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# Design and Simulation of Dual Band Slotted Patch Antenna Using Two H Shaped Slots

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***Abstract-*** *In this paper a dual band slotted patch antenna has been designed, using two H-shaped slots embedded in the original patch. First the simple patch has been simulated and various performance parameters of this patch have been calculated. Secondly, two H shaped slots are cut on the conducting surface of square patch which gives dual band operation of the original patch with improved parameters of the patch. The original square patch resonates at 10 GHz and H's shaped slotted antenna resonates at 8GHz And 12 GHz. The performance comparisons of both structures for different parameters have also been done. All simulations have been done using IE3D simulation tool.*

**Keywords :** Patch, slot, parameters, IE3D etc.

## I.INTRODUCTION

Antenna is an electronic device that converts electrical power into radio waves and radio waves into electrical power. Antennas also use to radiate or receive electromagnetic waves. Thus antennas play very important role in finding the characteristics of the system in which they are employed. Microstrip patch antennas are widely used among all of the other antennas family due to its simplicity and inexpensive manufacturing. In microstrip antennas, when patch is printed on dielectric slab, volume of antenna reduce due to which bandwidth also reduces while Q factor increases with the dielectric constant of substrate. Microstrip patch antennas are mostly operated on high frequency bands like UHF and also provide satisfactorily directive gain of near around 6 to 9 dB and much higher gain is also achieved by just adding patch array which results in little high cost of the structure. These antennas have several advantages over other antennas like low weight, low manufacturing cost, low profile and can easily modified [17]. Coaxial feed technique has been used for proposed design because this feed can placed at any point in patch in order to match input impedance characteristics according to wish of designer. The slotted antennas are popular because they can be cut out of whatever surface they are to be mounted on, and have radiation patterns that are roughly omni directional. In slotted antennas, slots are cut into the conducting surface and the currents travel around the slot perimeter increasing the electrical length. As such, a slotted small size antenna is made to perform equivalent to its larger counterpart. Operating frequency range of these antennas are from 300 MHz to 24 GHz. New categories of slot antennas are also developed like printed slot antenna for wireless application [14].Miniaturization of slot can also done by virtually implement boundary condition at the end of slot antenna to reduce the size of slot antenna [2].Insertion of slots in patch are new technique to reduce the resonant length and also improved bandwidth performance [6]. Many researchers are working on different shapes of slot inserted into patch like U shape [6], W shape, E shape [16], T shape [7] etc so if compared slot loading antennas with conventional rectangular patch antenna then former gives better performance [15].

 

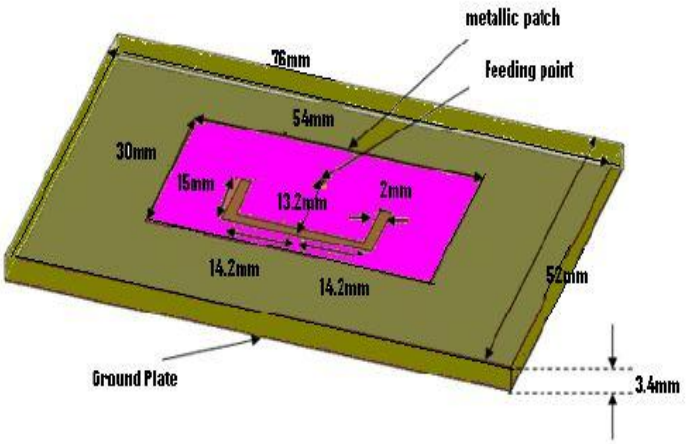


Fig 1: Slot loading antenna

**II ANTENNA DESIGN AND SIMULATION RESULTS**

Simulation tool is use for proposed work is IE3D electromagnetic simulation and optimization package, it is advanced technology to obtain high accuracy analysis and to design RF printed circuit, complex microwave circuit, antennas and other electronic component.IE3D simulation tool is introduced in 1993 IEEE International Microwave Symposium, it is adopted as industrial standard in 3D and planar electromagnetic simulation.IE3D tool becomes more easy to use, most versatile, efficient and accurate. Zealand software presents IE3D simulation tool is full wave, MOM(method of moment) simulator solve current distribution on multi layered structure and 3D structure of general shape.

Dimensional specifications of proposed antenna are mention in this section of paper. Square patch antenna is of dimensions 18.81 mm × 18.81 mm with substrate thickness of 1.524 mm, dielectric constant 2.6 and loss tangent .0025 with probe feed position 17.5 and -17.5.Original square patch is shown in Fig.2.

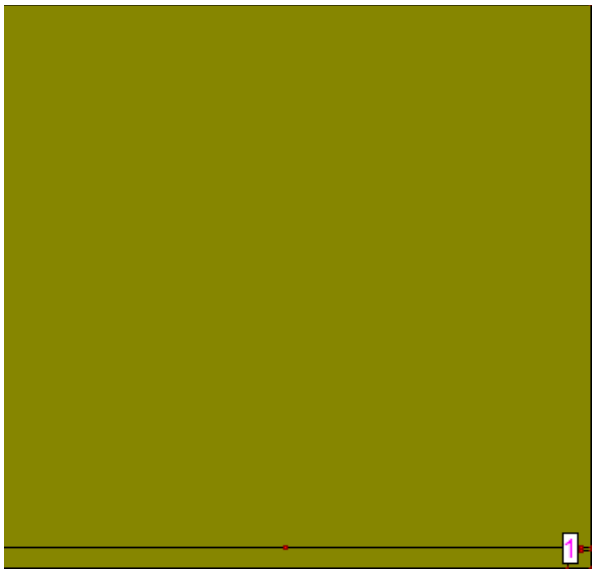


Fig 2: Original view of square patch antenna

Parameters like return loss, gain, directivity, radiation pattern, VSWR etc plays vital role in predicts the performance of antenna. Firstly we observed Return Loss parameters which show Return loss also measures the effectiveness of power delivery from transmission line to antenna. Graph of S11 verses frequency shows the return loss curve, which shows sharp dip that shows minimum dB value at that frequency. Square patch is resonates at frequency 10 GHz and return loss is observed is -20.4 dB in Fig. 3. After that we observed VSWR which shows the proper impedance matching between feed line

 

and antenna. VSWR observed is 1.2 in above Fig.4. .The 3D radiation pattern plot for square patch is also shown in Fig 5. Radiation pattern parameter provides the plot of radiations in the three dimensional space. The graph of radiation pattern is three dimensional and hence can't be completely represented on plain paper. An antenna's bandwidth specifies the range of frequencies over which its performance does not suffer due to poor impedance match. The frequency at which return loss or scattering parameters value is minimum is taken as resonant frequency of antenna and bandwidth for square patch is 2.2 GHz

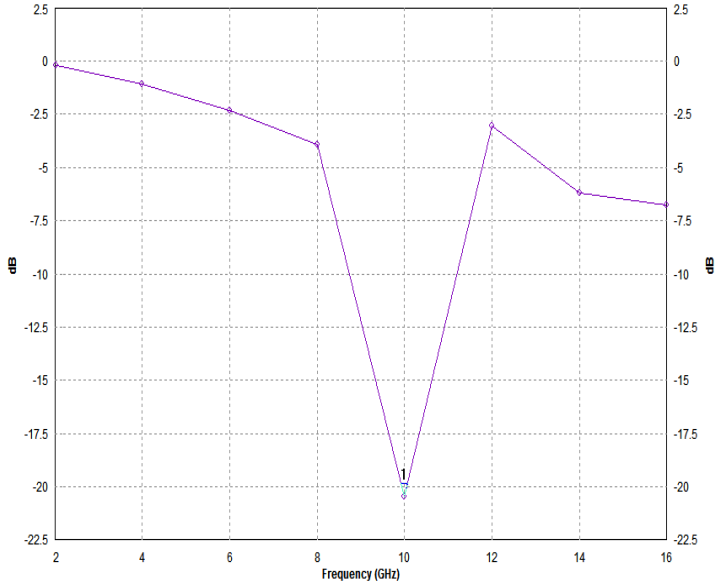


Fig 3: Return loss plot of square patch antenna

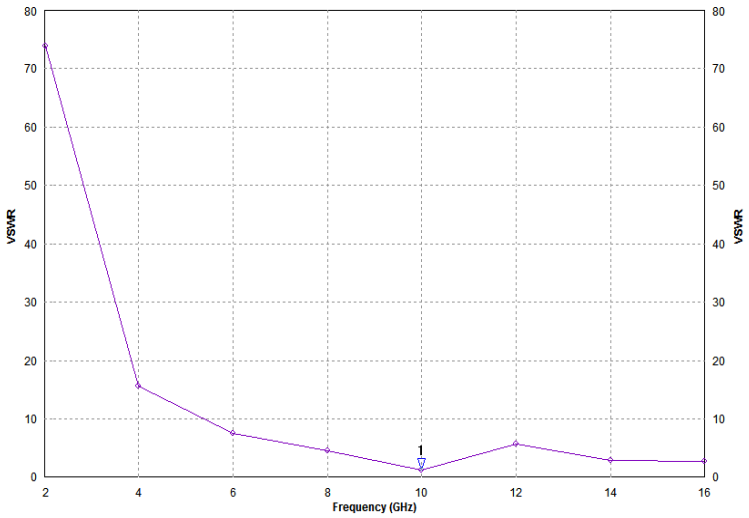


Fig 4: VSWR plot of square patch

 

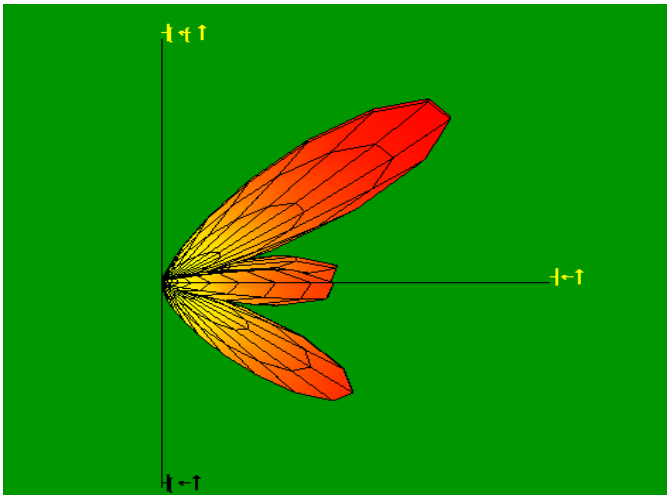

Fig 5 : Radiation pattern of square patch antenna at 10 GHz

Other performance parameters are also calculated like gain which is main descriptor of antenna performance because gain is the measure of the ability of an antenna to direct the input power in to the radiation in a particular direction and then measure at peak radiation intensity. Gain at frequency 10 GHz is 9.7 dB as shown in Fig. 6. Directivity is also important parameter to analyze antenna performance and it defined as ratio of radiation intensity in that direction to the average radiated power or also can define it as ratio of total radiated power by subject antenna to power radiated by isotropic antenna for the same radiation intensity. For radiating Square patch directivity observed is 11.6 db at frequency 10 GHz as shown in Fig. 7

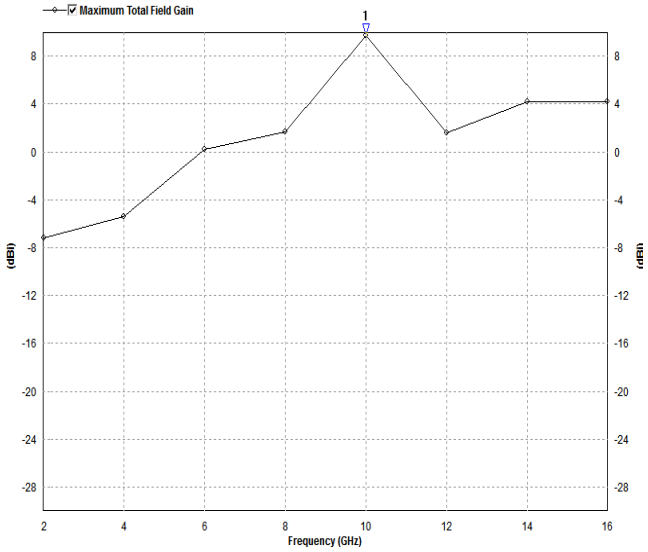


Fig 6: Gain plot of square patch

 

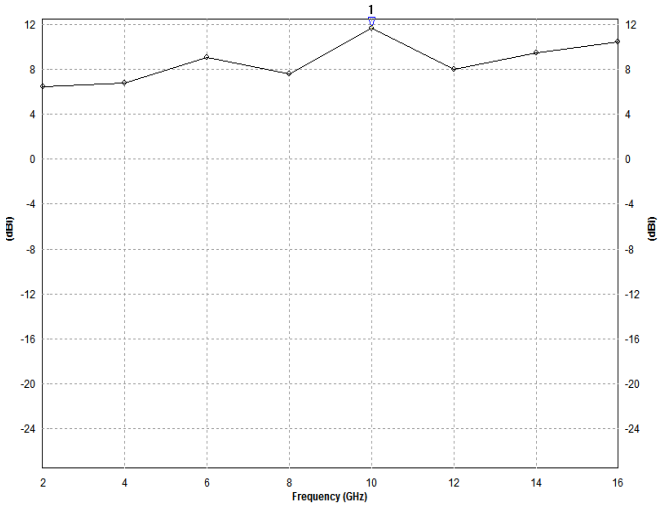


Fig 7 : Directivity plot of square patch

Table 1: summary of all performance parameters of the square patch antenna

| **Performance Parameters** | **Resonant frequency at 10GHz** |
|---|---|
| Return loss | -20.4 dB |
| VSWR | 1.2 |
| Bandwidth | 2.2 GHz |
| Directivity | 11.6 dB |
| Gain | 9.7 dB |
| Efficiency | 65.4 % |

Above half of paper shows the simulation results of square patch antenna .Now second part of design is consists of dual H band slotted antenna which is composed of inserting 2 H shaped slots in the patch. Dimensions for these slots are 10mm × 3mm (L × W) in horizontal section and 8mm × 2mm (L × W) of the vertical section as shown below in figure 8. In this antenna, frequency is resonates at 8 GHz and 12 GHz and all the performance parameters are then observed at these frequency. Firstly compute return loss at 8 GHz and 12 GHz which is -24.5 dB and -18 dB respectively as shown in Fig.9 and VSWR values are 1.1 and 1.2 clearly shown in Fig .10

 

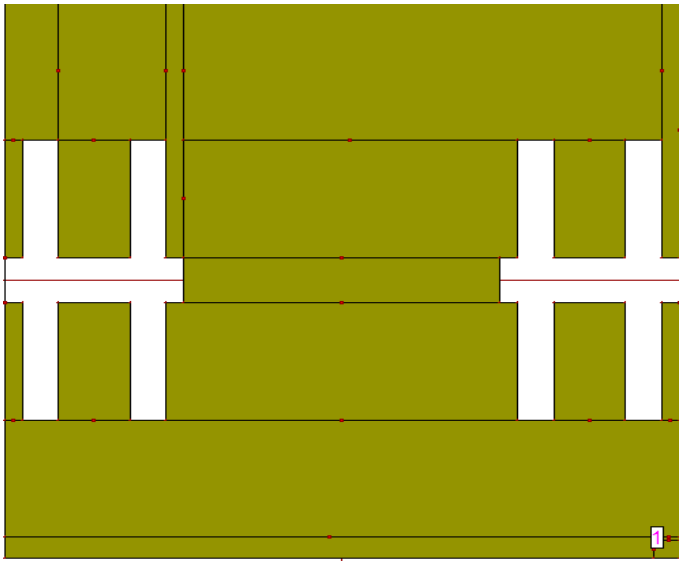


Fig 8: View of proposed design

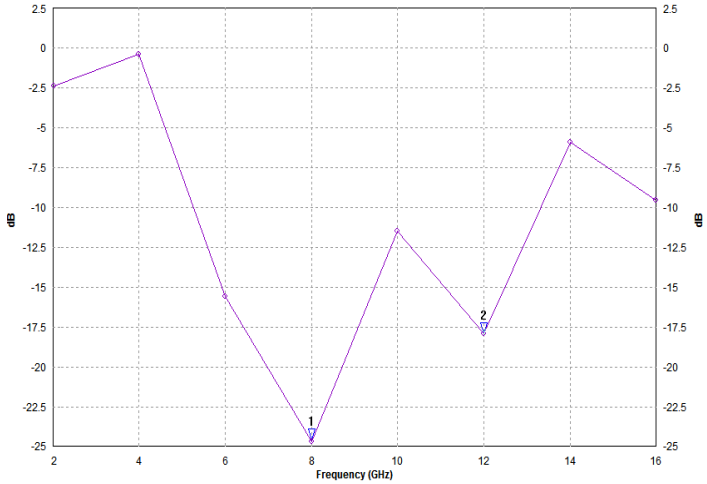


Fig 9 : Return loss plot of proposed design

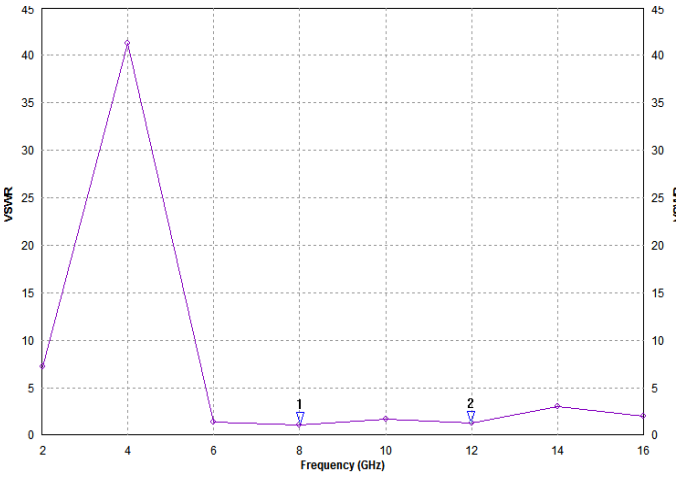


Fig 10 : VSWR plot of proposed design

 

Bandwidth plays important role in while analyze the performance of antenna. The bandwidth can be considered as the range of frequencies on either side of the center frequency where the antenna characteristics (such as input impedance, pattern, beamwidth , etc.) are within an acceptable value of those at the center frequency. For broadband antennas, the bandwidth is usually expressed as the ratio of the upper to lower frequencies of acceptable operation. The frequency for which the return loss value is the minimum is taken as resonant frequency of the antenna. Bandwidths at these frequencies are 1.5GHz and 1.84 GHz at frequency 8 and 12 GHz respectively. It is clearly seen that bandwidth range improves from previous square patch antenna from 2.2 GHz to 1.5 and 1.84 GHz. Radiation pattern plot is also observes at two frequencies 8 GHz and 12 GHz as shown in Fig 11and Fig. 12.

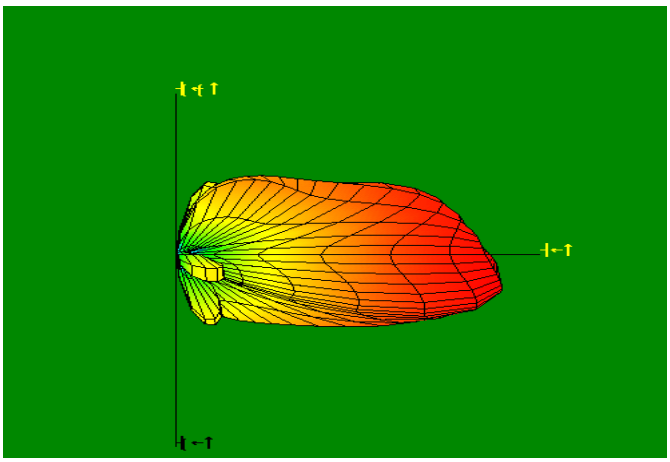

Fig 11: Radiation pattern of proposed design at 8 GHz

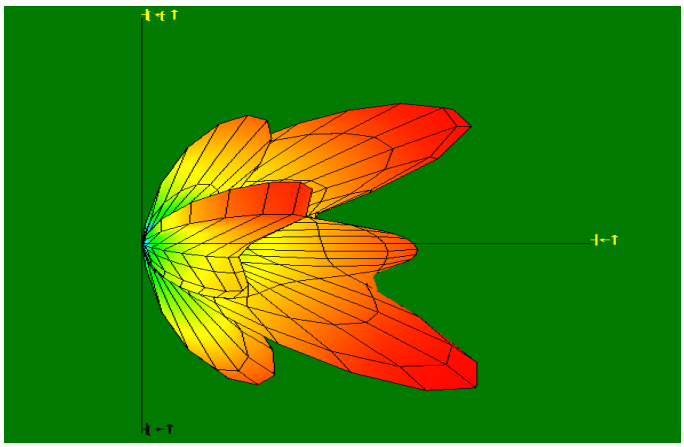

Fig 12: Radiation pattern of proposed design at 12 GHz

Next parameters are gain and directivity to observe. Antenna gain relates the intensity of an antenna in a given direction to the intensity that would be produced by a hypothetical ideal antenna that radiates equally in all directions or isotropically and has no losses. The antenna is said to have certain directivity. This is commonly expressed in decibel (dB). Assuming all radiation occurs in one half of hemisphere, this results in 3 dB directivity. This case is often described as perfect front to back ratio, all radiation towards the front and no radiation towards the back. The total field gain at frequency at 8 GHz and 12 GHz are 5.3 dB and 5 dB respectively as shown in Fig. 13 and field directivity plot of dual H band slot at freq 8 GHz and 12 GHz are 9 dB and 8.8 dB respectively as shown in Fig. 14.

 

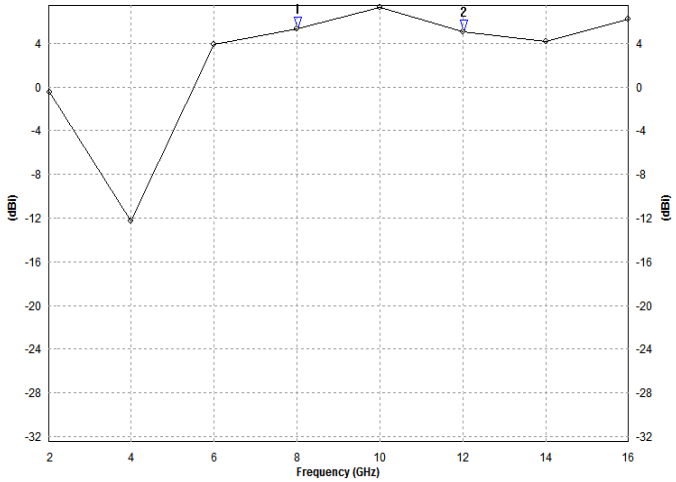


Fig 13 : Gain plot of proposed design

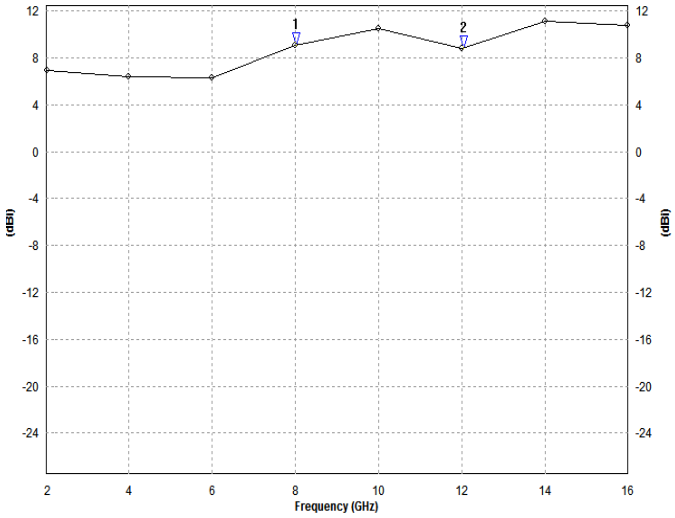


Fig 14 : Directivity plot of proposed design

The summary of this proposed antenna have been put in the table 2. Also a comparison chart has been prepared form the simulation results for comparison of simple square patch and proposed antenna which shown in tabular form in table no. 3

Table 2: Summary of performance parameters

| **Performance Parameters** | **Resonant Frequency at 8 GHz** | **Resonant Frequency at 12 GHz** |
|---|---|---|
| Return loss | -24.5 dB | -18 dB |
| VSWR | 1.1 | 1.2 |

 

| | | |
|---|---|---|
| Bandwidth | 1.5 GHz | 1.84 GHz |
| Gain | 5.3 dB | 5 dB |
| Directivity | 9 dB | 8.8 dB |

Table 3 : Comparison of performance of square patch antenna with dual H slotted patch antenna

| **Performance Parameters** | Square patch antenna | Dual H slot patch antenna at 8 GHz | Dual H slot patch antenna at 12 GHz |
|---|---|---|---|
| Return loss | -20.4 dB | -24.5 dB | -18 dB |
| VSWR | 1.2 | 1.1 | 1.2 |
| Bandwidth | 2.2 GHz | 1.5 GHz | 1.84 GHz |
| Gain | 11.6 dB | 5.3 dB | 5 dB |
| Directivity | 9.7 dB | 9 dB | 8.8 dB |

Proposed antenna resonates at 8 GHz and 12 GHz frequency range which works for X band range like satellite communication, motion detectors etc. All performance parameters are measured using IE3D simulation package tool. IE3D simulation tool is really easy to use.

## III. CONCLUSION AND FUTURE SCOPE

In this paper, antenna is design in two parts in first part simple square patch antenna been designed which resonates at frequency 10 GHz and its performance parameters are studied. In second part of design a symmetrical geometry of H shaped at the edge of simple square patch( which designed above) been cut which resonates at two frequency 8 GHz and 12 GHz due to which bandwidth improves and reduces frequency. Reduction in size of patch also seems but the efficiency decreases as the more slots are cut on the patch . As the proposed antenna works for frequency range of 8 GHz to 12 GHz. Table 3 shows the comparison of radiating square patch antenna with Dual H slot patch antenna .Table 3 shows the improved return loss values and bandwidth values .This antenna find application in X band ( refers to extended AM broadcast band) spectrum like in military communication satellites, modern radar, Terrestrial communications, networking, motion detectors ,in traffic lights etc. For future work, can also add two more H shaped slot at the middle of patch and also insert some other shapes slots

 

on the patch. Mathematical analysis can also be done on this procedure. Slot patch antennas have bright future as it expands its fields into many different and new area which would also improves and further developed in future like neural networks, meta material cover over patch, printed multiband patch, MIMO antennas etc

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