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# Designing of a Miniature Microstrip Patch Antenna for Wireless Applications

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***Abstract: This research paper we have developed a new study concerning the miniaturization of microstrip patch antenna by using defected ground structure DGS resonating at 3.16 GHz. The goal from this work was to shift the resonance frequency from 10 GHz to 3.16 GHz. A miniature microstrip patch antenna has been developed, analyzed and validated for S-Band applications. The aspects of single band microstrip antenna have been studied. In this thesis, a typical miniature microstrip patch antenna with DGS forming a simple and efficient technique of design has been introduced for the betterment of bandwidth and impedance matching, also, giving the same performance at the desired resonant frequency. Finally simulation will be done by using design software HFSS13.0. This parametric study would be of a great interest in the designing of miniature antennas for wireless communications operating in DGS.***

***Keywords: DGS, Ring type slots, Rectangular microstrip patch antenna, S-Parameters, smith chart, radiation pattern, bandwidth, VSWR, resonant frequency, HFSS13.0.***

## I. INTRODUCTION

Microstrip Patch Antennas has quite a lot of advantages over other antennas due to their light weight, low profile, low cost of production, and are easily well-suited with optoelectronic integrated circuits (OBICs) and microwave monolithic integrated circuits (MMICs). Due to these striking features, the researchers are having noteworthy attention towards microstrip antennas. Microstrip patch antennas are used in extensive range of applications such as in wireless communication and biomedical diagnosis. There are many feeding techniques used for the Microstrip patch antennas. To keep the structure planar, a microstrip line in the plane of the patch can be etched to feed the antenna. But again, it suffers from the drawbacks that the feed network interferes with the radiating properties of the antenna leading to undesired radiations. For the microstrip feed, an increase in the substrate thickness increases its width, which in turn increases the undesired feed radiations.

In recent years, due to its various number of benefits including stable radiation pattern, high gain, low profile and inexpensive fabrication the printed microstrip slot antennas were significantly researched. For UWB applications numerous antennas were designed. Among them, one of the antenna requires a large ground plane that rises dimension. As a result, that is not included in microwave integration [2]. Various line feeding and waveguide feeding antennas were offered for UWB applications. For achieving the characteristics of wide impedance bandwidth monopole architectures are commonly used, such as elliptical, pentagon, rectangular, square, hexagonal, annular ring and circular ring antennas

Antenna is the most fundamental block of the wireless communication. Recently, the growth of wireless systems leads to a lot of innovations in the Microstrip antenna designs. Microstrip patch antenna has become an integral part of these devices working in ultra to super high frequency ranges. The patch and slot are the two parameters which affect the overall antenna's performance. Microstrip patch antennas are useful in various applications having requirements like broader bandwidth, smaller in size, lighter in weight, lower in cost and compatibility with integrated circuits [1-2]. A variety of wireless communication engineering applications, such as wireless links, remote sensing, cellular mobile phones and internet are in extensive demand and have witnessed a tremendous growth recently. The microstrip antenna has narrow bandwidth of the order upto 5%. This low bandwidth is not useful for many wideband wireless applications. Previously published literature has reported several possible techniques to improve bandwidth of the microstrip antenna.

In recent years, the widespread proliferation of wireless communication has augmented the demand for compact broadband antennas for handheld devices, satellite systems, etc. But it has a disadvantage of producing narrow bandwidth and low gain. To overcome the inherent limitation, many techniques such as probe fed antenna, stacked shorted patches, patch antenna with thick substrate electrically and slotted patch antenna have been planned and investigated[3].

## II. ANALYSIS OF ANTENNA

The length of the patch is denoted by L and width of the patch is denoted by W. Because the dimensions of the patch are finite along the length and width, the fields at the edges of the patch undergo fringing. Since some of the waves travel in the substrate and some in air, an effective dielectric constant $\varepsilon reff$ is introduced to account for fringing and the wave propagation in the line.

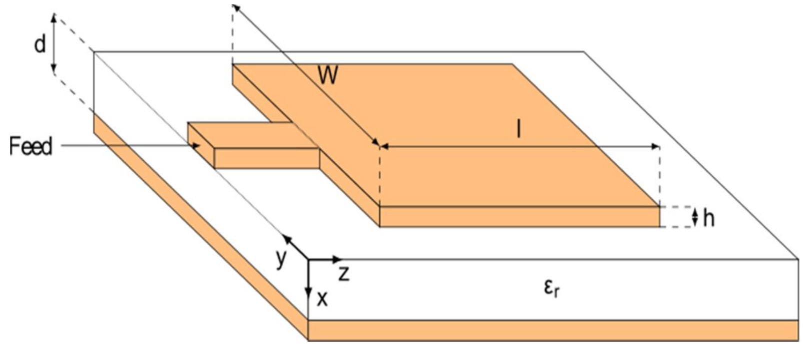


Figure 1 Basic Geometry of Microstrip Patch Antenna

## II. DESIGNS OF MICROSTRIP PATCH ANTENNA WITHOUT DGS

The geometry of proposed antenna which is for S-Band applications and fed by Microstrip Edge line feeding Technique is depicted in figure 2. The dimensions of the designed antenna are taken from reference paper as:

Table 1:- Dimension of antenna without DGS

| | |
|---|---|
| Ground size | 27 x 30mm |
| Substrate size | 27 x 30mm |
| Patch size | 7 x 5.95mm |
| Feed size | 1 × 5mm & 3 × 7mm |

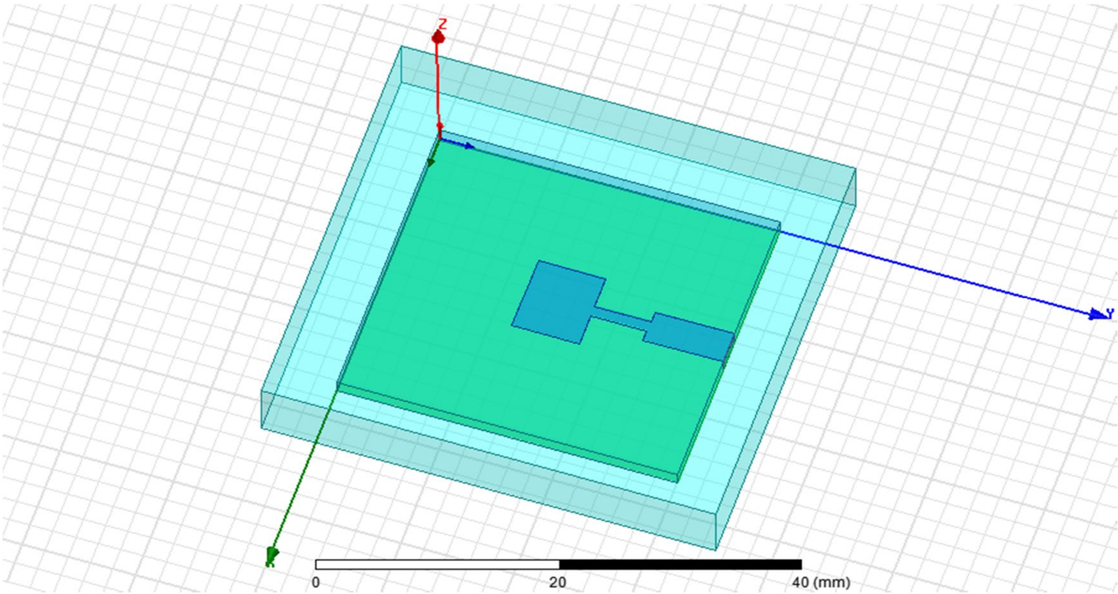


Figure 2:-Geometry dimension of antenna without DGS.

The return loss plot for the designed antenna at -10 dB bandwidth is shown in figure 3 as below. It is observed from the return loss that antenna is resonating at 9.81 GHz at -12.22 db which is very close to the reference antenna frequency and 490 MHz bandwidth also observed.

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Figure 3:-Simulated return loss

VSWR plot for the proposed antenna. The value of VSWR is 1.64 observed that is less than 2 which is practically good.

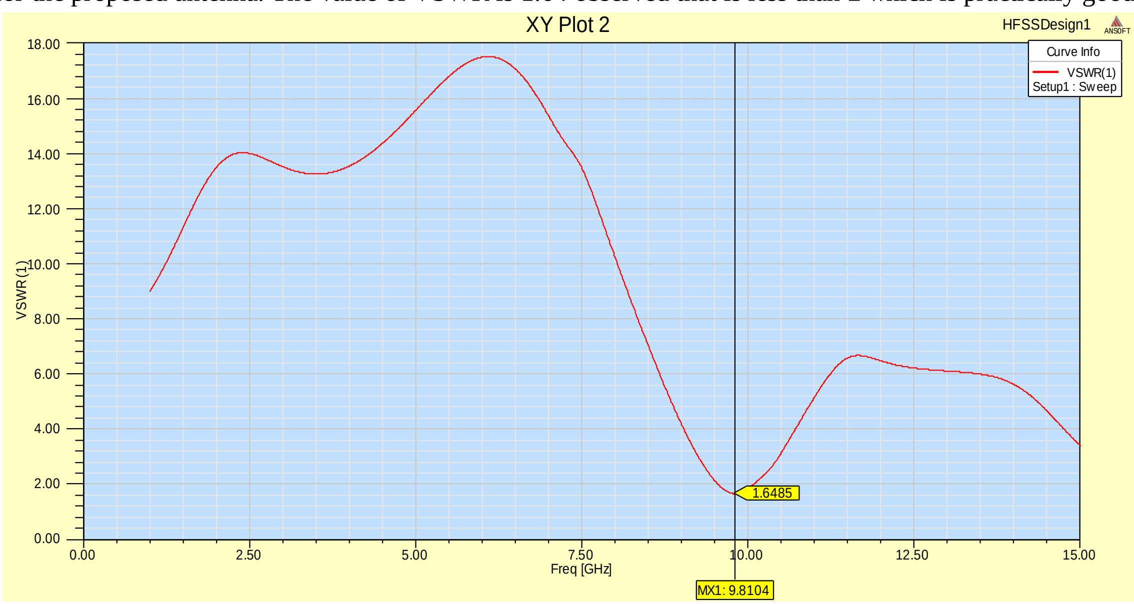


Figure 4:- VSWR plot.

Table 2:- Summarized results of reference antenna without DGS.

| Sr.No | FREQUENCY (GHz) | RETURNLOSS(dB) | BANDWIDTH | VSWR |
|---|---|---|---|---|
| 1 | 9.81 | -12.22 | (10.04-9.55)GHz=0.49GHz=490MHz | 1.64 |

*A. Microstrip Patch Antenna Designing Using DGS (Implementation Of Reference Paper):-*

The geometry of proposed antenna which is MSL fed for an S-Band application is depicted in figure 5. In which the antenna parameter are same as above but there is a change in the normal structure is that six similar size ring structure and a rectangular slot are subtracted from Ground Structure. The dimensions of the proposed designed antenna are same as above except DGS.

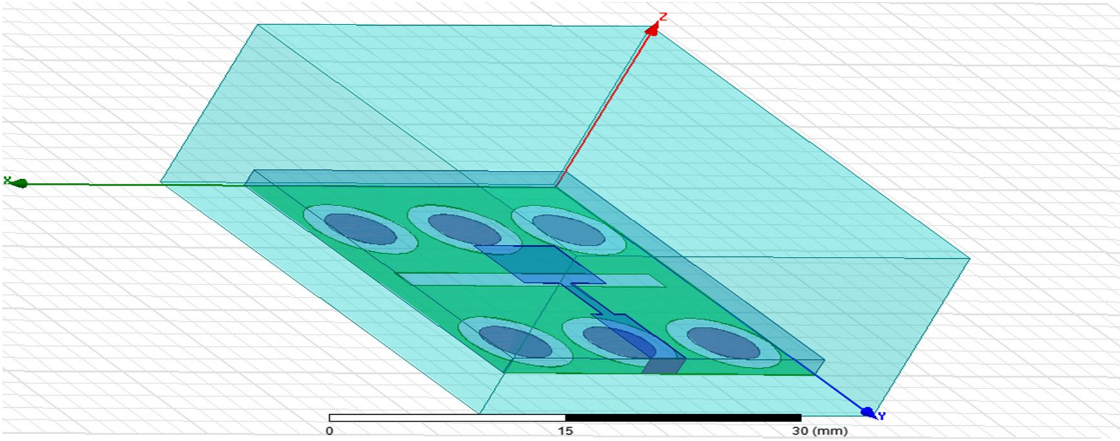


Figure 5:-Geometry dimension of antenna using DGS.

The return loss plot for the designed antenna at -10 dB bandwidth is shown in figure 6 as below. It is observed from the return loss that antenna is resonating at 3.4 GHz at -13.20 db which is very close to the reference antenna frequency and 3000 MHz bandwidth also observed.

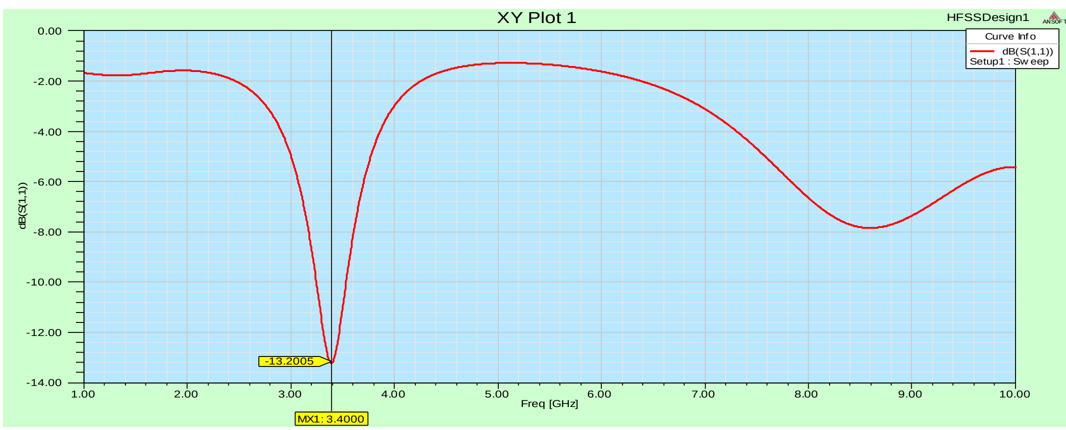


Figure 6:-Simulated return loss

VSWR plot for the proposed antenna. The value of VSWR is 1.56 observed that is less than 2 which is practically good.

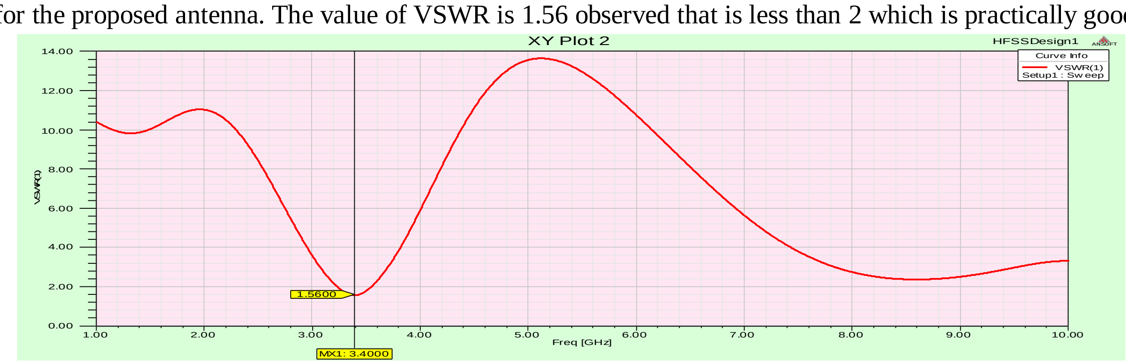


Figure 7:- VSWR plot.

Table 3:- Summarized results of reference antenna using DGS.

| Sr.No | FREQUENCY (GHz) | RETURNLOSS(dB) | BANDWIDTH | VSWR |
|---|---|---|---|---|
| 1 | 3.4 | -13.20 | (3.52-3.22)GHz=0.3GHz=300MHz | 1.56 |

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*B. Design of Proposed Antenna*

The geometry of proposed antenna which is microstrip line fed for S-Band application is depicted in figure 8. In which the antenna parameter are same as above but there is a change DGS (Defected Ground Structure) and uses normal patch plane.

The position and values of inner and outer radius of the ring slot is changes and double ring is introduced to get the desired result.

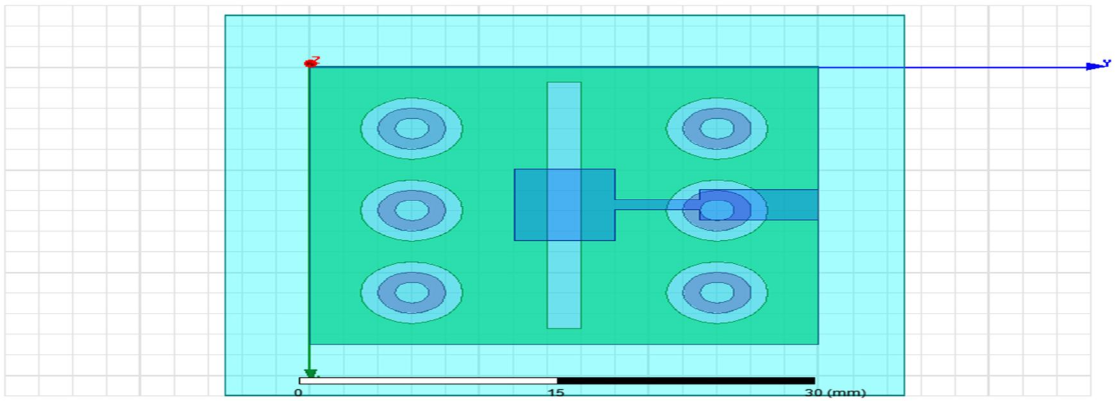


Figure 8:-Geometry dimension of proposed antenna.

The return loss plot for the designed antenna at -10 dB bandwidth is shown in figure 9 as below. It is observed from the return loss that antenna is resonating at 3.16 GHz at -29.92 db and 597.8 MHz bandwidth is observed that is so high (597.8MHZ -400 MHz=197.8MHz) w.r.t reference antenna bandwidth.

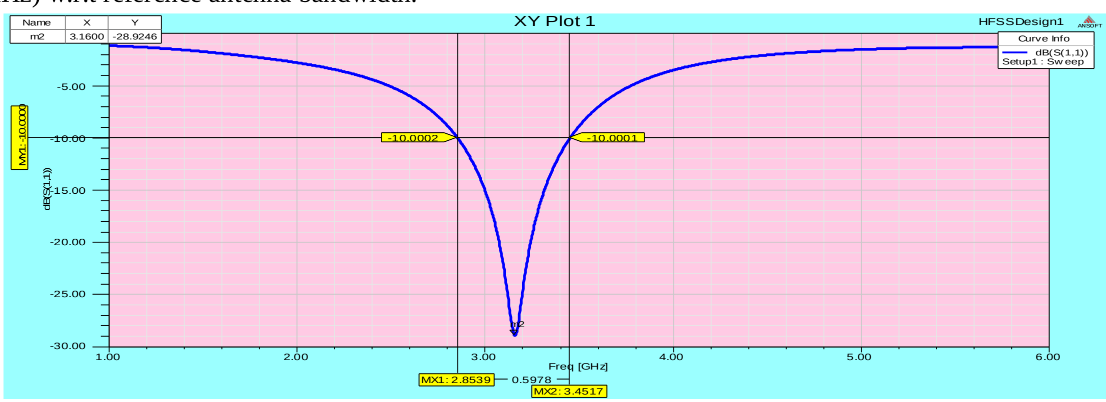


Figure 9:-Simulated return loss

VSWR plot for the proposed antenna. The value of VSWR is 1.07 observed that is not only less than 2 but also very close to ideal value 1.

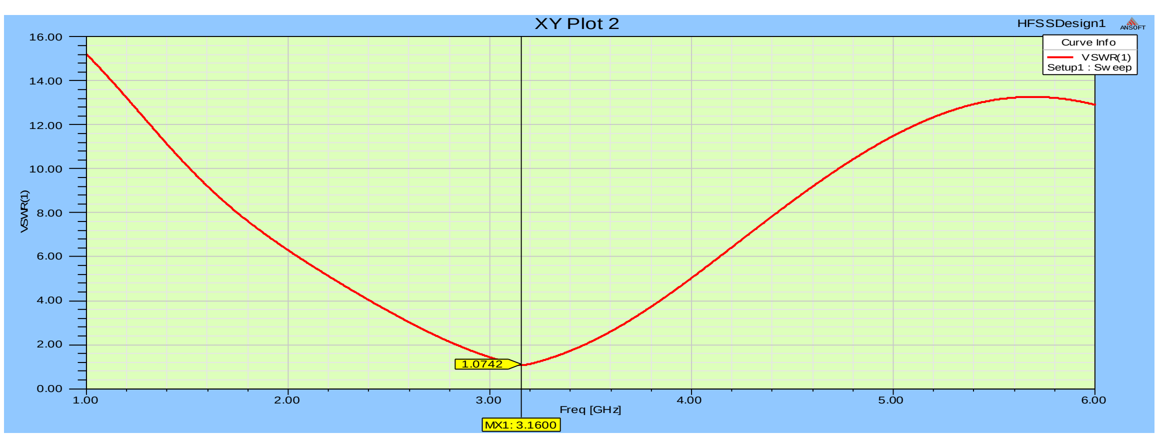


Figure 10:- VSWR plot

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Table 4:- Summarized results of the proposed antenna.

| Sr.No | FREQUENCY (GHz) | RETURNLOSS(dB) | BANDWIDTH | VSWR |
|---|---|---|---|---|
| 1 | 3.16 | -28.92 | (3.4517-2.8539)GHz= 0.5978GHz=597.8MHz | 1.07 |

*C. Comparasion of results of reference & proposed antenna:*

Table 5:- Comparison of results

| Sr. No | Difference | Frequency (GHz) | RETURNLOSS(dB) | BANDWIDTH | VSWR |
|---|---|---|---|---|---|
| 1 | Reference Antenna | 3.5 | -30 | (3.7-3.3)GHz= 0.4GHz=400MHz | Not Given |
| 2 | Reference Antenna (Implemented) | 3.4 | -13.20 | (3.52-3.22)GHz= 0.3GHz=300MHz | 1.56 |
| 3 | Proposed Antenna | 3.16 | -28.92 | (3.4517-2.8539)GHz= 0.5978GHz=597.8MHz | 1.07 |

## IV. CONCLUSION

In this work we have developed a new study concerning the miniaturization of microstrip patch antenna by using defected ground structure DGS resonating at 3.16 GHz. The goal from this work was to shift the resonance frequency from 10 GHz to 3.16 GHz. A miniature microstrip patch antenna has been developed, analyzed and validated for S-Band applications. The aspects of single band microstrip antenna have been studied. In this thesis, a typical miniature microstrip patch antenna with DGS forming a simple and efficient technique of design has been introduced for the betterment of bandwidth and impedance matching, also, giving the same performance at the desired resonant frequency. Also, the feeding point selection i.e. proper matching of feed and patch is very important for having desirable features. The performance properties are analyzed for the optimized dimensions.

The proposed antenna has been designed by using rectangular type defected patch i.e DGS (Defected Ground Structure). We can also conclude that by changing the feed point where matching is perfect, the high return loss can be achieved at the resonant frequency.

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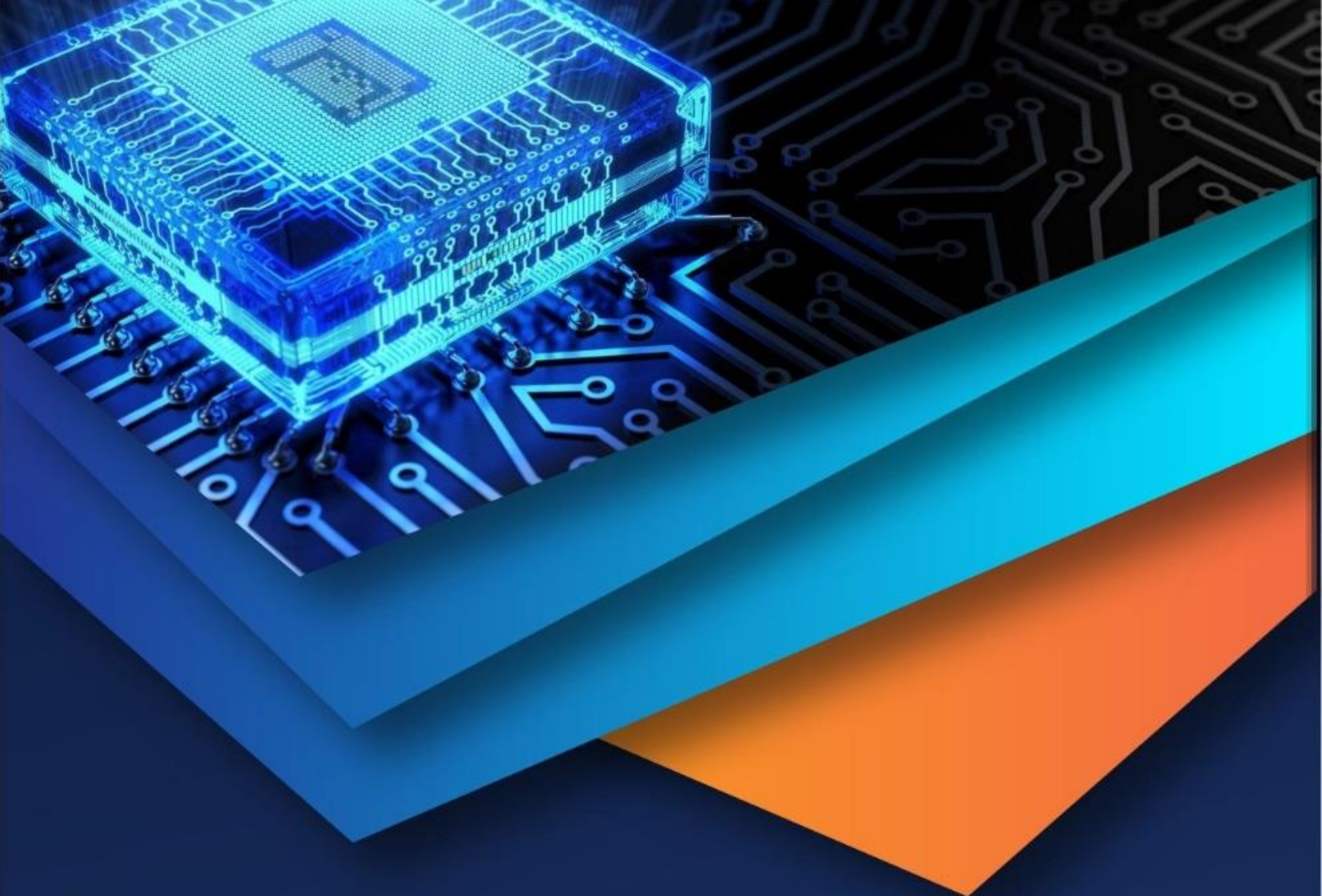


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