CPW-Fed Octagon Shaped Ring Slot Monopole Antenna

B T P Madhav, K V Vineetha, A Durga Sindhu, B Sruthi Anmisha, T Balaji

Abstract: The octagonal ring-shaped antenna for CPW and Microstrip fed is provided for wideband service. The radiating area of the planned octagonal ring antenna is asymmetrical slot instead of a traditional ring microstrip antenna. The ground plane is made up of two rectangular spaces, whereas the radiator and the ground plane are on the same plane using the available space around the radiator. The antenna being proposed is simulated by the High-Frequency Structure Simulator (HFSS) of Ansoft. Measured results show a balanced agreement with the results of the simulation. The prototype is designed with dimensions of 30 mm x 30mm, achieving good return loss, constant group delay and good radiation patterns over 3.2 GHz,15 GHz and 18 GHz operating bandwidths. Thus, the proposed antenna is applicable for S and Ku band applications.

Index Terms: CPW , Microstrip fed, return loss, radiation pattern, return loss, fractal strategy

1. INTRODUCTION

Wireless communication massive growth has placed emphasis on the development of diversity antennas to enrich wireless network performance[1-3]. Reconfigurability is essential to dynamically change the operation according to the specific application in order to accommodate multiple wireless radio functions in a single antenna. This leads to the need to render a reconfigurable antenna with diversity properties to reduce channel interference for a secure communication link. Generally speaking[4-12], pattern diversity antennas are more powerful and useful in preserving signals in a multi-path fading environment. There was a growing need for multi-purpose tools. For reconfigurable antennas, this need can be met. Because of its lightweight, low cost and good quality broadband microstrip antennas play an important role in meeting these requirements. The researchers are extensively investigating the antennas with wideband properties as a major component[13-20]. A challenging task is to design an efficient small size antenna for wideband applications. Wireless systems require a large impedance bandwidth antenna and excellent radiation patterns across the entire band. Printed microstrip patch antennas were very useful as they can easily be inserted into complex circuits such as antenna array, trident form, etc[21]. This article introduces an octagonal ring-shaped antenna for wireless applications powered by a coplanar waveguide (CPW). The antenna spans 3.2 to 18 GHz frequency band. The performance of the antenna being proposed is analyzed in terms of patterns of return loss, gain, delay and radiation[22-30]. The oddity of the work that is proposed is that the plan of a CPW-Fed Octagon shaped Ring slot Monopole the antenna which is an alluring structure for improving gain, return loss and elite performance. The paper shows a fractal structure which have a wide application in the plan of scaled-down wire reception because of its novel self-resemblance nature[31-35]. They make a minimal radio wire with greater conductivity that can be accomplished utilizing this fractal structure. Under the growing need for size decrease in Antenna structure with a low profile, the fractal hypothesis can help give an extraordinary number of answers for the scaled-down antenna. A fractal is an irregular structure that is divided into various parts which increment the current length and size decrease should likewise be possible by fractal strategy[36-40]. At the point when a single shape is reused on various occasions called iteration which in turn produces a fractal antenna. In nowadays in many fields of science, designing fractal term is utilized. Numerous highlights can be created and improved by fractal strategy; size reasoning, intensify of bandwidth are of them. By fractal, the enhanced wideband structure can be created; which is utilized for wideband transmitters and collectors[41-44]. As a result of the multiband conduct of the fractal. By fractal and its different properties size decrease is simple.

- *Department of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Andhra Pradesh, India.*

2 DESIGN OF OCTAGONAL ANTENNA

The geometrical development of the Microstrip fed proposed antennas is shown in the Fig. 1.(a-c). The basic structure consists of Microstrip fed octagonal patch on a FR-4 dielectric material with substrate permittivity of ε_r = 4.3 is shown on Fig.1.a. A octagonal slot structure is shown on Fig.1.b which is etched on the octagonal patch to enhance the impedance matching. The distance between outer octagonal patch and inner octagonal slot is 2.94 mm, length of the side of the outer octagonal patch is 5mm and the length of the side of the inner octagonal slot is 3mm. The overall dimensions of the ground plane is 30x30 mm^2. An octagonal ring slot is etched to the structure is shown in Fig. 1.c to enhance the impedance matching gain and bandwidth of antenna.

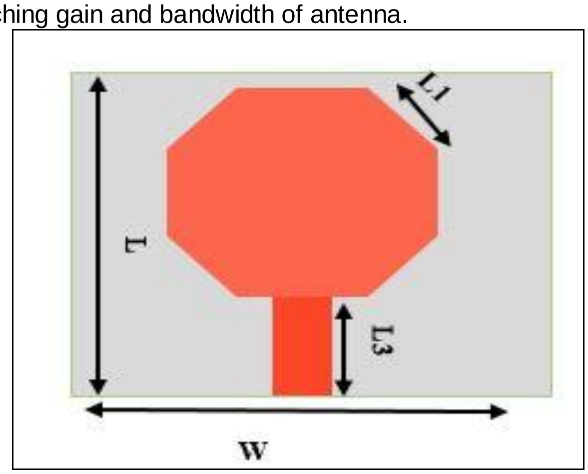

Fig. 1.*a.Microstrip fed combined octagonal antenna*

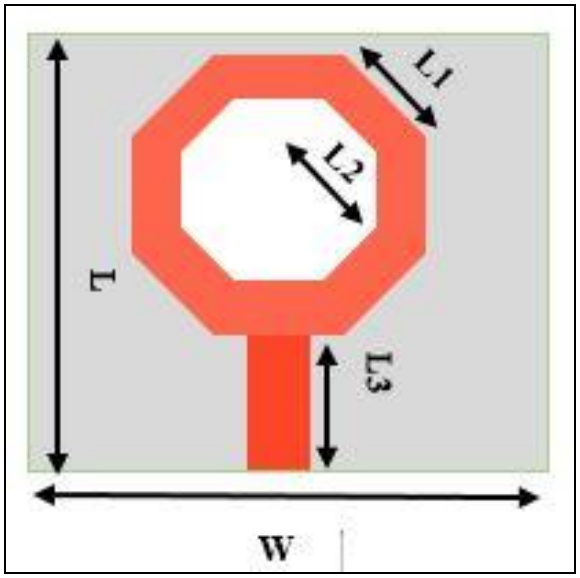

Fig. 1.b*.Microstrip fed slot octagonal antenna*

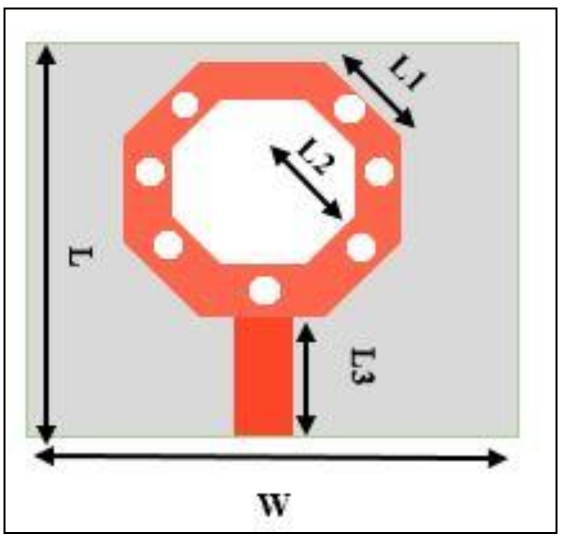

Fig. 1.c*.Microstrip fed octagonal ring slot antenna*

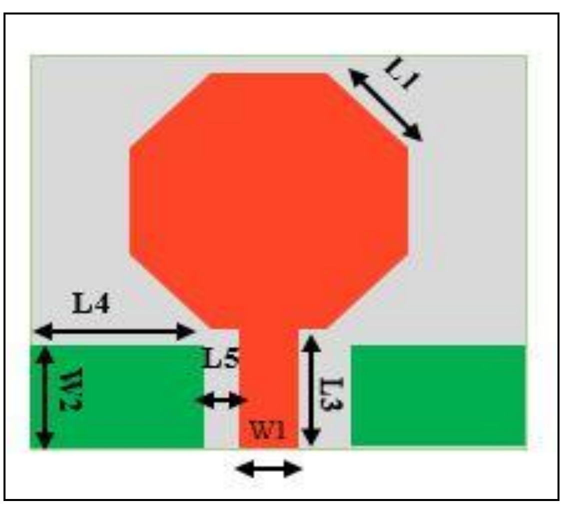

Fig. 1.d*.CPW fed combined octagonal antenna*

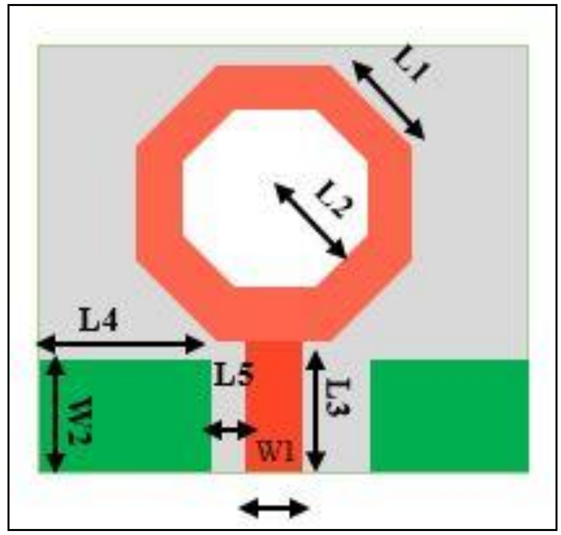

Fig. 1.e*.CPW fed slot octagonal antenna*

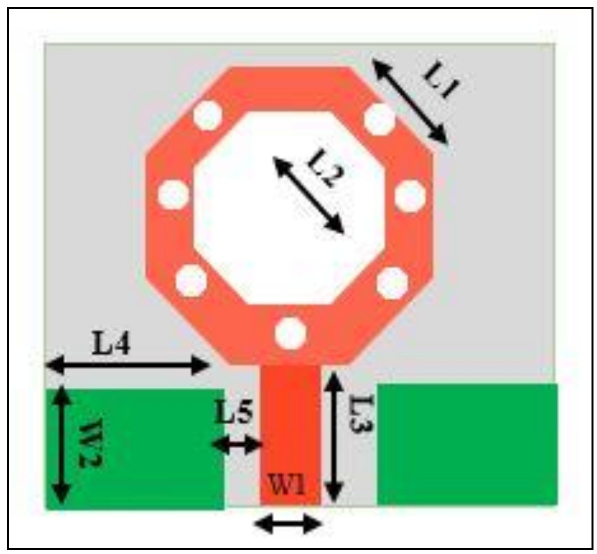

Fig. 1*.f..CPW fed octagonal ring slot antenna*

The geometry of CPW fed proposed antenna appeared in the Fig. 1.(d-f). The essential structure comprises of CPW encouraged octagonal fix on an FR-4 dielectric material with substrate permittivity of εr = 4.3 is appeared in Fig.1.d. An octagonal opening slot structure has appeared in Fig.1.e which is etched on the octagonal patch to upgrade the impedance match. The dimensions are similar to Microstrip feed and the separation between the external octagonal patch and an inward octagonal slot is 2.94 mm, the length of the side of the external octagonal fix is 5mm and the length of the side of the internal octagonal opening is 3mm. The general components of the ground plane are 30x30 mm2. An octagonal ring slot is etched to the outer octagonal patch is appeared in Fig. 1.f to improve the impedance coordinating gain and data transfer capacity of the antenna. An ordinary octagonal shape is a shut structure of equivalent sides and inward points of 135 with eight sides. One way to deal with figuring is by making use of the hexagonal microstrip antenna's resonant frequency which equalizes its zone with that of the circular Microstrip antenna. A comparative methodology has been adjusted in our work to compute the successful span. In this procedure, the octagonal patch is thought to be a resonant cavity with excellent conducting capacity of the walls. As the circular disc is the restricting instance of the polygon with an enormous number of sides, the resonant frequency prevailing and higher-request modes can be determined by making use of the equivalent radius instead of the radius

The octagonal patch's resonant frequency is given by

$$F_r = \frac{X_{lm} v}{2\pi(1.24d)\sqrt{\in_r}} \quad \text{\_\_\_\_\_\_\_\_\_\_\_ (1)}$$

where resonant frequency is given by Fr,Xlm is the least order mode ,speed of the light is given by v, relative permittivity of the dielectric medium is given by ε_r, and r_{eq} is the equivalent radius of the shape. Consequently, the regular octagon's area can be determined by comparing the region of normal octagon having side(d) and a circlular disc's radius r_{eq}.

$$\pi r_{eq}^2 = 2d^2(1+\sqrt{2})$$

$$r_{eq} = 1.24d \quad \text{--------------(2)}$$

By substituting (2) in (1), we get the resonance frequencies of the octagonal antenna system which is given by

$$F_r = \frac{X_{lm} v}{2\pi r_{eq}\sqrt{\in_r}} \quad \text{------------(3)}$$

By clustering the octagonal arrays in the form of a grid , the fractal array structures are formed. As indicated by the octagonal properties, the interior point is about 135° and the outside point is about 45°. In this way we can infer that

$$\cos\left(\frac{135^\circ}{2}\right) = \frac{d/2}{r} \mapsto r = 1.306 \quad \text{---------(4)}$$

The octogonal array factor can be acquired from the condition,

$$A^{\wedge}F_p(\theta,\psi) = \frac{1}{8p}\prod_{p=1}^{p}\sum_{n=1}^{8} e^{j\xi p-1[1.306\pi\sin\theta\cos(\psi-\psi_n)+\alpha_n]}$$

$$\psi_n = (n-1)\frac{\pi}{4} \quad \text{--------(5)}$$

$$\alpha_n = -1.306\pi\sin\theta\cos(\psi-\psi_n)$$

3 RESULTS & DISCUSSIONS

3.1 Reflection coefficient and Transmission coefficient

The reflection coefficient is expressed as the number of electromagnetic waves that are reflected in a framework because of impedance irregularity in the transmission line or lossless line. Reflection coefficient can be determined by the formula

$$\Gamma = \frac{V_{ref}}{V_{fwd}} \quad \text{--- (1)}$$

Where Γ is Reflection coefficient

V_{ref} is Reflecting voltage

V_{fwd} is Forward voltage

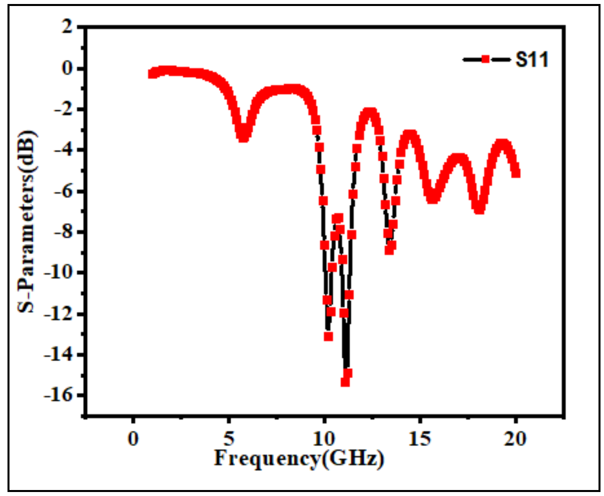

Fig. 2 *Reflection coefficient of Microstrip octagonal patch*

From the investigation of Fig. 2, the characteristics of the return loss were seen that the octagonal patch is having a reflection coefficient estimation of 15.30dB with an operating range of frequency around 11.1Ghz, 13.06dB with an operating range of frequency around 10.3Ghz and 8.88dB with an operating range of frequency around 10.3Ghz which is utilized for satellite applications..

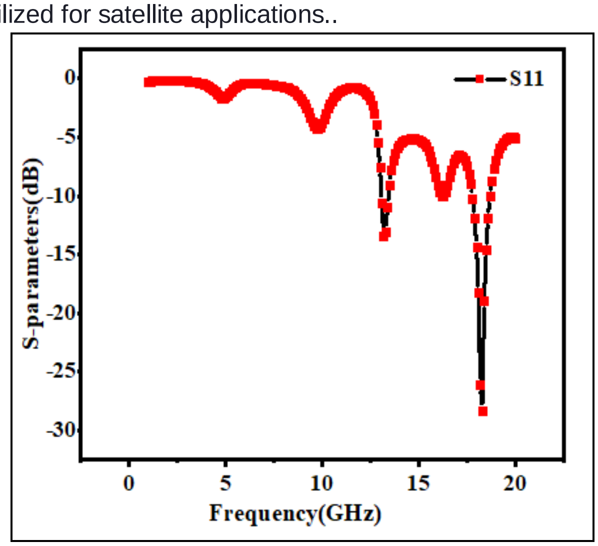

Fig. 3 *Reflection coefficient of MIcrostrip octagonal slot*

From the investigation of Fig. 3, the characteristics of the return loss were seen that the octagonal patch is having a reflection coefficient estimation of 28.31dB with an operating range of frequency around 18.3Ghz, 13.39dB with an operating range of frequency around 13.2Ghz and 10.05dB with an operating range of frequency around 16.3Ghz which is utilized for satellite ,Ku and X band applications..

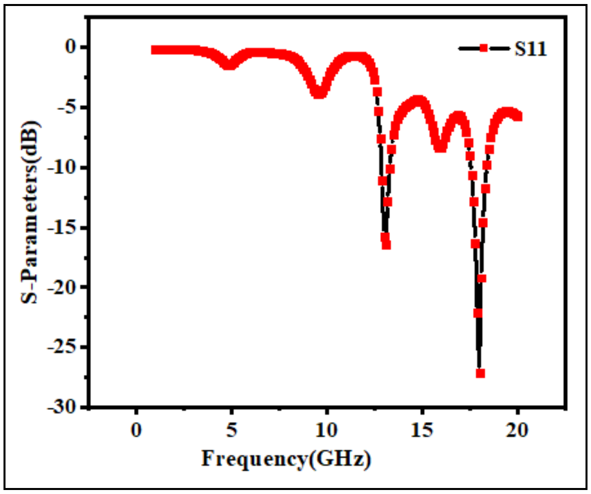

Fig. 4 *Reflection coefficient of Mirostrip octagonal ring*

From the investigation of Fig. 4, the characteristics of the return loss were seen that the octagonal patch is having a reflection coefficient estimation of 16.4dB with an operating range of frequency around 13.1Ghz, 27.14dB with an operating range of frequency around 18.0Ghz and 8.3dB with an operating range of frequency around 16Ghz which is utilized for Radar applications

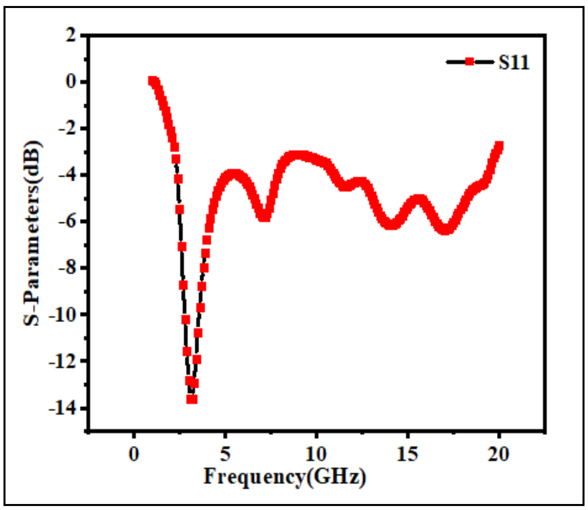

Fig. 5 *Reflection coefficient of CPW fed octagonal patch*

Slot antennas shows high bandwidth, lower scattering, and lower radiation loss than Microstrip antennas CPW likewise gives simple methods for matching the impedance and enhancing the gain , ease of incorporation with solid microwave

From the investigation of Fig. 5, the characteristics of the return loss were seen that the octagonal patch which is CPW fed is having a reflection coefficient estimation of 13.62dB with an operating range of frequency around 3.2Ghz , 5.75dB with an operating range of frequency around 7.2Ghz and 6.14dB with an operating range of frequency around 14Ghz which is utilized for earth satellite, wireless local hoop applications..

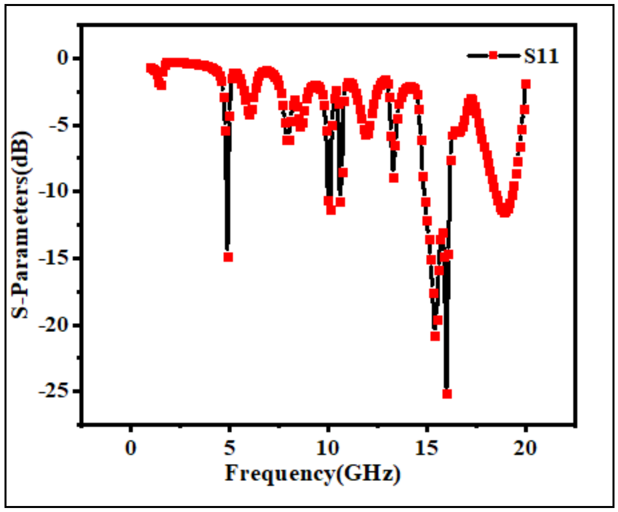

Fig. 6 *Reflection coefficient of CPW fed octagonal slot*

From the investigation of Fig. 5, the characteristics of the return loss were seen that the octagonal patch which is CPW fed is having a reflection coefficient estimation of 11.34dB with an operating range of frequency around 10.1Ghz, 14.82dB with an operating range of frequency around 5Ghz and 20.78dB with an operating range of frequency around 15Ghz which is utilized for earth satellite, Radar applications..

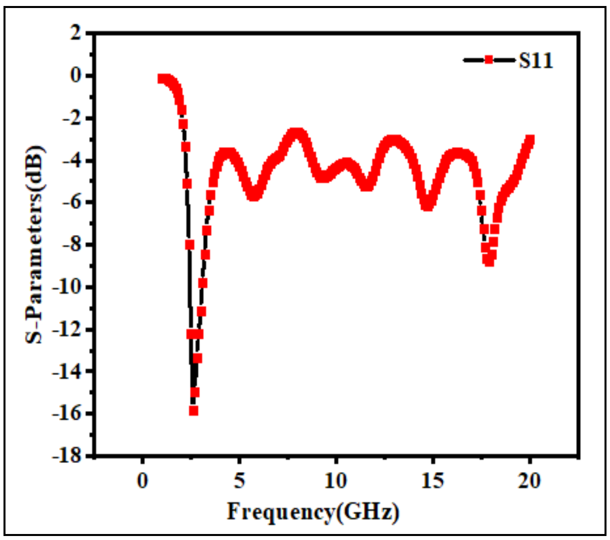

Fig. 7 *Reflection coefficient of CPW fed octagonal ring slot*

From the investigation of Fig. 5, the characteristics of the return loss were seen that the octagonal patch which is CPW fed is having a reflection coefficient estimation of 15.82dB with an operating range of frequency around 2.60 Ghz, 8.70dB with an operating range of frequency around 17.9Ghz and 5.20dB with an operating range of frequency around 11.6Ghz which is utilized for earth satellite, radars, Wireless LAN, bluetooth applications

3.2 Voltage Standing Wave Ratio (VSWR)

The VSWR is a significant parameter in the microstrip patch antenna to settle on the impedance coordinating characteristics. Generally, the VSWR values are relied upon to lie somewhere in the range of 1 and 2 for appropriate impedance coordinating. Here, VSWR depicts different VSWR plots on a single graph as . The grey colour bend depicts VSWR attributes of the Microstrip octagonal patch antenna. The red colour bend depicts VSWR attributes of the Microstrip octagonal slot antenna and the solid blue bend depicts VSWR attributes of the Microstrip octagonal ring antenna. From the chart it is clearly seen that the estimation of VSWR lies somewhere in the range of 1 and 1.4

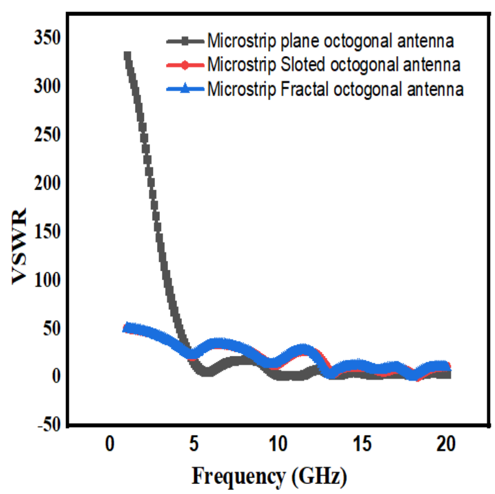

Fig. 8 *VSWR of three different microstrip octagonal antennas*

From the investigation of Fig. 8, the VSWR versus frequency was shown for three different microstrip octagonal antennas.The microstrip octagonal patch antenna here shows a VSWR with 1.6845dB and 1.414dB at 10.3Ghz and 11.1Ghz frequencies respectively. The microstrip octagonal slot antenna shows a VSWR with 2.0dB and 0.667dB at 13.2Ghz and 18.3Ghz frequencies respectively. The microstrip ring octagonal patch antenna here shows a VSWR with 1.92dB and 0.76dB at 13.1Ghz and 16Ghz frequencies respectively.

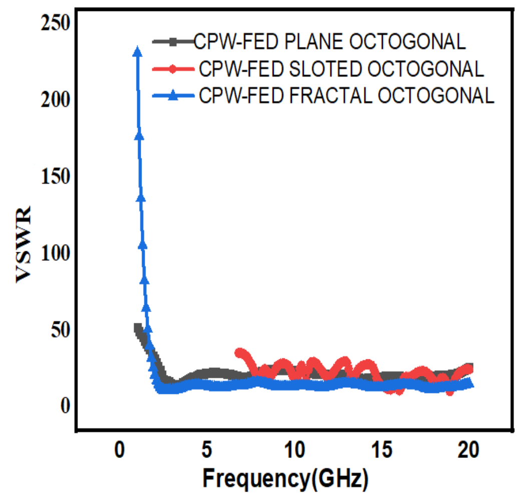

Fig. 9 *VSWR of three different CPW octagonal antennas*

From the investigation of Fig. 9, the VSWR versus frequency was shown for three different CPW octagonal antennas.The CPW octagonal patch antenna here shows a VSWR with 3.67dB and 9.37 dB at 3.2 Ghz and 14 Ghz frequencies respectively. The CPW octagonal slot antenna shows a VSWR with 1.59 dB and 3.18 dB at 15Ghz and 5Ghz frequencies respectively. The CPW ring octagonal patch antenna here shows a VSWR with 1.55dB and 2.53dB at 2.60Ghz and 17.59Ghz frequencies respectively

3.3 Radiation pattern

The Radiation property of any antenna can be examined to comprehend the distribution of power intensity throughout the direction. The radiation pattern is shown for h = 0° and h = 90°. An antenna can be either be directional or omnidirectional depending upon the application that it is used for the radiation distribution pattern is shown for all the microstrip and CPW fed antennas

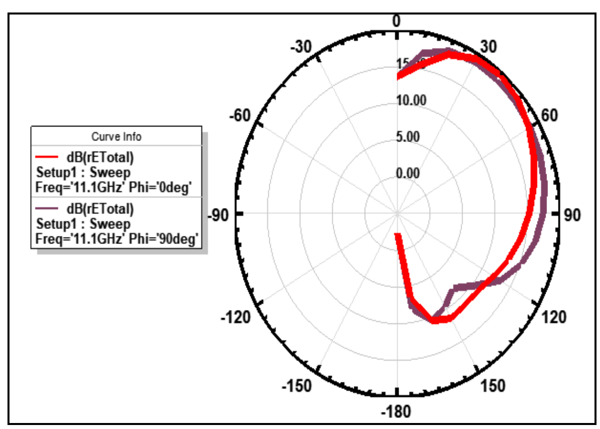

Fig. 10 *Radiation pattern of Microstrip octagonal antenna*

From Fig .10 , It is to be noted that the antenna is directional antenna

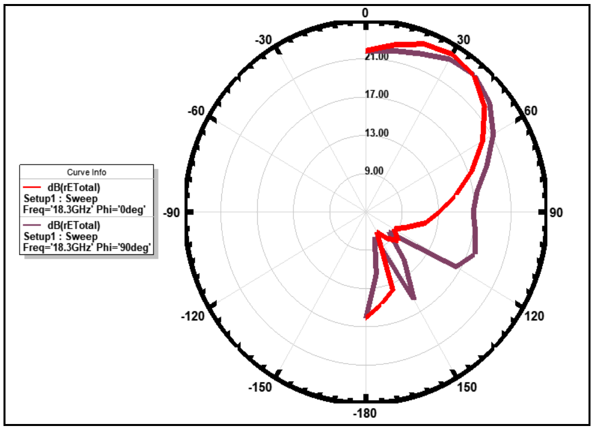

Fig. 11 *Radiation pattern of Microstrip octagonal Slot antenna*

From Fig. 11 ,It is to be noted that the antenna is directional antenna

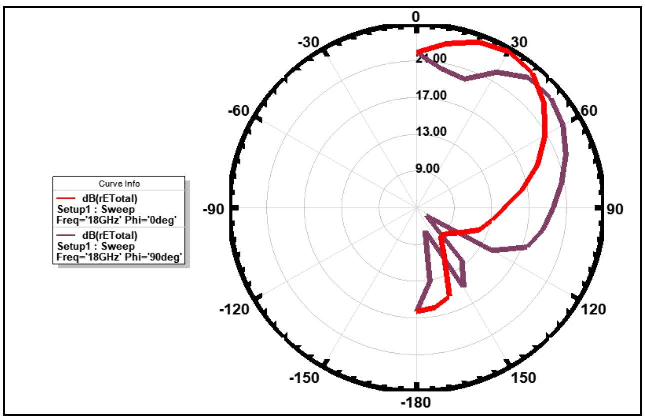

Fig. 12 *Radiation pattern of microstrip octagonal Ring Slot antenna*

From Fig. 12 , It is to be noted that the antenna is directional antenna

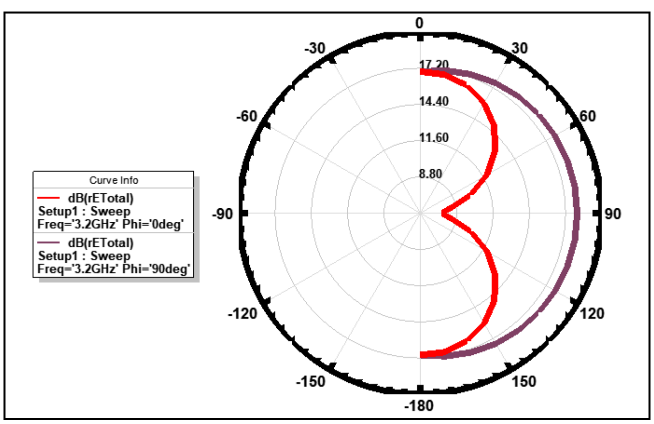

Fig. 13 *Radiation pattern of CPW fed octagonal antenna*

From Fig. 13 , It is to be noted that the antenna is directional antenna

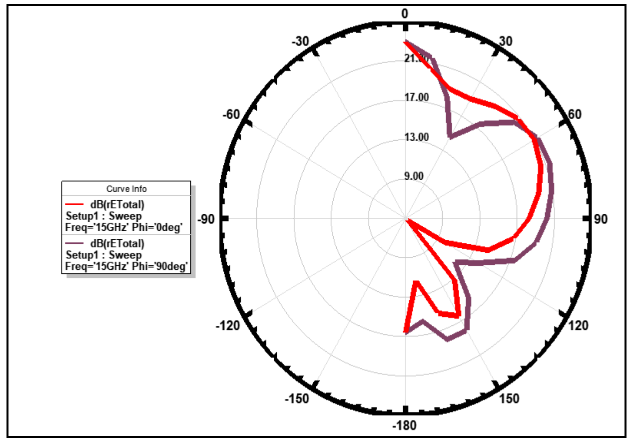

Fig. 14 *Radiation pattern of CPW octagonal slot antenna*

From Fig. 14 ,It is to be noted that the antenna is directional antenna

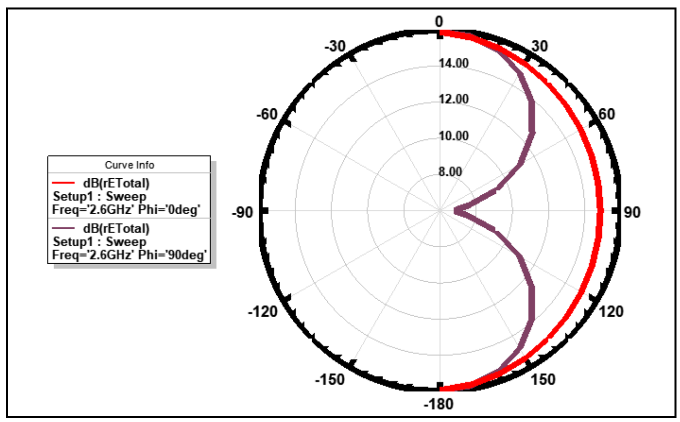

Fig. 15 *Radiation pattern of CPW octagonal ring slot antenna*

From Fig. 15 ,It is to be noted that the antenna is directional antenna

3.4 Gain

The Gain is a significant parameter in the microstrip patch antenna . Its attributes rely upon the dielectric substrate. When there is a thickness of the dielectric substrate diminishes, the antenna's gain apparently increases. The 3D gain plot for all the different antennas are depicted in the below plots

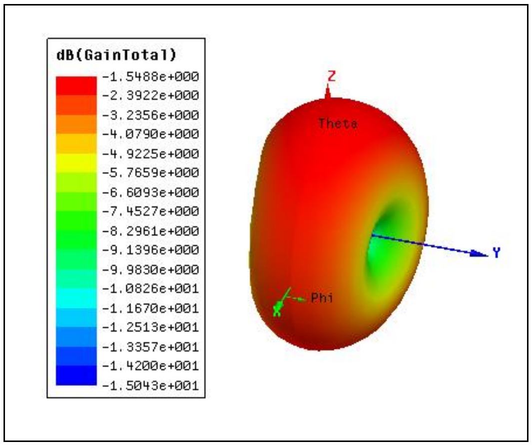

Fig. 16 *3-D gain plot of octagonal Microstrip patch antenna*

From the Fig. 16 it was observed that the antenna is having Gain of 1.54dB

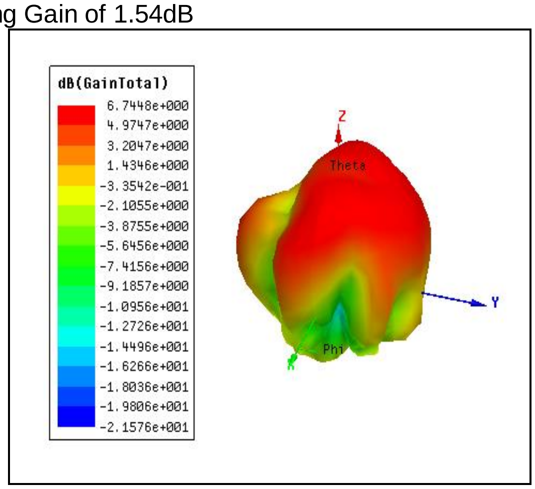

Fig. 17 *3-D gain plot of octagonal Microstrip slot antenna*

From the Fig. 17 ,it was observed that the antenna is having Gain of 6.67dB

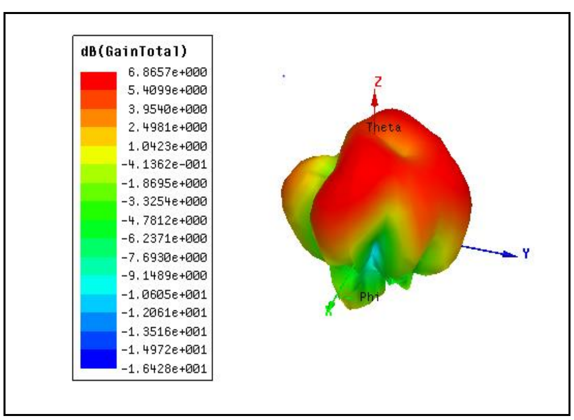

Fig. 18 *3-D gain plot of octagonal Microstrip ring slot antenna*

From the Fig. 18, it was observed that the antenna is having Gain of 6.86dB

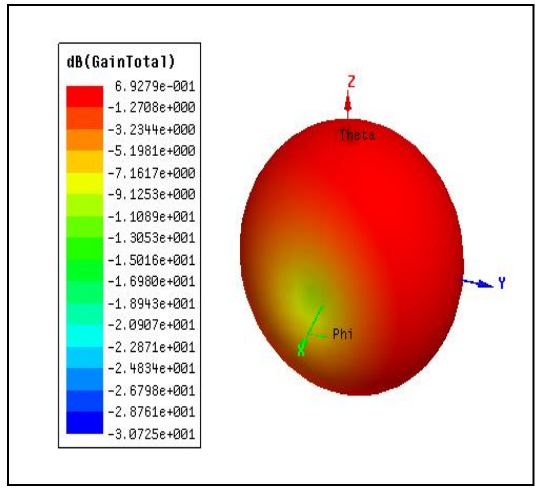

Fig. 19 *3-D gain plot of octagonal CPW fed antenna*

From the Fig. 19, it was observed that the antenna is having Gain of 6.92Db

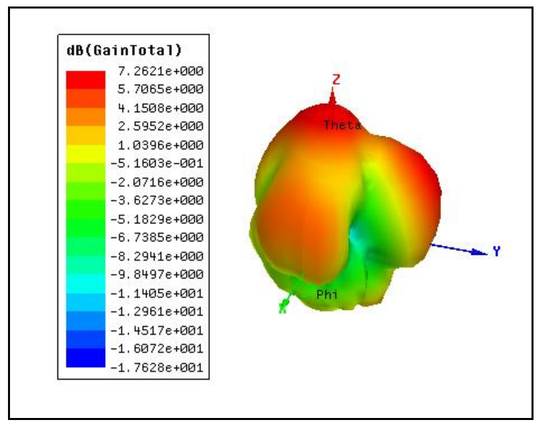

Fig. 20 *3-D gain plot of octagonal CPW fed slot antenna*

From the Fig. 20, it was observed that the antenna is having gain of 7.26dB

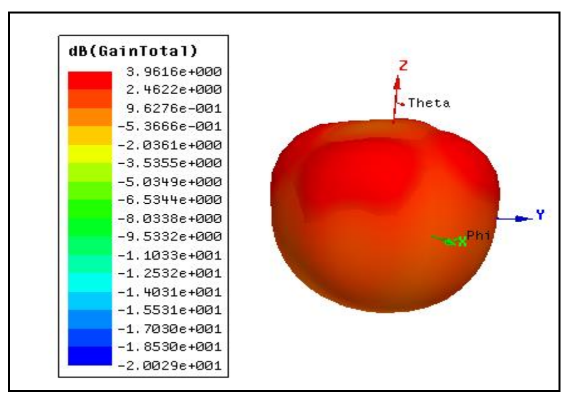

Fig. 21 *3-D gain plot of octagonal CPW fed slot antenna*

From the Fig. 21, it was observed that the antenna is having ain of 9.96dB

3.5 E field and Current distributions

A piece of information on the genuine current appropriation is required for precise field and impedance computations. The charge dissemination still date are discrete: comprised of its own point particles. This is conversely with a continuous charge circulation, which has more than one nonzero measurement. Hence, we can sum up the meaning of the electric field. We essentially separate the charge into minute pieces and minute piece are treated as point chargesAs the charge is quantized, there is nothing of the sort as a "genuinely" ceaseless charge circulation. But, practical cases are mostly dealt with the complete charge making the field include such a colossal number of discrete charges that we can securely overlook the discrete idea of the charge

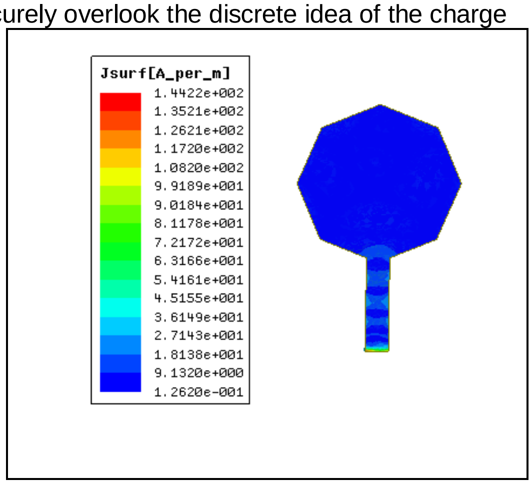

Fig. 22 *Current distribution of Microstrip octagonal patch*

From the Fig. 22, it was observed that the antenna J-Field is having 1.44 (A_per_m)

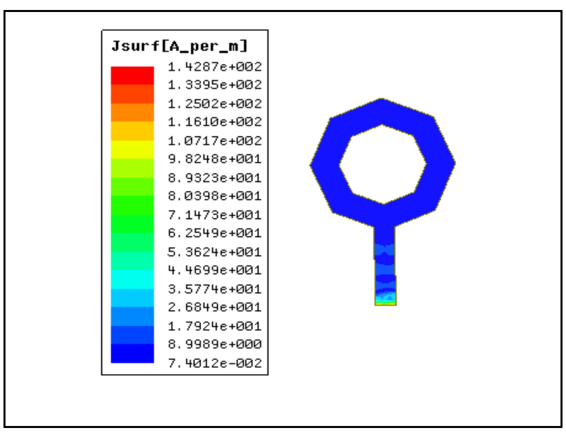

Fig. 24 *Current distribution of Microstrip octagonal slot*

From the Fig. 24, it was observed that the antenna J-Field is having 1.42(A_per_m)

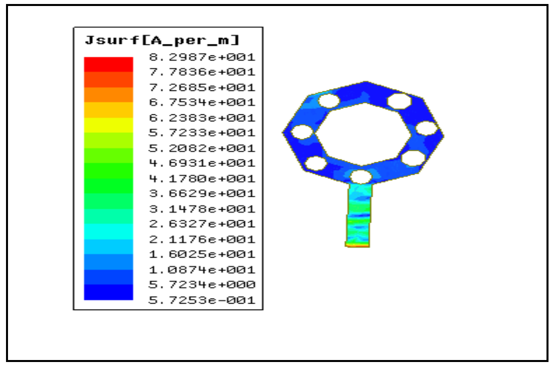

Fig. 26 Current distribution of Microstrip octagonal ring slot

From the Fig. 26, it was observed that the antenna J-Field is having 8.29(A_per_m)

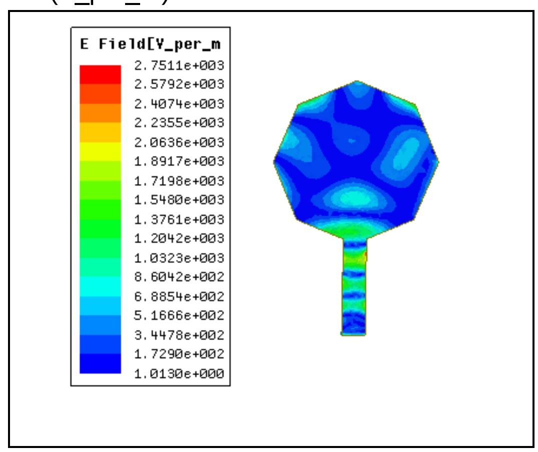

Fig. 23 *E-field of Microstrip octagonal patch*

From the Fig. 23, it was observed that the antenna J-Field is having 2.75(v_per_m)

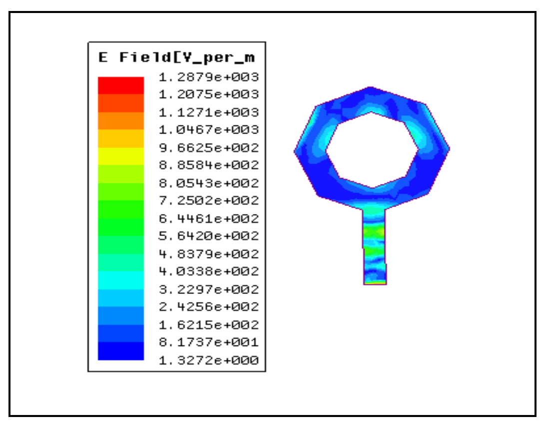

Fig. 25 *E-field of Microstrip octagonal slot*

From the Fig. 25, it was observed that the antenna J-Field is having 1.28(v_per_m)

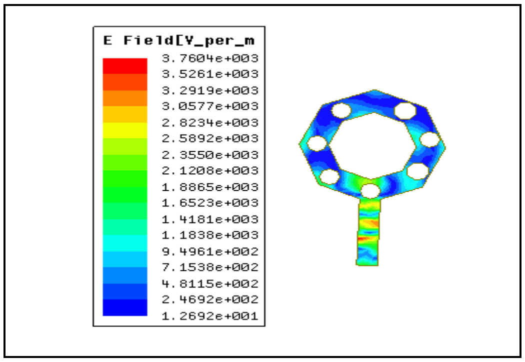

Fig. 27 *E-field of Microstrip octagonal ring slot*

From the Fig. 27, it was observed that the antenna J-Field is having 3.76(v_per_m)

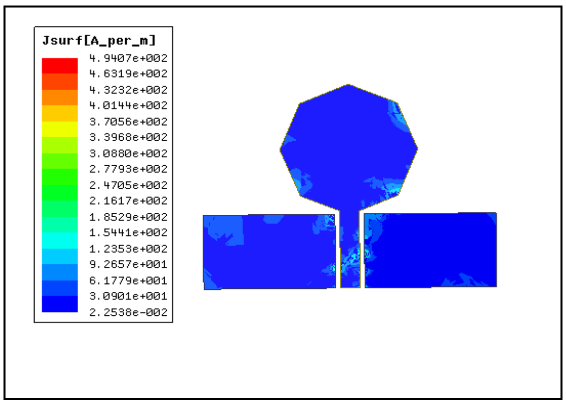

Fig. 28 *Current distribution of CPW octagonal patch*

From the Fig. 28, it was observed that the antenna J-Field is having 4.94(A_per_m)

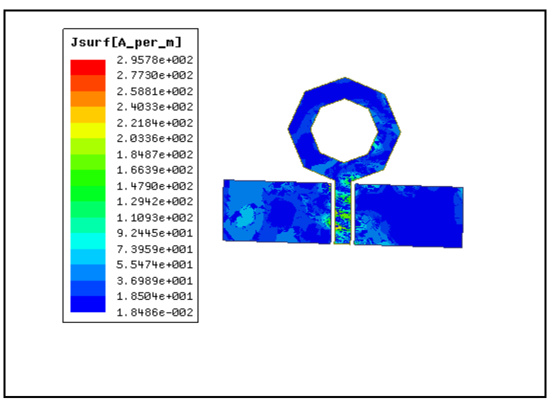

Fig. 30 *Current distribution of CPW octagonal slot*

From the Fig. 30, it was observed that the antenna J-Field is having 2.96(A_per_m)

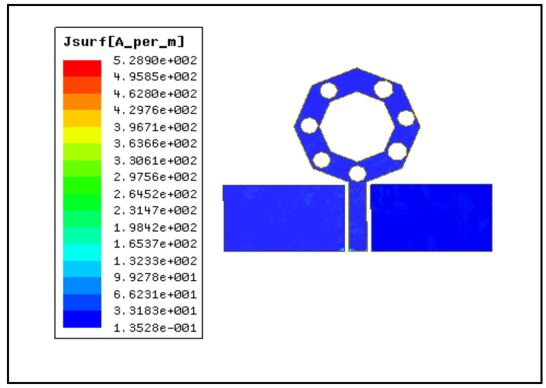

Fig. 32 *Current distribution of CPW octagonal ring slot*

From the Fig. 32, it was observed that the antenna J-Field is having 5.28(A_per_m)

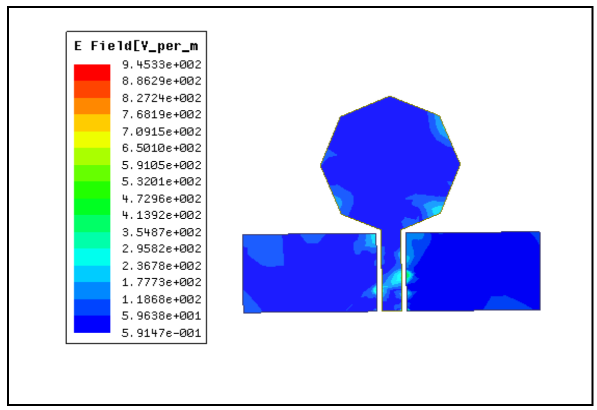

Fig. 29 *E-field of CPW octagonal patch*

From the Fig. 29, it was observed that the antenna J-Field is having 9.45(v_per_m)

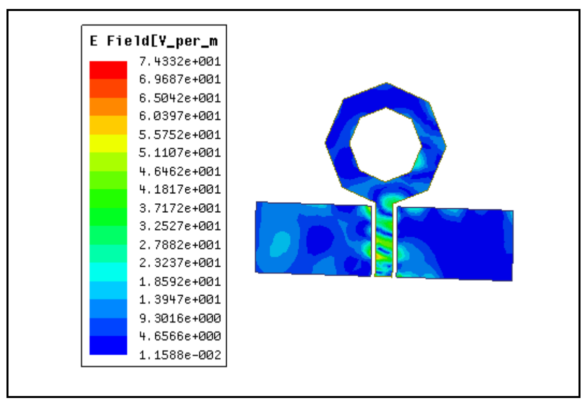

Fig. 31 *E-field of CPW octagonal slot*

From the Fig.31, it was observed that the antenna J-Field is having 7.40(v_per_m)

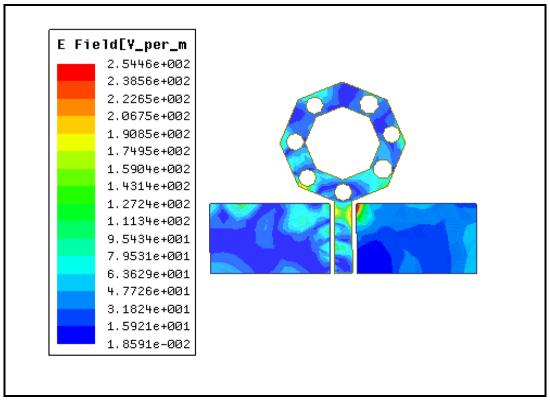

Fig. 33 *E-field of CPW octagonal ring slot*

From the Fig. 33, it was observed that the antenna J-Field is having 2.54(v_per_m)

4 CONCLUSION

A wideband microstrip antenna in the form of a CPW-Fed octagon ring is presented in this study. The proposed antenna shows wideband performance for a return loss of less than 10 dB in the frequency band 3.2 GHz to 18 GHz. The proposed antenna's simulated and calculated results show a good agreement on return loss, antenna gain, and radiation patterns. Over the entire operating bandwidth, the radiation patterns are satisfactory. The proposed antenna gave approximately 130 percent impedance bandwidth, which enables its use in various wireless applications.

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