Characterization of Dielectric Substrate Material Using Fork Resonators

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The high frequency dielectric characterization of materials can be performed using stripline resonator techniques. The materials of interest are used as substrates on which stripline resonators with specified lengths are fabricated. Measuring the resonant frequency and the *Q* factor of a resonator, one is able to determine the real and imaginary parts of the complex dielectric constant of the substrate material. The stripline resonator technique is particularly useful because microwave integrated circuits are commonly constructed using striplines on dielectric substrates. Thus, this technique allows measurement of the dielectric properties of materials as they are used in actual substrate forms. Here, a new microstrip resonator with fork shape feeders for coupling energy in and out of the resonator is proposed for high frequency dielectric characterization of materials. The performance of this resonator is compared with that of a stripline resonator with overlap feeders.

The stripline resonators require multilayer structures and the coupling from the input feeder to the resonant segment and from the resonant segment to the output feeder can be adjusted by controlling the amount of overlap between the feeder segment and the stripline resonator. As the thickness of the substrate become very small, manufacturing these resonators become more difficult and less accurate. In this paper a microstrip fork resonator is introduced to enhance the coupling efficiency and allow for single layer characterization with no adhesive material or multi layer requirements. Measurements of several dielectric materials are performed using the proposed microstrip fork resonator. From these measurements, resonant frequencies and Q factors are directly obtained. Then, a numerical simulation is performed to determine the effective resonant length. The real and imaginary parts of the dielectric constant for the substrate material are calculated using the measured data and the relationships that model a microstrip resonator based on quasi-TEM approximations. Results for the real and imaginary parts of tested materials are presented for a frequency range of 0.5-4.0 GHz.

The satisfactory results obtained from the fork resonator measurements and the easier manufacturing process of these resonators enhance the motivation for using the fork resonator technique in future high frequency characterization of materials.