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Two-Frequency Ultrasonic System with Direct Digital Frequency Synthesizers and Vernier Caliper Phase Meter for Measuring Air Temperature

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In this article, we present an improved algorithm for two-frequency continuous wave (TFCW) ultrasonic temperature measurement. This method is based on the transmission of a TFCW signal that is generated by two direct digital frequency synthesizers (DDFSs). The phase shift between the transmitted and received signals is measured using a vernier caliper phase meter (VCPM). The phase shift data is recorded to determine the ultrasound speed. The changes in the ultrasound speed are then calculated and used to determine the average temperature of bulk air. In a temperature-controlled chamber, two 40±2 kHz ultrasonic transducers are placed face to face with a fixed distance between them. The DDFS algorithm is programmed into a single-chip microprocessor to generate highly accurate TFCW signals for temperature measurement. Experimental results show that the proposed measurement system reaches a high accuracy of ±0.2°C within a temperature range from 0 to 80°C, with a resolution of 0.01%. The main advantages of this ultrasonic temperature measurement system (UTMS) include high accuracy, high resolution, low cost, and ease of implementation.

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