A Design of CPW fed Micro-Strip Half Cut Patch Antenna by Miniaturization Concept for UWB Application

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ABSTRACT
A 50-ohm Coplanar Waveguide feed antenna is used as a monopole half cut antenna having half fork-shaped radiating patch and extended ground plane to cover frequency band 3.1 GHz to 10.6 GHz. As the proposed antenna provides frequency coverage for UWB frequency spectrum. A half cut technique is used for the miniaturization of the antenna. This antenna provides worldwide compatibility for communication among of Microwave frequency band from 3.1GHz to 10.6 GHz. This literature covers the effects of miniaturization on the reflection coefficient [S11 Parameter] and VSWR. A comparative study of antenna parameter here I discussed. Enhance the performance of the antenna in terms of constant gain, radiation pattern, and impedance matching directivity. The parametric analysis and prototype simulation has been done with the help of An-soft HFSS.

Keywords
Monopole, UWB, VSWR, Miniaturization, CPW.

1. INTRODUCTION
Services advancement is gradually increasing day by day in the field of wireless communication technologies like uninterrupted service, high speed, low cost and compatibility to other devices. To serving various services over the wireless network the new allocation of the band is required. However, the frequency spectrum range from 3.1 GHz to 10.6 GHz is a very prime band in the communication [1]. This band covers the license (Wi-MAX, 3.1-3.5 GHz, and WLAN 5-6 GHz) and unlicensed spectrum of channels[2]. Moreover, the spectrum of ultra wide band (UWB) has the ability of low-power, stable gain, high bandwidth, economic cost and high range propagation characteristics and compatibility with other supporting technologies or devices.

In this literature, a Coplanar Waveguide (CPW) fed compact micro strip half cut patch antenna design by the miniaturization technique is presented for the UWB application [3]. CPW fed antenna received much attention of their attractive features like small dimension, low profile, high bandwidth, simple design with easy fabrication, high-speed transmission rate, low power consumption and easy to integrate with monolithic microwave integrated circuits (MMIC) [4]. There are numerous antennas having a different design with printed slots shapes have been presented for ultra-wide band application. The proposed design is the half cut off the CPW fed fork-shaped antenna [5]. The comparative study of half cut and the full antenna is also concluded in terms of reflection coefficient (S-Parameter) and VSWR. This paper covers the miniaturization method and its performance to the antenna parameters.

2. ANTENNA DESIGN
2.1 Actual Design
The actual design of the antenna is consisting of the FR4 dielectric substrate (ε_r=4.4) with the thickness of 1.6mm **[8]** and dimensions are 25*30 mm^2. The existence of ground plane and radiation plane on the surface of the Z=1.6 plane, so that this design is associated as coplanar waveguide (CPW) fed. A 50-ohm fork-shaped CPW fed Antenna has implemented a version of the actual reference antenna. This antenna is propagating the frequency from 3.1 GHz to 10.6 GHz; the spectrum licensed and unlicensed band along with the UWB (3.1 GHz-10.6 GHz) band is covered by the antenna.

2.2 Miniaturized Design
The dimension of the original design is a 25*30mm^2 area in XY plane and the thickness of the dielectric is 1.6mm. The original design is split with reference to the center line at X=12.5mm. This causes the new two version of the miniaturization the design as right half and left half portion [6]. Both are symmetric to each other as the dimension of 12.5*30mm^2 with the thickness (H) of 1.6mm. These format symmetric structures have similar antenna characteristics like resonance, VSWR, and reflection coefficient, etc. as the full original antenna. In Fig.1 the original design of antenna along with the top-view and the side view is represented.

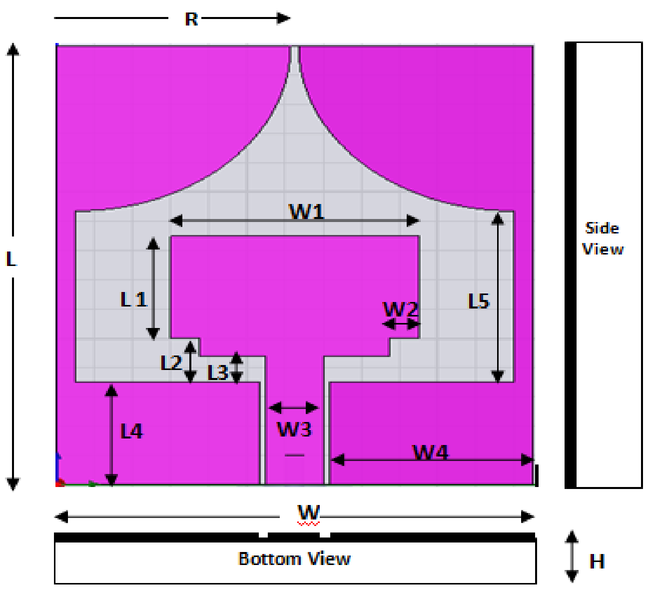
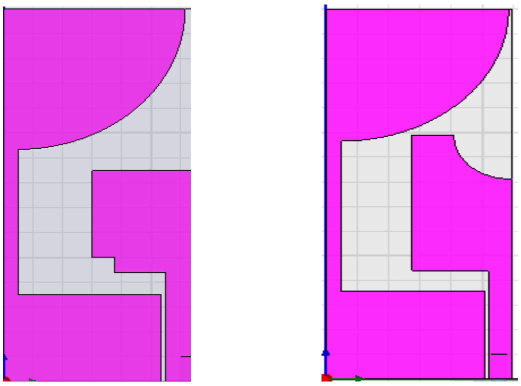


Fig. 1: The actual design of Antenna

Table 1. Dimensions of Antenna

Parameter	Value	Parameter	Value
W	25mm	L	30mm
W1	13mm	L1	6.7mm
W2	1.5mm	L2	1.25mm
W3	3.0mm	L3	1.75mm
W4	10.5mm	L4	7.0mm
R	12.3mm	L5	10.6mm



(a) (b)

Fig. 2: View of the proposed antenna by the miniaturization concept (a) Half Cut Antenna without Slot (b) Half Cut Antenna with Circular Slot

In Fig. 2(a) represent the left symmetry view of the miniaturized antenna of original antenna and Fig. 2(b) a small circular cut [R=12.33mm] is applied to the propagation plane.

3. SIMULATION PROCESS

The prototype of the antenna is designed and simulated. Measurements of antenna parameters are achieved by using an-soft HFSS [7]. HFSS is a high-performance full-wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modeling that takes advantage of the familiar Microsoft Windows graphical user interface. The proposed half cut antenna is implemented by applying the miniaturization concept on original antenna design. The parametric analysis is covered the frequency band from 3.1 GHz to 10.6 GHz, which associated with the UWB band [6]. The Simulation process is involved the comparative measurement of reflection coefficient [S11] and Voltage Standing Wave Ratio [VSWR] over the frequency range [8]. The graphical comparisons are presented in the figure of this literature.

4. PERFORMANCE ANALYSIS

4.1 Voltage Standing Wave Ratio [VSWR]

A 50ohm CPW feed antenna with feed line dimension of 3.0mm (W3) is characterized by independently adjusts. Ansoft HFSS measured the VSWR for the both antennas (reference and proposed) followed the FIT method in the simulation. Fig. 3 represents the measurement of VSWR over the UWB spectrum. The simulated VSWR value of reference antenna and half cut proposed antenna is ≤ 2, over the frequency range of 3.1 to 10.6 GHz, i.e. UWB band. In Fig. 3 the solid line and dash/dotted lines indicate the value of VSWR for respectively Reference Antenna and Half Cut without slot and Half cut antenna with the circular slot. The numerical formula for VSWR measurement is given as [10]:

$$\frac{Z_L}{Z_0} = \frac{1+\Gamma}{1-\Gamma}$$

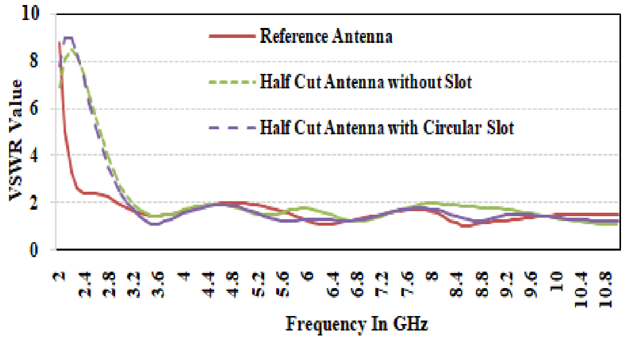


Fig. 3: Measurement of VSWR

4.2 Reflection Coefficient [S11]

The Reflection Coefficient [S-parameter] was calculated by the Ansoft HFSS. Fig. 4 represents the result for the miniaturized half cut proposed antenna without and with a slot (dash-line) and reference antenna (solid line) over the bandwidth of 7.5GHz from the UWB band i.e. 3.1GHz to 10.6GHz. There is no discrepancy in the S-parameter by the miniaturized concept applying in the original reference design. In this comparative graph, the value of reflection coefficient is below -10dB over the frequency range of UWB band [8]. A mathematical formula for the reflection coefficient is given as [9]:

$$Reflection\ Coefficient\ (\Gamma) = \frac{V_0^-}{V_0^+}$$

Where: V_0^- is reflected voltage
V_0^+ is a forwarded voltage

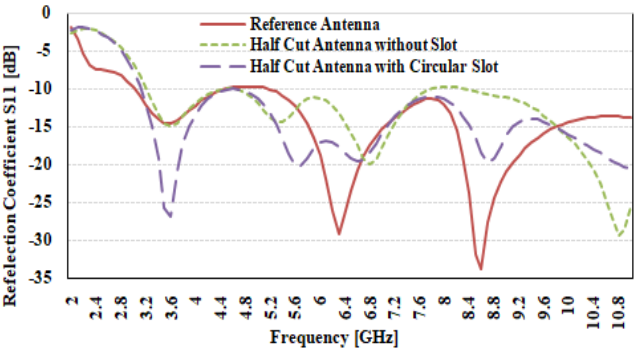
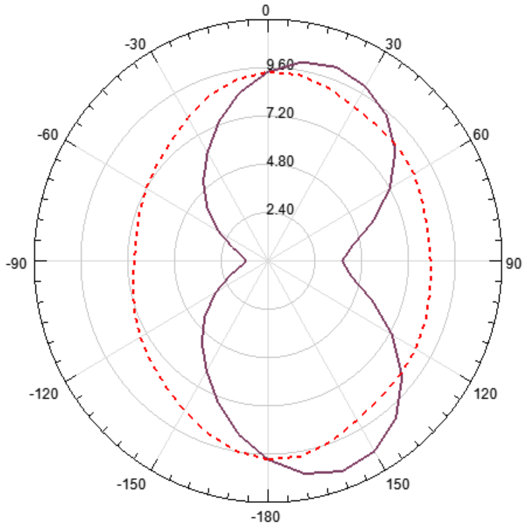


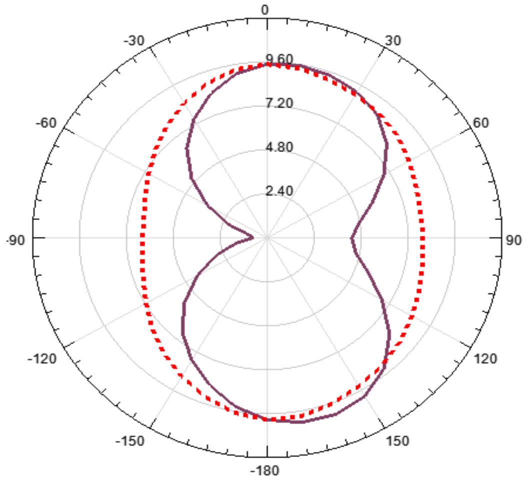
Fig. 4: Measurement of Reflection Coefficient [S11] in dB

4.3 Radiation Pattern

The simulated radiation pattern for the half cut proposed antenna is shown in Fig. 5 at different frequencies. Field pattern is given in the figures is followed the angle position of E-plane or YZ plane at [ϕ=0°, 180°, 0° ≤ θ ≤ 90°] and H plane or XZ plane at [ϕ=90°, 270°, 0° ≤ θ ≤ 90°] represented by dash line and solid line respectively. Radiation Pattern is representing the stability over the radiating frequency band. This band covers the frequencies from 3.1 GHz to 10.6 GHz that is UWB spectrum.



(a)



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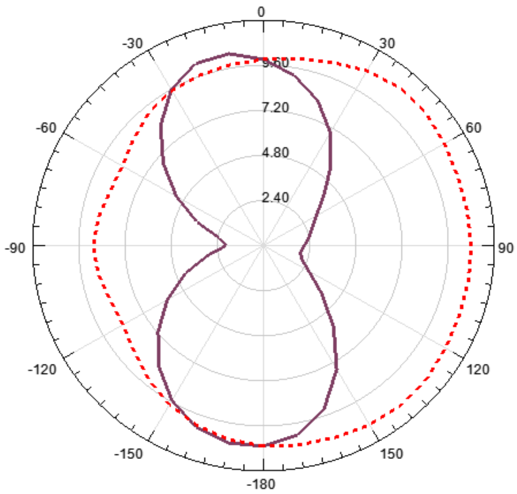

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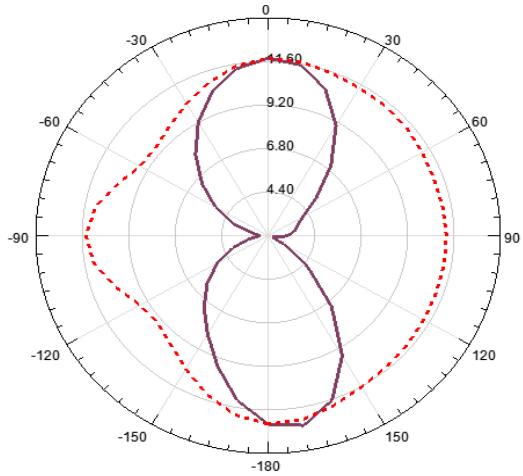
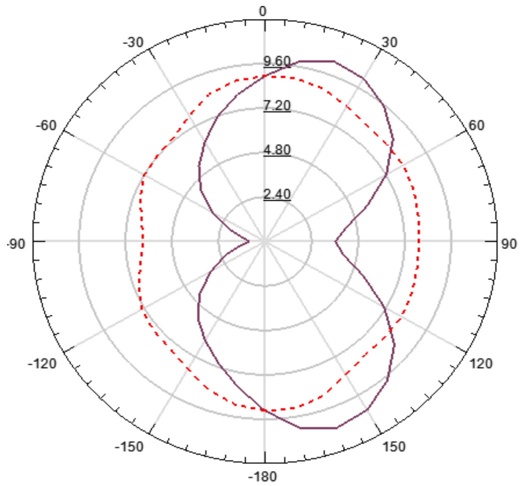
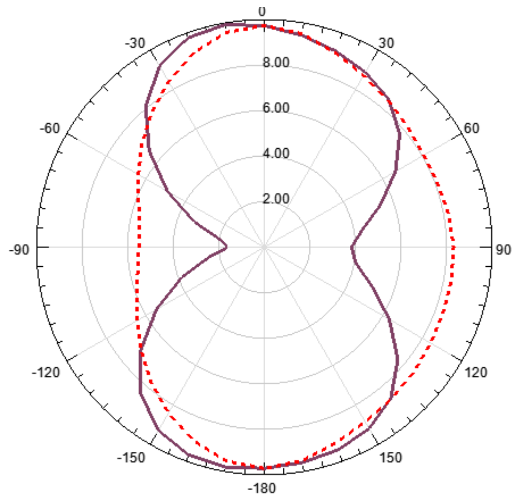


(d)

Fig. 5: Simulated Radiation Pattern of Half Cut Antenna without Circular Slot in Propagation Plane at different frequencies (a) 7GHz, (b) 6.5GHz, (c) 5GHz, (d) 4.5GHz.



(a)



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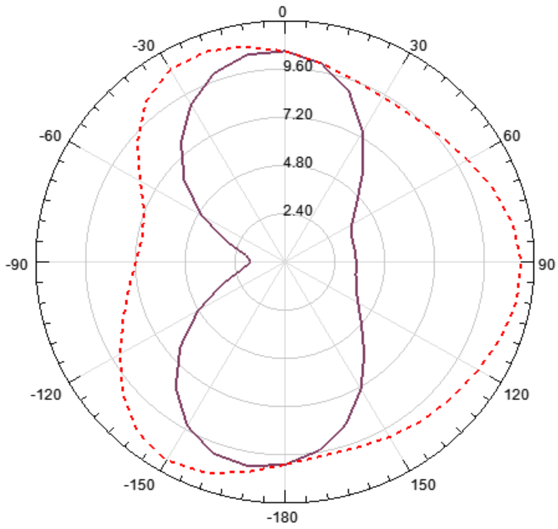

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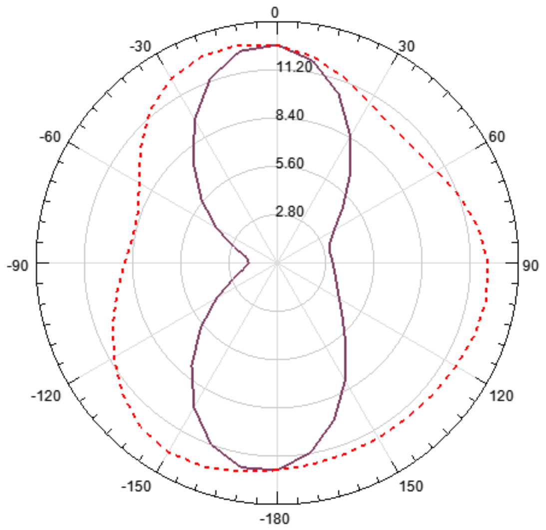

(d)

Fig. 6: Simulated Radiation Pattern of Half Cut Antenna with Circular Slot in Propagation Plane at a different frequency (a) 7GHz, (b) 6.5GHz, (c) 5GHz, (d) 4.5GHz.

5. RESULT COMPARISON

According to the simulation process in term of various antenna parameters, the result has been reported. All the parameters are recorded over the frequency range of 3.1 GHz to 10.6 GHz. The size of antenna, feeding method and use of the material is same as inference antenna and proposed designs. Introducing the circular slot in the propagation plane of half cut design will give the very appropriate and fine results. The comparative studies in term of antenna parameters such as reflection coefficient, VSWR, and radiation pattern are explained after the simulation process was completed. In all case of antenna radiation pattern, the position is vertically polarized and the radiation pattern is Omni directional. The following table gives the result of both antennas.

Table 2. Comparison of antenna parameters

Parameters	Half Cut Antenna without Circular Slot in Propagation Plane	Half Cut Antenna with Circular Slot in Propagation Plane
VSWR	1.07	1.1
Reflection Coefficient[S11]	-20 dB	-25.86 dB
Bandwidth	7.5 GHz	7.5 GHz
Radiation Pattern	Omni- Direction	Omni- Direction
Elevation Polarization	Vertical Polarized	Vertical Polarized
Radiating Frequency Band	UWB [3.1-10.6 GHz]	UWB [3.1-10.6 GHz]

6. CONCLUSION

A CPW feeds miniaturized UWB antenna approx of 50% reduced in size was designed for the HFSS environment. The implemented size of the antenna with the dimension of 12.5*30*1.6 simulated and characterized by the VWSR$\leq$ 2 , S-parameter $\leq$ -10dB [Reflection Coefficient] and Radiation patterns was an exhibit with the same characteristics of the reference antenna. The proposed miniaturized antenna has significant antenna characteristics over the wide bandwidth of 7.5 GHz from 3.1 to 10.6 GHz. These analyses of antenna characteristics ensure that the proposed antenna is feasible to the UWB band operations. In this work a CPW Fed Micro strip Half Cut Patch Antenna has been carried out with the help of Miniaturization Concept but still, there is an adequate possibility for improvement in terms of range of radiation frequency to cover the Bluetooth band along the UWB band and moreover avoid the radiation of the License Band [Wi-Max and WLAN] in the transmission of UWB range.

7. REFERENCES

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