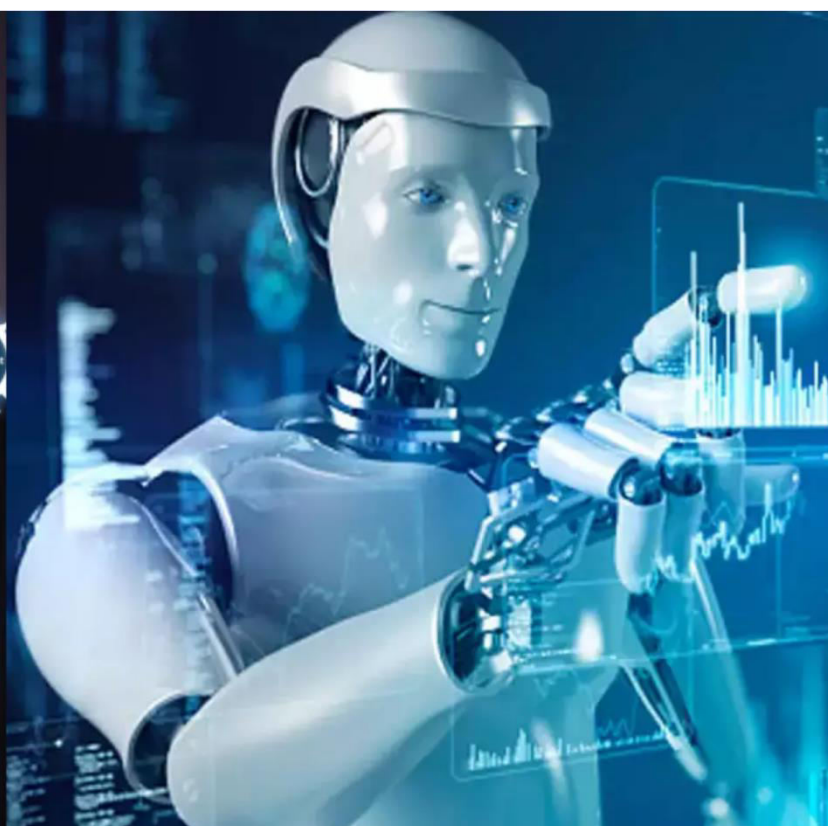




International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 3, March 2025

Survey on Performance Analysis of KU Band Antenna

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ABSTRACT: Studies on metamaterials based microstrip patch antennas are carried out for dual band and wide band operation. Metamaterials like CSRR, MUC, ENGTL VIAs and RIS are used to design compact dual band antennas and high impedance surface is used to design miniaturized wide band antennas with linear polarization at KU bands. Microstrip patch antenna is very much popular now a day because of its compact size and low power consumption. Here, the shape of patch is rectangular and partial ground plane is used. Feeding is done by using microstrip feed line. The dual band and wide band antennas studied in this paper and provide good impedance bandwidth at both the bands and good circular polarization bandwidth at patch mode band. These antennas are best suitable for handheld gadgets which support wireless applications.

KEYWORDS: Microstrip Antenna, Partial Ground Plane, Ku band, Metamaterials

I. INTRODUCTION

Antennas are very important component in wireless communication system. There are different types of antennas exist practically which we used for transmit and receive EM waves. Out of these microstrip antenna is one of the most important antenna nowadays due to their attractive features such as low profile, light weight, low cost and ease in fabrication. Due to increase demand of communication engineering, in respect of maximum data transmission at higher range it is necessary to have measure lessening and enhanced data transmission with opened fix radiator to meet the prerequisite for functional applications. From numerous years or decades the utilization of microstrip radio wires have been seriously expanded in electronic circuits and correspondence frameworks like satellite correspondence, radar, and so on., because of its position of safety, low-weight, little size, minimal effort [1].

All things considered, microstrip reception apparatuses regularly experience the ill effects of low increase, poor polarization virtue, and constrained power limit, by choosing reasonable substrate, changing the radio wire shape or size, utilizing an assortment of encouraging strategies and impedance coordinating techniques, the issues can be solved[2], [3]. The microstrip line is used for feeding because of its ease in fabrication and simple to match by controlling inset positions. A $VSWR < 2$ and $S_{11} < -10$ dB is achieved for a frequency range of 6.5-14.8 GHz in U slot and 4.5-12.89 in T-stair slot with stable E- and H-plane radiation patterns. Keeping in mind the end goal to determine the shortcoming of microstrip receiving wires and increment the data transfer capacity, a grouping of little openings were connected in both sides of rectangular basic fix. Pick up of fix component has been created by utilizing sustain point and ground plane [5]. Subsequent to getting appropriate pick up and data transfer capacity, very order opened patches were substituted in cluster by utilizing wide band sustaining circuit in the opposite side of ground plane. In this paper, in light of the hypothesis of microstrip cluster reception apparatus, numerical figuring and reenactment are figured it out. A productive and new conservative layered coaxial bolster rectangular opened microstrip fix reception apparatus is proposed for Ku-band satellite applications with diminished size. The novel state of fix reception apparatus is appeared in Fig.1. The plan and advancement have done to work reasonably at Ku-band by presenting diverse openings in emanating patch.

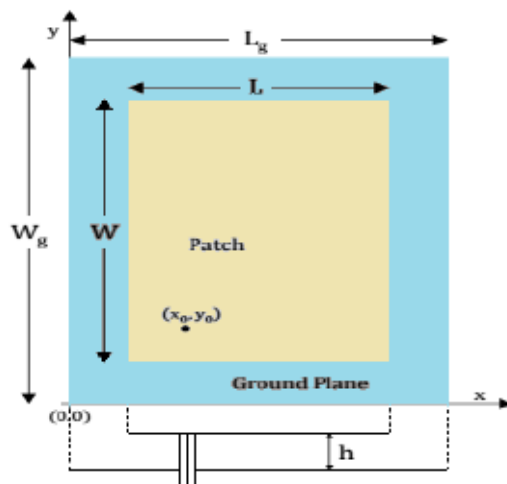


Figure 1: Microstrip patch Antenna

Microstrip patch antennas are mainly fed by two techniques one is based on direct contact and other is on indirect contact [5]. There are four most popular techniques are available for feeding which are Microstrip line, coaxial probe, aperture coupling and proximity coupling [6]. Here the first two are direct (contacting) type feeding and the last two are indirect (non-contacting) type feeding. Performance of any Microstrip patch depends on how it is designed i.e. its physical dimensions.

II. LITERATURE REVIEW

R Praveena et al. [1], presents a Three-band polarization unfeeling microwave metamaterial antenna (MMA). The proposed MMA comprises of a unit cell comprised of a top metallic fix and a ground metallic plane, with these parts isolated by a FR4 dielectric substrate that is incredibly flimsy, with a thickness of just 0.014 times the frequency (λ) of the episode electromagnetic waves. This construction has been intended to accomplish brilliant retention properties in various recurrence groups. The result of this work is utilized to figure out the hazardous location, detecting and radar applications. Through measurements, the manufactured microwave Metamaterial Absorber (MMA) has been evaluated and confirmed. Its plan was at first dissected utilizing mathematical recreations performed with CST Microwave Studio Programming.

T. J. Nagalakshmi et al. [2], Ka-band are a piece of the electromagnetic range utilized for different correspondence and innovation applications. It alludes to the scope of radio frequencies inside the microwave band, explicitly traversing from around 26.5 to 40 gigahertz (GHz). This frequency range is higher than the C-band and Ku-band, which are more well-known. This Ka band is principally utilized in Satellite Correspondence, Radar Frameworks, Earthly highlight point correspondence and so on. Ka-band has advantages in terms of data capacity and speed, but it also has drawbacks like a shorter propagation distance and vulnerability to rain fade (signal degradation in heavy rain), both of which are caused by increased atmospheric absorption. Subsequently, its utilization is frequently advanced for explicit applications where its qualities line up with the prerequisites of the correspondence or detecting frameworks. A spanner-formed fix receiving wire is a kind of microstrip receiving wire that is planned looking like a spanner or wrench. This unmistakable shape fills both utilitarian and tasteful needs. This receiving wire shape can be utilized in different applications, including remote correspondence frameworks and radio recurrence (RF) gadgets. In this work the spanner molded microstrip fix receiving wire is intended for Satellite correspondence application. In this examination work Spanner molded fix radio wire which is planned at 10GHz utilizing FR-4 Substrate. FEKO was used to analyze the antenna's performance. The simulated results are depicted in the Spanner-shaped patch antenna constructed with the FR-4 substrate, which has a gain of 4.12 dB, directivity of 5.587 dB, reflection coefficient of 0.009 dB, and VSWR of 1.06. Primarily it is utilized in satellite correspondence frameworks. They can be coordinated into satellite payloads to send and get signals at 10 GHz frequencies, which are usually utilized for uplink and downlink correspondence with satellites in geostationary or low Earth circles.

Dipanjan Dutta et al. [3], a double wideband dielectric resonator receiving wire (DRA) is accounted for with a microstrip feed and two round cut and rectangular cut evenly in ground structure as Deserted Ground structure (DGS). Emanated electric fields, gain and impedance matching have talked about at the full frequencies at 7.2 GHz, 17.7 GHz. At 7.2 GHz, $S_{11} = -51.19$ dB and at 17.7 GHz, $S_{11} = -23.51$ dB showing solid impedance matching at those functioning frequencies. Generally size of $35 \times 35 \times 1.575$ mm is given by the proposed twofold band radio wire. Furthermore, the proposed receiving wire offers the main band (5.67-8.24GHz), second band (15.58GHz-19.04GHz), have data transmissions of 35.69% and 19.54%, separately. At 7.2GHz and 17.7GHz, the maximum gain is 4.4dB. Radiation proficiency supposedly is more prominent than 96% inside the designated working recurrence band 5.67 GHz to 8.24 GHz, and almost 100% at recurrence 15.58GHz to 19.04GHz Proposed radio wire is unmistakably appropriate for millimeter wave applications in C-and Ku-band reasonable for radar and satellite correspondence.

Youssef Frist et al. [4], present an original recurrence reconfigurable radio wire plan that use the standards of parted ring resonator (SRR) and surrendered ground structure methods (DGS). These methods are decisively applied to the receiving wire's fix and ground, individually. Moreover, the fuse of two PIN diodes, arranged inside the emanating component and the ground plane, acquaints the ability with accomplish particular resounding frequencies. Strikingly, these frequencies length the scope of 8 GHz to 26 GHz, really covering the X, Ku, and K groups. The design of the proposed radio wire integrates two PIN diodes, empowering us to accomplish four particular states. Outstandingly, a larger part of the thunderous frequencies display a positive increase, bringing about a normal increase of 2.55 dBi. Furthermore, the pinnacle S_{11} esteem is important, and the VSWR remains reliably under 2 across generally full frequencies. The radiation design in the E-plane is omnidirectional, offering wide inclusion, while in the H-plane, we notice a directional radiation design overwhelming all things considered frequencies. To guarantee the unwavering quality of our discoveries, we utilize CST Microwave Studio (MWS) for introductory reproductions and consequently approve the results utilizing HFSS.

H. Shirzad et al. [5], are proposing a straightly enraptured (LP) printed dipole radio wire (PDA) joined with a transmissive-type recurrence specific surface (FSS). The proposed FSS changes over LP waves to circularly energized (CP) with two recurrence groups with the comparing place frequencies of $f_1 = 7.2$ GHz and $f_2 = 9.1$ GHz, individually. The LP double band PDA is planned so that its impedance transfer speed (IBW) covers with the working frequencies of the FSS converter. The proposed PDA has two fractional IBW spanning 6.98–7.29 GHz and 8.95–10.07 GHz, as determined by simulation and experiment. The typical estimated gains of the first and second recurrence groups are around 6.23 dBi and 6.51 dBi, exclusively. Taking into account the benefits of straight to-roundabout polarization transformation, the FSS polarization converter has been implanted on top of the receiving wire to accomplish the ideal roundabout polarization. Estimated results show that the mix of the PDA and the FSS converter frames a CP which uncovers a 3-dB pivotal proportion data transfer capacity (ARBW) in the first (6.91-7.42 GHz) and second (8.93-9.35 GHz) recurrence groups.

A. Eslami et al. [6], study presents another plan of a four-component different information numerous result (MIMO) receiving wire, which is reasonable for X-band applications. The roundabout polarization (CP) activity in this work is achieved by utilizing Judo formed patches and L-molded takes care of. The proposed four-component MIMO radio wire accomplishes two thunderous frequencies, the first at around 7.75 GHz and the second one with CP radiation is at roughly 10.15 GHz recurrence. The deliberate seclusions between ports with 46.7×46.7 mm² absolute aspects are < -20 dB. Because of the trials, the encompass relationship coefficient for the symmetrical and equal ports of the proposed MIMO receiving wire is < 0.003 and 0.005 , individually. Furthermore, the introduced receiving wire has a circularly energized presentation in the recurrence band of 9.75-10.41 GHz and the typical acknowledged top addition very nearly 2 dBic. In this work, the investigated antenna is constructed and tested, with satisfactory results.

A. Siahcheshm et al. [7], principal point of this work is to plan a new math of printed helix receiving wires in a straightforward construction that main purposes planar FR4 substrates, not at all like customary wire helix radio wires. The helix's main body is made up of four rectangular substrates that hold the helix arms and form a box. The printed helix arms are planned in a manner that they meet each other in the edges of substrates when set close to each other. The main benefits of this work are presenting a strategy that makes the helix receiving wire creation and furthermore the impedance coordinating technique more straightforward. The introduced helix radio wire has endfire radiation in Z-course with round polarization reasonable for L-and S-groups applications. The proposed antenna has a wide impedance bandwidth of 1.37 GHz from 1.56 GHz to 2.93 GHz, a 3 dB axial ratio bandwidth of 1.18 GHz from 1.58 GHz to 2.76 GHz, and a maximum gain of 11.3 dBic at 1.6 GHz, according to simulations and measurements.

Shuchismita Pani et al. [8], talks about the impact of various miniature strip feed highlight single E and twofold E molded fix receiving wire with a wide functional data transmission for remote and satellite correspondence. The return misfortune and radiation example of various fix plans are examined. The single E fix radio wire works from 2.8GHz-11GHz with gain 9.6dB-14.5dB. The twofold E formed fix radio wire works in multiband recurrence with gain got from 7dB-9dB. At higher recurrence this can be utilized for Ku-band and satellite correspondence.

III. FORMULATION OF DESIGNING METHOD

In the process of design we need to calculate some parameters for substrate and the ground and which will be easily calculated by formulas discussed below:-

To calculate width of the dielectric substrate,

$$W = \frac{1}{f_r \sqrt{\mu_0 \epsilon_0}} \sqrt{\frac{2}{\epsilon_r + 1}} \quad (1)$$

Where f_r is the resonance frequency, ϵ_r dielectric constant of the substrate & μ_0, ϵ_0 are the permeability and permittivity of free space respectively.

$$W = \frac{v_0}{f_r} \sqrt{\frac{2}{\epsilon_r + 1}} \quad (2)$$

Where v_0 shows the velocity of wave in free space. Now after calculating width of dielectric next is dielectric constant which we have to calculate and the formulas used to calculate dielectric constant is given by,

$$\epsilon_r = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2\sqrt{1 + \frac{12h}{W}}} \quad (3)$$

Here we consider effective length instead of original length because the Microstrip antenna looks longer as only because of fringing effect and the effective length of the antenna is differ by ΔL from the physical length.

This extension in length is simply the ratio of width to the height and ϵ_{eff} which is given by below formula

$$\frac{\Delta L_{eff}}{h} = 0.412 \frac{(\epsilon_{eff} + 0.3) \left(\frac{W}{h} + 0.264 \right)}{(\epsilon_{eff} - 0.258) \left(\frac{W}{h} + 0.8 \right)} \quad (4)$$

Now the original length is given by

$$L = \frac{1}{2f_r \sqrt{\epsilon_{eff} \mu_0}} - 2 \Delta L \quad (5)$$

After calculating all these we have to calculate the dimension of the ground plane which will be varied for same antenna in some amount and this relation is given by

$$L_g \geq \left(\frac{\lambda_{eff}}{4} \right) * 2 + L \quad (6)$$

$$W_g \geq \left(\frac{\lambda_{eff}}{4} \right) * 2 + W \quad (7)$$

By above flow chart it is very clear that the calculations of patch parameters like length, width and feeding point all are calculated with the help of MATLAB tool using special function with high accuracy, for this in very first step antenna working frequency is selected, now dielectric material chosen to work on given frequency.

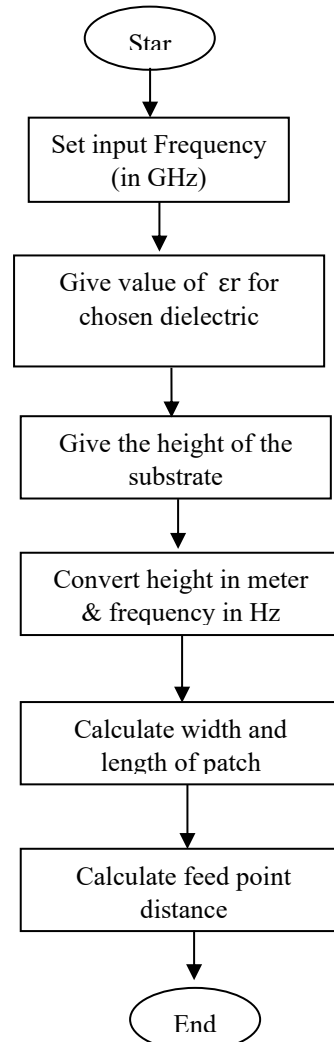


Figure 2: Flow Chart for Patch Parameter Calculation.

Now optimum height of the substrate is inserted in the next step and the desired parameters are calculated. It gives us the flexibility to change our input frequency, height of subtract at run time and the time which is required for simulation is also very less.

Table 1: Patch antenna parameters for various frequencies

S. No.	Input Frequency (GHz)	ϵ_r	Length (mm)	Width (mm)	Height (mm)	Feed Point Distance
1.	12.5	4.1	51.131	7.514	1.6	1.872
2.	12.6	4.1	5.083	7.455	1.6	1.854
3.	12.7	4.1	5.035	7.396	1.6	1.837
4.	12.8	4.1	4.987	7.338	1.6	1.819
5.	12.9	4.1	4.9414	7.281	1.6	1.802
6.	13.0	4.1	4.8956	7.225	1.6	1.785

For the various frequencies with same dielectric constant the simulation results are shown in the below Table 1 where we see that width and length of the radiator is get changes as the frequency varies this shows the inverse relation, which exist in between them .

IV. PARAMETRIC OPTIMIZATION

The design parameters that govern the input impedance are substrate height, feed-point location and gap width.

a) Effect of Feed Point Location

For three different feed-point locations from the center of the patch, there is variation in the VSWR with frequency, shown in Fig. 3. With increase in frequency, the input impedance moves in a clockwise direction in the smith chart [7, 8]. As x moves from 1mm (feed-point is shifted to the edge), the input impedance loci shifts in the right direction on the smith chart implying that the impedance is increasing. A perfect match of 50 ohm feed-line is obtained for 4.75 mm along $-x$ direction, which gives a bandwidth of 3.21 GHz for VSWR 2.

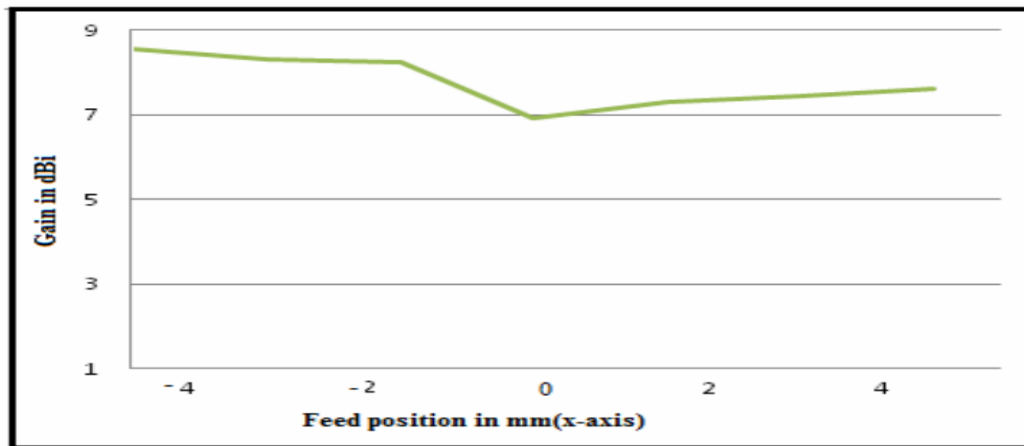


Figure 3: Gain variations of microstrip antenna

b) Effect of Gap Width

Gap width governs the interaction between the coupled patch and the main patch. Increase in the gap width decreases the size of the impedance loci, because the interaction between the resonators decreases. Also the impedance loci shift toward the left side of the smith chart is shown in Fig. 4(a) and (b). Further increase in the gap width decreases the size of the impedance loci and the loop disappears for larger gap width. In this case, the gap width is varied from 0.0073 to 0.033. The optimized value of 0.0073 gives good bandwidth thereby increasing the interaction between the co-patch and the main patch [9].

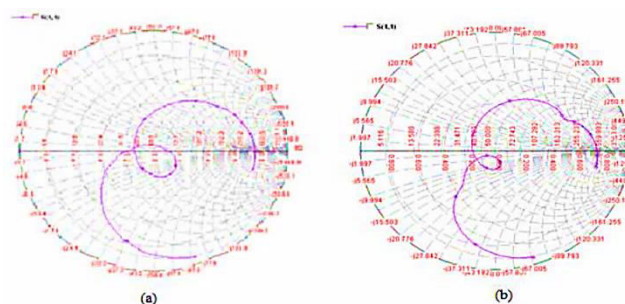


Figure 4: (a) Smith chart for optimized gap width (b) Smith chart for increased gap width

c) Effect of Height, h

With increase in height h , from 0.083 to 0.093 the fringe fields from the edges increase, which increases the extension length and hence the effective length, thereby decreasing the resonance frequency. The bandwidth of the antenna increases from 1.575 GHz to 3.21 GHz, for the optimized height 0.093. The increase in the probe inductance of the feed moves the input impedance in clockwise, thereby introducing inductive shift [12].

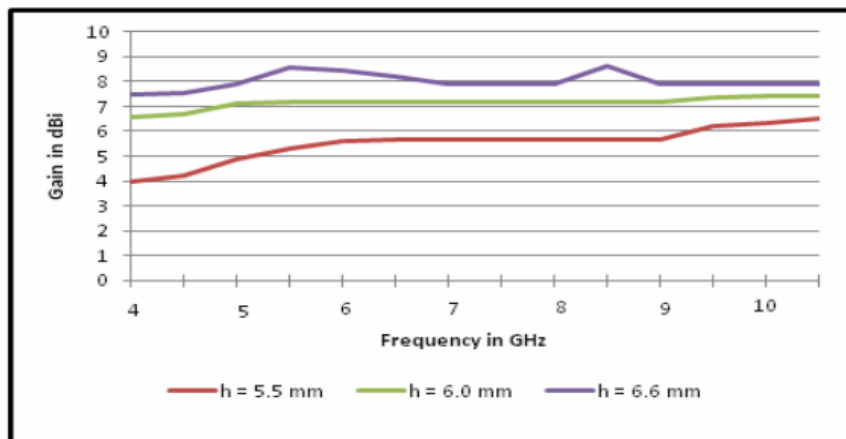


Figure 5: Gain variations of microstrip antenna

d) Effect of Width, W

Patch width affects the bandwidth to a larger extent [13]. A larger patch width increases the bandwidth, radiated power and the radiation efficiency. Patch width is chosen greater than the patch length, with good excitation. It is observed that the patch width varies from $0.45\lambda < W$

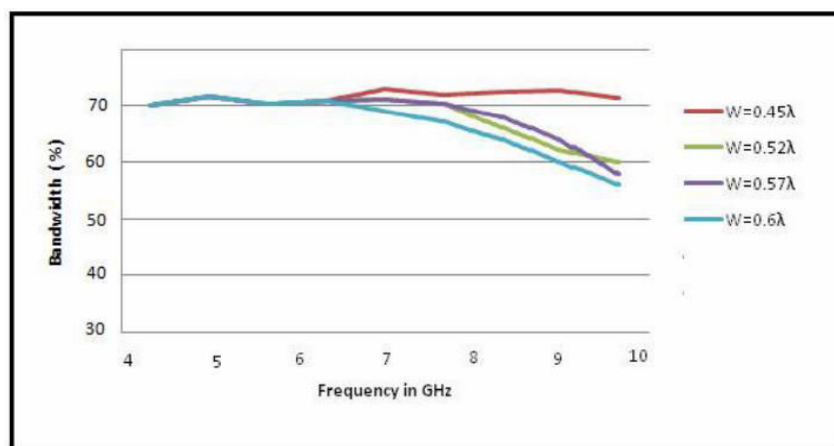


Figure 6: Bandwidth variations of microstrip antenna

V. TOOLS AND PARAMETERS

Tool: The Ansys HFSS software suite is used for the design and analysis of the antenna design. It is a full-wave electromagnetic test system dependent on FEM. It breaks down 3D and multilayer structures of broad shapes. It has been generally utilized in the structure of MICs, RFICs, fixed reception apparatuses, wire antennas, and other RF/remote receiving antennas. It tends to be utilized to compute and plot the S11 parameters, VSWR, current distributions, in addition to the radiation patterns. HFSS version 13.0 is utilized to get the design and analysis of the antennas.

Parameter:

Proposed antenna will simulate using HFSS software & corresponding graphs are obtained to analyze the performance in terms of output parameters, such as return loss, gain, radiation pattern and VSWR.

VI. CONCLUSION

Still more compact dual band antennas can be designed by adopting the combination of different types of metamaterials and fractals. An aspect of microstrip antenna has been studied. The antenna is suitable for designing purpose as well as transmission in Ku band. It is clearly visible from the simulation results that VSWR is < 2 throughout the operating bandwidth. Further, the design resulted in compact size antenna with good radiation characteristics for all operating frequencies. Moreover, the performance of this presented antenna illustrates that it is a good candidate for Ku bands applications

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