Slits in Radiating Patch of Microstrip Antenna with Truncated Ground Plane by Same type Slits

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Abstract

In this paper, a simple design of microstrip antenna (MSA) having 4 slits shape patch, one is bent with angle 45°, other one is bent with angle 135° and this is same with other two. Ground plane is truncated with same type slits as patch only their sizes are small. This antenna is basically covered some applications such as: DCS-1800, 3G IMT-2000, & GPS L1. This antenna is radiate with 50-Ω microstrip feed line. The simulation of the proposed antenna has been carried out using IE3D software. An input impedance bandwidth of 42% at 1.741GHz(resonance freq) for VSWR ≤2 has been obtained from the proposed antenna. This bandwidth is achieved by using truncated ground plane with slits in the radiating patch. Radiation and other characteristics of the proposed antenna have also been investigated. The proposed antenna has low VSWR, better return loss and compact size.

keywords: **Slits, truncated ground plane, microstrip line, IE3D.**

I. INTRODUCTION

The microstrip antenna is a very good common element to cover different applications such as: DCS-1800 (digital communication system), 3G IMT- 2000 (3G international mobile telecommunication) & GPS L1. The frequency ranges of above applications as: 1710-1810MHz, 1885-2200MHz & 1.525- 1.595MHz respectively. The resonant frequency of DCS-1800 is 1.747GHz & GPS L1 is 1.575GHz. Microstrip antennas (MSAs) have sparked interest among researchers because of their many advantages over conventional antennas, advantages such as low cost, light weight, conformal structure, low profile, reproducibility, reliability, ease in fabrication and integration with solid-state devices, etc, [1]-[12]. Accordingly, increasing the bandwidth of the MSA has been a primary goal of research in the field.

However, their further use in specific systems is limited because of their relatively narrow bandwidth. In principal, wide bandwidth of microstrip patch antennas (MPAs) or bandwidth enhancement can be achieved by several efficient approaches, namely (i) increasing the substrate thickness (ii) optimizing impedance matching (iii) reducing the substrate effective permittivity or (iv) incorporating multiple resonance (v) embedding the slits in the radiating patch (vi) truncated ground plane. Much effort has also been increasingly devoted to increasing the frequency agility of (MPAs) [13].

In this paper the increment of bandwidth of the proposed antenna by introducing the slits in the radiating patch & using truncated ground plane with same type slits having small dimensions as slits in radiating patch.

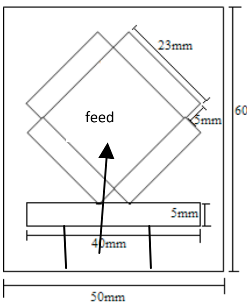
II. ANTENNA DESIGN AND SIMULATION

Here the proposed antenna is designed to support 3GHz operating frequency and corresponding simulation has been done by using the IE3D version 12.32 simulator. The proposed antenna is designed by using Glass epoxy dielectric substrate with permittivity, ε_r = 4.2, loss tangent, tan δ = 0.0013 and height, h =1.6 mm. The dimension of antenna is 50 mm × 60 mm. The design of antennas are given below as fig 1.

First design of microstrip antenna having 4 slits shape patch, one is bent with angle 45°, other one is bent with angle 135° and this is same with other two & a rectangular horizontal strip with width 5mm. This design of antenna 1 is radiate with a 50-Ω microstrip feed line at point (20,5) at centre. The length & width of microstrip feed line is 23 mm and 10 mm respectively. The design of antenna 1 is shown as in fig. 1(a).

Second design is same as antenna 1 with a rectangular horizontal strip with width 10mm. This design of antenna 2 is radiate with a 50-Ω microstrip feed line at point (25,2.5) at centre. the length & width of antenna 2 is 23 mm and 5 mm respectively. The design of antenna 2 is shown in fig. 1(b).

Third design is same as first type design of microstrip antenna, here ground plane is truncated with same type slits as patch only their sizes are small. This design of antenna 3 is radiate with a 50-Ω microstrip feed line at point (20,2.5) at centre. The length & width of antenna1 is 23 mm and 5 mm respectively. The design of antenna 3 is shown in fig. 1(c).



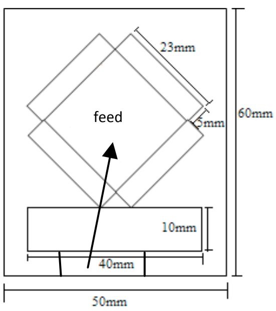


fig. 1(a) Antenna 1 fig. 1(b) Antenna 2

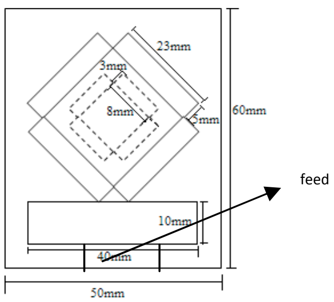


fig. 1(c) Antenna3

Figure 1. Designs of the proposed antennas

III. RESULTS

The proposed designs of all antennas has been simulated with commercially available moment of method analysis package, that is IE3D simulation software (IE3D v12.32). The simulated return losses curves, directivity curve, gain curve & radiation curve of the proposed antennas is depicted in given Figures as follows:

(A) FIRST ANTENNA

(1a.) Return loss

Fig. 2 (a) shows S_{11} characteristic of the proposed antenna.

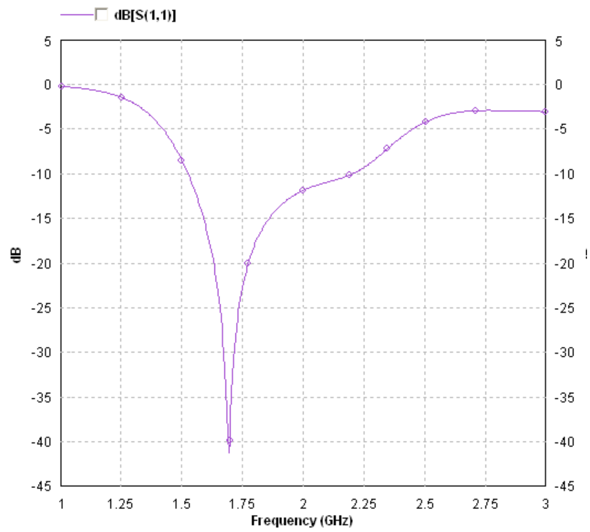


Figure 2(a). Return loss of the proposed design for antenna 1

From the return loss curves, it is clearly seen that the proposed antenna has a bandwidth of 36.07% (10dB return loss), which ranges from 1.529 to 2.202 GHz frequency & Centre frequencies is 1.693GHz frequency. The value of lowest return loss at 1.693 GHz frequency is -41.21dB.

(1b.) Directivity

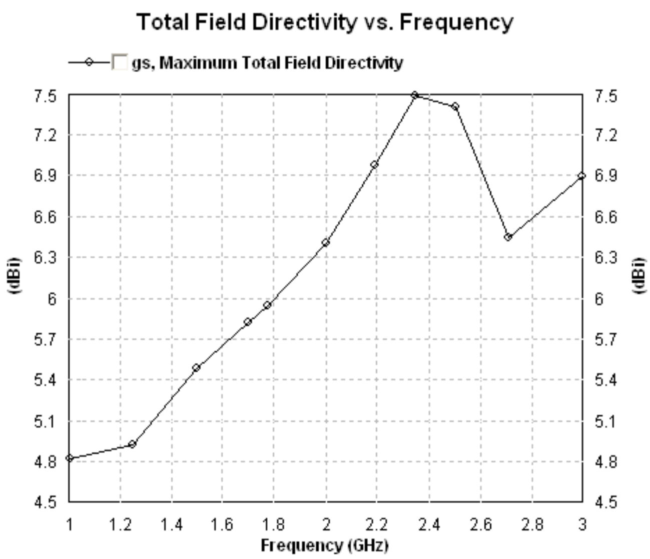


Figure 2(b). Directivity of the proposed antenna for design of antenna 1

From the directivity curves, it is clearly seen that the proposed antenna has 5.85 dBi at 1.693 GHz frequency.

(1c.) Gain

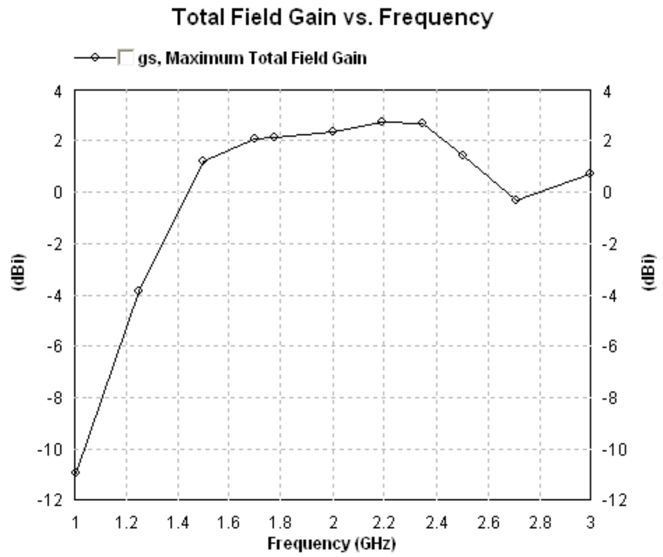


Figure 2(c). Gain of the proposed design for antenna 1

(B) SECOND ANTENNA

(2a.) Return loss

Fig. 2 (a) shows S_{11} characteristic of the proposed antenna.

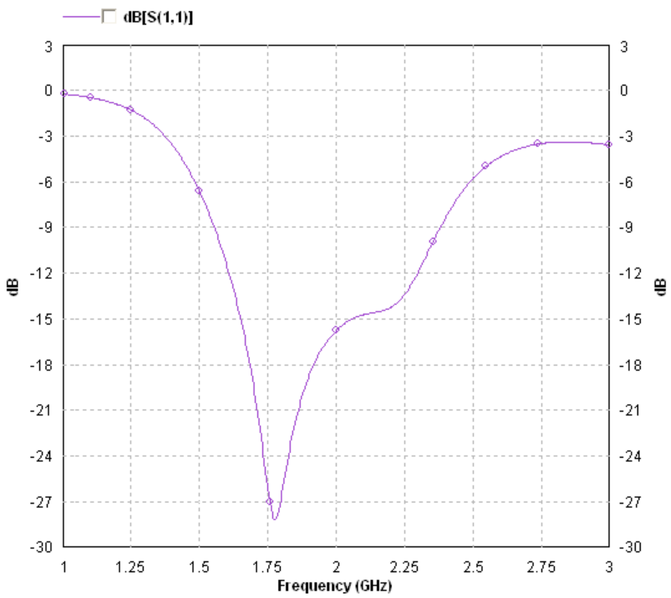


Figure 3(a). Return loss of the proposed design for antenna 2

From the return loss curves, it is clearly seen that the proposed antenna has a bandwidth of 38.44% (10dB return loss), which ranges from 1.601 to 2.363 GHz frequency & resonates at 1.76 GHz frequency. The value of lowest return loss at 1.76 GHz frequency is -28.1dB.

(2b.) Directivity

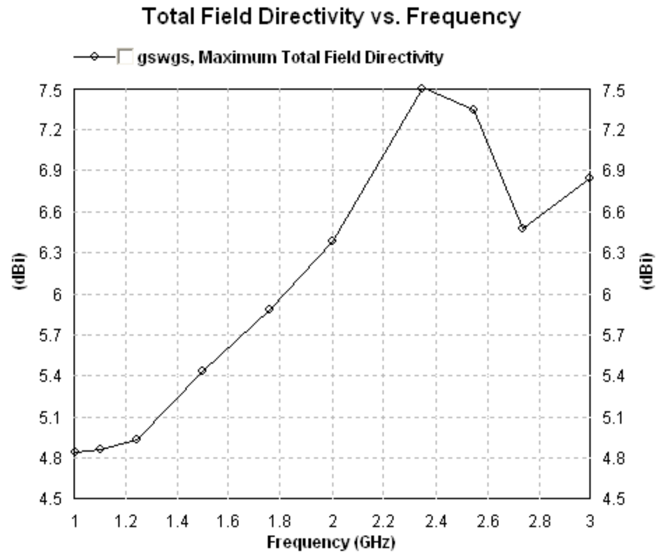


Figure 3(b). Directivity of the proposed design for antenna 2

From the directivity curves, it is clearly seen that the proposed antenna has 5.9 dBi at 1.76 GHz frequency.

(2c.) Gain

The peak antenna gain v/s frequency characteristics of the proposed antenna design as antenna 2 is shown in fig. 3(c).

(2d.) VSWR

The VSWR v/s frequency characteristics is shown in fig. 3(d).

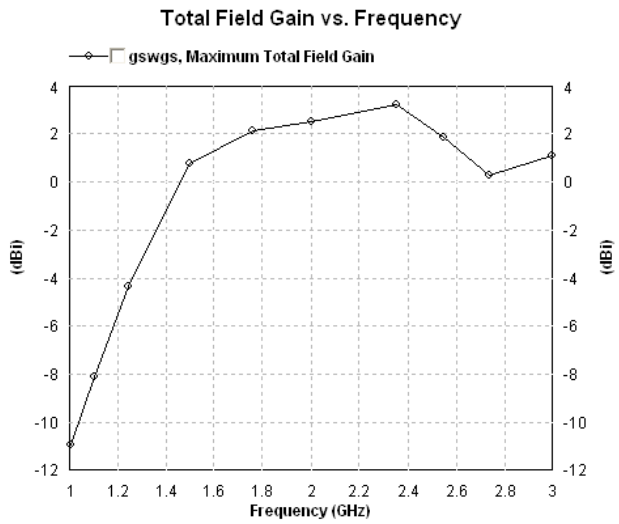


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Figure 3(c). Gain of the proposed design for antenna 2

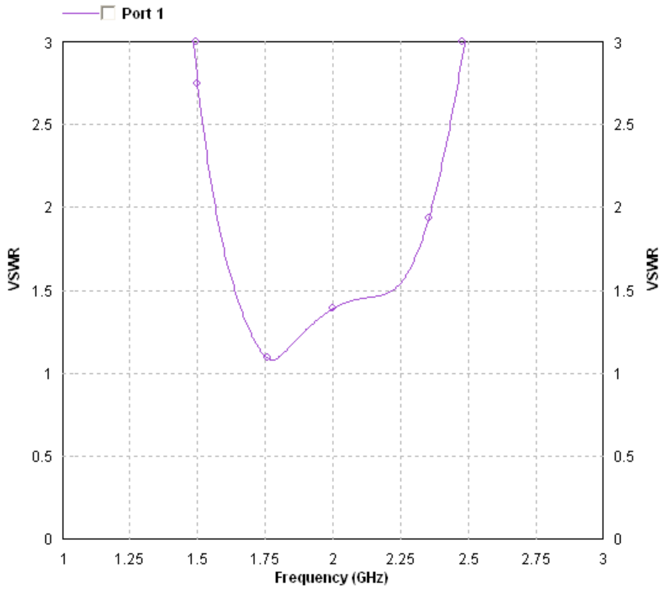

Figure 3(d). VSWR of the proposed design for antenna 2

(C) THIRD ANTENNA

(3a.) Return loss

From the return loss curves, it is clearly seen that the proposed antenna has a bandwidth of 42% (10dB return loss), which ranges from 1.545 to 2.363 GHz frequency & resonates at 1.741 GHz frequency. The value of lowest return loss at 1.741 GHz frequency is -32.27dB.

(3b.) Directivity

From the directivity curves, it is clearly seen that the proposed antenna has 5.84 dBi at 1.741 GHz frequency.

(3c.) Gain

The peak antenna gain v/s frequency characteristics of the proposed antenna design as antenna 2 is shown in fig. 4(c).

(3d.) VSWR

The VSWR v/s frequency characteristics is shown in fig. 4(d).

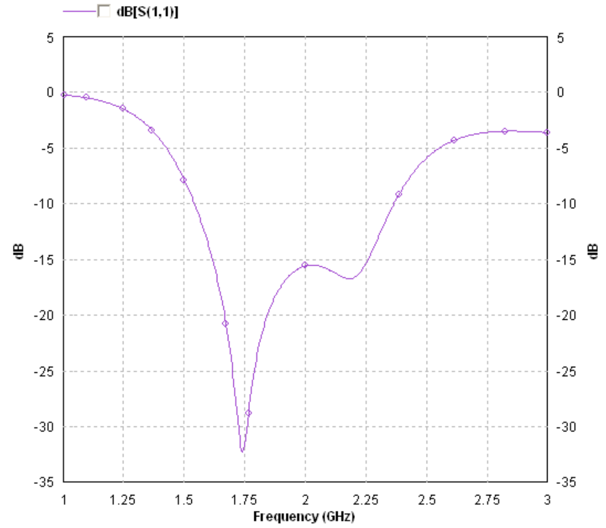

Figure 4(a). return loss of the proposed design for antenna 3

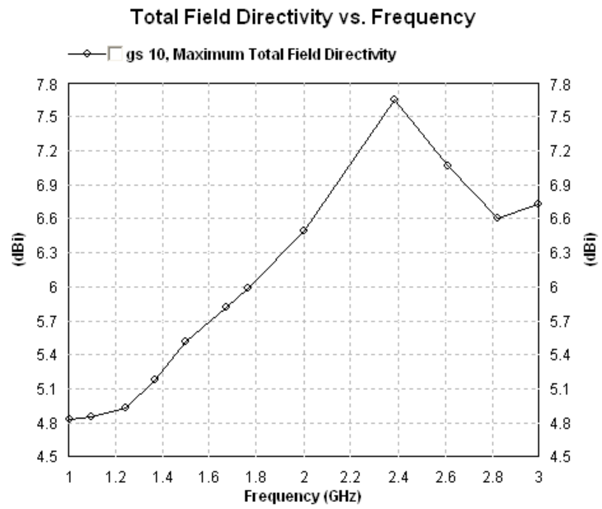

Figure 4(b). Directivity of the proposed design for antenna 3

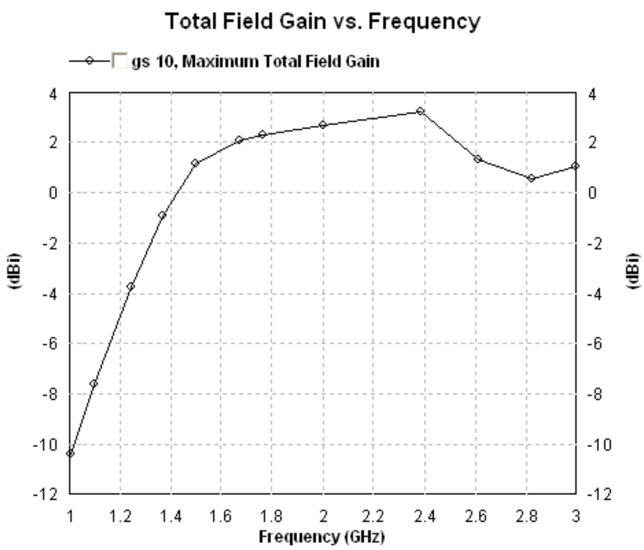

Figure 4(c). Gain of the proposed design for antenna 3

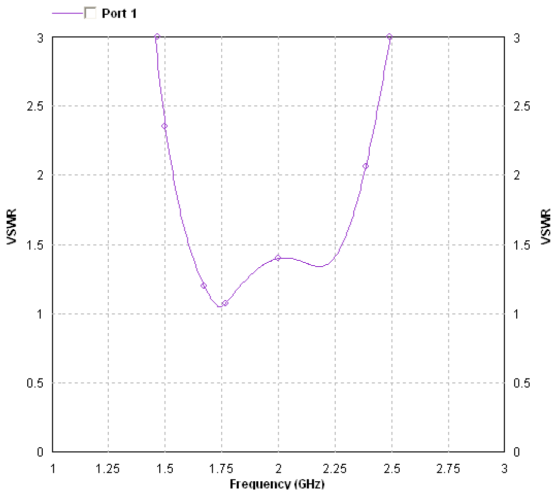

Figure 4(d). VSWR of the proposed design for antenna 3

IV. COMPARISON OF ALL MICROSTRIP ANTENNAS

The resonance characteristics & bandwidth of all designs of microstrip antennas presented in table 1. From this table 1, it is clear that the third antenna design has broad bandwidth such as 42%.

Antennas No.	Resonant freq(GHz)	Upper freq(GHz)	Lower freq(GHz)	Bandwidth(%)
Antenna 1	1.693	2.202	1.529	36.07
Antenna 2	1.76	2.363	1.601	38.44
Antenna 3	1.741	2.363	1.545	42

Table 1. Simulation performance of proposed antenna having Resonance characteristics & bandwidth

V. CONCLUSION

It is clearly shown that after simulations, all designs of proposed microstrip antennas, the 3rd antenna gives better performance in terms of bandwidth as 42 % at 1.741 GHz frequency. This broad bandwidth is achieved by using truncated ground plane.

VI. ACKNOWLEDGEMENT

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