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Implementation of Radio – Over – Fiber Technology with Different Filtartion Techniques

Abhishek Sharma[1], Savita Rana[2]
[1,2]*Department of ECE, Sri Sai University Palampur, India*

Abstract: ***The Radio Over Fiber technology is an enhanced form of wireless communication. But this also suffers from various issues such as limited number of users, introduction to noise in signals, unwanted frequencies, low quality of signals due to noise etc. Therefore, the objective of this study is to design such a RoF communication system which can accomplish communication by using multiple users and also filter the noise from the signals to enhance the quality of the signals.***
This study has been conducted with an objective to implement the best of the modulation on communication system and results are analyzed on three different systems with different form of filtration techniques i.e. Low Pass Bessel, Low Pass Gaussian Filters and low Pass Rectangular Filters. The disadvantage of earlier system was that it did not supports more than one users at a time therefore the proposed work also facilitates to perform communication by using 8×8 transmitters and receivers. The model is designed by using Opti-system. The result section depicts the proficiency of proposed model.
Keywords: Radio Over Fiber, Modulation, CPFSK, Filteration, Low Pass Bessel Filter, Low Pass gaussian Filter, Low Pass Rectangular Filter.

I. INTRODUCTION

Nowadays, due to enhanced stipulation of broadband facilities the data traffic [1] over the network has been also increased. In 2010, a survey was conducted which concluded that around 50% income of the telecommunication organizations had been increased because of wireless communication services. Therefore in order to fulfill the[2] requirement of higher bandwidth, fast data transmission, symmetric bandwidth, to replace the wired communication system with wireless communication the technology shifted towards radio over fiber communications [3]. Radio over fiber also known as RoF is a combination of two technologies i.e. microwave and optical networks as shown in figure 1. This technology is a solution to the problem of enhanced capacity and mobility, reduced cost in the network [4].
Radio over Fiber is a communication technology that utilizes the optical fiber channels[5] to transfer data from sender to receiver. The modulation is performed in RoF directly with radio signals or at any intermediate frequency. As we know each and every technology has some advantages and disadvantages. Similarly, RoF has some advantages and lacking points as follows [6]:
Some of the advantages and benefits of the RoF technology are discussed follow:

A. Low Attenuation Loss
B. Large Bandwidth
C. Immunity to radio frequency interference
D. Easy installation and maintenance
E. Multi-Operators and multiservice operations

RoF system [7] is an analogue transmission system. It detects light and modulates the analogue signals. Hence like any analogue system signal impairments like distortion and nose in the signals are vital in RoF also[8]. These impairments are used to bounds a limit on Noise Figure and Dynamic Range NF and DR respectively. DR stands for dynamic range and plays an important role in mobile systems [9] like GSM because the power at Base station which comes from MUs fluctuates continuously [10]. It refers that the power received from MU which is located nearest to the base station may be higher as compare to that one which is located far away from the Base station but within in the range of same cell[11].

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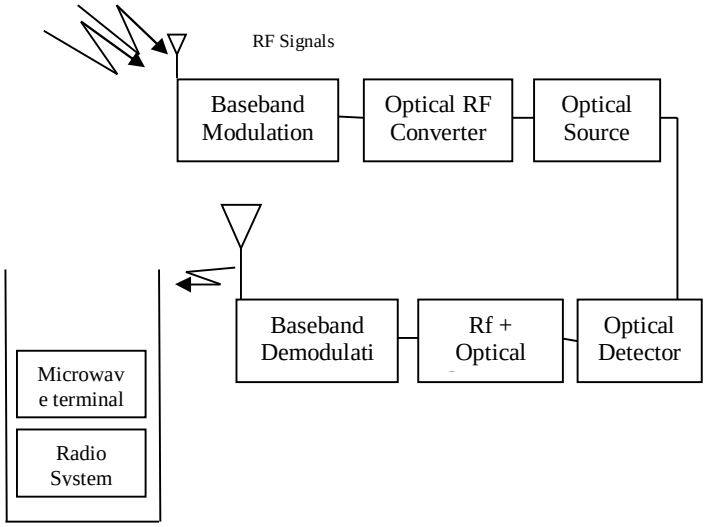

Figure 1: Basic diagram of Radio over Fiber Technology

II. QUALITY PARAMETERS

The quality parameters that are used in this work to evaluate the proficiency of proposed work are as below [12]:

A. Bit Error Rate

Bit Error Rate is a performance parameter that gets affected by introduction of noise in transmission channel, ISI, distortion, attenuation and fading etc[13]. The BER can be improved by electing strong signal strength, most suitable modulation technique for modulating the signals. The applied modulation technique should be robust enough [14]. After having a review to the various research works that had been done in past it is observed that the BER in case of multimode fiber is always high [15]. The increase in length of the fiber and pulse broadening can leads to the reduction in BER. After comparing the BER of analog and digital RoF [16], it5 is notified that the BER of Analog RoF is higher than the BER of Digital RoF which proves that digital RoF is better with less value of BER as compare to Analog RoF [17]. The value of BER also varies by using different modulation schemes. BER can be evaluated by using the following equation. Here E_b depicts error per bit [18].

$$BER = \frac{E_b}{N} \qquad (1)$$

B. Q Factor

The Q Factor is a performance parameter that did not follow any dimension. It shows the level of quality of output. Highest value of Q factor depicts the lowest BER. For example in case of networking the higher Q factor means that the energy loss by the network is lower. On order to evaluate the Q factor the following equation is used [19].

$$Q = \frac{2\pi f_o E}{P} \qquad (2)$$

III. BACKGROUND

Nowadays with the advancement of optical communication system there is a need of high data rate to send more data[20]. As the demand for high broadband capacity and wide coverage network is rising exponentially, Radio over fiber is becoming an important technology for the wireless transmission [21]. Subscriber's demands for high speed network at lower cost. This demand can be achieved by sending the large data at higher speed. For this there is need of large bandwidth with low BER and high Q factor. Different modulation schemes [22-35] have been proposed till now to evaluate individual technique in terms of performance and efficiency.

IV. PROPOSED WORK

The conventional systems designed for RoF technology i.e. to transmit radio signal over optic fiber cable comprises of various drawbacks such as limited number of users, less improvement in BE, unwanted frequencies in the signals and quality of the system.

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The need to overcome all of the drawbacks will be fulfilled by implementing the proposed work. The proposed method is enhanced form of traditional work along with the implementation of filtration technique to remove the unwanted frequencies from the signals. The proposed work is comprises of such methods that can be able to handle the large number of users to the system at a given time instance. Use of these filters can decrease the attenuation in the signal. Comparison has been performed between different filters to enhance the efficiency and performance of the proposed technique. The Motive behind the implementation of the present work is to improve the BER and Q-Factor of the communication system.

V. RESULTS AND DISCUSSION

This section organize the results that are obtained after applying CPFSK to fiber optic communication and results are analyzed by applying three various filters i.e. Low Pass Bessel Filter (LBF), Low Pass Gaussian Filter (LGF) and Low Pass Rectangular Filter (LRF). Along with this the CPFSK modulation scheme is used for modulation due its better performance over other modulation schemes.

The figure 2 below depicts the Simulink model for fiber optic communication system for L which is comprised of 8 users i.e. transmitters and Receiver, a Combiner and various analyzers and regenerators. This model is also comprised of Low Pass Bessel Filter for filtering the signals.

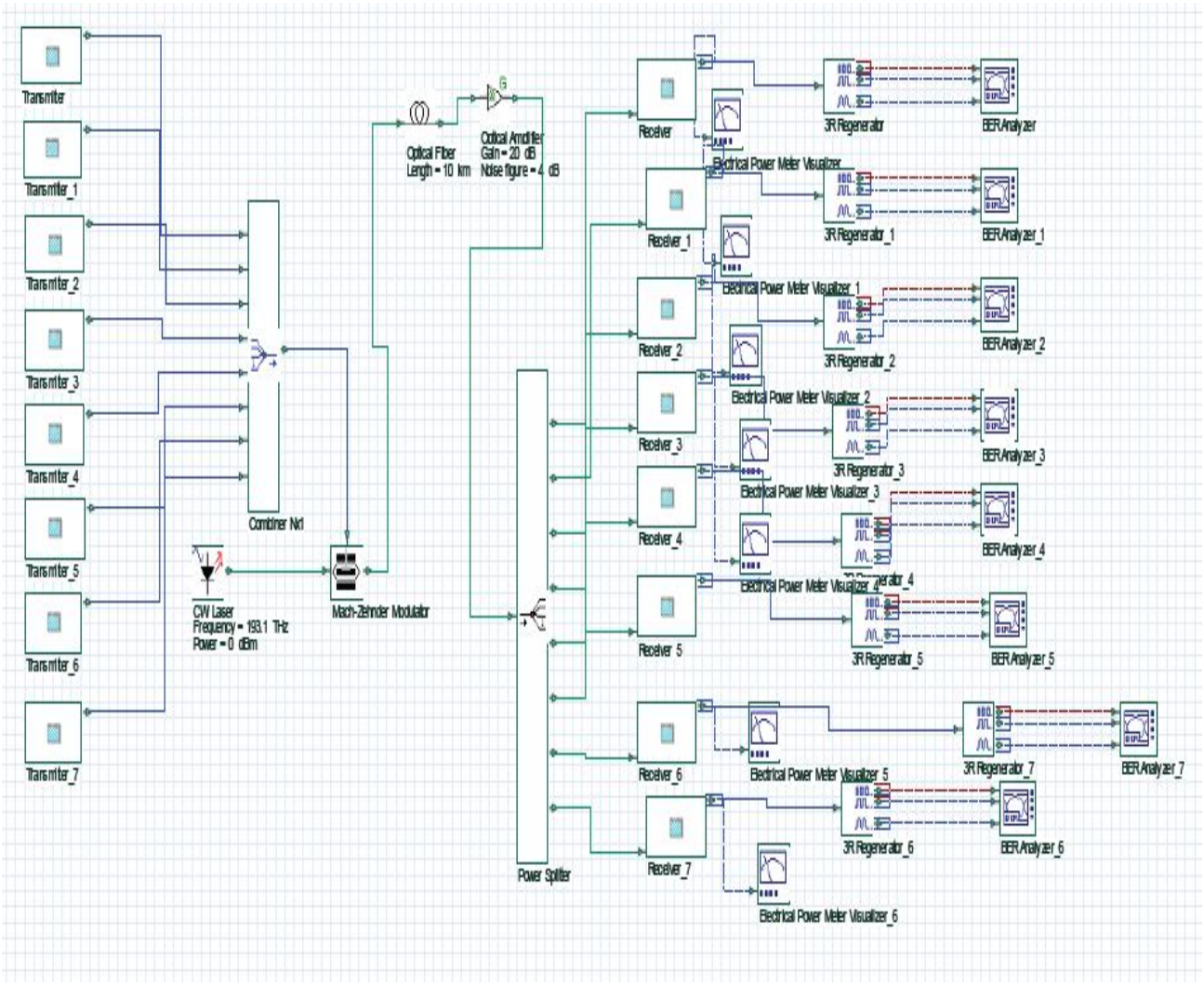

Figure2 Simulink model for LBF

The figure 3 represents the Simulink model for fiber optic communication system in which Low Pass Gaussian filter is applied along with CPFSK modulation.

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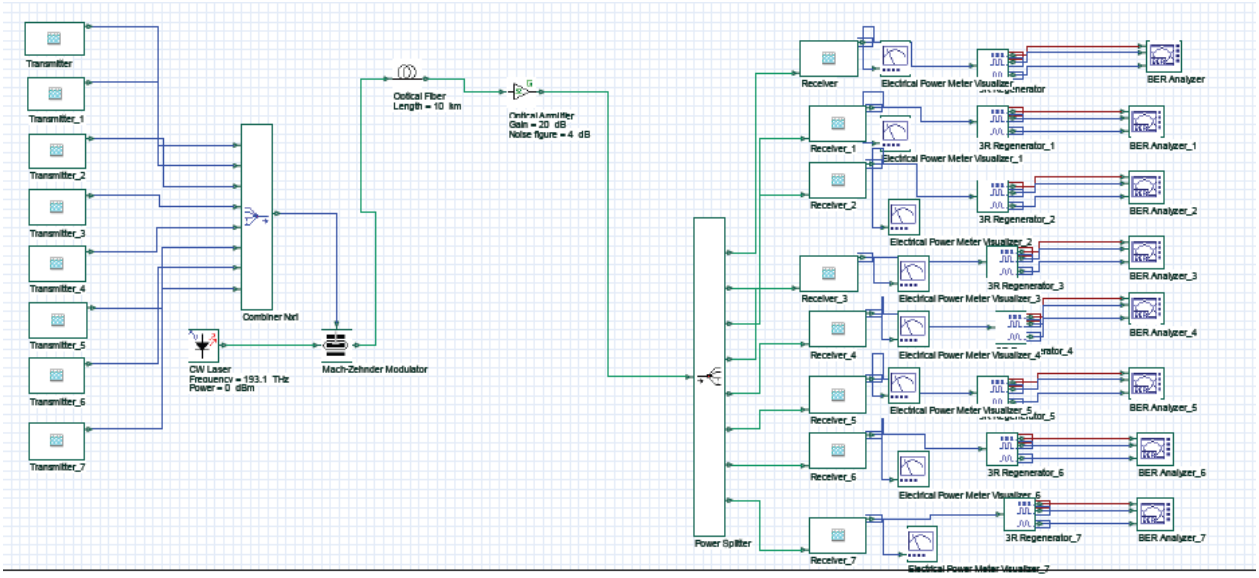

Figure3 Simulink model for LGF

The Simulink model for system including Low Pass Rectangular filter and CPFSK modulation is shown below in figure 4.

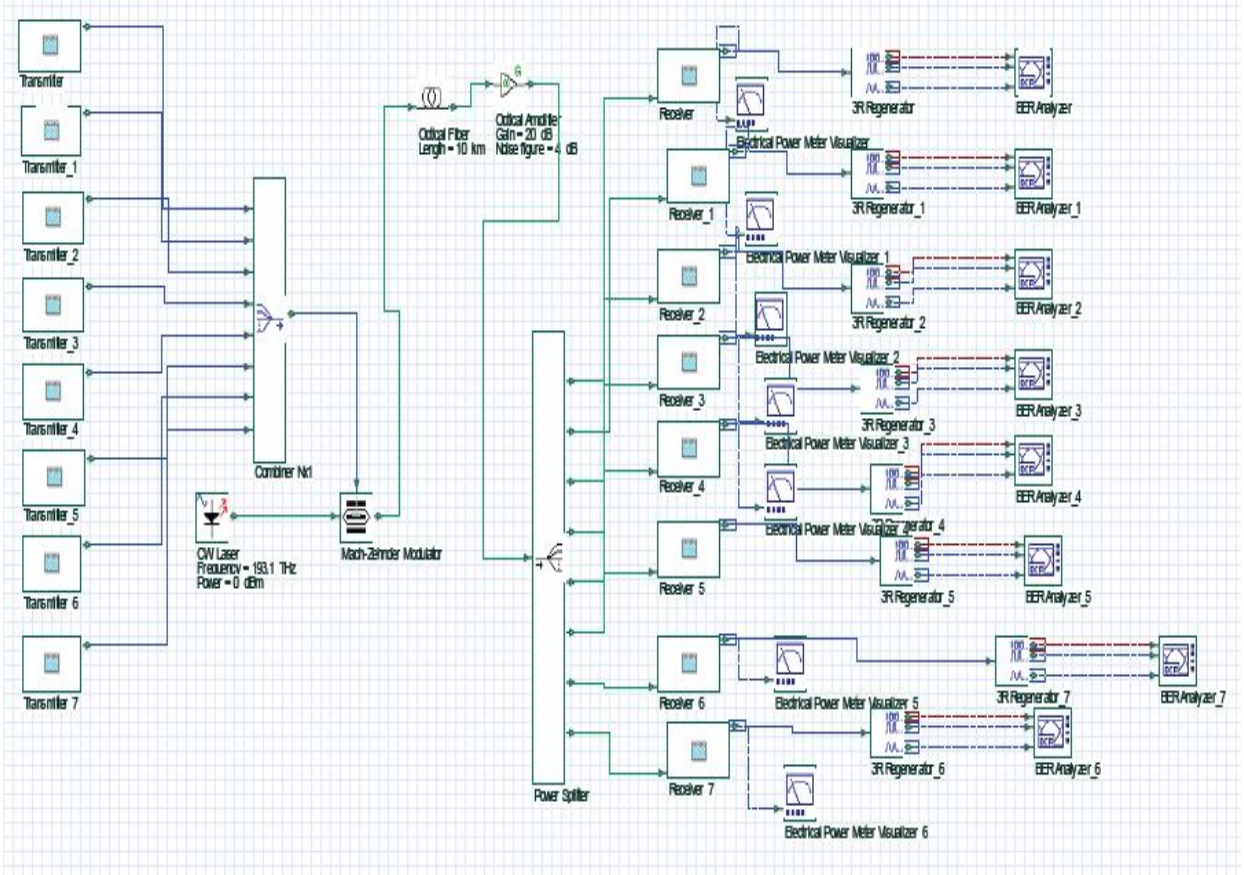

Figure4 Simulink model for LRF

The following table depicts the value of BER, Q Factor, Eye Height and Output power of low pass Bessel filters. The input power is 0 dBm.

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Table 1: Performance Parameters of system using LBF Filter with CPFSK

S.No.	Parameters	Value(dBm)
1.	Output Power	-19.443
2.	BER	$6.6978e^{-014}$
3.	Q.Factor	7.40174
4.	Eye Height	0.0008074

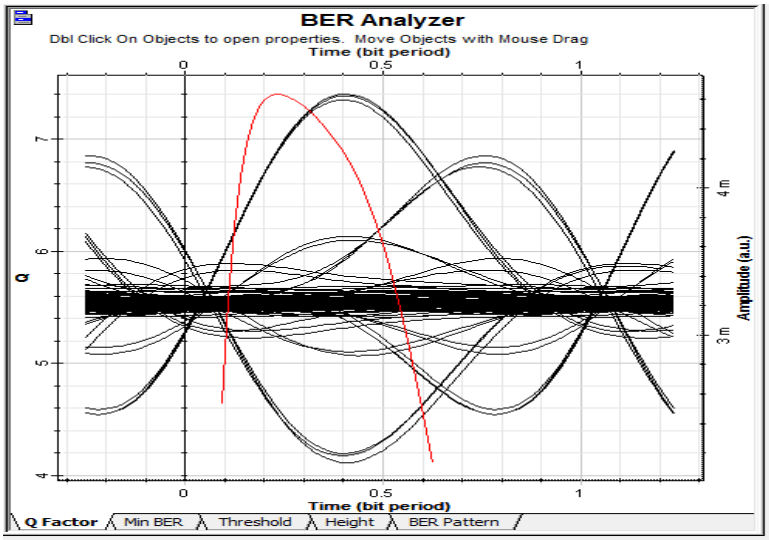

Figure 5 Eye Diagram of Q Factor in LBF filters

The Q Factor for Low Pass Bessel Filter is shown in figure5. It also depicts the value of Eye Height, Q Factor, BER and threshold. The table 2 depicts the value of performance parameters for optical system with LGF filters and CPFSK modulation scheme.

Table 2: Performance Parameters of system using LGF Filter with CPFSK

S.No.	Parameters	Value(dBm)
1.	Output Power	-19.443
2.	BER	$6.49279e^{-014}$
3.	Q.Factor	7.40606
4.	Eye Height	0.00083357

The eye diagram for above defined table is presented in figure 6.

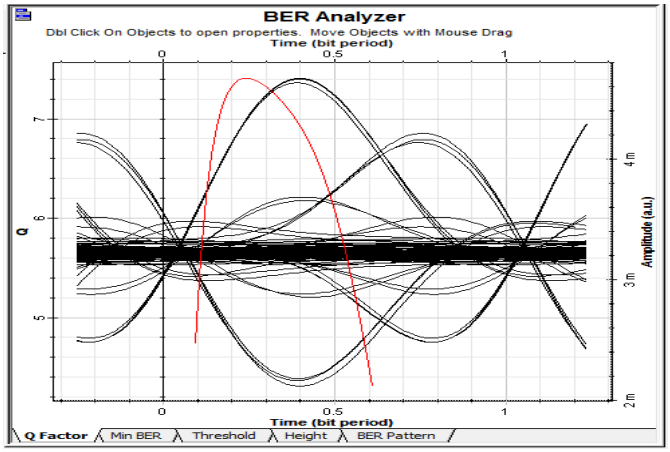

Figure 6 Eye Diagram of Q Factor in LGF filters

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The table given below represents the value corresponding to various performance parameters in case of LPF filters with CPFSK modulation. The input power in all of the cases is considered as 0 dBm.

Table 3: Performance Parameters of system using LPF Filter with CPFSK

S.No.	Parameters	Value(dBm)
1.	Output Power	-19.443
2.	BER	$6.6978e^{-005}$
3.	Q.Factor	7.40174
4.	Eye Height	0.0008074

The values defined in above table are derived from the eye diagram that is given in figure 7. The eye diagram is based on Q factor of communication system which applies LRF filters for filtration.

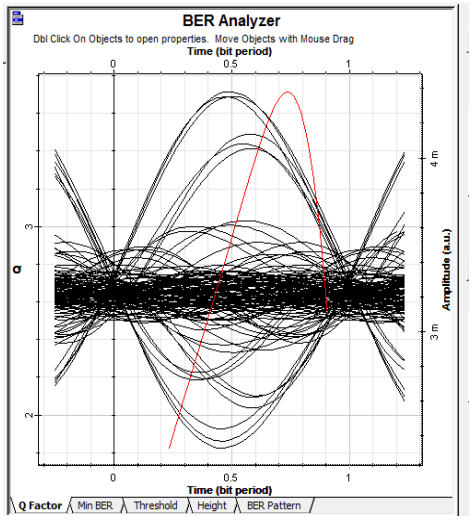

Figure 7 Eye Diagram of Q Factor in LRF filters

VI. CONCLUSION

Radio Over Fiber is combination of two technologies and facilitates the users to communicate via wireless network with a high bandwidth. RoF also uses various modulation schemes to modulate the signals. This study implements the CPFSK modulation to the signals as it is one of the prominent modulation scheme as compare to others. It is concluded in this study that when the CPFSK is applied with low pass Bessel filters then it produce s the better results in terms of BER, Q Factor and Output. Further enhancements can be done by applying advance filtration mechanisms to reduce the effects of noise from the signals and it will lead to an enhancement in signals quality.

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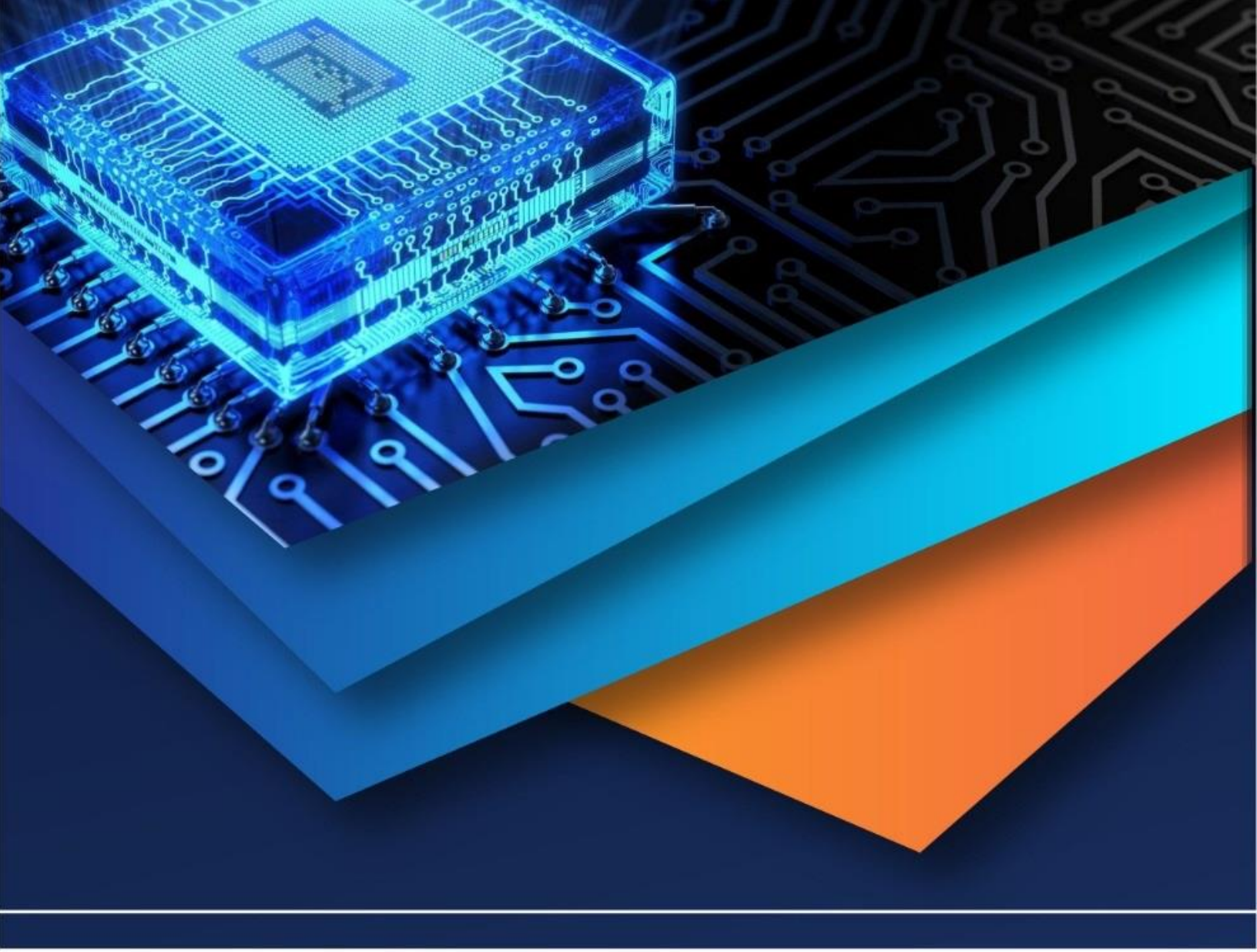

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