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Fabrication of UWB Planar Antenna

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ABSTRACT: Reduced ground plane UWB planar antenna with slot on square patch on FR4 substrate is modeled and its analysis is presented in this paper. Performance analysis was carried out for return loss, VSWR, radiation characteristics and input impedance. HFSS tool is used for simulation and the result shows multi resonance characteristics with bandwidth of 4.6 GHz in UWB range with VSWR of 1.4. Proposed structure is optimized to yield the impedance of 47.7 O. Better results are obtained on compared with the similar results of the previous work.

KEYWORDS: UWB antennas, Planar slot antenna, HFSS simulation, FR4 substrate, multiband resonance antenna.

I. INTRODUCTION

Recently, Ultra Wide Band (UWB) technology has gains the attention of industry and academia due to its potential application to handle high data rate, relatively low power requirement and low cost. UWB technology should have bandwidth ranging from 3.1 GHz to 10.6 GHz in which practical efficiency and suitable omni directional radiation patterns are the critical requirement. UWB antenna is one of the key components for realizing the UWB multiband communication systems. However, designing a UWB antenna to deliver high performance is much more challenging with the conventional narrowband antennas. UWB antenna to should cover wide bandwidth and, to have an omni directional radiation pattern and to have a compact size as well as a simple configuration. In order to cover UWB frequency range, various design approaches such as an elliptically shaped antenna with notches [1] and a semicircular shaped antenna with defected ground structure [2] or a circular shaped antenna with slots [3] were used. With simple planar structur it is very difficult to cover the entire spectrum of UWB range. Hence, notches and different type of parasitic components are usedwith simple planar structure to provide the optimum solutions. Several approaches are used to match the impedance, such as many impedance matching stair case section structure [4], ,a rectangle shaped with curved section [5], slotted rectangular shaped structure [6] to match the impedance antenna between the feed line and patch. Radiation characteristics of antenna are mainly depends on the substrate dielectric material. Several antenna substrate materials with low dielectric constant and loss tangent are available. FR4 substrate with thickness of 1.6 mm is used in [2] and [7]. RT Duroid is used as substrate material in [1] and thick foam is used as substrate material in [8] among these material

FR4 substrate have good performance and, also flexible for the fabrication of antenna and easily available. Micro strip patch antenna design methodology is used for UWB antenna basic structure of micro strip antenna is shown in figure mainly contains three types of elements they are patch, substrate and ground plane. Perfect electric conductor is used as a patch material, FR4 substrate material, where L, W are length and width of patch and h is the thickness of the substrate. This paper is organized as follows; section II explains UWB planar antenna model and the parameters used for modeling. In section III the simulated results are discussed followed with conclusion.

II. UWB PLANAR ANTENNA DESIGN

A square shape monopole antenna with slot has been chosen as basic structure to operate over wide bandwidth and provide good radiation characteristics. Antenna dimensions are calculated based on the maximum operating frequency of 10.1 GHz. The ground plane width is λ (28 mm) and patch length as 0.5λ (14 mm). Ground plane length is selected between 0.4λ (11 mm) to 0.6λ (17 mm).

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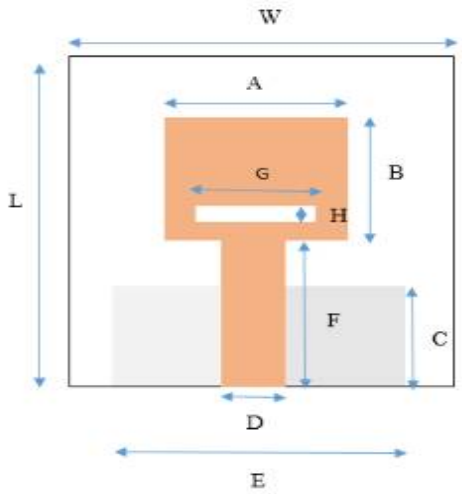

Figure 1. Schematic of proposed UWB planar antenna with slot

The schematic of proposed UWB planar patch antenna having slot on square shaped patch is shown in Figure 1. It is to be fabricated on.FR4 substrate of dimension, 30 mm x 32 mm and 1.6 mm of length, width and thickness, with material parameter having relative permittivity of 4.4 and loss tangent of 0.002. The geometry of the proposed UWB planar antenna design used in simulation is given in Table 1. Return loss depends on the ground plane length. Hence, by varying the ground plane length, the resonance frequency and return loss of antenna. The minimum ground plane length for this design is 11 mm.

TABLE I. DIMENSION OF PROPOSED UWB PLANAR ANTENNA

Parameter	Dimension (mm)
L	30
W	32
A	14
B	14
C	11
D	4
E	28
F	12
G	12
H	1

III. RESULTS AND DISCUSSION

Proposed 3D model UWB planar antenna structure used in simulation is shown in the Figure 2. It is simulated in An soft High Frequency Structure Simulator (HFSS) v11 tool. The haracteristics of proposed antenna are investigated through a parametric study. Frequency and time domain results were measured and are presented in terms of VSWR and radiation pattern. The antenna was excited using a rectangular edge-fed microstrip line. A partial conducting ground plane was used to enhance the bandwidth of the antenna. The simulated results of the return loss |S | and the standing wave ratio (VSWR) of theantenna for frequency range 3.1 GHz to 10.6 GHz and input impedance are discussed.

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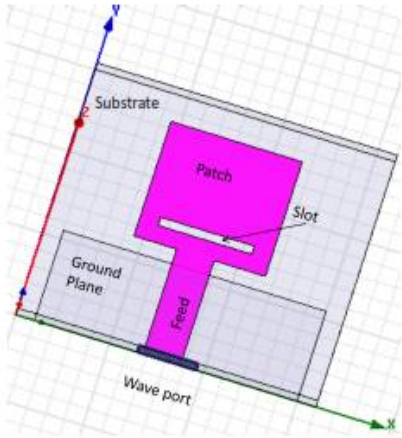

Figure 2. Schematic view of proposed UWB planar antenna in HFSS tool.

A. RETURN LOSS

Return loss for the proposed antenna is analyzed by varying the ground plane length (c) from 11mm to 17mm. the simulation results for the selected dimension is shown in the Figure 3. It is observed antenna model having dimension C11,F12, L30 shows low return loss on comparing with othermodels.

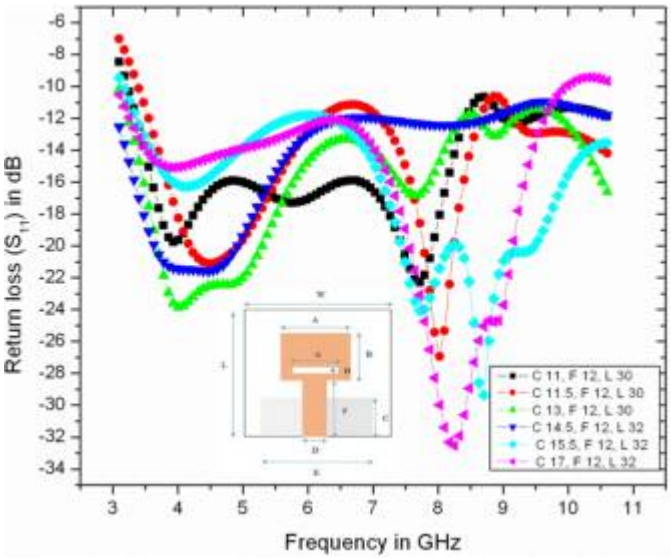

Figure 3. S11 -characteristics for different ground plane length

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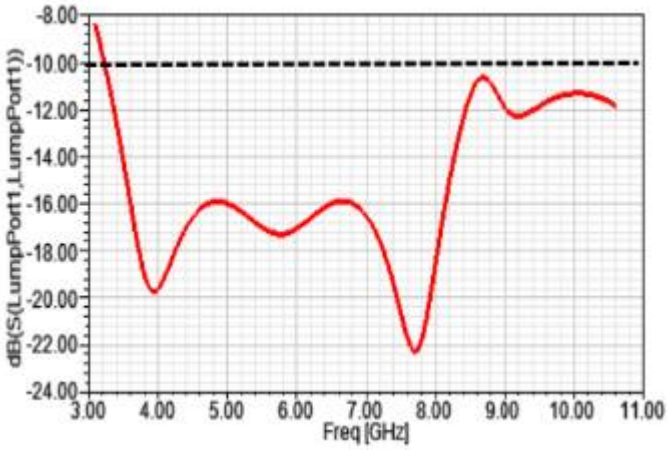

Figure 4. S11-characteristics for dimension C11, F12, L30

Figure 4 shows the simulated results of return loss for antenna model having dimension C11, 12, L30. It is observed that first resonance occurs at 3.9 GHz with S value of -20 dB. The second resonance occurs at 5.8 GHz with S11 value -17 dB.The third resonance occurs at 7.8 GHz with S11value of -22dBand the fourth resonance value occurs at 9.2 GHz with S11value of -12 dB. From this result it is inferred that proposed UWB planar antenna has multi resonance property and S11 results are better on comparing the results reported in previouswork [6], [9-13].

B. VOLTAGE STANDING WAVE RATIO

The voltage standing wave ratio (VSWR) for the proposed UWB planar antenna model is shown in the Figure 5. Fordifferent value of C, F and L VSWR are measured and hemodel having dimension C11, F12, L30 shows VSWR below1.8 over UWB range.

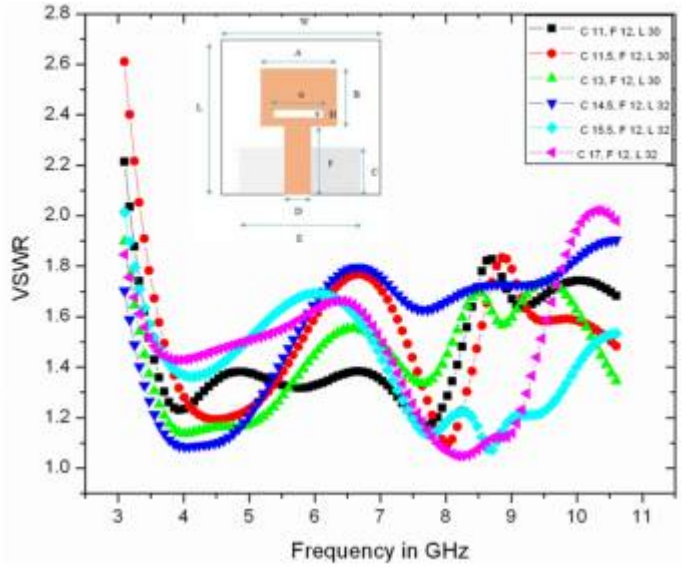

Figure 5. Simulated results of VSWR for different ground plane length

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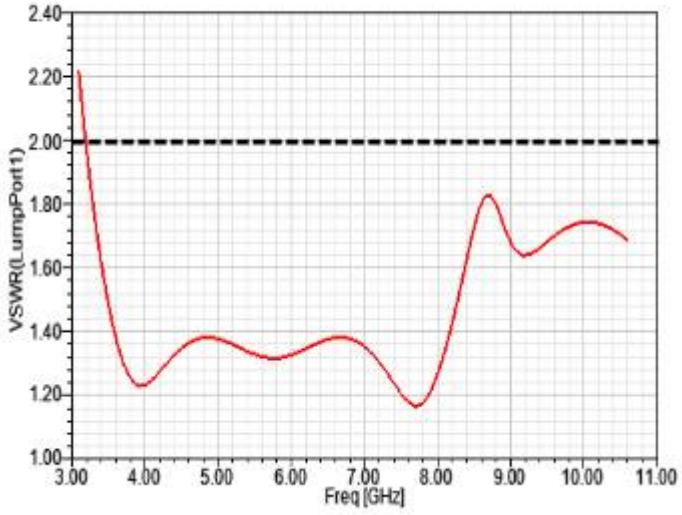

Figure 6. VSWR characteristics for dimension C11, F12, L30

The VSWR for dimension C11, F12, L30 is shown in Figure 6. It is inferred that for the proposed UWB planar antenna dimension has VSWR value below 1.4 from 3.6 GHz to 8.2 GHz.
Figure 7, illustrates the 3D radiation patterns of proposed antenna in polar form. It shows omni directional characteristics; hence the proposed design is capable of transmitting or receiving signals in all directions

C. IMPEDANCE MATCHING

Smith chart which is used to find that input impedance of proposed antenna. Figure 10 shows the impedance measurement of the proposed UWB planar slot antenna. Resonance occurs at 7.85 GHz at point m3 which produces an input impedance of 47.5 O, and it is close to the ideal impedance value of 50 O.

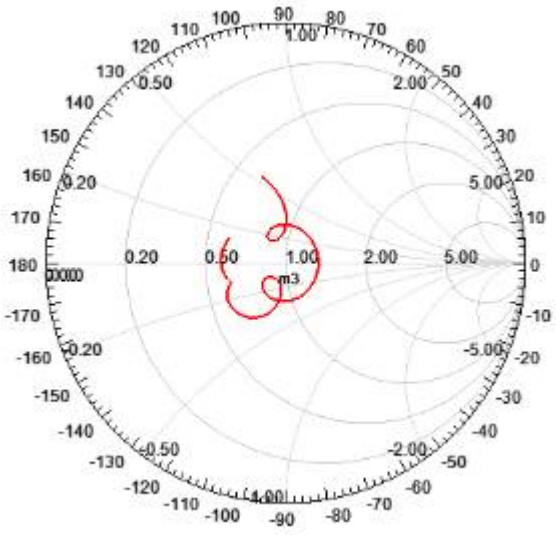

Figure 7. Smith chart for impedance measurement

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IV. FABRICATED ANTENNA

Proposed antenna is fabricated by using PCB (printed circuit board) technology in Figure 11a is the front view of the antenna which having the square patch, feed line and slot, copper is the conducting material used for the fabrication and 11(b) shows the bottom view of the antenna having the ground plane that is also the copper and finally SMA connector is soldered to the antenna

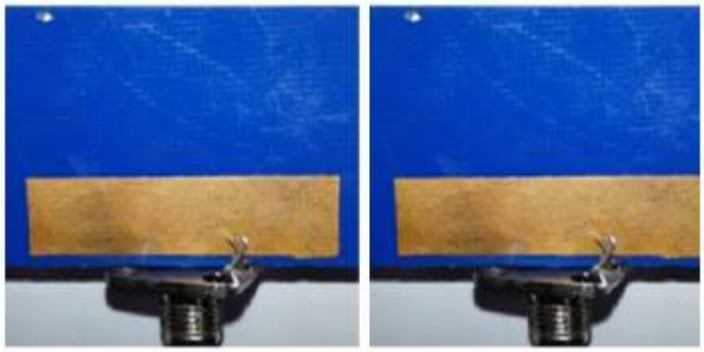

Figure 8. Figure 11: Fabricated antenna (a)Front view (b) Bottom view

A.COMPARISON OF SIMULATED AND TESTED RESULTS:

Comparison done between the theoretical and practical results of the proposed antenna for the VSWR and S-parameter Figure 12 shows the comparison of simulated and practical results for S-parameters black colour plot is practical return loss and blue colour plot is simulated return loss is below -10dB from (3-9) GHz frequency for simulated antenna but for practical case it is 2.55 GHz to 3GHz frequency also it covering with lowest return loss -30 dB and also having lowest return loss of -38dB where the simulated result only having the lowest return loss of -19 dB

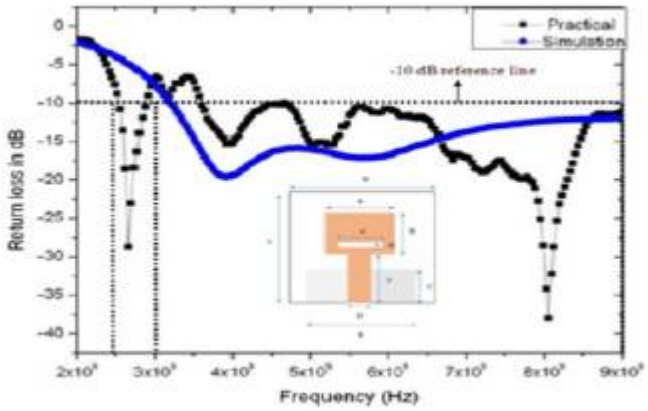

Figure 12: Comparisons for simulated and practical results of S-parameters

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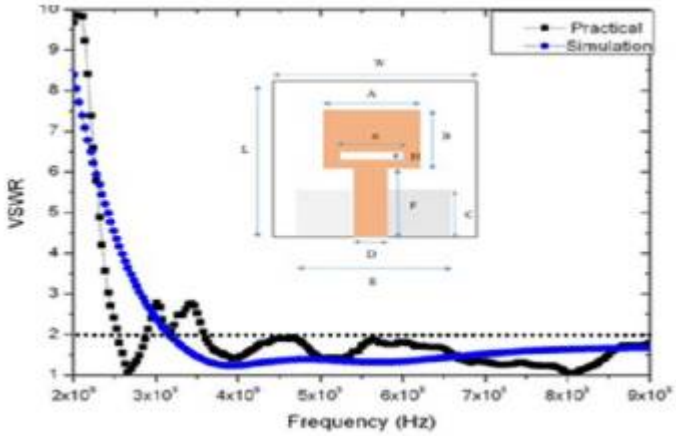

Figure 13: Comparisons for simulated and practical results of VSWR

Figure 13 shows the comparison for simulated and tested results of proposed antenna blue colour plot is the simulated result and black colour is the tested result Tested result VSWR is below two for the 2.55 GHz to 3 GHz frequency where the simulated results is above two for this frequency, from 3 GHz to 9 GHz simulated results is below two where practical results is below 2 from 3.5 GHz to 9GHz frequency but over all practical results cover more band width so practical results is best compared to the tested results

IV. CONCLUSION

Simple low profile planar UWB patch antenna for ultra wide band applications was proposed, simulated the antenna in the software with derived dimensions and optimization done for the obtained results by adjusting the ground plane length simulated results of the proposed antenna achieved the specifications of UWB antenna like Return loss obtained less than -10 dB for the UWB frequency range (3.1 GHz to 10.6 GHz). VSWR also obtained below 2 for the UWB frequency range, impedance of the antenna is also matched with the characteristic impedance value of 50. After optimization of simulated results proposed antenna is fabricated by using Printed circuit board fabrication process after fabrication proposed antenna is tested and tested results is compared with the simulated results by comparing with simulated results practical results have better characteristics.

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