Step Slotted Microstrip Patch Antenna with Defected Ground Structure (DGS) for wideband applications

Ekambir Sidhu

Abstract--- **In this paper, wideband rectangular Microstrip patch antenna with numerous step slots etched on the patch and slotted reduced ground plane has been designed with wide impedance bandwidth and minimal return loss, suitable to be effectively utilized for WLAN, Wi-MAX and IMT applications. The antenna has been designed and simulated using CST Microwave Studio 2010. The simulated antenna is a dual resonant antenna having two resonant frequencies of 3.8 GHz and 5 GHz with adequate bandwidth of 4.2857GHz and minimal return loss of -30dB and -46dB respectively. The gain and directivity is higher at high resonant frequency.**

Keywords- **Microstrip patch antenna, return loss, slotted reduced ground plane, step slotted patch, wideband.**

1. INTRODUCTION

With the rapid growth of wireless communication, it has become important that the antenna which is used for transmitting and receiving signals should be compact in size so that it can be easily installed in portable devices. Microstrip patch antenna is one of the antennas which have various advantages such as small size, less weight, easy fabrication and installation etc. which makes it suitable to be used for wireless applications [1]. It consists of a substrate which is having a ground plane on its bottom side and a conducting patch on its top. The substrate is made up of dielectric material with particular permittivity and the patch and ground should be of perfect electric conductor (PEC) material. The patch can take any shape such as rectangular, circular, elliptical, ring etc [2]. The main drawback of microstrip patch antenna is that it has narrow bandwidth and low efficiency [3].

Manuscript received July,2014

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A step slotted patch has been used with reduced ground plane having defect on it. With the use of step slotted patch, the size of the antenna has been reduced and bandwidth has been also sufficiently improved. It has been also analyzed that the defected reduced ground plane provides better results in terms of bandwidth enhancement than full ground plane structure.

2. ANTENNA GEOMETRY

Fig. 1and Fig. 2 represents the geometry of step slotted microstrip patch antenna showing front and bottom view respectively. As shown in the Fig.1, there are many step slots cut on the patch and Fig.2 shows that the ground plane is reduced and partially slotted. The patch is fed by a microstrip feed line of certain specified width so as to properly match with the port impedance of typically 50 ohms. The antenna is fabricated on FR4 substrate having relative permittivity of 4.4 and thickness of 1.6mm. The width of the feed line is adjusted to make sure that the impedance of antenna is 50 ohms. The various dimensions of proposed antenna are listed in Table1.

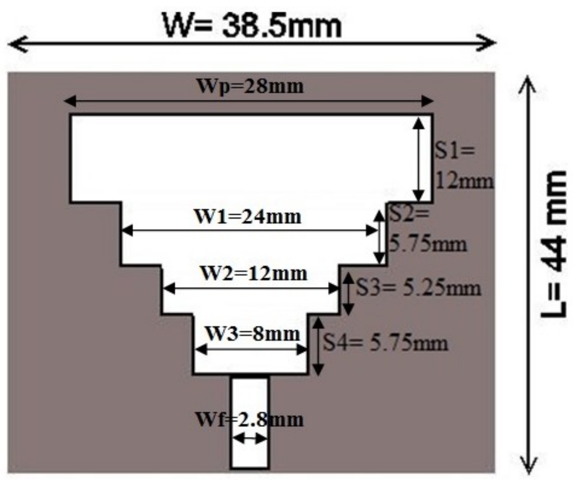

Fig.1Top view of step slotted MPA.

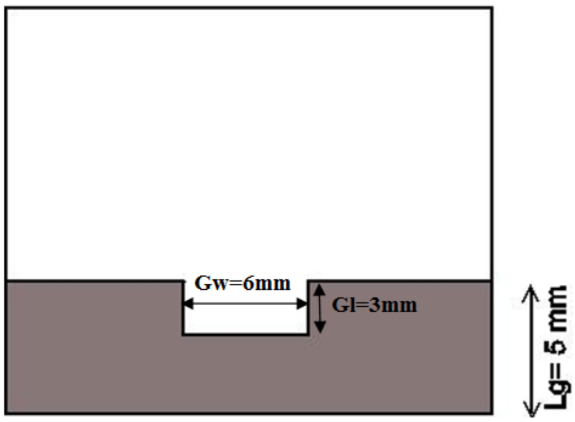

Fig. 1(b) Bottom view of step slotted MPA.

Table 1 Dimensions of step slotted MPA

Antenna Parameter	Specification
Ground size	38.5 x 5 mm
Substrate size	38.5 x 44 mm
Patch Steps	
(a) Wp x S1	28 x 12 mm
(b) W1 x S2	24 x 5.75 mm
(c) W2 x S3	12 x 5.25 mm
(d) W3 x S4	8 x 5.75 mm
Ground Slot (Gw x Gl)	6 x 3 mm
Feed line width	2.8 mm

3. RESULTS AND DISCUSSIONS

The proposed antenna has been simulated using CST Microwave Studio 2010 and the performance of the antenna has been analyzed in terms of return loss, VSWR, radiation pattern and gain. The antenna has also been designed physically and then tested using E5071C, ENA series network analyzer.

Fig.3 below represents the simulated return loss plot results of step slotted patch antenna. It has been analyzed that the antenna is dual resonant antenna having two resonant frequencies of 3.8 GHz and 5.0 GHz. The return loss for designed antenna is -30.85dB at 3.8 GHz and -46.78dB at 5.0GHz and the impedance bandwidth for the antenna is 4.2 GHz.

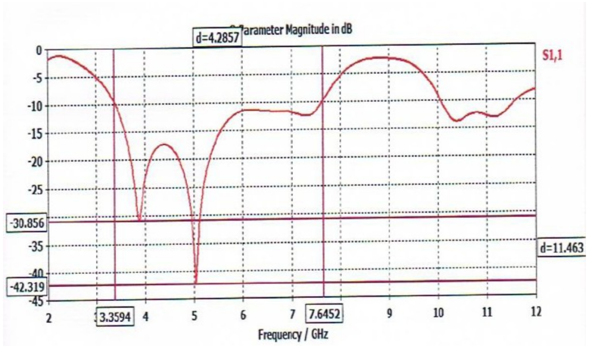

Fig. 3 Return loss plot of step slotted MPA

Fig.4 (a) and Fig.4 (b) represents the 3D radiation pattern showing directivity of step slotted MPA at both resonant frequencies. The directivity is 3.1dBi at 3.8GHz and 4.3 dBi at 5.0 GHz. It has been observed that directivity is better for higher resonant frequencies.

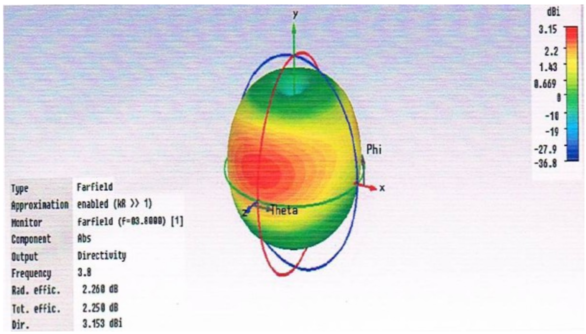

Fig. 4(a) Directivity of step slotted MPA at 3.8 GHz

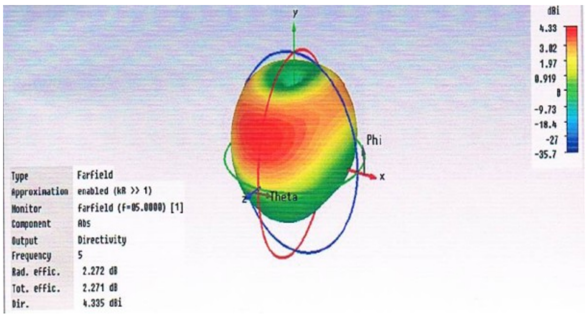

Fig. 4(b) Directivity of step slotted MPA at 5.0 GHz

Fig.5 (a) and Fig 5 (b) illustrates the simulated results of gain for the designed MPA. The 3D radiation pattern shows that the gain is 5.4dB at 3.8 GHz and 6.6dB at 5.0 GHz. It shows clearly that the value of gain is higher for higher frequencies.

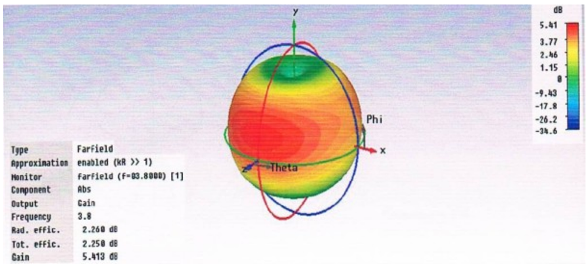

Fig. 5(a) Gain of step slotted MPA at 3.8 GHz

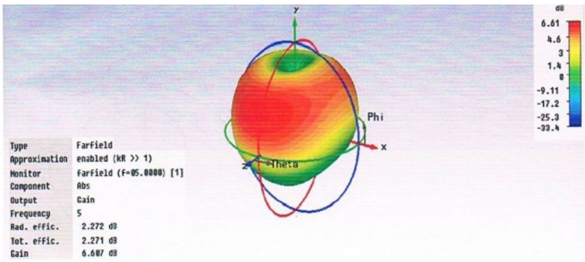

Fig. 5(b) Gain of step slotted MPA at 5.0 GHz

Fig.6 shows the simulated VSWR plot for the designed MPA. For efficient working of the antenna, the VSWR should be less than 2. From the results, it can be seen that the designed antenna works satisfactorily as VSWR is less than the maximum acceptable value of 2.

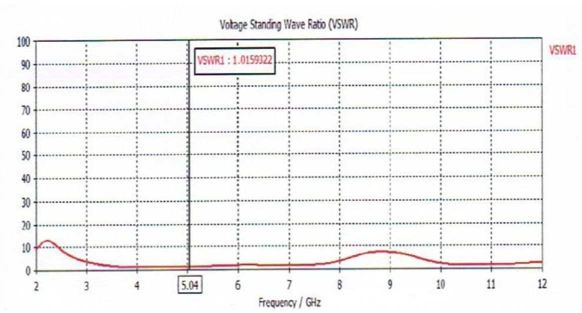

Fig. 6 VSWR plot of step slotted MPA

4. FABRICATED ANTENNA DESIGN AND PRACTICAL RESULTS

The proposed antenna has been designed practically by fabrication process as shown in Fig. 7 and tested using E5071C ENA series network analyzer. The practical results of step slotted MPA is shown in Fig. 8 which approximately matches with the simulated results.

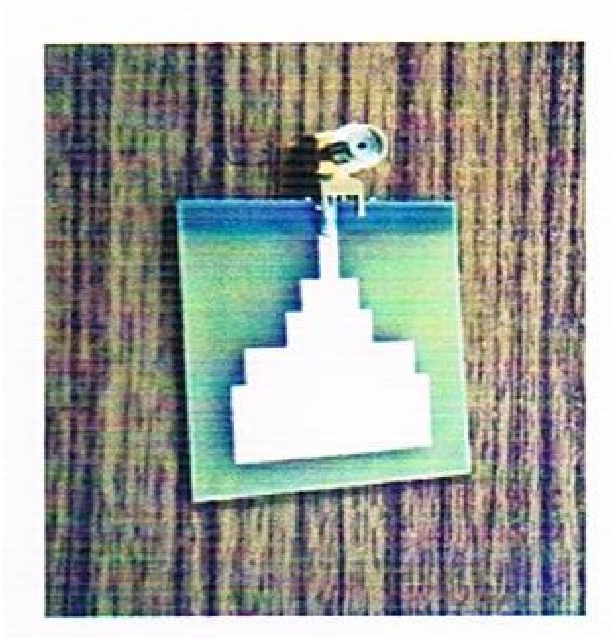

Fig. 7 Fabricated Step slotted MPA

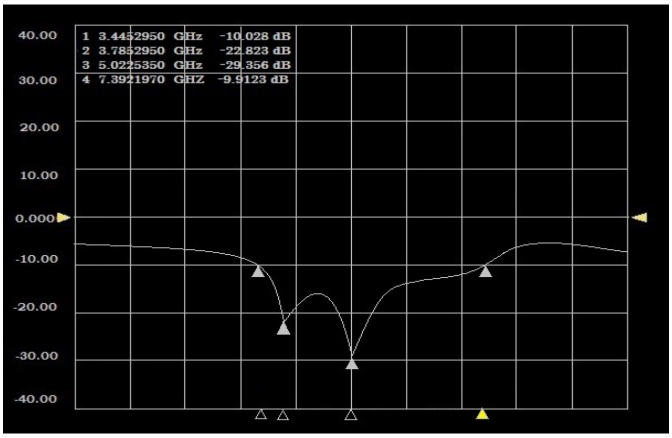

Fig. 8 Practical Results for step slotted MPA

5. CONCLUSION

It has been observed that the maximum bandwidth can be achieved by step slotting the patch and through defected ground (reduced ground with slot) technique. It has been shown that the cutting of ground slot and etching the steps in patch does have an effect on return loss (S_{11}) performance and impedance bandwidth. The slotted antenna with defected ground structure provides better return loss and impedance bandwidth results than un-slotted antenna.

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BIOGRAPHIES

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