



Development of an Automated Low-Frequency Calibration System for Healthcare Device Calibration Needs in Indonesia

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Introduction

According to the Regulation of the Minister of Health of the Republic of Indonesia, all medical devices used in healthcare facilities must undergo testing and calibration and 30% of the list are associated with time and frequency measurement units. Calibration of medical devices, particularly those related to low-frequency measurements, poses significant challenges due to the lengthy process involved.

System Overview

The development of a low-frequency calibration system to support the quality assurance of medical devices in Indonesia consists of two components: low-frequency source calibration and low-frequency meter calibration. The frequency source calibration system has been developed by automating the frequency counter as the frequency measurement standard. This system utilizes the automation of the Agilent 53132A Universal Frequency Counter. The Universal Frequency Counter is connected to a computer via a GPIB-USB communication cable and linked to UTC(IDN) as the national time and frequency standard in Indonesia. The system is illustrated in Figure 1.

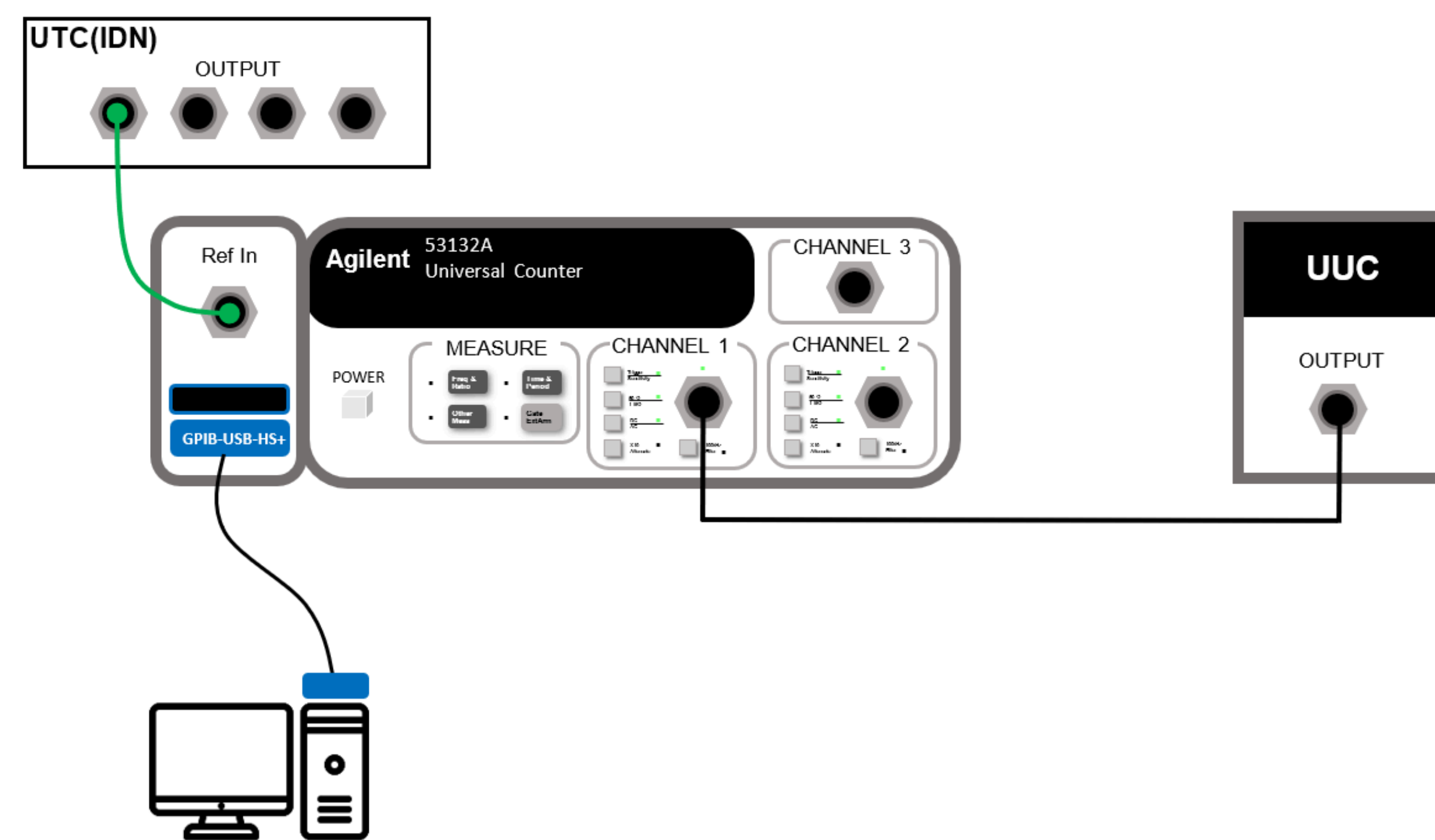


Fig 1. Hardware Diagram of Integrated System

The low-frequency calibration system uses Gate-Time settings adjusted to the measurement points being tested. Each measurement point is measured five times based on the period value of the measurement point. The selected measurement points in this study are 0.01 Hz, 0.1 Hz, 1 Hz, and 10 Hz.

All Universal Counter configurations are automated using the developed software. The developed software communicates with the Universal Frequency Counter via a GPIB-USB cable, and measurement results are recorded in Ms. Excel. The measurement results will be validated by comparing the manually obtained values with those from the automated system. The automated measurement system results will be considered valid when the En Score falls within the range of -1 to 1.

Recent Progress Achieve

The automation software for low-frequency measurements has been developed. The graphical user interface (GUI) of the software is shown in Figure 2.

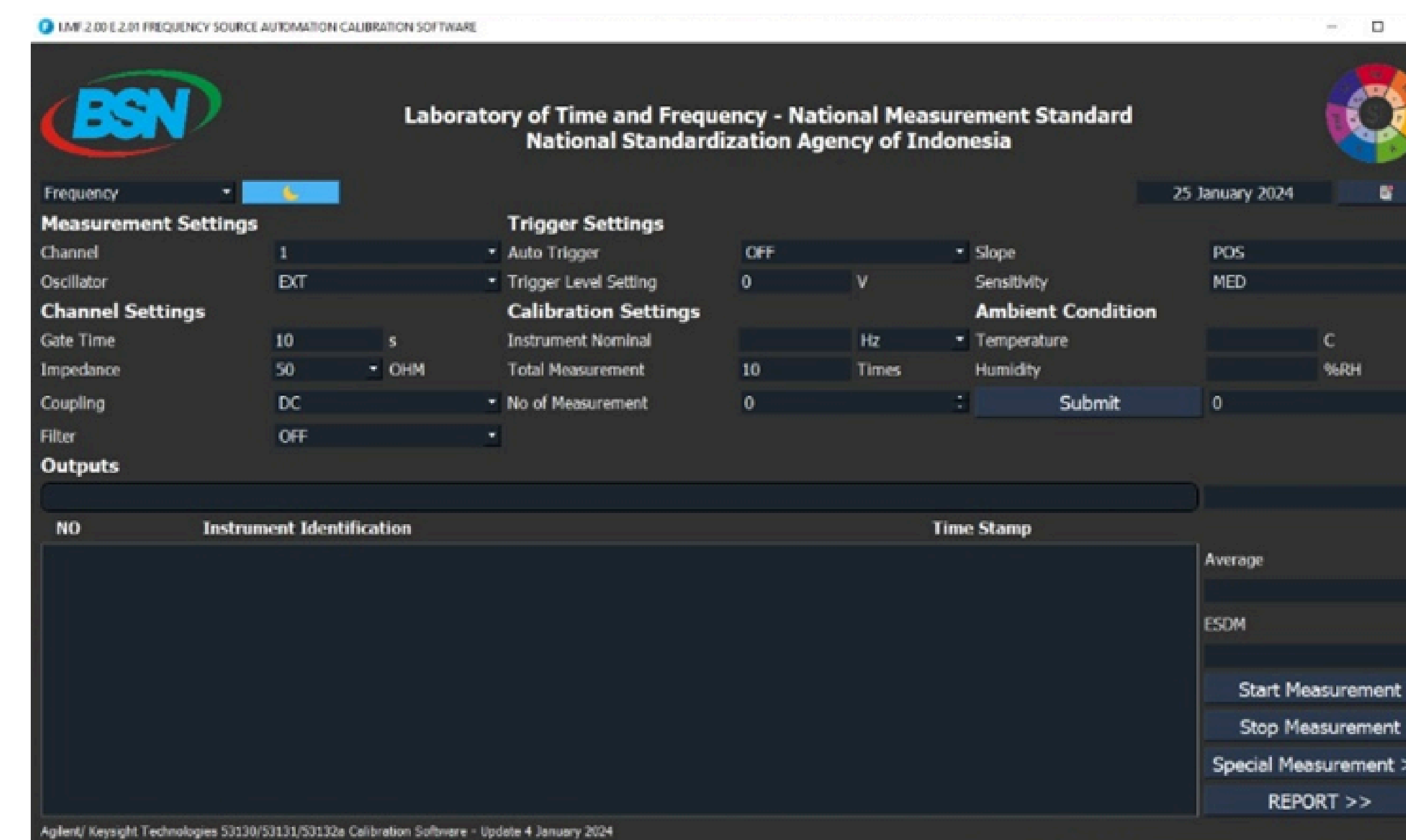


Fig 2. GUI Automated Calibration Software

To verify the validity of the automatic method in comparison to the manual method, En-Score calculations were conducted for both UUCs. The outcomes of these calculations are detailed in Table 1 and 2. These tables provide a comprehensive comparison, illustrating how the semi-automatic method aligns with the manual approach, further supporting its reliability and accuracy.

Table 1. Measurement and Validation Results of first UUC

Measurement Point	Uncertainty (Hz)		En-Score
	Manual	Automated	
0.01 Hz	2.76E-08	1.24E-08	0.23
0.1 Hz	4.49E-07	8.18E-06	0.48
1 Hz	4.20E-06	2.76E-05	0.34
10 Hz	8.40E-06	3.03E-04	0.30

Table 2. Measurement and Validation Results of Second UUC

Measurement Point	Uncertainty (Hz)		En-Score
	Manual	Automated	
0.01 Hz	6.62E-08	7.05E-08	0.20
0.1 Hz	1.55E-07	1.31E-07	0.24
1 Hz	2.25E-07	2.61E-06	0.44
10 Hz	1.30E-05	1.12E-05	0.41

The En-Score values for all measurement points across both UUCs lie within the range of $-1.0 < En < 1.0$, which confirms the validity of the developed automatic method. This consistency underscores the reliability and accuracy of the automatic approach when compared to traditional manual measurements.

Future Development

The next development will focus on a calibration system for low-frequency meters utilizing Optical Character Recognition (OCR) technology. This system is expected to extend beyond low-frequency meters to encompass a broader range of medical devices in Indonesia. Additionally, the development of the Digital Calibration Certificate (DCC) system is being carried out in parallel

Conclusion

An automated measurement system has been successfully developed to meet low-frequency calibration needs. This system simplifies instrument setup, automates data acquisition, and improves measurement resolution. The next phase of development for the low-frequency meter calibration system will soon begin. Simultaneously, a Digital Calibration Certificate (DCC) system will be developed to support all measurement scopes, enhancing efficiency and digital transformation in calibration processes.

Related References

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