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Microstrip Patch Antenna with DGS for Bluetooth Application

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***Abstract*— A Compact Microstrip Patch Antenna With Defected Ground Structure(DGS) is proposed for Wirless Applications (Bluetooth). By Inserting E shaped Slot in the gnd of patch to enhance the bandwidth of antenna. Results show that an excellent Bandwidth is achieved with DGS, besides reduction in the antenna size by applying DGS concept. Higher bandwidth is achieved by DGS techniques with adding E shaped Slot to gnd of radiating patch. The different shapes U,I,T & E etc in gnd of patch antenna is analysed to design broadband antenna. This compact antenna fed by insert microstrip feeding to edge of patch.The proposed antenna exhibits a much higher impedance bandwidth(2.38-2.53GHz) of about 150MHz and also yields return loss better than −15 dB in the useful range of Bluetooth application. It has been found that this antenna offers higher bandwidth with good radiation properties required for Wireless applications. The proposed antenna possesses a gain of 2.56 dB with the overall size is 60mm*60mm*1.6mm.**

Keywords: DGS, HFSS, Microstrip, Insertfeed, E-shape slot,etc.

I. INTRODUCTION

Communication plays an important role in the worldwide society, now a days most of the communication systems are wireless because it provides less expensive alternative and flexible way for communication. Thus different new emerging technologies are introduced for optimization of antenna. Antennas are becoming primary aspects in communication systems, so antenna designing is becoming more active field. Microstrip patch antenna is one of the antenna type which is been used widely. Microstrip patch antenna consists of radiating patch and one side of dielectric substrate which has ground plane on other side. The patch is made of conducting materials such as copper/gold and can take any possible shapes. The radiating patch and feed lines are usually etched on dielectric substrate[1].patch can be available in shapes like rectangular, square, elliptical, circular or some other common shapes.

Due to advantages provided by microstrip patch antennas such as light weight, low volume, low cost, compatibility with integrated circuits and easy to install on rigid surface. However microstrip patch antennas have narrow bandwidth, thus bandwidth enhancement is necessary for practical applications, so for bandwidth enhancement different approaches have been utilized. DGS is one of them.

The DGS introduces shape defected on a ground plane which disturbs shielded current distribution depending on shape and dimensions of defect made on the ground [2].This affects the input impedance and current flow of antenna.

Thus enhanced bandwidth and less return loss can be achieved with DGS. Therefore in this paper we design a microstrip patch antenna with DGS for Bluetooth applications to determine the effect of using DGS.

II. LITERATURE SURVEY

From the book Antenna Theory by Balanis, the basic information about antenna and antenna parameters as well as calculations performed over here was taken. From reference [4] design of multilayer aperture coupled stacked microstrip patch antenna for WLAN application, observations such as operating frequency is 2.51 GHZ, antenna consist of 3 FR4 substrate layer, high gain and bandwidth was concluded.

It was needed to do some experiments for Bluetooth application too. So, after going for it, from article compact design of H shape fractal Microstrip patch antenna using different DGS for wireless Applications [5] antenna operating frequency is 2.7 GHZ and return loss is -17.66 observed. However the results can get improved by changing the shape of DGS was observed.Going ahead, from patch antenna design analysis for wireless communication optical frequency is 0.9 GHZ, 0.87 GHZ, and 0.90 GHZ an antenna is simulated in HFSS software.

III. MICROSTRIP ANTENNA DESIGN

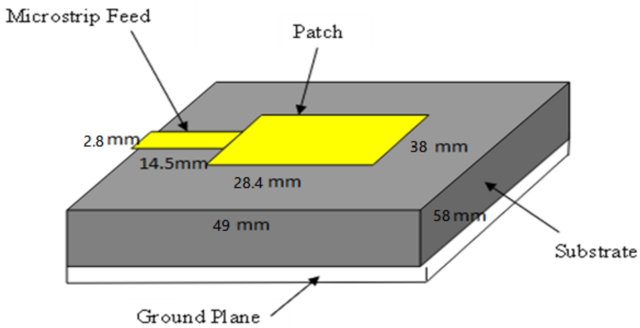

Figure 1: microstrip patch antenna

This figure shows microstrip patch antenna using microstrip line feeding technique. In this proposed antenna rectangular shaped patch is used and feeding which is used to patch antenna section to 50Ω transmission line.

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Microstrip antenna in rectangular shape is the easiest geometry for designing and implementation. The rectangular patch antenna dimension is 28.4 mm×38 mm using the dielectric FR4 substrate having permittivity 4.4 and thickness is 1.6 mm and operated at 2.45 GHZ frequency.

IV. METHODOLOGY

The value of resonant frequency (Fr) is 2.45 GHz and dielectric constant of the substrate (εr) is 4.4 and Height of dielectric substrate (h) is 1.6mm.

Next step is to calculate the other parameters like length and width of micro strip patch is given as follows [3]:

Step 1:

Width of micro strip patch is given below:

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Step 2:

Length of micro strip patch is given below:

$$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

Step 3:

Substrate dimension-

For this design this substrate dimension would be

Ls=L+2*6h

W_s =W+2*6h

Step 4:

Feed Length-

Feed length (fl) =lam/4*sqrt (4.4)

Step 5:

Feed width

$$Z = \frac{377}{\sqrt{er}(w/t+2)}$$

where,

er=dielectric const=4.4

w=width of feed line=?

t=thickness of substrate=1.6mm

z=50 ohm

Sr. No	Parameters	Calculated Dimensions(mm)
1.	L	28.4
2.	W	38.0
3.	Ls	49.0
4.	W_s	58.0
5.	Fl	14.5
6.	Wf	2.8

Table 1: calculated parameters

V. SIMULATION RESULTS

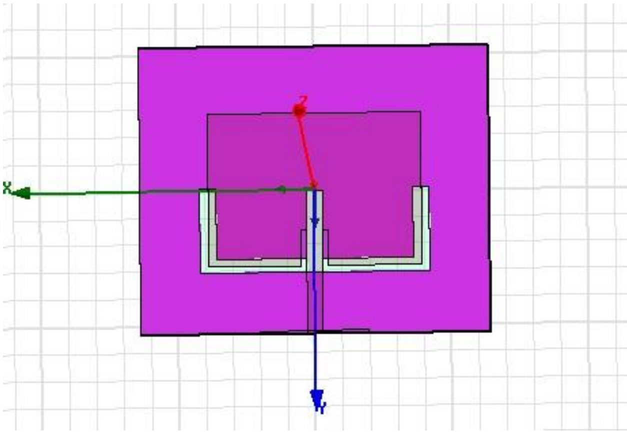

Figure 2: E slot on patch

Simulation of this antenna has been carried out in HFSS. As shown in above figure the shape of DGS designed is E .The simulation results are given in the following section:

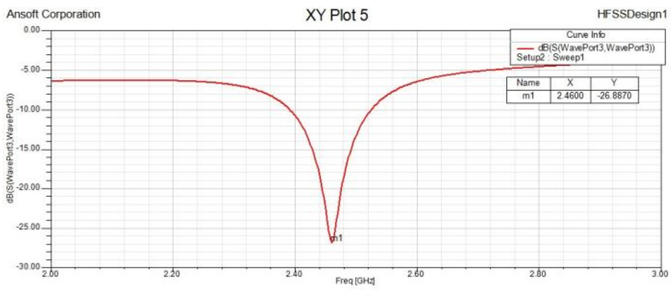

Figure 3: Return loss

The figure 3 shows the return loss of the antenna with DGS. The result shows return loss -26.88 dB. The return loss graphs shows S-parameter versus frequency for which antenna is designed. The antenna which is designed shows return loss at 2.45GHz.

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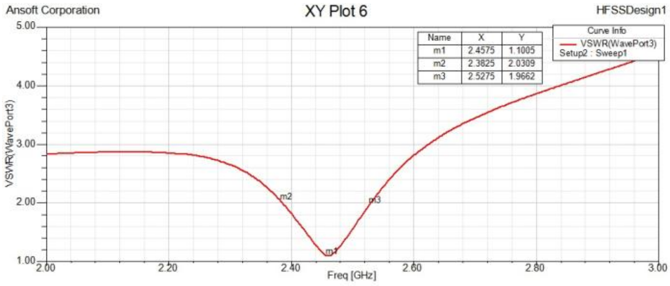

Figure4: VSWR

The ratio between the maximum voltage and the minimum voltage along the transmission line is defined as the Voltage Standing Wave Ratio or VSWR. An increase in VSWR indicates an increase in the mismatch between the antenna and the transmission line. As shown in figure 4 the value of VSWR is 1.10.

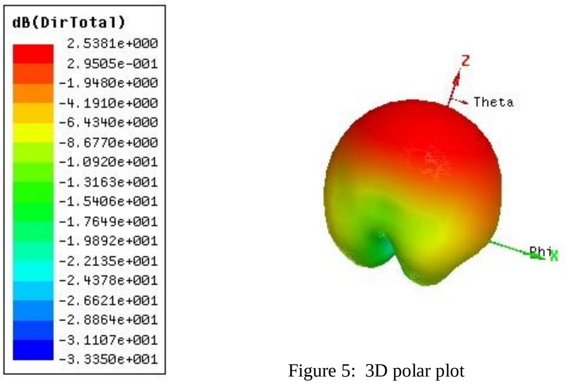

Figure 5: 3D polar plot

The 3D view for the gain of antenna with DGS is also shown in the figure 5.Obtained gain with E shaped structured DGS is essential to operate antenna with resonant frequency 2.45 GHZ.

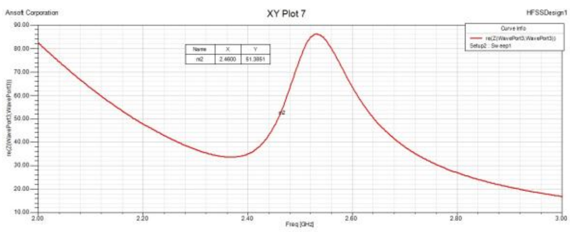

Figure 6: Impedance

The VSWR provides an indication of how closely the impedance of an antenna matches the impedance of the connecting transmission line. If an impedance mismatch exists, a reflected wave will be created towards the energy source. As shown in figure: 6 the value of Impedance is 51.38.

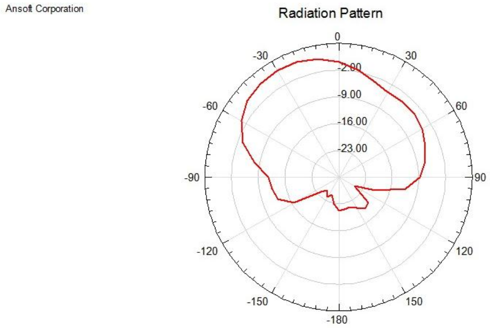

Figure 7: Radiation pattern

The radiation pattern of antenna is shown in figure 7 in which fields are presented.

VI. COMPARISON OF VARIOUS SHAPES

Sr. No.	Shape in GND	Frequency (GHz)	Return loss (dB)	VSWR	Band width (MHz)
1.	U shaped slot	2.47	-21.19	1.19	117
2.	T shaped slot	2.47	-17.14	1.32	120
3.	I shaped slot	2.47	-19.46	1.25	140
4.	E shaped slot	2.46	-26.88	1.10	148

Table 2: comparison of various shapes

VII. HARDWARE RESULT

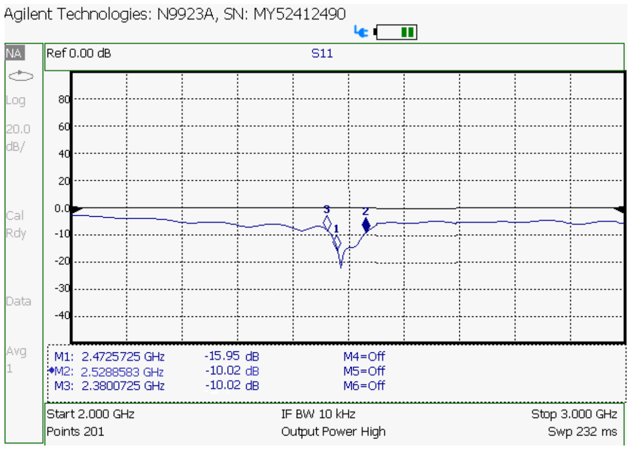

Figure 8: Return loss

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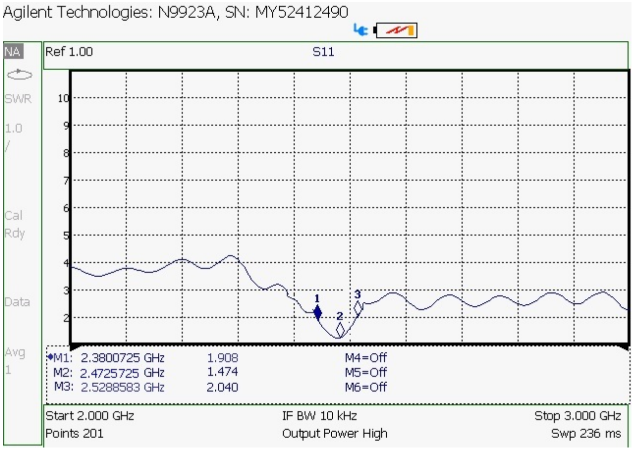

Figure 9: VSWR

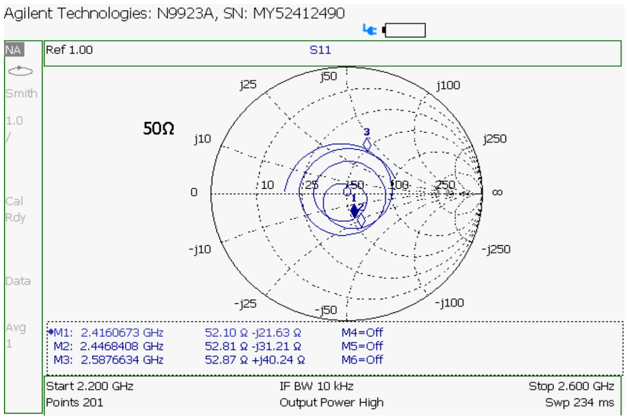

Figure 10: Smith Chart

Sr. No.	Results	Freq (GHz)	Return loss(dB)	VSWR	BW (MHz)
1.	Simulated Results	2.46	-26.88	1.10	148
2.	Measured Results	2.47	-15.95	1.47	150

Table 3: Software and hardware results comparison

From above table it is seen that hardware testing results are approximately meeting software simulation results. The hardware results are low as compared to software results due to some losses such as connector losses, hardware tolerance, insertion losses, etc.

VIII. CONCLUSION

The microstrip antenna with DGS was presented for Bluetooth applications. This DGS configuration has been shown previously to improve the antenna's impedance bandwidth. The E shape in ground was used to get size better size reduction & more bandwidth.

The proposed geometry exhibits the return loss less than −15 dB. With optimum slot dimensions this antenna offers bandwidth 150MHz.The simulated results showed very good results. The proposed antenna have some favorable characteristics such as; compact size, almost symmetrical radiation pattern , higher Bandwidth, satisfactory return loss and acceptable bandwidth in desired frequency. Analysis of this antenna has been carried out on the basis of type of antenna that is with DGS and without DGS. Overall simulated parameters of proposed antenna are suitable for the wireless communication.

Type of Antenna	frequency (GHZ)	Return Loss (dB)	VSWR	Bandwidth (MHZ)	Directivity (dB)
Without DGS	2.44	-16.91	1.35	65	4.47
With DGS	2.46	-26.88	1.10	148	2.90

Table 4: comparison table

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