iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** VII **Month of publication:** July 2015

DOI:

Volume 3 Issue VII, July 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Analysis of Multiband Patch Antenna Using Coaxial Feed and Microstrip Line Feed

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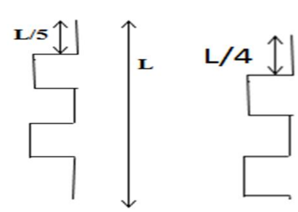
Abstract- In this paper the analysis of hybrid shape multiband microstrip patch antenna is presented which uses FR-4 substrate and have thickness of 2.4mm. Firstly results are produced using coaxial probe feed. Minkowski Fractal geometry is used for multiband behavior. The proposed antenna resonates at 2.2GHz, 5.2GHz and 6.1GHz with bandwidths 100MHz, 200MHz and 300MHz respectively. Then a comparison is made using microstrip feed technique. Simulation is carried out using IE3D software. The proposed antenna covers S, C and X microwave bands. Different parameters of antenna like return loss, gain, VSWR and efficiency are studied.
Keywords- hybrid, multiband, IE3D, return loss, efficiency

I. INTRODUCTION

In this era of wireless communication, there is an increased demand for compact antennas to be used in wireless communication devices. Due to the ease of fabrication and availableness, microstrip patch antennas are used. They have a simple geometry hence are easy to design and manufacture. Microstrip antennas structure is planar and have low profile. They have applications in aircraft, satellite and missile whose requirements are size, weight and complexity. They are less bulky and capable of resonating at different bands. They have many disadvantages like low bandwidth, low gain, poor polarization, high Q factor and low efficiency [1]. To make improvement in these factors there are many techniques like use of fractal geometry, defected ground structures and slot cutting [2-5]. Fractal means self-similar fragments. There are many fractal geometries like Minkowski, Hilbert curve, Koch curve, Sierpinski and fractal arrays [6-9]. By the use of fractal geometry on patch, resonant length increases which leads to decrease of patch size and increase in the number of frequency bands [10-12]. To have wideband characteristics, defected ground structure can be used. Their weight is less and they have thin profile configuration which can be made conformal [13]. Further linear and circular polarization is possible using these antennas [14]. Dual frequency and dual polarization can be made easily and these antennas are suitable for mass communication. Currently the main challenges faced by patch antenna are narrow bandwidth, low gain and low radiation efficiency [15-18].

II. METHODOLOGY

The first step in designing of any antenna is to select its frequency of operation. Then the dimensions of antenna are calculated. If antenna is to be designed for mobile use, it implies to design antenna for GSM, Wi-Max, Bluetooth and many other applications. It is not possible to design single antenna for each application which will make mobile bulky, hence fractal geometry is applied to produce multiband characteristics [19]. In this paper, two different fractal iteration factors have been applied to patch of antenna on both of its sides to form hybrid shaped fractal patch antenna. It is called as hybrid shaped because it has E-shape on one side and F-shape on the other side. Design and implementation is carried out using IE3D software [20]. The dimensions of patch are taken as 28mm sq. Initially the feed is taken at (0,5). The following two iteration factors are applied on the patch to form hybrid shaped patch antenna.



(a) (b)

Figure1: Fractal algorithm for (a) E-shaped FMPA, (b) F-shaped FMPA

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ISSN: 2321-9653
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For making E- shape on one side, 1.5mm from top and bottom is left to have a square of 25mm and then L/5 algorithm is applied. And the side is divided into 5 equal parts. Then to have F-shape on the other side L/4 algorithm is applied on the whole length of 28mm. Figure 2(b) shows this design. Second iteration is made by making cuts of 1mm on E-shape side and 1.75mm on F-shape side as shown in figure 2(c). This is the proposed antenna design of this paper. This antenna is fed using coaxial feed at point (13,8). Further the comparison is made by using microstrip feed technique. Much improvement in results is observed.

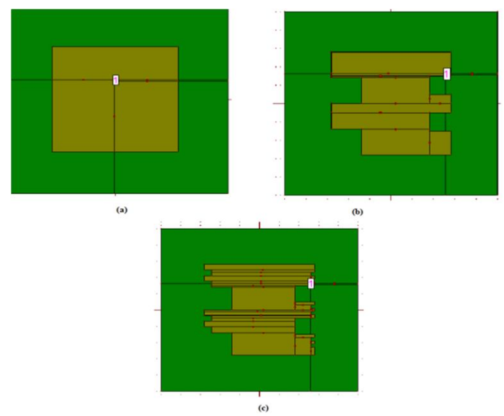

Figure 2: Hybrid FMPA (a) 0thIteration (b) 1st Iteration and (c) 2nd iteration (proposed design)

III. RESULTS AND DISCUSSIONS

Return loss versus frequency for different iterations are shown in figure 3. Firstly patch antenna with feed point(0,5) represented by pink line resonates at 4.9 GHz, 5.6 GHz and 7.2 GHz having return loss of -21.42 dB, -11 dB and -12.30 dB with bandwidth of 200Mhz, 120Mhz and 150Mhz. Then first iteration was done, which resonated the antenna at 2.2 GHz, 5.1 GHz, 6 GHz and 8.2 GHz having return loss of -16.09dB, -13.17 dB and -15.41db and-16.41db. Now to improve results further, second iteration has been done which resonated at 2.2 GHz, 5.2 GHz, 6.1GHz having return loss of -12.30dB, -21.65 dB and -20.23 dB with bandwidth of 100 MHz, 200 MHz and 300 MHz having efficiencies of 36.86%, 41.63% and 33.08% respectively. Radiation pattern for proposed antenna is shown in figure 4.

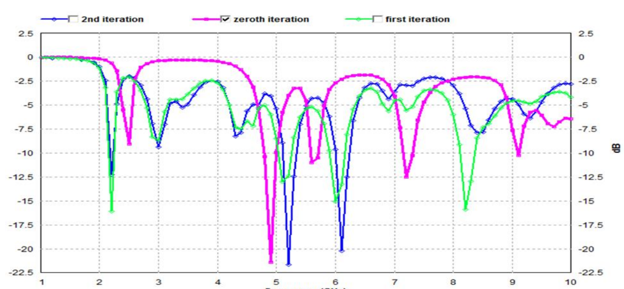

Figure 3: Return Loss Vs Frequency for Different Fractal Iterations of Hybrid shaped FMPA

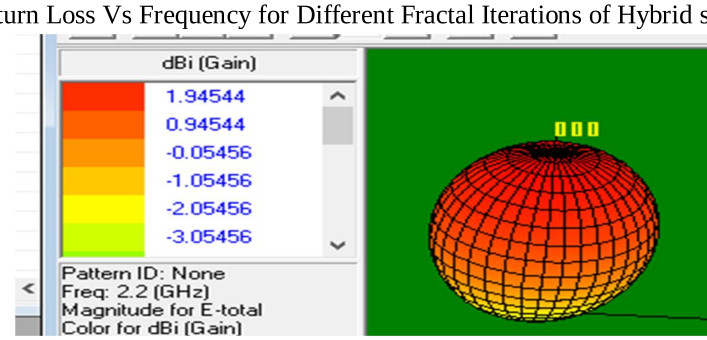

Figure: 4 **(a)**

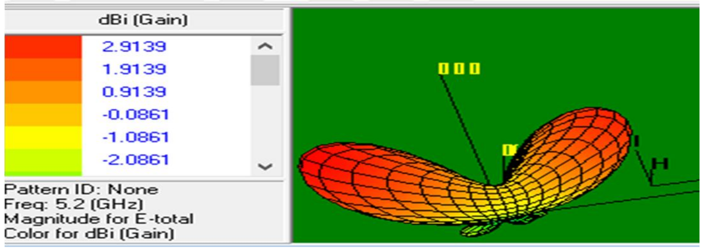

Figure: 4(b)

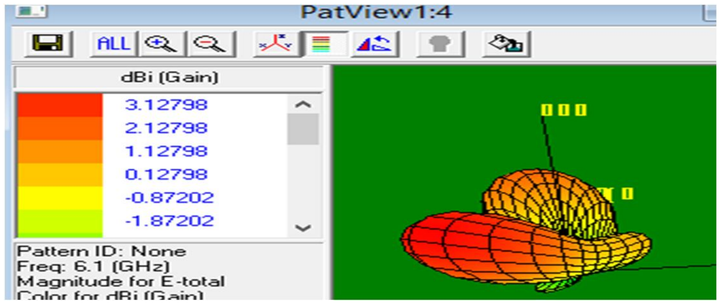

Figure 4 (c)

Figure 4: 3D Radiation Pattern of Hybrid shaped FMPA at (a) 2.2 GHz, (b) 5.2 GHz and (c) 6.1 GHz

Table I: Comparison Results of Different Iterations of Hybrid-shaped FMPA

Iteration Number	Resonance Frequency (GHz)	Return Loss (dB)	Gain (dBi)	Directivity (dBi)	Bandwidth (MHz)	Radiation Efficiency (%)
0th Iteration	4.9	-21.42	3.10	7.50	200	36.64
	5.6	-11	0.36	8.52	120	16.56
	7.2	-12.30	6.73	11.64	150	34.20
1st Iteration	2.2	-16.09	2.14	6.53	30	37.35
	5.1	-13.17	2.65	6.85	200	40.11
	6	-15.41	3.45	8.1	270	36.06
	8.2	-16.41	2.88	8.5	250	28.17
2nd iteration	2.1	-12.5	1.91	6.54	100	36.86
	5.2	-21.5	2.91	6.74	200	41.63
	6.1	-20	3.12	7.91	300	33.08

Table I shows the results for each iteration. It discusses the gain, directivity and efficiency values.

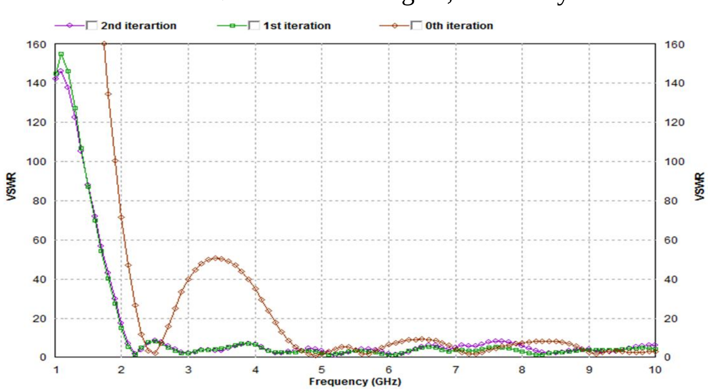

Figure 4:-VSWR for different iterations

Volume 3 Issue VII, July 2015
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With the increase in fractal iteration, the antenna resonates at higher frequencies with minimum return loss, good bandwidth and improved VSWR between 1 and 2. Figure 5 shows the efficiency graph for three iterations.

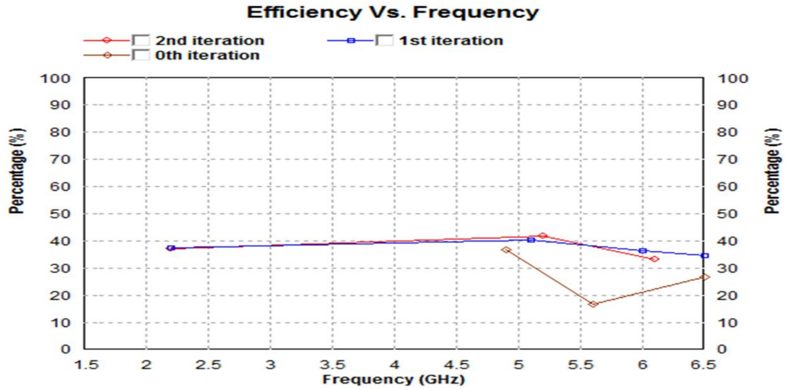

Figure 5: radiation efficiency of different iterations

IV. ANALYSIS USING MICROSTRIP FEED

The proposed antenna design is now fed using microstrip line feed. The design for this is shown in figure 6.

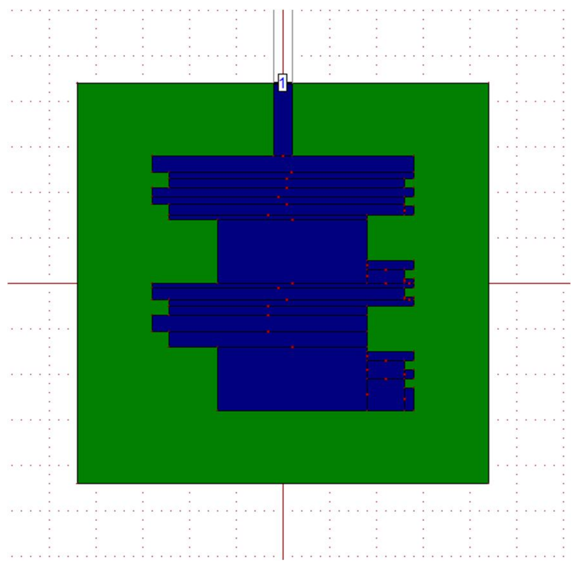

Figure 6: Proposed design using microstrip feed

The advantage of using microstrip feed is that it is easy to fabricate and no hole is to be drilled in the substrate which makes the planar antenna structure. The comparative results using both feeds are shown in the table II

Table II. Comparison between microstrip feed and coaxial feed

Type of feed	Resonance frequency (Ghz)	Return loss (db)	Directivity (dbi)	Gain (dbi)	Bandwidth (MHz)
Coxaial feed	2.1	-12.5	1.91	6.54	100
	5.2	-21.5	2.91	6.74	200
	6.1	-20	3.12	7.91	300
Microstrip feed	2.4	-15.44	4.55	1.91	255
	8.5	-14.39	7.93	7.77	500

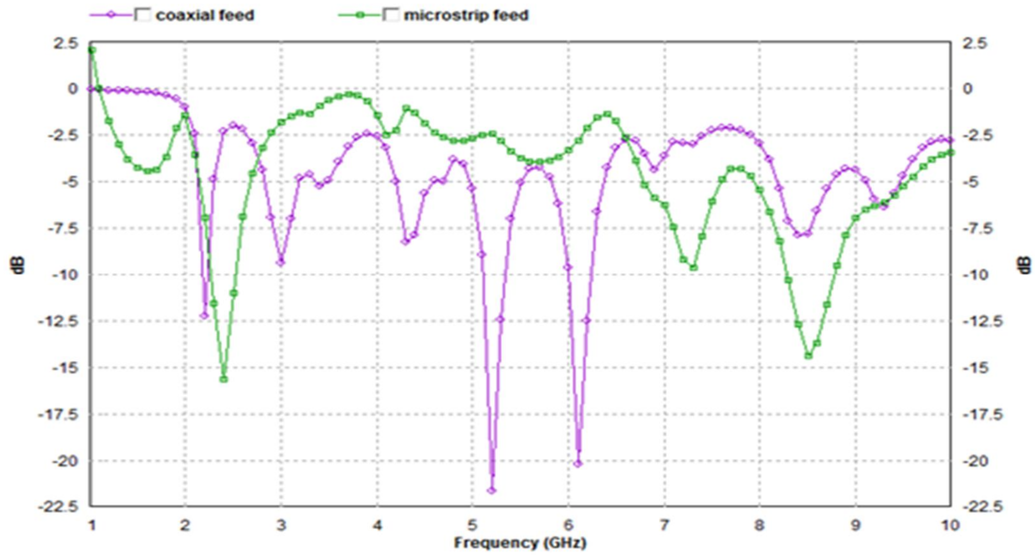

Figure 6:- Comparison of Return loss for both feeds

This shows that antenna now resonates at 8.5GHz with increased bandwidth (500MHz) having gain of 7.77dbi and return loss of -14.39.

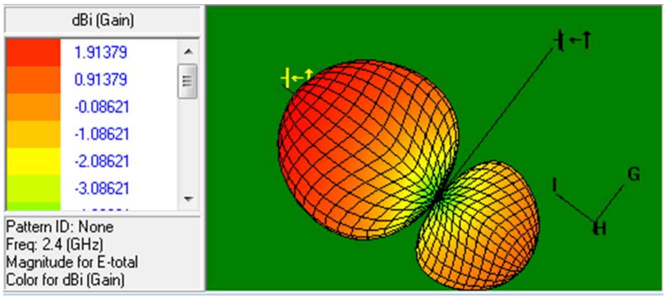

Figure 7(a): 3D radiation pattern at 2.4Ghz

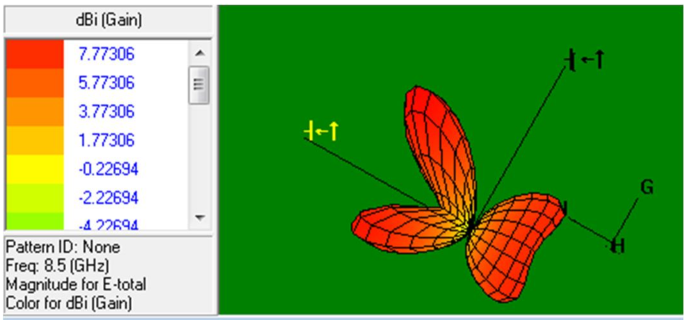

Figure 7(b) :- 3D radiation pattern at 8.5Ghz

Figure 7 shows the 3D radiation pattern for microstrip feed design. This shows the improvement in gain as compared to coaxial feed.

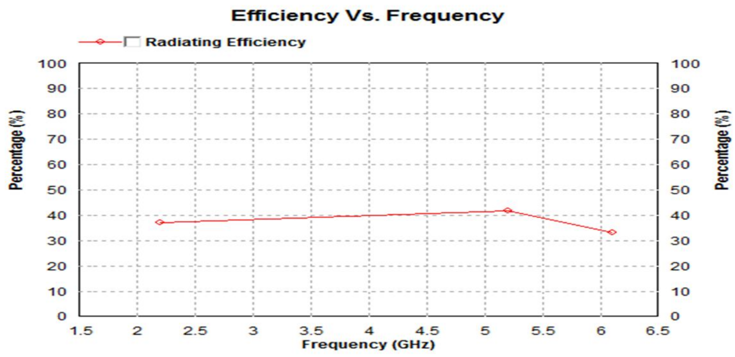

Figure 8: Efficiency for coaxial feed

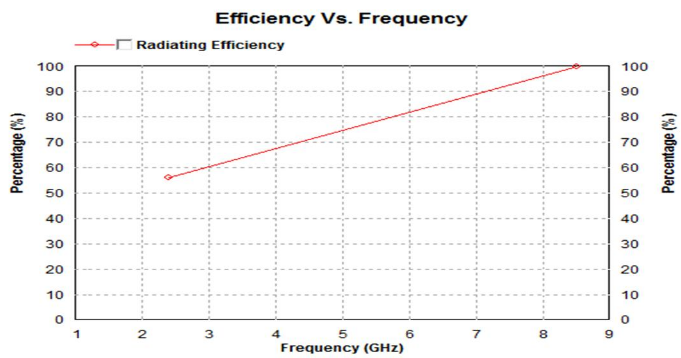

Figure 9: Efficiency for microstrip feed

Figure 8 and figure 9 shows the radiation efficiency of proposed design using both the feeds. There is much improvement in efficiency also. The maximum radiation efficiency using coaxial feed is 41.63 % and using microstrip feed is 100%.

V. CONCLUSION

In this paper Hybrid shaped fractal microstrip patch antenna for wireless applications is designed. Initially square patch is analyzed. To improve the characteristics of this antenna, two iterations of hybrid fractal geometry are applied to form Hybrid shaped fractal patch antenna which resonates at three different bands 2.1 GHz, 5.2GHz and 6.1 GHz with good bandwidth and gain. Then the results are compared using microstrip line feeding technique. And there is much improvement in bandwidth, gain and efficiency. Parametric analysis has been performed in terms of antenna characteristics. Proposed Antenna works for wireless applications like long distance radio telecommunications, microwave relays, satellite communication and radar. These lie in S, C and X microwave bands.

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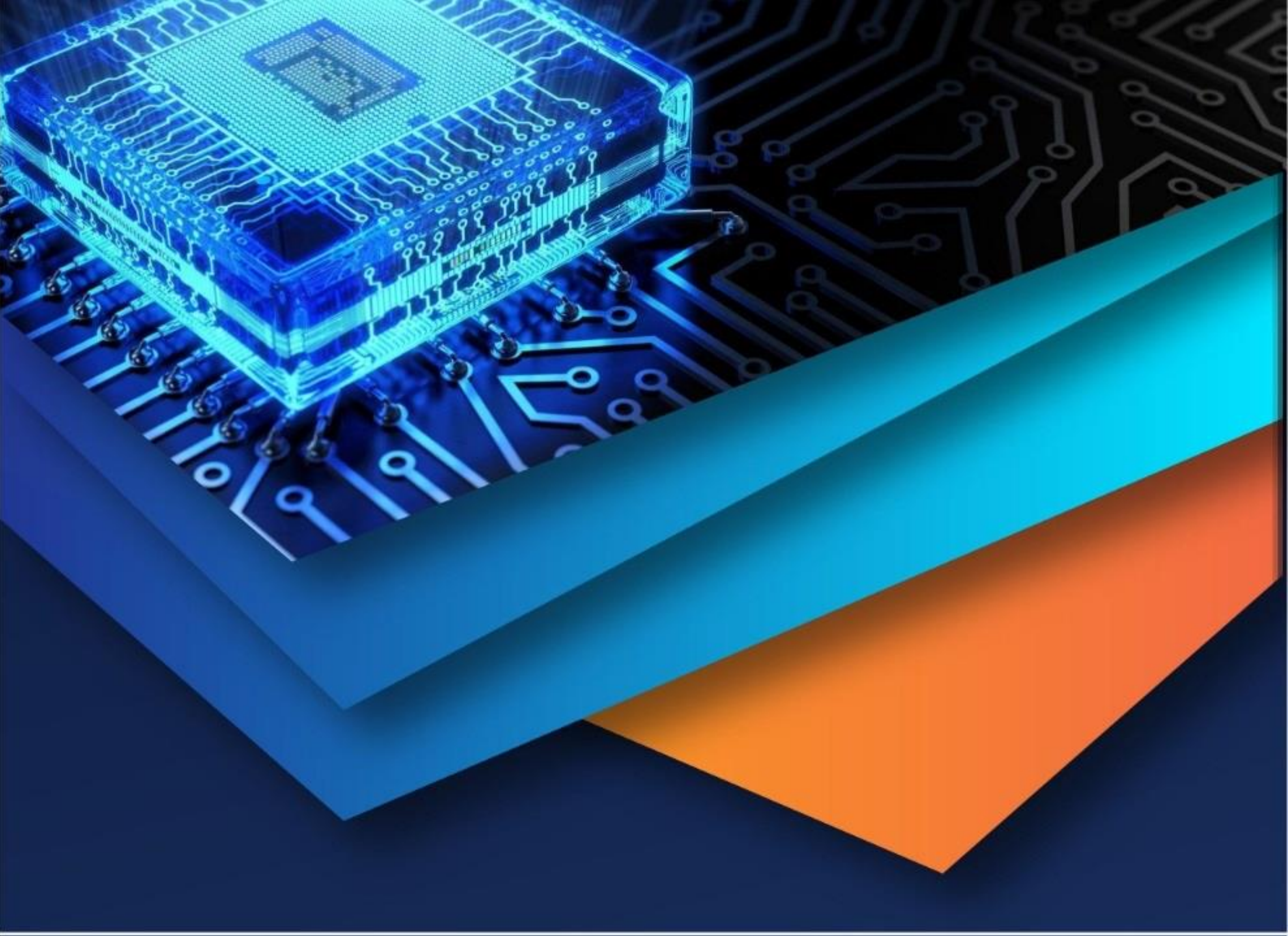

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