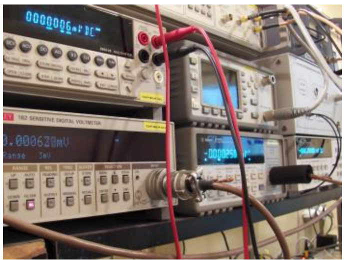
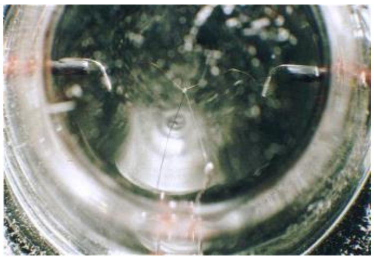
Instituto Português da Qualidade
PORTUGUESE INSTITUTE FOR QUALITY

LNM

FIELD OF ACTIVITY





The Electricity Laboratory has the mission to materialize, maintain and disseminate the units of DC Voltage and Current, DC Resistance, AC Voltage and Current and Impedance, as well as the development and implementation of new methods and measurement capabilities.
In the frame of its activities has as its main concerns:

- Assure the traceability of electrical units allowing its dissemination in a national level;
- Participate and coordinate I&D and EURAMET projects and interlaboratory comparisons;
- Support technically the legal metrology.

SI UNIT

International System Base Unit of Electricity:

ampere (A) defined as:

The **ampere** is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2 x 10^{-7} newton per metre of length (9th CGPM de 1948 – Resolution 2).

Derived Units

Potential difference	volt (V)	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$
Resistance	ohm (Ω)	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
Capacitance	farad (F)	$m^{-2} \cdot kg^{-1} \cdot s^4 \cdot A^2$
Inductance	henry (H)	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-2}$

TRACEABILITY

DC Voltage and Josephson Effect

The DC voltage unity is reproduced by the Josephson Effect experimental system which allows the materialization of the volt as an intrinsic standard, only dependent on the fundamental constants. The implemented system is based on Josephson arrays and uses the accepted international value of the Josephson constant K_{J-90} = 483 597,9 ± 0,2 GHz·V^{-1} with the capability to generate values until 10 V.

DC Resistance and Quantum Hall Effect

DC resistance national unity is maintained by a group of standard resistors with nominal value of 1 Ω and 10 kΩ, which traceability is obtained by interlaboratoty comparisons, performed with BIPM.

The quantum Hall effect implementation allows the materialization of the resistance unity in terms of an intrinsic standard allowing the determination of the instability and drift with time of the conventional standards and the unity value in the SI and to obtain the traceability to the National Standards using the adopted value to the *von Klitzing* constant, $R_{K-90} = h/e^2$ = 25 812,807 Ω.

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TRACEABILITY

AC Voltage and Current - AC-DC Transfer

The AC voltage and current measurements at the low frequency range (until 1 MHz) are based on the use of AC-DC transfer devices, ideally, with the same behaviour on AC and DC. The deviation from the ideal model is defined as a so-called AC-DC transfer difference:

$$\delta_i = \frac{I_f - I_0}{I_0}\ ;\ \delta_u = \frac{U_f - U_0}{U_0}$$

It is usually expressed as a relative value and considered as positive if the AC component is higher than the DC reference value. Sets of multi-junction thermal converters associated with resistors and shunts are the national base of AC Voltage and Current measurements.

Impedance

Capacitance: The national reference of Capacitance is based on high precision standard-capacitors, which values are traceable to BIPM, on a bi-annual scheme. It is available a calibration service for Standard-Capacitors with dielectric of several materials, including fused-silica, dry-nitrogen, air and mica.

Inductance: The national base for Inductance measurements (the Henry and its submultiples) uses as reference a group of standard-inductors, calibrated with an automatic bridge and assuring reduced uncertainties.

AVAILABLE SERVICES

Calibration

EQUIPMENTS	RANGE	UNCERTAINTY
Solid State Voltage Standard	1 V - 10 V	0.1 - 1.5 µV/V
Calibrators	1 mV - 10 V	3 - 50 µV/V
	10 V - 1000 V	3 - 5 µV/V
Nanovoltmeters, Voltmeters	1 mV - 1000 V	3 - 50 µV/V
Resistive Dividers	0,1 - 1	$3{,}0 \cdot 10^{-6}$
Standard-Resistors	0,01 mΩ - 10 mΩ	10 µΩ/Ω - 5 µΩ/Ω
	0,1 Ω	2 µΩ/Ω
	1 Ω and 10 kΩ	1,2 µΩ/Ω
	10 Ω - 100 kΩ	1,5 µΩ/Ω - 2 µΩ/Ω
	0,1 MΩ - 1 MΩ	2 µΩ/Ω - 10 µΩ/Ω
	1 MΩ - 10 MΩ	10 µΩ/Ω - 100 µΩ/Ω
	10 MΩ - 100 MΩ	100 µΩ/Ω
	0,1 GΩ - 100 TΩ	1 mΩ/Ω - 10 mΩ/Ω
Standard-Capacitors	1 pF - 1 nF	10 µF/F
	1 pF - 1 µF	100 µF/F
AC-DC Transfer Standards: Thermal Converters	(1 V - 5 V); (10 Hz - 1 MHz)	3 µV/V - 67 µV/V
	(5 V - 1000 V); (10 Hz - 1 MHz)	6 µV/V - 103 µV/V
AC-DC Transfer Standards plus Shunts	(0,005 A - 20 A); (10 Hz - 100 kHz)	20 µA/A - 130 µA/A

CIPM MRA

CONTACTS

PORTUGUESE INSTITUTE FOR QUALITY **(Portuguese Institute for Quality)**

Rua António Gião, 2 , PT-2829-513 Caparica

ELECTRICITY LABORATORY
Luís Ribeiro
Tel +351 212 948 161 E-mail: lribeiro@ipq.pt

DC Resistance
Vitor Cabral
Tel +351 212 948 389 E-mail: vcabral@ipq.pt