Integrated circuit configured to operate in the quantum hall effect regime for obtaining a predetermined standard of resistance

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Invention

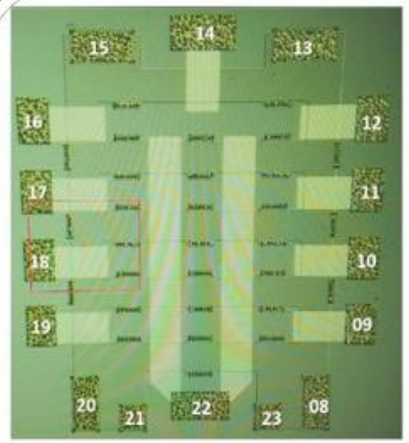
The proposed **electronic circuit exploits the quantum Hall effect and mainly aims to obtain a resistance standard**, particularly for the calibration of different electronic devices.

The quantum Hall effect is widely used as a metrological standard for electrical certifications and calibrations, due to the extreme accuracy with which the quantization of transverse resistance is experimentally achieved.

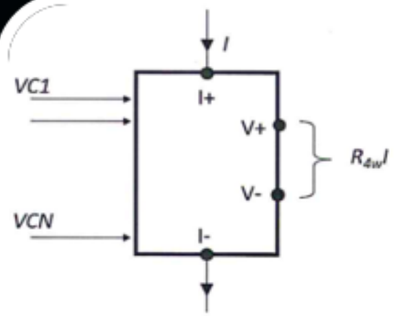
The invention has been shown to provide a **resistance standard in a highly accurate manner** that does not result in spurious potential drops due to the presence of internal current-carrying contacts. It is further contemplated that the obtained resistance standard is **easily reconfigurable** such that different voltage values can be obtained, and different resistance values are derived, without compromising the accuracy of the measurement.

CNR - CONSIGLIO NAZIONALE DELLE RICERCHE is also a patent applicant.

Drawings & pictures



First feasibility studies for prototypes for metrological validation of individual circuit elements and demonstration of scalability up to 4 stages of bisection.



Industrial applications

The invention is applicable to the **Electronics and Telecommunications industry** and more specifically to the field of **Electrical Metrology**.

Various techniques have been used to obtain resistance quanta of arbitrary values, to allow direct calibration of resistors of different sizes and to meet the calibration requirements of the market. In particular, several integrated circuit architectures consisting of quantum Hall elements, known as QHARS "Quantum Hall Array Resistance Standards", have been proposed, allowing integer fractions of the von Klitzing constant RK to be obtained. However, QHARS have several drawbacks. Firstly, the number of circuit elements required to obtain the desired resistance value with a certain accuracy does not scale favorably. In addition, QHARS include 5 various interconnections with ohmic contacts traversed by finite currents. For this reason, QHARS are affected by systematic errors due to spurious potential drops occurring at the ohmic contacts. Therefore, QHARS have important practical limitations for the realization of a metrological level sample. In addition to the above, QHARS are non-configurable structures; therefore, a dedicated circuit must be built to provide a certain amount of resistance.

The proposed invention is characterized instead by:

- **absence of any ohmic contact** causing spurious resistances;
- possibility of **logarithmically scaling up** the complexity of the circuit;
- an obvious "cost" of the proposed approach, consisting in the use of a large number of field-effect gate electrodes.

Possible developments

The invention relates to the construction of an electronic circuit for:

- the creation of **new calibration standards based on quantum metrology**, given their level of refinement;
- the creation of **electrical resistance standards** which, in combination with other elements such as the Josephson effect in superconducting junctions, enable the calibration of voltages, capacitances and various electrical properties of devices;
- the production of **reconfigurable resistance standards** that can reproduce a large number of resistance values with metrological-level accuracy;
- the use in **"primary" calibrations** that are confined to various private companies;
- the certification of the **linearity of an electrical system with great precision**; an obvious example would be analogue-to-digital converters which are used in a variety of circumstances, and which often have to guarantee a certain degree of linearity.

In view of the further tests to be carried out and the progress of technological development in terms of TRL, it is certainly desirable to directly involve industrial partners who are interested in validating the invention beyond the current one.

Companies potentially interested in the proposed technology could be electronic instrumentation manufacturers as well as organizations providing electrical calibration services.

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