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Compact antenna for higher order harmonic reduction using efficient defected ground structure

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Abstract

To suppress higher order harmonic using Inverted 'U' shapes defected ground structure (DGS) with two symmetric inverted 'L' shape stubs is presented here. At first, a study was made on the resonant frequencies of traditional line feed microstrip antenna. An Inset feed with inverted slots is introduced to eliminate all the higher-order modes up to the third harmonics in the WiMAX Band. To get wide-area stopband characteristics, dimensions and position of DGS and stubs are optimized. The proposed DGS area along with the radiated patch is more compact and stable rather than in a few reported articles. This microstrip antenna is designed and perfectly matches the WiMAX frequency band (3.3–3.7 GHz) application while suppressing other frequencies. The proposed inverted 'U' shapes DGS are designed with an equivalent circuit. Finally, the proposed Stub with DGS Antenna (SDA) is fabricated and measured. The proposed structure is verified with measurements and it has satisfactory gain, radiation pattern and reflection coefficient at 3.5 GHz.

1. Introduction

Different harmonics and their higher-order modes are generated by using different nonlinear elements in a circuit. These higher-order modes and harmonics cause other noises in the device, and its performance level decreases. So, these unwanted harmonics and their higher-order modes can be eliminated using different stopbands and low pass filters but it increases the device sizes. Due to the demand for a compact, lightweight transmitter for wireless communication, we try to avoid this technique. To maintain this requirement, the researcher used a different approach for suppression harmonics and their higher-order modes. DGS is a cascading defective configuration for periodic or non-periodic which is etched in the ground plane. The DGS is easy to implement in an antenna that does not need a large area. Researchers take different approaches by controlling the harmonics or suppressing the frequencies of the antenna by using defective ground structures [1–4]. H-shape DGS is used in [5] to reduce the single higher-order harmonic of an antenna and the DGS unit cell acts as a stopband filter. Whereas, in [6] presents a single microstrip patch antenna with a dimensions photonic gap. Harmonics were suppressed by combining two photonic bandgap structures (PBG) and compact microstrip resonant cell (CMRC)2. In [7] indicates, that a simple photonic gap can significantly diminish in radiation pattern between normal and PBG structures. Researchers follow power divider and array structure for harmonic suppression [8–10]. Moreover, the fractional bandwidth will increase and suppress more harmonic with these structures but in terms of circuit design, it will be quite complex. Also, in [11, 12] different types of resonator-based antenna as a compact filter are used to attenuate different frequency bands. Different DGS shapes, like dumbbell shapes used [13] to improve the suppression of harmonics. Whereas in [14], a RF power divider is used for harmonic suppression. For size reduction and harmonic suppression, different DGS structures are also used [15, 16]. A Partial ring shape DGS and dumbbell shape stub in the microstrip line to control up to 3rd harmonic of an antenna, whereas a single harmonic is eliminated by using only stubs [17]. A