NEW GROUP RESISTANCE STANDARDS

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Abstract

The standards are based on the groups of metal-foil resistors connected by four-terminal junctions. Their values are choosen approximately in the middle of the range where the most accurate measurements are made in practice. In manufacturing, the connection error is reduced by the method of virtual currents. The stability of resistors determines the value of standards with an error of about 0.02 ppm during 6 months between their measurements using the QHR. The new 1 Ohm group standard may be used for direct link between the voltage of 1 V and the current of 1 A.

Introduction

For maintenance the Ohm size between the QHR measurements, the system of group standards on the basis of transitive resistance measures [1-3] is the most convenient. Such standards allow to maintain the Ohm size simultaneously at least by three nominal values, they possess all properties of group measures and may be used for achieving the high measurement accuracy at the great load currents.

Up-to-date manufacturing of metal-foil resistors allow to introduce new possibilities in the technological process of creating and investigating these standards [4].

The present papers describes the appropriate theory and preliminary results for realization this concept.

Method of virtual currents and voltages

The main problem in combining a group of four-terminal resistors in parallel is to obtain the connection error below the level of measurement accuracy [1-3]. For this purpose, we used the method of virtual currents.

For analysis we divided each current i_i in n standard resistors on two components: I_i and ΔI_i. Virtual current I_i is the current at the perfect parallel connection when, in ideal case, all products $I_i R_i$ are equal to the virtual measurement voltage U_v. The current ΔI_i is the difference between real current i_i and current I_i.

Since the measurement voltage U_v and total current I must be the same in both cases, it is easy to find the total connection error:

$$\delta R_{||} = \frac{\sum U_R + \sum U_L - (U_1 + U_n)}{nU_v},$$

where U_R and U_L are the real voltage drops on the potential resistors in the right and left arm of the connection circuit.

Analysis of this expression shows the optimal ways to reduce the connection error directly in manufacturing of group standards [4].

Investigations

The group standards MC 3008 (nominal value 100, 800, 6 453 and 12 906 Ohm) and MC 3018 (nominal value 1, 10 and 100 Ohm) were fabricated at the Krasnodar Plant (Russia) on the basis of metal foil resistors [5,6].

Alongside with the Hamon transfer resistance standards, ensuring the ratio n^2, the method of virtual currents was used for investigations of the standards on the basis of dual transition, made of resistors with a various weight factor, that allows to obtain the ratio different from n^2.

The results of investigations allow to make a conclusion that the transition error of about 0.01 ppm is real and in future the transitive measures will be used as group standards for the maintenance of the size of the unit and for direct link between the voltage of 1 V and the current of 1 A.

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