A CPW Loaded Quasi-T Shaped Planar Antenna for WLAN and X-Band Applications

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Abstract

In this paper, a compact, geometrically simple, dual band and high gain coplanar waveguide (CPW) fed antenna for WLAN and X-band is proposed. The antenna is designed on Rogers RT/Duroid 5880 substrate with overall size of 25 mm × 33 mm × 0.79 mm. The proposed antenna consists of circular and rectangular stubs with one rectangular slot. The stubs and slots are introduced in order to achieve the desired bandwidth and high gain. The proposed antenna is designed and analyzed using the electromagnetic (EM) tool HFSS. Moreover, the proposed antenna design is compared to previously published work, and the comparison shows that our proposed antenna is a good candidate for radar applications.

1. Introduction

Antennas and propagation devices provide a communication link between electronic systems [1]. Many designs and feeding techniques have been utilized in designing the antennas. Among various feeding techniques, coplanar waveguide (CPW) fed antennas have arisen as a potential candidate for modern communication systems due to their achievability of wideband characteristics [2]. In addition, this feeding technique allows the reduction of the dimensions of the propagation element and an ability of incorporating lumped elements [3].

The X-band of electromagnetic spectrum, with an approximate frequency range of 7–13 GHz is a promising band for radar applications [4]. Numerous antennas operating in the X-band have been proposed in the literature. In [5], an S-shaped patch antenna with elliptical slots in the ground plane has been presented. The antenna offers 0.45 GHz and 1.010 GHz bandwidth but has a large physical size.

In [6], an antenna with planar and circular slots is presented with total dimensions of 40 mm × 40 mm. The antenna resonates at 10.25 GHz with a gain of 4. 31 dBi with a disadvantage of narrow bandwidth and large dimensions. In [7], a planar patch antenna is proposed with dimensions of 32 mm × 48 mm. The reported design offers three frequency bands, but again, with a disadvantage of narrow bands being 0.18 GHz, 0.56 GHz and 0.36 GHz, respectively. In [8], the authors present a 40 mm × 40 mm antenna operating in X-band with peak gain of 5.01 GHz. The reported design has again a disadvantage of large dimensions. In [9], a 30 mm × 30 mm antenna is presented with peak gain of 4.6 dBi and resonance frequency of 9.5 GHz. Although this last antenna offers high gain, its structural complexity implies potential fabrication difficulties.

In this paper, a compact, high gain and wide band antenna operating in WLAN and X-band is presented. Among other numerous advantages, the proposed design offers a simple T-shaped geometrical configuration which significantly facilitates the fabrication. In Section-II, the design methodology of the proposed antenna is presented, whereas Section-III covers the results for various performance parameters. In Section-IV, the paper is concluded.

2. Proposed Antenna

Fig. 1 depicts the proposed antenna geometry. The proposed antenna is designed on the substrate material Roger RT5880, which has the relative permittivity of 2.2 and loss tangent of 0.0009 with a thickness of 0.502 mm. The overall dimension of the proposed antenna is 25 mm × 33 mm. The radiator consists of a quasi-T shaped patch along with two semi-circles divided by a rectangular stub. Various iteration steps are used to achieve wideband and high gain characteristics.

The CPW feeding technique is utilized. This technique offers low dispersion and simple etching methodology, since it is only etched on one side of the substrate. The gap between the feedline and virtual ground plane is adjusted in order to achieve 50Ω line impedance. The design is validated by the commercially available electromagnetic simulation software High Frequency Structural Simulator (HFSS).

3. Results and Discussion

Fig. 2 represents the reflection coefficient of the proposed CPW fed antenna. From the figure, it can be observed that the

antenna operates at dual frequency bands with three resonance frequencies of 2.2 GHZ, 9.1 GHz and 11 GHz. The antenna offers a narrow band at WLAN frequency spectrum ranging from 2 – 2.5 GHz and a wide band at X-band, ranging between 8.3 – 12 GHz.

The radiation pattern of the proposed antenna at resonance frequencies of 2.2 GHz and 11.5 GHz is depicted in Fig. 3. It is clearly visible from the figure that, at the resonance frequency of 2.2 GHz, the antenna offers an omni directional radiation pattern in E-plane (ϕ = 0°), and bi-directional radiation pattern in H-plane (ϕ = 90°). For 11.5 GHz, a fan-shaped radiation pattern is observed in the E-plane (ϕ = 0°), and bi-directional radiation pattern in H-plane (ϕ = 90°). The shape of the radiation pattern is due to the multiple alteration and stub insertions. The numerically calculated value of the gain is 2.3 dBi at 2.2 GHz, 4.5 dBi at 9.5 GHz and 5.85 dBi at 11.5 GHz.

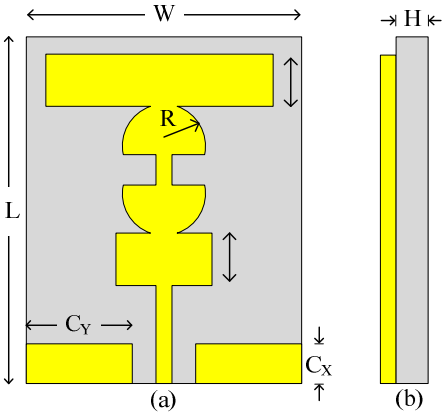

Fig.1. Proposed antenna geometry (a) front view (b) side view.

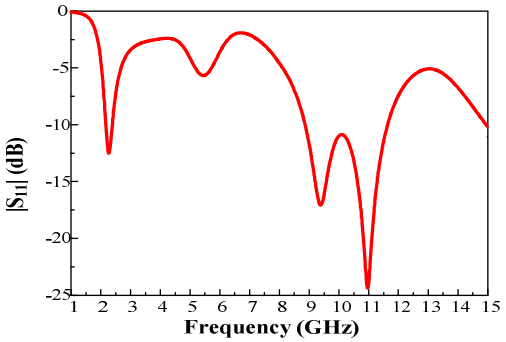

Fig.2. Reflection Co-efficient of proposed CPW feed antenna.

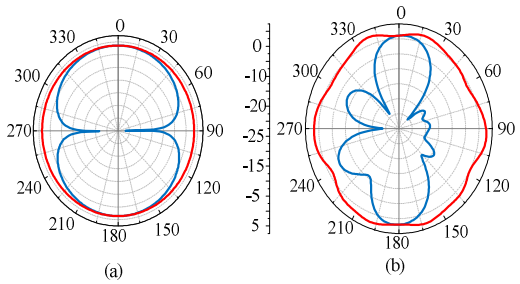

Fig.3. Radiation pattern of proposed antenna (a) 2.2 GHz (b) 11.5 GHz.

Table I Comparison of proposed antenna with already published antenna in literature.

Ref	Dimensions (mm × mm)	Operational Frequency (GHz)	Bandwidth (GHz)	Peak Gain (dB)	Design Methodology
[5]	20 × 17.2	8.95 / 11.06 / 11.85	0.45 / 1.010 / 0.45	4.46	S-Shaped Patch with Elliptical Slots in Ground Plane
[6]	40 × 40	10.25	1.59	4.31	Planar Patch with Circular and Rectangular Slots
[7]	32 × 48	5.1 / 8.4 / 9.4	0.18 / 0.56 / 0.36	6.637	Planar Patch with 2 Inverted T-Shaped Slots
[8]	40 × 40	10.3	0.4	5.01	Two E-Shaped Patches
[9]	30 × 30	9.5	1.56	4.6	Swastika Shaped Patch with Rectangular Slot Cuts
This Work	**25 × 33**	**2.2/11.5**	**0.5/3.3**	**2.3/5.8**	**Quasi-T Shaped CPW feed Patch Design**

4. Conclusion

This paper presents a geometrically simple, compact, wideband, high gain quasi-T shaped patch antenna for WLAN and X-band applications. The antenna offers resonances at 2.2 GHz, 9.3 GHz and 11.5 GHz. A multiple iteration process of the design was used in order to achieve the desired bandwidth in the internationally registered X-band spectrum. Moreover, the present design has been compared to comparable designs in the literature. The results, discussion and comparisons show that the proposed antenna is a good candidate for WLAN wireless communication and X-band radar applications.

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