A Compact and Simple Prototype CPW-Fed Dual Band Antenna for ISM, Wi-Fi, and WLAN Applications

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***Abstract*— In this paper, a compact, geometrically simple, and low profile CPW fed dual-band antenna is proposed for ISM, WLAN, and Wi-Fi applications. The proposed antenna is embedded on substrate material Roger/RT 5870 with a thickness of 0.79 mm. The overall size antenna is 23 mm × 32 mm. The proposed design consists of a rectangular monopole radiator with a CPW feed line along with slots and two stubs at the top and bottom of the rectangular radiator to improve the performance of the antenna. The antenna is designed and analyzed by using the software tool HFSS (High Frequency Solution Simulator).**

***Keywords*— CPW feed, compact size, ISM, WLAN, dual-band antenna.**

I. Introduction

With each passing day, communication systems are being designed and integrated with the wireless systems at an exponential rate, due to the increased number of users connecting with the internet. The inclusion of wireless communication systems in electronic systems has raised the demand for high-performance antennas along with efficient propagation systems [1]. Antennas with optimal and specific characteristics allow efficient communication between the devices. Coplanar waveguide feed antennas have arisen as a potential candidate for the usage of contemporary communication systems due to their ease of integration with RF circuity [2].

In addition, dual-band antennas have significantly gained recognition to allow communication in two-band spectrums. The band spectrum of 2.45 and 5 GHz is one of the most commonly used spectrums as it is utilized in a number of communication technologies like Bluetooth and Wi-Fi [3]. Therefore, antennas with characteristics of multiband, with a tolerable frequency of guard bands have advantages that are generally not obtained from the ultra-wideband antennas [4].

Several antennas have been presented in the literature for dual-band ISM and WLAN applications [5-9]. In [5], an arrow-like planer monopole patch antenna is presented with dimensions of the 15 mm × 15 mm operating on dual bands. The antenna has the gain of 5 dBi at the operational band spectrum but the reported work has relatively less bandwidth. A multilayered design reported in [6] operates at dual bands of 2.4 GHz and 3.3 GHz. The proposed work has a setback of complex geometry dual to multilayer structure as well as narrow bandwidths of 0.25 GHz and 0.75 GHz.

Another dual-band antenna is reported in [7], operating on the same frequency bands. The setback of the antenna is large and has a complex geometry. In [8], a single-band antipodal antenna is presented. The antenna is capable of operating on a single band, which may limit its operational characteristics. A dual-band antenna in [9] consists of a truncated patch with the dimensions of 30 mm × 17 mm with operational frequencies of 2.45 GHz and 5.65 GHz. The proposed antenna has a very low gain along with negative magnitude (-3.57 dBi).

In the proposed design, a geometrically simple, compact, dual-band, CPW feed and high gain antenna for ISM and WLAN applications. The rest of the papers is divided as follows, section-II presents the designing methodology section-III covers the performance parameters, while the discussion is concluded in section-IV.

II. Proposed Antenna Design

The geometrical configuration of the proposed dual-band Co-Planner Waveguide (CPW) antenna is depicted in Fig. 1. The antenna is designed over the top side of substrate material RT/Roger 5870 with relative permittivity of 2.33, a low loss tangent of 0.0012, and thickness of 0.79 mm. The CPW feeding technique is used with the advantages of low dispersion and simple realization due to etching on one side. The proposed design has an overall dimension of *23 mm* × *32 mm* × *0.79 mm* ($A_1 \times B_1 \times H$). The Electromagnetic solver HFSS (High Frequency Structural Simulator) is used to simulate and design the proposed antenna.

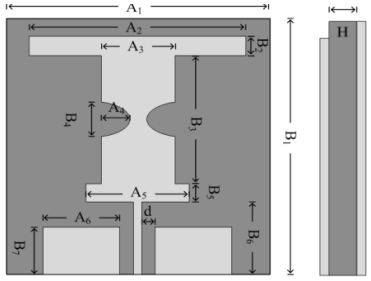

Fig. 1. Front (left) and side (right) views of the proposed CPW feed stub loaded patch antenna. A_1 = 23 mm, A_2 = 21 mm, A_3 = 8 mm, A_4 = 3.5 mm, A_5 = 10 mm, A_6 = 6 mm, B_1 = 32 mm, B_2 = 2 mm, B_3 = 16 mm, B_4 = 4 mm, B_5 = 2 mm, B_6 = 10 mm, B_7 = 5 mm, H = 0.79 mm.

The proposed antenna is obtained after passing through various design steps. Iinitially, a rectangular-shaped quarter-wave monopole antenna is designed for 2.8 and 7.8 GHz, as shown in Fig. 2. Afterwards, a triangular-shaped slot is etched from the middle of both sides of the rectangular patch, which shows shift in higher band (i.e, from 7.8 GHz to 7 GHz) with an improvement in impedance matching. In the third step, a rectangular slot is inserted at the bottom of the patch antenna, which improves impedance matching along with shifting in the second band from 7 GHz to 6.5 GHz. In the final step, another rectangular stub is introduced to the proposed design on the top side of the rectangular patch. Due to this insertion, the first band shift from 2.87 GHz to 2.45 GHz, while the second band shifts from 6.5 GHz to 5.5 GHz.

III. Results and Discussions

Fig. 3 illustrates the reflection coefficient of the proposed CPW fed dual-band patch antenna. It can be observed, that the antenna offers dual bands at the resonance of 2.45 GHz and 5.5 GHz ranging from 2.2 – 2.7 GHz and 5.1 – 7 GHz, respectively for ISM, WLAN, and Wi-Fi bands for modern communication systems. From the figure, it is also clear that the antenna has a return loss of < -22 dB at resonance frequencies.

Fig. 4, represents the radiation pattern of proposed antenna at both resonance frequencies at E and H-plane. It can be observed that antenna offers omni-directional radiation pattern in E-plane ($\phi = 0°$), and bi-directional radiation pattern in H-plane ($\phi = 90°$) for 2.45 GHz. For 5.6 GHz, antenna offers dual beam slightly titled radiation pattern for principal E-plane ($\phi = 0°$) and bi-directional radiation pattern in H-plane ($\phi = 90°$). The numerically calculated value of gain is 2.3 dBi at 2.45 GHz and 3.5 dBi at 5.6 GHz.

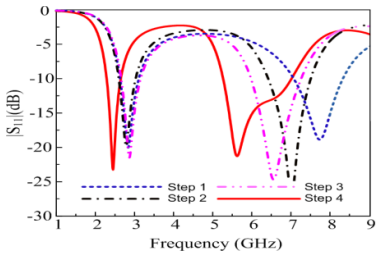

Fig. 2. Various design stages and its impact on $|S_{11}|$ Parameter.

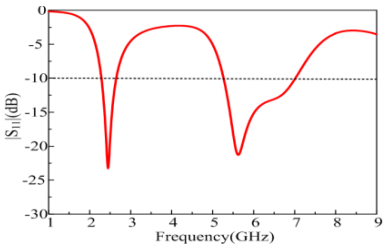

Fig. 3. Reflection Co-efficient of proposed CPW feed dual band antenna.

IV. Conclusion

This paper presents the design and analysis of low profile, geometrically single, CPW feed and dual-band stub loaded patch antenna for ISM/WLAN applications. The antenna offers dual bands at 2.45 GHz and 5.5 GHz with bandwidths ranging from 2.2 – 2.7 GHz and 5.1 – 7 GHz, respectively. Two stubs one between the feedline and rectangular patch, second on the top side of the rectangular patch is introduced in order to optimize the results. Moreover, the proposed antenna over-performed the rest of the work by showing a good combination of compact size, low profile, dual band, along with high gain which makes the proposed work a protentional candidate for future 5G communication in ISM and WLAN applications.

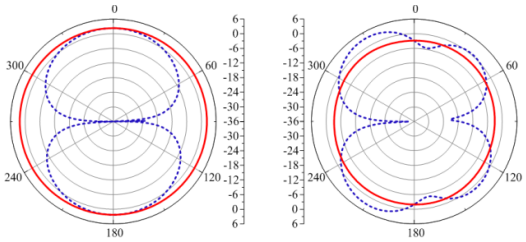

Fig. 4. E-plane (red-line) and H-plane (blue line) radiation patterns of proposed antenna at 2.45 GHz (left side) (b) 5.6 GH (right side).

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