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Design & Analysis Of An Inverted-T Shaped Antenna With DGS For Wireless Communication

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***Abstract*- A new and unique methodology for designing a compact micro strip patch antenna for lower microwave frequencies is proposed. A very Compact inverted-T shaped micro strip patch antenna with DGS (Defected Ground Structure) is designed and analyzed for S-BAND wireless communication. The resonance frequency of the designed antenna is decreased step by step to obtain low microwave frequency applications. By putting little variations in the ground plane five bands are obtained at 3.5GHZ, 2.7GHZ, 2.4/2.5GHz, 2.36GHZ and 2.2GHZ. The proposed antenna has a low profile and can easily be fed by using a 50 Ω micro strip line. The designing has been done in IE3D software which is an EM solver and works on the principle of moments of method.**

***Keywords*- DGS, IE3D Software, VSWR, Return Loss, Bandwidth**

INTRODUCTION

Micro strip antennas are attractive due to their light weight, conformability and low cost. These antennas can be integrated with printed strip-line feed networks and active devices [1]. This is a relatively new area of antenna engineering.

In response to the increasing demand for compact and easily fabricated antennas for use in various wireless communication systems, several T-shaped antennas have been developed over the past decade [2–7]

In this research paper a compact micro strip inverted-T shaped patch antenna is designed and analyzed with Inverted-T shaped DGS for wireless communication system.

ANTENNA DESIGN

In this design of a compact inverted-T shaped micro strip patch antenna, FR4 dielectric material (ε_r = 4.4) with dielectric loss tangent of 0.02 is selected as the substrate with 1.6 mm height. Inset feeding is used as a feeding method.

The design parameters are given in Table1.Using these parameters antenna is designed and simulated in IE3D simulator.[8-9].

The geometry of the designed antenna is shown in Fig.1 and the simulated results are shown in fig.2.and fig.3. This antenna has shown -20.03 dB return loss and bandwidth of 80.22MHZ at 3.5GHz resonant frequency. At this frequency antenna radiate maximum transmitted power and reflects minimum power.The value of VSWR at this resonant frequency is 1.18. This antenna can be used for 3.5 GHz WiMAX application.

TABLE 1: DESIGN PARAMETER OF INVERTED-T SHAPED MICROSTRIP PATCH ANTENNA FOR 3.5 GHZ

Width of vertical Arm	4mm
Length of vertical Arm	12mm
Width of horizontal Arm	4mm
Length of horizontal Arm	8mm
Input Resistance of Patch	50Ω
Inset Depth of Patch(D_0)	0.5 mm
Inset width of patch	3mm
Width of microstrip line(W_0)	2mm
Length of microstrip line(L_0)	15mm

Fig. 1: Inverted-T shaped Microstrip Antenna

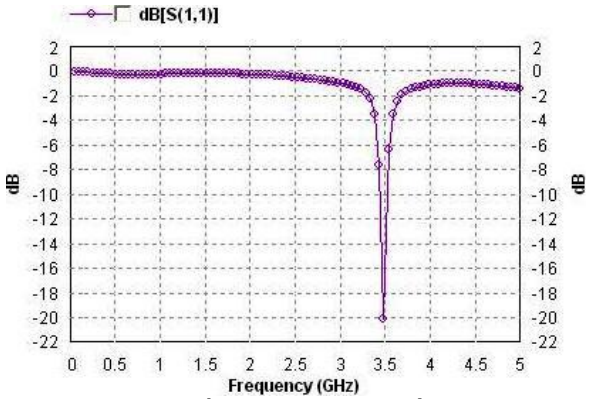

Fig. 2: Variation between Return Loss and Frequency

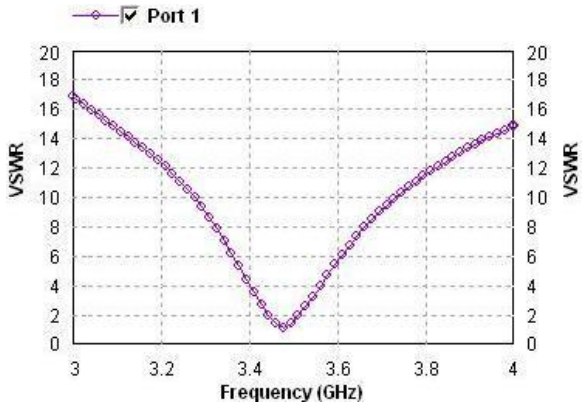

Fig. 3: Variation between VSWR and Frequency

In this paper ,this patch antenna is used as a reference antenna to design other antennas having the same patch but different ground structure and resonant frequencies. At these resonance frequencies antenna parameters Bandwidth, VSWR and Return loss is measured and analyzed.

MODIFICATION OF GROUND STRUCTURE

The patch antenna designed above and all its parameters are remain same, only the ground of the antenna is modified.

An inverted-T shaped ground is introduced and modified to obtain following resonance frequencies.

A . Patch With Ground 1.

A inverted –T shape ground is introduced with parameters given in table 2. The geometry of the designed antenna is shown in Fig.4 and the simulated results are shown in fig.5.and fig.6. This antenna has shown -31.64 dB return loss and bandwidth of 313.2 MHZ at 2.71GHz resonant frequency. At this frequency the value of VSWR is 1.054.

TABLE 2: DESIGN PARAMETER OF INVERTED-T SHAPED GROUND 1.

Width of vertical Arm	4mm
Length of vertical Arm	16mm
Width of horizontal Arm	6mm
Length of horizontal Arm	12mm

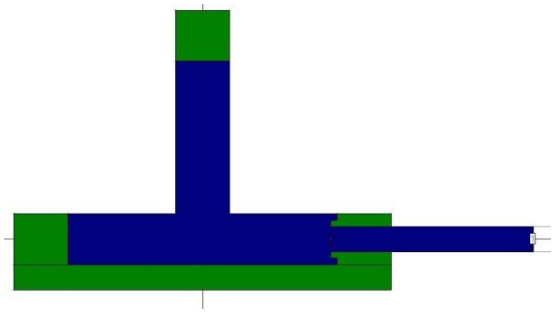

Fig. 4:Patch with Inverted-T shaped ground 1.

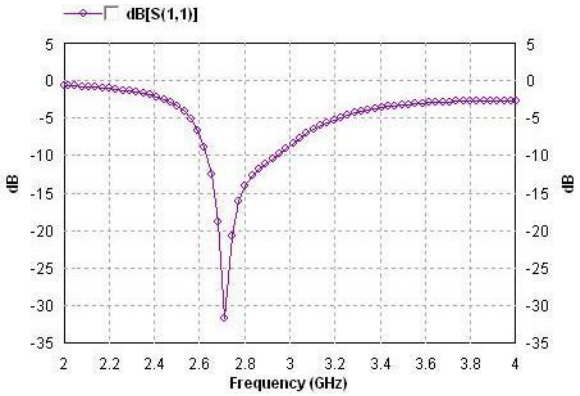

Fig. 5: Variation between Return Loss and Frequency for patch with ground 1.

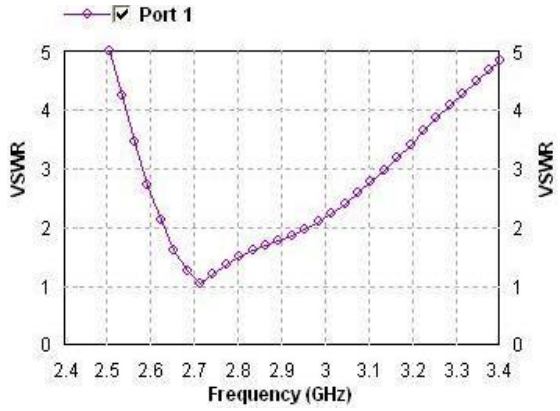

Fig. 6: Variation between VSWR and Frequency for patch with ground 1

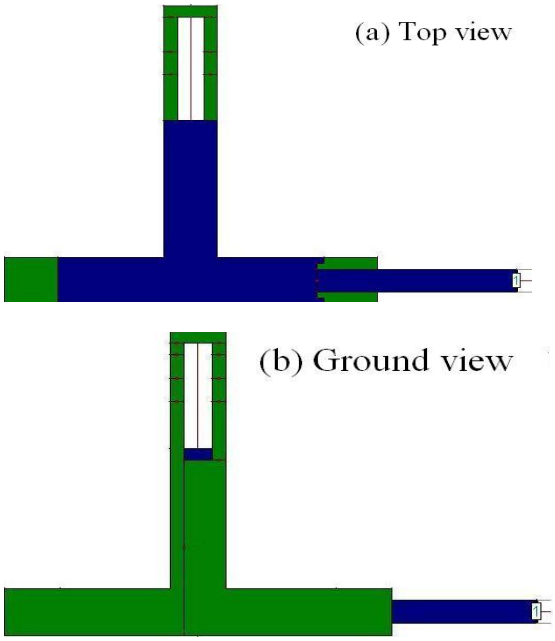

Fig. 7:Patch with Inverted-T shaped ground 2.(a) Top view (b) ground view(bottom view)

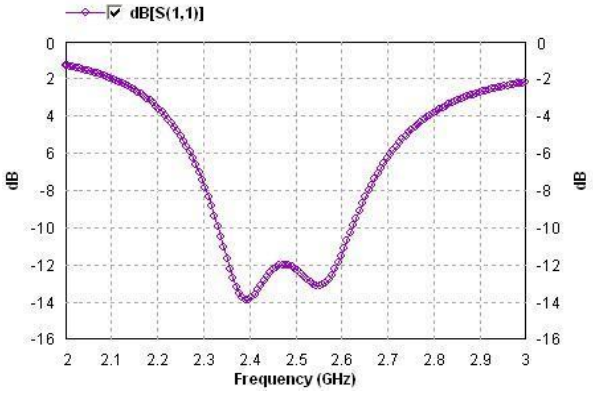

Fig. 8: Variation between Return Loss and Frequency for patch with ground 2

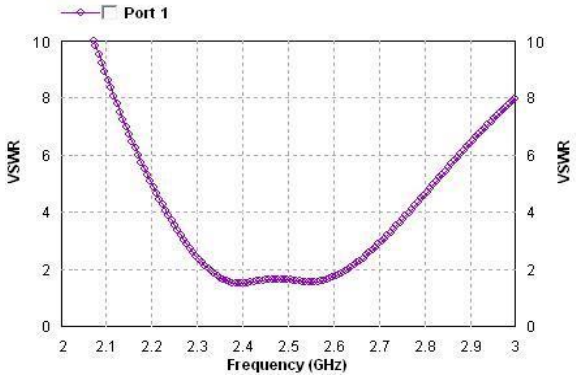

Fig. 9: Variation between VSWR and Frequency for patch with ground 2

B. Patch with ground 2

The parameters of the inverted-T shaped ground is given in the table 3. A rectangular slot of 10 mm X 2mm is introduced in the ground. The geometry of the designed antenna is shown in Fig.7 and the simulated results are shown in fig.8.and fig.9. This antenna has shown -13.88 dB return loss and bandwidth of 291.1 MHZ at 2.4GHz resonant frequency. At this frequency the value of VSWR is 1.51. This antenna is suitable for use in ISM band, 2.4GHzWLAN/2.5GHz WiMAX.

TABLE 3 : DESIGN PARAMETER OF INVERTED-T SHAPED GROUND 2.

Width of vertical Arm	4mm
Length of vertical Arm	22mm
Width of horizontal Arm	4mm
Length of horizontal Arm	12mm

C. Patch with ground 3

The parameters for this ground structure are remain same as for ground 2 structure, these parameters are given in the table 3. A narrow rectangular slot of 12 mm X 1mm is introduced in the ground. The geometry of the designed antenna is shown in Fig.10 and the simulated results are shown in fig.11.and fig.10. This antenna has shown -36.93 dB return loss and bandwidth of 116.13 MHZ at 2.36GHz resonant frequency. At this frequency the value of VSWR is 1.02.This antenna can be used for DARS application.

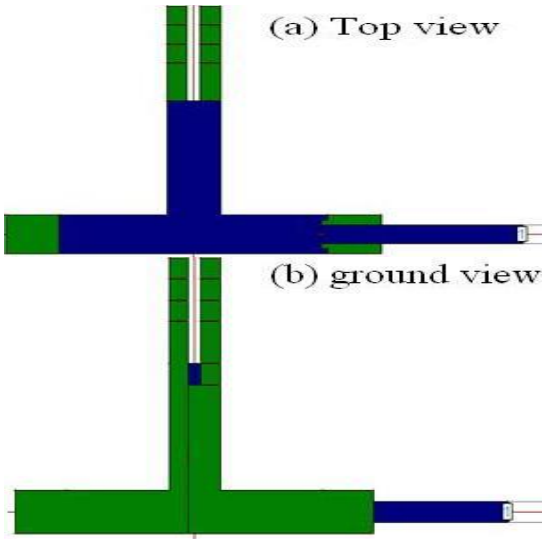

Fig. 10:Patch with Inverted-T shaped ground 3.(a) Top view (b) ground view(bottom view)

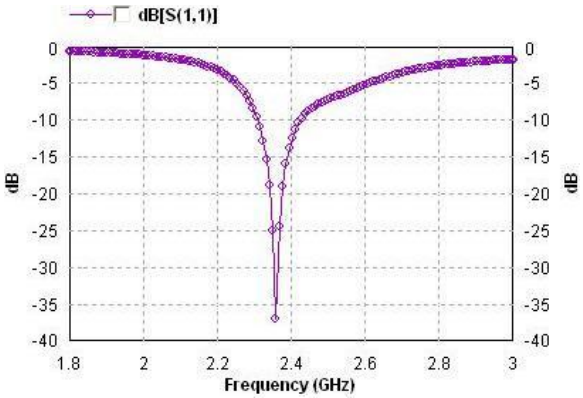

Fig. 11: Variation between Return Loss and Frequency for patch with ground 3

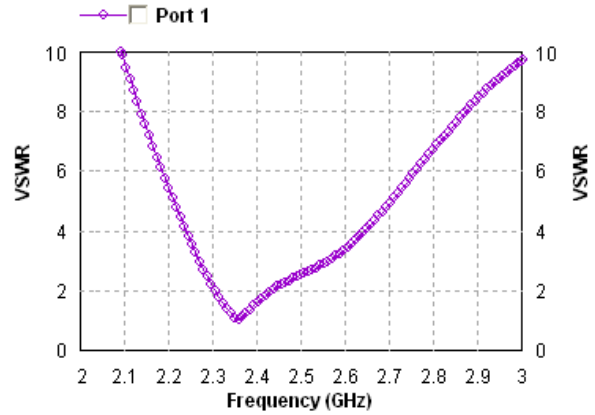

Fig. 12: Variation between VSWR and Frequency for patch with ground 3.

D. Patch with ground 4

The design parameters of the inverted-T shaped ground is given in the table 4. Two rectangular slot of 18 mm X 2mm and 6mm X 1mm is introduced in the ground. The geometry of the designed antenna is shown in Fig.13 and the simulated results are shown in fig.14.and fig.15. This antenna has shown -34.29 dB return loss and bandwidth of 137.1 MHZ at 2.21GHz resonant frequency. At this frequency the value of VSWR is 1.03.

TABLE 4 : DESIGN PARAMETER OF INVERTED-T SHAPED GROUND 4.

Width of vertical Arm	4mm
Length of vertical Arm	22mm
Width of horizontal Arm	4mm
Length of horizontal Arm	12mm

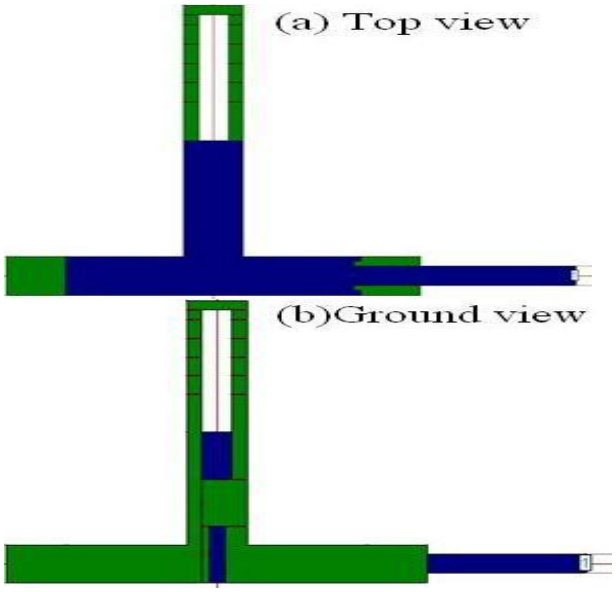

Fig. 13: Patch with Inverted-T shaped ground 4.(a) Top view (b) ground view(bottom view)

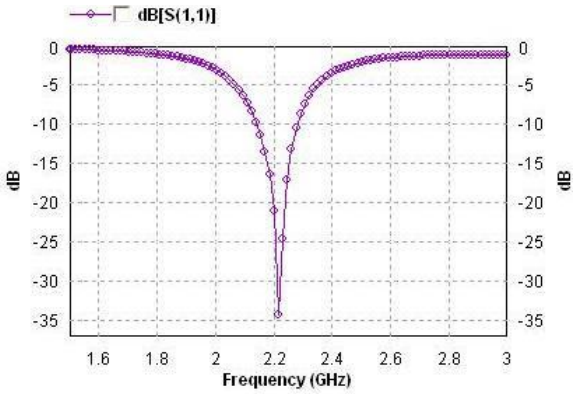

Fig. 14: Variation between Return Loss and Frequency for patch with ground

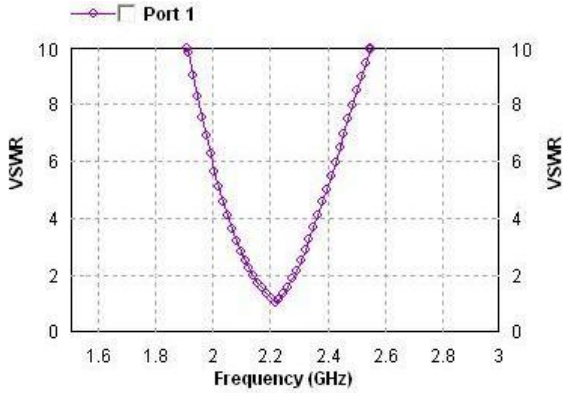

Fig. 15: Variation between VSWR and Frequency for patch with ground 4

RESULT AND DISCUSSION

TABLE 5 : COMPARISON OF INVESTIGATED ANTENNA PARAMETERS.

	Resonance Frequency (GHz)	Return Loss (dB)	Bandwidth (MHz)	VSWR
Refrence patch	3.5	-20.03	80.22	1.18
Patch with ground 1	2.71	-31.64	313.2	1.054
Patch with ground 2	2.4	-13.88	291.1	1.51
Patch with ground 3	2.36	-36.88	116.13	1.02
Patch with ground 4	2.21	-34.39	137.1	1.03

A compact inverted-T shaped patch is designed for 3.5 GHz . This patch is analyzed with a inverted-T shaped ground structure. It is found that by varying the length of vertical arm, width of horizontal arm and cutting rectangular slots on the inverted-T shaped ground the resonance frequency decreases. A different resonance frequency is obtained for different ground structure. At these resonance frequencies antenna parameters Return Loss, Bandwidth and VSWR are measured and compared. Investigated results of return loss,VSWR and bandwidth for patch with different ground structure are shown in Table 5.

CONCLUSION

The size of the antenna is increases as the resonance frequency decreases thus designing a compact antenna for low microwave frequency is a challenging topic. In this research paper a antenna is designed at higher resonance frequency to obtain compact geometry then Ground plane is modified to obtain lower resonance frequencies. The Return Loss, Bandwidth and VSWR is measured and compared at these resonance frequencies. These antenna parameters are found suitable for an antenna to be used for wireless communication.

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