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Simulation and Performance Analysis of a Metamaterial based Dual band Monopole Antenna using Rectangular Complemetary Split Ring Resonator in the Ground plane for GSM900 and Wi-Max Applications

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ABSTRACT: The present day Mobile systems use different Antennas for different Wireless Applications such as GSM, Wi-Fi, Wi-Max, DCS, PCS, UMTS and so on. With the evolution of Wireless technologies such as 4G, 5G and so on, the need for Frequency Reconfigurable Antennas have become inevitable that are multifunctional and at the same time change their polarization and radiation pattern in real time.This paper highlights the proposed design for a dual band Frequency Reconfigurable Monopole antenna fed through a 50Ω line feed over the Rogers RT/Duroidsubstrate of permittivity 2.2 for GSM 900 and Wi-Max applications. The novelty of the proposed work lies in using two perpendicular strips loaded with Rectangular Complementary Split Ring Resonator in the Ground plane. The Monopole antenna is proposed to tune between two frequencies of 0.9GHz and 3.5GHz.The radiating structure resulted in a Gain of 6.7dBi, 8.65dBi,a Bandwidth of 80.5MHz ,144MHz for the lower and the upper frequency bands respectively. The structure resulted in an omnidirectional radiation pattern in the Wi-Max band and a Figure of eight in the GSM band under E and H plane respectively. The Antenna is compact in size with a dimension of 100mm×40mm with a thickness of 1.6mm.

KEYWORDS: GSM, Wi-Max, Frequency Reconfigurability, Monopole, RCSRR.

I. INTRODUCTION

With the tremendous advancement in modern communication devices supporting different Wireless standards such as Wi-Fi, Wi-Max, GSM, UMTS and WLAN, the need for Reconfigurable and Multi Band Antennas is increasing. Multiband Antennas have the capability to transmit and receive multiple Frequency bands with moderate Gain and Directivity. The present day Mobile systems use different Antennas for different Applications such as GSM, Wi-Fi ,Wi-Max,DCS,PCS,UMTS and so on. With the evolution of Wireless technologies such as 4G, 5G and so on, the need for Frequency Reconfigurable Antennas have become inevitable that are multifunctional and at the same time change the polarization and radiation pattern in real time. Meta-materials are artificial media built from periodic unit structure that are compactly crowded into an effective material with properties that are impossible to observe in natural materials. They give negative refractive index for which the permittivity and permeability are simultaneously negative. Examples are perfect lensing, invisibility cloaking and miniaturization of microwave devices. SRR's were introduced by Pendry in 1999. They exhibit negative permeability in a certain frequency range. The main feature of SRR include their ability to exhibit quasi-static resonant frequency at wavelengths that are much larger than its own size[5].Split Ring Resonators were primarily used for applications involving small antenna design. They are used for improving the gain of the antennas. The size reduction of the antenna can be achieved by including CSRR's in Ground plane[6]. In

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[1], a Microstrip patch Antenna loaded with split Ring resonator has been proposed on a 1.6mm thick FR4 substrate which has a permittivity of 4.4.A slot cut in the form of a split ring has been loaded on the surface of a patch resulting in multiple resonant frequencies at 2.4GHz, 3.5GHz and 5.2GHz. which finds application in Wi-Max, HIPERLAN/WLAN and Bluetooth applications. The Antenna resulted in a Gain of 4.41dB and -0.9dB for 2.4GHz and 3.5GHz bands. The Antenna resulted in a Bandwidth of 90 MHz and 60MHz for both the lower and the upper frequency bands respectively. The overall dimension of the structure was 50mm×50mm×1.6mm.The radiation pattern was nearly omnidirectional in the H plane and figure of 8 under E planes for both the bands respectively.In [2], a compact tri band four port diversity based Antenna has been proposed on a FR4 substrate for MIMO related application. The split ring resonators were incorporated primarily to provide Isolation between the diagonal element of the antenna. The structure resulted in a Gain of 2.5dBi, 3.7dBi and 4.4dBi for 2.4GHz, 3.5GHz and 5.5GHz frequency bands covering the UMTS, LTE2300 and Wi-Max bands respectively. The proposed Antenna structure resulted in a return loss of -27dB and -18dB for the lower and the middle frequency bands along with a Bandwidth of 450 MHz and 480 MHz respectively. The maximum isolation achieved were 17 dB for the 2.4GHz band. The overall size of the compact multiport antenna system is 0.26λ × 0.26λ × 0.01λ with a minimum isolation of 22dB between its elements. In [3], a compact wide band concentric SRR based metamaterial antenna with dual band characteristic has been proposed for ISM band and WiMAX band. The novelty of proposed work lies in using three concentric spilt ring resonators and one closed ring resonator. The structure is designed on a FR4 substrate with a permittivity 4.4. The antenna is compact in size with a dimension of 25.3mm×27mm×1.6mm. The reported gains were 1.12dBi, 1.48dBi and 2.42dBi for 2.89GHz, 3.7GHzand 5.7GHz. The bandwidths reported were 160MHz and 3.49GHz for the lower and upper bands respectively. The structure resulted in a return loss of -25dB, -38dB for the lower and upper bands respectively with a nearly omnidirectional radiation pattern.In [4], the authors designed a dual band parabolic slotted Ground plane Antenna for WLAN Applications. The proposed Antenna resulted in a Gain of 1.68dBi and 2.33 dBi for the lower and the upper Frequency bands respectively. In [5] a complementary spilt ring resonator fed with a Microstrip transmission line connected at the edge of the outer ring is presented. The structure resulted in a return loss of -18dB and -17.0 dB at 4.0GHz and 5.4GHz respectively with a dimension of 20mm×20mm×0.8mm. The observed radiation pattern was figure of 8 under both E and H-planes for both the frequency bands respectively. The proposed gains were 1.0 dBi and 2.0 dBi, bandwidth of 580MHz and 110MHz for the lower and upper frequency bands respectively. The antenna has been simulated on a Arlon substrate of permittivity 2.2. In [6], a comparative analysis of various reconfigurable and multiband antenna concepts was presented. The different techniques for realizing Multiband Antennas such as PIN diodes, MEMS switches, and varactors were discussed. In [7], a dual band antenna based on metamaterial planar structure operating in S band and C band is designed and developed for Space and Radar communication Applications. The novelty of the work lies in incorporating CSRR in the Ground plane for achieving the dual band operation. The structure has been designed on a FR4 substrate of permittivity 4.4 with a dimension of 21.7mm X 20.4mm with a substrate thickness of 1.6mm along with Microstrip line feeding technique. It resonates at 2.7GHz, 7.5GHz with the return loss of -17.27dB, -29.63dB, respectively with a -10dB impedance Bandwidth of 6.8GHz .The average Gain of the Antenna is 5.82dB.In [8], a metamaterial based dual band Antenna has been proposed for Wi-Max Application using Complementary Split Ring resonator. The radiating structure resonates at two different frequencies of 3.5GHz and 5.5GHz .The radiating structure resulted in a return loss of -24.5dB,-31dB,a Bandwidth of 112.1MHz and 92.1MHz for both the lower and the upper bands respectively. The structure has been designed on a Rogers's substrate of permittivity 2.2 and resulted in a Gain of 4.5dBi and 5.0dBi for both the lower and the upper bands respectively. In [9], a multiband monopole antenna has been designed on a Rogers substrate of permittivity 3.23.The novelty of the proposed work lies in using two side by side CSR structures resulting in multi band operation covering the WLAN and the Wi-Max bands. The structure resulted in a gain of -1.0 dBi,1.0dBi and 4.0 dBi, a return loss value of -25dB,-15.0dB and -20.0dB respectively for 2.4GHz,3.5GHz and 5.2GHz frequency bands respectively. The radiating structure resulted in a Bandwidth of 440MHz, 200MHz and 200 MHz for the lower, middle and the upper bands respectively. The radiation pattern is omnidirectional for all the three frequency bands of interest. In [10], a dual band patch antenna is designed by loading a U-slot metamaterial structure on the surface of the rectangular patch .The structure has been designed on a FR4 substrate with a thickness of 6mm.Three different structures have been realized by using U shaped slots. The structure with two additional U shaped slots resulted in a resonant frequency of 3.58GHz and 5.74 GHz with a return loss value of -16.0dB,-12.5dB and a Bandwidth of 490MHz and 650 MHz for the lower and the upper frequency bands respectively. In [11], a Tri-band Frequency Reconfigurable Monopole Antenna for GSM, UMTS and

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Wi-Fi Applications has been designed.The proposed antenna resonates at 0.9GHz, 2.1GHz and 2.4 GHz covering the GSM, UMTS and WiFi frequency bands respectively. The Antenna resulted in a Gain of 5.3dBi, 6.32dBi and 8.0dBi, aBandwidth of 61MHz, 127MHz and 50MHz for 0.9GHz, 2.4GHz and 3.5GHz frequency bands respectively. In [12], a dual band antenna based on fractal geometry using CPW feed is proposed on a FR4 substrate for GSM-900 and Wi-Fi frequency bands respectively. The antenna resulted in a gain of 2.41dBi, 6.24dBi, a bandwidth of 111MHz and 107MHz for the lower and upper bands respectively. The return loss of the proposed Antenna were -21.0dB,-28.75dB for both the bands respectively. The proposed Antenna was compact with a dimensions 70mm×70mm.In [13], a novel fractal antenna for GSM applications is proposed. This antenna uses second iteration of Sierpinski carpet for fractal geometry. This antenna radiates at 900MHz and 1.8GHz and gives an Omni directional radiation pattern. The antenna gives a return loss of -23dB and -17.0dB, Gain of 2.79dBi and 2.67dBi for 900MHz and 1.8GHz frequency band respectively. It covers a frequency band of 100 MHz at resonant of 900 MHz and 80 MHz at 1800 MHz. The reported Antenna dimensions were 13.65cm×10.7cm×0.24cm.In[14],a dual band Microstrip fractal antenna using a Sierpinski triangle shape along with a modified ground plane is proposed. The antenna resonates at three frequencies 1.58GHz (GPS band), 3.5GHz and 5.6GHz (WiMAX band). The proposed antenna gives a gain of 4.1dBi, 3.75dBi and return loss of -24dB, -15dB and -20dB for 1.58GHz, 3.5GHz and 5.6GHz respectively. The Bandwidths reported were 50MHz and 250 MHz for the lower and upper bands respectively. The Antenna is designed on a FR4 substrate and is compact with dimensions of 50mm×50mm. In [15], dual band David fractal Microstrip patch antenna for GSM and WiMAX applications has been proposed. The antenna resonates at 1.8GHz and 3.4GHz and gives good radiation pattern and moderate gains of 6.93dBi and 5.3dBi for 1.8GHz and 3.4GHz respectively. The antenna gives a return loss of -18.7dB, -14.3dB for 1.8GHz and 3.4GHz respectively. The radiating structure resulted in a -10dB impedance bandwidth of 55MHz and 31MHz, Gain of 6.93dBi and 5.3dBi for the lower and upper bands respectively. The radiation pattern reported were hemispherical for 1.8GHz and horizontal figure of 8 for 3.5GHz respectively.In [16], a Dual band fractal monopole antenna suitable for a Long Term Evolution (LTE) standard has been proposed on an Arlon dielectric substrate of permittivity 3.38. This antenna works on 700MHz and 2600MHz frequency bands. The fractal monopole antenna showed a good return loss below -10dB for both the bands and a gain of 5.06dB and 6.41dB respectively for the lower and the upper frequency bands respectively. The structure resulted in aOmni directional radiation pattern with a dimension of 800mm×800mm×0.8mm.

II. RELATED WORK

The proposed Antenna consists of two rectangular shaped conducting strips which are perpendicular to each other loaded with a Rectangular Complementary Split Ring Resonator in the Ground plane.The Length of the Longer arm (L1 +L3) decides the resonant Frequency of the lower frequency band of interest namely 0.9GHz while the length of the side arm(L3) decides the resonant Frequency for the upper Frequency band of interest.The role of the Rectangular Complementary split Ring resonator has been to isolate the two Frequency bands of interest and to improve the Gain.The structure has been designed on a Rogers RT/Duroid substrate of permittivity 2.2 and a thickness of 1.6mm.The Length of the Ground plane is kept at 11.5mm to give a Monopole like characteristic feature.The width of the conducting strip is kept equal to 3.0mm and near the top edge of the main arm the width has been slightly increased to 3.7mm to get resonance at lower Frequency band of interest. The width of the arm Length L2 has been kept equal to 3.0mm for the upper frequency band of interest. The substrate chosen is Rogers RT/Duroid (5880tm) of permittivity 2.2,with a loss tangent of 0.0004. The Length and the width of the substrate has been kept equal to 100mm×40mm with a thickness of 1.6mm.

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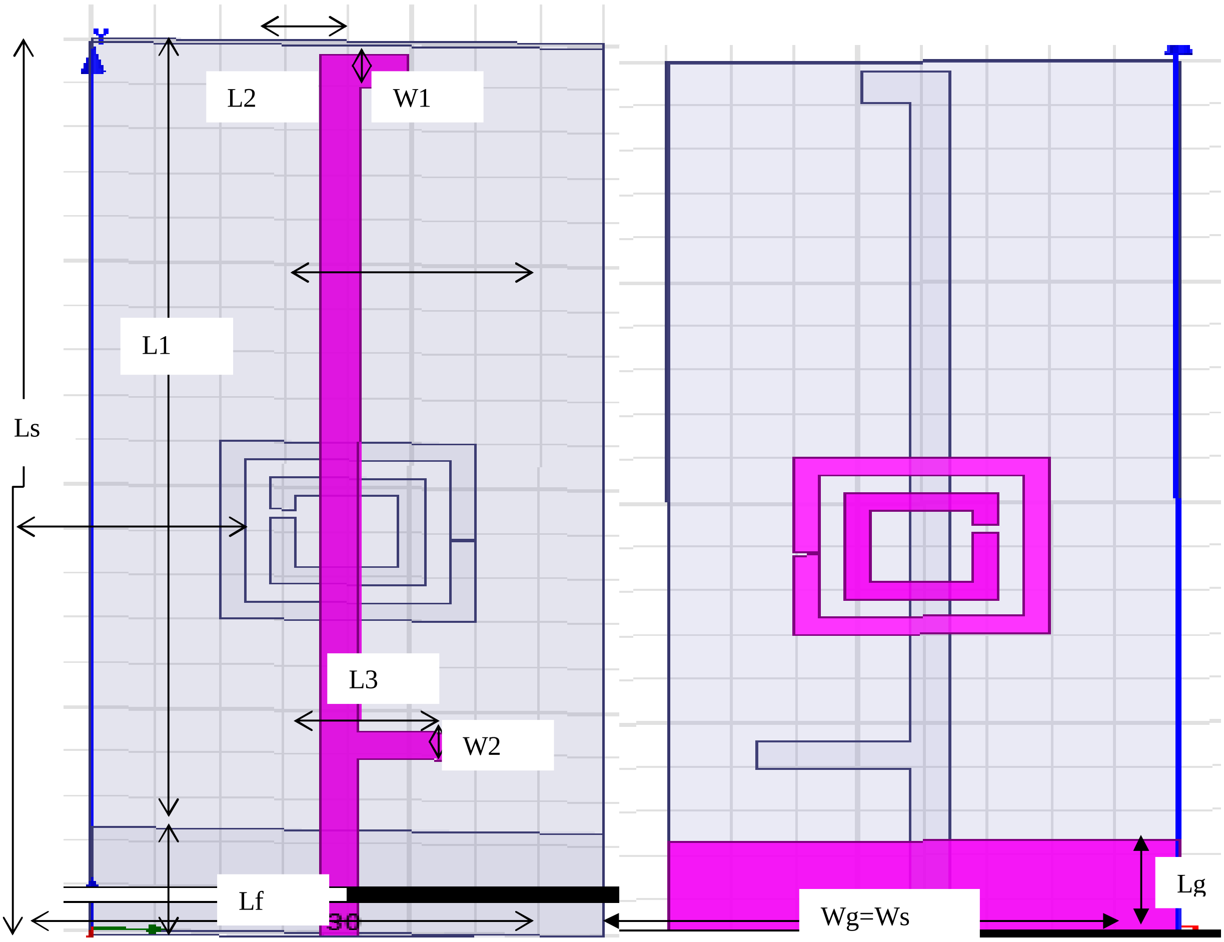

Fig.1 (a) Showing the snap shot of top view of the Antenna design in HFSS (b) Ground plane view of the Antenna.The Length L1 is set equal to 99.0mm and L2=6.8mm and together decide the Frequency of operation in the lower band.The width of the conducting strip is 3.0mm for L1 and 3.7mm for L2.The Lenght and width of the side arm (L3 & W2)) has been set equal to 12.0mm and 3.0mm respectively.The Length and width of the Ground plane are selected such that Lg=11.5mm and Wg=40.0mm

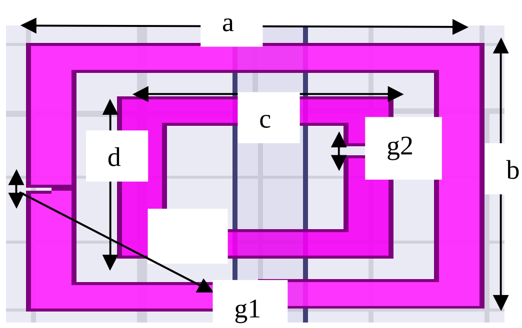

Fig.2 Showing the snap shot of the Rectangular Complementary Split Ring Resonator in the Ground plane.There are two rectangular split rings with one embedded within the other.The dimensions of the outer ring are a=20mm and b=20mm with a gap width g2=0.3mm.The dimensions of the inner split Ring are selected such the c=12mm and d=12mm with a gap ,g1=0.9mm .The thichness of the conducting strip of both the split Rings is set equal to 2.0mm.

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Proposed algorithm

A. Design of the Monopole Antenna:

$L1 + L2 = L_{0.9GHz} = \frac{\lambda g}{4}$----------------------(1)

Where L1+L2=Length of the Main Monopole resonating at 0.9GHz.

λg=Guide wavelength.

$\lambda g = \frac{\lambda_0}{\sqrt{\varepsilon_{reff}}}$----------------------------------- (2)

Where ε_{reff}= Effective electrical permittivity of the dielectric substrate.

Where λ_0=Free space wavelength corresponding to frequency of operation.

$\varepsilon_{reff} = \left[\left(\frac{\varepsilon_r+1}{2}\right) + \left(\frac{\varepsilon_r-1}{2}\right)\left(1 + \frac{12h}{W}\right)^{\frac{-1}{2}}\right]$--(3)

Where ε_r =Relative permittivity of the substrate.

W=Width of the Monopole Antenna

h= substrate thickness.

Z=$\frac{60}{\sqrt{\varepsilon_{reff}}} ln\left[\frac{8h}{W} + \frac{W}{4h}\right]$-------------------------(4)

Where Z=50 Ohms (port Impedance)

W=Width of the Monopole.

L3= $L_{3.5GHz} = \frac{\lambda g}{4}$------------------------------ (5)

Where L3 represents the side Lengths of the Monopole Section.

Ls=6h+ L -------------------------------------(6)

Ws=6h+W------------------------------------- (7)

Where Ls=Substrate Length

Ws=Substrate Width.

B. Design of Rectangular Complementary Split Ring Resonator.

The Split Ring Resonators are metamaterials that exhibit negative values of permittivity and permeability. The main purpose of using the split Ring resonators is to improve the Isolation between the Frequency bands of interest and at the same time improve the Return Loss and Gain. The dimensions of the inner split ring were selected to match for the upper frequency band namely Wi-Max while outer split Ring was designed to match for the Lower Frequency band of Interest. Referring to Figure 2, the Expression for the resonant Frequency[11] is given by

$$fr1 = \frac{a}{4(a + b - 2g1)\sqrt{\varepsilon_{reff}}} ----(8)$$

Where c=Velocity of light=300000000m/sec

a= length of outer SRR

b= Width of the outer SRR

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g1=gap width of the outer SRR

fr1=Resonant frequency corresponding to 0.9GHz

$$fr2 = \frac{d}{4(c + d - 2g2)\sqrt{\varepsilon_{reff}}} \;----(9)$$

c= length of inner SRR

d= Width of the inner SRR

g2=gap width of the inner SRR

fr2=Resonant frequency corresponding to 2.4GHz.

B. Description of the Proposed Algorithm:

Aim of the proposed algorithm is to design a Dual band Monopole Antenna using Rectangilar split Ring resonator in the Ground plane.

Step 1: Calculating Length of the Main Monopole Antenna of Length L1 +L2 under Quarter wavelength resonance condition using Equation 1 and calculate the width of the Monopole antenna using equation for assuming substrate thickness h=1.6mm and port Impedance equal to 50 Ohms.

Step 2: Insert a conducting strip perpendicular to the length of the main arm and set its length equal to L3 as 12mm.The perpendicular conducting strip is inserted at the point where current density is maximum. The width of the conducting strip is retained as equal to the same value that is 3.0mm.

Step 3: Partially remove the Ground plane such that the Lengths and widths are optimized properly to get a proper resonance at the two Frequency bands of interest namely 0.9GHz and 3.5GHz.

Step 4: To further improve the return loss value and provide a proper Isolation between the lower and the upper frequency bands of interest, etch a Rectangular Complementary split ring resonator in the Ground plane with a small gap.

Step 5: Set the dimensions of the outer split Ring such that it coincides with the lower Frequency band of interest and the inner split Ring for the upper Frequency band of interest.

Step 6: Adjust the gap widths g1 and g2 present in the split rings to control the return loss characteristics and improve the isolation.

Step 7: Assign boundaries as perfect E for the Monopole, the Ground plane and the Rectangular Complementary Split Ring Resonator. Construct an air box surrounding the Antenna and assign the Boundary as Radiation.

Step 8: Create an Analysis set up ,with two different values of frequencies namely 0.9GHz and 3.5GHz and assign a valid Frequency sweep by giving the range of Frequencies that the Antenna is supposed to take.

Step 9: Run the design in the HFSS Simulation window and observe the Return Loss characteristics. Optimize the dimensions of the antenna till you get a desired resonant Frequency with a return loss vale below -10dB, VSWR<=1.5.

Step 10: Observe the three dimensional Gain plot and the two dimensional radiation pattern of the Antenna for both the Frequency bands of interest and calculate the peak value of the Gain and the -10dB impedance Bandwidth.

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III. SIMULATION RESULTS

The overall authentication and validation of the proposed structure was accomplished by simulating the structure on HFSS software version 15.0 after theoretical calculations as per the design equations. The initial design was done with the theoretical values and further optimization was done to obtain the desired results. The following Antenna parameters namely Return Loss, VSWR, Gain, Bandwidth, and Radiation pattern were analyzed and the results were tabulated for the dual band operation.

Results of the Dual Band Antenna

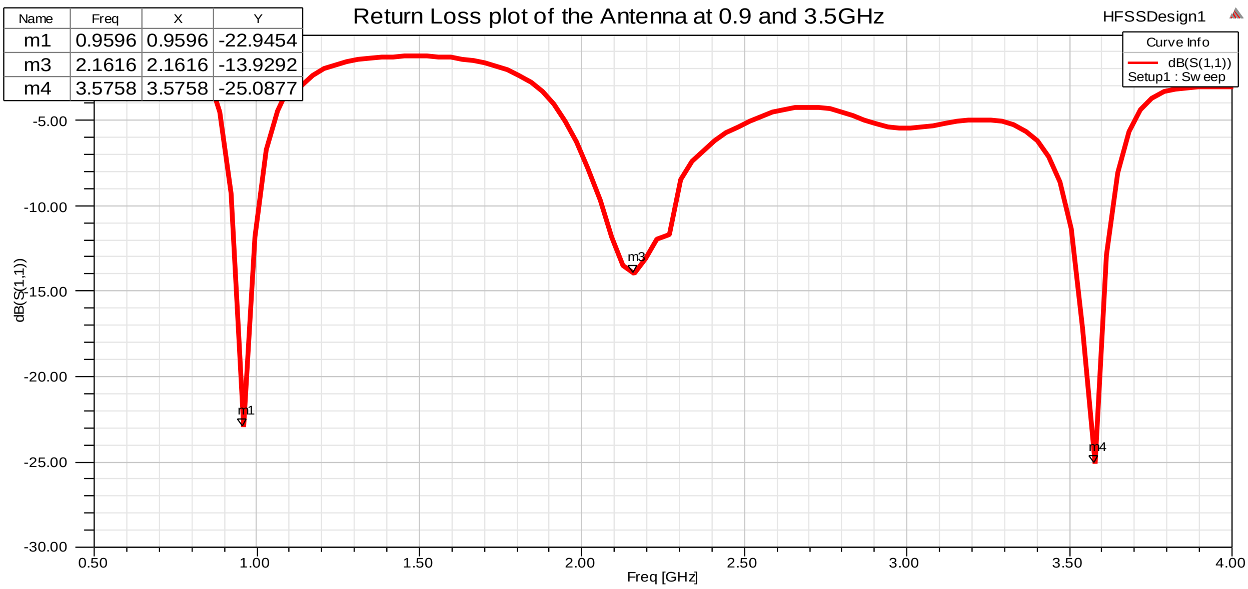

Fig. 3. Return Loss plot showing a value of -22.94dB and -25dB for resonating at 0.9GHz and 3.5GHz bands respectively.The Return loss of the Antenna is the ratio of the power Reflcted to the power incident at the port 1 itself and indicates the Reflection coefficient at the Frequency of operation.For a practical antenna Return loss should be below -10.0dB.

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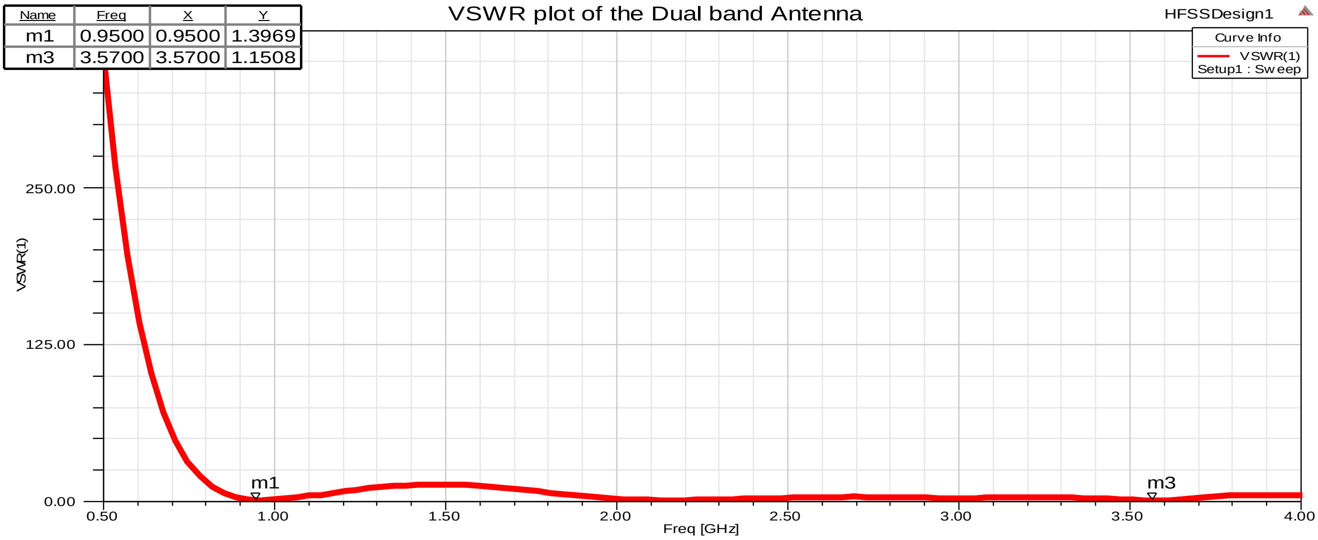

Fig.4. VSWR plot of the Monopole Antenna showing a value of 1.3 and 1.1 for 0.9GHz and 3.5GHz respectively. The Voltage standing wave ratio indicates the extent of impedance matching between the Antenna and the feed. Ideally VSWR value should be 1.0 for both the Frequency bands of interest.

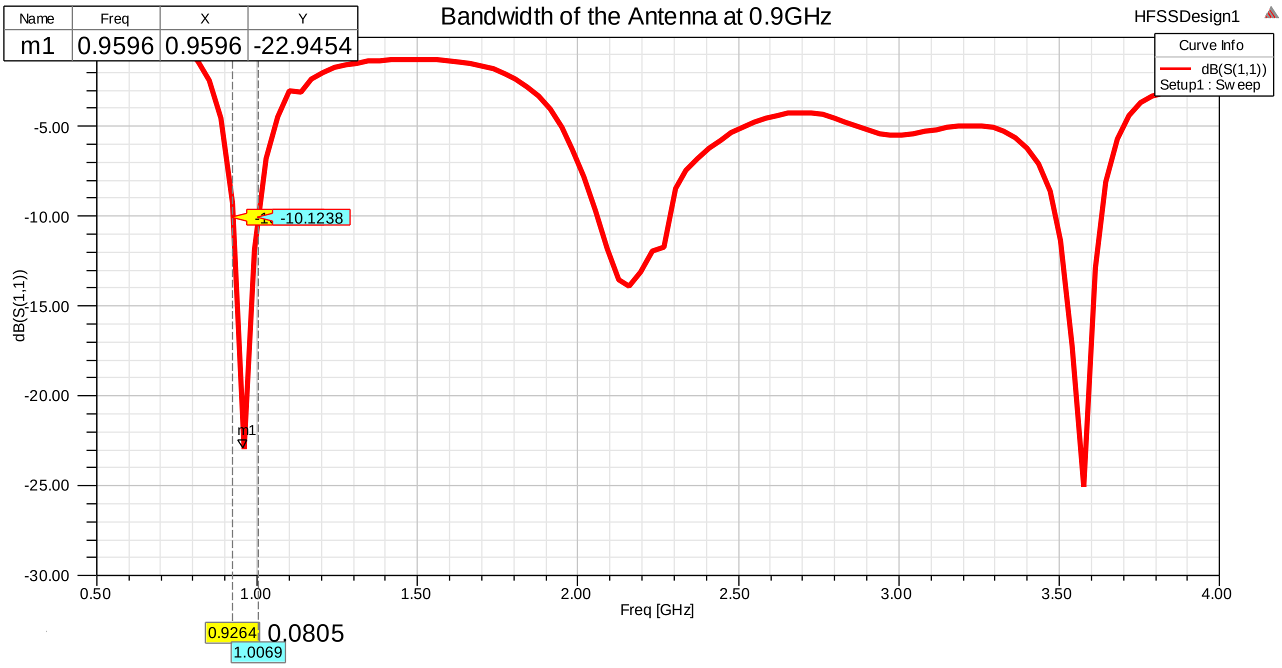

Fig.5 Showing the Band width of the antenna at 0.9GHz.The reported Bandwidth is 80.5MHz.The -10dB impedance Bandwidth is the range of Frequencies for which the Antenna is able to maintain nearly 50 Ohm impedance and represents the number of frequencies that can be coupled to the free space without undergoing any attenuation.

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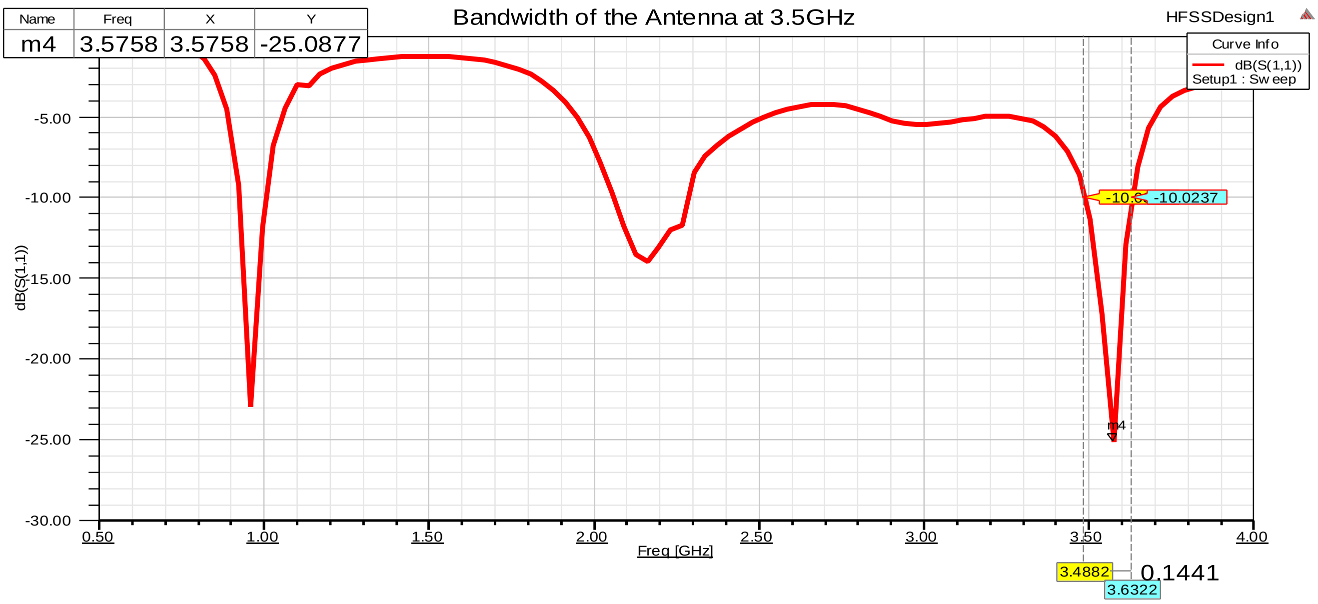

Fig.6 Showing the Bandwidth of the Antenna at 3.5GHz.Thereported Bandwidth is 144MHz at 3.5GHz Frequency.The Frequencies in the range of 3.4882 GHz to 3.6322 GHz are faithfully transmitted by the Antenna without undergoing any attenuation. The difference between the upper -10dB cut off Frequency and the lower -10dB cut off frequency represents the Antenna Bandwidth.

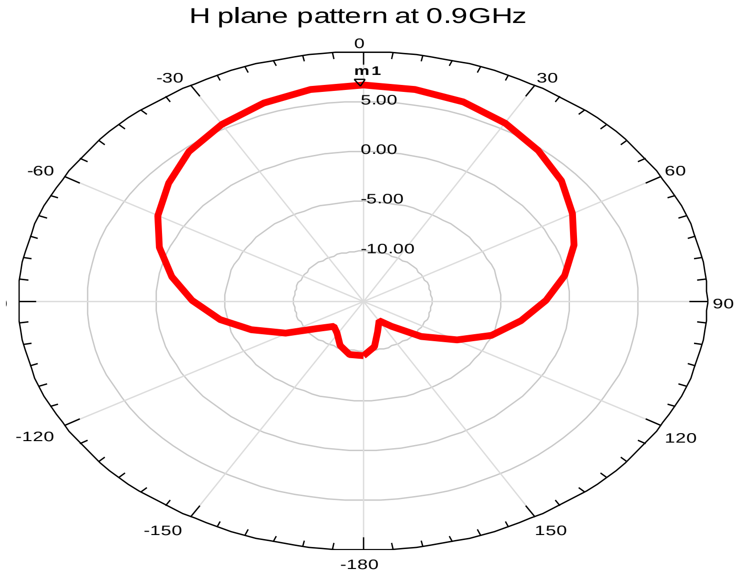

Fig 7.Two dimensional Radiation pattern of Antenna under H plane resonating at 0.9GHz with a peak boresight Gain of 6.7dBi.The two dimensional radiation patter of the Antenna represents the variation of Electric field intensity as a function of Elevation angle (θ) and azimuthal angle (Θ).As can be seen from the figure, normally maximum Gain occurs at an angle of 0 degrees which is also called as bore sight Gain.

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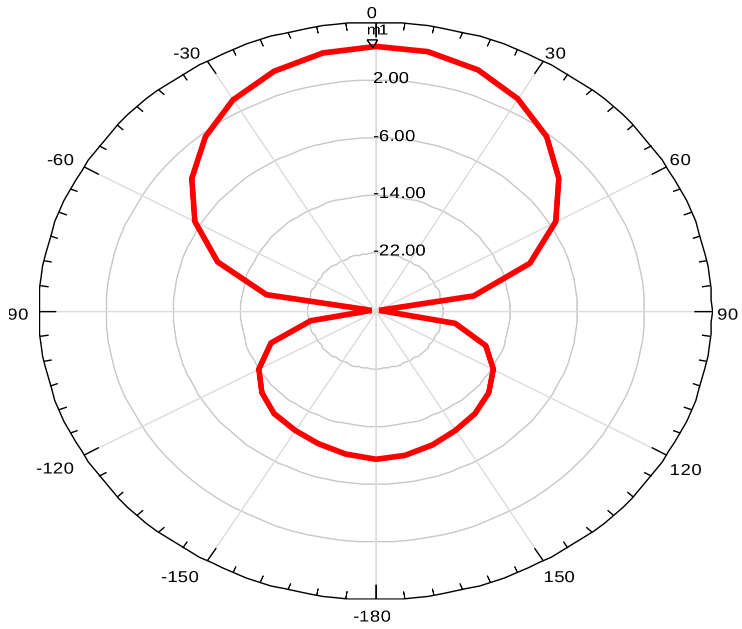

Fig. 8. Radiation pattern of Antenna under E plane resonating at 0.9GHz with a peak boresight Gainof 6.7dBi.As can be seen from the figure the radiation pattern under E plane is a bidirectional Figure of 8 with maximum Gain taking place at 0 degrees, with a value of 6.7dBi.As can be seen from the Figure there is one main lobe and one back lobe and the power level gradually decreases as we depart from zero degrees.

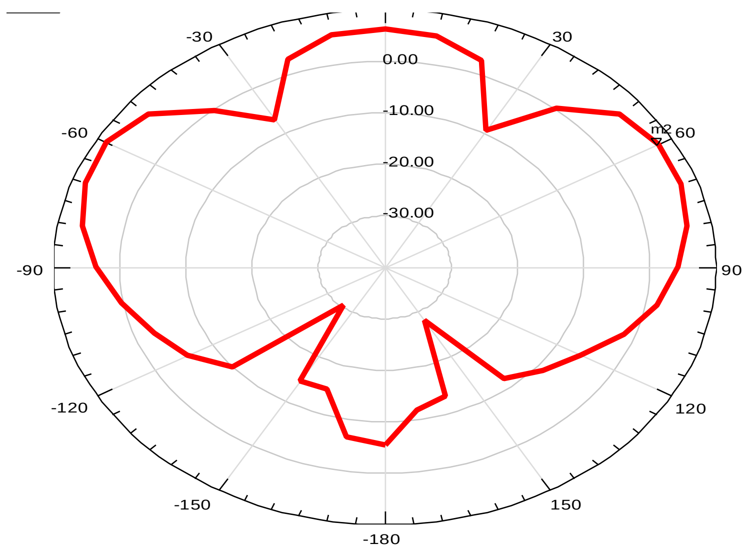

Fig. 9. Radiation pattern under H plane resonating at 3.5GHz with a peak boresight Gain of 6.29dBi.From the figure it is clear that the value of the Gain is nearly a constant with a value equal to 6.29dBi for most of the angles which represent that the Antenna is radiating or receiving a constant power from all the directions and correspond to Omni directional nature of radiation pattern.

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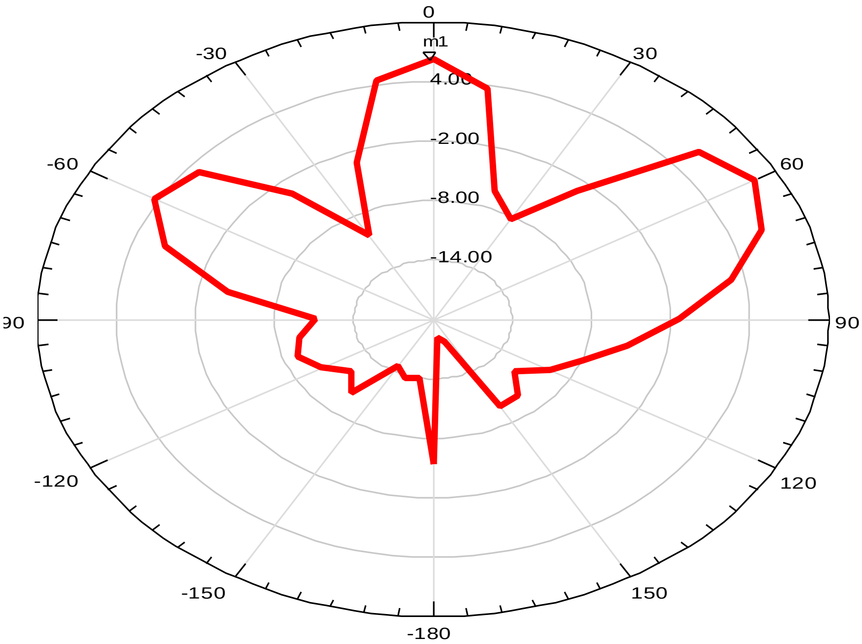

Fig.10 Radiation pattern under E plane resonating at 3.5GHz with a peak boresight Gain of 6.29dBi.From the figure it is clear that the value of the Gain is nearly a constant with a value equal to 6.29dBi for zero degrees,sixty degrees and -60 degrees. And represents the points of Maxima on the radiation pattern where the power radiated or received is maximum.

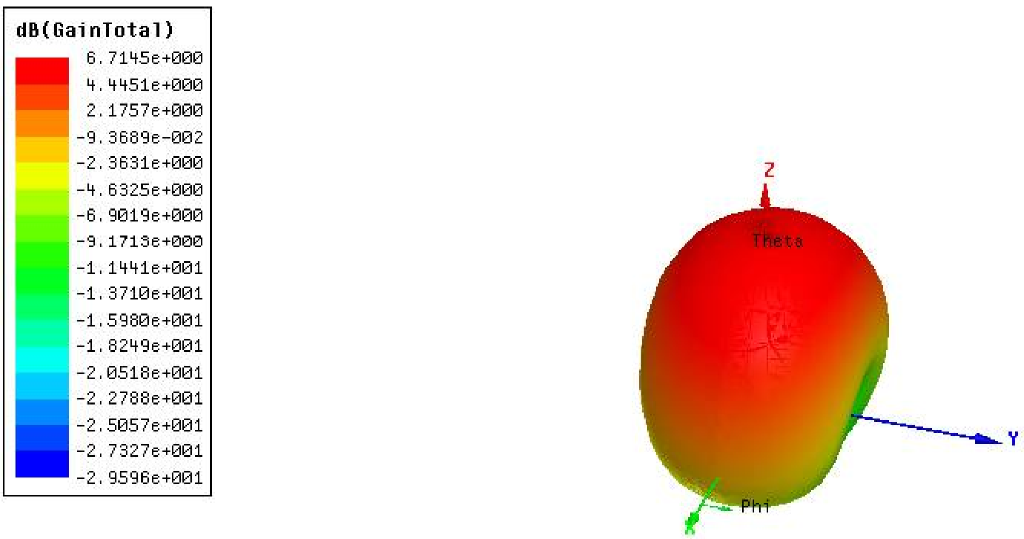

Fig.11 .Three dimensional Gain plot of the antenna resonating at 0.9GHz band.As can be seen from the figure the regions marked with red represents the points corresponding to direction of maximum radiation and has a value equal to 6.714dBi along the z direction which is also the direction normal to the Antenna Axis(Assuming Antenna placed on xy plane).

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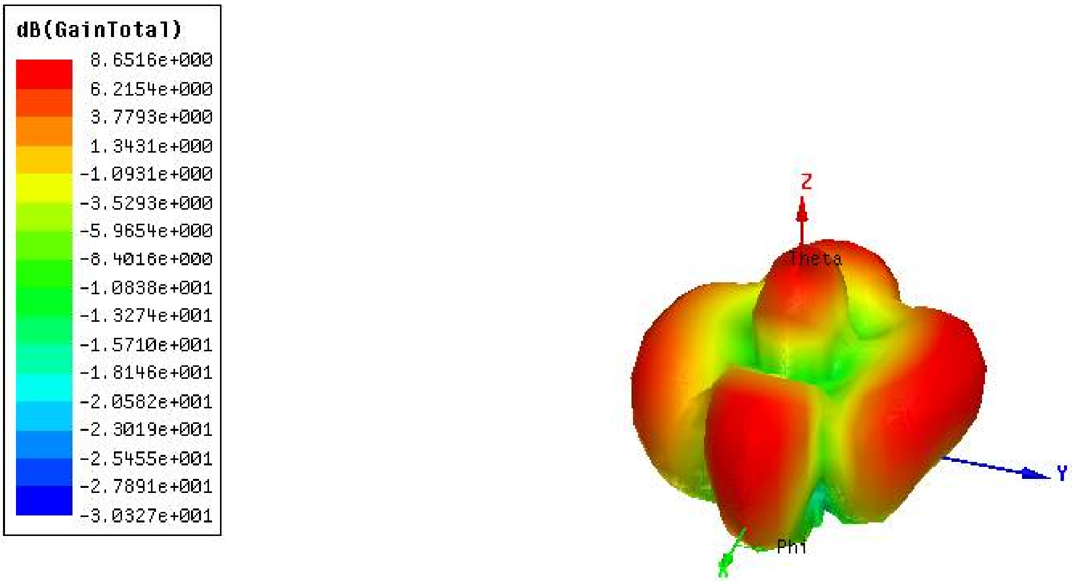

Fig.12 .Three dimensional Gain plot of the antenna resonating at 3.5 GHz band.As can be seen from the figure, the region marked with red represents the points corresponding to direction of maximum radiation and has a value equal to 8.65dBi along the z direction which is also the direction normal to the Antenna Axis (Assuming Antenna placed on xy plane).

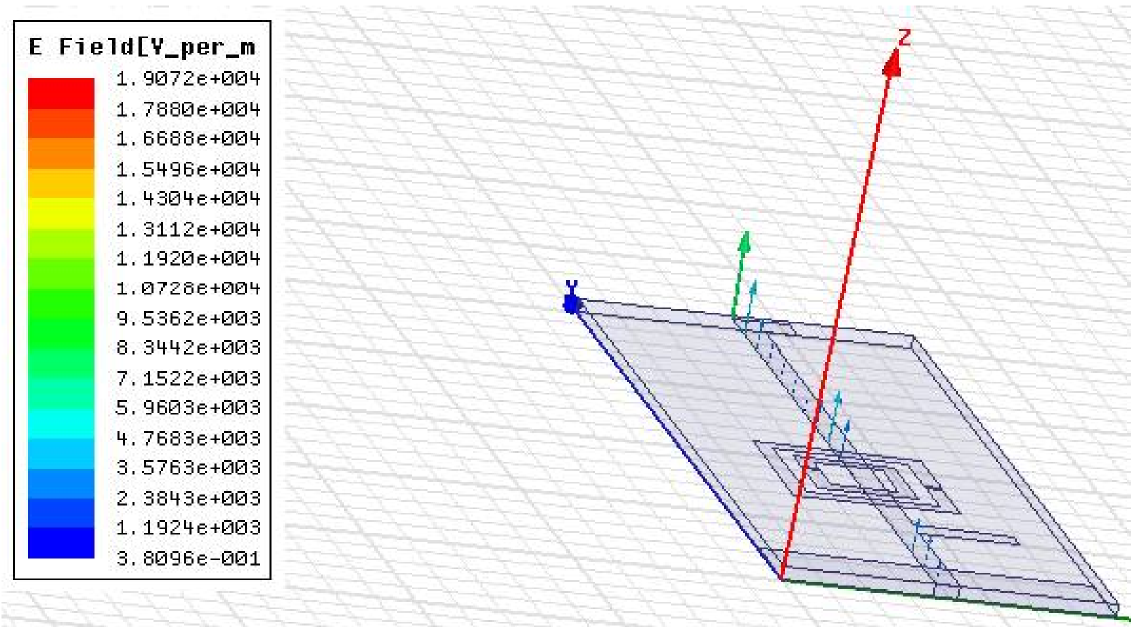

Fig.13 Vector Electric field intensity plot of the Antenna resonating at 0.9GHz.The reported value of the electric field intensity is 19.072KV/m. From the figure it can be seen that most of the electric field lines escape from the main arm of L1 of the Monopole indicating that this portion of the Length is utilized for transmitting the 0.9GHz frequency.

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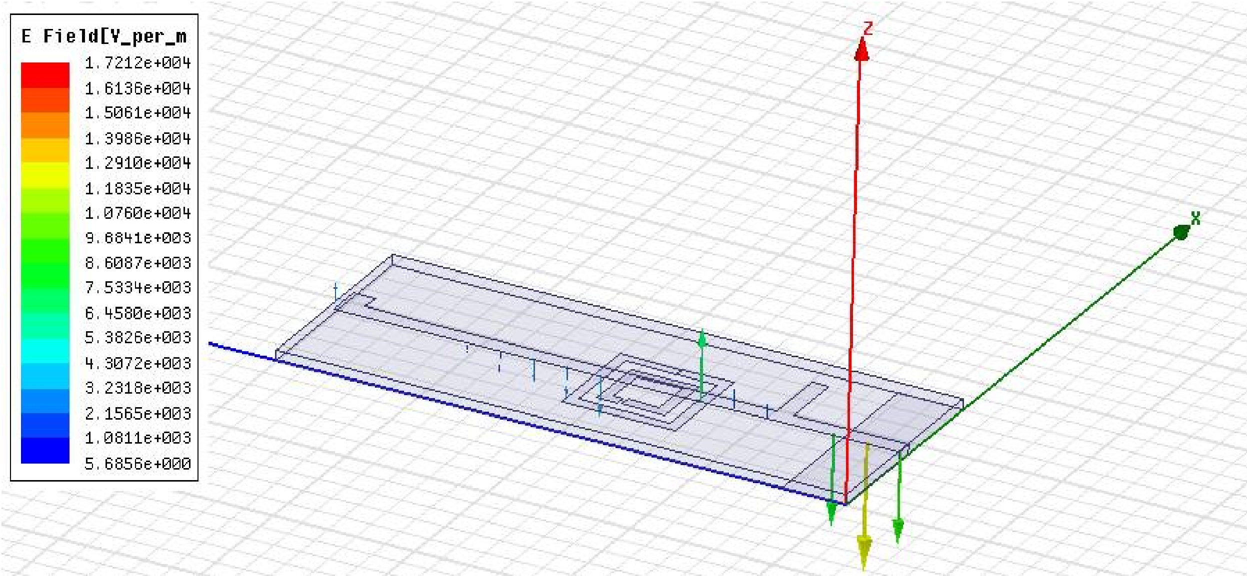

Fig.14 Vector Electric field intensity plot of the Antenna resonating at 3.5GHz.The reported value of the electric field intensity is 17.212KV/m. . From the figure it can be seen that most of the electric field lines escape from the feed above the ground plane and contributes for radiation in the 3.5GHz band.

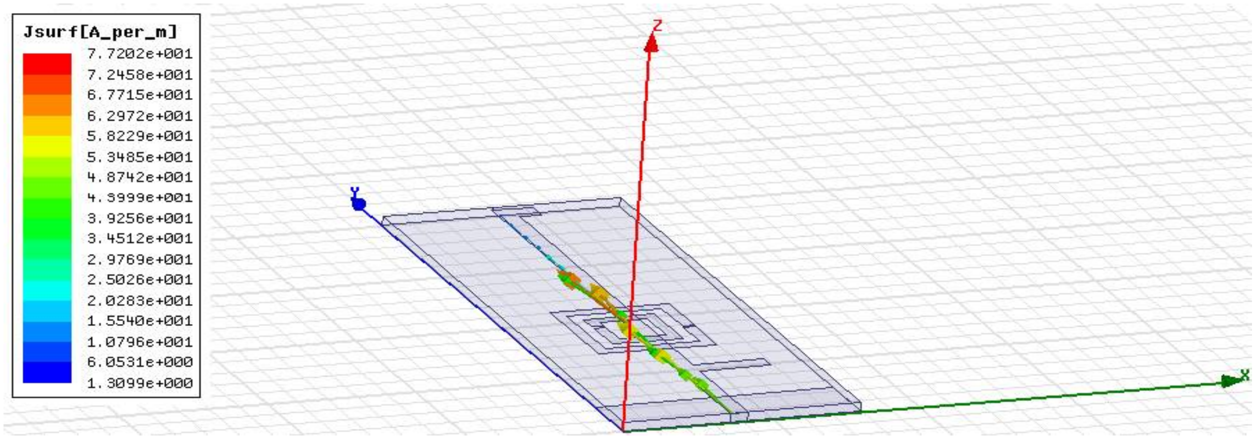

Fig.15Magnitude of the Vector current density plot of the Antenna resonating at 0.9GHz .The reported value of the current density is 77.2Ampere per m.From the figure it is clear that the current density moves along the longer monopole of Length L1 for the GSM 900 MHz frequency band indicating that this section of Length contributes for the radiation in the lower band. The current density is a constant value.

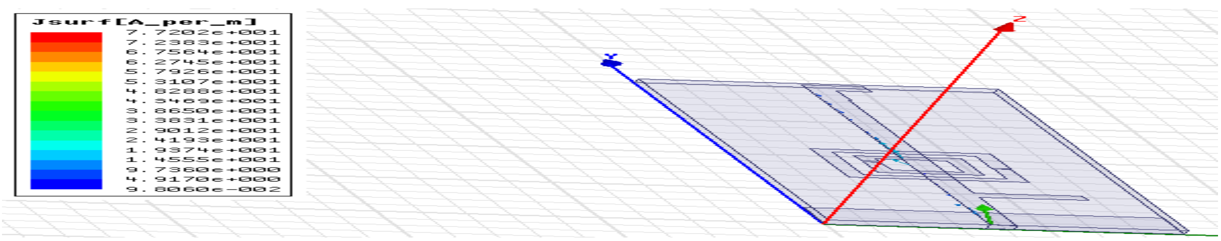

Fig.16 Magnitude of the Vector current density plot of the Antenna resonating at 3.5GHz .The reported value of the current density is 77.2Ampere per m.From the figure it is clear that the current density moves along the feed above the Ground plane for the GSM 900 MHz frequency band

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indicating that this section of Length contributes for the radiation in the higher band. The current density has a constant value.

Table.1Showing the comparison of the various Antenna parameters reported in the Dual band Antenna Design.

Sl No	Antenna parameters	0.9GHz	3.5GHz
1	Return loss	-22.94 dB	-25.08
2	VSWR	1.3	1.1
3	Gain	6.7dBi	8.65dBi
4	Bandwidth	0.0805GHz	0.144GHz
6	Radiation pattern	Figure of 8 under E plane and Hemispherical under H plane	Nearly Omni directional under E plane and H plane

Table.2 Showing the other performance parameters of the Dual band Antenna

Sl No	Additional Antenna parameters	GSM 900 band	Wi-Max band
1		0.9GHz	3.5GHz
2	Max Radiation Intensity U	0.271040W/sr	0.302609 W/sr
3	Radiated Power	0.721154 W	0.539142 W
4	Accepted Power	0.725775 W	0.518731 W
5	Incident Power	1.000000 W	1.000000 W
6	Radiation Efficiency	0.993633	1.039349
7	Front to Back Ratio	41.781506	55.973458

IV. CONCLUSION AND FUTURE WORK

In the present work, a dual band Antenna has been designed targeting the GSM 900 and the Wi-Max (3.5GHz) bands. From the Simulation results reported, it is clear that the Return loss of the Antenna is -22.94dBi at 0.9GHz and -25.08dBi at 3.5GHz indicating that the Antenna is radiating efficiently. The Antenna reported a VSWR value of 1.3 and 1.1 showing that the proposed structure resulted in a good impedance match at both the Frequency bands of interest. The Gain reported is 6.7dBi and 8.65dBi at the lower and the upper frequency bands showing that the Gain is directly proportional to the square of the Frequency. The radiation patterns reported were Hemispherical and Figure of 8 under H and E plane respectively with a peak boresight Gain of 6.7dBi for the GSM 900 band. In the Wi-Max band, the structure resulted in a nearly Omni directional radiation pattern in both the planes with a peak boresight Gain of 6.29dBi. The Antenna size is compact with a dimension of 100mm ×40mm.The bandwidth and the Gain reported were quite high in the Wi-Max band when compared to GSM band. The Front to Back ratio reported was 41.7815 for the GSM band and 55.9734 for the Wi-Max band indicating that the presence of side lobes and back lobes in the radiation pattern. The radiation efficiency reported were 99.3% and 1.03% indicating that the Antenna losses are minimized to a greater extent. The radiation intensity reported is 0.27W/Sr for the GSM band as against 0.3W/Sr for the Wi-Fi band indicating that the radiation intensity increases as the frequency increases. The introduction of the metamaterial in the Ground plane has enhanced both the Gain and Bandwidths in the upper Frequency band thereby providing good isolation between the bands. After this design we plan to extend the work to improve the Return loss at the lower band and the Gain and Bandwidth in the lower band by using metamaterials. Different metamaterial structures can be investigated such as circular to look into the performance parameters of Antennas. The structure can be made more compact by using Fractal structures loaded with a metamaterial. The Gain and the Bandwidths can be improved by further changing the thickness of the substrate or loading with the slots.

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REFERENCES

1 Bhupendra Singh, Haneet Rana, AshuVerma, AbhinavDuhan, Mohd.Zayed, "*SRR loaded Microstrip Patch Antenna for Bluetooth, HIPERLAN/WLAN andWIMAX*", 3rd International Conference on Signal Processing and Integrated Networks (SPIN), 2016.

2 Anitha Ramachandran, Sumitha Mathew, Vivek Rajan and Vasudevan Kesavath, "*A Compact Tri-Band Quad Element MIMO Antenna Using SRR Ring for High Isolation*", IEEEAntennas and Wireless Propagation Letters,Vol .16,2017

3 Sameer Kumar Sharma, Raghvendra Kumar Chaudhary, Chan-Wang Park, "*A Compact Wideband Concentric SRR-based Metamaterial Antenna with Dual-band Characteristics*", URSI Asia-Pacific Radio Science Conference, August 21-25, 2016.

4 M.Z.M.Nor, S.K.A,Rahim,M.I.Sabran & F.Malek*,"Dual- Band, parabolic, slotted ground plane directive antenna for WLAN Applications*", Journal of Electromagnetic waves and Applications, Vol .27.No2, 2013.

5 O. Benabdelouahab, I. Aznabet, M. Aznabet, O. EL Mrabet, M. Khalladi, J. Floc'h, M. Drissi, F. Falcone, "*A Dual-Band Compact Antenna with SRR for Wireless Communication Systems*", IEEE Microwave Symposium, Morocco,2014

6 N.Haider, D.Caratelli, and A.G.Yarovoy *"Recent developments in Reconfigurable and Multiband antenna technology"*, International Journal of Antennas and Propagation Vol.2013, January 2013.

7 A. Taksala Devapriya, Gulfa Rani and S. Robinson, "*Dual resonant Microstrip patch antenna using metamaterial planar structures for S band and C band applications*", ICTACT Journal on Communication TechnologyVol.7, Issue.4,pp-1432-1437,December 2016

8 Mohamed A. Bassiuny, Ehab K. I. Hamad, Wael A. Aly, andMohamed Z. M. Hamdallah, "*Dual-band Microstrip Antenna for WiMAX Applications Using Complementary SplitRing Resonators*", 33rd National Radio Science Conference,Feb 22-25, Egypt,2016.

9 S.C. Basaran, U. Olgun and K. Sertel, "*Multiband Monopole antenna with complementary split-ring resonators for WLAN and WiMAX applications*", Electronics Letters, Vol. 49, pp 10, 2013.

10 Rajesh Saha, Santanu Maity, "*Design of Dual Band Patch Antenna by Loading Metamaterial Structure on Rectangular patch*", International Journal of Wired and Wireless Communications Vol.3, Issue 2, 2015.

11. Mr. Prasanna paga, Dr.H.C.Nagaraj, Dr.T.S.Rukmini, "Design of a Tri-Band Frequency Reconfigurable Monopole Antenna for GSM UMTSand Wi-Fi Applications", International Journal of Electronics and Communication Technology, Vol. 8, Issue 2,2017.

12 T. Benyetho, L. El Abdellaoui, J. Terhzaz, H. Bennis, N. Ababssi, A. Tajmouati, A. Tribak, M. Latrach, "*Design of a Novel Fractal Multiband Planar Antenna with a CPW-Feed*", International Journal of Electrical, Computer, Electronics and Communication Engineering Vol.9, No.1, 2015.

13 Mahesh V. Tank, M. D. Amipara, "*Design of Fractal Antenna for GSM PhoneApplications*", International Journal of Engineering Research & Technology (IJERT) , Vol. 3 Issue 3, 2014.

14 I. Zahraoui, J. Terhzaz, A. Errkik, El. H. Abdelmounim, A. Tajmouati, L. Abdellaoui, N. Ababssi, M. Latrach, "*Design and Analysis of a New Dual-Band Microstrip Fractal Antenna*", World Academy of Science, Engineering and Technology International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering Vol. 9, 2015.

15 Jacob Abraham, Thomaskutty Mathew, "*Dual Band David Fractal Microstrip PatchAntenna for GSM and WiMAX Applications*", Wireless Engineering and Technology, Vol.6, pp: 33-40, 2015.

16. Leonardo Lizzi, Andrea Massa, "*Dual-Band Printed Fractal Monopole Antenna for LTE Applications*", IEEE Antennas and Wireless Propagation Letters, Vol. 10, 2011.