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Filtenna Designed with Defected Ground Structure (DGS) for Ultra-wideband Applications

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ABSTRACT

In microwave imaging applications, filter and antenna are the key components as front-end devices and function independently. Antenna radiates and receives signals to or from nearby scattered objects while filter is used to suppress unwanted signals noise before and after the required bandwidth. Current antennas suffer from high loss, bandwidth limitation and impedance mismatch and deteriorate their performance near the band-edges if connected as a stand-alone device. Due to the current trend towards simplicity and size reduction, researchers are focusing on integrating the filter and antenna into a single module called integrated filter-antenna (IFA) or filtering antenna (filtenna). These would improve the noise performance of the system and pre-filtering requirements such as complexity algorithm in inverse scattering techniques This paper introduces a novel contribution in the field of UWB antenna design by incorporating Defected Ground Structure (DGS) on both the antenna and filter. Thus, the main aim of this research is to conduct detail parametric studies of the proposed integrated filter-antenna with defected ground structure (DGS) to enhance the performance of imaging system. The proposed IFA will be analysed on Rogers RO4003C dielectric substrate by using EM tool, Computer Simulation Technology (CST) and measured using R&S Vector Network Analyzer (VNA). A compact ultra-wideband (UWB) filter and UWB elliptical antenna are designed and examined in detail before combining the devices. Different types of DGS are designed and act as the ground layer of the proposed filtering antenna. The bandwidth of each design is then compared with and without the existence of DGS. The results show that the proposed IFA with DGS implementation achieve the targeted objective, with compact size, enhanced bandwidth and better performance compared to the conventional design of filter and antenna. By integrating filter and antenna into one subsystem, it can help to reduce the loss and enhancing the bandwidth of the system thus letting the antenna to operate at more different frequencies that fall within the range. Both simulated and measured results prove that by integrating filter and antenna into one module, a low loss and larger bandwidth can be accomplished. High performance compact IFA can act as microwave transceiver to improve the overall performance of the microwave imaging system, MIS.

Keywords: Integrated Filter-Antenna (IFA) or Filtering Antenna (filtenna), Defected Ground Structure (DGS), Ultra-wideband (UWB), Rogers RO4003C dielectric substrate, Computer Simulation Technology (CST), R&S Vector Network Analyzer (VNA).

INTRODUCTION

In the past two decades, Microwave Imaging System (MIS) has been studied as a novel imaging and diagnostic approach for breast cancer diagnosis. Several early clinical tests on a modest scale have clearly demonstrated the technology's promise, while also showing considerable remaining obstacles. MIS is also acknowledged as a viable alternative (or complement) to existing medical imaging methods such as X-ray, ultrasonic, and magnetic resonance imaging, several technological hurdles must be resolved (Commission, 2002).

Recently, ultra-wideband (UWB) technology has shown great attention due to the potential in the development of modern wireless communication systems. Since early February 2002, the US Federal Communication Commission (FCC) has permitted the unlicensed use of the ultrawideband (3.1-10.6 GHz) frequency spectrum for indoor and