Dual Band Suspended Hexagonal Patch Antenna

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Abstract—**This paper presents a suspended hexagonal Antenna. The hexagonal antenna with stub tunes for a two frequencies 1.9GHz(used in PCS mobile applications) and 2.4GHz (used in Bluetooth application).In this paper demonstrate the suspended structure of the antenna that enhance the bandwidth of the antenna 102 MHz for PCS and 172 MHz for Bluetooth. The design of the proposed antenna is tested by experimentally. To study the effect of different height of the air gap on the performance of the antenna.**

Index Terms—Hexagonal patch antenna, Bandwidth enhancement, Dual band, Suspended antenna.

INTRODUCTION

Microstrip patch antenna used for many of the applications because of their many advantages like Light weight and low volume ,compact size, can be easily integrated with electronic circuits. Now a day's wireless communication systems supports many applications .In one communication systems supports for many applications. So instead of using number of antennas for different applications use multiband antennas. Yazdan Khan et.al 2013[9] has discuss Bandwidth Improvement of the Rectangular Micro strip Antenna by Using Single Dipole Stub of different length that improves the Bandwidth up to 21 %. K. P. Ray et.al 2010 [10] has discuss Suspended Hexagonal Micro strip Antennas for Circular Polarization. This configuration has been realized by inserting perturbations along two opposite sides of the suspended hexagonal microstrip antenna and achieves broad bandwidth of 70 MHz. Gehan Sami [20] has been fabricated rectangular tri-band patch antenna and measured for wireless communication systems. The introduced antenna is designed for WLAN and WiMAX applications. The desired tri-band operation was obtained by proper loading for a rectangular patch antenna using slots and shorting pins. The results obtained from our simulated antenna show 5.8% impedance matching band width at 2.4 GHz, 3.7% at 3.5 GHz and 1.57% at 5.7 GHz. Deepak[21] has demonstrate the , dual band antenna for 2.4, 5.2 & 5.8 GHz ISM band applications, on a substrate of relative permittivity 4.3 used. The wide band at higher resonance is due to the modified planar dipole and the lower resonance is achieved by a stepped impedance resonator (SIR), which is electrically coupled to the modified dipole. The 2:1 VSWR impedance bandwidth of this antenna is 95MHz for the first resonance and 1.38GHz for the second resonance . M. Abou Al-Alaa [23] has fabricated compact reconfigurable multi-band monopole antenna . To achieve frequency reconfigurability, a PIN diode is used. There are two states of switch. State 1: when the switch is OFF, the antenna operates at four bands: 2.45, 3, 3.69, and 5.5 GHz with impedance bandwidth of 9.95, 5.96, 12.57, and 10.76%, respectively.In this [32] paper presents a low cost and high quality small planar antenna design for the Texas Instruments 2.4 GHz Bluetooth low energy and Proprietary System Chip application All simulation results for the antenna voltage standing wave ratio (VSWR) are verified by measurements and they are below 2 in the complete 2.4 – 2.485 GHz frequency band**.**

This antenna used for personal mobile communication applications and Bluetooth applications.

In this antenna design the separation of two bands and good impedance bandwidth and axial ratio with circular polarization using the HFSS software is take place.

This paper is organized as follows section II describes the antenna design ,Section III represents the simulation results and discussion, section V conclusion.

ANTENNA DESIGN

The geometry of the proposed antenna is hexagonal with coaxial probe feed [8] shown in fig 1.This antenna is designed for a 2.4GHz frequency so that the resonance frequency (fo) is selected 2.4GHz putting resonance frequency in formula.

1. Calculation of the width of Patch (W)-

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

For c=3*10^8 m/s2, f o=2.4GHz, ε r=4.4

We get W=38.22 mm

2. Calculation of effective dielectric const-

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

For εr=4.4, h=1.6mm, W=38mm

We get εreff=3.99

3. Calculation of Length of Patch(L)-

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

For c=3*10^11 mm/s, εreff=3.99, f o=2.4GHz

We get Leff =30.25 mm

Due to fringing the dimension of the patch as increased by ΔL on both the sides, given by

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

For W=36.4mm, h, =1.53mm, εreff=3.99
We get ΔL=0.70mm
Hence the length the of the patch is: L= Leff-2ΔL=28.4 mm

4. Calculation of Substrate dimension-

Ls=L+2*6h

Ws=W+2*6h

The width, length, substrate dimension, effective dielectric constant is calculated for a hexagonal patch of the antenna with FR4 dielectric material with dielectric constant 4.4 with height 1.6mm is used. In this antenna design select the hexagonal shape of the patch .In this section we compare the simulated results of the suspended hexagonal microstrip patch antenna with stub with measured results of fabricated antenna.

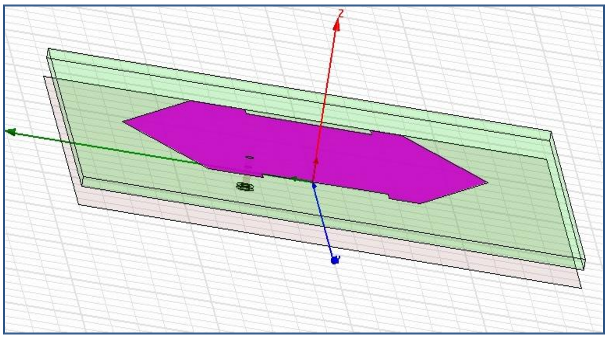

Figure 1: Geometry of suspended Hexagonal patch Antenna

The above geometry shows the suspended antenna. In this suspended antenna geometry air gap is present between the ground plan & substrate. According with the geometry air gap antenna characteristics get changed.

In the following section shows the effect of air gap on antenna results. By varying the air gap 2mm,3mm,4mm .

a) If Air gap =2mm suspended antenna shows following results.

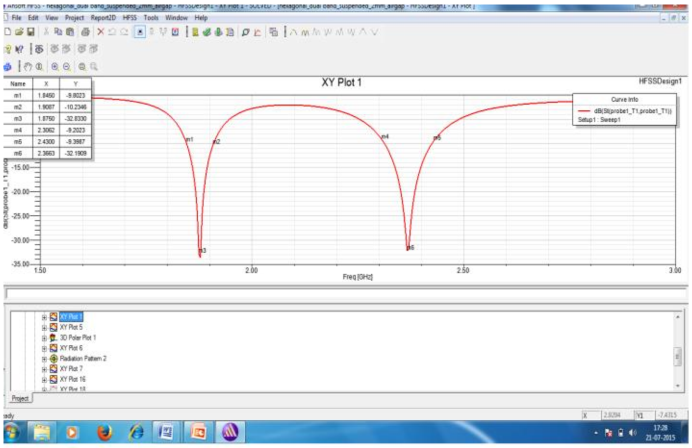

Figure 2 Return loss of suspended antenna with air gap 2mm

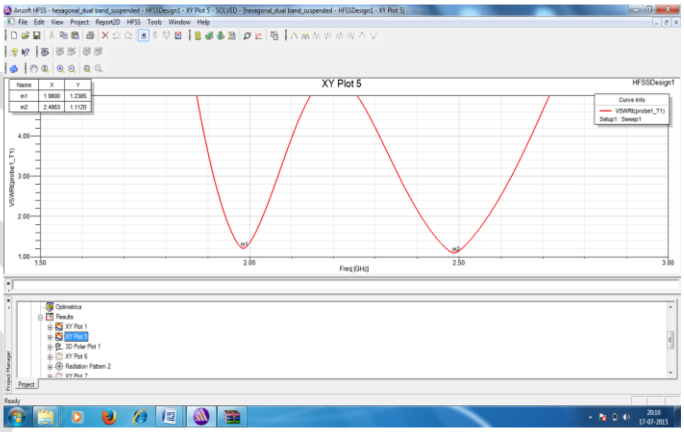

Figure 3 VSWR of suspended antenna with air gap 2mm

From the above axial ratio and VSWR results shows the return loss of 1.9GHz & 2.4 GHz bands are -10.23 & -9.39 and VSWR of 1.9GHz & 2.4 GHz bands are 3.12 & 1.5.That values are not adequate patch antenna.

b) If Air gap =3mm suspended antenna shows following results

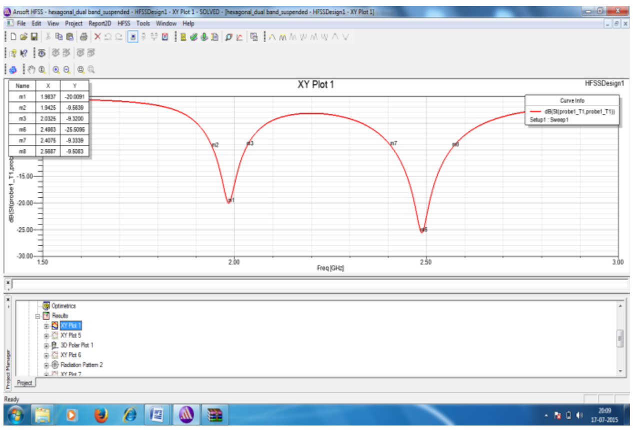

Figure 4 Axial Ratio of suspended antenna with air gap 3mm

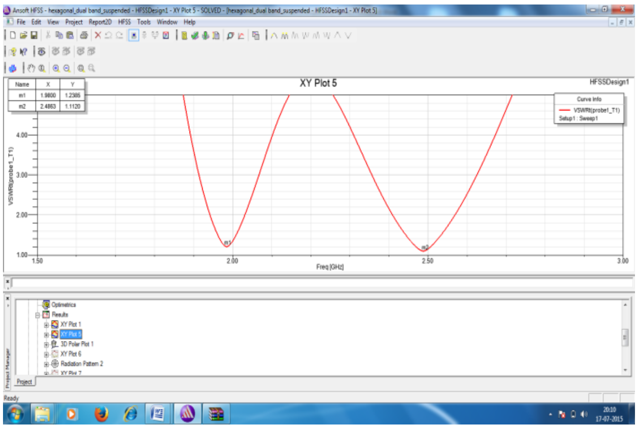

Figure 5 VSWR of suspended antenna with air gap 3mm

From the above axial ratio and VSWR results shows the return loss of 1.9GHz & 2.4 GHz bands are -20 & -25.50 and VSWR of 1.9GHz & 2.4 GHz bands are 1.23 & 1.11.That values are adequate for patch antenna.

c) If Air gap =4mm suspended antenna shows following results

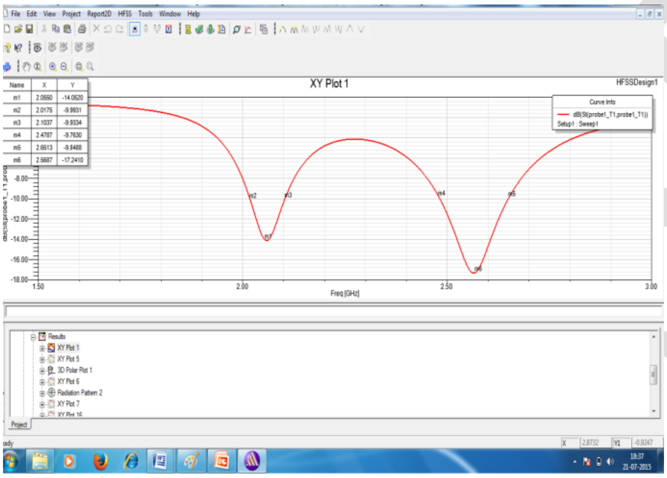

Figure 6 Axial Ratio of suspended antenna with air gap 4mm

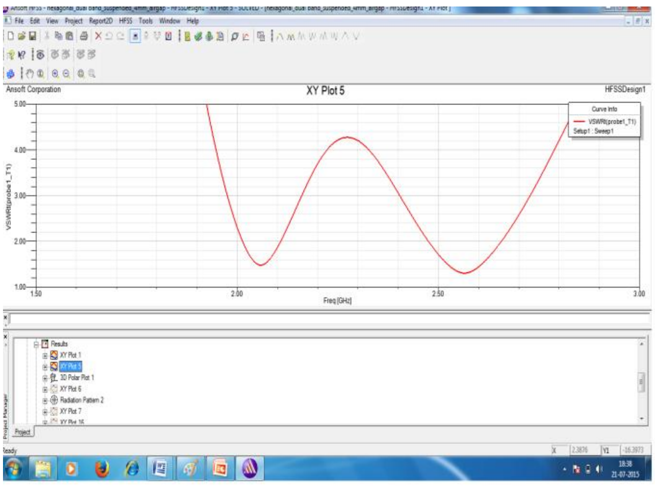

Figure 7 .VSWR of suspended antenna with air gap 4mm

From the above axial ratio and VSWR results shows the return loss of 1.9GHz & 2.4 GHz bands are -2 & -6 and VSWR of 1.9GHz & 2.4 GHz bands are 4.3 & 3.0.That values are not adequate for Patch antenna.

From this simulated results concluded that for air gap of suspended antenna is equal to 3mm gives the results of standard antenna. So that antenna is simulated at frequency 2.4 GHz & 1.9GHz.

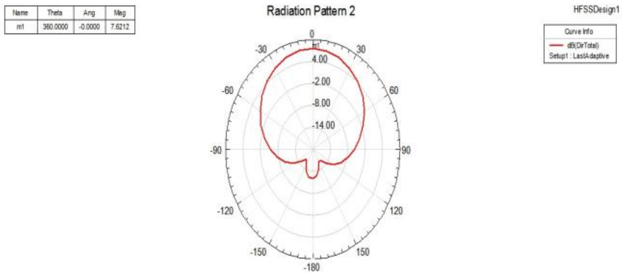

Figure 8 Radiation Pattern

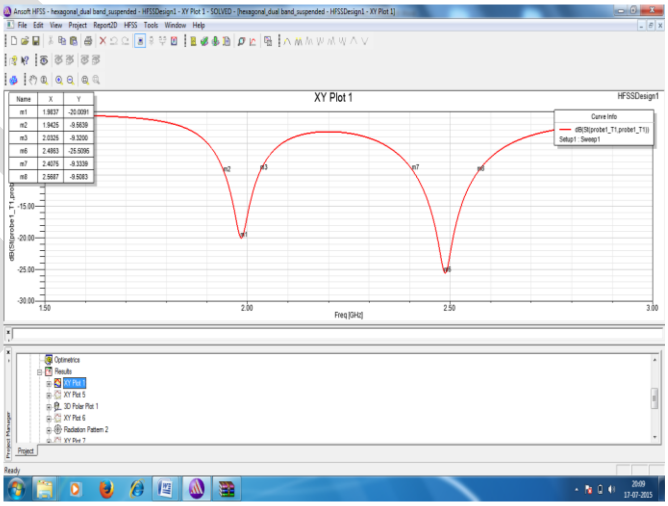

Figure 9 Return loss of suspended antenna

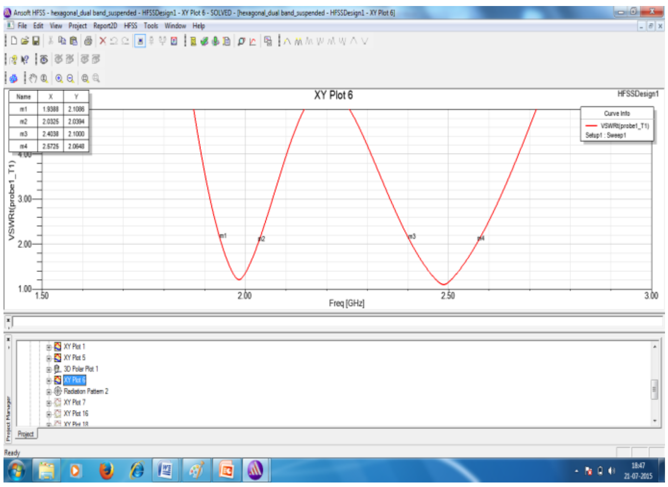

Figure 10 Bandwidth of suspended antenna

From the above results shows that the return loss, Bandwidth and radiation pattern of the suspended antenna at 2.4GHz and 1.9GHz.This antenna is fabricated by using photolithographic process.

The fabricated antenna is tested by using Network Analyzer.

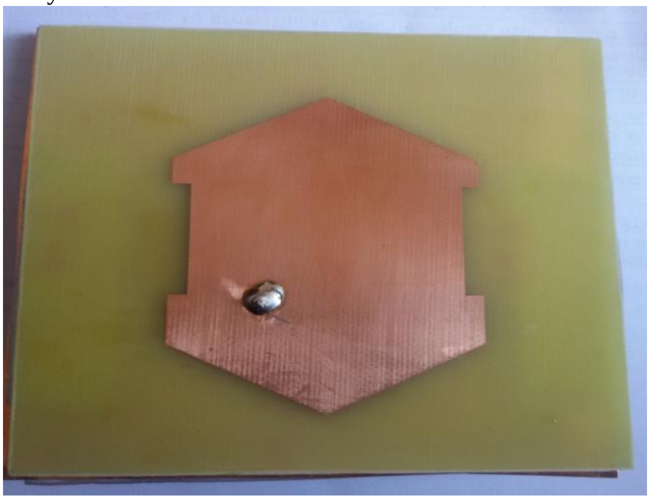

Fig11. Top view of fabricated Antenna

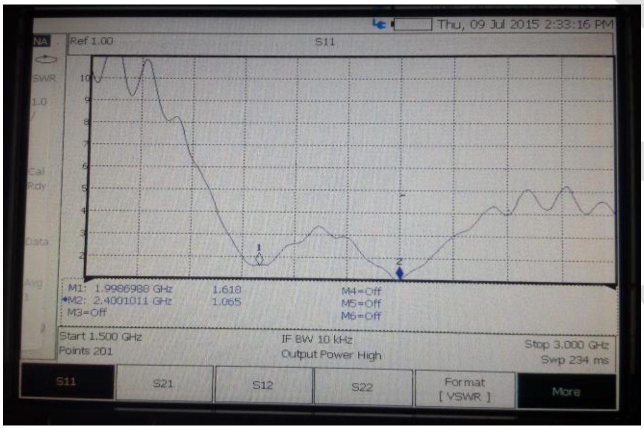

Figure .12 Measured VSWR of suspended antenna

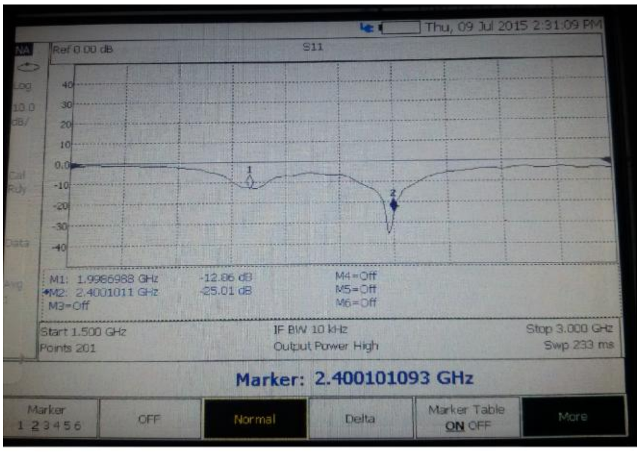

Figure 13 Measured S11 of suspended antenna

RESULTS AND DISCUSSION

The proposed antenna is optimized by using HFSS simulator software. HFSS is an interactive software package for calculating the electromagnetic behavior of a structure. The software includes post-processing commands for analyzing this behavior.

Due to the dual stub this antenna makes the dual band for a frequency 2.4GHz and 1.9GHz. The suspended structure of the antenna enhances the bandwidth of the antenna for both the antenna. The top view of the fabricated antenna shown in fig11.The comparison between the simulated and measured results shown in following table.

Table 1.Comparison Rsults

Sr.No.	Shape of MSA	Freq (GHZ)	Return Loss (dB)	VSWR	Bandwidth (MHZ)	Impedance
1	Simulated Results	1.98	-20	1.23	94	52.9
		2.48	-25.5	1.11	170	
2	Measured Results	1.99	-12.86	1.61	102	53
		2.4	-25.23	1.06	172	

From the above results shows that bandwidth of the suspended antenna get improved. A reasonable agreement is observed between simulated and measured results. Small discrepancies between the measured and simulated results are due to cable effect ,SMA connector and fabrication imperfection.The return loss that is less than -10dB.

CONCLUSION

The proposed antenna is a dual band circular polarized hexagonal microstrip antenna is applicable for 1.9 GHZ (Personal mobile communication) and 2.4 GHZ (Bluetooth) applications with axial ratio bandwidth of 1.11 % and 2.12 % respectively obtained that is improved by using suspended structure of the antenna.

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