

Use of a 100 M Ω step Hamon resistor for calibration of pico-ammeters in DC current in the range 100 pA \div 100 nA



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Abstract- The poster describes a measurement circuit for the pico-ammeters calibration in the range 100 pA \div 100 nA, based on a 100 M Ω Hamon network developed at INRiM. The 100 M Ω Hamon network involved in this project was originally developed to improve the traceability level of 1 GW standard. The measurement system consists, besides the Hamon network, of a precision dc voltage source and an electronic circuit used as voltage guard driver. Considerations about the Hamon network, a scheme of the calibration circuit and the uncertainties budget of the calibration method are shown in detail on the poster.

The measurement method

The Hamon network is made up of ten resistors with a nominal value of 100 M Ω with low temperature and voltage coefficients. The resistors are connected in series in a structure that works as a support also for the coaxial connectors. The main resistor network is **guarded** by means of an of ten auxiliary resistors each one with a nominal value of 10 M Ω .

Before the use, the Hamon resistor is calibrated in parallel configuration (10 M Ω) by comparison with a 10 M Ω standard using a high precision DMM.

Then a high precision dc voltage source is applied to the Hamon resistor in series configuration (1 G Ω), in order to form the current source, and to the input of the guarding system. The output of the resistor is connected to the pico-ammeter under calibration through the guard driver circuit and a coaxial adapter. The driver sets the voltage of the low side of the Hamon guard circuit. The common terminal of the pico-ammeter is connected to the low output of the voltage source. The temperature inside the device is monitored by a NTC probe and a 6^{1/2} digits DMM.

The Hamon network

Internal view of the Hamon network. The main resistors are provided of a guarding system to reduce the leakage current

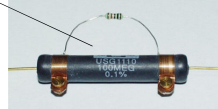


The series-parallel change of configuration is made by means of a servocontrol that moves the set of electrical contacts.

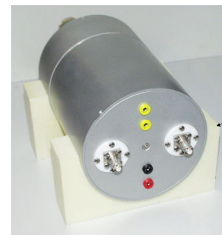
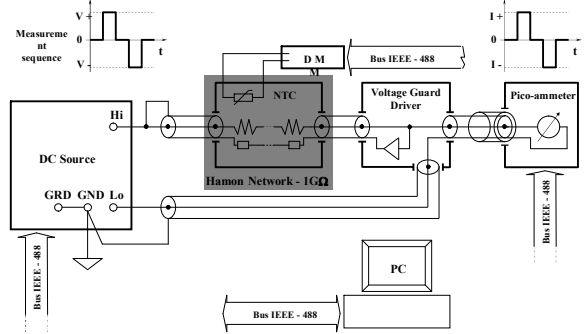


All the connectors are coaxial ones with their shield connected to the guarding system

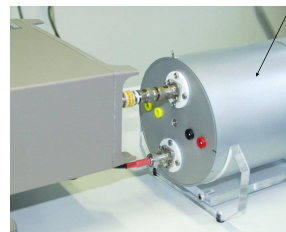
The main resistors, 10 x 100 M Ω Caddock type, are always connected in series



The measurement circuit



The Hamon network is placed inside a cylindrical box which contains also the guarding resistors and the servocontrol to perform the parallel connection.



The device is directly connected to the input of the pico-ammeter under calibration in order to minimize the leakage current, triboelectric effects and electromagnetic noise.

Uncertainty budget

Main **uncertainty components** of the method:

- calibration of the Hamon standard in parallel configuration;
- short time instability of the standard;
- temperature and voltage effects on the resistor;
- effects due to voltage burden;
- calibration of the dc voltage source;
- accuracy specifications of the voltage source.

Range	100 pA	1 nA	10 nA	100 nA
$U(2\sigma)$	$4,2 \cdot 10^{-4}$	$4,7 \cdot 10^{-5}$	$1,9 \cdot 10^{-5}$	$2,1 \cdot 10^{-5}$

Comparison with a different method

The described system has been compared with a method based on the charge and discharge of a gas-dielectric capacitor.

Positive G+ and negative G- instrument gain measured with the two methods. The **agreement** resulted **better than $4 \cdot 10^{-5}$** .

