Research Article

A microstrip antenna for Bluetooth, WLAN and X band communication applications using Defective Ground Structure

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Abstract: In this article, a multi band antenna designed using FR-4 Epoxy as a substrate is introduced and discussed. The proposed antenna has a thickness of 1.6mm. A L shaped slot and a I shaped slot is etched on the metal portion of the ground structure. The introduced antenna resonates at 2.6, 5.2, 7.3 and 9.4GHz frequencies which are useful for Bluetooth, Wireless Local Area Network and X band communication. The significance of the projected antenna is to obtain the parameters S_{11}, VSWR, bandwidth, radiation pattern and gain. The obtained result confirms that the designed antenna works good with the gain 3.57 to 5.52 dB with working bandwidth for VSWR less than 2.

Keywords: Bluetooth, WLAN, X band, DGS

1. Introduction

The antenna is used for accumulation and broadcast signals, for filtering of phony signals a bandpass filter is cascaded after the antenna [1]. Communication Systems with broad-band capacity in high mobility environment are the future generation requirements of our wireless networks. The approach of multi-functional single-aperture are very important part of wireless systems [11]. Mainly researches have been done in improving the data transfer capacity, but inadequate in enhancing the gain. Antenna is fundamental component in wireless networks and the added advantage of using an antenna its simple execution, fabrication, size, less weight and it needs the same tie to fulfil three main classes of necessities. i) geometrical characteristics ii) electrical execution and iii) manufacturing necessities. Medical and scientific industries have largely expanded the demand of wireless devices. hence to reach several applicants the market is grown enormously [19]. Principally, the antenna needs to have high addition, little physical size, broad bandwidth, versatility, adaptability, particularly and the bandwidth for impedance, polarization, axial ratio, radiation patterns and gain increase are turning into the most significant elements that influence the use of antennas in future wireless communications[3]. A media transmission gadget needs to have high portability where a small and light weight antenna is one of the most suitable applications [10].

The improvement of an antenna appropriate for a scope of frequency bands which are broadly utilized in present day microwave communication system. Examples of microstrip patch antennas are communication relay satellite, TV- broadcast, high-frequency direction finder, encryption of radio waves, wireless local area network [16], sonar and medical diagnosis [14]. The wireless communication industry has seen an extreme improvement in the field of low force, short range microwave correspondence devices like cell phones [5]. These highlights make them ideal segments of present communications systems, especially in cellular and WLAN applications. [18].A new standard called as WiMAX (world-wide inter-operability for microwave access) this is established by an IEEE working group whose data rate is 70mbpsTherefore, to upgrade present-day communication systems innovation, analysts have been reading different approaches for making noveland creative antenna.[7] In wireless communication system antennas play a very unique role. The microstrip patch antenna is well known in miniature antenna.FR-4 Epoxy is the dielectric substrate used in microstrip patch antenna along with a ground plain on the other side.

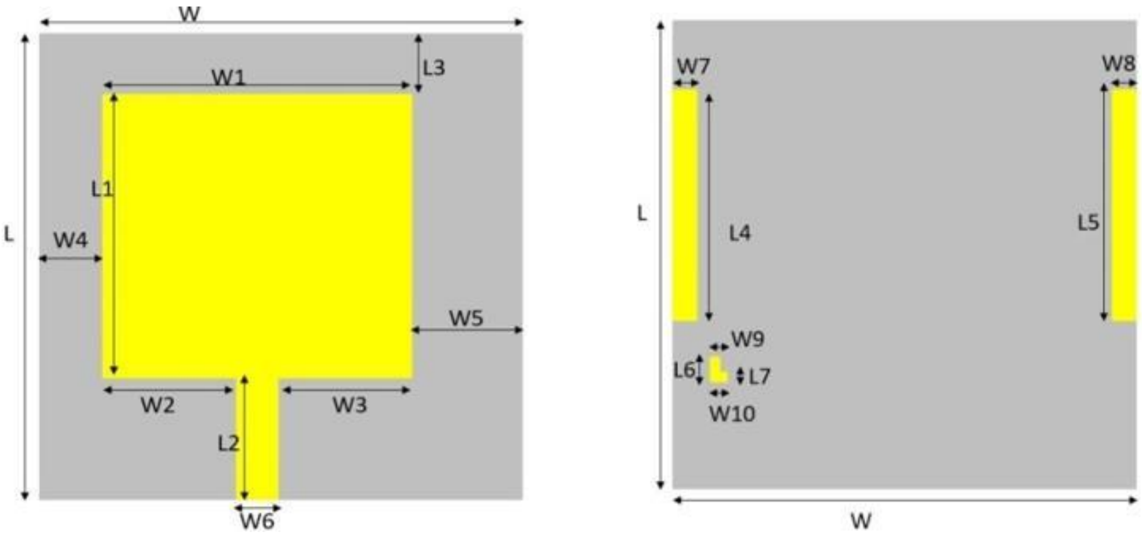
The key point is low fabrication cost, less weight, also has low profile planar design and has the ability to join with microwave composed circuits. For example, pagers, digital phones, radar frameworks, wireless communications system and satellite correspondences frameworks.[12] Copperor gold is popularly used material for the patch of the antenna as it would take any possible shape. The patch is a radiating element which is chiseled along with the feed lines on to the dielectric substrate [17]. After reflecting of the ground, the, electromagnetic waves are being radiated into the air. [19].The data transfer capacity of the patch can be improved by inserting various kind of slots intothe transmitting component [13]. Higher rate of information and smaller size of gadgets is the demandof next generation. In this advancement two noteworthy standards are Wi-Fi (WLAN) and Wi- MAX.A compact antenna and proficient is the key for success of many wireless communication applications which gets progressively more noteworthy in our life.

Microstrip reception apparatuses (MSA) have some of these qualities like simplicity and low profile which illustrates that MSA are suitable. We use FR-4 Epoxy as our substrate as it is a thick dielectricsubstance having a dielectric constant of 4.4 which results in a good capability, greater transmission of data and enhanced radiation. this design has traditionalist, basic structure, smaller and practical.The making of a conventional antenna to execute as a multiband antenna with different techniques prompted. The restriction of narrow band width by using a conventional patch in its place of broadband antennas is a major problem associated with patch antenna [9]. Regardless of various appealing highlights, microstrip patch antenna experiences a few detriments, narrow bandwidth[14]Adjustment of the radiation part fragmentary ground plane, feeding of structure, embeddings capacitor connects patch to its DGS, embeddings chip resistor between them or embeddings a chip inductor are the few standard methods that can be used for widening impendence[9].As a result, single patch antennas with multi-band attributes has pulled in much consideration.[11]

This antenna design is designed and analysed by using High Frequency Structural Simulator. The dimensions of the design are of 40 mm x 40 mm with a thickness of 1.6 mm and it consists of slots inI and L shape which is used for Bluetooth, WLAN and X band applications [4]. A detailed analysis is produced with accurate position and size of the structure. The obtained outcomes comprise of S (1,1), bandwidth, VSWR, radiation pattern which permits both E and H plane radiation [8].In order to obtainresults in a lower operating frequency and changing the current distribution we add slots on non- radiating edges of radiating patch [18].

2. Design of a novel wideband antenna

The proposed Novel wideband antenna format and detail setup is introduced in Fig. 1 and its last



measurements are gi

(a) (b)

Fig. 1 (a) Proposed antenna layout (b) detailed configuration

Antenna Formulas:

Width of the proposed configuration

$$w = \frac{c}{2f_0\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Calculation of Effective length (L)-

Table1: Measurements of antenna

W=40mm	L=40mm
W1=28mm	L1=26mm
W2=11.5mm	L2=9mm
W3=14mm	L3=5mm
W4=4mm	L4=18mm
W5=8mm	L5=18mm
W6=2.5 mm	L6=1.4mm
W7=2mm	L7=0.8mm
W8=2mm	W10=1mm

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{eff}}}$$

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}}$$

3. Results

A Simulated Results

The proposed structure of antenna resonating at 2.6, 5.2, 7.3, 9.4GHz with a return loss of -14.49, -18.95, -17.63, -17.37dB respectively. Initially the proposed antenna gives us 2.6, 5.2, 7.4 and 9.5GHz frequencies with VSWR to be 1.89, 1.277, 1.740 and 1.37 correspondingly, when the patch is placedat the centre. To obtain a improved results in gain and VSWR the patch is shifted towards the left and the feed length is increases to 9mm which resulted in 1.73, 1.42, 1.31 and 1.50 VSWR values. To improve the VSWR of the design a 1.4*1mm (L shape) slot is inserted in the ground structure and the obtained VSWR values are 1.75, 1.12, 1.23, 1.15 and the gain obtained is less. A symmetric slot of dimension 18mm x 2mm is incorporated in the ground plane, without altering the resonance the VSWR of all the frequencies reduced to values<1.6 with good gains.

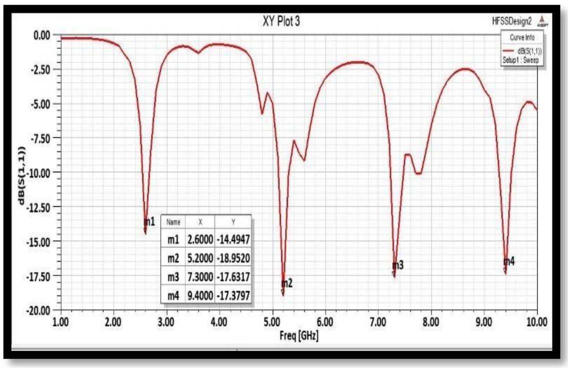


Figure 3: S11vs Frequency

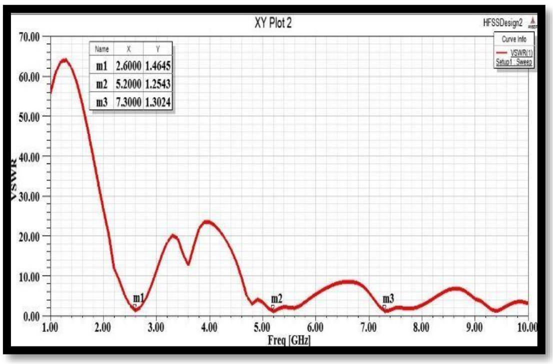


Figure 4: VSWR vs Frequency

The S11 of proposed structure is illustrated in figure.3 and the voltage standing wave ratio is depictedin figure. 4

Design evolution steps analysis :

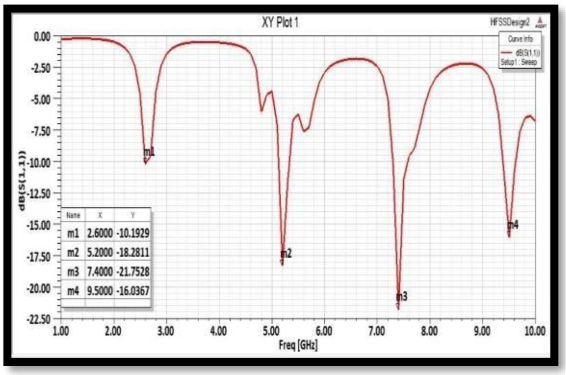


Figure5:step #1- Patch at center

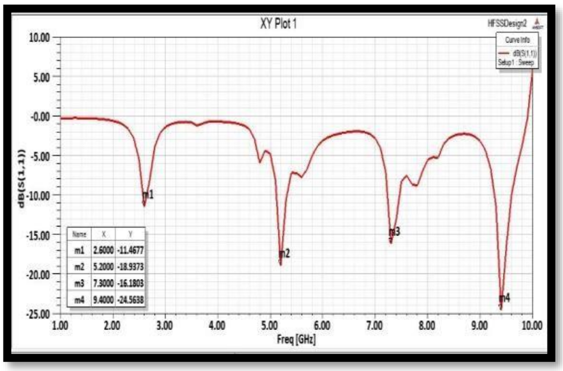
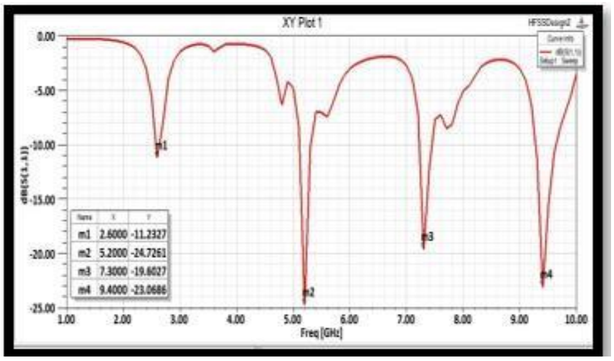


Figure 6: step **#2-**Shifting the patch to the left by 2mm.



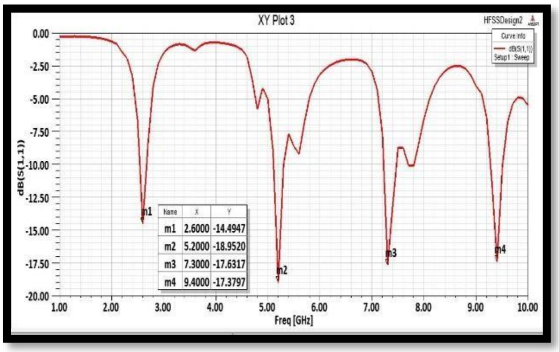


Figure7: step #4 -Inserting L slot in the ground. Figure8: I shape ground plane

Table2: Intermediate design levels

SL.No.	**Steps**	**Frequency (GHz)**	**VSWR**
1.	Microstrip patch antenna at centre.	2.6/5.2/7.4 and 9.5	1.89/1.27/1.74 and 1.37
2.	Shifting the patch to the left by 2mm.	2.6/5.2/7.2 and 9.2	1.73/1.42/1.31and 1.50

3.	Inserting L slot of size 1.4x1mm.	2.6/5.2/7.3 and 9.4	1.75/1.12/1.23 and 1.15
4.	I shape ground structure with DGS	2.6/5.2/7.3 and 9.4	1.46/1.25/1.30 and 1.31

The proposed structure of antenna resonating at 2.6, 5.2, 7.3, 9.4GHz with a return loss of -14.49, -18.95, -17.63, -17.37dB respectively. Initially the proposed antenna gives us 2.6, 5.2, 7.4 and 9.5GHz frequencies with VSWR to be 1.89, 1.277, 1.740 and 1.37 correspondingly, when the patch is placed at the center. To obtain a improved results in gain and VSWR the patch is shifted towards the left and the feed length is increases to 9mm which resulted in 1.73, 1.42, 1.31 and 1.50 VSWR values. To improve the VSWR of the design a 1.4*1mm (L shape) slot is inserted in the ground structure and the obtained VSWR values are 1.75, 1.12, 1.23, 1.15 and the gain obtained is less. A symmetric slot of dimension 18mm x 2mm is incorporated in the ground plane, without altering the resonance the VSWR of all the frequencies reduced to values<1.6 with good gains.

Gain :

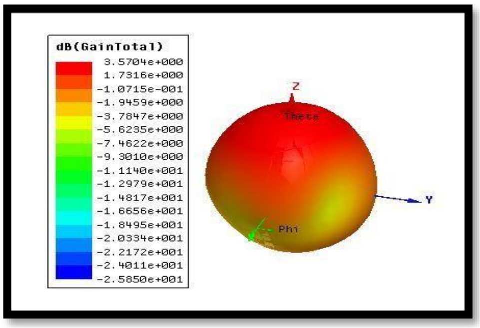


Figure9: 3.57dB for 2.6GHz

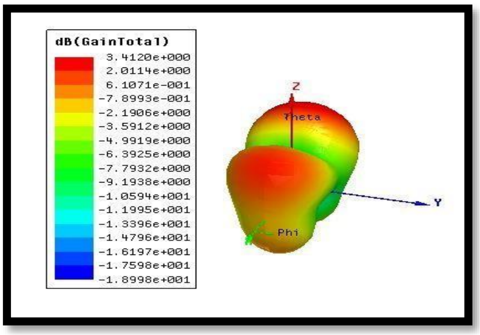


Figure10: 3.41 dB for 5.2GHz

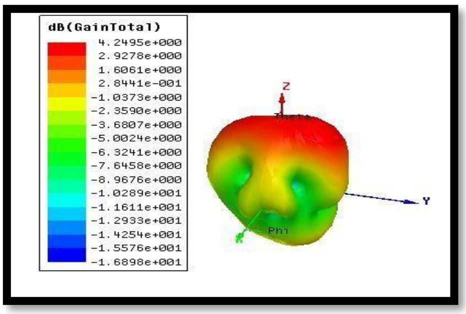


Figure11: 4.24 dB for 7.3GHz

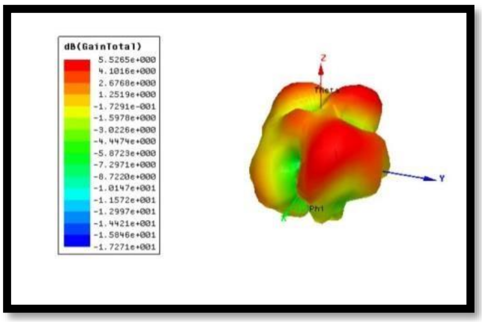


Figure12: 5.52 dB for 9.4GHz

This figure reveals that the designed antenna produces a gain of about 3.4120dB at 2.6GHz, 3.5704 dB at 5.2GHz, 4.2495 dB at 7.3 GHz, 5.5265 dB at 9.4 GHz.

4. Radiation pattern:

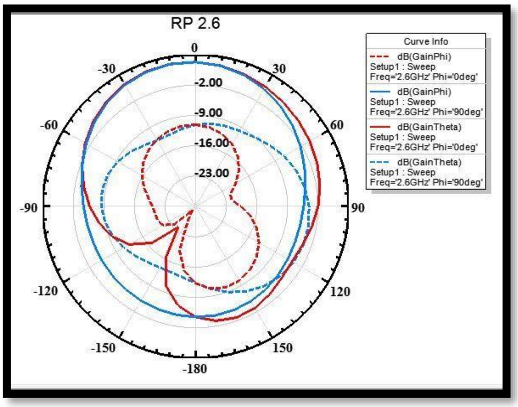


Figure13: For 2.6GHz

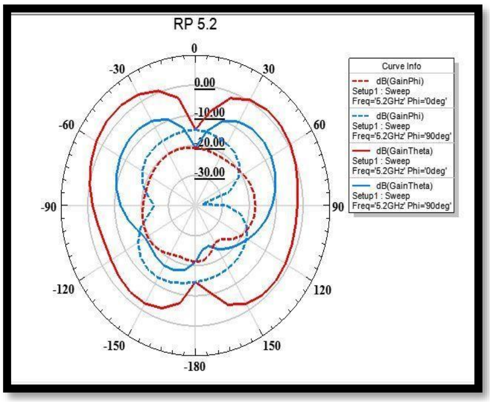


Figure14: For 5.2GHz

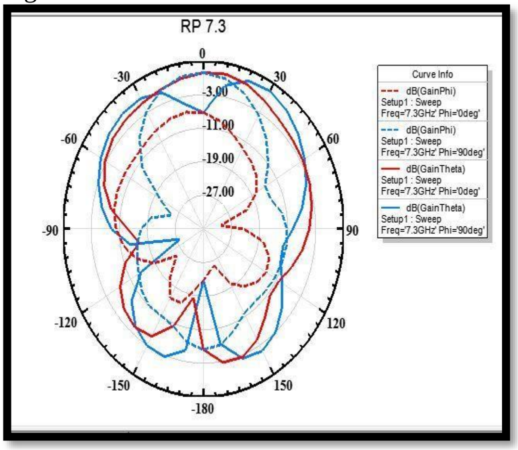


Figure15: at 7.3GHz

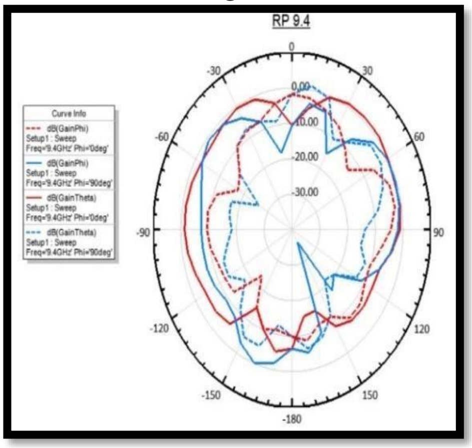


Figure16: at 9.4GHz

5. Conclusion

The designed antenna resulted in operating frequencies of 2.6, 5.2, 7.3 and 9.4GHz. The obtained frequencies are useful for applications of Bluetooth, Wireless Local Area Network and X band correspondingly. Reduction in the value VSWR obtained due to the effect of defective ground structure. The gains and return loss acquired are acceptable. The DGS play an important role in minimizing the VSWR without altering the resonance in every design step.

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