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T Shaped Monopole patch antenna with CPW Feed for Triple and Wide Band Wireless Application

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Abstract: A novel T-shaped monopole patch antenna using coplanar waveguide (CPW) feed is proposed and experimentally studied. The proposed antenna is designed for triple band and wide band operations at 1.5GHz, 2.8GHz and 9.4GHz frequency band with their impedance bandwidth of 18%, 72%, and 3.5% respectively. Both theoretical and experimental results for Return loss, VSWR, gain, and radiation characteristics are presented and discussed. The measured and simulated results presented show good agreement.
Keywords: Rectangular microstrip patch, parasitic elements, Bandwidth enhancement, Monopole antenna, Wide-band, CPW-Antenna, AWR.

I. INTRODUCTION

In recent years, the technology for multiple band operation and the bandwidth enhancement for wireless applications have developed very quickly [1].

Now days, the demand is compact wireless devices for multi- applications. This implies that the size of antennas should be small enough and the antenna operates at multi-band. For this purpose, patch antennas are suitable because of their light weight, low profile, simple structure, and ease of fabrication [2-3].

For multi-applications, the patch antenna suffers a problem of narrow bandwidth that can be solved by applying the wideband feeding techniques [4-6]. There are several feeding techniques like coaxial probe fed, microstrip line fed, edge fed, inset fed, CPW fed. In the proposed antenna, CPW feed is used due to its wide band characteristics and low VSWR [7-9].

In this paper, a T-shaped monopole patch antenna with CPW-fed technology including two symmetrical rectangular ground plane is proposed for WLAN applications. By adjusting the size of the spacing gap ‘g’ and feed line, the overall performance of the proposed antenna can be improved.

II. ANTENNA GEOMETRY AND PARAMETRIC STUDIES

The geometry of the proposed T-shaped monopole patch antenna is shown in Fig. 1. The antenna has been designed using the rectangular T-shape patch in a monopole configuration. The monopole structure provides impedance matching over the wide range of frequency.

The proposed antenna is designed with the calculated dimension of the patch using finite element based electromagnetic simulator HFSSv.13 (High-frequency structure simulator) software. The proposed antenna is designed on single layer FR4 substrate of dimension (L_s*W_s = 50mm*40mm), thickness 1.6 mm, relative permittivity 4.4 and dielectric loss tangent of 0.002.

The proposed antenna structure is a T shaped rectangular patch. The horizontal part of this T-shape structure has the dimension of L_1= 25.5 mm, and W_1= 4 mm and the vertical part of this structure (CPW feed line) has the dimension of L_2= 32 mm, and W_2= 3 mm. The two equal finite ground planes are placed on the both side of the CPW feed-line symmetrically with the dimension of L_3= 27 mm, and W_3= 22 mm.

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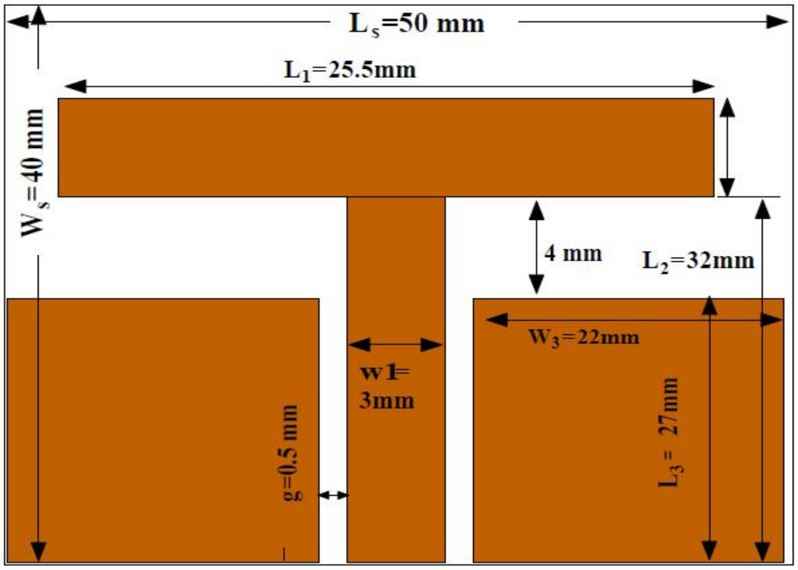

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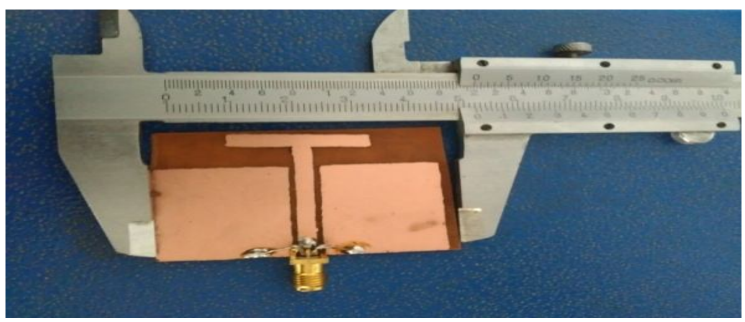

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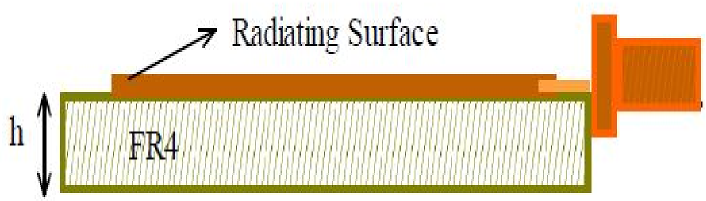


(c)

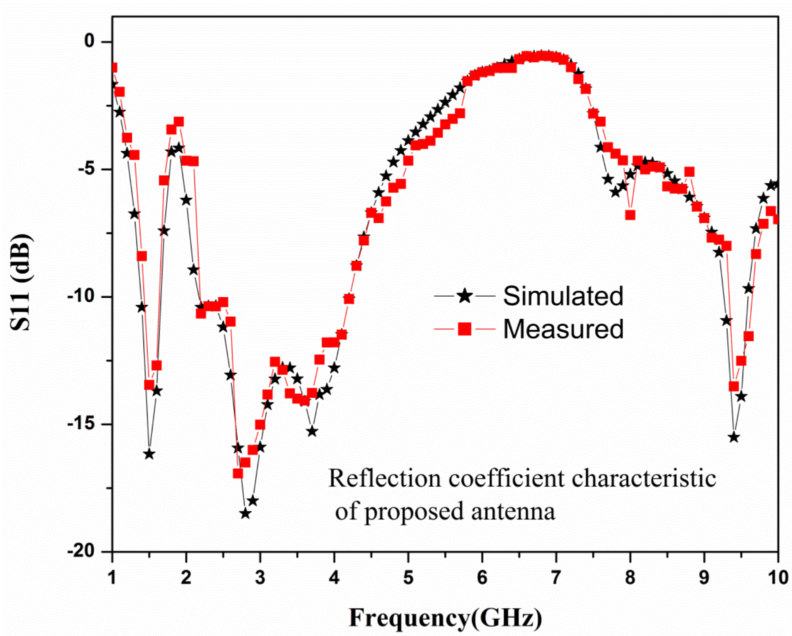
Figure 1: (a) Geometry of the proposed antenna,(b) hardware of proposed antenna, (c) Side view of proposed antenna

Table 1

Parameters	Values (mm)
Length of strip (monopole) (L_s=L+L_g)	31
Width of strip (monopole) (W)	3
Length of ground patch (L_g)	27
Width of ground patch (W_g)	22
Coupling gap (g)	0.5
Hieght of substrate (h)	1.6

III. RESULTS AND DISCUSSION

The microstrip patch antenna has been designed on finite element based electromagnetic simulator AWR software. The measured and simulated return loss of the proposed antenna is shown in Figure 2(a). It is seen from the figure that the proposed antenna can operate from 1.5GHz, 2.8GHz and 9.4GHz resonance frequency with an impedance bandwidth of 18%, 72% and 3.5% respectively. At 2.8 GHz frequency band the wide bandwidth is achieved by the T- shaped structure of the proposed antenna and using CPW feed line. The VSWR and gain of the proposed antenna are shown in figure 2(b) and figure 3 respectively. The plot of VSWR observed less than 2 at 1.5GHz, 2.8 GHz and 9.4 GHz frequency band and all three frequency bands achieved the positive gain of average value 2 dB.



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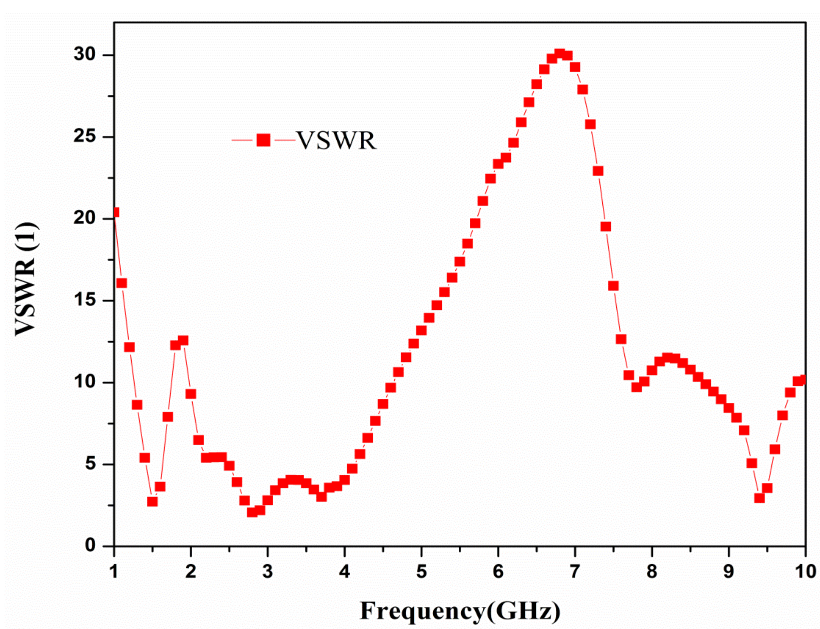

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Figure 2. (a) Return Loss of the proposed antenna (b) VSWR of proposed antenna

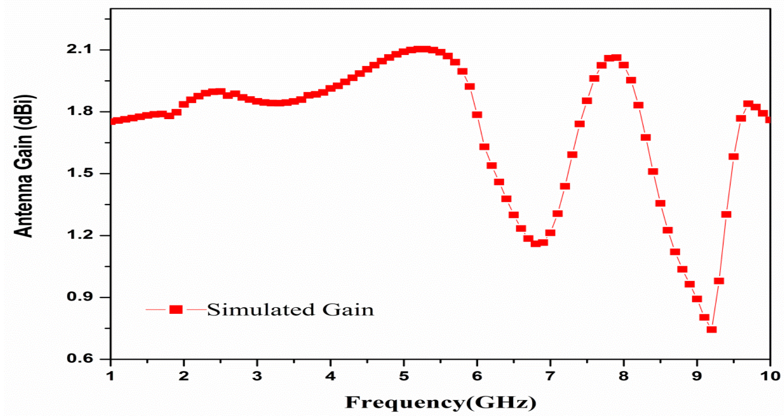
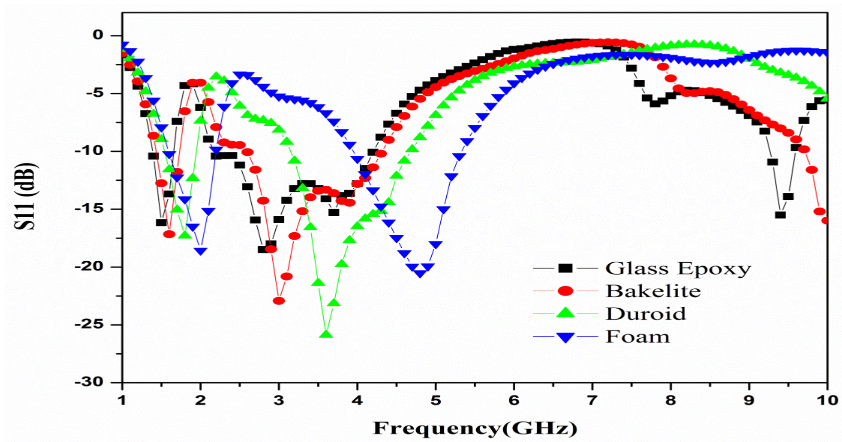


Figure 3. Gain of the proposed antenna

IV. PARAMETRIC STUDY

Figure 4(a) shows the parametric analysis of return loss by variation of dielectric constant of the substrate using different types of the substrate material. From the figure, it is seen that the double frequency band obtained at low dielectric constant (Foam).when the dielectric constant is increased the number of frequency band increased and also obtained the wide-band.

Figure 4(b) shows the parametric analysis of return loss by variation of the thickness of substrate material. The lower frequency band is shifted towards the lower frequency range when the thickness of substrate material increased. At a higher value of the thickness of substrate obtained the multi-band and also obtained the wideband at lower frequency band.



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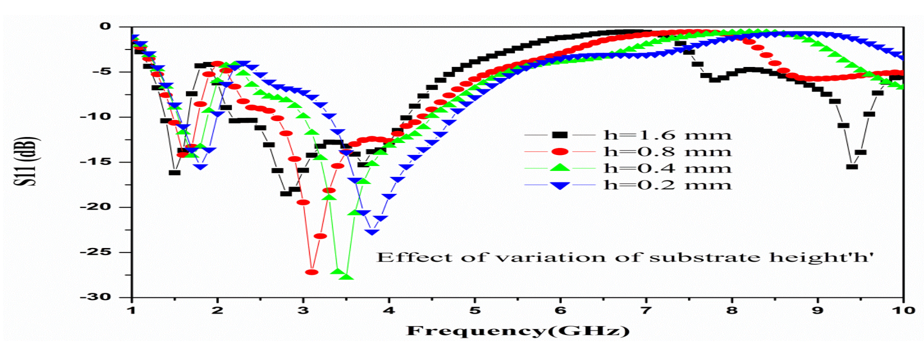

(b)

Figure 4. (a) Simulated return loss vs frequency plot for different types of material of substrate of proposed antenna, (b) Simulated return loss vs frequency plot for different height of substrate of proposed antenna

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V. CURRENT DISTRIBUTION OF PROPOSED ANTENNA

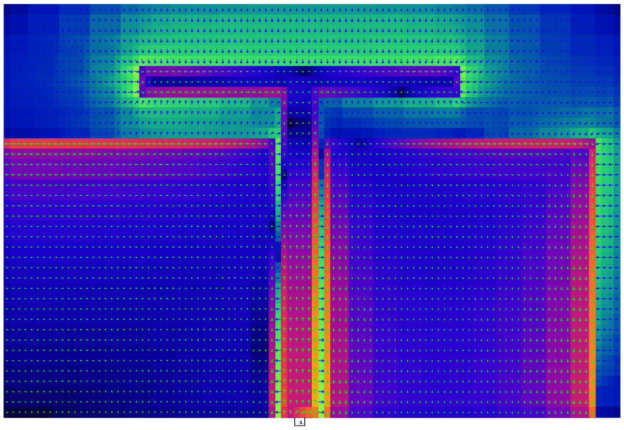


Fig.5(a)

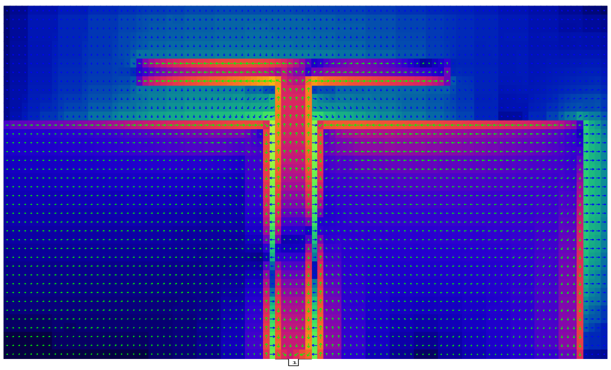


Fig.5(b)

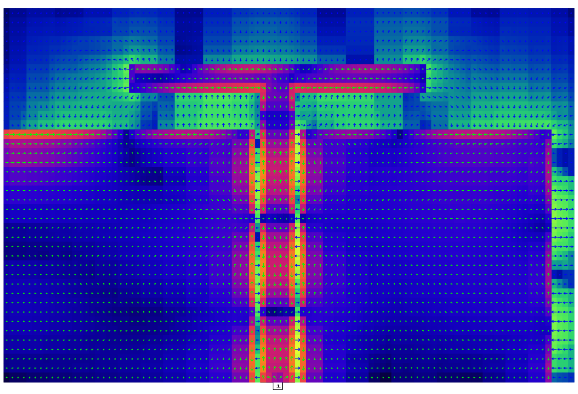
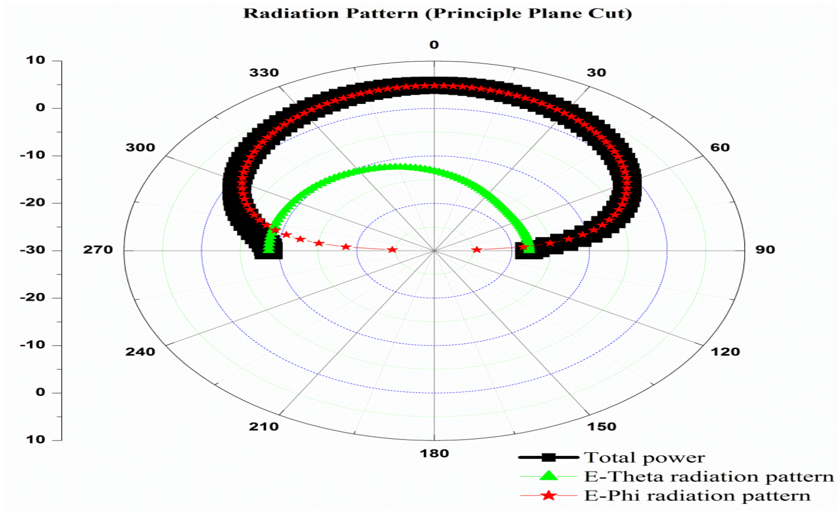


Fig.5(C)

Figure5.Current distribution at resonant frequency (a)1.5GHz(b)2.8GHz(c)9.4GHz

The current distribution characteristics of the proposed antenna are shown in figure-5. From the figure it is clear that the current is varying along the CPW fed strip and by mutual effect corner of the finite ground plane. When CPW fed line behaves as open ended transmission such variation is not occurs.

VI. RADIATION PATTERN



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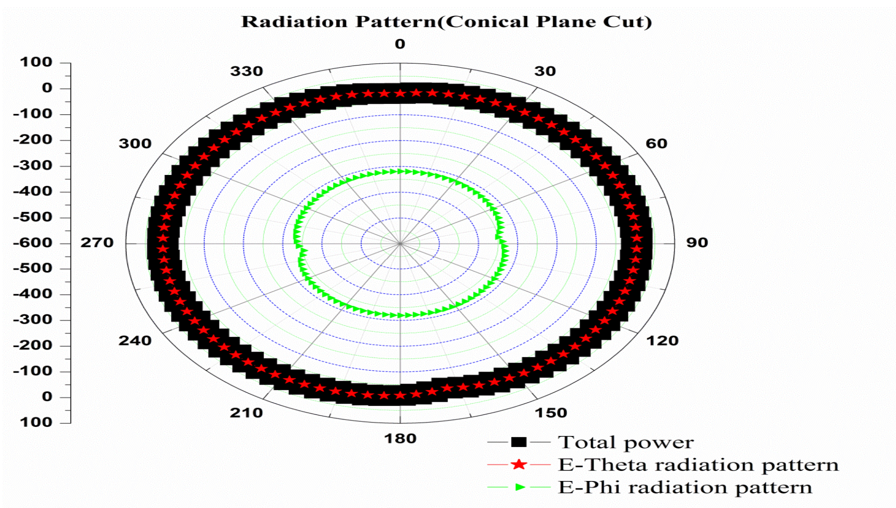

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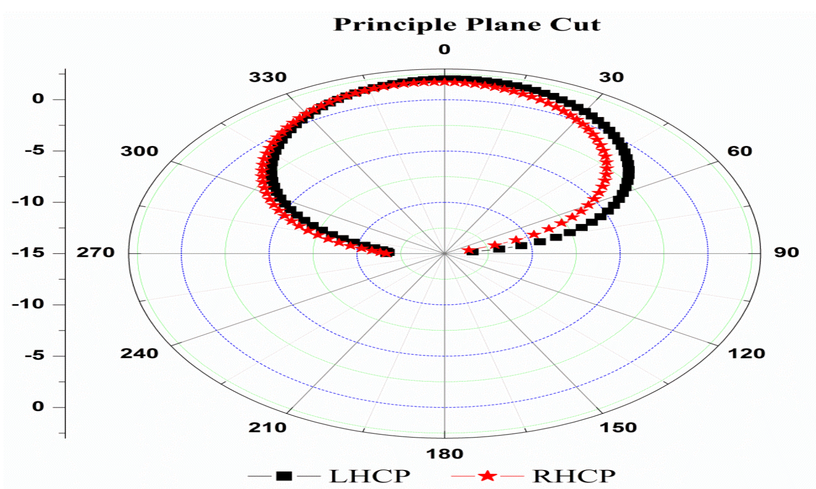

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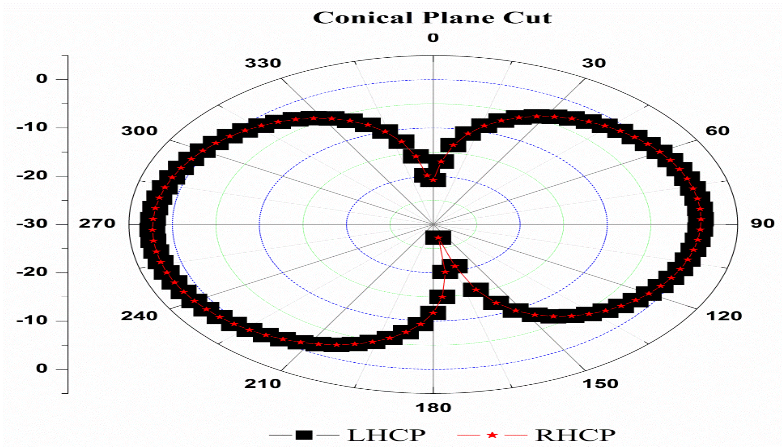

(d)

Figure 6. Radiation Pattern of Proposed Antenna: (a) Principle Plane Cut, (b) Conical Plane Cut, (C) Polarization in Principle Plane Cut and Conical Plane Cut, (d) Theta and Phi is fixed sweeps Frequency.

The Radiation Pattern of the proposed antenna is shown in figure-6. From the figure, it is clear that in principle plane cut when Theta is fixed at 0 degrees and Phi is varying give the information about cross polarization and co-polarization and calculating 3dB sartorial bandwidth about 88.6 degrees and gain around to be 1.739 dBi of total radiated power in the elevation plane. Conical plane cut Phi is fixed at 0 degrees and Theta is varying give the information about cross polarization and co-polarization for azimuth plane.When Theta and Phi are fixed sweeps Frequency that is a good agreement.

VII. CONCLUSIONS

The proposed antenna is based on CPW-Fed technique and provides the three resonating frequencies as 1.5GHz, 2.8GHz and 9.4GHz with an average gain of 2 dBi. The T-shape of the proposed antenna enhanced the impedance bandwidth of 2.8 GHz frequency band up to 72 %. Hence this compact microstrip antenna can be used for GPS antenna (1.5GHz), multichannel multi point distribution service (MMDS)WiMAX (2.8GHz) and X band (9.4 GHz)for radar applications. An optimization between size reduction and bandwidth enhancement is maintained in this work.

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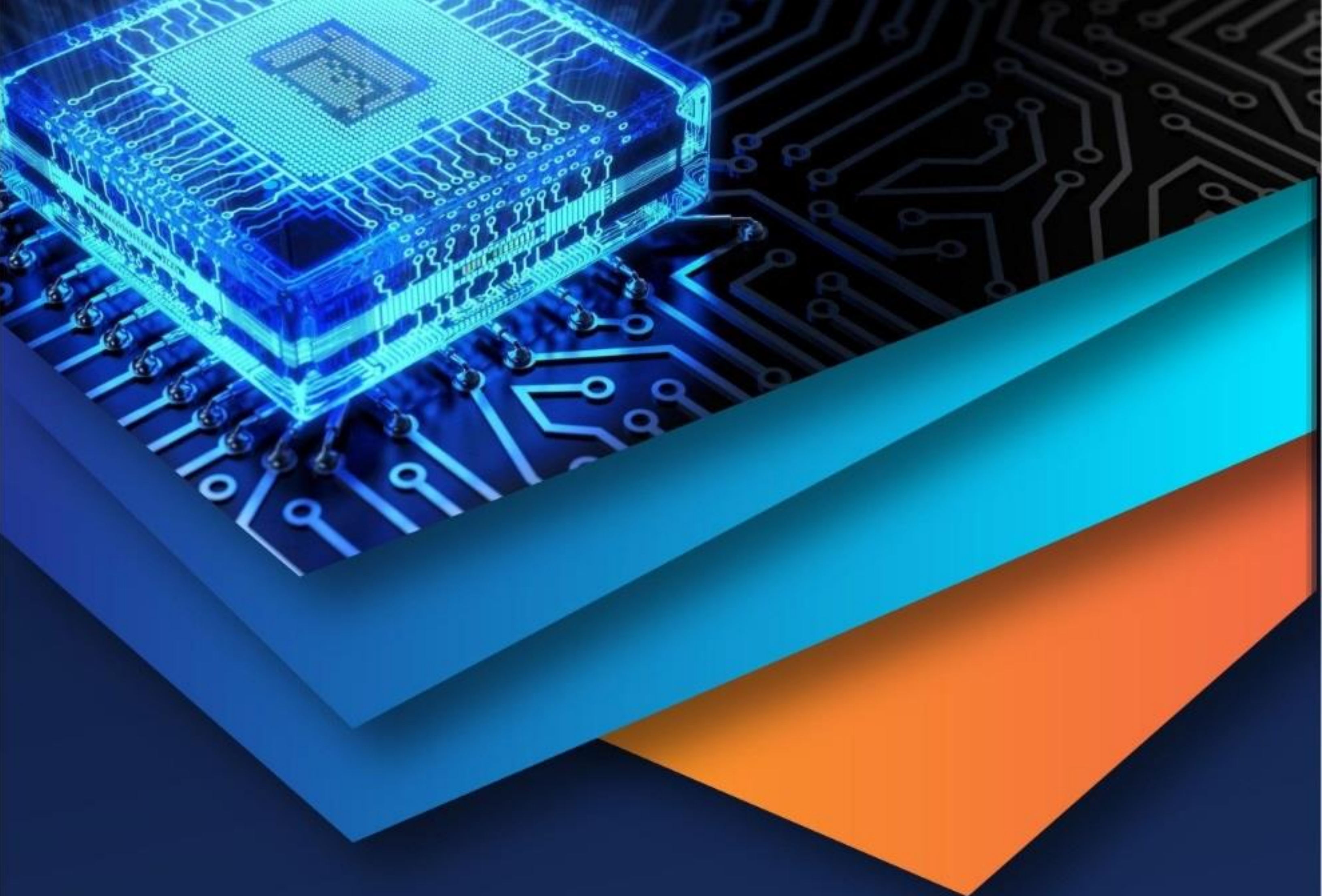

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