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An Integrated Fuzzy Controlled Three Level Single Stage PFC Ac-Dc Converter

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Abstract: ***Today the wide usage of non linear loads like variable speed drives has made power factor improvement difficult due to the presence of harmonic currents. These harmonics cause overheating, and the amplification of these harmonics cause failure or damage of capacitors and other system components. Thus this paper presents fuzzy controlled three level single stage PFC AC-DC converter. This converter is used for low power applications. It has high power factor with lesser switches working at constant duty cycle. The proposed converter has a fuzzy based controller, a modified switching scheme and a inductor and diode bridge with dc-dc converter. Fuzzy controller allows fast responses with low output current and lower voltage ripples. This proposed converter is stimulated in the MATLAB software and the design and performance is further studied and analyzed.***
Keywords: ***AC-DC converter, PFC, fuzzy controller, Matlab***

I. INTRODUCTION

With the continuous research and development in the field of semiconductor and power electronics, design and circuit improvements have been made for superior performance, be it by the use of PWM, VSD etc. Inverters and converters have also gained researchers popular interests. A 3 phase voltage source inverter gives out variable voltage and frequency to AC drives. Series and parallel connections are important to get certain current and voltage ratings. Nowadays, multilevel inverters are used because of its better harmonic spectrum and voltage ratings. With increasing use of electrical equipments, power converter manufacturers have implemented a form of PFC- power factor correction according to the harmonic standards of IEC 1000-3-2. The power converters have high power factor and low input current harmonics as its performance criteria.

The power factor correction is broadly of 2 types- Active power factor correction technique and Passive power factor correction technique. In this paper, a fuzzy controlled three-level single stage PFC converter is proposed. The switches used in the converter are the minimum with an integrated boost PFC converter and 3 level dc-dc converter and no additional components. The switching scheme is modified to achieve high power factor and output voltage regulation through fuzzy controller.

II. CONVERTER TOPOLOGY

The figure below shows the three level single stage power factor correction AC-DC converter which has fuzzy controller for output voltage regulation and fast response

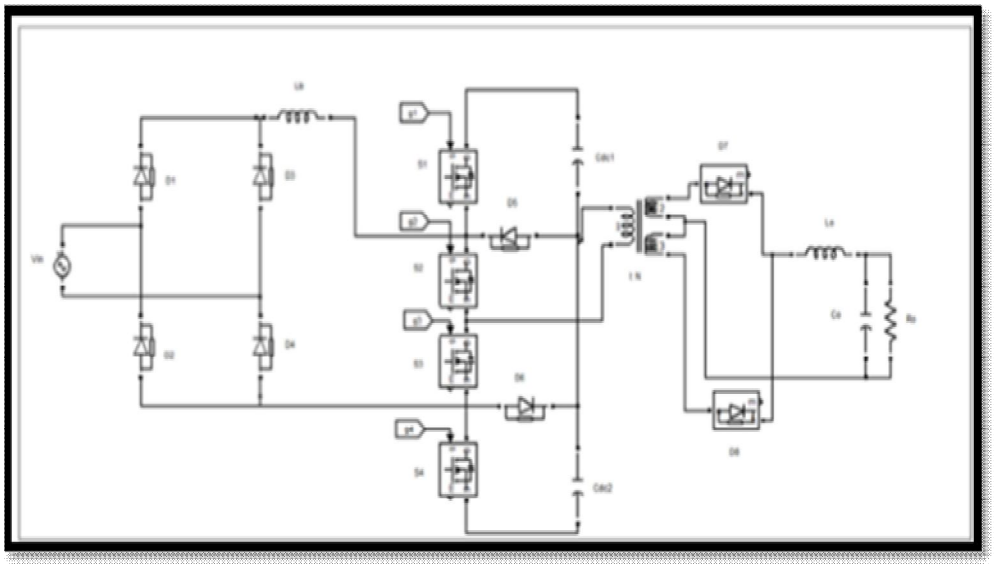

Fig 1- Fuzzy controlled 3 level single stage PFC converter

Fig. 3.1 shows the topology of proposed converter. S1, S2, S3 and S4 are the four switches. D1, D2, D3 and D4 are the rectifying diodes. There are six modes of operation for the converter. Mode 1 has S1, S2 on, Mode 2 has S2, S3 on, Mode 3 has S3,S4 on, Mode5 has S2 on and Mode 6 has S1, S2 on.

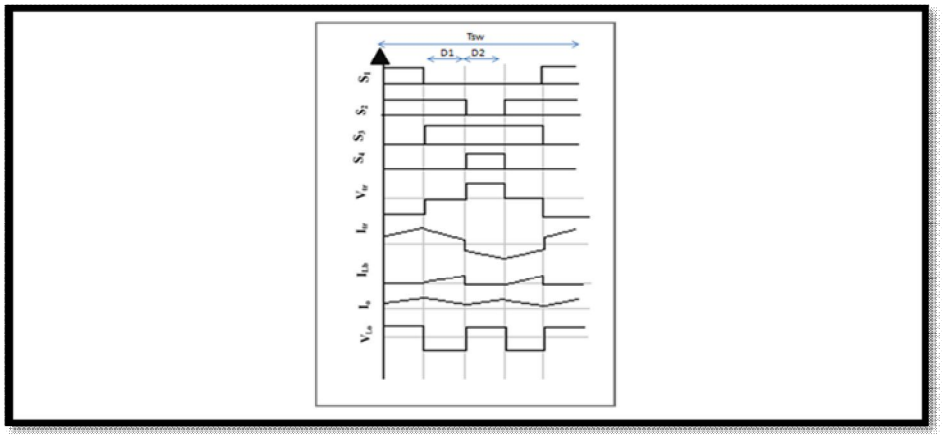

Fig 2 – Switching sequence S1-S4, primary side transformer voltage and current, input inductor current, output inductor current and voltage.

III. FUZZY LOGIC CONTROLLER

A fuzzy logic controller is used due to its better performance and faster response as compared to the controllers. Here Mamdani style fuzzy interface system is used. Fuzzy controller can be designed easily and figures below show the structure and response of fuzzy controller

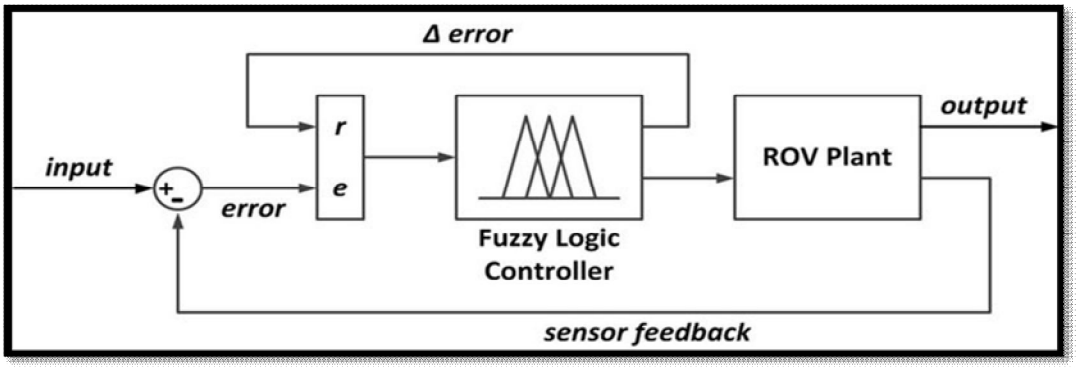

Fig 3- Fuzzy logic system

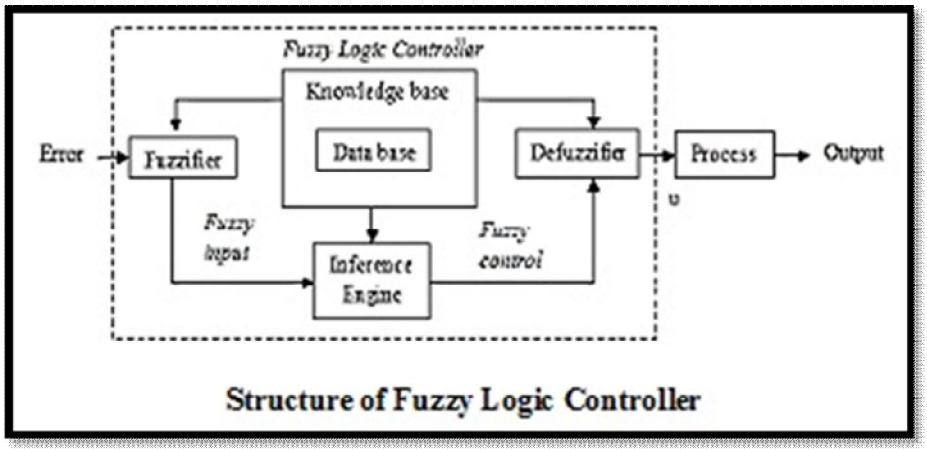

Fig 4- Structure of fuzzy logic controller

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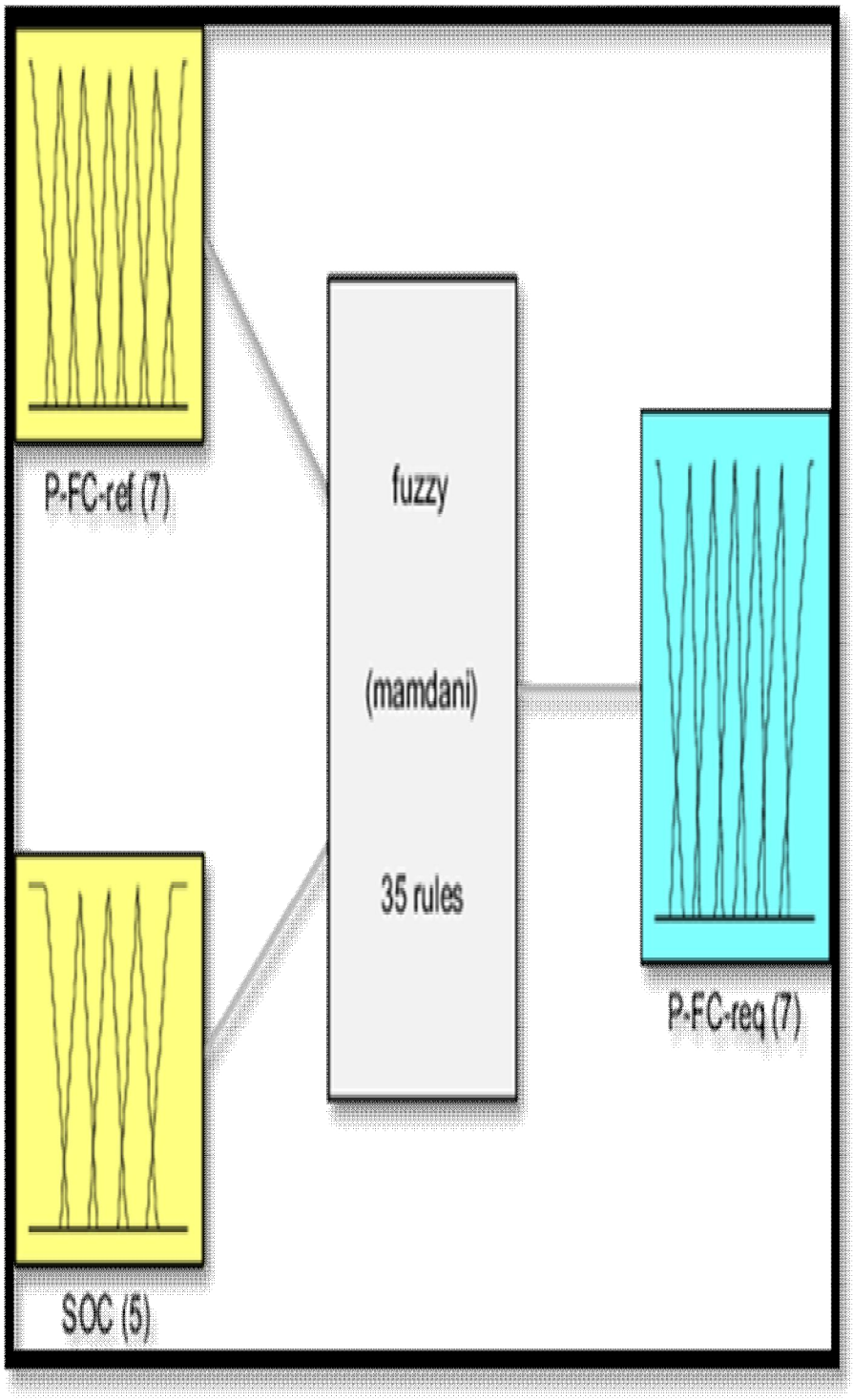


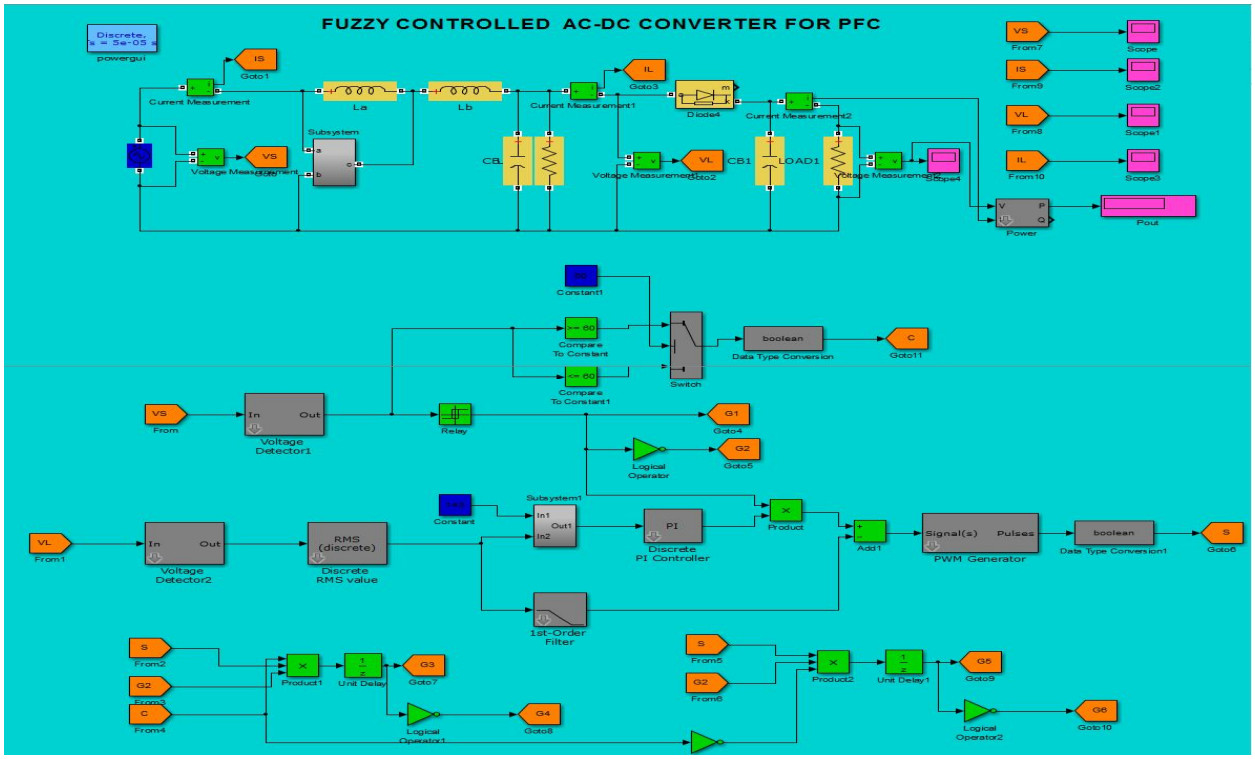
Fig 5- Waveform of fuzzy

IV. MATLAB RESULTS

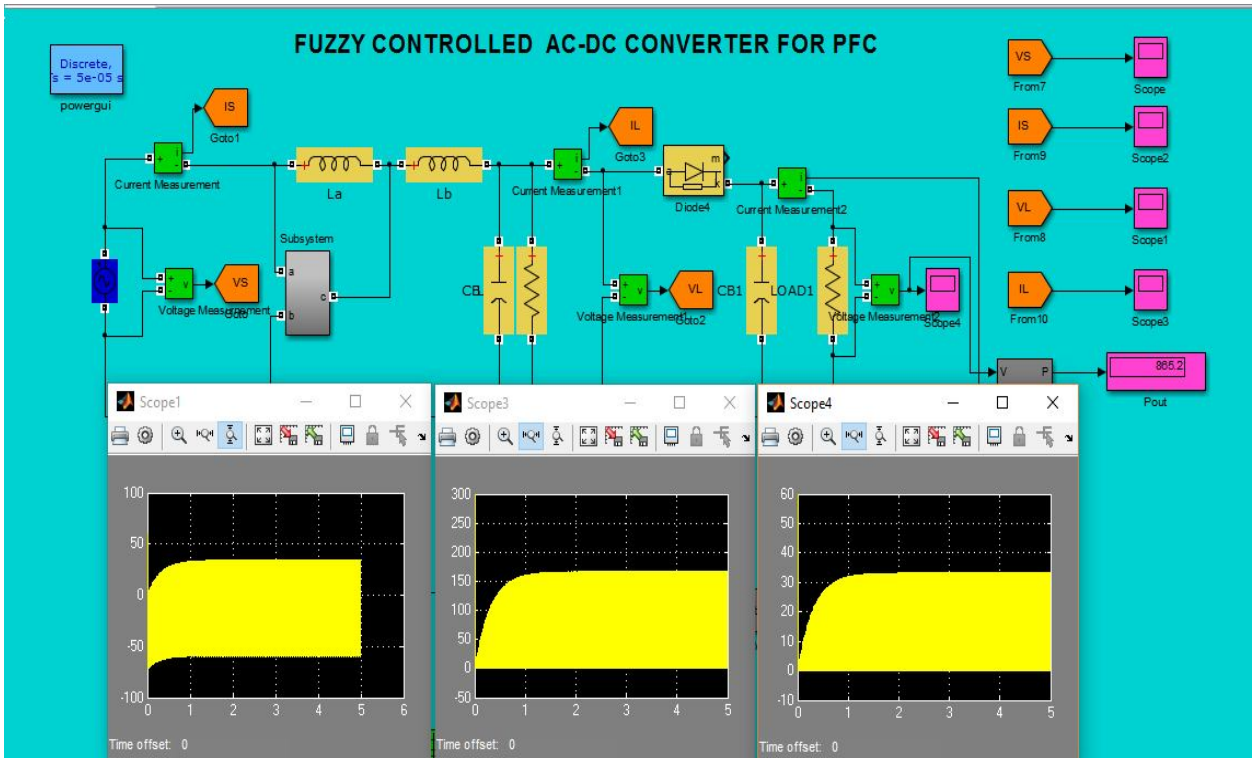
The three-phase AC-DC converter with flying capacitor was verified with MATLAB; a commercially available software package for power electronic simulations. The circuit is drawn using MATLAB software components. Digital values of voltage and current

are displayed by using the display block present in the Simulink. Finally, set the run time value and run the simulation. Simulation results can be viewed by using the scope in the Simulink library.

1) Simulation circuit of proposed converter in matlab



2) Stimulation results scope outputs



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V. CONCLUSION

Here in this paper we have proposed three level single stage PFC AC-DC converter using fuzzy controller. Matlab software is used to experimentally verify the performance of this converter and to obtain the results. The results and graphs obtain show that the new converter has lower current harmonics and ripples and has faster response of converter. The design aspects can still be improved as the future scope of this project to have more efficient output performance.

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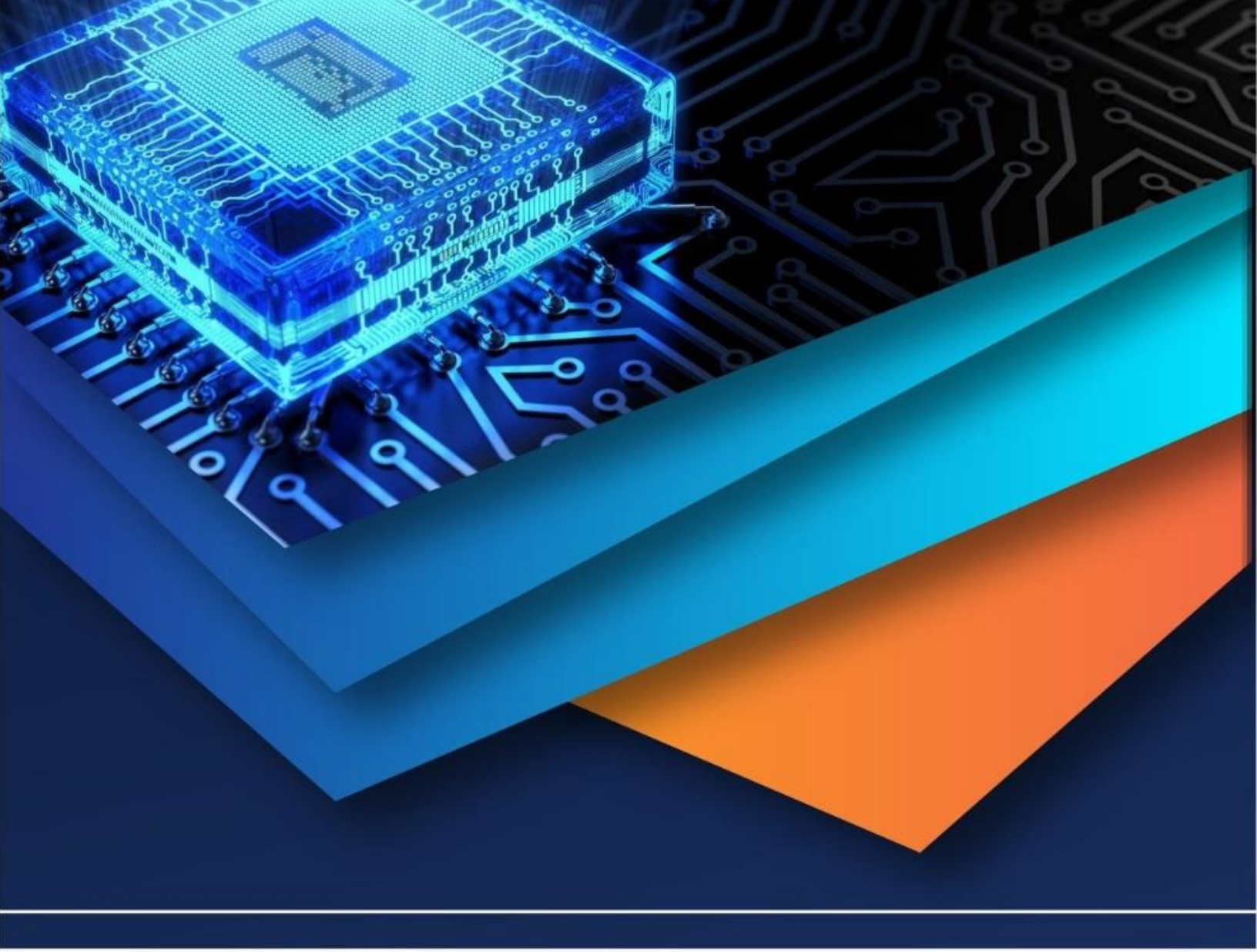

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