A Co-axial probe fed slotted I- shaped Microstrip Patch Antenna for Multi-band Applications

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Abstract

In this article a simple, low-cost and high gain I -shaped microstrip patch antenna with suitable co-axial probe feeding techniques is demonstrated. The main objective of this paper is to design a slotted patch antenna for multi-band applications. The simulation is performed by IE3D Zeland software Version 14.0 and provide a maximum return loss of -30.07dBi at 6.90GHz and -16.45dBi at 3.50GHz and -14.60dBi at 8.00GHz by using FR-4 Epoxy substrate with dielectric constant Єr = 4.4 and height of the substrate(h) = 1.60 mm . After analysing all necessary characteristics in perspective of gain, bandwidth, polarization and return loss the proposed patch is well applicable for WLAN (2.4/3.2/5.2 / 5.8 GHz) and WiMAX (5.5GHz) communications.

Keywords

I. Introduction

In recent years, communication systems requires the development of low cost, minimal weight and low profile antennas that are capable of maintaining high performance over a wide spectrum of frequencies. Microstrip patch antenna is a single layer design which contains mainly these four parts - Patch, Ground plane, Substrate and Feeding part. It is very simple in construction using conventional microstrip line feed. Patch can be given any shape but rectangular and circular configurations are mostly used. Ground Plane can be finite or infinite according to model (Transmission line - model, cavity model, full wave Model or method of moments) used for analysis of dimensions [1-4]. Relative Permittivity (Єr) and height (h) are two important characteristics for substrate, Feeding Part can be implemented in these ways - Microstrip line, coaxial probe, Aperture coupled and Proximity coupled Feed [5-7]. Single microstrip patch antenna has some advantages (low cost, light weight, conformal & low profile), but it has little disadvantages too like low gain, low efficiency, low directivity and narrow bandwidth. In this article, we present an I- shaped slotted antenna with defected ground plane for achieving multi-band applications. The proposed structure is low size, easy to fabricate, in perspective of gain, bandwidth and return loss, the proposed one is applicable for WLAN and WiMAX applications.

II. Design Procedure

At first we consider a square patch length of 15mm and width of 15mm and a ground plane size of 25×25 mm2 work as a reference antenna also the size of the substrate same as the ground plane where , Єr=4.4 and thickness (h) = 1.60mm. Reducing the size of the antenna is one of the key factors to minimize the wireless communication devices. However, reducing the antenna size will usually reduce its impedance bandwidth as well. Therefore in the next step the geometry of the patch is given an I-shape . Further modifications of the reference antenna we inserted two rectangular close ended slots in the ground plane. A 50 ohm microstrip line is used for excitation. The antenna design has been carried out by a set of method of moments(MoM) simulations with commercial software [8].The proposed structure with its dimensions is shown in Fig.1.The remaining designing parameters are given in Table.1

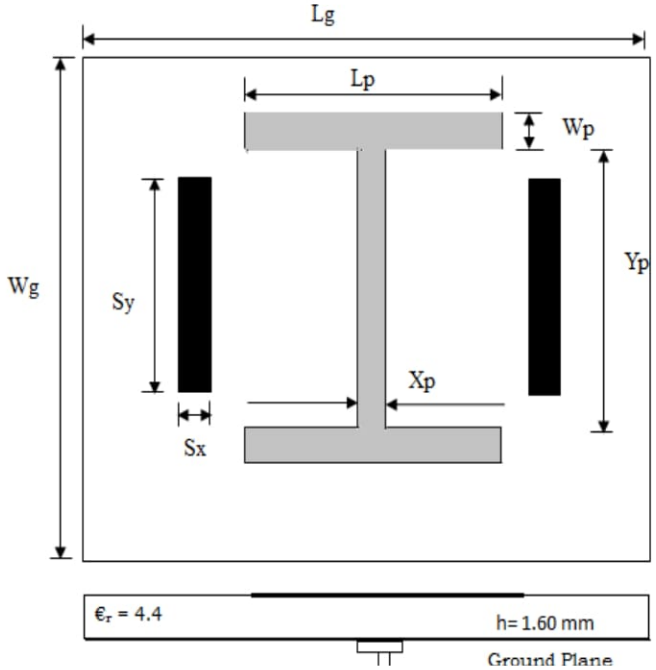

Fig.1 Proposed structure

Table 1. Proposed Structure parameters

Wg (mm)	Lg (mm)	Wp (mm)	Lp (mm)	Xp (mm)	Yp (mm)	Sx (mm)	Sy (mm)
25.00	25.00	2.50	15.00	2.50	17.95	2.50	14.00

III. Results and Discussion

After simulation and optimizing the feeding point of the reference antenna along with the ground plane we denote it as Antenna 1. Then using an I-shaped slot as a patch we denote it as Antenna 2 (where the ground plane dimensions are same as Antenna 1.) and finally after the proposed figure is denoted as

Antenna 3 where two rectangular slot are inserted in a ground plane. The S11(dB) vs frequency(GHz) plot of Antenna 1, Antenna 2 and Antenna 3 is shown in Fig 2. For Antenna 1 , the resonant frequency is 3.5GHz, 6.90GHz and 8.00GHz. For Antenna 2, the resonant frequency is 6.15GHz. The compactness of Antenna 3 is 82% where resonant frequency occur at 2.5GHz at lower band and the higher band resonant frequency is 5.2GHz (5-6.2 GHz) and -10dB bandwidth is 1.2GHz which satisfy the WLAN band. The current distribution and 3D radiation pattern are shown in Fig 3 and Fig.4 respectively.

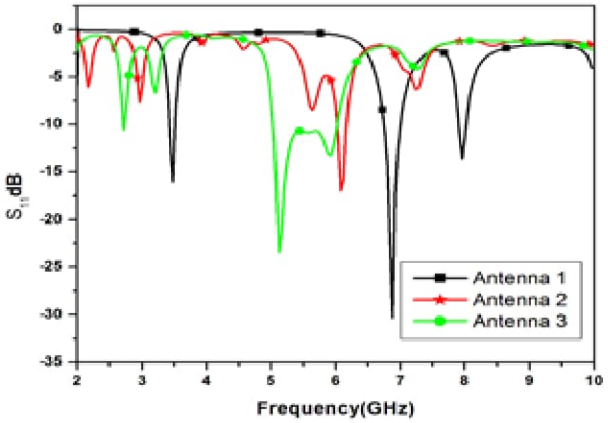

Fig.2 S_{11} vs. frequency plot of Antenna 1,2 and 3

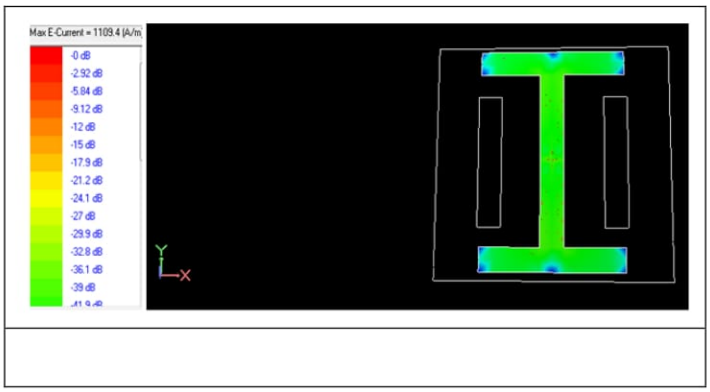

Fig.3 Current Distribution Pattern

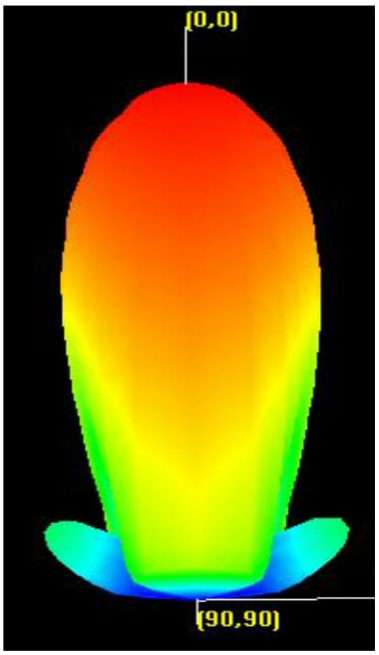

Fig.4. *3D Radiation pattern*

From Fig.2 , we can see that the proposed figure will work for multiple frequencies and is capable of dual or triple frequency operation and polarization of any type.

IV. Conclusion

We have designed I-shaped microstrip patch antennas with rectangular slots on the ground plane.The characteristics of proposed antenna have been investigated through different parametric studies using IE3D simulation software. The proposed antennas have achieved good impedance matching, stable radiation patterns, and high gain. The I –shaped antenna can be used for WLAN (2.4/3.2/5.2 / 5.8 GHz) and WiMAX (5.5GHz) communications. Fabrication and Verification of simulated results can be carried out in future.

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