GAIN ENHANCEMENT WITH MINIATURIZED DUAL BAND T-SHAPED, U-SHAPED, H-SHAPED, E-SHAPED ANTENNAS FOR WLAN APPLICATIONS

M. **Ramamohan Reddy 1st , G. Venkata Naga Sai Krishna[2] , K. Sai Mohan Vamsi[3]**

K. Vamsi Krishna[4] , M. Pavan Kumar[5] , N. Srikanth[6]

[1]Associate Professor ,Dept:ECE ,PBR VITS, Kavali, Andhra Pradesh – 524201

[2,3,4,5,6] UG students Dept. of ECE,PBR VITS, Kavali, Andhra Pradesh -524201 India

Abstract - The Antenna is a dual-band microstrip-fed patch antenna in which the glowing structure is formed with a pair of reversed L-shape patches and ground plane is being altered to a - shape. Both the radiating patch and modified ground plane are faultless electric conductors. The patch is in print on a readily accessible Epoxy Glass (FR-4) substrate with thickness 1.6 mm, relative permittivity 4.4, and loss tangent 0.0024. The intentional microstrip patch antenna (MPA) design is capable of generating two distinct operating bands with 10-dB return loss as follows 3.34–3.54 GHz and 4.90–6.26 GHz for T-shape, 6-7 GHz and 8– 9 GHz for U-Shape, 7.50-10 GHz and 12.50-15 GHz for E-Shape. The impedance bandwidths are wide enough to cover the essential bandwidths of 3.3– 3.5 GHz, 5.15–5.35 GHz, 5.725–5.825 GHz for wireless local area network, 3.3–3.5 GHz for multiple input multiple output, 5.25–5.85 GHz for world-wide interoperability for microwave access, 5.650–5.670 GHz for uplinks and 5.830–5.850 GHz for downlinks of Amateur Satellite, and 5.9 GHz wireless access in the vehicular environment (WAVE-IEEE 802.11p). Planned MPA was simulated using the HFSS software tool.

INDEX TERMS – T-Shaped Antenna, U- Shaped Antenna, H-Shaped Antenna, E- Shaped Antenna

I. INTRODUCTION:

The project of a microstrip patch antenna (MPA) is one of the greatest exciting developments in electromagnetic history because of its salient features which are not frequently exhibited in other antenna configurations including ease of fabrication, good radiation control, low cost of production, low profile, lightweight, simple, and reasonable to fabricate using modern day printed circuit board technology, compatible with microwave and millimeter-wave integrated circuits, and ability to conform to planar and non-planar surfaces. These structures are largely responsible for the success of MPA as a viable topic for new research. The concert and operation of a MPA is driven mainly by the geometry of the in print patch and the material features of the substrate onto which the antenna is published. Recently, the ability to mix more than one communication standard into a single system has become an increasing demand of a modern portable wireless communication device. Also, a current antenna requires not only the function of provided that a dual or multiband operation but also a modest structure, compact size, high gain, and easy integration with the system circuit. Dual band multifrequency systems combination of various IEEE 802.11a/ b/g standards are becoming more good-looking. A dual-band/ wideband antenna is a key component for such communication systems. Such dual-band antennas with single feed have been planned in various configurations. These antennas either provide inadequate coverage at the specific resonating frequencies or they cannot be easily united in portable devices. Also, the size of antennas proposed is very large and complex which reduces an antenna's application in wireless communication. In this Project, a high-gain dual-band MPA having multifrequency operation formed with a pair of inverted L-shape patches printed on a FR-4 substrate with defected ground structure (DGS) is presented for filling different wireless communication standards simultaneously.

II. LITERATURE REVIEW:

[1] Y. Cao, C. Lu, and Y. Zhang: A novel dual-band antenna for wireless local area network(WLAN) applications in 802.11a/b/g is inspected. The proposed antenna efficiently covers both 2.4/5-GHz bands with three resonances that are caused by the L-slot and two

connected patches. The parametric learning is attained in order to know the characteristics of the planned antenna. The return loss, radiation pattern, gain are calculated too. The simulation return loss specifies the accuracy of this antenna for the WLAN applications.

[2] Q. He, B. Wang, and J. He: A wideband and dual-band dipole antenna with an united balun feed is given. First, the antenna structure is improved and a 41.5% bandwidth is obtained where voltage standing wave ratio (VSWR) is less than 2. In order to further get a greater bandwidth and dual-band capabilities of this antenna, some rectangle apertures are etched onto the antenna surface, and a better dipole antenna is fabricated. Through investigating rectangle aperture with different sizes, a 47.8% bandwidth is obtained at L-band, and a 15.1% bandwidth comes true at S-band. Contract between calculations and measurements is very good. The result specifies that the novel design not only may attain better wideband characteristic but also can let the dipole antenna work at L- and S-bands.

[3] M.J. Kim, C.S. Cho, and J. Kim: In this letter, the design procedure and electrical recital of a dual band (2.4/5.8GHz) printed dipole antenna using spiral structure are planned and examined. For the first time, a dual band in print dipole antenna with spiral configuration is planned. In addition, a matching method by adjusting the transmission line width, and a new bandwidth broadening method changing the distance between the top and bottom spirals are described. The operating frequencies of the intentional antenna are 2.4GHz and 5.8GHz which cover WLAN system. The planned antenna achieves a decent matching using tapered transmission lines for the top and bottom spirals. The required resonant frequencies are attained by adjusting the number of turns of the spirals. The bandwidth is better by varying the distance between the top and bottom spirals. A relative location of the bottom spiral plays an significant role in attaining a bandwidth in terms of 10-dB return loss.

III. EXISTING METHOD:

Micro strip antenna includes of a very thin metallic strip located on a ground plane with a di-electric material in-between. The radiating element and feed lines are positioned by the process of photo-etching on the di-electric material. Usually, the patch or micro-strip is nominated to be square, circular or rectangular in shape for the ease of examination and fabrication. Here we have shown the modest form of patch antenna where the patch etched on the substrate is half-wavelength long while the thickness of the same is very fewer than λ. Also, excitation to the antenna is on condition that through feed lines connected to the patch. Now the substrate which is unknown but the dielectric material is used to detached the strip from the ground plane. A microstrip or patch antenna works in a way that when current though a feed line spreads the strip of the antenna, then electromagnetic waves are shaped.

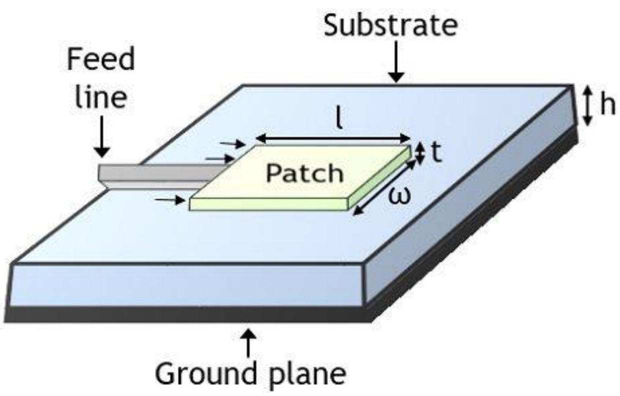

Fig.1: Top View of Microstrip Antenna

The waves from the patch start getting radiated from the width side. But as the thickness of the strip is very slight thus the waves that are shaped within the substrate get reproduced by the edge of the strip. The continuous structure of the strip along the length does not permit the emission of radiation. Furthermore, on suffering a sudden break in the structure of the patch, radiations are again emitted from the second width side of the patch. As this broken structure favours reflections, thus the patch antenna radiates only a small fraction of full incident energy. This makes the antenna unsuccessful, that rather showing the characteristics of a good radiator, it somewhat acts as a cavity. The low radiating ability of microstrip antenna allows it to cover the only small distances of wave transmissions like local offices, stores or any indoor locations. As such unsuccessful transmission is not supportable at a federal location in an extremely large area.

DISADVANTAGES

- Low gain
- Low Bandwidth
- Limited coverage area

IV. PROPOSED METHOD:

MPA (microstrip patch antenna) of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. Dielectric constant of the substrate (fir) is typically in the range 2.2 < fir < 12. The radiating patch and the feed lines are regularly photo etched on the dielectric substrate. MPAs radiate mainly because of the fringing fields between the patch edge and the ground plane. The geometry of the planned antenna accomplished for dual-band operational characteristics. In our present plan structure, the antenna is fixed on both sides of FR-4 substrate with relative dielectric constant 4.4, thickness 1.6 mm, loss tangent 0.0024. There is a regular DGS having wide vertical arm with dimensions and narrow horizontal arm with dimensions printed on the back of the substrate. This shapes ground plane is responsible for bandwidth enhancement of the upper resonating band. The normal dimensions of rectangular MSA are design by scheming the width (W) and length (L)

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

$$\varepsilon_{reff} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}[1+12\frac{h}{w}]^{-1/2}$$

$$L = \frac{\lambda_o}{f_o\sqrt{\varepsilon_{reff}}} - 2\Delta L$$

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

Fig.2: Standard Dimensions

The bandwidth restriction is usually overcome by numerous techniques like using air substrate, cutting slots in the patch , using stacked patch antenna , reducing the thickness of the substrate etc. Among all these techniques cutting slots in the patch is good-looking due to the reason that it keeps the thin profile features of the patch. Some of the frequently used patch shapes using slots are U shaped patch antenna, E shaped patch antenna, H shaped patch antenna, T-shaped patch antenna etc. The major advantage to dual band antennas is their skill to provide a strong, stable wireless connection in often hard to reach locations. For this reason they are often used in devices such as cellular or dual band wireless access points. The two most mutual frequencies used in these antennas are 2.4 GHz (802.11g/N) and 5.1 GHz (802.11a/N). These two “channels” have variances in terms of their skills. The 5.1 GHz option has the developed frequency and subsequently, a smaller range. However, this higher frequency also permits the 5.1 GHz antenna to grip more information at any one time. The 2.4 GHz option inversely has a lesser frequency; allowing the antenna to cover larger distances as well as enter surfaces more efficiently. Here the given below are the compulsory equations and Physical layouts of the planned various shapes of antennas.

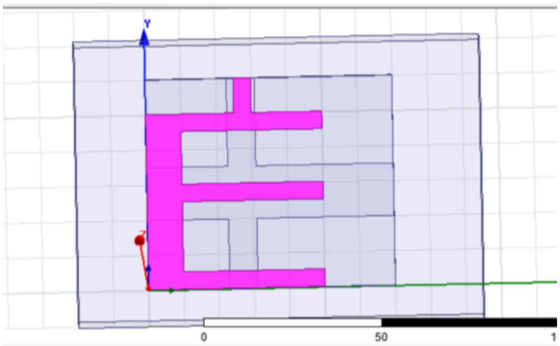

Fig.3: Top View Of E-Shaped Antenna

Material Name	Length (y)	Width (x)	Height (z)
Substrate	60mm	70mm	1.6mm
Radiation Box	80mm	115mm	15mm
Ground 1	15mm	-70mm	
Ground 2	60mm	-8mm	
Rectangle 1	50mm	10mm	
Rectangle 2	5mm	40mm	
Rectangle 3	5mm	40mm	
Rectangle 4	5mm	40mm	
Rectangle 5	10mm	5mm	

Table.1: Specifications Of E-Shaped Microstrip Antenna

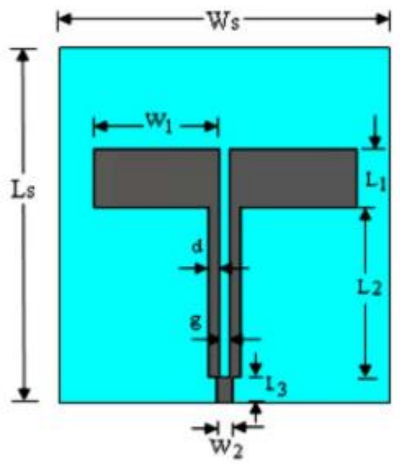

Fig.4: Top View Of T-shaped Antenna

Material Name	Length (y)	Width (x)	Height (z)
Substrate	60mm	70mm	1.6mm
Ground 1	3mm	-5mm	
Ground 2	60mm	8mm	
Radiation Box	106mm	116mm	47.6mm
Rectangle 1	3mm	-5mm	
Rectangle 2	2mm	-33.5mm	
Rectangle 3	-2mm	-33.5mm	
Rectangle 4	-23mm	-11.7mm	
Rectangle 5	23mm	-11.7mm	

TABLE.2: DESIGN SPECIFICATIONS OF T-SHAPED ANTENNA

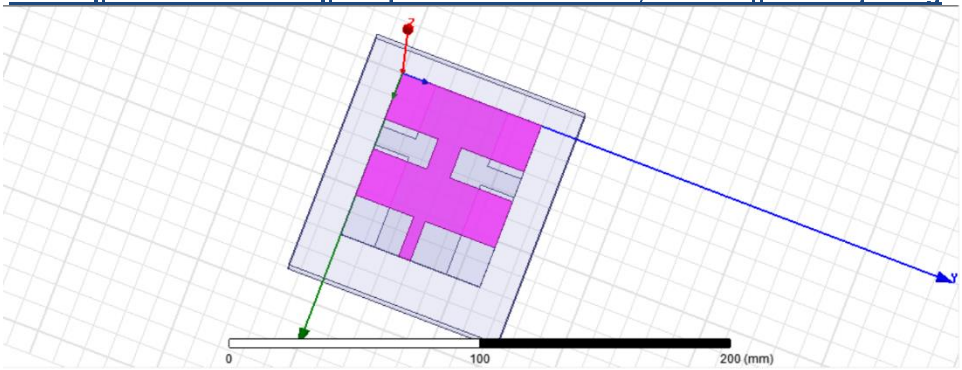

Fig.5: Top View Of H-Shaped Antenna

Material Name	Length (y)	Width(x)	Height(z)
Substrate	60mm	70mm	1.6mm
Ground 1	60mm	-8mm	
Ground 2	31mm	-70mm	
Radiation Box	90mm	100mm	15mm
Rectangle 1	60mm	20mm	
Rectangle 2	60mm	20mm	
Rectangle 3	10mm	13mm	
Rectangle 4	5mm	17mm	

Table.3: Design Specifications Of H-shaped Antenna

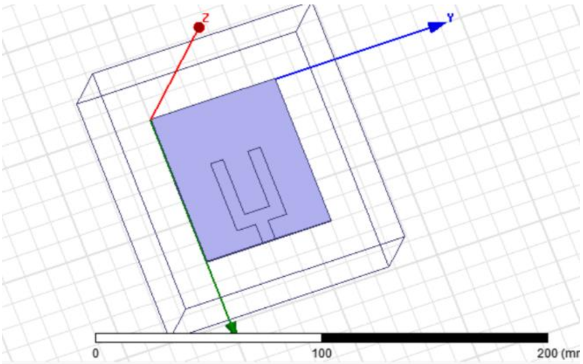

Fig.6: Top View Of U-Shaped Antenna

Material Name	Length (y)	Width (x)	Height(z)
Substrate	60mm	70mm	1.6mm
Ground 1	31mm	-70mm	
Ground 2	60mm	8mm	
Rectangle 1	6mm	27mm	
Rectangle 2	6mm	27mm	
Rectangle 3	24mm	6mm	
Rectangle 4	6mm	9mm	
Radiation Box	106mm	116mm	47.6mm

Table.4: Design Specifications Of U-Shaped Antenna

ADVANTAGES

1. Enhanced gain
2. Small form factor
3. Dual band capability
4. Improved signal quality
5. Larger coverage area

V. RESULTS AND DISCUSSION:

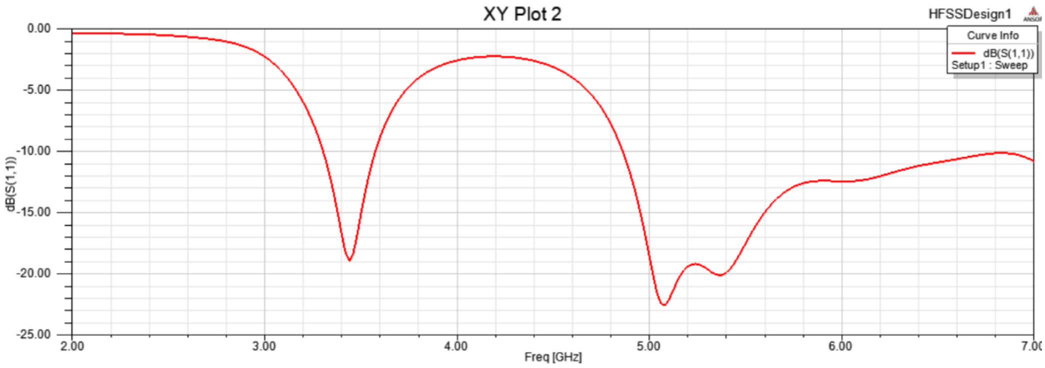

Fig.7: S11 Plot For T-Shaped Antenna

The S11 plot, also identified as the reflection coefficient plot or the VSWR plot, is a graphical picture of the magnitude and phase of the reflection coefficient (S11 parameter) of a T-shaped dual-band microstrip antenna as a purpose of frequency. The S11 plot is an vital tool to estimate the impedance matching and concert of the antenna.The S11 plot for a T-shaped dual-band microstrip antenna characteristically shows two resonance frequencies corresponding to the two working frequency bands.

The plot shows the difference of the reflection coefficient with frequency, where a lower value of S11 (or higher return loss) specifies improved impedance matching. The S11 plot and gain can be found using electromagnetic simulation tools such as Ansys HFSS, CST Microwave Studio, or FEKO. The plot can also be measured experimentally using a vector network analyzer (VNA).

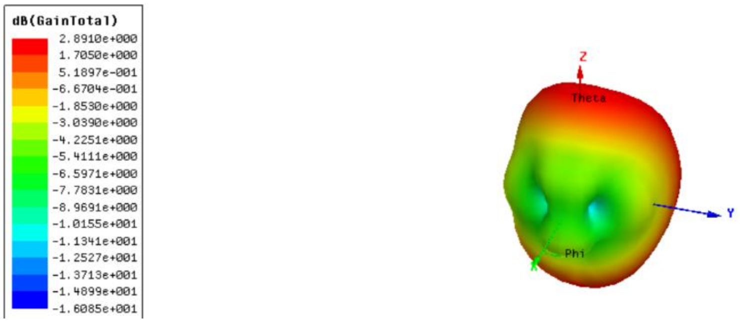

Fig.8: Gain Of T-Shaped Antenna

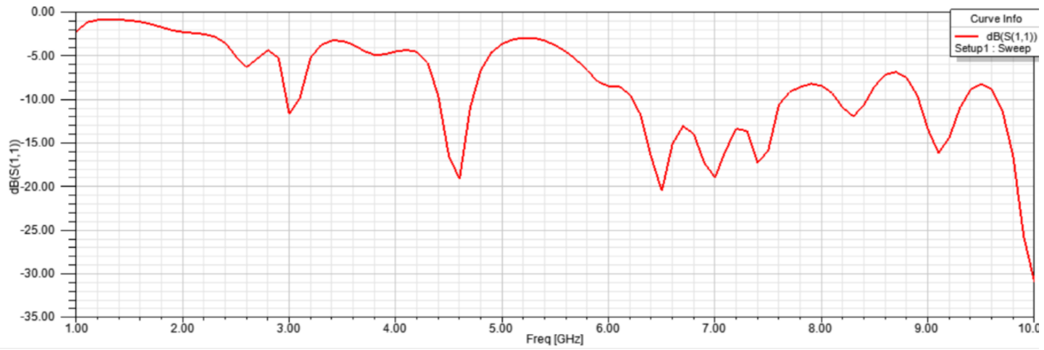

Fig.9: S11 Plot OfH-shaped Antenna

The S11 plot of a h-shaped dual band microstrip antenna is typically considered by two dips or minima corresponding to the antenna's resonant frequencies. The first dip corresponds to the lesser resonant frequency, while the second dip corresponds to the greater resonant frequency. The shape and depth of the dips in the S11 plot depend on several factors, including the substrate's dielectric constant, the feed point's position, and the size and shape of the radiating element. A well-intended h-shaped dual band microstrip antenna will characteristically have deep and narrow dips in the S11 plot, representative good impedance matching and low reflection coefficient at the resonant frequencies.

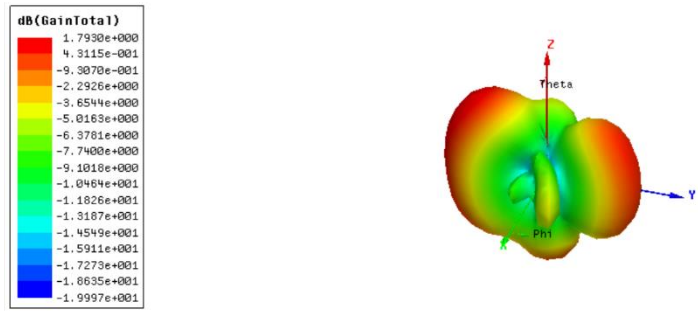

Fig.10: Gain For H-Shaped Antenna

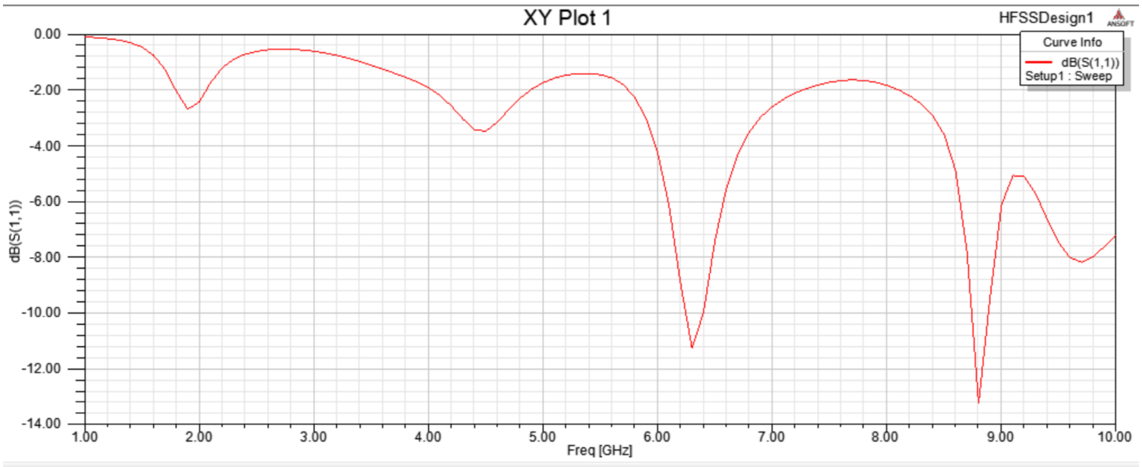

Fig.11: S11 Plot Of U-Shaped Antenna

The S11 plot of a U-shaped antenna characteristically shows two distinct resonant frequencies, corresponding to the two operating bands. The resonant frequencies are considered by dips in the S11 curve, which specify that the antenna is efficiently absorbing power at those frequencies. The shape and position of the dips in the S11 plot be contingent on the dimensions and geometry of the U-shaped antenna, as well as the material properties of the substrate and other environmental factors.

The gain of a U-shaped dual-band microstrip antenna is an vital parameter to consider in antenna design, as it controls the effective radiated power of the antenna and its skill to transmit and receive signals over a certain distance.

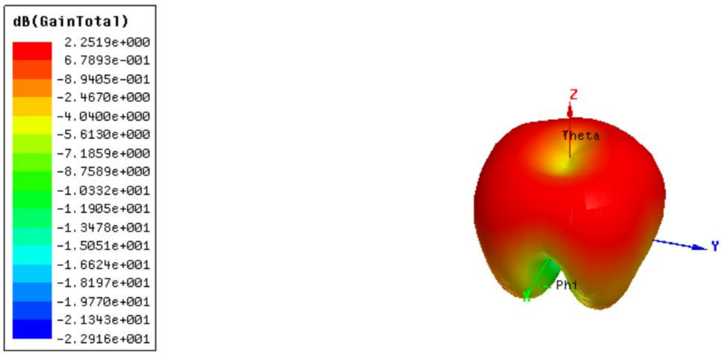

Fig.12: Gain Of U-Shaped Antenna

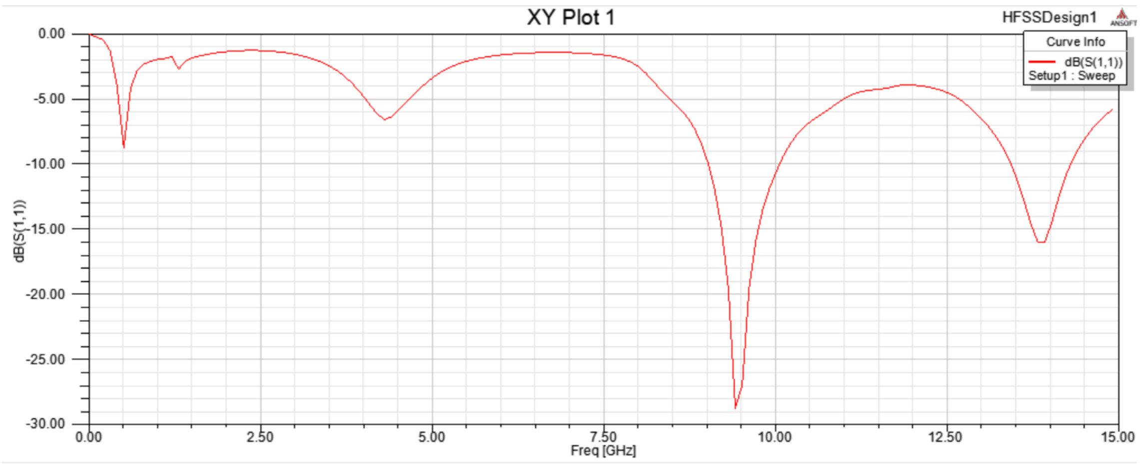

Fig.13: S11 Plot For E-shaped Antenna

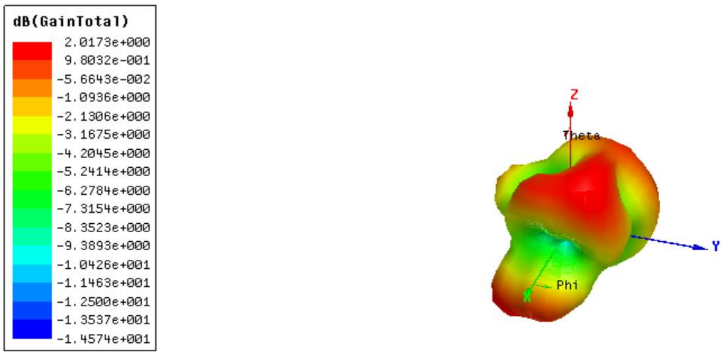

Fig.4.4: Gain of E-shaped Antenna

VI. CONCLUSION

In this project, a dense, high-gain and dual-band MPA shaped with a pair of inverted L-shape patches and -shape ground plane is accessible that is fit for WLAN and other long-distance communication applications. In this exact antenna structure, DGS has been combined which is really answerable for the extensive impedance bandwidth of 24% from 4.90 to 6.26 GHz. Taken as a whole, the act of the antenna meets the wanted supplies in terms of return loss, high gain, and VSWR at the two working frequencies. From this Project, it can be decided that the act of the microstrip antenna depends deeply on the dimensions of the inverted L-shape patches and DGS been used. The type, thickness, and dielectric constant of substrate also contribute in the antenna performance. The planned antenna production costs are increases because of using a FR-4 substrate. It is seen that the planned antenna having simple structure attained very decent performance and can be built with a less cost. Hence, the planned dual-band design will meet the necessities of various wireless communication standards with small size and can be easily united to microwave circuits for practical wireless applications.

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