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A PVA Integrated DC-DC Converter with Feedback Loop Control

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Abstract: This paper gives the detail information about "A PVA integrated DC-DC converter with feedback loop control". The output voltage from the PV Array is controlled in this by using feedback loop system. The MATLAB simulations results show that the output voltage is stable.
Index terms: PV Array, feedback loop, MOSFETS, high frequency transformer, converters.

I. INTRODUCTION

A photovoltaic array is a combination of several individual photovoltaic cells. Sometimes PV modules are also called as solar panels. To form PV Array number of solar panels are connected electrically. As surface area of array increases the electrical power output increases.

A. How PV cell works?

The most commonly used energy is solar energy. The PV is used to convert light energy into electrical energy. The single solar cell has a capacity to generate 0.5 volts. Several Solar Cells are connected in series to produce large voltage. It works on the principle of photo voltaic effect.

Solar cells are made up of Semiconductors(Silicon).It consist of three layers
P type
N type
P-n junction(depletion layer)

Whenever Sunlight Strikes on PV then photons from sunlight will fall on depletion layer. The photon releases an electron. The holes moves towards n type and electrons move towards p type. The released electrons move to the outer circuit which helps in producing the electricity.

B. Closed Loop System

In the closed loop system, the output is measured is continuously and is feed back to the input system. The Error Detection Unit is used to detect the error with respect to the output. The error is fed to the Controller. The controller controls the amount of input according to the desired output response and the controlled input goes to the process section and we get desired output. The presence of feedback compensates for the disturbance and improves the accuracy of the system.

C. PWM Generator

It consists of comparator which compares saw tooth waveforms and modulating signal. If modulating signal magnitude is greater than saw tooth waveform magnitude then PWM output is positive value. If the modulating signal magnitude is less than the saw tooth waveform output is negative.

D. PID controller

PID controller is a proportional integral derivative controller. It is used to maintain constant output value like temperature, voltage, speed, flow, pressure.

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II. BLOCK DIAGRAM

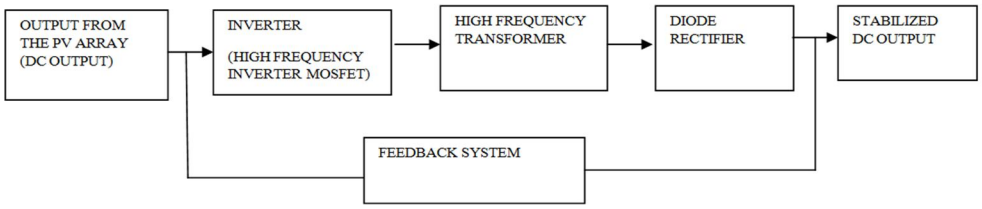

Fig1: Typical block diagram

In the above block diagram the output from the PV Array is given to the inverter. The DC is converted to the AC by the high frequency inverter. The generated AC is transferred to the secondary side by using high frequency transformer. Then the AC is converted back to DC by using diode rectifier. The obtained DC is compared with the Vref and then error will be generated depending upon the error the feedback system will come into action and it will give the specified DC output voltage.

III. A PVA INTEGRATED DC-DC CONVERTER WITH FEEDBACK CONTROL

A. Simulation link model

1) Circuit Diagram

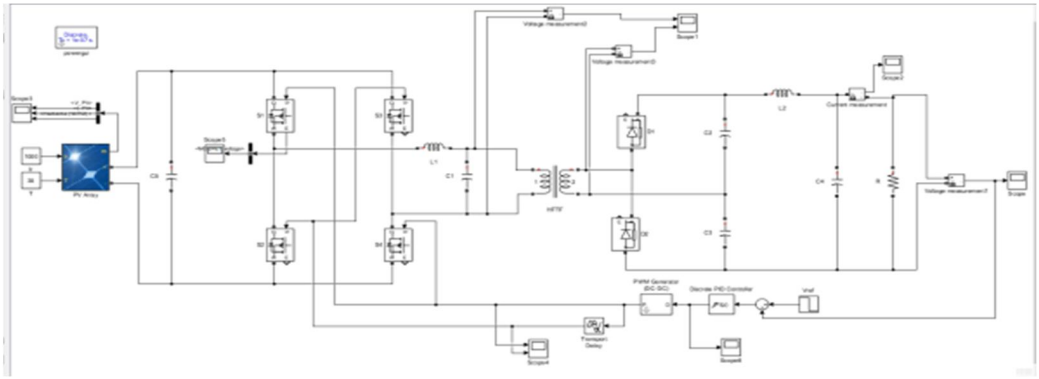

Fig 2: circuit diagram of A PVA integrated DC-DC converter with feedback control

2) Working: In this we have used PV Array which consists of one series connected module per string and 10 parallel strings with a voltage of Vmp=54.7V and each panel wattage is 350W. The output voltage from the panel which may contain ripples can be reduced by the capacitor C5,so that we can get clean DC voltage. First the circuit get started with 0.5 duty ratio that is 50% from which voltage is generated. After that the switching timing of the MOSFET is decided by the PID Controller (with the help of duty ratio) which is used to control the MOSFET switching. The output of the PID Controller is given to the PWM Generator. The PWM Generator generate the pulses to the MOSFET's that is S1,S2,S3,S4 with the specified duty ratio. The output of PWM Generator is given to the transport delay which helps the switches to operate in the first and second half cycle with delay. The pulses are fed to the MOSFETs after that in the first half cycle S1, S4 will operate (TURN ON) then the flow of DC will be through supply-S1-L1-Primary winding-S4-Back to the supply. In the second half cycle S3,S2 will operate(TURN ON) and S1,S4 will turn off then the flow of DC will be through Supply-S3-Primary winding-L1-S2-Back to the supply. Now positive and negative voltage waveforms are generated on the primary side of the transformer with the help of high frequency inverter. High frequency AC voltage is transferred to the secondary side with the help of high frequency transformer. We are using diode rectifier to convert positive waveform on secondary side then we will obtain DC voltage. We are using capacitors C1 and C2 to reduce the voltage peak overshoot generated by the transformer. Capacitor C4 is used to reduce the ripples in the voltage across the load (Resistor). Now the reference voltage is compared with the measured output voltage of the converter and after comparing error will be generated. The error is fed to the discrete PID Controller, then the PID Controller will generate the duty ratio from which we can decide the operation of the MOSFET switches. Now the cycle gets repeated in the same manner and we will get the specified voltage as mentioned in the Vref.

B. Design Parameters

DESIGN PARAMETERS	RATING
PVA	10 parallel strings,1 series connected modules for string
MOSFET	IRF840
L1	25mH
L2	50mH
C1	200pF
C2	100pF
C3	100pF
C4	20mF
C5	10mF
Ton	50%
Toff	50%
T	100%
Switching Frequency	50KHz
Transformer Ratio	1:4
Diode	IN4007
Output Voltage	250-100V
Output Current	2.5-1A
Output Power	625-100W

Table 1: The above values are the specifications of the circuit model

IV. SIMULATION RESULTS OF A PVA INTEGRATED DC-DC CONVERTER WITH FEEDBACK LOOP CONTROL

The simulation is done using MATLAB simulation and the output voltage waveforms are presented. The output waveforms are displayed by using the scope.

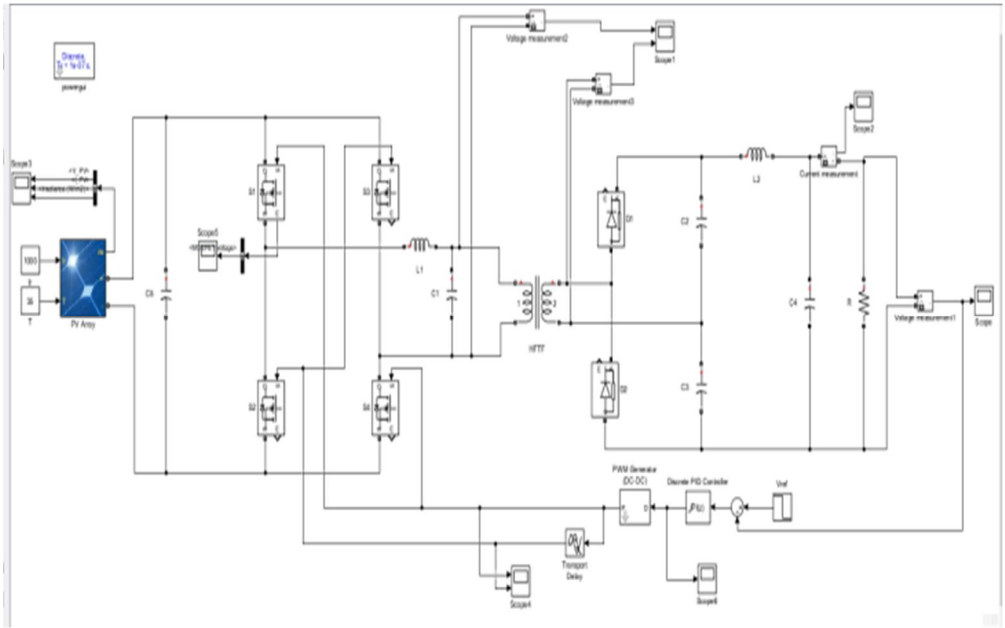

Fig3: circuit diagram of A PVA integrated DC-DC converter with feedback loop control.

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A. Pulses

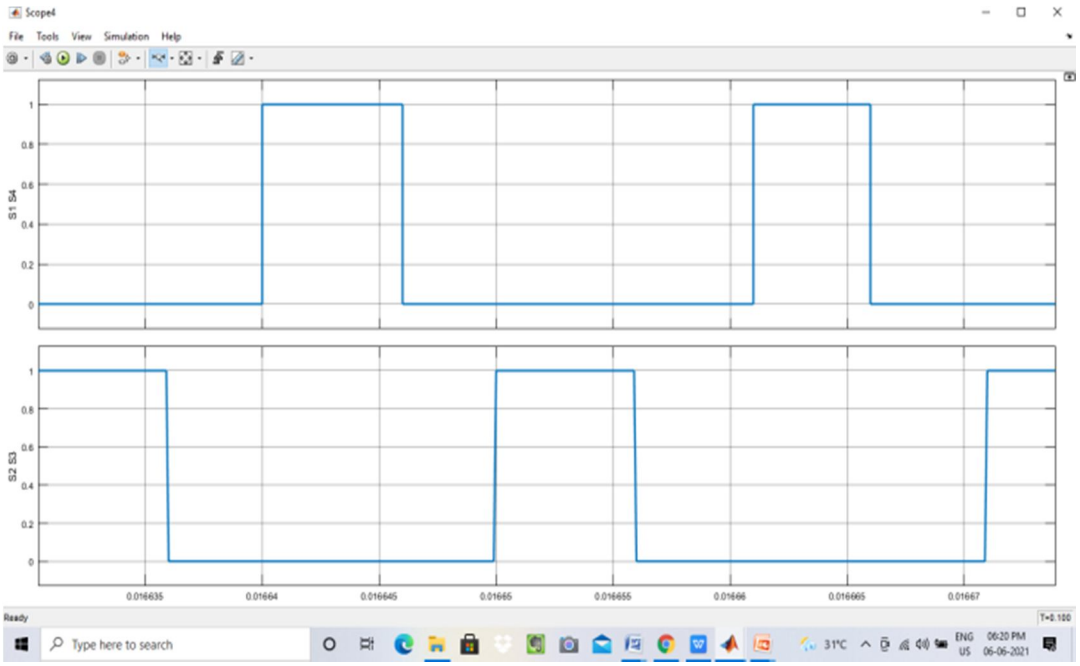

Fig4: Driving pulses for MOSFET(X axis-time (sec), Y axis-Amplitude

B. Primary and Secondary Voltages of Transformer

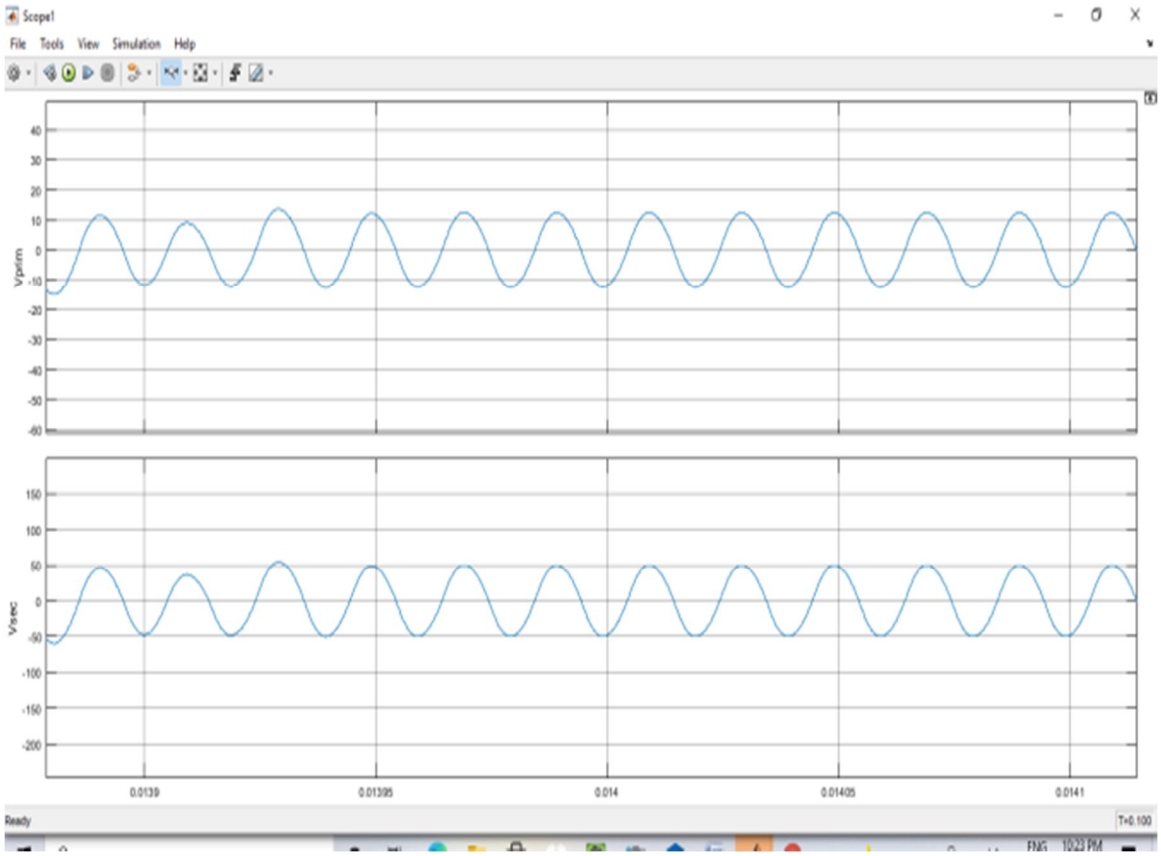

Fig5: Transformer primary and secondary voltages waveforms.
(X axis-Time (sec), Y axis-Amplitude)

C. Output Current

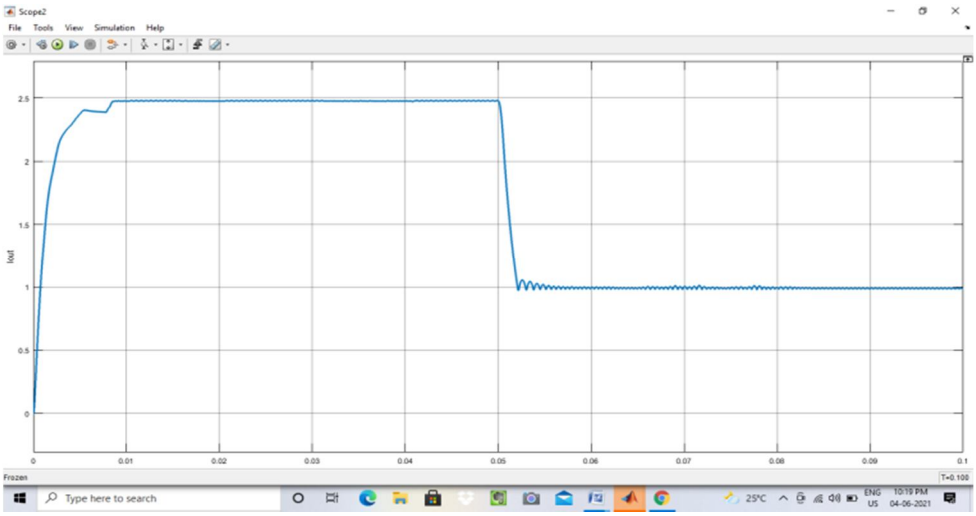

Fig6: Output current
(X axis-Time (sec), Y axis-Current (Amps))

D. Output Voltage

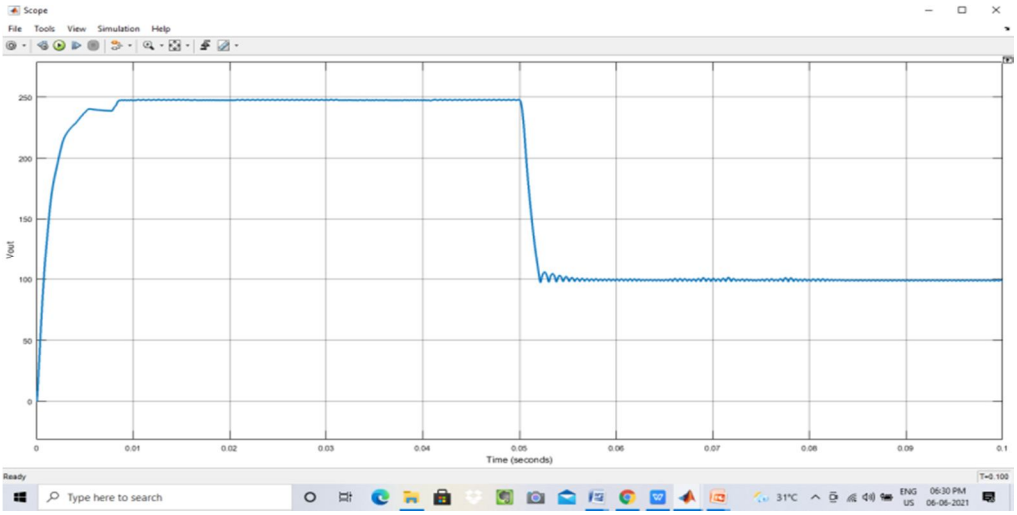

Fig7: Output voltage
(X axis-Time (sec), Y axis-Amplitude)

V. ADVANTAGES, DISADVANTAGES, APPLICATIONS

A. Advantages

We can generate required voltage.
By giving Vref and according to that duty cycle will automatically adjusted as a result we will get the required voltage.
Stabilized output voltage is obtained.
With this we can protect the load from being damaged.

B. Disadvantages

Output voltage will oscillate slightly.

C. Applications

It is used in real time applications like Stabilizers, Adaptor and Charges etc.

VI. CONCLUSION

This paper provides a complete analysis of A Photovoltaic Array DC-DC Converter with feedback loop control. It can be used widely for electrolyser applications as it has desirable features with feedback loop control. As it is a closed loop system output voltage contains some ripples. Based on delay value given by transport delay output will change from given initial value to final value. We can get the required output voltage value from variable input (from PVA).Voltage peak overshot at output of rectifier is reduced by using capacitors.

VII. FUTURE SCOPE

Almost the fossil fuels are exhausting very rapidly due to usage for the production of electrical energy, so we need to find alternate method for producing electrical energy in many industrial and commercial applications Photovoltaic system is used for producing the electrical energy. So it has more scope to develop in future very rapidly by including PVA integrated DC-DC converter with feedback loop control technique. We can get the stabilized and required value of output voltage. With this the load system becomes more reliable and more efficient for usage of many electrical appliances.

VIII. ACKNOWLEDGEMENT

With an understanding that work like this can never be the outcome of a single person, we take this opportunity to express our profound sense of gratitude of to all those who helped us through duration of this work. We would like to express deep felts of appreciation and external gratitude to Dr.P.Sharathkumar, Associate professor, EEE department, our guide for his skill guidance, constant supervisions, timely suggestions, keen interest and encouragement in completing this project with in the stipulated time.

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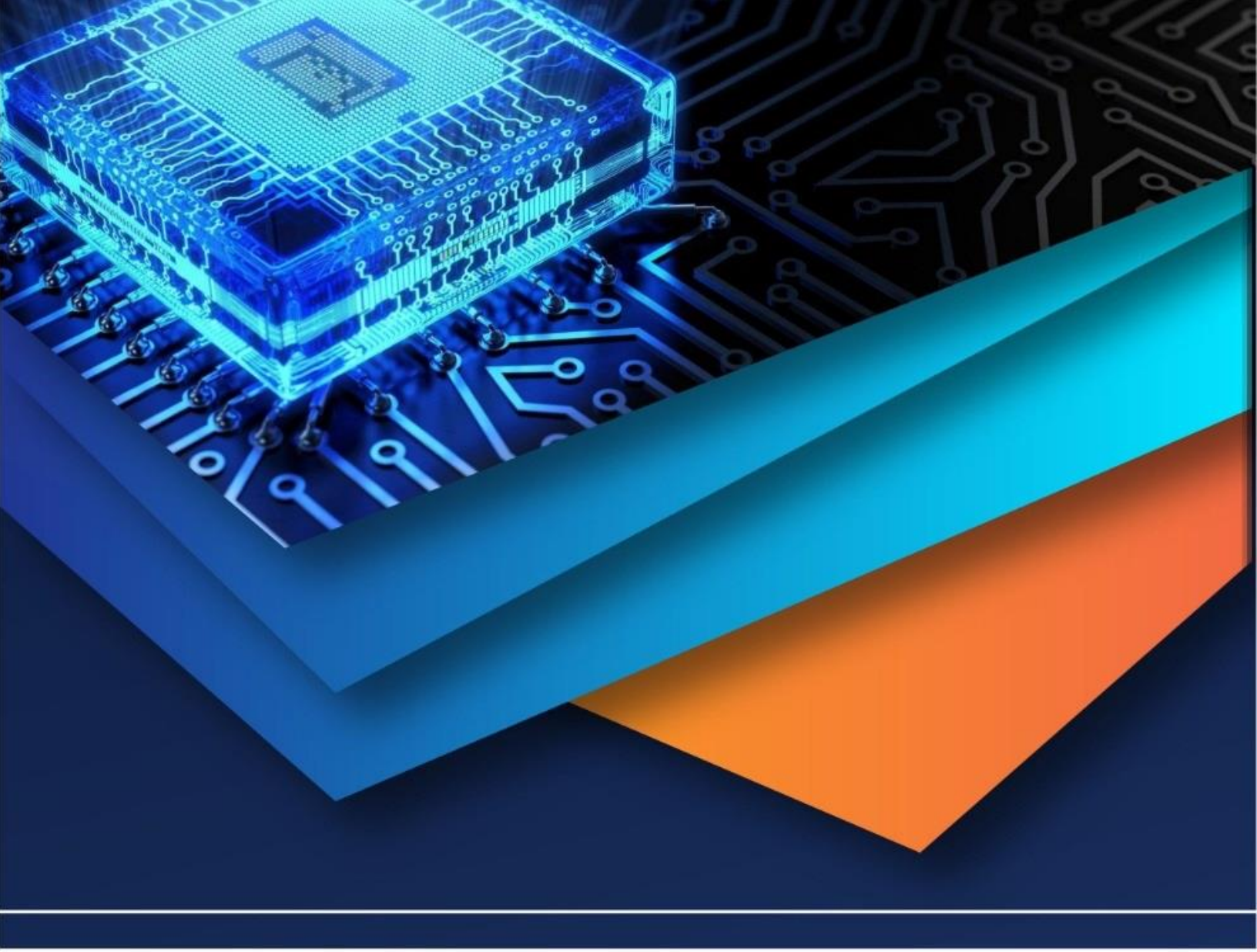

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