Dielectric characterization of FR4 substrate using antenna resonance frequency technique

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Abstract

Dielectric constant () and loss tangent () of a laminate are required parameter to design RF and microwave circuits. The most commonly used laminates for RF is Rogers, which are very costly for commercial use. A cheaper alternative that has a stable dielectric property is Isola. There are many available dielectric substrates which can be chosen depending on applications and cost factor. In commercial environment, the cost is a major driving factor for laminate selection and hence regular FR4 glass epoxy laminate is used. This is one of the cheapest available materials and also very common with commercial PCB designer’s. The major issue in using regular FR4 glass epoxy material in RF and microwave frequencies is the lack of accurate dielectric constant and loss tangent. Datasheets provided by various manufactures provide dielectric constant at 1 MHz or 10 MHz which makes it un-useable at RF and microwave frequencies. It is essential for circuit designers to characterize the material before using it in their design. This paper presents a technique to measure dielectric constant of the fibre glass FR4 laminate accurately at desired frequency using antenna resonance frequency method. With this method FR4 substrate is characterized at 1.9 GHz & 2.5 GHz with ±1.5% and ±0.15% accuracy respectively.

Keywords: Antenna, Substrate Dielectric, Dielectric Constant Measurement, Resonance Frequency Method.

1.

2. Introduction

Dielectric constant () and loss tangent () are required parameters to characterize and design RF and microwave circuits. To achieve the perfect 50Ω microstrip or strip line impedance, an accurate value