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Abstract

Resistance transfer devices are standards of 1:10 and 1:100 resistance ratios and are used in many laboratories of the National Metrology Institutes. They are used in systems for resistance scaling from the Quantized Hall Resistance Standard (QHR Standard) to the secondary resistance standards. At the Wroclaw University of Science and Technology, as a part of the NCBiR research project, such a system was also developed. The author was a participant in the project. The system provides two paths for the resistance unit transfer in a range from 100 kΩ to 10 TΩ in relation to the QHR Standard, which is in use in The Central Office of Measures (GUM). From 100 MΩ up to 100 TΩ the system consists of guarded high-resistance transfer devices. The use of guarding system in resistance transfer devices is to minimize the insulation leakage currents, which are the main source of resistance ratio errors.

The main purpose of the dissertation was the digital analysis of guarded resistance transfer devices' accuracy. The results of this analysis were used to modernize guarded transfer devices (that were already built for the path I) and to construct new devices for path II.

The analysis were caried out with the use of computer software (Wolfram SystemModeler and Wolfram Mathematica). The most important factors influencing the accuracy of resistance transfer ratios were identified and determined. This allowed to introduce design changes aimed to improve the accuracy of resistance transfers. In particular, insulation leakage was taken into account. A new method of guarding resistors selection has been proposed. The new method minimizes leakage currents more effectively.

The correct values of the resistance ratios of the analyzed transfer devices along with their uncertainties were also determined. For transfers (10-100-1000) MΩ, (0.1-1-10) GΩ, and (1-10-100) GΩ the relative uncertainties are below 10^{-6}, for (0.1-1-10) TΩ transfer - a few times 10^{-6}. The least accurate is (1-10-100) TΩ with a relative uncertainty of a few hundredths %.

The dissertation also presents the results of the calibration of secondary resistance standards in the range from 100 MΩ to 100 TΩ (in this range, guarded transfer devices were used for calibration). The value of the 100 MΩ resistance standard was determined in relation to the QHR standard using a cryogenic comparator and transfers with single insulation. 100

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