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Design of Fractal Antenna For First Iteration

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***Abstract*-- This paper describes the design and fabrication of modified Sierpinski carpet fractal antenna. The analysis took place between ranges of 0.5GHz to 3GHz. The fabricated modified Sierpinski carpet fractal antenna proves that it is capable to create multiband frequencies.**

Index Terms:- microstrip antenna, fractal, return loss.

I. INTRODUCTION

IN modern wireless communication systems and increasing of other wireless applications, wider bandwidth and low profile antennas are in great demand for both commercial and military applications. This has initiated antenna research in various directions, one of them is using fractal shaped antenna elements. Traditionally, each antenna operates at a single or dual frequency bands, where different antenna is needed for different applications. This cause a limited space and place problem.

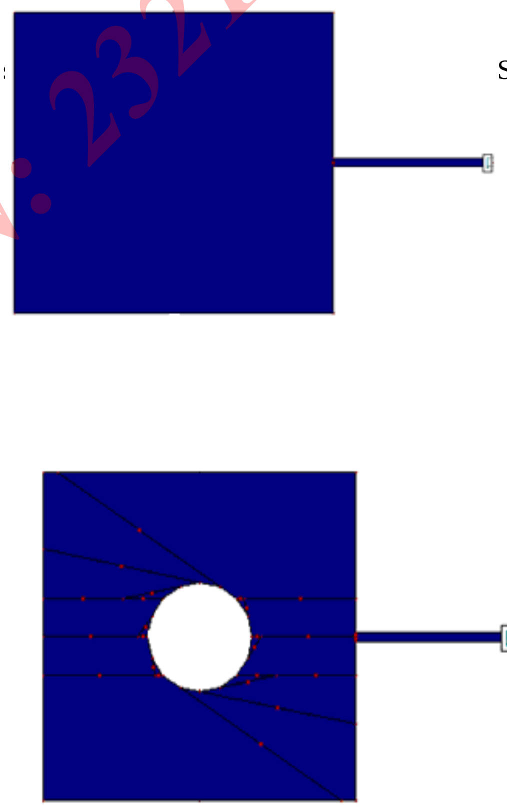
In order to overcome this problem, multiband antenna can be used, where a single antenna can operate at many frequency bands. One technique to construct a multiband antenna is by applying fractal shape into antenna geometry. The behaviors of this antenna are investigate such as return loss, number of iteration, simulation, fabrication and testing have been done. The entire fractal antennas shows multiband in resonant frequencies.

II. ANTENNA CONFIGURATION

The antenna was feed with transmission line feeding technique. The iteration process is done up to second iteration. The design is fabricated using glass-epoxy material with relative permittivity, $\varepsilon_r = 4.4$, substrate thickness, d = 1.6mm where the radiating element is the cooper clad. The iteration of the antenna

from zero :

Stage 0



Stage 1

Figure1: The stages iteration of modified Sierpinski Carpet Fractal antenna.

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The design of the antenna was start with single element using basic square patch microstrip antenna. The operating frequency is at 1.0GHz. Length, L and width, W can be calculated by using equation (1), (2), (3), and (4).

Width,

$$W = \frac{v_o}{2 f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

Effective dielectric,

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r + 1}{2}\left(\frac{1}{\sqrt{1 + 12d/W}}\right) \qquad (2)$$

Fringing field,

$$\Delta l = 0.412d \frac{\left(\varepsilon_{eff} + 0.3\right)\left(\frac{W}{d} + 0.262\right)}{\left(\varepsilon_{eff} - 0.258\right)\left(\frac{W}{d} + 0.813\right)} \qquad (3)$$

Length,

$$L = \frac{v_0}{2 f_r \sqrt{\varepsilon_{eff}}} - 2\Delta l \qquad (4)$$

Where:-

v_0 = Velocity of light in free space.

f_r = Operating resonant frequency.

ε_r = Dielectric constant of the substrate used.

ε_{eff} = effective dielectric constant.

d = height of the substrate.

The generalized formulas for iteration n are as follows:

N_n = The number of black box.

L_n = The ratio for length.

A_n = The ratio for the fractal area after the n_{th} iteration.

n = The iteration stage number.

$N_n = 8^n$

$$L_n = \left\{\frac{1}{3}\right\}^n \qquad (5)$$

$$A_n = \left\{\frac{8}{9}\right\}^n \qquad (6)$$

III. RESULT AND DISSCUSSION

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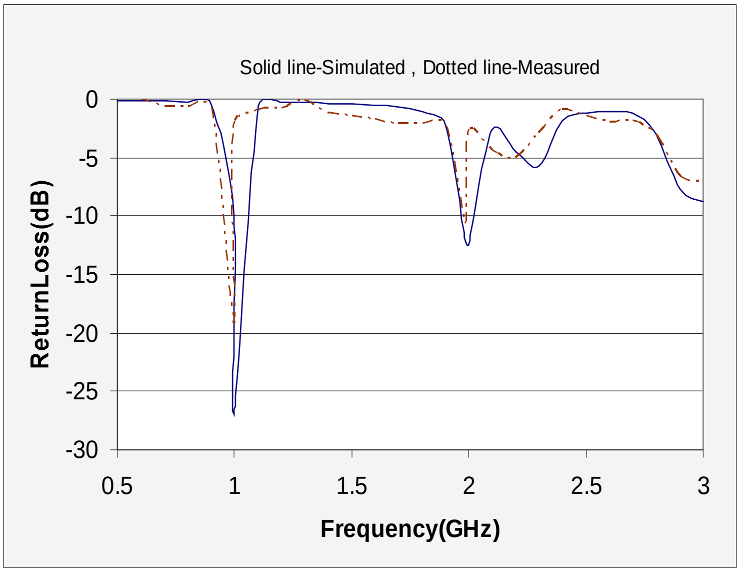
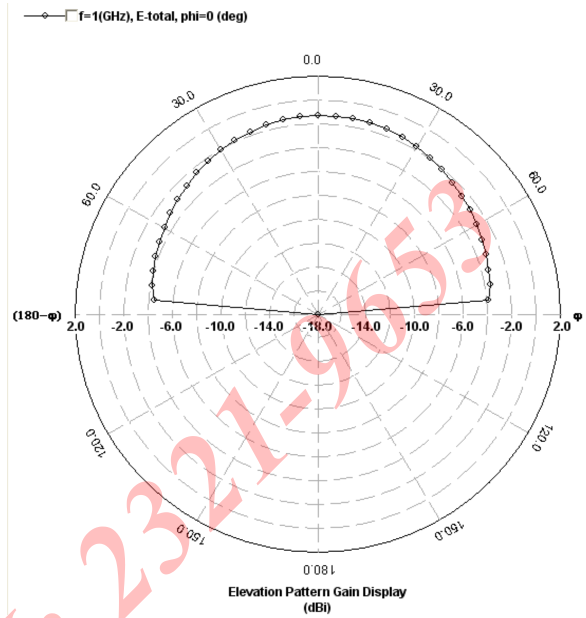


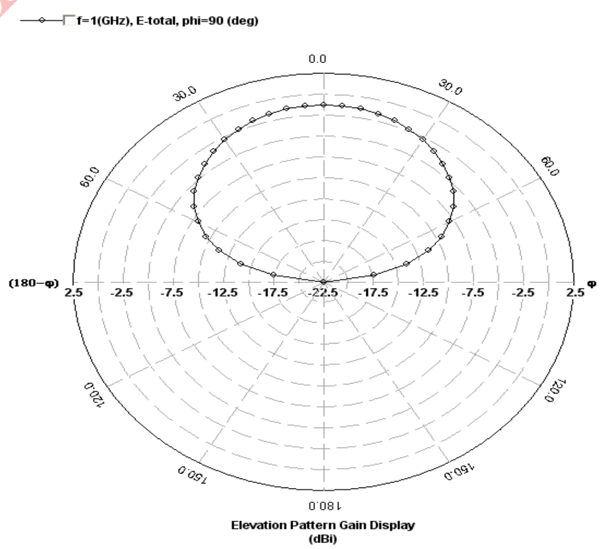
Figure 2: Variation of return loss with frequency for base shape.

Table 1 : Frequencies at which minimum return loss occur for base shape.

Frequency (Simulated)	1.0 GHz	2.0 GHz
Return loss (Simulated)	-26.78 dB	-12.46 dB
Frequency (Measured)	0.99 GHz	1.986 GHz
Return Loss (Measured)	-19.1 dB	-10.6 dB



(a)



(b)

Figure 3: Radiation pattern at f =1GHz

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(a) E-total, phi = 0(deg)

(b) E-total, phi = 90(deg

In figure2: The return loss -26.78 dB and -12.46 GHz with frequency 1.0GHz and 2.0 GHz respectively was obtained from simulation. The measurement response frequency has shifted to 0.99 GHz and 1.986 GHz with measured return loss -19.1 dB and -10.6 dB respectively.

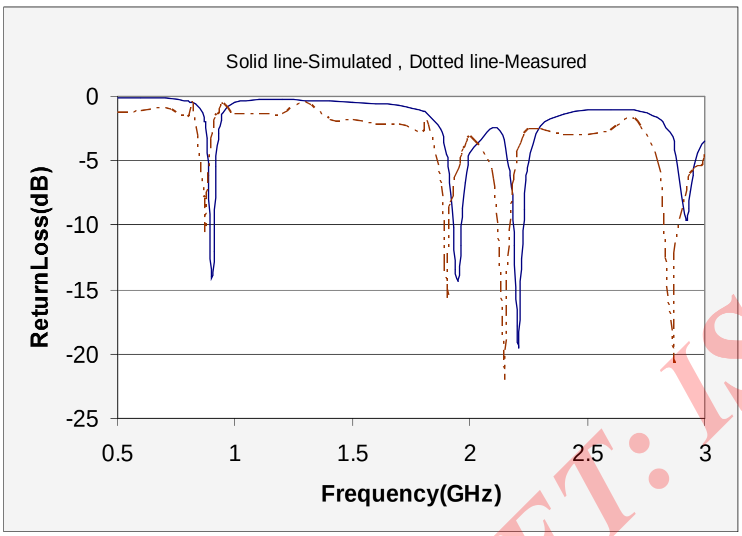
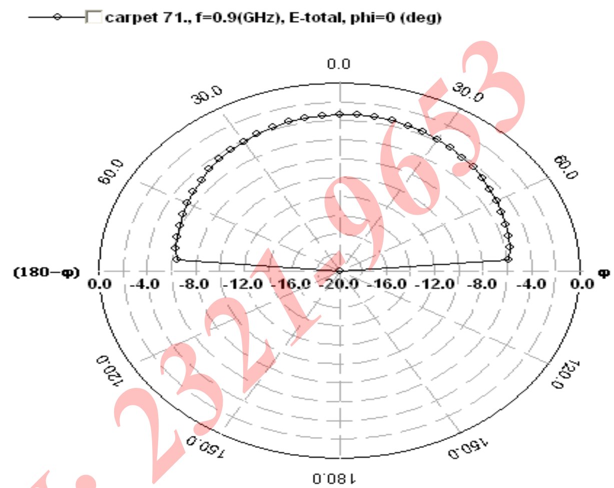


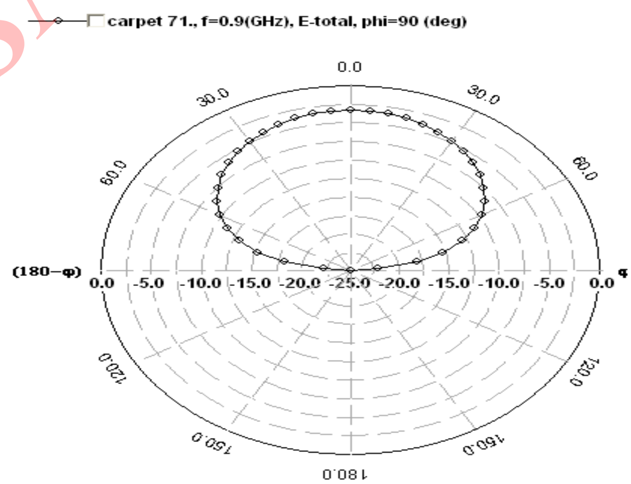
Figure 4: Variation of return loss with frequency for first iteration.

Table 2: Frequencies at which minimum return loss occur for first iteration

Frequency (Simulated)	0.9GHz	1.95GHz	2.21GHz
ReturnLoss (Simulated)	-14.05dB	-14.3dB	-19.43dB
Frequency (Measured)	0.876GHz	1.90GHz	2.14GHz
ReturnLoss (Measured)	-10.5dB	-15.6dB	-21.8dB



(a)



(b)

Figure 5 Radiation pattern at f =0.9GHz

(a) E-total, phi = 0(deg)

(b) E-total, phi = 90(deg)

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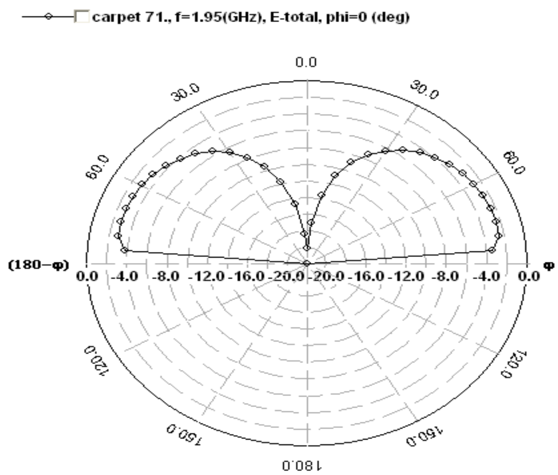

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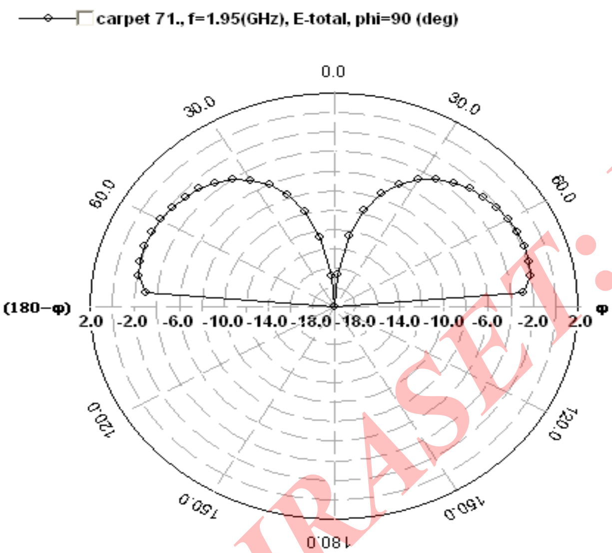
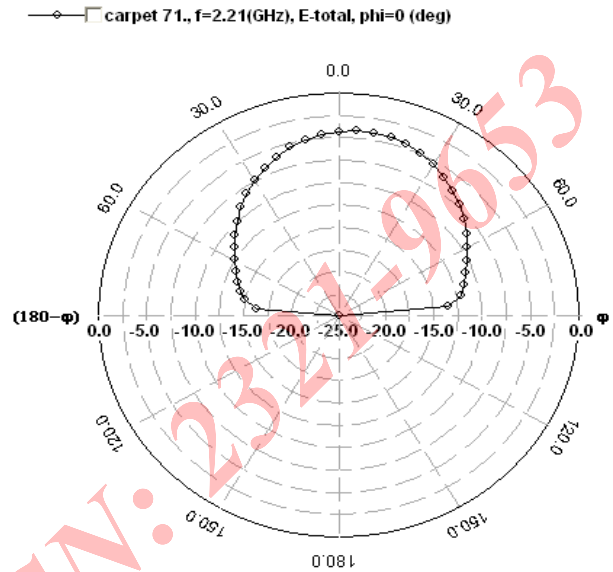


(b)

Figure 6: Radiation pattern at f =1.95GHz

(a) E-total, phi = 0(deg)

(b) E-total, phi = 90(deg)



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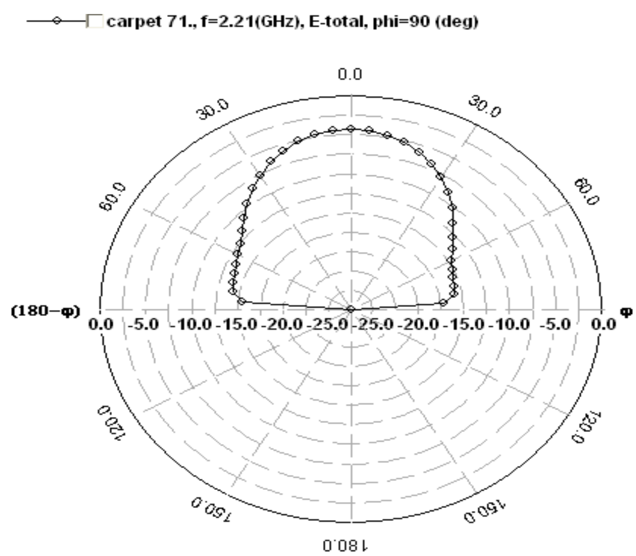

(b)

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Figure 7: Radiation pattern at f =2.21GHz

(a) E-total, phi = 0(deg)

(b) E-total, phi = 90(deg)

Figure 4: shows the result of return loss for first iteration. The resonant frequency was found at 0.9GHz, 1.95GHz and 2.21GHz from simulation. Measurement response frequencies have shifted at 0.876GHz, 1.90GHz, and 2.14GHz. The best return loss -19.43dB (2.21GHz) was found from simulation. Meanwhile, return loss -21.8dB (2.21GHz) was found from measurement.

IV CONCLUSION

The antenna has been design, simulated and fabricated. The multiband frequencies appeared after applied fractal technique. It is observed that as the number of iterations are increased, number of frequency bands also increases. For zero iteration two bands occur, for first iteration three bands occur and for second iteration five bands occur. The antenna can be used for GPS, WLAN applications.

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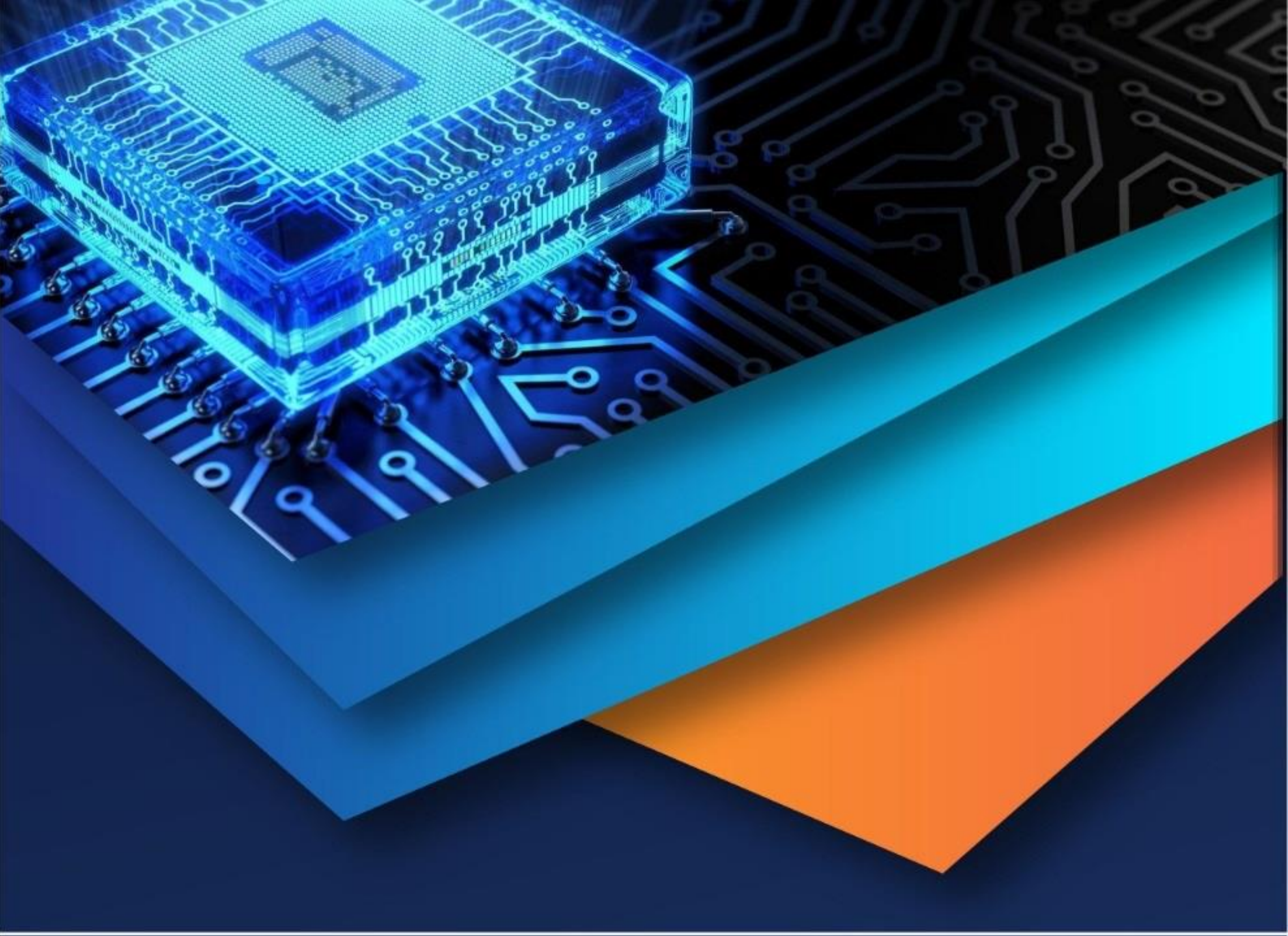

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