DGS based Planar Inverted F Antenna for Multiband Applications

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Abstract*: As Long Term Evaluation systems have more benefits when compared to other network systems, it became more popular. Integrating a lower band with a higher by considering space as a constraint became a challenge for designers. A simple PIFA (Planar Inverted F Antenna) with DGS(Defective Ground structure) is suggested inmultiple band applications. The proposed antenna is designed using the CST Microwave Suite 2017. The design is for substrate having ε,of 4.4(FR-4), (tan δ) 0.02 as loss tangent with a thickness of 1.53mm is preferred for designing of this antenna and is etched directly upon the substrate.

Keywords : Planar Inverted F Antenna,Defected Ground Structure (DGS), Multi band, Return Loss(RL).

I. INTRODUCTION

LTE (Long Term Evaluation) has been the main features of 4G mobile systems for enhanced broadband and multimode applications like GSM,UMTS.LTE has gained popularity among mobile network technologies. Applications of LTE in mobile phones and also in various types of computers has been very well recorded [1-9].

The compact size of the cellular phone with lower frequency LTE bands creates hurdles in the design of suitable antennas. have been widely experimented. For achieving desired characteristics, lot of effort goes in optimization of chosen design parameters. The chief aim of this research is to propose multiband characteristics for mobile handsets keeping in mind uncomplicated rules of design requires to attain minimal dimensions of satisfactory operation. For this purpose, DGS structure is with simple PIFA structure is preferred.

II. DESIGN METHODOLOGY

The size of the projected simple PIFA antenna has been displayed in figure 1. The design is carried out using CST Microwave studio suite 2017which works on FEM(Finite Element Method)using substrate of ε_r=4.4 (FR-4), loss tangent (tan δ) 0.02 , (dielectricconstant) 4.4 with a thickness of 1.53mm along with copper thickness of 0.035mm were chosenfor making DGS and patch below and up side of the substrate. The simple antenna based on PIFA has been governed by the following equation with centre frequency of 2 GHz.

$$f = \frac{c}{4\,(L1-gX)\sqrt{\varepsilon_r}} \quad (1)$$

Where f = operating frequency

$L1 - gX$= Length of antenna

ε_r =dielectric constant

C= Velocity of Light

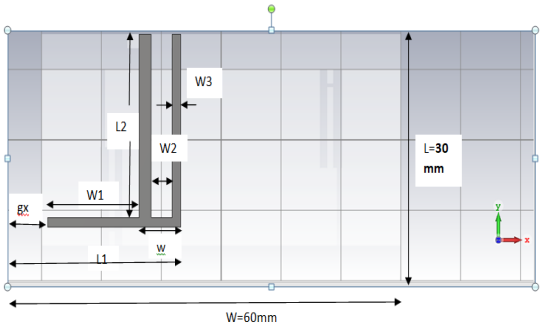
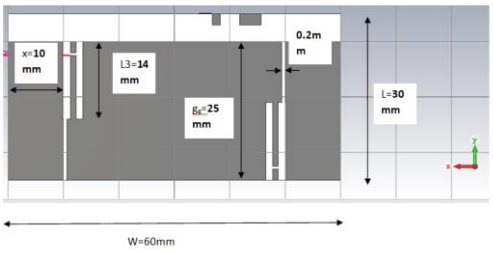
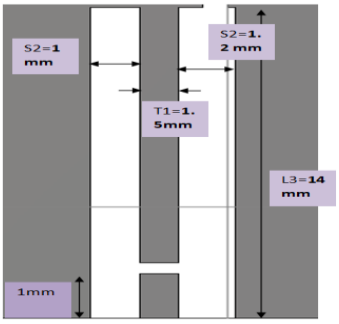


Figure 1: Geometry of the Proposed Antenna

1(a): Top View



1(b): Bottom View



1(c): Magnified slot View

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Table 1: Dimensions of the projected antenna

SL. NO	Parameter	Value(Mm)	SL. NO	Parameter	Value (Mm)
1.	Length Of Gnd Plane, L	30	9.	Thickness of patch ,hp	.035
2.	Width OF Gnd Plane, W	60	10.	Width ,W1	
3.	Distance from edge, g_x	10	11.	Slot distance from edge(X), x	10
4.	Width of patch, L1-gX	18	12	Gap between slots,T1	1.25
5.	Width of shorting Line ,W3	1.4	13.	Length of slot,L3	14
6.	Gap between two lines, W2	3.5	14.	Width of slot,S2	
7.	Length of patch , L2	25	15.	Length Of Gnd,g_g	25
8.	Thickness of substrate ,hs	1.53			

According to principle of PIFA antenna, the required length of the Monopole antenna (L1-gX) equals ƛ/4 wave length and is about 18mm at the frequency of 2GHz.The dimensions of the proposed simple PIFA structure with DGS is given in table 1.

III. RESULTS AND DISCUSSIONS

The simulation characteristics for without DGS is given in figure 2.This was resonating at 2 placeswith a -6dB impedance bandwidthfor the design shown in figure 1(a) at 1.87 GHz and 3.22 GHz with a RL of -3.22dB and -6.4dB respectively.

For further improvement of RL of the projected structure DGS structure is designed by etching various slots on the GNDhaddisplayed in fig.1(b).By etching slot 1(from bottom of the GND plane) another frequency is observed at 4.56GHz with a return loss of -15dB and also the frequencies of 1.87GHz and 3.22GHz is shifted to 1.69GHz and 2.77GHz with a return loss of -5.67dB and -24.5dB as shown in figure 3. Slot 2 (from top of the GND plane) is etched to have the same resonant frequencies with return loss of -5dB, -19dB and -16dB respectively as shown in figure 4. Slot 3 is etched which is connected with slot1 to make antenna to resonant at 2GHz so that the return loss is shifted to -10dB,-6.92dB and -14.4dB with frequencies of 2.057GHz,3.1GHz and 4.38GHz respectively as shown in figure 5. Similarly another slot is etched to connect with slot 2 to improve the performance further that results in appearance of another frequency at 3.76GHz with return loss of -4.97dB and also improved the return loss at the same frequencies as said before with slot 3 with return losses of -15dB,-3.3dB and -12dB as shown in figure 6. 5 was etched to improve return loss for 4.39GHz.By including this slot, the frequencies observed at -6dB bandwidth are 2.057GHz,3.114GHz, 3.767GHz and 4.39GHz with return loss of -13.78dB,-6.7dB,-5.16dB and -12.54dB respectively as shown in figure 7. Similarly slot 6 is etched that causes the shifting of frequencies to 1.89GHz,2.9GHz,3.77GHz and 4.757GHz with return loss of -10dB,-12.54dB,-3.3dB and -28.24dB respectively as shown in figure8.

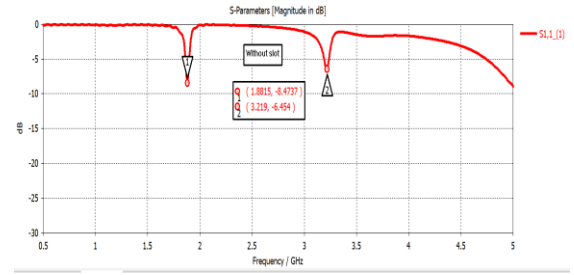

Figure 2: RL of projected antenna without slots

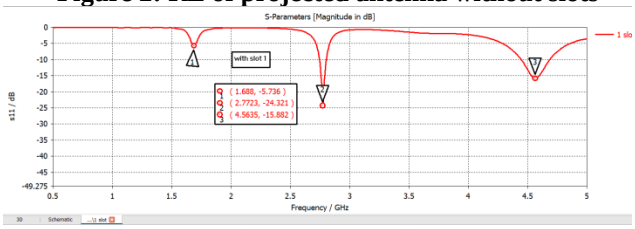

Figure 3: Return Loss of Proposed antenna with slot 1

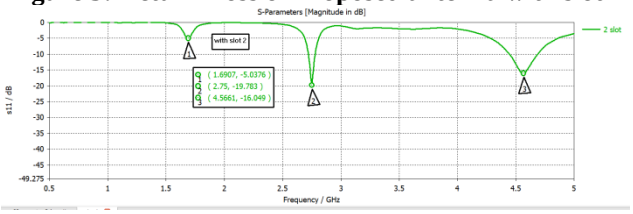

Figure 4: RL of projected antenna with slot 2

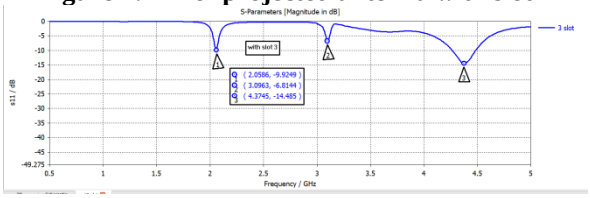

Figure 5: RL of projected antenna with slot 3

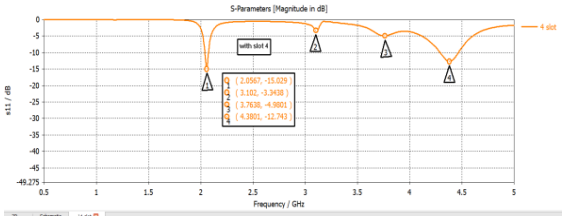

Figure 6: RL of projected antenna with slot 4

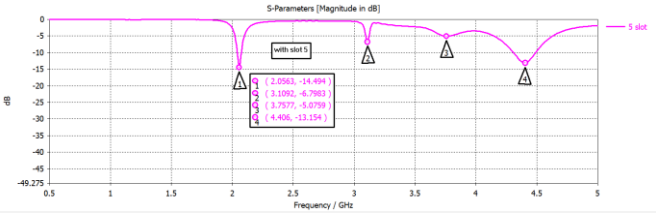

Figure 7: RL of projected antenna with slot 5

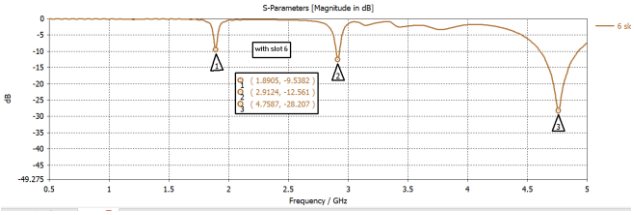

Figure 8: RL of projected antenna with slot 6

IV. PARAMETRIC STUDY OF PROJECTED ANTENNA

Parametric study was carried out to position the first slot for achieving better performance by varying the value of x from 5 to 10 and the value is optimized for 10mm from either side of the patch along X direction(width). Similarly parametric study was carried for length and width dimensions of slot and they are found to be 14mm and 1mm for better performance. The gap between the slots is also studied by varying it from 1mm to 1.5mm and the best value is found to be 1.25mm between the slots shown in figure 9. With this gap, the antenna resonates at three frequencies as 1.8797GHz, 2.912GHz and 4.82GHz at -10dB bandwidth there by covering L band, S band and C band respectively.For further improvement, horizontal slots were etched but there is no significant improvement for lower bands.

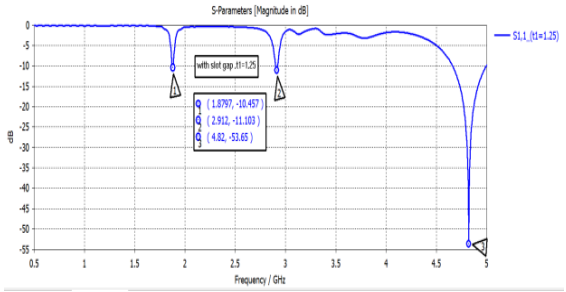

Figure 9: RL of projected antenna with gap between slots

V.CONCLUSION

In this paper, a simple PIFA with Defected Ground structure is proposed. By incorporating this structure, the operation of the antenna in terms of RL was improved in addition to exhibiting multiband characteristics which is suitable for L band, S band and C band applications.

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