Chapter 4
Compact Printed Antenna With Loaded and Etched Bandstop Resonators: Applications in UWB Spectrum

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ABSTRACT

In this chapter, band stop-embedded structures using half-wavelength circular and quarter wavelength straight open-ended slots and split ring resonators are presented and discussed. Simulation and measured results of some efficient applications in the UWB spectrum reported in the literature are discussed. We started by presenting the main research studies results dealing with a systemic design of embedded slots used to inhibit interferences in the UWB spectrum with narrow band systems. Then, we presented an overview of bandstop/bandpass structures using SRRs coupled to a coplanar waveguide, loaded near the feed line, and slotted on the patch antenna. Systemic designs reported in the literature followed by the main results proving the efficiency of these structures have been presented and discussed.

INTRODUCTION

Ultra-wideband (UWB) products have been reached the marketplace. This transmission system offers capabilities for short-range communications, ground and object penetrating radar, vehicular radar, security systems and measurement applications. The authors of Hayouni et al. (2011, 2012, 2014, 2015, 2017), Gao et al. (2013), and Hedfi et al. (2014) discuss in their research various UWB monopole antenna designs adopting several techniques widely used for omnidirectional radiation. However, there is a risk

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of possible electromagnetic interferences (EMI), as over the allocated spectrum 3.1-10.6 GHz awarded by the Federal Communication Commission (FCC) in 2002. This EMI problem happened due to the existing of narrowband communication systems, such as the world interoperability for microwave access WiMAX that operates in 3.3-3.7 GHz frequency range, the wireless local area network WLAN that operates in 5.15-5.285 GHz frequency band, and the downlink of X-band satellite communication systems that operates in 7.25-7.75 GHz frequency range. Various techniques are used to inhibit interferences with these narrow bands and have been reported in the literature. Indeed, Damla et al. (2010) discuss in their research transmission enhancement through deep subwavelength apertures using connected split ring resonators. In addition, the authors of hayouni et al (2017) and Kang et al. (2015) have effectively notched the 5.5-GHz WLAN band by using arc-shaped slots inserted in the monopoles. Huang et al. (2015) have notched the 2.4 GHz and 5 GHz bands by adding an inverted U-shaped slit on the patch and two C-shaped strips over the ground plane. The authors of Toktas et al. (2021) have proposed and investigated a UWB antipodal tapered slot antenna with reflectionless bandstop. The proposed antenna uses an integrated absorptive bandstop filter, that is consisting of two quarter-wavelength open-circuit stubs and a 50 Ω resistor, to produce a reflectionless notched band. In addition, Li et al. (2021) proposed a coplanar waveguide (CPW)-fed triple-band flexible antenna operating at 5, 5.8, and 6.6 GHz for wireless local area network (WLAN) and wireless body area network (WBAN) applications. A SRR structure was etched on the same side of the patch. This provides the required bandstop characteristics for the targeted frequency bands, compactness, minimize losses, and backward radiation when used in close proximity to the human body. The proposed flexible antenna provides stable results in terms of performance parameters and specific absorption rate (SAR). Sharma et al. (2022) presented a bandstop characteristic by loading a pair of metamaterials inspired rectangular split ring resonator near the feed line and by etching SRR slots on a radiating patch. Jairath et al. (2021) presented a compact reconfigurable (bandstop/bandpass) and frequency-tunable structure based on S-shaped split-ring resonators (S-SRRs). Indeed, a S-SRR coupled to a coplanar waveguide (CPW) provides a stopband in the transmission characteristic of the line. Abbas et al. (2021) proposed a UWB antenna with a triple-rectangular notch band at 5G, WLAN, and Satellite downlink bands. The 5G and WLAN bands are notched by using a pair of electromagnetic bandgap (EBG) structures while the satellite downlink band is notched by using two split-ring resonators (SRRs). The EBG structure is a metallic conductor loaded on the backside of the radiator which is connected to the patch via a shorting pin.

This chapter is organized as follows. In the first Section, an overview of ultra-wideband industrial applications is presented. Next, measured and simulation results of UWB antennas with quarter and half-wavelength etched slots, using CST Studio Suite, are discussed in Sections 2 and 3. In addition, UWB applications of some proposed bandstop structures with loaded and etched bandstop SRRs, recently reported in the literature, follows in Section 4, and conclusions are drawn in Section 5.

1. ULTRA-WIDEBAND: INDUSTRIAL APPLICATIONS

Ultra-wideband is useful for real time location systems and precision capabilities and low power make it well-suited for radio-frequency sensitive environments, such as hospitals. UWB gained widespread attention for its implementation in Synthetic Aperture Radar (SAR) technology. Due its high-resolution capacity using lower frequencies, UWB SAR was heavily researched for its object-penetration ability. In addition, UWB pulse Doppler radars have also been applied to monitor vital signs of the human body,