Ensuring the validity of measurement results through the use of triangulation rules

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1 Introduction

Measurement results are critical in various industries, including healthcare, aerospace, and manufacturing. Inaccurate measurements can lead to severe consequences, such as faulty medical diagnoses, airplane crashes, and defective products. Therefore, it is essential to ensure the validity of measurement results to maintain the integrity and reliability of measurements.

The ISO/IEC 17025 standard provides guidelines for laboratories to ensure the validity of measurement results. This standard specifies requirements for the competence, impartiality, and consistent operation of laboratories [ISO/CASCO(2017)]. It outlines the procedures for testing, calibration, and sampling that laboratories must follow to produce reliable measurement results.

To comply with the ISO/IEC 17025 standard, laboratories must demonstrate the validity of their measurement results. They can achieve this by using the triangulation rules, which involves using multiple methods or instruments to measure the same quantity. By comparing the results of multiple measurements, laboratories can identify any discrepancies.

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2 The triangulation rules

The proposed triangulation tool consists of performing the calibration of a certain equipment using different traceability chains related to each other. The proposed tool is indicated, for example, for measurements involving ratios, such as the calibration of high standard resistors by means of a Dual Source High Resistance Ratio Bridge.

The triangulation tool can help laboratories guarantee the validity of their measurement results by providing a systematic approach to calibration. The tool can also help laboratories identify and correct measurement errors and improve the accuracy and precision of their measurements.

To demonstrate the robustness of the presented tool, several tests were conducted to evaluate its performance. The tests involved simulations using Monte Carlo method. The results showed that the triangulation tool was suitable for detecting inconsistencies in the measurement and therefore for ensuring the validity of the results.

This tool can be used as a statistical technique to compare results obtained by different methods, different standards, or a combination thereof, and is used in conjunction with monitoring results. The methods used to guarantee the validity of the results, such as retesting or recalibration of retained items, use of calibrated alternative instrumentation to provide traceable results, intralaboratory comparisons, replicated tests or calibrations, using the same methods or different methods, among others, should have the application of statistical techniques for analysis whenever practicable [ISO/CASCO(2017)].

An application example of the triangulation tool includes the calibration of high value resistors [Mihai(2022b), Mihai(2022a)], where the limited availability of measurement methods prevents a comparison using different methods. In this case, the tool provides a possibility to increase confidence in the functioning of the measurement system even if it is not possible to use different methods. Next, the theoretical background and real examples carried out in the laboratory and tests, even as simulations are shown to demonstrate the use of the proposed tool.

3 Examples and performed tests

When determining a resistance value using different ratios, one can use resistors of different resistance values and compare them all. In this way, there are different traceability chains related to each other. You can then compare three resistors of different values $A = 1$, $B = 1$, and $C = 10$, where the ratios between each pair would be $R_{ab} = 1$, $R_{ac} = 0.1$ and $R_{cb} = 10$, and $R_{ab} = R_{cb} \times R_{ac}$. Each ratio has its associated uncertainty. In the case where only one pair is analyzed, if the values are incompatible, that is, with the difference greater than the limit, there is no indication of which of the two resistors could have been the origin of the problem. When analyzing the different pairs, one can indicate which resistor has a problem or which

measurement needs to be revised, which helps the user in detecting discrepancies, and provides an indication of the validity of the measurement results.

4 Conclusion

In conclusion, ensuring the validity of measurement results is critical for maintaining the integrity and reliability of measurements. Compliance with the ISO/IEC 17025 standard is essential for laboratories to achieve this goal. The presented triangulation tool is a reliable and robust approach to testing and calibration that can help laboratories guarantee the validity of their measurement results.

References

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