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APPLYING MINIMAX APPROXIMATION TO DETERMINE A CALIBRATION LINE OF A MEASURING INSTRUMENT

Dorozhovets M., Kubiszyn P.
Rzeszow, PRz, Poland
Lviv, NULP, Ukraine

The thesis describes the essence of the MINIMAX method for determining the calibration line of the measuring instuments and also sensors, including examines the characteristics of the calibration line obtained in this way, and compares them with the parameters of the line determined by the least squares method.

The idea of using the MINIMAX method is based on the fact that in estimation theory it is known that if the random observations taken from a population with a uniform distribution are processed, then, using the most commonly used maximum likelihood method of estimation, the parameters of the population should be determined according to the criterion of minimizing the maximum deviation. In particular, the best estimator of the population location parameter (with minimum standard uncertainty) is the midrange of the random sample, and the best width parameter is the half of the range [1]. Therefore, when estimating a line describing the relationship between the input and output values of a measuring instrument, assuming a uniform distribution of possible deviations, this MINIMAX criterion should also be applied.

Beside it, in metrology practice, the MINIMAX criterion is used to describe the metrological properties of measuring instruments. Namely, manufacturers of measuring instruments usually indicate the values of the maximum permissible error (MPE). The GUM Guidelines [2] clearly state that in the absence of knowledge about the probability distribution of possible deviations of the measuring instrument readings, a uniform distribution in the range ± MPE should be used.

This article provides a description of the MINIMAX approximation procedure in detail. And also gives two examples of determining the calibration line based on the primary calibration data (obtained in licensed LABBiKAL laboratory, PRz, Poland) of a multimeter Fluke 8845A in the DC and AC voltage measurement modes, as well as the sensor. A comparison of the results obtained using MINIMAX with the results obtained using the traditional least squares method is provided.

Analysis of the results showed that, although the least squares method is the most suitable for calculating the parameters of the calibration function, it does not always provide a completely correct determination of the MPE limits of the calibrated measuring instrument. In particular, a few experimental points can often exceed the extended uncertainty limits.

In contrast, the MINIMAX in this respect much better reflects the calibration line along with the limits of possible deviations of experimental points from this line.

References

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