates these units through calibration of accredited and industrial laboratories' standards.

Most of INRiM's activities are part of an international collaboration, which is also of immediate benefit to the national community.

The four major international reference bodies for INRiM are:

- the **CIPM (Comité International des Poids et Mesures)**, the heart of both the Metro Convention and the international metrological community;
- the **BIPM (Bureau International des Poids et Mesures)**, the international organisation established by the Metro Convention through which member states act together in matters relating to the science of measurement;

- **EURAMET (European Association of National Metrology Institutes)**, the organisation coordinating metrology at the European level and supporting research programs through EU funding;
- the **European Union**, which dictates the main direction of scientific research in Europe.

INRiM provides the national economy with a wide range of **calibration and measurement services** in the different areas of metrology. While ensuring metrological traceability also according to the ILAC-P10 criteria "ILAC Policy on the Traceability of Measurement Results", the Institute offers more than 400 different types of Calibration and Measurement Capabilities (CMC) declined in over 300 instrument calibration services used in the fields of **mechanics, thermodynamics, time and frequency, electricity, photometry, acoustics, and chemistry**.

TRACEABILITY OF INRiM MEASUREMENTS: CIPM MRA AND ILAC-P10:01/2013, par. 2 point 1

INRiM is a signatory and has participated for Italy in the **Mutual Recognition Arrangement (MRA)** since its signature, dated October 14th, 1999. The Comité International des Poids et Mesures (CIPM) promoted this agreement to facilitate global trade by setting criteria for the mutual recognition of the national measurement standards and all the calibration and measurement certificates issued by the National Metrological Institutes of the MRA member states.

INRiM Calibration and Measurement Capabilities (CMCs) included in the CIPM MRA are published in the BIPM's KCDB database (<https://www.bipm.org/kcdb/>). In addition, in the calibration and measurement certificates issued, the CMCs are marked by the CIPM MRA logo on the first page and the MRA note.

TRACEABILITY OF INRiM MEASUREMENTS: ILAC-P10: 01/2013, par. 2, p. 3a)

For certificates concerning calibration and measurement activities not comprised in the CIPM MRA international agreement, INRiM provides the evidence referred to in the document mentioned above ILAC P10:2020, appendix A, including in the calibration/measurement certificate the annexe "Traceability of measurements ILAC-P10:07/2020, par. 2, point 3a)".

MANAGEMENT SYSTEM FOR QUALITY

INRiM Quality Management System applies to products and services of calibration, measurement, and testing covered by the CIPM MRA agreement, published by the KCDB database on the BIPM website, to those referred to in Law 273/91, to related activities and certified reference materials. Therefore, it complies with option A of ISO/IEC 17025:2017, "General requirements for the competence of test and calibration laboratories", and ISO 17034:2016, "General requirements for the competence of manufacturers of reference materials". Furthermore, INRiM's General Management, through the Steering Committee for Quality (CIQ), defines the strategies and policies to pursue the objectives set.

INRiM is a member of the Technical Committee for Quality (TC-Q) of EURAMET, to which it reports annually on the status of its management system and for which the TC-Q Steering Committee evaluates it. In addition, INRiM undergoes peer reviews conducted by international experts from National Metrological Institutes (NMIs); participates in and coordinates interlaboratory comparisons, key and supplementary comparisons of measurement promoted internationally in all metrological areas of competence.

AGREEMENT WITH ACCREDIA, THE ITALIAN ACCREDITATION BODY

INRiM and ACCREDIA have entered into a collaboration agreement whereby ACCREDIA recognises calibration certificates issued by INRiM in accordance with the metrological traceability criteria set out in document ILAC P10: 2020, par. 2, points 1) and 3a).

In the framework of the National Calibration System (Law no. 273/91), INRiM, acting as the Primary Metrological Institute, and the accredited calibration centres (LAT) are responsible for the dissemination of units of measurement based on national standards and the calibration of secondary standards and measuring instruments.

GENERAL NOTES

The catalogue sections refer to the "Classification of services" of the metrological areas defined in the KCDB database. The KCDB database, where the measurement and calibration capabilities of INRiM recognised in the CIPM MRA are published, is available at the link: <https://www.bipm.org/kcdb/>.

For each metrological area, a description of the dissemination activity carried out by INRiM and a list of calibration and measurement services provided are available.

For each service, the following shall be identified:

- **Service code:** Identifies the unique INRiM code of the calibration/measurement service
- **Service name:** Describes the calibration/measurement service by identifying the type of instrument being calibrated, the calibration/measurement range and any notes;
- **Calibration/measurement uncertainty:** indicates the extended uncertainty obtained by multiplying the standard uncertainty by the coverage factor k corresponding to a confidence level of about 95%.

Uncertainty statements without specifications shall be of a relative type.

When not otherwise specified, declared uncertainties refer to best capability and may also be worsened as a function of the measurand.

- **Method:** describes the calibration/measurement method used;
- **Contact person:** Identifies the contact person to request detailed technical information or the economic offer to perform the calibration/measurement.

- **CMC:** Indicates the type of measuring and calibration capability to support the calibration/measurement service provided:

A - service supported by CMC included in the CIPM MRA agreement, published on the KCDB database (<https://www.bipm.org/kcdb/>) and marked by the presence of the CIPM MRA logo on the first page of the calibration and measurement certificates issued and the MRA note.

B - service supported by CMC partly covered by the CIPM MRA agreement and partly following the document ILAC-P10:2020, Appendix A. Parts not covered by CIPM MRA are indicated in the column "Service name".

C - CMC not included in the CIPM MRA agreement, but carried out in compliance with the Law of August 11th, 1991, n.273, following the document ILAC-P10:2020, Appendix A, marked by the presence of the annexe to the calibration certificate/ measure "Traceability of measures ILAC-P10:07/2020, par. 2, point 3a)."

AUV - ACOUSTICS, ULTRASOUND AND VIBRATION

Acoustics, ultrasound, and vibration are metrological sectors linked by measurement methods: they are based on dynamic quantities that are variable in time and often analysed in the frequency domain.

Acoustics involves pressure waves that propagate in air within a frequency range from a few Hz to about 50 kHz. Ultrasound refers to pressure waves that primarily propagate in liquids within a frequency range from hundreds of kHz up to 40 MHz.



The field of vibration, on the other hand, deals with elastic waves in solids and the movement of solid bodies at frequencies ranging from fractions of a Hz to several tens of kHz.

INRiM has declared calibration and measurement capabilities in all three sectors and participates in international comparisons organised by CIPM and EURAMET to support the equivalence of certificates within the MRA framework.

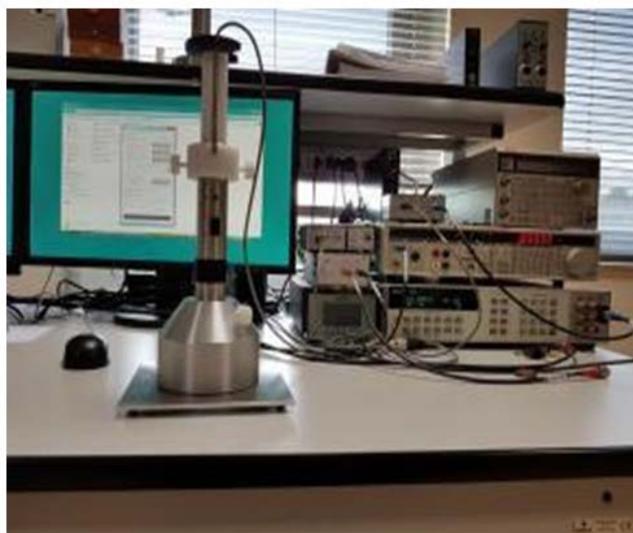
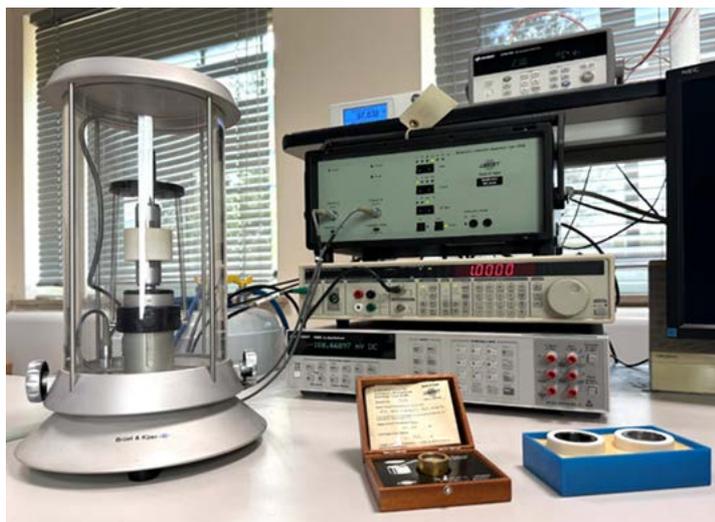
These quantities are particularly important in fields such as healthcare, environmental monitoring, noise emission evaluation, and predictive maintenance of machinery.

SOUND IN AIR AND ULTRASOUND

METROLOGY OF SOUND IN AIR.

The national standard of sound pressure comprises 1" and 1/2" **Laboratory Standard microphones (LS)**, calibrated by the **primary pressure reciprocity method**. The covered frequency range is from 31,5 Hz to 25 kHz.

In addition, Laboratory Standard microphones used by accredited laboratories for traceability of measurements are calibrated by the primary reciprocity system together with INRiM Laboratory Standard microphones.



The calibration of **acoustic calibrators**, both mechanical (pistonphones) and electrodynamic type, allows the dissemination of the physical quantity of sound pressure with an uncertainty of the order of 0,1 dB at 250 Hz and 1 kHz. The calibration of **multi-frequency acoustic calibrators** allows the dissemination of sound pressure in the frequency range of 31,5 Hz to 16 kHz for the verification of sound level meters.

The **Working Standard microphones (WS)** are calibrated by comparison against the Laboratory Standard microphones (LS) in pressure-field and free-field conditions. Corrections between pressure response and free-field response are determined by measurements in acoustic coupler and anechoic chamber, with echo removal techniques in the latter case.

The **sound level meters and their octave and one-third octave filters**, used for noise characterisation, are verified according to IEC EN standards.

CHARACTERISATION OF ULTRASONIC FIELDS.

INRiM is capable of ensuring a complete characterization of the ultrasonic beam emitted by a transducer, whether it is a plane wave (Piston-Like) or focused, such as HIFU (High Intensity Focused Ultrasound), in the frequency range of 1 MHz to 15 MHz. For the determination of ultrasonic power, a measurement system based on the radiation force balance principle is used. The triaxial scanning system for hydrophones, with a wide set of available hydrophones, enables the complete determination of the ultrasonic field emitted by the transducer.

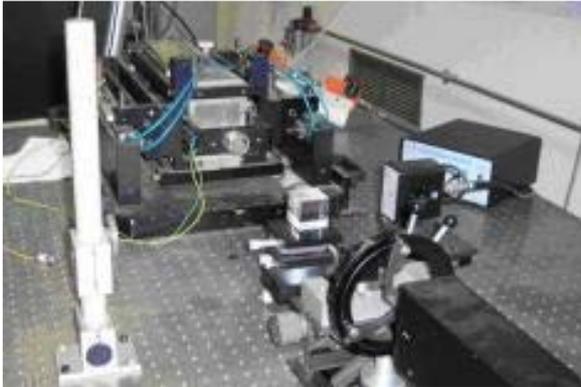
The measurement capabilities are as follows:

- Measurement of ultrasonic power (10 mW – 150 W);
- Measurement of the main parameters for the description and characterization of the field generated by the ultrasonic source (0.5 MHz – 20 MHz).

VIBRATIONS

DYNAMIC ACCELERATIONS AND VIBRATIONS.

The **dynamic acceleration and vibration** laboratory realises and maintains the «primary system of calibration of dynamic accelerations» with the fringe count interferometric method (ISO 16063-11).



The calibration system refers to national time and length standards, and guarantees measurements with an extended uncertainty ranging from 0.4% and 0.6%.

A system for calibrating accelerometers under shock conditions (ISO 16063-22) has recently been acquired. In addition, a set-up has also been realised to calibrate simultaneous

comparison on three axes of MEMS/NEMS sensors.

AUV							
Acoustics, Ultrasound, Vibration							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
AUV.0-a1	Calibration of octave-band and fractional-octave band filters	Frequency: from 20 Hz to 20 kHz. Sound Pressure Level SPL: from 20 dB to 145 dB.	Integrating-averaging and non-integrating sound level meters, constant percentage bandwidth spectrum analyzers	From 0,12 dB to 0,34 dB	Calibration performed by verifying the conformance of the characteristics of the filters incorporated in the instruments under test with the requirements of Standard CEI EN 61260-1. Measurements are performed according to the methods described by the Standard CEI EN 61260-3.	Mario Corallo m.corallo@inrim.it Fabio Saba f.saba@inrim.it	C
AUV.1.1-a1	Pressure calibration of Laboratory Standard microphones by the primary reciprocity technique <i>Field not CIPM MRA covered:</i> Frequency: 25 kHz for LS2 microphones	Sound pressure sensitivity: from -20 dB to -45 dB (re 1 V/Pa). Frequency: from 31,5 Hz to 10 kHz for LS1 microphones and from 31,5 Hz to 25 kHz for LS2 microphones.	LS1 and LS2 Laboratory Standard condenser microphones	Sound pressure sensitivity: from 0,05 dB to 0,20 dB. In particular: 0,08 dB at 31,5 Hz; 0,05 dB from 63 Hz to 8 kHz; 0,08 dB at 10 kHz; 0,10 dB from 12,5 kHz to 16 kHz; 0,15 dB at 20 kHz; 0,20 dB at 25 kHz.	Primary pressure reciprocity method described by the Standard CEI EN 61094-2	Fabio Saba f.saba@inrim.it	B
AUV.1.1-b1	Pressure calibration of Working Standard microphones by comparison with sequential and simultaneous excitation <i>Field not CIPM MRA covered:</i> Frequency: 16 kHz. Frequency: 250 Hz and 1000 Hz, for WS3 microphones only.	Sound pressure sensitivity: from -15 dB to -60 dB (re 1 V/Pa). Frequency: from 31,5 Hz to 16 kHz.	Working Standard condenser microphones	Sound pressure sensitivity: from 0,1 dB to 0,3 dB. In particular: 0,2 dB at 31,5 Hz; 0,1 dB from 63 Hz to 2 kHz; 0,2 dB from 3,15 kHz to 8 kHz; 0,3 dB from 10 kHz to 12,5 kHz; 0,3 dB at 16 kHz.	Pressure calibration by comparison with simultaneous excitation using the active coupler, according to the method described by the Standard CEI EN 61094-5. Pressure calibration by comparison with sequential excitation using sound calibrators.	Mario Corallo m.corallo@inrim.it Fabio Saba f.saba@inrim.it	B

AUV							
Acoustics, Ultrasound, Vibration							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
AUV.2.1-a1	Calibration of sound calibrators <i>Field not CIPM MRA covered:</i> Sound Pressure Level SPL for pistonphones and sound calibrators at 250 Hz or 1000 Hz by WS2 microphones. Frequency of acoustic signals. Total Distorsion of acoustic signals. Corrections for B&K 4226 calibrators.	Sound Pressure Level SPL: from 90 dB to 125 dB. Frequency: from 31,5 Hz to 16 kHz.	Sound calibrators, pistonphones, and multifunction calibrators B&K 4226	Sound Pressure Level SPL: 0,08 dB for pistonphones and sound calibrators at 250 Hz or 1000 Hz by LS1 microphones; from 0,09 dB to 0,11 dB for pistonphones and sound calibrators at 250 Hz or 1000 Hz by LS2 and WS2 microphones; from 0,1 dB to 0,3 dB for B&K 4226 calibrators. Frequency: 0,012 %. Total Distorsion: from 0,08 % to 0,15 %. Corrections for B&K 4226 calibrators: from 0,02 dB to 0,03 dB.	Calibration performed according to the method described by the Standard CEI EN IEC 60942:2018-6, by the insert voltage technique	Mario Corallo m.corallo@inrim.it Fabio Saba f.saba@inrim.it	B
AUV.13.1-a1	Ultrasound Power Calibration	Frequency : 1.8 MHz - 11 MHz, Power : 0.01 W - 15 W	Ultrasound Power Meter	3.0% - 8.0 %	Calibration by comparison of the ultrasonic power values measured (P) with the primary instrument based on the radiation force balance, RFB, method with the average values, obtained from five measurements in the same nominal conditions, of ultrasonic power measured by the instrument under calibration (Pr).	Giovanni Durando g.durando@inrim.it	A
AUV.21.1-a1	Acceleration generators	0.5Hz to 10kHz (0.01m / s ² to 800m / s ²)	Acceleration generators	from 0,3% to 0,5%	ISO 16063-11:1999 Primary vibration calibration by laser interferometry	Alessio Facello a.facello@inrim.it Alessandro Schiavi a.schiavi@inrim.it	A

AUV							
Acoustics, Ultrasound, Vibration							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
AUV.21.1-a2	Acceleration generators	0,5Hz to 10kHz	Acceleration generators	from 0,8% to 1,2%	ISO 16063-21-2003 "Vibration calibration by comparison to a reference transducer"	Alessio Facello a.facello@inrim.it Alessandro Schiavi a.schiavi@inrim.it	A
AUV.21.4-a1	Vibrometric chains and transducers	0,5Hz to 10kHz (0,01m / s ² to 800m / s ²)	Accelerometric chains	from 0,4% to 0,6%	ISO 16063-11:1999 Primary vibration calibration by laser interferometry	Alessio Facello a.facello@inrim.it Alessandro Schiavi a.schiavi@inrim.it	A
AUV.21.4-b1	Vibrometric chains and calibrators	0,5Hz to 10kHz	Vibrometric chains and calibrators	from 0,8 to 1,2%	ISO 16063-21-2003 "Vibration calibration by comparison to a reference transducer"	Alessio Facello a.facello@inrim.it Alessandro Schiavi a.schiavi@inrim.it	A
AUV.21.4-c1	Calibration by comparison of shock accelerometric chains <i>Field not CIPM MRA covered: 50 m·s⁻² - 100 km·s⁻²</i>	50 m s ⁻² - 100 km s ⁻²	Accelerometric chains	2,0%	ISO 16063-22 "Shock calibration by comparison to a reference transducer"	Alessio Facello a.facello@inrim.it Alessandro Schiavi a.schiavi@inrim.it	C

EM - ELECTRICITY AND MAGNETISM



INRiM provides a calibration service for standards and instruments for generating and measuring electromagnetic quantities, with traceability to the International System.

The main quantities covered by this service include:

- **voltage, current and electrical power** in continuous and variable regimes;
- **resistance and impedance**;
- **static electromagnetic fields** and in the variable regime, up to the microwave domain;
- **magnetic properties of materials**.

The available calibration points span several orders of magnitude, up to the 20 of electrical resistance ($100 \mu\Omega - 100 T\Omega$).

The services are ranked here according to the (internationally valid) classification of services of BIPM's Consultative Committee on Electricity and Magnetism (CCEM).

VOLTAGE, CURRENT AND RESISTANCE IN DC AND LOW FREQUENCY

MULTIFUNCTION INSTRUMENTS FOR ELECTRICAL MEASUREMENTS.

INRiM offers calibration services for all high-precision instrumentation to measure the five electrical quantities. Mainly it is possible to obtain calibration and characterisation of instrumentation with MRA certifications extended to hundreds of measuring points. Numerical precision multimeters (DMMs) and multifunction calibrators (MFCs) are currently among the most widely used measuring instruments as reference standards in high-level electrical

metrology laboratories. These instruments operate on five functions, voltage and current in DC or AC and resistance, with measurement ranges of considerable extension.

It is possible to certify:

1. Direct voltage 1 mV ÷ 1000 V
2. Alternating voltage 1 mV ÷ 1000 V $f = 10 \text{ Hz} \div 1 \text{ MHz}$
3. Direct current 10 μA ÷ 100 A
4. Alternating current 100 μA ÷ 100 A $f = 10 \text{ Hz} \div 10 \text{ kHz}$
5. Direct current resistance 1 Ω ÷ 1 G Ω



The laboratory is active in interlaboratory comparisons (ILC) relating to measuring and electrical generation instrumentation and works to characterise new instrumentation released on the market.

ALTERNATING VOLTAGE AND CURRENT MEASURING INSTRUMENTS.



The service has the primary standards for disseminating the **voltage and alternating current** quantities that receive traceability directly from the respective national standards.

The service primarily aims at customers who require calibrations and measurements for high-level electronic instruments and equipment using the J. Fluke 792A electronic transfer unit operating in voltage or combination with the J. Fluke mod. A40, A40A and A40B current shunts as a reference standard.

The operating fields of the services offered are:

- Alternating Voltage ACV meters type 5790A: 1 mV to 1000 V in the frequency range from 40 Hz to 1 MHz;
- AC/DC transfer error in current: the apparatus consists of a thermal transfer standard / AC measurement standard type 5790A, associated with current SHUNT, in the range from 1 mA to 20 A and for frequencies from 40 Hz to 5 kHz.



The service is actively involved in developing new standards and measurement methods for maintaining and extending the operating ranges of reference quantities.

The CMCs associated with the service, published on the KCDB website, result from participation in international comparison cycles organised

and coordinated by the International Committee for Weights and Measures (CIPM).

RESISTANCE STANDARDS.

INRiM is developing new standards and methods for measuring and maintaining the unit of electrical resistance in a continuous regime.

Services are provided, such as calibration of **electrical resistance standards in the continuous regime**, in the range from 1 $\mu\Omega$ to 100 T Ω ; characterisation of **resistance standards in**

temperature, voltage and power;
calibration of **current comparator bridges**
for resistance measurement.

The laboratory is involved in interlaboratory comparisons, offers technical advice and organises training courses in DC electrical measurements.



DIRECT CURRENT VOLTAGE.

INRiM is developing new standards and methods for measuring and maintaining the unit of measurement of electrical voltage in a continuous regime.

Services are provided, such as:



- calibration of **electric voltage standards** in the continuous regime, in the range from 100 mV to 1000 V;
- characterisation of **standard voltage or direct current generators or meters**;
- calibration of **resistive dividers** for ratio measurements;
- non-linearity calibration for high-accuracy **digital multimeters**.

Interlaboratory comparisons in connection with electrical voltage measurements and voltage ratios are organised, and technical advice in metrology and collaboration in applied industrial research are also delivered.

IMPEDANCE

ELECTRICAL IMPEDANCE STANDARDS.

INRiM realises the units of electrical impedance (ohm, henry and farad) and the scales of electrical resistance in the alternating regime, electrical capacitance and inductance using digital impedance bridges; it maintains the corresponding CMC stated in the KCDB for the Branch “Impedance”.

INRiM offers a calibration service for AC resistors in the range from 1 Ω to 1 M Ω , capacitors and measurement bridges in the range from 1 pF to 100 μ F, self-inductors and mutual inductors from 100 μ H to 10 H, and inductance and capacitance boxes. The laboratory also realises small continuous current scales from 10 fA to 5 μ A and calibrates meters in the same ranges.

VARIABLE VOLTAGE AND CURRENT, POWER AND ENERGY

The laboratory realises the national standards for voltage, current, power and energy in sinusoidal and time-varying regimes with reference to fundamental physical constants by means of the Josephson effect and the quantum Hall effect in DC.



INRiM realises the primary standard of AC voltage and current and the related national scales through the thermal AC-DC transfer using suitable single-junction and planar multi-junction thermal transfers. Dissemination of the

ALTERNATING VOLTAGE AND CURRENT.



primary scales of AC voltage and current, at the highest level, is accomplished by calibrating multi-range AC-DC electronic transfer standards, Model J. Fluke 792A, coupled with additional coaxial resistors for voltage and coaxial shunts for current. The primary measuring systems available are the automatic low thermoelectric force comparators.

The calibration service offered by the laboratory includes the following ranges

- for AC voltage from 1 mV to 1 kV in the frequency range from 10 Hz to 1 MHz;
- for AC from 1 mA to 100 A in the frequency range from 10 Hz to 100 kHz.

ALTERNATING POWER AND ENERGY.

The laboratory realises and maintains the national single-phase and three-phase Power and Energy standard by simultaneously sampling voltage and current waveforms in a sinusoidal regime. In addition to traditional measurement systems, for several years, the



laboratory has been developing innovative measurement systems and methods based on precision digitisers and broadband current and voltage transducers to build the traceability of measurements associated with *power quality* parameters. A three-phase automatic measuring bench was recently installed to verify and calibrate wattmeters and static energy meters in the sinusoidal and non-sinusoidal regimes.

The calibration service offered by the laboratory for single and three-phase active and reactive power/energy includes the following measurement ranges:

- for voltages from 15 V to 600 V
- for currents from 5 mA to 120 A;
- for frequencies from 47 Hz to 65 Hz;
- power factor from 0 to ± 1 .

The laboratory periodically proposes and organises bilateral and multilateral inter-laboratory calibration comparisons (ILC) on behalf of ACCREDIA.

HIGH VOLTAGE AND CURRENT

HIGH VOLTAGE AND CURRENT.

The **High Voltage and High Current Laboratory** (LATFC), housed in INRiM's historic premise, near to downtown, is responsible for maintaining the standards and disseminating the high-voltage and high-current quantities relating to the tests. The reference systems are realised in such a way as to guarantee the calibration of the equipment even at the customer's premises (on-site).

The laboratory performs the international comparisons promoted within EURAMET to support the CMCs.

The LATFC facility allows high voltage, overtemperature with steady-state and transient current (short-circuit) calibrations and tests to be carried out.



LATFC is equipped to perform tests on electrical equipment (switchboards, circuit breakers, fuses, contactors, measurement transformers, etc.).

The generation and measurement capabilities of the laboratory are as follows:

- Transient (short-circuit) currents up to 100 kA equivalent for 1 second (220 kA peak);
- Stationary currents up to 10 kA three-phase 50 Hz and continuous (DC);
- High alternating voltages (50 Hz) up to 200 kV;
- High impulse voltages up to 720 kV.

HIGH DIRECT AND ALTERNATING VOLTAGES, HIGH VOLTAGE IMPEDANCE.



INRiM develops and maintains the standard systems for DC and AC high voltage, ratio of DC and AC high voltages, electrical charge, capacitance and dissipation factor in high voltage and ensures their dissemination using the calibration of sources, sensors and measuring systems for accredited calibration laboratories, manufacturers of

high voltage equipment and devices and for industrial test laboratories.

The calibration services provided include:

- calibration of DC measuring systems and dividers up to 100 kV;
- calibration of AC voltage sources and measuring systems up to 100 kV (RMS value measurement);
- calibration of high voltage gas capacitors up to 100 kV;
- measurement of error of ratio and angle in voltage transformers up to 100 kV and non-conventional sensors and transformers up to 50 kV;
- calibration of measuring bridges for voltage transformers through set-ups for generating known ratio errors;
- calibration of partial discharge calibrators with an apparent charge from 0.1 pC to 50 nC.

The CMCs associated with the service offered are published in the BIPM's KCDB and are validated through participation in international measurement comparisons within EURAMET.

HIGH ALTERNATING CURRENT.

INRiM develops and maintains standard systems for high current in alternating regimes and ensures dissemination by calibrating sensors, transducers and measuring systems for accredited calibration laboratories, manufacturers and industrial test laboratories.



Calibration services provided include:

- measurement of error of ratio and angle in current transformers for primary currents from 0.1 A to 10 kA through current comparator;
- measurement of error of ratio and angle in sensors, unconventional current transformers and AC measuring systems for primary currents from 0.1 A to 7.2 kA by comparison with standard current transformers;

- calibration of measuring bridges for current transformers through set-ups for generating known ratio and angle errors.

The CMCs associated with the service offered are published on the BIPM's KCDB site and are validated through participation in international measurement comparisons within EURAMET.

ELECTROMAGNETIC COMPATIBILITY.

INRiM develops and maintains reference systems for calibrating pulse generators in electromagnetic compatibility (EMC) tests.

The calibration services provided include the calibration of instruments used for testing immunity to the following phenomena:

- electrostatic discharge (ESD);
- transients/electrical pulse bursts (fast transient/burst);
- combined voltage and current waves (surge);
- oscillatory waves (ring wave);
- damped oscillatory waves.



ELECTRIC AND MAGNETIC FIELDS

RADIO-FREQUENCY ELECTRIC FIELDS.

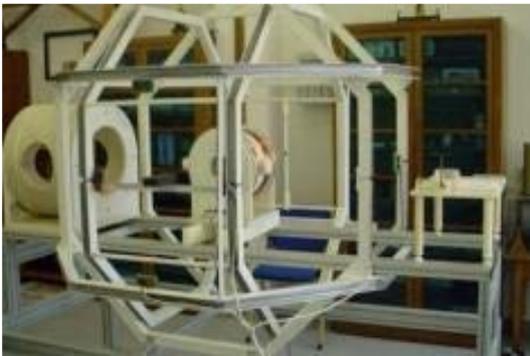
INRiM has a reference radio-frequency electromagnetic field generation system based on a TEM cell, a G-TEM cell and an anechoic chamber. This system enables the calibration of electromagnetic field meters in the frequency range from 100 kHz to 18 GHz. The CMCs associated with the service offered are published in the BIPM's KCDB and are validated through participation in international measurement comparisons within EURAMET.

STATIC MAGNETIC FIELDS.

INRiM maintains national standards of magnetic quantities: magnetic flux and magnetic flux density in the air. It ensures the traceability of magnetic measurements and performs calibrations of magnetometers.

Several reference magnetic induction sources ranging from 10 μT to 1 T are available.

In particular:



- triaxial Helmholtz coils with a diameter of 1.20 m, with compensation of the terrestrial and environmental magnetic field (with residual levels around 30 nT);
- Helmholtz reference coils for the 10 μT – 20 mT range;
- highly stable and homogeneous electromagnets providing the reference in the 43 mT – 1 T range.

The laboratory also has various instruments, including nuclear magnetic resonance magnetometers and Hall probe and fluxgate magnetometers. Calibration of measuring instruments is performed by comparison with INRiM standards.

LOW-FREQUENCY ELECTRIC AND MAGNETIC FIELDS.

The dissemination of the quantities of electric field and low-frequency magnetic induction is ensured by INRiM's standard generation systems, through which the calibrations of the meters used for the estimation of human exposure, and for the assessment of electric and magnetic field levels generated by electrical energy transmission, distribution and use.

In particular, INRiM offers:

- Helmholtz coil reference magnetic induction generation systems from 5 Hz to 100 kHz with intensities ranging from 0.2 μT to 3 mT (25 μT at 100 kHz);
- Parallel plate generation system for standard electric fields, for field strengths up to 40 kV/m at an industrial frequency, and up to 500 V/m in the range from 10 Hz to 2 kHz;
- Calibration systems by comparison with a standard meter for magnetic field generators (Helmholtz coils) and for determining the coil constant (induction generated per unit current) from 5 Hz to 100 kHz.



The CMCs associated with the service offered are published in the BIPM's KCDB and are validated through participation in international measurement comparisons within EURAMET.

RADIOFREQUENCY MEASUREMENTS

"S" PARAMETERS.



The services provided by INRiM are:

- calibration of matched/mismatched loads, attenuators, directional/ bidirectional couplers and power dividers in the frequency range 9 kHz- 50 GHz;
- organisation of interlaboratory comparisons for S-parameter measurements;
- metrological consultancy and collaborations for industrially applied research.

The CMCs for the quantities 'Reflection Coefficient' and 'Transmission Coefficient (Attenuation)' are based on participation in international comparison cycles organised by the metrological bodies coordinated by the CIPM.

ELECTROMAGNETIC COMPATIBILITY.

INRiM develops and maintains reference systems for the main instruments used in electromagnetic compatibility (EMC) testing. Calibration services provided include the calibration of receivers for radio interference measurements, artificial networks, coupling and decoupling networks, absorption clamps, voltage and current probes, directional couplers, attenuators and coaxial cables, and oscilloscopes.

MATERIALS

MEASUREMENTS ON ELECTROMAGNETIC MATERIALS.

Various instruments, such as hysteresisgraphs and wattmeters, are available for measuring magnetic properties according to IEC and ASTM measurement standards on materials used in electrotechnical applications (soft and hard magnetic materials and weakly magnetic/paramagnetic materials). Soft magnetic materials are measured as a torus or plate from DC to 1 MHz. Hard magnetic materials can be magnetised up to 7 T in a pulsed magnetic field and measured up to 2.5 T.



EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.1.1-a1	Calibration of solid state voltage sources	1V 1.018V 10V	Fluke mod. 732A/B/C. Fluke mod. 7001. Datron mod. 4910. Valhalla mod. 2734A	0.5 e-6 for 10 V nominal voltage, 3 e-6 for 1.018 V nominal voltage	Substitution Measurement	Pier Paolo Capra p.capra@inrim.it Claudio Francese c.francese@inrim.it Tet Luca Roncaglione l.roncaglione@inrim.it	A
EM.1.1-a2	Calibration of DC voltage sources with a quantum standard based on Josephson effect (SI volt realization)	0 V - 10 V	DC voltage sources (es. Fluke 732A/B/C)	0.04 $\mu\text{V/V}$ (k=2) at 10 V, 0.1 $\mu\text{V/V}$ (k=2) at 1 V and 1.018 V, 1 $\mu\text{V/V}$ (k=2) at 0.1 V	Primary realization / Comparison	Paolo Durandetto p.durandetto@inrim.it Emanuele Enrico e.enrico@inrim.it	A
EM.1.1-b1	Calibration of DC voltage reference sources	1V 1.018V 10V	Fluke mod. 732A/B/C. Fluke mod. 7001. Datron mod. 4910. Valhalla mod. 2734A	0.5 e-6 for 10 V nominal voltage, 3 e-6 for 1.018 V nominal voltage	Substitution Measurement	Pier Paolo Capra p.capra@inrim.it Claudio Francese c.francese@inrim.it Tet Luca Roncaglione l.roncaglione@inrim.it	A
EM.2.1-a1	Measurements and calibration of electrical resistance in continuous regime	1 ohm - 100 Tohm	Standards resistors, current comparator bridges, dc resistance meters	0,5 uohm/ohm - 0,66 mohm/ohm	calibration by comparison with standard resistors by bridge systems, multimeters or current comparators	Pier Paolo Capra p.capra@inrim.it	A

EM Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.2.1-d1	<p>Calibration of standard resistors in the range from 0.1 mΩ to 100 mΩ, with currents up to 100 A.</p> <p>Calibration of shunts and resistors in the range from 1 μΩ to 1 mΩ, with currents up to 2000 A.</p>	From 1 μΩ to 100 mΩ	Resistors; Shunts	From 250x10 ⁻⁶ to 2x10 ⁻⁶	Comparison by means high current comparator bridge	Enrico Gasparotto e.gasparotto@inrim.it	A
EM.2.1-d2	<p>Calibration of standard resistors in the range higher than 100 mΩ up to 10 Ω, with currents up to 100 A</p> <p><i>Field not CIPM MRA covered:</i> Calibration of standard resistors in the range higher than 100 mΩ up to 10 Ω, with currents up to 100 A</p>	Higher than 100 mΩ up to 10 Ω	Resistors; Shunts	2x10 ⁻⁶	Comparison by means high current comparator bridge	Enrico Gasparotto e.gasparotto@inrim.it	C
EM.3.2-a1	Calibration of low-current meters	10 fA to 5 μA	Low dc current meter (picoammeter)	from 6E-6 to 3E-3	Calibration with the capacitance charging method; calibration with standard transresistance amplifier	Vincenzo D'Elia v.delia@inrim.it	A
EM.4.1-a1	Calibration of resistors in the AC regime	from 1 Ω to 1 MΩ @ 50 Hz to 10 kHz	Resistors	from 20E-6 to 40E-6	Calibration by substitution	Vincenzo D'Elia v.delia@inrim.it	A
EM.4.2-c1	Calibration of capacitance bridges	from 1 pF to 1 μF	Capacitance bridge	from 1E-6 to 17E-6	direct reading	Vincenzo D'Elia v.delia@inrim.it	C

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.4.2-c2	calibration of impedance meters	from 10 pF to 100 μ F @ 120 Hz, 1 kHz from 100 μ H to 10 H @ 120 Hz, 1 kHz from 1 Ω to 1 M Ω @1 kHz	impedance meters	Capacitance: from 50E-6 to 300E-6 Inductance: from 100E-6 to 400E-6 Resistance: from 50E-6 to 300E-6	direct reading	Vincenzo D'Elia v.delia@inrim.it	C
EM.4.2-d1	Calibration of capacitors	from 1 pF to 1 μ F @ from 50 Hz to 20 kHz	capacitance standard	from 7E-6 to 1499E-6	direct reading with capacitance bridge	Vincenzo D'Elia v.delia@inrim.it	A
EM.4.2-d2	Calibration of capacitance boxes	from 1 pF to 1 μ F @ from 50 Hz to 20 kHz	capacitance decade box	from 7E-6 to 1499E-6	direct reading with capacitance bridge	Vincenzo D'Elia v.delia@inrim.it	A
EM.4.3-a1	Calibration of capacitors	from 10 nF to 100 μ F @ 120 Hz and 1 kHz	capacitance standard	from 14E-6 to 36E-6	calibration with three-voltmeter method	Vincenzo D'Elia v.delia@inrim.it	A
EM.4.3-a2	Calibration of inductors	from 1 mH to 10 H @ 120 Hz and 1 kHz	Inductance standard	from 15E-6 to 29E-6	calibration with three-voltmeter method	Vincenzo D'Elia v.delia@inrim.it	A
EM.4.3-b1	Calibration of inductors	from 100 μ H to 10 H @ 120 Hz, 1000 Hz	Inductance standard	from 50E-6 to 300E-6	calibration by substitution	Vincenzo D'Elia v.delia@inrim.it	A
EM.4.3-b2	Calibration of inductance boxes	from 100 μ H to 10 H @120 Hz, 1000 Hz	inductance decade box	from 50E-6 to 300E-6	calibration by substitution	Vincenzo D'Elia v.delia@inrim.it	A

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.4.3-b3	Calibration of mutual inductors	from 100 μ H to 10 H	mutual inductor	1.00E-03	calibration by substitution	Vincenzo D'Elia v.delia@inrim.it	C
EM.5.1-b1	Calibration of ac/dc thermal converters plus additional resistors by step-up (from 5V to 1kV).	5V to 1kV @ 40Hz to 1MHz	AC/DC thermal converters plus additional resistors; Multi-range ac/dc thermal transfer units	from 5 μ V/V to 1.0E2 μ V/V	Comparison against INRIM reference standards	Danilo Serazio d.serazio@inrim.it	A
EM.5.1-b2	Calibration of ac/dc thermal converters (from 250 mV to 5 V).	200mV to 5V @ 40Hz to 1MHz	AC/DC thermal converters; Multi-range ac/dc thermal transducers	from 4 μ V/V to 5.0E1 μ V/V	Comparison against INRIM standards	Danilo Serazio d.serazio@inrim.it	A
EM.5.1-c2	Calibration of standard ac/dc thermal converters plus resistive dividers by step-down (from 1mV to 300mV).	1mV to 300mV @ 40Hz to 1MHz	Standard thermal converters plus resistive dividers; Multi-range ac/dc thermal transfer units	from 2.5E1 μ V/V to 1.0E3 μ V/V	Comparison against INRIM standards	Danilo Serazio d.serazio@inrim.it	A
EM.5.2-e1	Calibration of an alternating voltage meter/transfer J.Fluke mod. 5790 for comparison with the J.Fluke mod. 792A	as reference matrix	J.Fluke 5790	From 9 μ V/V to 2954 μ V/V	Calibration by comparison with reference standard J.Fluke mod. 792A	Tet Luca Roncaglione l.roncaglione@inrim.it	A
EM.5.3-a1	Calibration of signal conditioners <i>Field not CIPM MRA covered:</i> from 0.5 Hz to 10 kHz	from 0.5 Hz to 10 kHz	Charge or voltage amplifier	0.10%	Transfer function (only module)	Alessio Facello a.facello@inrim.it	C

EM Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.5.3-b1	Calibration of signal conditioners for strain gauge bridges and calibrators	-5 to +5 mV/V	Signal conditioners for strain gauge bridges and calibrators	from 0,000012 to 0,000020 mV/V	Calibration by comparison	Alessio Facello a.facello@inrim.it Andrea Prato a.prato@inrim.it	C
EM.5.3-c1	Calibration of signal conditioners <i>Field not CIPM MRA covered:</i> from 20 mV to 5000 mV in the frequency range 0,5 Hz ÷ 1000 Hz	from 20 mV to 5000 mV in the frequency range 0.5 Hz ÷ 1000 Hz	multimeters, cards and analyzers	0.10%	Comparison with reference data acquisition system	Alessio Facello a.facello@inrim.it	C
EM.6.1-c1	Calibration of standard ac/dc thermal converters plus current shunt.	2mA to 100A @ 10Hz to 100kHz	Thermal converters plus shunts; AC-DC transfer standards plus shunts	from 2 µA/A to 70 µA/A	Comparison against INRIM standards	Danilo Serazio d.serazio@inrim.it	A
EM.6.1-d1	Calibration as AC to DC transfer of the Fluke Mod. 5790A/B associated with current shunts	from 2 mA to 20A for frequencies f= (40-300-1000-5000) Hz	Assembly consisting of J.Fluke 5790 Transfer/Meter associated with alternating current shunts	as reference matrix from 45 µA/A to 120 µA/A	comparison with reference standard	Tet Luca Roncaglione l.roncaglione@inrim.it	A

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.6.2-c1	Calibration of a calibrator	DC Voltage (1 mV to 1 kV) AC Voltage (1 mV to 1 kV) – (10 Hz to 1 MHz) DC Current (10 µA to 100 A) AC Current (100 µA to 100 A) – (10 Hz to 10 kHz) Resistance R (1 Ω - 100 MΩ)	DCV direct voltage (1 mV to 1 kV)	DC voltage (DCV) 0.6 x 10 ⁻⁶ to 13 x 10 ⁻⁵ AC voltage (ACV) 7.4 x 10 ⁻⁶ to 7.4 x 10 ⁻⁴ DC current (IDC) 1.7 x 10 ⁻⁶ to 1 x 10 ⁻⁴ AC current (ACI) 2 x 10 ⁻⁵ to 25 x 10 ⁻⁵ Resistance R 1.1 x 10 ⁻⁶ to 21 x 10 ⁻⁶	Calibration of a calibrator by comparison with reference standards	Marco Lanzillotti m.lanzillotti@inrim.it	A
EM.6.2-d1	Numeral multimeter calibration	DC Voltage (1 mV to 1 kV) AC Voltage (1 mV to 1 kV) – (10 Hz to 1 MHz) DC Current (10 µA to 100 A) AC Current (100 µA to 100 A) – (10 Hz to 10 kHz) Resistance R (1 Ω - 1 GΩ)	DCV direct voltage (1 mV to 1 kV)	DC voltage (DCV) 1.1 x 10 ⁻⁶ to 30 x 10 ⁻⁵ AC voltage (ACV) 2.8 x 10 ⁻⁵ to 10 x 10 ⁻⁴ DC current (IDC) 10 x 10 ⁻⁶ to 1 x 10 ⁻⁴ AC current (ACI) 3.5 x 10 ⁻⁵ to 3 x 10 ⁻⁴ Resistance R 1.3 x 10 ⁻⁶ to 8 x 10 ⁻⁵	Calibration of a digital multimeter by direct comparison with the reference calibrator	Marco Lanzillotti m.lanzillotti@inrim.it	A
EM.7.1-b1	Calibration of single-phase/three-phase wattmeters. Calibration of fictitious power generators/calibrators. Calibration of single-phase/three-phase energy meters. Calibration of single-phase/three-phase power and energy comparators.	Voltage : 15 V to 600 V Current : 0.005 A to 120 A Frequency : 47 Hz to 65 Hz Power factor : 1 to 0, inductive or capacitive	Power meters. energy meter, power converter, power comparator	40 - 60 µW/VA, µvar/VA 66 - 80 µW/VA, µvar/VA	Calibration by comparison with reference standards (INRIM)	Danilo Serazio d.serazio@inrim.it	A

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.8.1-a1	Calibration of high voltage DC measuring systems <i>Field not CIPM MRA covered:</i> Voltage values ≥ 0.5 kV and < 1 kV and > 80 kV and ≤ 100 kV	± 0.5 kV - ± 100 kV	High voltage DC measuring system	0.0022%	Comparison with reference measuring system	Giorgio Varetto g.varetto@inrim.it	B
EM.8.1-b1	Calibration of high voltage DC dividers <i>Field not CIPM MRA covered:</i> Applied voltage ≥ 0.5 kV and < 1 kV and > 80 kV and ≤ 100 kV. Output voltage ≥ 0.01 V and < 0.8 V.	Applied voltage from ± 0.5 kV to ± 100 kV. Output voltage from ± 0.01 V to ± 1000 V. Voltage ratio from 10 to 100000.	High voltage DC divider	0.0022%	Comparison with reference voltage divider	Giorgio Varetto g.varetto@inrim.it	B
EM.8.2-a1	Calibration of high voltage capacitors <i>Field not CIPM MRA covered:</i> Applied voltage ≥ 0.1 kV (rms value) and < 1 kV (rms value) Applied voltage > 100 kV (rms value) and ≤ 150 kV (rms value) Dissipation factor $> 1.4E-3$	Applied voltage from 0.1 kV (rms value) to 150 kV (rms value). Frequency = 50 Hz. Capacitance value from 50 pF to 10000 pF. Dissipation factor from 0 to 1. 4E-3	High voltage capacitor	Capacitance value: 50 μ F/F. Dissipation factor value (applied voltage from 0.1 kV (rms value) to 50 kV (rms value)): 1.0E-5. Dissipation factor value (applied voltage > 50 kV (rms value) to 150 kV (rms value)): 3.0E-5.	Determination of the capacitance value and dissipation factor value by comparison with a reference capacitance using a current comparator.	Giorgio Varetto g.varetto@inrim.it	B

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.8.3-a1	Calibration of measurement systems for high alternating voltages at industrial frequency. used for measuring the applied voltage during dielectric tests	1kV - 800kV (Peak/ $\sqrt{2}$) 1kV - 800kV (RMS)	Measurement systems for high alternating voltages	Peak/ $\sqrt{2}$: $\geq 1\%$ RMS: $\geq 0,7\%$	Peak value/ $\sqrt{2}$: Calibration by comparison at a frequency of 50 Hz in the range of values between 1 kV and 800 kV (on-site only above 275 kV) RMS value: Calibration by comparison at a frequency of 50-60 Hz in the range of values between 1 kV and 200 kV (on-site only above 275 kV). Calibration at INRiM above 100 kV or if combined with a peak voltmeter Calibrations in accordance with IEC 60060-2	Paolo Emilio Roccato p.roccato@inrim.it Gian Paolo Scialpi g.scialpi@inrim.it	A
EM.8.3-b1	Calibration of high voltage ac measuring systems (rms value) <i>Field not CIPM MRA covered:</i> Applied voltage >100 kV (rms value) and ≤ 120 kV (rms value)	from 1 kV (rms value) to 120 kV (rms value)	High voltage AC measuring system	0.2%	Comparison with reference measuring system	Giorgio Varetto g.varetto@inrim.it	B
EM.8.3-c1	Calibration of voltage transformers <i>Field not CIPM MRA covered:</i> Primary voltage ≥ 0.02 kV (rms value) and <1 kV (rms value). Primary voltage >100 kV (rms value) and ≤ 153 kV (rms value). Secondary voltage ≥ 1 V (rms value) and <5 V (rms value). Secondary voltage >200 V (rms value) and ≤ 600 V (rms value).	Primary voltage from 0.02 kV (rms value) to 153 kV (rms value). Secondary voltage from 1 V (rms value) to 600 V (rms value). Frequency = 50 Hz. Ratio error from 0% to $\pm 10\%$. Phase error from 0 rad to $\pm 9999 \mu\text{rad}$.	Voltage transformer	Ratio error: 50 $\mu\text{V/V}$. Phase error: 50 μrad .	Determination of ratio error and phase error of voltage transformer by absolute method, using a current comparator and no. 2 high voltage reference capacitor.	Giorgio Varetto g.varetto@inrim.it	B

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.8.3-d1	Calibration of non conventional voltage transducers	Primary voltage from 0.5 kV (val. eff.) to 50 kV (val. eff.). Secondary voltage from 10 mV (rms value) to 200 V (rms value). Frequency from 40 Hz to 60 Hz. Ratio error from 0% to $\pm 2\%$. Phase error from 0 rad to ± 20 mrad.	Non conventional voltage transducer	Ratio error: 0.01%. Phase error: 100 μ rad.	Dedicated set-up composed of voltage transformer, digitizer and automatic acquisition system.	Giorgio Varetto g.varetto@inrim.it	A
EM.8.3-e1	Calibration of voltage transformers test sets	Applied voltage for ratio error: 20 V (rms value) to 200 V (rms value). Applied voltage for phase error: from 20 V (rms value) to 120 V (rms value). Frequency from 40 Hz to 60 Hz. Ratio error from 0 % to ± 2 %. Phase error from 0 rad to ± 20 mrad.	Voltage transformer test set	Ratio error: from 0.001 % to 0.01 %. Phase error: from 10 μ rad to 200 μ rad.	Comparison with reference values of ratio errors and phase errors.	Giorgio Varetto g.varetto@inrim.it	A
EM.8.4-a1	Calibration of high voltage pulse generators for EMC tests: voltage peak value	from 0.2 kV to 6 kV	High voltage pulse generators for EMC tests	6 %	EN 61000-4-5, EN 61000-4-12, EN 61000-4-18	Giuseppe Vizio g.vizio@inrim.it	C
EM.8.4-a2	Calibration of high voltage pulse generators for EMC tests: current peak value	from 0.01kA to 3kA	High voltage pulse generators for EMC tests	6 %	EN 61000-4-5, EN 61000-4-12, EN 61000-4-18	Giuseppe Vizio g.vizio@inrim.it	C
EM.8.4-a3	Calibration of high voltage pulse generators for EMC tests: rise time	from 0.3 μ s to 100 μ s	High voltage pulse generators for EMC tests	0,05 μ s	EN 61000-4-5, EN 61000-4-12, EN 61000-4-18	Giuseppe Vizio g.vizio@inrim.it	C

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.8.4-a4	Calibration of high voltage pulse generators for EMC tests: duration at half value	from 10 μ s to 150 μ s	High voltage pulse generators for EMC tests	0,1 μ s	EN 61000-4-5, EN 61000-4-12, EN 61000-4-18	Giuseppe Vizio g.vizio@inrim.it	C
EM.8.4-a5	Calibration of high voltage pulse generators for EMC tests: oscillation frequency	50kHz to 150kHz	High voltage pulse generators for EMC tests	50 Hz	EN 61000-4-5, EN 61000-4-12, EN 61000-4-18	Giuseppe Vizio g.vizio@inrim.it	C
EM.8.4-a6	Calibration of high voltage pulse generators for EMC tests: oscillation frequency	from 0.5 MHz to 1.5 MHz	High voltage pulse generators for EMC tests	5 kHz	EN 61000-4-5, EN 61000-4-12, EN 61000-4-18	Giuseppe Vizio g.vizio@inrim.it	C
EM.8.4-a7	Calibration of high voltage pulse generators for EMC tests: damping / decay	from 0.2 to 1.1	High voltage pulse generators for EMC tests	0.04	EN 61000-4-5, EN 61000-4-12, EN 61000-4-18	Giuseppe Vizio g.vizio@inrim.it	C
EM.8.4-a8	Calibration of high voltage pulse generators for EMC tests: repetition rate	20Hz to 80Hz;	High voltage pulse generators for EMC tests	0,005 Hz	EN 61000-4-5, EN 61000-4-12, EN 61000-4-18	Giuseppe Vizio g.vizio@inrim.it	C

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.8.4-b1	Measurement systems for high voltages used for the measurement of lightning impulse voltage	4V-700kV	Measuring system for high impulsive voltage	Full wave: 4 V - 2 kV: $U_t \geq 0.5\%$; $T_1 \geq 1,5\%$; $T_2 \geq 1\%$; $\beta \geq 0,5\%$ 0,4 kV - 200 kV: $U_t \geq 0.5\%$; $T_1 \geq 2\%$; $T_2 \geq 1\%$; $\beta \geq 0,5\%$ 200 kV - 700 kV ($T_1 < 1,2$ us): $U_t \geq 0,9\%$; $T_1 \geq 2\%$; $T_2 \geq 1\%$; $\beta \geq 0,5\%$ 200 kV - 700 kV ($T_1 \geq 1,2$ us): $U_t \geq 0,5\%$; $T_1 \geq 2\%$; $T_2 \geq 1\%$; $\beta \geq 0,5\%$ Chooped wave: 20 kV - 200 kV: (0,4 us - 1,6 us): $U_p \geq 2,0\%$; $T_c \geq 5,4\%$	Calibration according to standard IEC 60060-2	Paolo Emilio Roccato p.rocato@inrim.it Gian Paolo Scialpi g.scialpi@inrim.it	A
EM.8.5-a1	Current shunt calibration (ESD target): transfer impedance	From 0.05 Ω to 1.5 Ω	Current shunt (ESD target)	From 0,0008 Ω to 0,0019 Ω	IEC 61000-4-2	Giuseppe Vizio g.vizio@inrim.it	A
EM.8.5-a2	Current shunt calibration (ESD target): input resistance	From 0.8 Ω to 2.2 Ω	Current shunt (ESD target)	0,017 Ω	IEC 61000-4-2	Giuseppe Vizio g.vizio@inrim.it	C
EM.8.5-a3	Current shunt calibration (ESD target): insertion loss	From -60dB to -20dB; from 100 kHz to 4 GHz	Current shunt (ESD target)	From 0,26 dB to 0,54 dB	IEC 61000-4-2	Giuseppe Vizio g.vizio@inrim.it	C
EM.8.5-a4	Current shunt calibration (ESD target): reflection coefficient	From 0 to 1; from 100 kHz to 4 GHz	Current shunt (ESD target)	From 0,009 to 0,04	Vector network analyzer	Giuseppe Vizio g.vizio@inrim.it	C

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.8.5-b1	Calibration of electrostatic discharge generators	from 1 to 30 kV	Electrostatic discharge generator: output voltage	2 %	IEC 61000-4-2	Giuseppe Vizio g.vizio@inrim.it	C
EM.8.5-b2	Calibration of electrostatic discharge generators	from 0.5ns to 2ns	Electrostatic discharge generator: rise time	0,05 ns	IEC 61000-4-2	Giuseppe Vizio g.vizio@inrim.it	A
EM.8.5-b3	Calibration of electrostatic discharge generators	from 0.1A to 120A	Electrostatic discharge generator: current peak value	6 %	IEC 61000-4-2	Giuseppe Vizio g.vizio@inrim.it	A
EM.8.5-b4	Calibration of electrostatic discharge generators	from 0.1A to 120A	Electrostatic discharge generator: current values at 30 ns and at 60 ns	6 %	IEC 61000-4-2	Giuseppe Vizio g.vizio@inrim.it	A
EM.8.5-c1	Calibration of partial discharge calibrators <i>Field not CIPM MRA covered:</i> Rise time: from 5 ns to 100 ns.	Apparent charge: from 0.5 pC to 50000 pC. Rise time: from 5 ns to 100 ns.	Partial discharge calibrator	Apparent charge: from 1% to 3%. Rise time: 2 ns.	Comparison with reference charge.	Giorgio Varetto g.varetto@inrim.it	B
EM.8.6-a1	Calibration of measuring systems for high direct or alternating currents at industrial frequency, used for measuring current during leakage and breaking tests <i>Field not CIPM MRA covered:</i> AC: 170 kA - 230 kA DC: 0,1 kA - 40 kA	0.1kA-170kA, 10m(A2S) - 6400M(A2S)	Measuring systems for high transient currents (Short-circuit)	Ufs ≥0,6%, Ui2t ≥ 3,2%	Reference measurement system comparison (in accordance with IEC 62475)	Paolo Emilio Roccato p.roccato@inrim.it Gian Paolo Scialpi g.scialpi@inrim.it	B

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SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.8.6-b1	Calibration of current transformers	Nominal transformation ratios: from 0.4 to 10000; Primary currents: from 0.05 to 10000 A; Secondary currents: 1 and 5 A; Frequency: from 40 to 60Hz	Current transformers	ratio error: 10 to 40 ppm; angle error: 20 to 60 μ rad	Comparison with set-up based on standard current comparator	Federico Fissore f.fissore@inrim.it	A
EM.8.6-c1	Calibration of bridges for measurement of ratio and angle of current transformers	Ratio error: from 0 to 0.02; angle error: from 0 to 1 crad	bridges for measurement of ratio and angle error of current transformers	Ratio error: 1.0E-5 to 2E-4 ; Angle error: 10 μ rad to 200 μ rad	Measurement with imposed ratio and angle errors	Federico Fissore f.fissore@inrim.it	A
EM.8.6-d1	Calibration of measurement systems for high alternating currents at industrial frequency in steady state <i>Field not CIPM MRA covered:</i> 1 A \div 10 000 A	1 A \div 10 000A	Measurement systems for high alternating currents	\geq 0.2%	Reference measurement system comparison (in accordance with IEC 62475)	Paolo Emilio Roccato p.roccato@inrim.it Gian Paolo Scialpi g.scialpi@inrim.it	C
EM.10.1-a1	Calibration of electric field meters at industrial frequency	From 1 V/m to 40000 V/m. Frequency: 50 Hz.	Electric field meter	0.26%	Comparison with reference electric field	Giorgio Varetto g.varetto@inrim.it	A
EM.10.1-b1	Calibration of low frequency electric field meters	Electric field value from 1 V/m to 500 V/m. Frequency from 10 Hz to 2000 Hz.	Low frequency electric field meter	0.26%.	Comparison with reference electric field	Giorgio Varetto g.varetto@inrim.it	A
EM.10.2-a1	Calibration of static magnetic induction flux density meters	from 15 μ T to 1 T	Digital B(T) Meter			Luca Toso l.toso@inrim.it	A

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.10.2-c1	Calibration of low and medium frequency magnetic field meters. <i>Field not CIPM MRA covered:</i> 501 Hz - 1000 Hz, 101 μ T - 1000 μ T 301 kHz - 400 kHz, 1 μ T - 3 μ T	100 nT - 3 mT, 5 Hz - 400 kHz.	Measurement systems / magnetic field meters.	Ur, from 0,004 T/T to 0,07 T/T.	Direct comparison with standard.	Andrea Agosto a.agosto@inrim.it	B
EM.10.2-d1	Measurement of the system constant/calibration factor and correction factors for parasitic parameters <i>Field not CIPM MRA covered:</i> 0,25 % from 1,01 mT/A to 40 mT/A, DC, 0,4 % from 201 μ T/A to 300 μ T/A, from 1,1 kHz to 15 kHz 0,7 % from 201 μ T/A to 300 μ T/A, from 16 kHz to 100 kHz	From 0.5 μ T/A to 40 mT/A - DC to 100 kHz	Helmholtz coil magnetic field generation systems. system constant / calibration factor and correction factors for parasitic parameters	From 0,25 % to 0,7 %	Reference set-up for magnetic flux density and current measurement / Direct comparison with standard	Andrea Agosto a.agosto@inrim.it	B
EM.10.2-d1	Calibration of DC magnetic flux meters	from 0.0001 Wb to 0.02 Wb	Digital magnetic induction fluxmeters	Relative combined standard uncertainty: uc = 0.0005 – 0.001 Extended uncertainty: U = 0.001 – 0.002	The calibration method imply the comparison between the magnetic flux values generated by mutual reference inductances and the value of the magnetic flux read on the fluxmeter.	Nicoleta Banu n.banu@inrim.it	A
EM.10.3-a1	Calibration of electromagnetic field sensor	From 100 kHz to 18 GHz; from 1 V/m to 60 V/m	Electromagnetic field sensor	From 8 % to 20 %	Reference field in TEM, G-TEM cell and anechoic chamber	Giuseppe Vizio g.vizio@inrim.it	A

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SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.3-a1	Calibration of Coupling/Decoupling Networks (CDN)	From 50 Ω to 250 Ω ; from 150 kHz to 300 MHz	Common mode impedance	From 1,5 Ω to 58 Ω	EN 61000-4-6	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.3-a2	Calibration of Coupling/Decoupling Networks (CDN)	From -0.7 to 0.7	Common mode reflection coefficient	From 0,009 to 0,052	EN 61000-4-6	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	A
EM.11.3-a3	Calibration of Coupling/Decoupling Networks (CDN) <i>Field not CIPM MRA covered:</i> From -15 dB to -8 dB; from 150 kHz to 300 MHz	From -15 dB to -8 dB; from 150 kHz to 300 MHz	Voltage division factor	From 0,16 dB to 0,27 dB	EN 61000-4-6	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	B
EM.11.3-a4	Calibration of adapters for coupling / decoupling networks (CDN)	From 8 dB to 11 dB; from 150 kHz to 300 MHz	Insertion loss	From 0,16 dB to 0,27 dB	EN 61000-4-6	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	A

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.3-c1	Calibration of passive coaxial devices: magnitude of the transmission coefficient	From -70dB to 0dB; from 9 kHz to 4 GHz	Coaxial devices with 2 ports and N type connectors	From 0,1 to 1,85 dB	Vector network analyzer	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	A
EM.11.3-c2	Calibration of passive coaxial devices: magnitude of the transmission coefficient	From -70 dB to 0 dB, from 9 kHz to 1 GHz	Coaxial devices with 2 ports and BNC type connectors	From 0,1 dB to 1,85 dB	Vector network analyzer	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	A
EM.11.3-c3	Calibration of passive coaxial devices: reflection coefficient	From -1 to 1; from 9 kHz to 4 GHz	Coaxial devices with 1 or 2 ports and N-type connectors	From 0,009 to 0,037	Vector network analyzer	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	A
EM.11.3-c4	Calibration of passive coaxial devices: reflection coefficient	From -1 to 1; from 9 kHz to 1 GHz	Coaxial devices with 1 or 2 ports and BNC type connectors	From 0,028 to 0,067	Vector network analyzer	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	A

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.3-d1	Calibration of directional couplers: coupling factor	From 10 dB to 70 dB; from 10 kHz to 4 GHz	Directional couplers	From 0,10 dB to 0,35 dB	Vector network analyzer	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.3-d2	Calibration of directional couplers: insertion loss	From 0,10 dB to 0,20 dB; from 10 kHz to 4 GHz	Directional couplers	From 0,10 dB to 0,20 dB	Vector network analyzer	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.3-d3	Calibration of directional couplers: directivity	From 0 dB to 40 dB; from 10 kHz to 4 GHz	Directional couplers	From 0,25 dB to 3,8 dB	Vector network analyzer	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.3-e1	Calibration of asymmetric artificial networks: magnitude of common mode impedance	From 100 ohms to 200 ohms	Asymmetric artificial networks	From 2,9 Ω to 3,5 Ω ; from 0.15 to 30 MHz	EN 55016-1-2	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.3-e2	Calibration of asymmetric artificial networks: phase of common mode impedance	From -20 to 20 degrees; from 0.15 to 30 MHz	Asymmetric artificial networks	From 2,6 to 4 degrees	EN 55016-1-2	Giuseppe Vizio g.vizio@inrim.it	C

EM							Electricity and magnetism						
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC							
EM.11.3-e3	Calibration of asymmetric artificial networks: longitudinal conversion loss	From 35 dB to 80 dB; from 0,15 to 30 MHz	Asymmetric artificial networks	From 0,9 dB to 2,8 dB	EN 55016-1-2	Giuseppe Vizio g.vizio@inrim.it	C						
EM.11.3-e4	Calibration of asymmetric artificial networks: voltage division factor	From 8 dB to 11dB; from 0,15 to 30 MHz	Asymmetric artificial networks	0,2 dB	EN 55016-1-2	Giuseppe Vizio g.vizio@inrim.it	C						
EM.11.3-e5	Calibration of asymmetric artificial networks: isolation	From 10 dB to 80 dB; from 0,15 to 30 MHz	Asymmetric artificial networks	From 0,2 dB to 1,2 dB	EN 55016-1-2	Giuseppe Vizio g.vizio@inrim.it	C						
EM.11.3-f1	Calibration of the "S" Parameters ("Scattering"). Reflection Coefficient of passive devices with one or more ports, 50 ohm, in coaxial connection type 2.92mm/K <i>Field not CIPM MRA covered:</i> 9KHz - 50MHz	Frequency: from 9kHz to 40GHz; dynamic range: -1,0 to 1,0 in real and imaginary format	Loads (matched/mismatched), short circuits, open circuits, attenuators, adapters, cables, power dividers, couplers (directional/bidirectional).	9 KHz - 50 MHz: from 0,008 to 0,027; 50 MHz - 2 GHz: from 0,008 to 0,019; 2 GHz - 20 GHz: from 0,008 to 0,020; 20 GHz - 40 GHz: from 0,013 to 0,034.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	B						
EM.11.3-f2	Calibration of the "S" Parameters ("Scattering"). Transmission coefficient of passive devices with two or more ports, 50 ohm, in coaxial connection type 2.92mm/K <i>Field not CIPM MRA covered:</i> 9KHz - 50MHz	Frequency: from 9kHz to 40GHz; dynamic range: -1,0 to 1,0 in real and imaginary format.	Attenuators, adapters, cables, power dividers, couplers (directional/bidirectional)	9 KHz - 50 MHz: from 0,00007 to 0,01065; 50 MHz - 2 GHz: from 0,00010 to 0,00520; 2 GHz - 20 GHz: from 0,00009 to 0,00764; 8 GHz - 40 GHz: from 0,00018 to 0,01724.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	B						

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.3-f3	Calibration of the "S" Parameters ("Scattering"). Transmission coefficient of passive devices with two or more ports, 50 ohm, in coaxial connection type 2.92mm/K <i>Field not CIPM MRA covered: 9KHz - 50MHz</i>	Frequency: from 9kHz to 40GHz; dynamic range: 0 dB to -50 dB in logarithmic format.	Attenuators, adapters, cables, power dividers, couplers (directional/bidirectional)	9 KHz - 50 MHz: from 0,10dB to 0,19 dB; 50 MHz - 2 GHz: from 0,05dB to 0,27 dB; 2 GHz - 20 GHz: from 0,07dB to 0,23 dB; 20 GHz - 40 GHz: from 0,15dB to 0,49 dB.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	B
EM.11.3-f4	Calibration of the "S" Parameters ("Scattering"). Reflection Coefficient of passive devices with one or more ports, 50 ohm, in 2.4mm type coaxial connection	Frequency: from 9kHz to 50GHz; dynamics: -1.0 to 1.0 in real and imaginary format	Loads (matched/mismatched), short circuits, open circuits, attenuators, adapters, cables, power dividers, couplers (directional/bidirectional).	9 KHz - 50 MHz: from 0,008 to 0,024; 50 MHz - 2 GHz: from 0,006 to 0,013; 2 GHz - 20 GHz: from 0,006 to 0,017; 20 GHz - 40 GHz: from 0,010 to 0,029; 40 GHz - 50 GHz: da 0,012 a 0,036.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	A
EM.11.3-f5	Calibration of the "S" Parameters ("Scattering"). Transmission Coefficient of passive devices with two or more ports, 50 ohm, in 2.4mm type coaxial connection	Frequency: from 9kHz to 50GHz; dynamic range: -1,0 to 1,0 in real and imaginary format.	Attenuators, adapters, cables, power dividers, couplers (directional/bidirectional)	9 KHz - 50 MHz: from 0,00007 to 0,01042; 50 MHz - 2 GHz: from 0,00004 to 0,00352; 2 GHz - 20 GHz: from 0,00004 to 0,00650; 20 GHz - 40 GHz: from 0,00018 to 0,01336; 40 GHz - 50 GHz: da 0,00066 a 0,01677.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	A

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.3-f6	Calibration of the "S" Parameters ("Scattering"). Transmission Coefficient of passive devices with two or more ports, 50 ohm, in 2.4mm type coaxial connection	Frequency: from 9kHz to 50GHz; dynamic range: 0 dB to -50 dB in logarithmic format.	Attenuators, adapters, cables, power dividers, couplers (directional/bidirectional)	9 KHz - 50 MHz: from 0,09dB to 0,19 dB; 50 MHz - 2 GHz: from 0,03dB to 0,11 dB; 2 GHz - 20 GHz: from 0,06dB to 0,11 dB; 20 GHz - 40 GHz: from 0,12dB to 0,48 dB; 40 GHz - 50 GHz: from 0,14dB to 1,66 dB.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	A
EM.11.3-f7	Calibration of the "S" Parameters ("Scattering"). Reflection Coefficient of passive devices with one or more ports, 50 ohm, in 3.5mm type coaxial connection	Frequency: from 9 kHz to 26.5 GHz; dynamic range: -1.0 to 1.0 in real and imaginary format	Loads (matched/mismatched), short circuits, open circuits, attenuators, adapters, cables, power dividers, couplers (directional/bidirectional)	9 KHz - 50 MHz: from 0,00003 to 0,00949; 50 MHz - 2 GHz: from 0,00009 to 0,00396; 2 GHz - 8 GHz: da 0,00002 a 0,00889; 8 GHz - 18 GHz: from 0,00003 to 0,01032; 18 GHz - 26,5 GHz: from 0,00005 to 0,01307.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	A
EM.11.3-f8	Calibration of the "S" Parameters ("Scattering"). Transmission Coefficient of passive devices with two or more ports, 50 ohm, in 3.5mm type coaxial connection	Frequency: from 9 kHz to 26.5 GHz; dynamic range: -1.0 to 1.0 in real and imaginary format	Attenuators, adapters, cables, power dividers, couplers (directional/bidirectional)	9 KHz - 50 MHz: from 0,09 dB to 0,26 dB; 50 MHz - 2 GHz: from 0,03 dB to 0,76 dB; 2 GHz - 8 GHz: da 0,08 dB a 0,15 dB; 8 GHz - 20 GHz: from 0,09 dB to 0,23 dB; 20 GHz - 26,5 GHz: from 0,11 dB to 0,46 dB.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	A

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.11.3-f9	Calibration of the "S" Parameters ("Scattering"). Transmission Coefficient of passive devices with two or more ports, 50 ohm, in 3.5mm type coaxial connection	Frequency: from 9 kHz to 26.5 GHz; dynamic range: -1,0 to 1,0 in real and imaginary format.	Attenuators, adapters, cables, power dividers, couplers (directional/bidirectional)	9 KHz - 50 MHz: from 0,004 to 0,021; 50 MHz - 2 GHz: from 0,004 to 0,013; 2 GHz - 8 GHz: from 0,006 to 0,023; 8 GHz - 20 GHz: from 0,006 to 0,027; 20 GHz - 26,5 GHz: from 0,006 to 0,028.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	A
EM.11.3-f10	Calibration of the parameters of "Scattering" ("S"). Reflection Coefficient of passive devices with one or more ports, 50 ohm, in N-type coaxial connection	Frequency: from 9 kHz to 18 GHz; dynamic range: -1.0 to 1.0 in real and imaginary format	loads (matched/misadapted), short circuits, open circuits, attenuators, adapters, cables, power dividers, directional/bidirectional couplers	9 KHz - 50 MHz: from 0,09 dB to 0,26 dB; 50 MHz - 2 GHz: from 0,03 dB to 0,76 dB; 2 GHz - 8 GHz: from 0,06 dB to 0,14 dB; 8 GHz - 18 GHz: from 0,08 dB to 0,21 dB.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	A
EM.11.3-f11	Calibration of the "S" Parameters ("Scattering"). Transmission Coefficient of passive devices with two or more ports, 50 ohm, in N-type coaxial connection	Frequency: 9kHz to 18GHz; dynamic range: -1.0 to 1.0 in real and imaginary format	Attenuators, adapters, cables, power dividers, couplers (directional/bidirectional)	9 KHz - 50 MHz: from 0,005 to 0,019; 50 MHz - 2 GHz: from 0,004 to 0,009; 2 GHz - 8 GHz: from 0,006 to 0,018; 8 GHz - 18 GHz: from 0,006 to 0,026.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	A
EM.11.3-f12	Calibration of the "S" Parameters ("Scattering"). Transmission Coefficient of passive devices with two or more ports, 50 ohm, in N-type coaxial connection	Frequency: from 9kHz to 18GHz; dynamic range: -1,0 to 1,0 in real and imaginary format.	Attenuators, adapters, cables, power dividers, couplers (directional/bidirectional)	9 KHz - 50 MHz: from 0,00003 to 0,00937; 50 MHz - 2 GHz: from 0,00009 to 0,00307; 2 GHz - 8 GHz: from 0,00002 to 0,00721; 8 GHz - 18 GHz: from 0,00002 to 0,00956.	Direct measurement of the "S" parameters using a measurement system based on a vector network analyzer.	Paolo Terzi p.terzi@inrim.it	A

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.3-j1	Calibration of artificial mains networks: magnitude of impedance	From 0,5 Ω to 200 Ω ; from 9 kHz to 110 MHz	Artificial mains networks	0,5 Ω	EN 55016-1-2	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.3-j2	Calibration of artificial mains networks: impedance phase angle	From -20 to 90 degrees; from 9 kHz to 110 MHz	Artificial mains networks	3,2 degrees	EN 55016-1-2	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.3-j3	Calibration of artificial mains networks: voltage division factor	From -2 dB to 20 dB; from 9 kHz to 110 MHz	Artificial mains networks	0,15 dB	EN 55016-1-2	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.3-j4	Calibration of artificial mains networks: isolation	From 10 dB to 80 dB; from 9 kHz to 30 MHz	Artificial mains networks	3,1 dB	EN 55016-1-2	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.6-a1	Calibration of fast transient generators: peak value of the output voltage <i>Field not CIPM MRA covered:</i> From 0,08 kV to 0,2 kV; from 6 kV to 8 kV	From 0.08kV to 8kV	Fast transient generators	8 %	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	B
EM.11.6-a2	Calibration of fast transient generators: pulse rise time	From 15ns to 150ns	Fast transient generators	0,11 ns	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	A
EM.11.6-a3	Calibration of fast transient generators: pulse width	From 15 ns to 150 ns	Fast transient generators	0,11 ns	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	A
EM.11.6-a4	Calibration of fast transient generators: pulse repetition frequency	From 3 kHz to 8 kHz; from 50 kHz to 150 kHz	Fast transient generators	6 x 10 ⁻⁴	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-a5	Calibration of fast transient generators: burst duration	From 0,5 ms to 1 ms; from 10 ms to 20 ms	Fast transient generators	6 x 10 ⁻⁴	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-a6	Calibration of fast transient generators: burst period	From 200 ms to 400 ms	Fast transient generators	6 x 10 ⁻⁴	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-b1	Calibration of oscilloscope: time base	From 30 ns to 500 ms	Oscilloscope	0,021 ns	EURAMET cg-7	Giuseppe Vizio g.vizio@inrim.it	C

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Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.6-b2	Calibration of oscilloscope: amplitude scale	From 40 mV to 40 V	Oscilloscope	from 0,05 % to 0,8 %	EURAMET cg-7	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-b3	Calibration of oscilloscope: bandwidth	From 150 MHz to 6 GHz; from -6 dB to 2 dB	Oscilloscope	0,6 dB	EURAMET cg-7	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-b4	Calibration of oscilloscope: rise time	From 60 ps to 4 ns	Oscilloscope	11 ps	EURAMET cg-7	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-b5	Calibration of oscilloscope: input resistance	From 45 Ω to 55 Ω ; from 0,9 M Ω to 1,1 M Ω	Oscilloscope	15 m Ω ; 180 Ω	EURAMET cg-7	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-b6	Calibration of oscilloscope: reflection coefficient	From 0 to 1; from 10 kHz to 1 GHz	Oscilloscope	From 0,015 to 0,035	Vector network analyzer	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-c1	Calibration of EMI measuring receivers: response to sinusoidal signals	From 9 kHz to 18 GHz	EMI measuring receivers	From 0,25 dB to 0,30 dB	EN 55016-1-1	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.11.6-c2	Calibration of EMI measuring receivers: linearity	From 20dB (μ V) to 110 dB(μ V); from 10 MHz to 100 MHz	EMI measuring receivers	From 0,7 dB to 0,4 dB	EN 55016-1-1	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-c3	Calibration of EMI measuring receivers: attenuators	From 20dB (μ V) to 110 dB(μ V); from 10 MHz to 100 MHz	EMI measuring receivers	From 0,7 dB to 0,4 dB	EN 55016-1-1	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-c4	Calibration of EMI measuring receivers: response to pulses	From 20 dB (μ V) to 70 dB (μ V); from 9 kHz to 1 GHz	EMI measuring receivers	From 0,5 dB to 0,6 dB	EN 55016-1-1	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-c5	Calibration of EMI measuring receivers: input impedance (VSWR)	From 1 to 5; from 9 kHz to 18 GHz	EMI measuring receivers	From 0,02 to 0,06	EN 55016-1-1	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.6-c6	Calibration of EMI measuring receivers: tuning frequency	From 9 kHz to 18 GHz	EMI measuring receivers	From 1×10^{-3} to 1×10^{-6}	EN 55016-1-1	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-c7	Calibration of EMI measuring receivers: bandwidth and selectivity	200 Hz, 9 kHz, 120 kHz e 1 MHz	EMI measuring receivers	0,5 dB	EN 55016-1-1	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-d1	Calibration of sine wave radio frequency generators: amplitude of the output signal	From -20 dBm to 20 dBm; from 10 kHz to 18 GHz	Sine wave radio frequency generators	From 0,2 dB to 0,6 dB	Direct comparison	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-d2	Calibration of sine wave radio frequency generators: dynamic of the output signal	From -70 dBm to 20 dBm; from 100 MHz to 1 GHz	Sine wave radio frequency generators	From 0,2 dB to 0,6 dB	Direct comparison	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.11.6-d3	Calibration of sine wave radio frequency generators: frequency of output signal	From 10 kHz to 90 MHz; from 100 MHz to 18 GHz	Sine wave radio frequency generators	1 x 10 ⁻⁰⁹ ; 1 x 10 ⁻⁰⁸	Direct comparison	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.6-d4	Calibration of sine wave radio frequency generators: amplitude modulation depth	From 10 % to 100 %	Sine wave radio frequency generators	3 %	Direct comparison	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
EM.11.7-a1	Calibration of attenuators for the verification of Burst/EFT generators: input resistance <i>Field not CIPM MRA covered:</i> From 45 Ω to 55 Ω; from 900 Ω to 1100 Ω	From 45 Ω to 55 Ω; from 900 Ω to 1100 Ω	Attenuators for the verification of Burst/EFT generators	From 0,013 Ω to 0,020 Ω; from 0,12 Ω to 0,24 Ω	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	B
EM.11.7-a2	Calibration of attenuators for the verification of Burst/EFT generators: voltage division factor	From 100 to 3000	Attenuators for the verification of Burst/EFT generators	From 0,5 to 15	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	C
EM.11.7-a3	Calibration of attenuators for the verification of Burst/EFT generators: reflection coefficient	From 0 to 1; from 10 kHz to 500 MHz	Attenuators for the verification of Burst/EFT generators	From 0,006 to 0,019	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	C

EM							Electricity and magnetism	
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC		
EM.11.7-a4	Calibration of attenuators for the verification of Burst/EFT generators: insertion loss	From 40 dB to 70 dB; from 10 kHz to 500 MHz	Attenuators for the verification of Burst/EFT generators	From 0,15 dB to 0,65 dB	EN 61000-4-4	Giuseppe Vizio g.vizio@inrim.it	C	
EM.11.7-b1	Calibration of radiofrequency current probes	From 1 Ω to 8 Ω; from 10 kHz to 500 MHz	Transfer impedance	From 0,05 Ω to 1,5 Ω	EN 55016-1-2	Valter Giusio v.giusio@inrim.it Giuseppe Vizio g.vizio@inrim.it	C	
EM.12.3-a1	Normal DC magnetization curve, relative magnetic permeability curve and hysteresis DC loop	Permeability, μ_r : 10 ÷ 100000 EPSTEIN, H : 0.5 ÷ 10000 (A/m); J : 0.05 ÷ 2,0 (T) SST, H : 5 ÷ 7000 (A/m); J : 0.05 ÷ 2.0 (T) TOROID, H e B variable depending on diameter and number of turns N1 and N2	Sheet standards (EPSTEIN format), single sheet standards (SST format) or toroidal (TORO).	The relative expanded uncertainties associated to the measurement are: Magnetic field (H): U(H) = 0,4 % - 1,6 % Magnetic polarization (J): U(J) = 0,4 % - 2,0 % Magnetic induction (B): U(B) = 0,4 % - 2,0 % Relative magnetic permeability (μ_r): U(μ_r) = 0,6 % - 5,0 %	Ballistic method	Nicoleta Banu n.banu@inrim.it Enzo Ferrara e.ferrara@inrim.it	A	

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
EM.12.3-c1	Characterization of magnetic materials in AC	Magnetic fields (H): 0,5 ÷ 10 (kA/m); Magnetic induction (B) and Magnetic polarization (J): 0,05 ÷ 2,0 (T); Specific power loss (Ps): 0,005 W/kg ÷ 200 (W/kg); Specific apparent power (Ss): 0,005 VA/kg ÷ 200 (VA/kg); Relative magnetic permeability (μ r): 10 ÷ 100000; Frequency range (f): 1 ÷ 10000 (Hz).	Epstein strips (EPSTEIN format), single sheet (SST format) or toroidal (TOROID).	Peak magnetic field Hp [A/m]: U(Hp) = 0,4 % - 1,6 % Peak magnetic polarization Jp [T]: U(Jp) = 0,4 % - 1,5 % Peak magnetic induction Bp [T]: U(Bp) = 0,4 % - 1,5 % Specific power loss Ps [W/kg]: U(Ps) = 1,0 % - 5,0 % Specific apparent power Ss [VA/kg]: U(Ss) = 2,0 % - 8,0 % Relative magnetic permeability μ r: U(μ r) = 0,5 % - 5,0 %	Wattmetric method with digital feedback, reference Standards: IEC 60404-2, IEC 60404-3, IEC 60404-4, IEC 60404-6, IEC 60404-10.	Nicoleta Banu n.banu@inrim.it Enzo Ferrara e.ferrara@inrim.it	A
EM.12.3-d1	Measurement of density (ρm) and resistivity (ρ) of ferromagnetic materials	$\rho = 1.2 \cdot 10^{-7} \div 5.3 \cdot 10^{-7} \Omega \cdot m$; $\rho_m = 7600 \div 7890 \text{ kg/m}^3$	Density (ρ_m). resistivity (ρ) of ferromagnetic materials	Resistivity (ρ), epstein strip or bulk U = 0.4 % Resistivity (ρ), SST U = 1.6 % Density (ρ_m) U = 0.4 % ; 2.0%	Standard 4-contact volt-amperometric method. Reference standard: IEC 60404-13 valid for Epstein and SST format laminations, respectively indicated in method A and method B.	Carlo Appino c.appino@inrim.it Enzo Ferrara e.ferrara@inrim.it	A
EM.12.4-a1	Normal DC magnetization curve, relative magnetic permeability curve and hysteresis DC loop - permeameter method	H = 100 ÷ 100000 (A/m); J = 0.05 ÷ 2.3 (T) ; $\mu_r = 10 \div 100000$; A $\geq 10 \text{ mm}^2$; l > 100 mm	Standards in the form of a bar (bulk) with a circular or rectangular cross section	Magnetic field (H): U(H) = 1.0 % - 2.0 % Magnetic polarization (J): U (J) = 1.0 % Magnetic induction (B): U(B) = 1.0 % Relative magnetic permeability (μ r): U(μ r) = 1.4 % - 5.0 %	Ballistic method. Use of permeameter, reference standard: IEC 60404-4; ref. 4.4.	Nicoleta Banu n.banu@inrim.it Enzo Ferrara e.ferrara@inrim.it	A

EM							
Electricity and magnetism							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
EM.12.5-a1	Magnetic susceptibility (χ) and relative magnetic permeability (μ_r) in feebly magnetic materials	Magnetic susceptibility (χ): 0.001 ÷ 3.0 Relative magnetic permeability (μ_r): 1 ÷ 4	Weakly magnetic (paramagnetic) standards in the form of rod-shaped semi-finished products with a circular or quadrangular cross-section.	Relative magnetic susceptibility (χ_r): $U(\chi) = 0.001 \div 0.480$	Method of solenoid. Standard IEC 60404-15, standard ASTM A342/A342M – 04; Test methodology N° 1 (fluxmetric method)	Nicoleta Banu n.banu@inrim.it Enzo Ferrara e.ferrara@inrim.it	A
EM.12.6-a1	DC characterization of permanent magnets	Magnetization $J = 0.1 \div 2.0$ T Remanent magnetization $J_r = 0.1 \div 2.0$ T Coercive field $H_{cJ} = 800$ A/m ÷ $2.4 \cdot 10^6$ A/m Coercive field $H_{cB} = 800$ A/m ÷ $1.6 \cdot 10^6$ A/m Maximum energy product $(BH)_{max} = 2$ kJ/m ³ ÷ 800 kJ/m ³	Permanent magnets	$U(J_r) = 0.5 \div 1.5$ % $U(H_c) = 0.5 \div 1.5$ % $U(BH)_{max} = 1.0 \div 2.0$ %	Hysteresigraph (IEC 60404-5)	Alessandro Sola a.sola@inrim.it Luca Toso l.toso@inrim.it	A

L - DIMENSIONAL MEASUREMENTS

Dimensional metrology measures the dimensions and shapes of physical objects, often material standards or technical artefacts. The fundamental SI unit of measurement is the metre; derived units are its powers from 0 to 3: (dimensionless) angles [m0], lengths [m1], surfaces [m2], and volumes [m3]. When it concerns position in a reference system, the metre is composed of vector quantities: along a straight line (scalar or 1D), in the plane (2D), and space (3D).

The scale of interest ranges from nanometrology (critical dimensions or features down to 1 nm) to large-scale metrology (tens of metres).

The dimensional metrology laboratories were built underground in order to be protected from changes in temperature and from vibrations. The temperature is conditioned to 20 °C (UNI EN ISO 1) to minimise the effects of the thermal expansion of bodies.

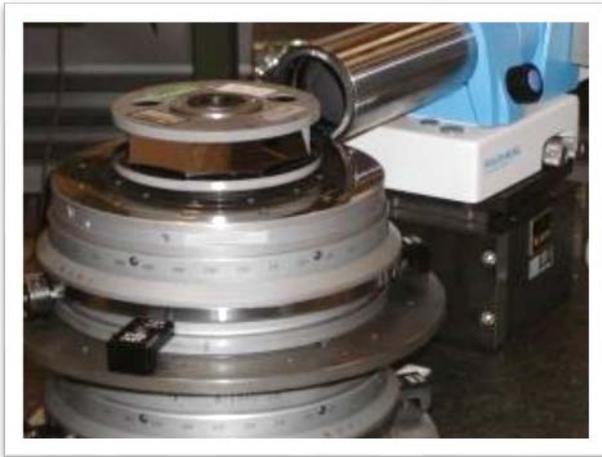
Laboratories conduct research according to projects and contracts, curiosity-driven research as well as calibrations. The latter range widely: very small objects (e.g. nanoparticles), nanometric characteristics of larger objects (e.g. surface texture and diffraction lattices), medium-sized dimensional standards (e.g. gauge blocks, rings, buffers, step gauges, spheres), shape standards (e.g. hemispheres, lines), standards and angular instruments (polygons, autocollimators, levels, encoders, inclinometers), coordinate measurements (gears, complex shapes), and laser distance meters.

ANGLES

ANGLE MEASUREMENTS.

INRiM angle laboratory realises and disseminates the **plane angle unit**.

INRiM has several standards, some based on dividing the circle into equal parts, such as the Moore index tables and the new angle comparator based on a rotary angle encoder (INRiM patent), and others based on



generating angles trigonometrically.

Standards calibrated at INRiM are optical polygons, autocollimators, index tables, angle blocks, electronic levels, angle encoders and inclinometers.

ROUNDNESS MEASUREMENTS.

The accurate measurement of circular form is fundamental in many production processes. In particular, the **roundness error** of a circular shape standard is a very significant parameter.

Roundness measurements at INRiM are carried out using Taylor Hobson's Talyrond 30 commercial roundness meter, modified ad-hoc to achieve the best performance.

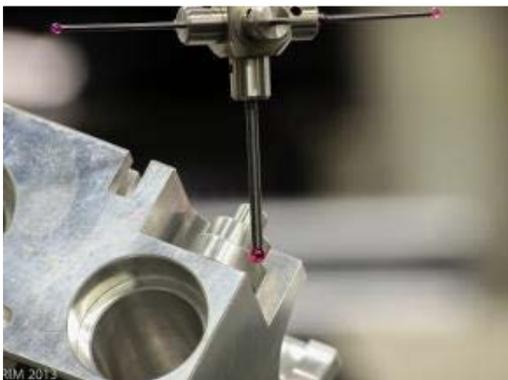


The roundness meter comprises a rotary table with an angular encoder and a mechanical probe, type LVDT, traceable to the metre. The calibration uncertainty is 7 nm.

COMPLEX GEOMETRY

COMPLEX GEOMETRY.

Technical artefacts (e.g. the crankshaft of an engine or a gear) can have very complex and virtually numerically unlimited shapes, depending on the imagination and expertise of the mechanical designer.



In principle, a dedicated tool would be needed for each shape: an internal gauge to measure the diameter of a hole, an external gauge for that of a plug, a depth gauge for the depth of a hole, and so on.

This need is overcome by the 'coordinate metrology' approach, which does not directly measure the feature of interest. Instead, it first samples points on

the technical surface by measuring their coordinates and then processes them to determine any geometric feature of interest by calculation.

DIMENSIONAL MEASUREMENTS

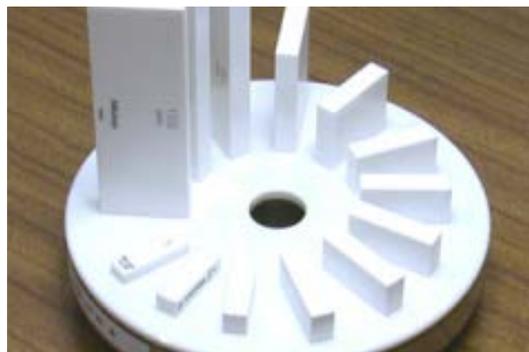
LINEAR AND DIAMETRAL STANDARDS.

The laboratory has a 1D comparator based on a Moore measuring machine and a laser interferometer. The environmental parameters (T, P, U) for compensation of thermal effects and refractive air index are traceable to the national standards.

A bi-directional mechanical probe is used with the diametric standards (spheres, rings and buffers), step gauges (up to 620 mm), linear standards and displacement transducers. In addition, an optical probe is used for the optical stripes.

The standards calibrated at INRiM are smooth rings and plugs, spheres, step gauges (up to 620 mm), optical scales, and displacement transducers.

STANDARDS WITH FACES.

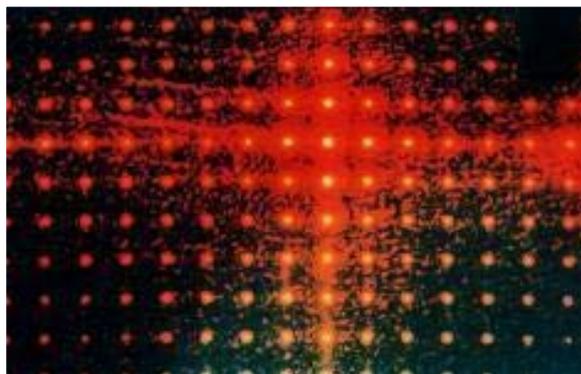


The laboratory is equipped with a **Fizeau interferometer** (Hilger & Watts) using three stabilised laser sources with wavelengths of 633 nm, 605 nm and 543 nm made at INRiM. The environmental parameters (T, P, U) for compensation of thermal effects and refractive air index refer to the national standards. Standards

calibrated by INRiM are gauge blocks grade "0" or "K" up to 100 mm long.

STEP ROUGHNESS STANDARDS. 1D AND 2D LATTICES.

The laboratory has a metrological probe microscope (mSPM), an optical diffractometer, an interferometric and confocal microscope, and stylus profilometers. The standards calibrated at INRiM are mainly roughness, groove or step standards, 1D and 2D lattices, and nanostructured standards.



LONG-DISTANCE MEASUREMENTS.

The long-distance measurement laboratory can accurately measure distances up to 27 m. The measurement system is based on a heterodyne interferometer, the moving arm of which consists of a retro-reflector mounted on a carriage that can move along a rail. The system calibrates commercial laser distance meters with an extended uncertainty of 0.18 mm at maximum distance.



1D MACHINES.

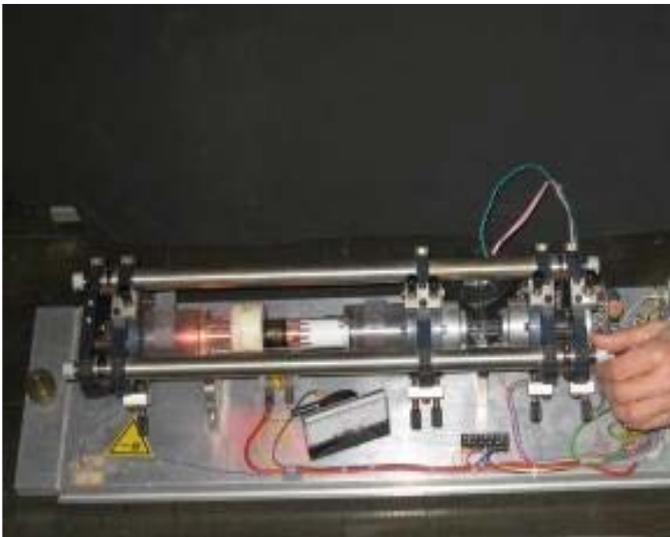
The laboratory performs 1D linear travel indication calibration, i.e., determines the error in the



position measurement of a carriage. This calibration applies to 1D measuring machines and, more generally, to any linear movement capable of providing position indication. Calibration occurs externally at the customer's premises, where the machine to calibrate is installed.

RADIATION OF THE “MISE EN PRATIQUE”

OPTICAL RADIATION OF THE “MISE EN PRATIQUE” OF THE METRE.



The laboratory is responsible for realising the metre definition, maintenance and dissemination of wavelength standards in compliance with Law no. 273 of 11 August 1991. The laboratory is placed at the top of the metrological pyramid, ensuring traceability to the unit of measurement in Italy

Compliance with the CIPM Mutual Recognition Arrangement requirements guarantees through maintenance of the quality system and participation in international comparisons, equivalence with the foreign primary metrological institutes and the mutual recognition of calibration certificates. The metre is manufactured using two alternative methods: by measuring the absolute frequency of a laser or by the so-called 'Mise en Pratique'. In the first case, a frequency comb is used to measure the

absolute frequency f of the laser source, obtaining the wavelength in vacuum λ_0 from the formula $\lambda_0 = c / f$, where c is the speed of light in vacuum. In the second case, the frequency of a laser is stabilised by reference to one of the radiations recommended by the *Comité Consultif pour la Longueur*.

L Length							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
L.1.1-a1	Stabilized He-Ne lasers	633 nm	He-Ne laser stabilized to active medium	$U = 1e-9$	Optical frequency heterodyne	Marco Bisi m.bisi@inrim.it	A
L.1.1-b1	Nd: YAG / I2 laser calibration	532 nm / 563 THz	laser / measuring: frequency - wavelength	0.01 fm / 10 kHz	Calibration by comparison with INRIM Nd:YAG/I2 standard	Massimo Zucco m.zucco@inrim.it	A
L.1.1-c1	He-Ne lasers of the "Mise en Pratique"	Absolute frequency: 474 THz Vacuum wavelength: 633 nm	Iodine-stabilized He-Ne laser	Absolute frequency: $U=24$ kHz vacuum wavelength: $U=0,04$ fm	Optical frequency heterodyne	Marco Bisi m.bisi@inrim.it	A
L.1.1-d1	Laser frequency calibration by optical frequency comb	532 nm to 1577 nm / 190 THz to 564 THz	Laser / frequency	Relative uncertainty 6×10^{-13}	Calibration by comparison with optical frequency comb	Massimo Zucco m.zucco@inrim.it	A
L.2.1-a1	Calibration of linear displacement transducers <i>Field not CIPM MRA covered: stroke from 50 to 100 mm</i>	Displacements up to 100mm	Linear millimeter displacement transducers	$Q[0.1 \mu\text{m}; 0.5 \times 10^{-6} \text{ L}]$	Linear displacement measured by a 1D measuring machine equipped with a interferometric laser system	Roberto Bellotti r.bellotti@inrim.it	B
L.2.1-b1	Calibration of nanometer displacement transducers <i>Field not CIPM MRA covered: Measurement range between 50 um and 500 um</i>	From 0 μm to 500 μm	Nanometric transducers / actuators	$Q[0.7; 0.5 \times 10^{-3} \text{ L}] / \text{nm}$	Heterodyne interferometer with double-pass differential optical setup	Roberto Bellotti r.bellotti@inrim.it	B
L.2.1-c1	Calibration of electronic distance meters	from 0 m to 27 m	electronic distance meters (EDM)	0.07 mm - 0.18 mm	calibration by comparison with an interferometer	Milena Astrua m.astrua@inrim.it	A

L Length							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
L.2.1-d1	Calibration of 1D measuring machines	from 0 m to 2 m	1D measuring machines	Q[21 nm; 0,72 × 10 ⁻⁶ L]	Interferometry	Davide Corona d.corona@inrim.it	C
L.2.2-a1	Calibration of gauge blocks <i>Field not CIPM MRA covered:</i> Deviation from flatness, f _d Variation in length, v	from 0.5 mm to 100 mm	Gauge blocks	Q[18 nm; 0.35×10 ⁻⁶ L]	Interferometry	Andrea Giura a.giura@inrim.it	B
L.2.3-a1	Piece width of standards	0.1 ÷ 30 μm	Stroke width standards	Q[15 nm; 1×10 ⁻³ p] / nm	Metrological atomic force microscopy	Roberto Bellotti r.bellotti@inrim.it	C
L.2.3-a2	Calibration of XY gratings	between 0.1 μm and 5 μm	Standards for microscopy, 1D and 2D gratings	Q[2 nm; 1×10 ⁻³ p]	Metrological atomic force microscopy	Roberto Bellotti r.bellotti@inrim.it	A
L.2.3-b1	Distance between strokes <i>Field not CIPM MRA covered:</i> distance between lines < 0.1 mm and > 280 mm	from 0.01 mm to 400 mm	Optical lines, object micrometers	Q[80; 0.87×10 ⁻⁶ L]	Measurement of the distance between lines of a optical linescale using a 1D measuring machine equipped with an optical microscope and camera for image acquisition	Roberto Bellotti r.bellotti@inrim.it	B
L.2.3-c1	Optical gratings 1D and 2D	p step from 0.3 μm to 50 μm	Optical gratings, grids	0.05×10 ⁻³ p / nm	Measurement of the diffraction angle of a laser beam	Roberto Bellotti r.bellotti@inrim.it	A
L.2.3-c2	1D and 2D optical grid	Pitch p da 0.3 μm a 50 μm	Optical grid	0.09×10 ⁻³ ×p ² / nm	Measurement of the diffraction angle of a laser beam	Roberto Bellotti r.bellotti@inrim.it	A

L Length							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
L.2.4-a1	Calibration of the diameter of rings and pads <i>Field not CIPM MRA covered:</i> diameters from 150 mm to 200 mm	1 mm to 200 mm	Diameter of rings and pads	Q[0.1 μm; 0.5×10 ⁻⁶ L]	1D measuring machine equipped with laser interferometer	Roberto Bellotti r.bellotti@inrim.it	B
L.2.4-a2	Calibration of calipers in steps	from 10 mm to 620 mm	Step gauges	Q[0.15 μm; 0.7×10 ⁻⁶ L]	Measurement of the distance between faces with a 1D measuring machine equipped with a laser interferometer	Roberto Bellotti r.bellotti@inrim.it	A
L.2.4-a3	Calibration of the diameter of spheres	Between 5 mm and 150 mm	Champion spheres	Q[0.1 μm; 0.5×10 ⁻⁶ L]	1D measuring machine equipped with a laser interferometer	Roberto Bellotti r.bellotti@inrim.it	A
L.2.4-a4	Calibration of standards for CMM	Between 10 mm and 330 mm	Ball Bar	0.4 μm	1D measuring machine equipped with a laser interferometer	Roberto Bellotti r.bellotti@inrim.it	A
L.3.1-a1	Calibration of index tables	da 0° a 360°	index table	0.07"	comparison with the angle generated by the primary standard	Milena Astrua m.astrua@inrim.it	A
L.3.1-a2	Calibration of autocollimators	from 0" to 1000"	autocollimators	0.07"	comparison with the angle generated by the primary standard	Milena Astrua m.astrua@inrim.it	A
L.3.1-a3	Calibration of rotating tables and angle blocks	from 0° to 360°	rotating tables and angle blocks	0.2"	comparison with the angle generated by the primary standard	Milena Astrua m.astrua@inrim.it	A

L Length							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
L.3.1-a4	Calibration of optical polygons	from 5° to 120°	optical polygons	0.07"	comparison with the angle generated by the primary standard by means of the multistep technique	Milena Astrua m.astrua@inrim.it	A
L.3.2-c1	Calibration of object micrometers <i>Field not CIPM MRA covered:</i> From 0.001 to 0.02 mm end from 20 to 100 mm: limited to this field, it is not covered by MRA (Activity compliant with Law 11 August 1991, n.273, in accordance with the ILAC-P10 document)	from 0.001 to 0.02 mm from 0,02 to 20 mm from 20 mm to 100 mm	distance between the strokes of the object micrometers and width of the strokes	from 0.001 to 0.02 mm: 0,09+(0,005*(distance in μm)/1000) μm from 0.02 mm to 20 mm: 0,09+(0,005*(distance in μm)/1000) μm from 20 mm to 100 mm: 0,09+(0,005*(distance in μm)/1000) μm	Measure of the distance of the left edges of the measured strokes from the left edge of the starting stroke "0" and the distance of the right edge from the left edge of all measured strokes (minimum stroke width 0,5 μm)p	Claudio Origlia c.origlia@inrim.it	B
L.3.3-a1	Calibration of clinometers	from 0° to 360°	clinometers	1"	calibration by means of a vertical index table	Milena Astrua m.astrua@inrim.it	A
L.3.3-b1	Calibration of electronic levels	from -1000" to +1000"	electronic levels	0.2"	the level is tilted by a sinebar, but the angle traceability is assured by a calibrated autocollimator which measures the rotation of a mirror mounted on the rotating arm of the sinebar	Milena Astrua m.astrua@inrim.it	A
L.3.5-a1	calibration of optical square	90°	optical square	0.5"	comparison between the angle of the standard and the angle generated by a reference index table	Milena Astrua m.astrua@inrim.it	A

L Length							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
L.4.2-a1	Roundness error	up to 20 µm, diameters from 4 mm to 150 mm	roundness standard: spheres, hemispheres, cylinders	from 7 nm to 210 nm	measurement of the radius of the standard by means of a stylus probe while the standard rotates around its axis and application of the multistep technique	Milena Astrua m.astrua@inrim.it	A
L.4.2-a2	Roundness error	up to 20 µm, diameters from 4 mm to 150 mm	flick standards	from 0.1 to 0.23 µm	measurement of the radius of the standard by means of a stylus probe while the standard rotates around its axis	Milena Astrua m.astrua@inrim.it	A
L.5.1-a1	Calibration of groove or step height standards using an optical profilometer	0.01 µm to 20 µm	groove or step height standards	Q[2.2 nm; 11×10 ⁻³ d]	Calibration of step height or groove depth without contact using an optical profilometer in PSI or VSI mode	Roberto Bellotti r.bellotti@inrim.it	A
L.5.1-b1	Calibration of groove or step height standards <i>Field not CIPM MRA covered:</i> range from 5 to 10 nm	From 0.005 µm to 15 µm	Groove or step height standards	Q[1 nm; 4.7×10 ⁻³ d]	Stylus profilometer	Roberto Bellotti r.bellotti@inrim.it Andrea Giura a.giura@inrim.it	B
L.5.1-c1	Calibration of roughness parameters <i>Field not CIPM MRA covered:</i> Measurements of RSm and step standards	Rz = 0.01 µm a 20 µm; R a = 0.01 µm a 20 µm; RSm = 50 µm a 500 µm; steps: tra 15 µm e 1 mm	Roughness standards type C and D, step standards, surfaces	Ra: Q[10 µm; 30×10 ⁻³ Ra]; Rz: Q[20 µm; 35×10 ⁻³ Rz]; RSm: 0.5 µm; Step: Q[110 µm; 0.35×10 ⁻³]	Calibration of the main roughness parameters using a stylus profilometer	Roberto Bellotti r.bellotti@inrim.it Andrea Giura a.giura@inrim.it	B

L Length							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
L.5.2-a1	Interferometric calibration of threaded standards (rings and cylindrical threaded plugs)	Rings diameter: between 6 mm and 90 mm;	Threaded cylindrical rings and pads	Diameter: 3 μm; Flank Angle: 3'; Pitch: 1.5 μm	1D measuring machine equipped with a laser interferometer and stylus profilometer	Roberto Bellotti r.bellotti@inrim.it	A
L.6.5-a1	Calibration of average diameter calibration of quasi-spherical particles	between 5 nm and 500 nm	Spherical particles	Q[1.8; 0.02 h] / nm	Metrological scanning probe microscopy	Roberto Bellotti r.bellotti@inrim.it	A

M - MASS AND RELATED QUANTITIES

From the earliest civilisations, the measurement of a quantity, now known as **mass**, has always been important; today, mass measurements find application in commerce, industry and support of technological experimentation.

Measurements of mass and its related quantities - which include **force, pressure, hardness, density of materials, viscosity, volumes, and gravitational acceleration** at the earth's surface - enable important results in different fields.



Achieving the highest accuracy in these activities requires establishing National Metrology Institutes to realise and disseminate the standards of the International System of units. Also, through their experts, these Institutes participate in the Consultative Committee on Mass and related quantities (CCM) international working groups.

MASS

MASS MEASUREMENTS.

The laboratory performs calibration of mass standards and weights in the range from 1 mg to 500 kg. The best-extended uncertainties of mass standards are less than 1/5 of the maximum permissible error for class E1, according to OIML document R 111. The magnetic properties of the mass standards are measured, and the limits prescribed by OIML document R 111 are verified. The laboratory calibrates the volume and density of class E1 standards according to the hydrostatic weighing method for standards up to 50 kg. Finally, measuring the centre of gravity of mass standards and artefacts of any shape standards is performed with an uncertainty of 1 μm .

PRESSURE

PRESSURE MEASUREMENTS.

The main service activities include developing, maintaining and disseminating the pascal pressure unit. INRiM disseminates the **pressure** scale over a wide range of orders of magnitude to meet the needs associated with different types of applications. This range currently extends from the medium vacuum (0.1 Pa) to high pressures (5-108 Pa).



The primary standards used to make the scale (more than ten) are based on different physical laws, depending on the pressure range.

The pascal dissemination is carried out through calibrations of secondary standards and transducers, including pressure balances (determination of the area of the piston-cylinder assembly for comparison with primary standards), pressure transducers under absolute, relative and differential conditions, and vacuum gauges.

FORCE

FORCE MEASUREMENTS.



The main activity is disseminating the unit of **force**, the newton.

The scale maintained and disseminated ranges from 0.5 N to 10 MN. The scale's part from 0.5 N to 1 MN is realised by primary force standard machines with '**dead weights**' (designed at INRiM) capable of

generating forces with an extended relative uncertainty of 2×10^{-5} (0.002%).

For higher ranges, up to 10 MN, the force is generated by hydraulic systems and measured by reference force transducers with a relative expanded uncertainty of 5×10^{-4} (0.05%).

Dissemination occurs at the highest level through the calibration of the calibration force machines of accredited laboratories and, subsequently, directly through the calibration of the force transducers used and the force measurement systems in the industrial field.

DENSITY

DENSITY MEASUREMENTS OF SOLIDS.

The laboratory performs precision calibrations of volume and density standards using the **hydrostatic weighing** method.

The methods used allow for obtaining state-of-the-art uncertainties. The density of distilled water (best relative expanded uncertainty 5×10^{-6}) or the density standard consisting of a 1 kg silicon sphere (best relative expanded uncertainty 2×10^{-7}) is used as a reference standard.

Calibrations of density meters (aerometers) used for determining absolute density or the concentration of dissolved compounds (alcohol content, salinity, etc.) are also performed.

Calibration is performed by hydrostatic weighing using the Cuckow method with a range from 500 kg/m^3 to 2000 kg/m^3 .

HARDNESS

HARDNESS MEASUREMENTS.

The main activity is developing, maintaining and disseminating the **hardness scales**.

The national scales are realised by primary standard machines (designed at INRiM) that realise the international definitions to the best of state of the art. The scales made at INRiM are all **Rockwell, Brinell, and Vickers scales**.



In addition, through specially developed measuring systems at INRiM, it is also possible to ensure the traceability of measurements of the geometric characterisation of Vickers, Rockwell diamond and Knoop diamond indenters.

Dissemination occurs at the highest level through the calibration of the standard **durometers** of the accredited laboratories and, subsequently, directly through the calibration of the primary reference blocks used by the accredited laboratories to calibrate durometers in the industrial field.



LOCAL GRAVITY ACCELERATION

ABSOLUTE MEASUREMENTS OF GRAVITY ACCELERATION.

The earth's gravitational field varies mainly due to location (latitude, altitude and local mass distribution) and time (lunar-solar attraction). At INRiM, a **gravimeter** was developed that realises the absolute measurement of gravity's local acceleration through an object's free-fall

motion. The method used is recognised as the primary method by the International Committee for Weights and Measures.



The instrument is transportable and is capable of on-site measurements with a maximum extended relative uncertainty of 1.5×10^{-8} .

Local gravity measurements are used in metrological and geophysical research. The absolute measurements performed by INRiM are the only ones in Italy (and among the few in the world) that can guarantee traceability to **gravity acceleration** measurements.

FLUID FLOW RATES

LIQUID FLOW RATES.

Service activities consist of the calibration of flow meters and water meters (mass or volume) in the measuring range from 0.01 L/s to 7 L/s at temperatures between 20 °C and 80 °C.

The maximum diameter of the flow meters is DN150.

Calibration of thermal energy meters is also performed.

LIQUID STATIC VOLUMES.

The laboratory performs calibrations of volume standards (capacity measurement of vessels) of various types: laboratory glassware (pycnometers, pipettes, flasks, etc.) and metal standards (standards tanks, hourglasses for calibrating gasometric bells, etc.).

Calibration is performed by the **gravimetric method** in the measuring range from 10 mL to 200 L and by the volumetric method between 100 L and 2000 L. The best relative uncertainty is 0.005%.

GAS FLOW RATES AND VOLUMES.

The laboratory maintains and develops national gas volume and gas flow rate standards. These standards allow the calibration and measurement capacities (CMC) declared and registered at the BIPM, which for volume flow extend between 2 mL/min and 160 m³/h with uncertainties varying between 0.05% and 0.12%; for the volume instead, the declared capacities extend between 20 L and 800 L (with flow rates ranging between 1 L/min and 160 m³/h) and uncertainties varying between 0.05% and 0.12%.

The laboratory calibrates all flow rate measuring instruments (except sonic nozzles) in capacities between 0.1 mL/min

and 160 m³/h, with uncertainties varying between 0.05% and 0.12%, and of all types of gas volume meters in the range covered by the CMCs.



M							
Mass and related quantities							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
M.1.1-a1	Mass sample calibration	from 1 mg to 500 kg	Mass samples	from 0.005 mg to 500 mg	Determination of mass and conventional value of mass standards	Davide Torchio d.torchio@inrim.it	A
M.1.1-b1	Calibration of non-automatic scales	1 mg - 200 kg	Weight scale	from 0,001 mg to 20 mg	Determination of repeatability, eccentricity and linearity according to EURAMET guide CG18	Davide Torchio d.torchio@inrim.it	C
M.1.1-c1	Calibration of automatic functioning scales	from 1 g to 60 kg	Weight scale	from 0,05 mg to 100 mg	Determination of repeatability, eccentricity and linearity	Davide Torchio d.torchio@inrim.it	C
M.2.1-a1	Density and volume measurements of solids: samples up to 50 kg <i>Field not CIPM MRA covered: density</i>	from 0.1 cm ³ to 6250 cm ³	density samples	mass standards: from 1 to 10 cm ³ U 0.4 mm ³ from 10 to 100 cm ³ U from 0.4 to 4 mm ³ from 200 to 1250 cm ³ U from 30 to 150 mm ³ density standards: from 100 to 300 cm ³ U 1 mm ³ ; from 300 to 400 cm ³ U 0.4 mm ³ ;	Determination of volume by hydrostatic weighing	Davide Torchio d.torchio@inrim.it	B
M.2.2-a1	Measurement of the density of liquids	from 500 Kg / m ³ to 1000 kg / m ³	Density of liquids	from 5x10 ⁻⁵ .p a from 1x10 ⁻² .p	Measurement of the density of liquids by the hydrostatic weighing method	Raffaella Romeo r.romeo@inrim.it Davide Torchio d.torchio@inrim.it	C

M							
Mass and related quantities							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
M.2.2-a2	Calibration of density meters	from 500 kg / m ³ to 2000 kg / m ³	Densimeters	from 2.4 x 10 ⁻⁵ to 2.7 x 10 ⁻⁵	Calibration by hydrostatic weighing using the Cuckow method	Raffaella Romeo r.romeo@inrim.it Davide Torchio d.torchio@inrim.it	A
M.3.1-a1	Calibration of pressure transducers in absolute and gaseous conditions	6.4 E03 Pa to 7.0 E06 Pa	Pressure transducer	0.5 Pa+2.4E-5 x p /Pa	Calibration of pressure transducers by comparison against primary standards in absolute conditions and in gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-a1	Calibration of pressure transducers in absolute, relative, relative negative and gaseous medium conditions <i>Field not CIPM MRA covered:</i> pressure transducers, absolute, relative or negative mode, range from 1 Pa to 3 Pa, uncertainty 3E-05 x p +0.02 Pa / Pa	Absolute and relative: 1 Pa at 15kPa; relative negative -1Pa to -15kPa	Pressure transducer	3E-05 x p +0.02 Pa /Pa	Calibration of pressure transducers by direct comparison against primary standards in absolute, relative and negative relative conditions and in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	B
M.3.2-a2	Pressure balances: comparison with primary standard	from 3 Pa to 15 kPa	Pressure balance	0.02 Pa + 3E-05 x p /Pa	Calibration of pressure balances by comparison with primary standards in gauge mode and in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-b1	Pressure balances: comparison with primary sample	from 6.4 kPa to 7.0 Mpa	Pressure balance	0.5 Pa + 2.4E-05 x p /Pa	Calibration of pressure balances by comparison with primary standards in relative mode and in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A

M							
Mass and related quantities							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
M.3.2-b2	Pressure balances: comparison with primary standard	7.0 MPa to 20 MPa	Pressure balance	$0.5 \text{ Pa} + 2.8E-05 \times p / \text{Pa}$	Calibration of pressure balances by comparison with primary standards in relative mode and in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-b3	Pressure balances: comparison with primary standard	from 2 MPa to 100 MPa	Pressure balance in liquid medium	$30 \text{ Pa} + 2.8 E-05 \times p / \text{Pa}$	Calibration of pressure balances by comparison with primary standards in relative mode and in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-b4	Pressure balances: comparison with primary standard	from 50 MPa to 500 MPa	Pressure balance in liquid medium	$1.4E-13 \times p^2 + 3E-05 \times p + 720 \text{ Pa} / \text{Pa}$	Calibration of pressure balances by comparison with primary standards in relative mode and in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-b5	Pressure balance: determination of the area of the piston-cylinder assembly	6.4 kPa to 7.0 MPa	Pressure balance	$0.5 \text{ Pa} + 2.4E-05 \times p / \text{Pa}$	Determination, by comparison against primary standards, of the effective area of the piston-cylinder assembly in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-b6	Pressure balance: determination of the area of the piston-cylinder assembly	7.0 MPa to 20 MPa	Pressure balance	$0.5 \text{ Pa} + 2.8E-05 \times p / \text{Pa}$	Determination, by comparison against primary standards, of the effective area of the piston-cylinder assembly in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-b7	Pressure balance: determination of the area of the piston-cylinder assembly	2.0 MPa to 100 MPa	Pressure balance	$30 \text{ Pa} + 2.8E-05 \times p / \text{Pa}$	Determination, by comparison against primary standards, of the effective area of the piston-cylinder assembly in a liquid medium	Stefano Pasqualin s.pasqualin@inrim.it	A

M							
Mass and related quantities							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
M.3.2-b8	Pressure balance: determination of the area of the piston-cylinder assembly	from 50 MPa to 500 MPa	Pressure balance	$1.4E-13 \times p^2 + 3E-05 \times p + 720Pa / Pa$	Determination, by comparison against primary standards, of the effective area of the piston-cylinder assembly in a liquid medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-c1	Calibration of pressure transducers in relative condition and gaseous medium	6.4 kPa to 7.0 MPa	Pressure transducer	$0.5 Pa + 2.4E-05 \times p / Pa$	Calibration of pressure transducers by direct comparison against primary standards in gauge conditions and in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-c2	Calibration of pressure transducers in relative condition and gaseous medium	7.0 MPa to 20 MPa	Pressure transducer	$0.5 Pa + 2.8E-05 \times p / Pa$	Calibration of pressure transducers by direct comparison against primary standards in gauge conditions and in a gaseous medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.3.2-c3	Calibration of pressure transducers in gauge conditions and in a liquid medium	from 2.0 MPa to 100 MPa	Pressure transducer in a liquid medium	$30 Pa + 2.8E-05 \times p / Pa$	Calibration of pressure transducers by direct comparison against primary samples in relative conditions and in liquid medium	Stefano Pasqualin s.pasqualin@inrim.it	A
M.4.3-a1	Calibration of force transducers <i>Field not CIPM MRA covered:</i> Values below 1 N and above 9 MN	from 0,4 N to 10 MN	Force measurement system	from 2×10^{-5} to 5×10^{-5}	Calibration of a force measuring system (UNI EN ISO 376, ASTM E74)	Andrea Prato a.prato@inrim.it	B

M							
Mass and related quantities							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
M.4.3-b1	Calibration of force standard machines <i>Field not CIPM MRA covered:</i> da 0,4 N a 10 MN	from 0,4 N to 10 MN	Force calibration machines	3 x 10 ⁻⁵	Calibration with the comparison method EURAMET cg-4	Andrea Prato a.prato@inrim.it	C
M.7.1-a1	Direct calibration of Rockwell diamond indenters	• Cone angle (120 ± 1) ° • Spherical cap radius (200 ± 20) µm • Inclination of penetrator axis • Straightness of generatrix	Rockwell diamond indenter	• Cone angle 0.05° • Spherical cap radius 1 µm • Inclination of penetrator axis 0.05° • Straightness of generatrix 0.135 µm	measurement of the geometric characteristics of diamond Rockwell penetrators	Claudio Origlia c.origlia@inrim.it	A
M.7.1-a2	Vickers indenter calibration	• Angle at the vertex of the faces (136 ± 1) ° • Angle of quadrature of the faces (90 ± 1) ° • Inclination of the axis of the penetrator • Planarity of the faces • Size of the roof of the pyramid	Vickers indenters	• Angle at the top of the faces 0.05° • Angle of the quadrature of the faces 0.06° • Inclination of the axis of the penetrator 0.05° • Flatness of the faces 0.135 µm • Size of the roof of the pyramid 0.135 µm	measurement of the geometric characteristics of Vickers penetrators	Claudio Origlia c.origlia@inrim.it	A
M.7.1-a3	Knoop indenter calibration	• Angle between edges (130 ° and 172.5 ° ± 1) ° • Angle at the vertex faces (129.5 ° ± 1) ° • Quadrature angle of faces (16 ° and 164 ° ± 1) ° • Indenter axis inclination • Flatness of the faces • Dimension of the pyramid roof • Coefficient c (0.07 ± 0.1)	Knoop indenter	• Angle between edges 0.05° • Angle at the vertex of faces 0.05° • Angle of quadrature of faces 0.06° • Inclination of penetrator axis 0.05° • Flatness of faces 0.135 µm • Size of pyramid roof 0.135 µm • Coefficient c 0.00047	measurement of the geometric characteristics of Knoop penetrators	Claudio Origlia c.origlia@inrim.it	A
M.7.1-b1	Calibration of Vickers hardness blocks <i>Field not CIPM MRA covered:</i> • From 0.196 N to 0,4903 N	• From 0.196 N to 19.61 N • From 29.42 N to 980.7 N	Vickers hardness blocks	• From 0.196 N to 19.61 N (1+ d/20) % • From 29.42 N to 980.7 N (1+ d/43) %	Block hardness calibration Calibration is limited to measuring the hardness value	Claudio Origlia c.origlia@inrim.it	B

M							
Mass and related quantities							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
M.7.1-b2	Rockwell hardness block calibration	<ul style="list-style-type: none"> • Scales A, C, D, N • Scales B, E, F, G, H, K, T 	Rockwell hardness blocks	<ul style="list-style-type: none"> • Scales A, C, D, N 0,3 HR • Scales B, E, F, G, H, K, T 0,4 HR 	block hardness calibration Calibration is limited to measuring the hardness value	Claudio Origlia c.origlia@inrim.it	A
M.7.1-b3	Calibration of Brinell hardness blocks	<ul style="list-style-type: none"> • From 29.42 N to 1838.7 N • From 2452 N to 29420N 	Brinell hardness blocks	<ul style="list-style-type: none"> • to 29,42 N of 1838,7 N (1+ 240/d) % • to 2452 N of 29420 N (1+ 1200/d) % 	block hardness calibration Calibration is limited to measuring the hardness value	Claudio Origlia c.origlia@inrim.it	A
M.7.1-b4	Rockwell indenter indirect calibration	<ul style="list-style-type: none"> • All scales (A, C, D, N, B, E, F, G, H, K, T) 	Rockwell indenters	0,1 HR	Comparison of the performance of the calibrated penetrator with the sample penetrator	Claudio Origlia c.origlia@inrim.it	A
M.8.1-a1	Absolute measurement of local acceleration due to gravity	(9.80 ± 0.05) m / s ²	Absolute measurement of local acceleration due to gravity	1.1 x 10 ⁻⁷ m/s ²	On site measurement performed with absolute gravimeter	Alessio Facello a.facello@inrim.it	A
M.9.10-a1	Calibration of gas flow meters <i>Field not CIPM MRA covered:</i> from 1.5E-6 L / s to 3.0E-5 L / s; DUC, method, uncertainty as for CMC MRA (extension request in project)	from 1.5E-6 L / s to 10 L / s	All types of gas flow meters	0.05% to 0.12%	Calibration through comparison to volumetric primary standards	Gaetano La Piana g.lapiana@inrim.it	B
M.9.10-b1	Calibration of gas volume meters	from 20 to 800 L with flow rates from 0.01 to 10 L / s	Any kind of counter	0.05% to 0.12%	Calibration through comparison to volumetric primary standards	Gaetano La Piana g.lapiana@inrim.it	A

M							
Mass and related quantities							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
M.9.10-c1	Calibration of water flow meters	from 0.01 L / s to 7 L / s	Flow meters or counters	from 0.1% to 0.2%	Calibration by comparison against primary standard	Raffaella Romeo r.romeo@inrim.it Davide Torchio d.torchio@inrim.it	A
M.9.10-d1	Calibration of volume standards by weighing deionized water	from 1 L to 200 L	Glass, metal or other containers with a capacity from 1 l to 200 l	0.005 %	Calibration of volume samples by weighing deionized water	Davide Torchio d.torchio@inrim.it	A
M.9.10-e1	Calibration of volume standars tanks by pouring	from 100 L to 2000 L	tanks with capacities from 100 l to 2000 l	0.01%	Calibration of volume standard tanks by transferring water from standard tanks	Davide Torchio d.torchio@inrim.it	A

PR - PHOTOMETRY AND RADIOMETRY

Radiometry is the field of metrology that deals with the physical measurement of the properties of electromagnetic radiation, including visible light. In **photometry**, the aim is to measure visible light in a way that considers the sensitivity of the human visual system. While radiometry measures light over the entire electromagnetic spectrum, photometry is limited to the visible region between 380 and 830 nm, where the human eye is sensitive.

All radiometric quantities have a corresponding photometric quantity where power or energy is appropriately weighted according to the visual sensation produced by a human observer. The photometric quantity **light intensity** is one of the seven fundamental units of the International System (SI). Its unit of measurement is the **candela (cd)**.

Photometry is essential for evaluating light sources and, more generally, devices used in lighting, light signalling, displays and any other application where light is intended to be seen by humans.

Radiometry is important in all applications where a human observer is not involved and, still, an evaluation in terms of energy and/or power is needed, such as in the characterisation of fibre-optic telecommunication devices, in photovoltaics, in photolithography for nano/microfabrication, in optical sensors for environmental monitoring, in power lasers used in metal cutting and welding, and in single-photon methods for quantum technologies.

INRiM is present in the relevant international technical committees:

- **CCPR**, the BIPM advisory committee for photometry and radiometry;
- **EURAMET TC-PR**, the technical committee for photometry and radiometry.

RADIOMETRY AND PROPERTIES OF DETECTORS AND SOURCES

SPECTRAL SENSITIVITY.

The response of a photodetector is measured over a wavelength range from ultraviolet (UV) to near-infrared (NIR).

The **spectral sensitivity** of the photodetector under calibration is measured by comparison with a standard photodetector with known spectral behaviour and traceable to the primary standard.

- In INRiM laboratories, a double subtractive monochromator is used to select a small band of a few nanometres from 300 nm and 1.6 μm . The monochromator, with sources (tungsten lamps or plasma source), coupling optics, mechanical handling and electronics, is in a light-proof box.

LASER POWER METERS.

The calibration of laser source power meters is performed at a wavelength of 633 nm, with reference to a standard photodetector, at a typical power of 100 μW , using a stabilised He-Ne laser.

UVA IRRADIANCE METERS (365 nm).

The calibration of UVA irradiance meters is performed at a wavelength of 365 nm, with reference to a standard photodetector, using a filtered Hg lamp.

■

PHOTOMETRY



INRiM provides light measurement services that take into account human visual sensitivity.

In photometry, light is measured in the visible spectral region from 360 nm to 830 nm, where the human eye is sensitive. Photometry is essential for characterising light sources used in lighting, signalling, displays and other applications where light is intended for human

observers.

LIGHT INTENSITY AND ILLUMINANCE.

INRiM carries out light intensity calibrations of incandescent lamps from 1 cd up to 4000 cd and illuminance (luxmeters) in the range from 5 lx to 5000 lx.

Measurements are performed in a laboratory with a 4 m optical bench, a set of luxmeters and standard lamps.

LUMINANCE AND LUMINANCE METERS.

INRiM calibrates luminance sources (integrating spheres) and luminance meters in the range from 1 cd/m² up to 1000 cd/m².

OPTICAL PROPERTIES OF MATERIALS

INRiM carries out measurements for the characterisation of optical materials and offers advice on the natural perception of materials.

REGULAR AND DIFFUSE TRANSMITTANCE.

INRiM performs regular and diffuse transmittance measurements in the range from 380 nm to 780 nm using a double-beam spectrophotometer.

The measurement of spectral transmittance can be performed at selected wavelengths or by using a scanning technique at regular intervals. The typical spectral bandwidth is 2.0 nm.

The measurement can be performed in solid media mounted in cuvettes or 50 mm x 50 mm square glass standards.

REGULAR AND DIFFUSE REFLECTANCE.

INRiM performs regular and diffuse reflectance measurements in the range from 380 nm to 780 nm using a double-beam spectrophotometer.

The measurement of spectral reflectance can be performed at selected wavelengths or by using a scanning technique at regular intervals. The typical spectral bandwidth is 2.0 nm.

WAVELENGTH OF ABSORPTION PEAKS.

INRiM performs wavelength calibrations of the absorption peaks of spectrally selective optical materials. To carry out the calibration, wavelength scans are used around the peak, with a typical bandwidth of 0.5 nm."

GLOSS.

INRiM performs gloss calibrations of reference tiles or gloss meters at the 20°, 60°, and 85° angles specified by the ISO 2813 standard.

PR							
Photometry and radiometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
PR.1.1-a1	Luminous intensity calibration of tungsten filament lamps using reference luxmeters	from 1 cd to 1000 cd	Incandescent lamp	0.90%	Lamps and reference photometers	Fernando Viarengo f.viarengo@inrim.it	A
PR.1.1-b1	Luminous intensity calibration of tungsten filament lamps using reference lamps	from 1 cd to 10000 cd	Incandescent lamp	0.94%	Photometers and reference lamps	Fernando Viarengo f.viarengo@inrim.it	A
PR.1.2-a1	Luxmeter calibration using reference lamps	-	Luxmeter	1.00%	Reference lamps and photometer	Fernando Viarengo f.viarengo@inrim.it	A
PR.1.2-b1	Lux meter calibration using reference lux meters	-	Luxmeter	1.01%	direct comparison	Fernando Viarengo f.viarengo@inrim.it	A
PR.1.4-a1	Calibration of lamp illuminance by means of reference lux meters	from 5 lx to 5000 lx	Incandescent lamp	1.00%	Reference photometers	Fernando Viarengo f.viarengo@inrim.it	A
PR.1.5-a1	Tungsten source luminance calibration using reference lux meters	from 1 cd / m ² to 1000 cd / m ²	Source with incandescent lamp	1.20%	Integrating sphere	Fernando Viarengo f.viarengo@inrim.it	A
PR.1.6-a1	Calibration of luminance meter by comparison with a luminance meter	CIE-A Illuminant Luminance 1-1000 cd/m ²	Luminance meter	1.30%	comparison with luminance meter	Fernando Viarengo f.viarengo@inrim.it	A

PR							
Photometry and radiometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
PR.2.9-a1	Irradiance spectral responsivity calibration of working standard detectors by monochromatic non coherent light at 365 nm	from 5 W/m ² to 40 W/m ²	UVA radiometer	4.8 %	Direct comparison	Marco Terzi m.terzi@inrim.it	C
PR.2.9-b1	Irradiance spectral responsivity calibration of detectors by monochromatic non coherent light at 365 nm <i>Field not CIPM MRA covered:</i> from 5 W/m ² to 40 W/m ²	from 5 W/m ² to 40 W/m ²	UVA radiometers	5.1 %	Direct comparison	Marco Terzi m.terzi@inrim.it	C
PR.4.1-a1	Regular spectral transmission calibration of optical filters	From T = 1 to T = 0.01 (for wavelength between 380 nm and 780 nm)	Optical filters	from 0,6% to 3% for T= 1 to T= 0,01	Absolute method based on ratio between direct radiant flux e radiant flux with optical filter	Marco Terzi m.terzi@inrim.it	A
PR.4.2-a1	Diffuse spectral transmission calibration of materials	From T = 1 to T = 0.001 (for wavelength between 380 nm and 780 nm)	Optical materials	from 1,2% to 5,2% for T= 1 to T= 0,001	The measurement method for the diffuse transmittance of a diffusing material utilizes an integrating sphere and is based on the ratio between the radiant flux Φ_D , measured by leaving the optical path of the beam free, and the transmitted radiant flux Φ_S , measured when the optical material is inserted into the beam's optical path.	Marco Terzi m.terzi@inrim.it	A

PR Photometry and radiometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
PR.4.5-a1	Diffuse spectral reflectance calibration of materials <i>Field not CIPM MRA covered:</i> From Rd=1 to Rd=0,1 (for wavelength between 360 nm and 830 nm)	From Rd=1 to Rd=0,1 (for wavelength between 360 nm and 830 nm)	Optical materials	From 0,8% to 1,2% for Rd=1 to Rd=0,1 -	Comparison with calibrated material from NMI with CMC BIPM	Marco Terzi m.terzi@inrim.it	C
PR.4.6-a1	Calibration in regular spectral reflection of optical material (mirrors)	R = 1 to R = 0.01 (for wavelength between 380 nm and 780 nm)	Optical material (mirrors)	from 1,2% to 5,2% pfor R = 1 to R = 0,01	Absolute method based on ratio between direct radiant flux e radiant flux with material (mirror)	Marco Terzi m.terzi@inrim.it	A
PR.4.15-a1	Wavelength calibration of spectrally selective optical material in transmission	Wavelength range between 250 nm and 650 nm	Spectrally selective optical material	from 0,5 nm to 3 nm with SBW = 0,5 to a SBW = 3 nm	Comparison with Hg lamp line emission in NIST-ASD Database	Marco Terzi m.terzi@inrim.it	A
PR.6.6-b1	Plate calibration for glossmeters <i>Field not CIPM MRA covered:</i> from 1 to 105 GU	from 1 to 105 GU	Plate for glossmeters	1 GU	Comparison with plate calibrated from NMI with CMC BIPM	Marco Terzi m.terzi@inrim.it	C

T - THERMOMETRY

Temperature is one of the most frequently measured physical quantities in science and technology, usually for the control and thermal monitoring of processes in various sectors such as the metallurgical and chemical industries, the environment, healthcare, etc. Thermometry is applied to temperature measurements for thermal control and to obtain an indirect measure of properties such as **relative humidity** (from dew or wet bulb temperature) or thermophysical properties of materials (through appropriate thermal analysis).



INRiM laboratories provide services in thermometry demonstrated by more than 100 internationally recognised measurement and calibration capabilities (CMC) included in Appendix C of the CIPM Mutual Recognition Agreement (MRA).

They also organise periodic interlaboratory comparisons (ILCs) and respond to specific requests on applied thermal metrology issues from public or private entities through training and participation in research projects and industrial collaboration.

TEMPERATURE

PRIMARY CONTACT THERMOMETRY.

The laboratory realises and disseminates the national temperature standards according to the International Temperature Scale of 1990 (ITS-90). Calibrations of standard platinum resistance thermometers are carried out at fixed points, from the triple point of Argon (-189.3442 °C) to the solidification point of silver (961.78 °C), in the various sub-ranges defined by ITS-90:

- H₂O (0.01 °C) - Gallium (29.7646 °C);

Mercury (-38.8344 °C) - Gallium;

Argon (-189.3442 °C) - Gallium;

- H₂O - Indium (156.5985 °C);

Argon - Indium;

- H₂O - Tin (231.928 °C);

Argon - Tin;

- H₂O - Zinc (419.527 °C);

Argon - Zinc;

- H₂O - Aluminium (660.323 °C);

Argon - Aluminium;

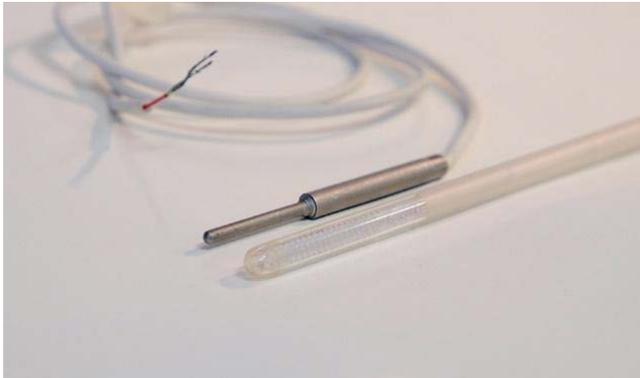
- H₂O - Silver (961.78 °C).

Calibrations of fixed-point cells and thermocouples are also performed.

INRiM works to support the industry by advising on thermal issues in various application sectors: temperature control systems with mK stability, *in-situ* calibrations, development of new sensors, and measurements for energy efficiency. In addition, the aim is to promote the use of data traceable to the International Temperature Scale.

INDUSTRIAL CONTACT THERMOMETRY.

INRiM disseminates the **kelvin**, the unit of temperature measurement, according to the



International Temperature Scale ITS-90, with calibrations by comparison of **resistance thermometers, thermocouples** and **thermometric chains** (digital indicators with probes) in the range from $-196\text{ }^{\circ}\text{C}$ to $1530\text{ }^{\circ}\text{C}$. The activity is based on more than 30 internationally recognised Measurement and Calibration Capabilities

(CMC) included in Appendix C of the CIPM Mutual Recognition Agreement (MRA).

CRYOGENIC THERMOMETRY.

INRiM realises and disseminates the **kelvin** base unit at cryogenic temperatures, in the range



from 4 K to 273.15 K of the International Temperature Scale STI-90, through 13 Measurement and Calibration Capabilities (CMC) on the KCDB database, internationally recognised by the CIPM member countries through the Mutual Recognition Agreement (MRA). Moreover, the laboratory offers measurement and calibration services for **capsule thermometers** (platinum resistance,

rhodium-iron) and **fixed-point cells**: hydrogen in equilibrium (13.8033 K), neon (24.5561 K), oxygen (54.3584 K), argon (83.8058 K).

RADIATION THERMOMETRY.

INRiM provides dissemination by radiation techniques of the unit of temperature measurement (kelvin), according to the International Temperature Scale (ITS-90), either to other NMIs or research centres, accredited calibration laboratories or directly to end users.

The laboratory performs calibrations of

- black-body cells at fixed points of indium, tin, zinc, aluminium, silver and copper;
- primary standard monochromatic radiation thermometers: calibration according to the requirements for ITS-90 above the silver solidification point (961.78 °C);
- precision infrared thermometers: calibration at fixed points between indium and silver;
- infrared radiation thermometers for industrial use (in the temperature range from -30 °C to 1500 °C);
- radiative heat flux meters of the Gardon and Schmidt Boelter type for high radiation levels (between 10 kW/m² and 120 kW/m²).



INRiM also advises on specific measurement problems in the various application areas of thermal measurements using non-contact measurement techniques, including through dedicated research projects and industrial contracts.

HUMIDITY

Thermal and Hygrometric Measurements.

The primary INRiM hygrometry laboratory develops and maintains primary standards of thermo-hygrometric quantities: relative humidity, dew/frost, and air temperature.

Measurements and calibrations (not all of them covered by CIPM MRA) performed by the laboratory are:



- Relative humidity measurement between 10 % and 95 % with the air temperature between -10 °C and 70 °C ;
- Measurement of dew/frost temperature between -105 °C and 95 °C ;
- Measurement of the mole fraction of water vapour between 5 nmol/mol and $10\text{ }\mu\text{mol/mol}$;
- Air temperature measurement between -70 °C and 180 °C .

The standards of the primary laboratory, which are used for scientific activities and metrological services, include equipment to ensure the traceability of thermo-hygrometric measurements in Italy. In particular, the following are available:

- A wet gas primary generator INRiM-01 that generates a gas with a constant dew point temperature between -20 °C and $+95\text{ °C}$; the generator is based on a single-pressure recirculation system;
- A wet gas primary generator INRiM-02 that generates a gas with a constant frost temperature between 0 °C and -85 °C ; the generator is based on a single-pressure recirculation system;

- A wet gas primary generator INRIM-03 that generates a constant frost temperature gas between $-105\text{ }^{\circ}\text{C}$ and $-20\text{ }^{\circ}\text{C}$ at 200 and 6000 hPa pressures; the generator is based on a two-pressure system;
- Two TS2500 primary relative humidity generators; the generator is based on the principle of 2 Pressures and 2 Temperatures; it can also be used as a secondary humid gas generator with a dew/defrost temperature between $-36\text{ }^{\circ}\text{C}$ and $+70\text{ }^{\circ}\text{C}$ and for measuring air temperature between $-10\text{ }^{\circ}\text{C}$ and $+70\text{ }^{\circ}\text{C}$;
- A reference system for air temperature measurement consisting of a thermostatic chamber, a sub-chamber and a standard thermometer in the range from $-70\text{ }^{\circ}\text{C}$ to $+180\text{ }^{\circ}\text{C}$.

The development and validation of standards are based on numerous national and international research projects for measuring gas humidity.

The laboratory offers dissemination services for thermo-hygrometric quantities such as:

- Calibration of dew/defrost temperature gauges;
- Calibration of sensors for measuring relative humidity;
- Calibration of thermometers for measuring air temperature;
- Calibration of climatic and thermostatic environments in the field;
- Interlaboratory comparisons (ILC) in thermo-hygrometry;
- Inter-laboratory comparisons (ILC) in climatic and thermostatic environments;
- Research collaborations with the industry to develop new sensors/measuring methods.

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.1.1-a1	Calibration of cells for cryogenic fixed point	13,8033 K	Cell for the triple point of equilibrium hydrogen	0.44 mK	Calibration for comparison (below 0°C) with reference thermometer, 1 calibration point, without calculation of calibration constants	Dario Imbraguglio d.imbraguglio@inrim.it	A
T.1.1-b1	Calibration of cells for cryogenic fixed point	24,5561 K	Cell for the triple point of neon	0.38 mK	Calibration for comparison (below 0°C) with reference thermometer, 1 calibration point, without calculation of calibration constants	Dario Imbraguglio d.imbraguglio@inrim.it	A
T.1.1-c1	Calibration of cells for cryogenic fixed point	54,3584 K	Cell for the triple point of oxygen	0.31 mK	Calibration for comparison (below 0°C) with reference thermometer, 1 calibration point, without calculation of calibration constants	Dario Imbraguglio d.imbraguglio@inrim.it	A
T.1.1-d1	Calibration of cells for cryogenic fixed point	83,8058 K	Cell for the triple point of argon	0.14 mK	Calibration for comparison (below 0°C) with reference thermometer, 1 calibration point, without calculation of calibration constants	Dario Imbraguglio d.imbraguglio@inrim.it	A
T.1.1-e1	Calibration of fixed-point cells for CSPRT	234.3156 K	Mercury fixed-point cell for CSPRT	0.26 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in the standard cell	Giuseppina Lopardo g.lopardo@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.1.1-e2	Calibration of fixed-point cells for LSPRT	234.3156 K	Mercury fixed-point cell for LSPRT	0.26 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in the standard cell	Giuseppina Lopardo g.loparto@inrim.it Federico Santoro f.santoro@inrim.it	A
T.1.1-f1	Calibration of fixed-point cells for LSPRT	0.01 °C	Triple point of water fixed-point cell for LSPRT	0.06 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in the standard cell	Giuseppina Lopardo g.loparto@inrim.it	A
T.1.1-g1	Calibration of fixed-point cells for LSPRT	-189.3442 °C	Argon fixed-point cell for LSPRT	0.60 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in the standard cell	Giuseppina Lopardo g.loparto@inrim.it Federico Santoro f.santoro@inrim.it	A
T.1.1-j1	Calibration of fixed-point cells for LSPRT	156.5985 °C	Indium fixed-point cell for LSPRT	0.80 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in the standard cell	Giuseppina Lopardo g.loparto@inrim.it Federico Santoro f.santoro@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.1.1-k1	Calibration of fixed-point cells for LSPRT	29.7646 °C	Gallium fixed-point cell for LSPRT	0.20 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in the standard cell	Giuseppina Lopardo g.loparto@inrim.it Federico Santoro f.santoro@inrim.it	A
T.1.1-l1	Calibration of fixed-point cells for LSPRT	231.928 °C	Tin fixed-point cell for LSPRT	0.60 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in the standard cell	Giuseppina Lopardo g.loparto@inrim.it Federico Santoro f.santoro@inrim.it	A
T.1.1-m1	Calibration of fixed-point cells for LSPRT	419.527 °C	Zinc fixed-point cell for LSPRT	0.90 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in standard cell	Giuseppina Lopardo g.loparto@inrim.it Federico Santoro f.santoro@inrim.it	A
T.1.1-n1	Calibration of fixed-point cells for LSPRT	660.323 °C	Aluminium fixed-point cell for LSPRT	2.30 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in the standard cell	Giuseppina Lopardo g.loparto@inrim.it Federico Santoro f.santoro@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.1.1-o1	Calibration of fixed-point cells for LSPRT	961.78 °C	Silver fixed-point cell for LSPRT	3.30 mK	measurement of the electrical resistance of a standard stem platinum resistance thermometer (SPRT), at the temperature of the fixed point under examination both in the cell being calibrated and in the standard cell	Federico Santoro f.santoro@inrim.it	A
T.1.1-p1	Calibration of blackbody cells at the silver fixed point	961.78°C	Black body cell at the silver fixed point	5.0E-2 K	Calibration for comparison with standards cell	Ferruccio Girard f.girard@inrim.it	A
T.1.1-q1	Calibration of blackbody cells at the copper fixed point	1084.62°C	copper fixed point blackbody cell / STI-90 temperature	5.0E-2 K	calibration for comparison with a standard cell	Ferruccio Girard f.girard@inrim.it	A
T.1.3-a1	Measurement of capsule thermometers	13,8033 K	Cell for the triple point of equilibrium hydrogen	0.35 mK	Measurement of platinum capsule resistance thermometers, 1 measuring point, without calculation of calibration constants	Roberto Maria Gavioso r.gavioso@inrim.it	A
T.1.3-a2	Measurement of capsule thermometers	24,5561 K	Cell for the triple point of neon	0.3 mK	Measurement of platinum capsule resistance thermometers, 1 measuring point, without calculation of calibration constants	Roberto Maria Gavioso r.gavioso@inrim.it	A
T.1.3-a3	Measurement of capsule thermometers	54,3584 K	Cell for the triple point of oxygen	0.25 mK	Measurement of platinum capsule resistance thermometers, 1 measuring point, without calculation of calibration constants	Roberto Maria Gavioso r.gavioso@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.1.3-a4	Measurement of capsule thermometers	83,8058 K	Cell for the triple point of argon	0.14	Measurement of platinum capsule resistance thermometers, 1 measuring point, without calculation of calibration constants	Roberto Maria Gavioso r.gavioso@inrim.it	A
T.1.3-a5	Measurement of capsule thermometers	234,3156 K	Cell for the triple point of mercury	0.12 mK	Measurement of platinum capsule resistance thermometers, 1 measuring point, without calculation of calibration constants	Roberto Maria Gavioso r.gavioso@inrim.it	A
T.1.3-b1	Calibration of LSPRT	Argon triple point,	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.60 mK	Fixed point calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-b2	Calibration of LSPRT	Mercury triple point,	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.26 mK	Fixed point calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-b3	Calibration of LSPRT	Water triple point,	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.05 mK	Fixed point calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-b4	Calibration of LSPRT	Gallium melting point,	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.14 mK	Fixed point calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-b5	Calibration of LSPRT	Indium freezing point,	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.7 mK	Fixed point calibration	Federico Santoro f.santoro@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.1.3-b5	Calibration of LSPRT	0.01°C to 231.928 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.96 mK	Fixed points calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-b6	Calibration of LSPRT	Tin freezing point,	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.42 mK	Fixed point calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-b6	Calibration of LSPRT	0.01°C to 419.527 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.96 mK	Fixed points calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-b7	Calibration of LSPRT	zinc freezing point, 419.527 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.84 mK	Fixed point calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-b8	Calibration of LSPRT	aluminium freezing point, 660.323 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	1.7 mK	Fixed point calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-b9	Calibration of LSPRT	silver freezing point, 961.78 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	2.6 mK	Fixed point calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-c1	Calibration of capsule thermometers	Da 24,5561 K a 273,16 K	Cells for the triple points of equilibrium hydrogen, neon, oxygen, argon, mercury and water	0.5 mK	Calibration of capsule platinum resistance thermometers, 6 calibration points, with calculation of calibration constants	Roberto Maria Gavioso r.gavioso@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.1.3-c2	Calibration of capsule thermometers	Da 54,3584 K a 273,16 K	Cells for the triple points of oxygen, argon, mercury and water	0.3 mK	Calibration of capsule platinum resistance thermometers, 4 calibration points, with calculation of calibration constants	Roberto Maria Gavioso r.gavioso@inrim.it	A
T.1.3-c3	Calibration of capsule thermometers	Da 83,8058 K a 273,16 K	Cells for the triple points of argon, mercury and water	0.3 mK	Calibration of capsule platinum resistance thermometers, 3 calibration points, with calculation of calibration constants	Roberto Maria Gavioso r.gavioso@inrim.it	A
T.1.3-d1	Calibration of LSPRT	-189.3442 °C to 0.01 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.62 mK	Fixed points calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-d2	Calibration of LSPRT	-38.8344 °C to 29.7646 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.28 mK	Fixed points calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-d3	Calibration of LSPRT	0.01°C to 29.7646 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.26 mK	Fixed points calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-d4	Calibration of LSPRT	0.01°C to 156.5985 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	0.85 mK	Fixed points calibration	Federico Santoro f.santoro@inrim.it	A
T.1.3-d7	Calibration of LSPRT	419.527 °C to 660.323 °C	Long stem Standard Platinum Resistance Thermometer (LSPRT)	da 0.96 mK a 2.4 mK	Fixed points calibration	Federico Santoro f.santoro@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.1.3-d8	Calibration of HTPRT	419.527 °C to 660.323 °C	High Temperature Platinum Resistance Thermometer (HTPRT)	da 2.4 mK a 3.6 mK	Fixed points calibration	Federico Santoro f.santoro@inrim.it	A
T.1.4-a1	Primary calibration of standard radiation thermometers at 650 nm and 1100 nm between 961.78 °C and 2000 °C	[962 to 2000] °C	Primary standard radiation / ITS-90 temperature	[5.0E-2 to 0.5] K	Absolute calibration, STI-90 implementation above 962 °C	Michael Florio m.florio@inrim.it	A
T.2.2-a1	Calibration for comparison of capsule thermometers	-196 °C	Capsule-type rhodium-iron resistance thermometer	0.02 °C	Comparative calibration of platinum resistance thermometers	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.2-a2	Calibration by comparison of resistance thermometers	-90°C to 0°C	Platinum resistance thermometers	0.01 °C	Comparative calibration of platinum resistance thermometers. Minimum 3 calibration points, without calculation of calibration constants. Minimum 5 measurement points, with calculation of calibration constants, depending on the required calibration range.	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
T.2.2-a3	Calibration by comparison of platinum resistance thermometers	-90°C to 0°C	Platinum resistance thermometers	0.01 °C	Comparative calibration of platinum resistance thermometers. Minimum 3 calibration points, without calculation of calibration constants. Minimum 5 measurement points, with calculation of calibration constants, depending on the required calibration range.	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.2-a4	Calibration by comparison of platinum resistance thermometers	from 100°C to 250°C	Platinum resistance thermometers	0.02 °C	Comparative calibration of platinum resistance thermometers. Minimum 3 calibration points, without calculation of calibration constants. Minimum 5 measurement points, with calculation of calibration constants, depending on the required calibration range.	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.2-a5	Calibration by comparison of platinum resistance thermometers	from 250°C to 450°C	Platinum resistance thermometers	0.05 °C	Comparative calibration of platinum resistance thermometers. Minimum 3 calibration points, without calculation of calibration constants. Minimum 5 measurement points, with calculation of calibration constants, depending on the required calibration range.	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
T.2.2-a6	Calibration by comparison of platinum resistance thermometers	from 450 °C to 900 °C	Platinum resistance thermometers	0.06 °C	Comparative calibration of platinum resistance thermometers. Minimum 3 calibration points, without calculation of calibration constants. Minimum 5 measurement points, with calculation of calibration constants, depending on the required calibration range.	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.2-b1	Calibration for comparison of capsule thermometers <i>Field not CIPM MRA covered:</i> from 25 K to 27 K	from 4 K to 27 K	Rhodium-iron capsule resistance thermometer	1.6 mK	Calibration for comparison of rhodium-iron capsule resistance thermometers, minimum 10 calibration points, with calculation of calibration constants	Roberto Maria Gavioso r.gavioso@inrim.it	B
T.2.3-a1	Calibration of base metal thermocouples for comparison	Calibration at the Gallium fixed point, 29.7646 °C	Base metal thermocouples	0.1 °C	fixed-point calibration	Federico Santoro f.santoro@inrim.it	A
T.2.3-a2	Calibration of noble metal thermocouples (Au/Pt type) at the single fixed point	Calibration at the Indium fixed point, 156.5985 °C	Base metal thermocouples	0.07 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a3	Calibration of noble metal thermocouples (Au/Pt type) at the single fixed point	calibration at the fixed point of the Tin, 231,928 °C	Base metal thermocouples	0.07 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.2.3-a4	Calibration of noble metal thermocouples (Au/Pt type) at the single fixed point	calibration at the Zinc fixed point, 419,527 °C	Base metal thermocouples	0.07 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a5	Calibration of noble metal thermocouples (Au/Pt type) at the single fixed point	calibration at the fixed point of Aluminium, 660.323 °C	Base metal thermocouples	0.05 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a6	Calibration of noble metal thermocouples (Au/Pt type) at the single fixed point	calibration at the fixed point of Silver, 961.78 °C	Thermocouples	0.05 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a7	Calibration of noble metal thermocouples (Au/Pt type) at the single fixed point	from 0 °C to 960 °C	Pure metal thermocouple (Au/Pt)	0.20 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a8	Calibration of noble metal thermocouples (type R, S) at the single fixed point	Calibration at the Gallium fixed point, 29.7646 °C	Thermocouples	0.23 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a9	Calibration of noble metal thermocouples (type R, S) at the single fixed point	calibration at the Indium fixed point, 156.5985 °C	Thermocouples	0.22 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.2.3-a10	Calibration of noble metal thermocouples (type R, S) at the single fixed point	calibration at the fixed point of the Tin, 231.928 °C	Thermocouples	0.22 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a11	Calibration of noble metal thermocouples (type R, S) at the single fixed point	calibration at the Zinc fixed point, 419.527 °C	Thermocouples	0.22 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a12	Calibration of noble metal thermocouples (type R, S) at the single fixed point	calibration at the fixed point of Aluminium, 660.323 °C	Thermocouples	0.22 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a13	Calibration of noble-metal thermocouple (type R, S) at fixed point	Calibration at the freezing point of silver, 961.78 °C	thermocouple	0.23 °C	Calibration at fixed point	Federico Santoro f.santoro@inrim.it	A
T.2.3-a14	Calibration of noble metal thermocouples (type R, S) at the single fixed point	Calibration at the copper fixed point, 1084.62 °C	Thermocouples	0.27 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A
T.2.3-a15	Calibration of noble metal thermocouples (type R, S) at the single fixed point	from 0.01 °C to 1084.62 °C	Thermocouples	0.40 °C	calibration at fixed points	Federico Santoro f.santoro@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
T.2.3-b1	Calibration by comparison of a pure metal thermocouple (Au/Pt)	from 0°C to 250°C	Pure metal thermocouple (Au/Pt)	0.23 °C	Calibration by comparison of a pure metal thermocouple. Minimum 3 measurement points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of the calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.3-b2	Calibration by comparison of a pure metal thermocouple (Au/Pt)	250°C to 450°C	Pure metal thermocouple (Au/Pt)	0.33 °C	Calibration by comparison of a pure metal thermocouple. Minimum 3 measurement points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of the calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.3-b3	Calibration by comparison of a pure metal thermocouple (Au/Pt)	450°C to 900°C	Pure metal thermocouple (Au/Pt)	0.3 °C	Calibration by comparison of a pure metal thermocouple. Minimum 3 measurement points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of the calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
T.2.3-b4	Pure metal thermocouples (Pt/Pd)	450°C to 900°C	Pure metal thermocouples (Pt/Pd)	0.3 °C	Calibration by comparison of a pure metal thermocouple. Minimum 3 measurement points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of the calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.3-b5	Noble metal thermocouples (S/R type) for comparison	from 0°C to 250°C	Noble Metal Thermocouples (S/R Type)	0.33 °C	Calibration by comparison of a pure metal thermocouple. Minimum 3 measurement points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of the calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.3-b6	Noble metal thermocouples (S/R type) for comparison	from 250 °C to 450 °C	Noble Metal Thermocouples (S/R Type)	0.45 °C	Calibration by comparison of a pure metal thermocouple. Minimum 3 measurement points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of the calibration constants	Giuseppe Braccialarghe g.braccialarghe@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
T.2.3-b7	Noble metal thermocouples (S/R type) for comparison	450°C to 900°C	Noble Metal Thermocouples (S/R Type)	0.3 °C	Calibration by comparison of a pure metal thermocouple. Minimum 3 measurement points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of the calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.3-b8	Noble metal thermocouples (S/R type) for comparison	900°C to 1065°C	Noble Metal Thermocouples (S/R Type)	0.8 °C	Calibration by comparison of a pure metal thermocouple. Minimum 3 measurement points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of the calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.3-b9	High temperature noble metal thermocouples	from 1065°C to 1550°C	High temperature noble metal thermocouples	0.36 °C	Calibration by comparison of a pure metal thermocouple. Minimum 3 measurement points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of the calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
T.2.3-b10	Calibration of base metal thermocouples for comparison	-90 °C to 250 °C	Base metal thermocouples	0.36 °C	Comparison calibration of a base metal thermocouple. Minimum 3 calibration points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of calibration constants	Giuseppe Braccialarghe g.braccialarghe@inrim.it Fabio Bertiglia f.bertiglia@inrim.it	A
T.2.3-b11	Calibration of base metal thermocouples for comparison	250 °C to 450 °C	Base metal thermocouples	0.56 °C	Comparison calibration of a base metal thermocouple. Minimum 3 calibration points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.3-b12	Calibration of base metal thermocouples for comparison	450 °C to 900 °C	Base metal thermocouples	1.1 °C	Comparison calibration of a base metal thermocouple. Minimum 3 calibration points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.2.3-b13	Calibration of base metal thermocouples for comparison	900 °C to 1100 °C	Base metal thermocouples	1.25 °C	Comparison calibration of a base metal thermocouple. Minimum 3 calibration points, without calculation of calibration constants. Minimum 5 measurement points in the field covered by the reference polynomial, with calculation of calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.3-c1	High temperature noble metal thermocouples	1065 °C to 1550 °C	High temperature noble metal thermocouples	0,8 °C to 1,5 °C	Calibration by comparison of a noble metal thermocouple on 6 measurement points in the range from 1065 °C to 1540 °C with calculation of calibration constants	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.4-a1	Calibration by comparison of a liquid column glass thermometer	from -90°C to 0°C	Liquid column glass thermometer	0.01 °C +1/2 division	Liquid thermometers. Calibration for comparison of a liquid column glass thermometer, partially or totally immersed, in a thermostatic bath, on 4 measurement points	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.4-a2	Calibration by comparison of a liquid column glass thermometer	from 0°C to 100°C	Liquid column glass thermometer	0.01 °C +1/2 division	Calibration by comparison of a liquid column glass thermometer, partial or total immersion, in a thermostatic bath, on 4 measurement points.	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.2.4-a3	Calibration by comparison of a liquid column glass thermometer	from 100°C to 250°C	Liquid column glass thermometer	0.02 °C +1/2 division	Calibration by comparison of a liquid column glass thermometer, partial or total immersion, in a thermostatic bath, on 4 measurement points.	Fabio Bertiglia f.bertiglia@inrim.it	A
T.2.5-a1	Calibration of blackbody cells at the indium fixed Point	156.5985	Blackbody cells at indium fixed point / ITS-90 temperature	8.0E-2 °C	calibration for comparison with a standard cell	Michael Florio m.florio@inrim.it	A
T.2.5-a2	Calibration of blackbody cells at the tin fixed point	231,928	blackbody cell at tin fixed point / ITS-90 temperature	8.0E-2 °C	calibration for comparison with a standard cell	Michael Florio m.florio@inrim.it	A
T.2.5-a3	Calibration of Blackbody Cells at the Zinc Fixed Point	419.527	zinc fixed point blackbody cell / ITS-90 temperature	8.0E-2 °C	calibration for comparison with a satandard cell	Michael Florio m.florio@inrim.it	A
T.2.5-b1	Calibration of blackbody cells at the aluminum fixed point	660.323°C	aluminum fixed point blackbody cell / ITS-90 temperature	8.0E-2 °C	calibration for comparison with a satandard cell	Michael Florio m.florio@inrim.it	A
T.2.5-c1	Fixed-point calibration of precision infrared thermometers	from 156 °C to 962 °C	Precision infrared thermometer / temperature (ITS-90 approximation)	[8.0E-2 to 0.14] °C	calibration at fixed points	Michael Florio m.florio@inrim.it	A
T.2.5-d1	Calibration of infrared thermometers (on five measurement points)	from -30°C to 1500°C	Infrared thermometer / temperature	from 0,4 °C to 2,4 °C	Calibration by comparison with a blackbody cavity at known temperature	Michael Florio m.florio@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
T.2.6-a1	Calibration of air temperature measuring instruments <i>Field not CIPM MRA covered:</i> From -70°C to -10°C and 80°C to 180°C	from - 70°C to 180°C	Instruments measuring the air temperature	U= 0.04 °C with -10 °C ≤ t ≤ 45 °C, U= 0.06 °C with 45 °C < t ≤ 70 °C	Calibration by comparison with a reference system using a comparator in air	Giulio Beltramino g.beltramino@inrim.it Riccardo Salerno r.salerno@inrim.it	B
T.2.7-a1	Thermometric chains composed of indicator with one or more resistance thermometers	-196°C	Thermometric chains composed of an indicator with one or more resistance thermometers	0.02 °C	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.7-a2	Calibration of thermometric chains composed of an indicator with one or more thermocouples	-90 °C to 0 °C	Thermometric chains composed of an indicator with one or more thermocouples	0.01 °C	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers with minimum 4 calibration points depending on the required calibration range	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.7-a3	Calibration of thermometric chains composed of an indicator with one or more thermocouples	from 0 °C to 100 °C	Thermometric chains composed of an indicator with one or more thermocouples	0.01 °C	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers with a minimum of 4 calibration points depending on the required calibration range	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
T.2.7-a4	Calibration of thermometric chains composed of an indicator with one or more thermocouples	from 100 °C to 250 °C	Thermometric chains composed of an indicator with one or more thermocouples	0.02 °C	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers with a minimum of 4 calibration points depending on the required calibration range	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.7-a5	Calibration of thermometric chains composed of an indicator with one or more thermocouples	from 250 °C to 450 °C	Thermometric chains composed of an indicator with one or more thermocouples	0.05 °C	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers with a minimum of 4 calibration points depending on the required calibration range	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.7-a6	Calibration of thermometric chains composed of an indicator with one or more thermocouples	from 450 °C to 900 °C	Thermometric chains composed of an indicator with one or more thermocouples	0.06 °C	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers with a minimum of 4 calibration points depending on the required calibration range	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.7-a7	Calibration by comparison of thermometric chains composed of an indicator with one or more	-196 °C	Thermometric chains composed of an indicator with one or more resistance thermometers	0.36 °C	Calibration for comparison. Minimum 4 calibration points depending on the required calibration range.	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
T.2.7-a8	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers	from -90 °C to 250 °C	Thermometric chains composed of an indicator with one or more resistance thermometers	0.36 °C	Calibration for comparison. Minimum 4 calibration points depending on the required calibration range.	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.7-a9	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers	from 250 °C to 450 °C	Thermometric chains composed of an indicator with one or more resistance thermometers	0.56 °C	Calibration for comparison. Minimum 4 calibration points depending on the required calibration range.	Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.7-a10	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers	from 450 °C to 900 °C	Thermometric chains composed of an indicator with one or more resistance thermometers	0.7 °C	Calibration for comparison. Minimum 4 calibration points depending on the required calibration range	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.7-a11	Calibration by comparison of thermometric chains composed of an indicator with one or more resistance thermometers	from 900 °C to 1100 °C	Thermometric chains composed of an indicator with one or more resistance thermometers	0.8 °C	Calibration for comparison. Minimum 4 calibration points depending on the required calibration range	Fabio Bertiglia f.bertiglia@inrim.it Giuseppe Braccialarghe g.braccialarghe@inrim.it	A
T.2.8-a1	Calibration of radiative heat flux meters	From 10 kW/m ² to 120 kW/m ²	Radiative / irradiation heat flux meter	5 %	Absolute calibration with respect to a blackbody cavity at known temperature	Michael Florio m.florio@inrim.it	C

T Thermometry							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
T.3.1-a1	Calibration of chilled-mirror hygrometers <i>Field not CIPM MRA covered:</i> National CMCs from 80°Cdp to 95°Cdp National CMCs from -105 °Cfp to -75 °Cfp	-105°Cfp to 95°Cdp	Chilled mirror hygrometers	from 0.11 °C to 0.04 °C	Calibration for comparison with primary or secondary wet gas generator	Giulio Beltramino g.beltramino@inrim.it Riccardo Salerno r.salerno@inrim.it	B

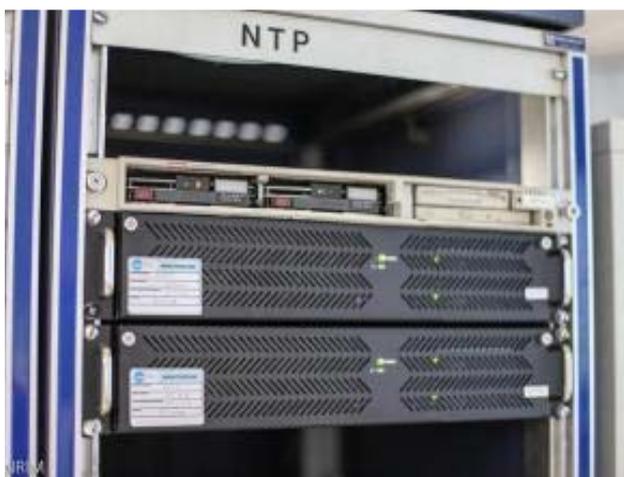
TF - TIME AND FREQUENCY



Time and frequency are the physical quantities whose units can be realised with the best precision. The basic unit, the 'second', therefore, occupies a very special place in the International System of Units (SI). Moreover, high-precision time and frequency measurements form the basis for satellite navigation systems such as **GPS, GALILEO**, etc.

The time and frequency laboratory can calibrate and test secondary standards and devices requiring traceability. In addition, periodic inter-laboratory comparisons are organised for frequency.

The laboratory manages and maintains Calibration Measurement Capabilities (CMC) for Time and Frequency as recognised by the Mutual Recognition Arrangement (MRA):



- Remote calibration of oscillators using The GPS signal;
- Commercial Cesium Beam and Rubidium oscillators;
- Timebase of electronic counters and signal generators;
- On-site calibration of oscillators regulated by GPS signal;
- Characterisation of oscillator instabilities;
- Synchronisation systems via NTP computer networks.

INRiM will also be able to provide Coordinated Universal Time (UTC) traceability to financial players under the Market in Financial Instruments Directive II (MiFID II) agreement, which is in preparation.

NTP. NETWORK TIME PROTOCOL.

INRiM provides a synchronisation service for computer systems connected to the Internet, based on three primary NTP (Network Time Protocol) servers.

The technical specifications of this synchronisation protocol are described in document RCF-5905.

The time deviation between the INRiM NTP servers and the Italian national time scale UTC(IT) is controlled and usually is less than one millisecond. The achievable synchronisation accuracy depends on the network type and the distance between the NTP server and the user; the typical time difference values are in the order of a few



hundred microseconds for systems belonging to the same network and can reach a few tens of milliseconds for remote networks.

The addresses of the INRiM primary NTP servers are as follows:

Name	IP address	Available services
ntp1.inrim.it	193.204.114.232	NTP (RCF-5905)
ntp2.inrim.it	193.204.114.233	NTP (RCF-5905)
time.inrim.it	193.204.114.105	NTP (RCF-5905), TIME (RFC-868), DAYTIME (RFC-867)

TF							
Time and frequency							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
TF.1.1-a1	Calibration of cesium atomic clock, rubidium, quartz and frequency reference devices, calibrated at INRIM laboratory	1PPS, 5 MHz, 10 MHz	Cesium atomic clock, rubidium, quartz and frequency reference devices.	from 1E-7 to 1E-13	Calibration by comparison. Normalized frequency deviation provided	Roberto Costa r.costa@inrim.it	A
TF.1.1-a2	Calibration of: cesium atomic clock, rubidium, quartz and frequency reference devices, calibrated in the INRIM laboratory <i>Field not CIPM MRA covered:</i> Frequency instability (Allan variance) of the 10 MHz output signal	1PPS, 5 MHz, 10 MHz	Cesium atomic clock, rubidium, quartz and frequency reference devices	from 1E-7 to 1E-13	Calibration by comparison. Normalized frequency deviation provided. Frequency instability (Allan variance) of the 10 MHz output signal	Roberto Costa r.costa@inrim.it	B
TF.1.1-b1	Calibration of time reference generator for computer networks (NTP server)	1PPS	Timestamp generator for computer networks (NTP server)	0.3 ms	Measurement of the time offset between the system clock of the device and the clock of a primary NTP server of INRIM, using the NTP synchronization protocol.	Alberto Mura a.mura@inrim.it Giuseppe Vizio g.vizio@inrim.it	C
TF.1.1-c1	Calibration of dual-frequency geodetic gnss satellite receivers for timing applications <i>Field not CIPM MRA covered:</i> 1 s	1PPS	Dual-frequency geodetic GNSS station for timing applications	3 ns / 6 ns / 10 ns	The calibration of the user's receiver (DUT) is based on a differential method based on a calibrated dual-frequency geodetic station hosted at INRIM. The calibration of the DUT can be carried out either on-site at INRIM, by directly comparing it with the INRIM reference geodetic station, or using a mobile station at the customer's premises	Andrea Perucca a.perucca@inrim.it	B

TF Time and frequency							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
TF.1.1-d1	Calibration of devices for time synchronization via fiber optic link	1PPS	Synchronization device based on the PTP protocol that has a 1PPS signal output synchronized to UTC(IT)	10 ns	Measurement of the time offset between the 1PPS signal generated by the DUT and that of the UTC(IT) time scale, using a travelling clock characterized at the INRiM time and frequency laboratory.	Alberto Mura a.mura@inrim.it Andrea Perucca a.perucca@inrim.it	C
TF.2.1-a1	Calibration of a relative frequency deviation of a reference oscillator of a time interval counter or synthesizer, calibrated at INRiM laboratory	10 MHz	Reference oscillator, time interval counter, synthesizer	from 1E-7 to 1E-13	Calibration by comparison. Normalized frequency deviation provided	Roberto Costa r.costa@inrim.it	A
TF.2.1-a2	Calibration of a relative frequency deviation of a reference oscillator of a time interval counter or synthesizer, calibrated at INRiM laboratory. Frequency instability (Allan variance) of the 10MHz output signal of the oscillator <i>Field not CIPM MRA covered:</i> Frequency instability (Allan variance) of the 10 MHz output signal	10 MHz	Reference oscillator, time interval counter, synthesizer	from 1E-7 to 1E-13	Calibration by comparison. Normalized frequency deviation provided. Frequency instability (Allan variance) of the 10 MHz output signal	Roberto Costa r.costa@inrim.it	B

TF Time and frequency							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
TF.2.1-b1	<p>Calibration of a GPS disciplined oscillator, calibrated in the INRIM laboratory</p> <p><i>Field not CIPM MRA covered:</i> Frequency instability (Allan variance) of the 10 MHz output signal</p>	10 MHz	GPS disciplined oscillator	1E-13	Calibration by comparison. Normalized frequency deviation (20 days of measurement) provided. Frequency instability (Allan variance) of the 10 MHz output signal	Roberto Costa r.costa@inrim.it	B
TF.2.1-b2	Remote calibration of a GNSS disciplined oscillator (annual calibration, with quarterly certificates)	10 MHz	Reference disciplined oscillator	1E-13	Calibration by comparison. Normalized frequency deviation provided, through satellite systems synchronization with INRIM format file	Roberto Costa r.costa@inrim.it	A
TF.2.1-b3	Remote calibration of a reference disciplined oscillator (over a given period of coverage, with a single certificate)	10 MHz	Reference disciplined oscillator	1E-13	Calibration by comparison. Normalized frequency deviation provided, through satellite systems synchronization with INRIM format file	Roberto Costa r.costa@inrim.it	A

QM - CHEMISTRY

Metrology in chemistry covers many measurements for the quantification of chemicals in various matrices in a wide range of concentrations for sectors such as environment, energy, health, and food safety.

The metrological traceability of chemical measurement results is ensured through primary methods, the development and characterisation of appropriate reference materials and the calibration of analytical instrumentation.

Participation in international measurement comparisons organised under CCQM and EURAMET guarantees the equivalence of the services offered by the various national metrological institutes, providing a solid and metrologically reportable basis for calibration services on a European and global level.



A key aspect of ensuring the traceability and dissemination of chemical measurement units is participating in characterisation and certification campaigns of reference materials proposed by metrological institutes and international organisations such as NIST, IAEA, and JRC-IRMM.

FOOD

ELEMENTAL ANALYSIS OF MACRO-CONSTITUENTS AND TRACE ELEMENTS.

INRiM provides calibrations for determining quantities of substances in matrices of various kinds, such as animal and plant-origin food samples, biological and environmental samples, soils, and materials.



Analyses for elemental quantification are offered for about 70 elements of the periodic table, both principal and trace elements. Some services are supported by CMCs included in the BIPM database. All measurements are, however, referable to the SI.

Substance quantities are measured by the Radiochemistry and Spectroscopy Unit of INRiM in Pavia through neutron activation analysis, a nuclear technique carried out using the TRIGA Mark II nuclear reactor at the University of Pavia.

GASES

GRAVIMETRIC MIXTURES AND ORGANIC ANALYSIS.

INRiM provides the calibration service of non-dispersive infrared (NDIR) analysers for carbon dioxide (CO₂) at atmospheric concentration. Calibration is performed under the Mutual Recognition Agreement (CIPM MRA) using primary reference mixtures of CO₂ in a nitrogen matrix or synthetic air.

OZONE IN THE AIR.

INRiM provides a calibration service for analysers and calibrators to measure the mole fraction of ozone in the atmosphere using the UV method in the measurement range 0÷1000 nmol/mol.

QM Chemistry and biology							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
QM.4.2-a1	Calibration of ozone analysers/calibrators in air at ambient level	0 - 1000 nmol/mol	Analyzers/Calibrators of ozone / mole fraction of ozone in air	Q[1.1; 0.022 x(O3)] nmol/mol	Calibration of analyzers/calibrators for the measurement of the ozone mole fraction in the atmosphere with UV method, uncertainty takes into account the contribution of the Ozone Cross-Section Hearn.1961.	Laura Revel l.revel@inrim.it	A
QM.4.2-b1	Calibration of non-dispersive infrared analyzers for the determination of CO2 in the gaseous phase	(100-1000) µmol/mol	Non-dispersive infrared (NDIR) analyzer/photometer for CO2 at atmospheric concentration in nitrogen	0.40 %	Calibration is performed using primary reference mixtures of CO2 in nitrogen or synthetic air matrix	Stefano Pavarelli s.pavarelli@inrim.it	A
QM.4.2-b2	Calibration of non-dispersive infrared analyzers for the determination of CO2 in the gaseous phase	(100-1000) µmol/mol	Non-dispersive infrared (NDIR) analyzer/photometer for CO2 at atmospheric concentration in air	0.40 %	Calibration is performed using primary reference mixtures of CO2 in nitrogen or synthetic air matrix	Stefano Pavarelli s.pavarelli@inrim.it	A
QM.4.2-c1	Calibration of gas mixtures of CO2 in nitrogen matrix	(100 - 1000) µmol/mol	Gas mixtures of CO2 in nitrogen matrix	0.33 %	Non-dispersive infrared spectroscopy - NDIR	Francesca Rolle f.rolle@inrim.it	A
QM.4.2-c2	Calibration of gas mixtures of CO2 in air matrix	(100 - 1000) µmol/mol	Gas mixtures of CO2 in air matrix	0.33 %	Non-dispersive infrared spectroscopy - NDIR	Francesca Rolle f.rolle@inrim.it	A

QM Chemistry and biology							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON	CMC
QM.11.1-a1	Elemental analysis for the determination of elements in matrix <i>Field not CIPM MRA covered:</i> partly present on KCDB 2.0 (CMC MRA and CMC NO MRA)	3 - 10 mg/kg (CIPM-MRA); 10 - 50 mg/kg (no CIPM MRA)	Measurand: Arsenic in fish tissue	3 - 50 mg/kg -> U = 3 - 3 (%)	Neutron activation analysis	Giancarlo D'Agostino g.dagostino@inrim.it Marco Di Luzio m.diluzio@inrim.it	B
QM.11.1-a2	Elemental analysis for the determination of elements in matrix <i>Field not CIPM MRA covered:</i> CMC MRA 1 - 10 mg/kg CMC no MRA 10 - 50 mg/kg	1 - 10 mg/kg (CIPM-MRA); 10 - 50 mg/kg (non CIPM MRA)	Measurand: Selenium in fish tissue	1 - 50 mg/kg / U = 2 - 6 (%)	Neutron Activation Analysis	Giancarlo D'Agostino g.dagostino@inrim.it Marco Di Luzio m.diluzio@inrim.it	B
QM.11.1-a3	Elemental analysis for the determination of elements in matrix	500 - 10000 mg/kg	Measurand: Iron il aluminum alloy	500 - 10000 mg/kg / U = 3.0 - 5.0 (%)	Neutron Activation Analysis	Giancarlo D'Agostino g.dagostino@inrim.it Marco Di Luzio m.diluzio@inrim.it	A
QM.11.1-a4	Elemental analysis for the determination of elements in matrix <i>Field not CIPM MRA covered:</i> CPM MRA 200 - 2000 mg/kg CPM no MRA 2000 - 10000 mg/kg	200 - 2000 mg/kg (CIPM-MRA); 2000 - 10000 mg/kg (no CIPM MRA)	Measurand: Chromium in aluminum alloy	200 - 10000 mg/kg / U = 2.0 - 4.0 (%)	Neutron Activation Analysis	Giancarlo D'Agostino g.dagostino@inrim.it Marco Di Luzio m.diluzio@inrim.it	B

QM Chemistry and biology							
SERVICE CODE	SERVICE NAME	RANGE	DEVICE UNDER CALIBRATION	UNCERTAINTY	METHOD	CONTACT PERSON CMC	
QM.11.1-a5	Elemental analysis for the determination of elements in matrix <i>Field not CIPM MRA covered:</i> CPM MRA 100 - 2000 mg/kg CPM no MRA 2000 - 10000 mg/kg	100 - 2000 mg/kg (CIPM-MRA); 2000 - 10000 mg/kg (no CIPM MRA)	Measurand: Manganese in aluminum alloy	100 - 10000 mg/kg / U = 2.4 - 3.5 (%)	Neutron Activation Analysis	Giancarlo D'Agostino g.dagostino@inrim.it Marco Di Luzio m.diluzio@inrim.it	B
QM.11.1-a6	Elemental analysis for the determination of elements in matrix	100 - 1000 mg/kg	Measurand: Chromium in polypropylene	100 - 1000 mg/kg / U = 1.6 - 1.8 (%)	Neutron Activation Analysis	Giancarlo D'Agostino g.dagostino@inrim.it Marco Di Luzio m.diluzio@inrim.it	A
QM.11.1-a7	Elemental analysis for the determination of elements in matrix	10 - 100 mg/kg (CIPM-MRA)	Measurand: Cadmium in Polypropylene	10 - 100 mg/kg / U = 1.8 - 2.4 (%)	Neutron Activation Analysis	Giancarlo D'Agostino g.dagostino@inrim.it Marco Di Luzio m.diluzio@inrim.it	A
QM.11.1-a8	Certification of matrix reference materials for the determination of elements	20 mg/kg - 1 g/kg (Matrix reference material for the determination of Cerium mass fraction in soils	20 - 1000 mg/kg / U = 0.6 - 10 (%)	Instrumental neutron activation analysis	Giancarlo D'Agostino g.dagostino@inrim.it Marco Di Luzio m.diluzio@inrim.it	C

SUPPLY CONDITIONS

Enquiries concerning the activities described in this catalogue may be addressed to the names in the "contact person" column. In contrast, questions concerning activities not included in the catalogue or enquiries involving several activities may be made to the customer service department (customerservice@inrim.it).

MODES OF EXECUTION OF ACTIVITIES

PRODUCTS AND SERVICES.

The products of the activities are reserved for the Customer and refer exclusively to these, and the objects described and specified in any documents issued. The activity results are valid only for the device on which they were obtained under the conditions of execution of the activity.

SUPPLY OFFER.

The amounts indicated in INRiM's offer refer only to the supply described, supplied under the terms and conditions specified therein; the offer also specifies its temporal validity. Unless otherwise specified, any additional costs (customs clearance, insurance, issuance of documents in another language, etc.) are not included and are charged on completion.

ORDER.

The execution of activities is subject to the receipt and acceptance by INRiM of a written order. The order must mention INRiM's supply offer, acceptance of its conditions in full and contain the necessary data for invoicing. The work order must be received within the validity period of the offer and, in any case, before the start of the activity.

CUSTOMER SUPPORT AND COOPERATION.

Support and cooperation are provided at the simple verbal request of users at any time during the activity and, where possible, as well at the end of the activity.

EXECUTION/SUSPENSION OF THE ACTIVITY.

The Customer acknowledges INRiM's competence in assessing the efficiency status of the device received and the real possibility of performing the requested activities. If the device received has different characteristics from those foreseen and/or specified in the offer, such as modifying the cost of the activity, the Customer will be notified in writing of the need to change the order. If the device under examination reveals defects such as jeopardising its execution during the activity, the execution may be suspended at the sole discretion of INRiM. In this case, a document will be issued stating the reasons of the suspension and the work performed will be invoiced.

PAYMENT TERMS AND DOCUMENTS DELIVERY.

PAYMENT TERMS:

For foreign customers payment shall be made by bank transfer 30 days from the end of the month following the invoice date.

Wire transfer:

Banco BPM SpA – Agency 1070

Piazza San Carlo, Via XX Settembre, 42 - 10121 Torino, Italy

IBAN code: IT44H0503401000000000032872

Account. no. 000000032872

SWIFT (BIC) code: BAPPIT21A70

Additional information: <https://trasparenza.inrim.it/it/home/pagamenti-dellamministrazione/iban-e-pagamenti-informatici>

DOCUMENTS DELIVERY:

- 1) Customers with accounts in good standing or new customers: documents will be delivered after verification of previous payments.
- 2) Customers with outstanding payments: documents will be delivered only after settlement of all outstanding invoices.
- 3) Foreign customers: documents will be delivered upon receipt of payment for the invoice.

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Certified E-Mail: inrim@pec.it

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