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TWO-PROBE IMPLEMENTATION OF MICROWAVE INTERFEROMETRY FOR MOTION SENSING AND COMPLEX REFLECTION COEFFICIENT MEASUREMENT

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This paper presents the results of the investigations into microwave probe measurements conducted at the Department for Functional Elements of Control Systems of the Institute of Technical Mechanics of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine over the past five years. These investigations resulted in a two-probe implementation of microwave interferometry that allows one to measure both the displacement of a mechanical object and the complex reflection coefficient of a material specimen. Reducing the number of probes from three (the conventional case) to two simplifies the design and manufacture of the waveguide section and alleviates the problem of interprobe interference. The possibility of using as few as two probes is demonstrated by analyzing the roots of the equation that relates the magnitude of the unknown complex reflection coefficient to the currents of the semiconductor detectors connected to the probes. The analysis shows that, theoretically, the displacement is determined exactly for reflection coefficient magnitudes no greater than the inverse of the square root of two and to a worst-case accuracy of about 4.4 % of the free-space operating wavelength in the general case and gives conditions under which the complex reflection coefficient is unambiguously determined from the detector currents. As shown by experiments, at an operating wavelength of 3 cm, a target double amplitude of 10 cm and 15 cm, and a target vibration frequency of about 2 Hz the proposed displacement measurement method allows one to determine the instantaneous target displacement with a maximum error of about 3 mm and an average error of about 1 mm without any preprocessing of the measured data, such as filtering, smoothing, etc. The results presented in this paper may be used in the development of microwave displacement sensors and vector reflectometers.

Keywords: *complex reflection coefficient, displacement, electrical probe, microwave interferometry, semiconductor detector, waveguide section.*

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