iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VIII **Month of publication:** August 2022

DOI: https://doi.org/10.22214/ijraset.2022.46467

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VIII August 2022- Available at www.ijraset.com

Three Phase Grid Connected Inverter for Solar Photovoltaic Systems

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Abstract: ***The main aim is to convert the Solar PV DC voltage into AC voltage by using 3 phase inverter and getting sinusoidal AC output voltage. To convert solar PV which is in DC needs to be converted into AC by using the devices like 3 phase inverter and boost converter. The solar PV is a variable DC that is to be converted into pure DC for which will convert variable DC to pure DC. The MPPT is designed and is applied to boost converter which increases the solar PV's efficiency. Then the output of boost converter which is DC voltage is given to 3 phase inverter. The 3 phase inverter which is connected to output of boost converter will convert the DC voltage into AC and we get sinusoidal AC. A three-phase grid-connected inverter designed for a photovoltaic power plant that features a maximum power point tracking (MPPT) scheme based on fuzzy logic. The whole system simulate in MATLAB. This fuzzy MPPT will shows accurate and fast response, and is integrated in the inverter.***
Keywords: Solar PV system; boost converter; MPPT technique; 3-phase inverter.

I. INTRODUCTION

A photovoltaic system is designed in a power system to feed solar power. It involves a number of components that having solar panels to take up and adapt sunlight into electricity, the electric current from dc to ac is changed by a solar inverter also its mounting, other electrical accessories and cabling that will also happen in a working system. For modifying the systems total performance here uses a solar tracking system and having an integrated battery solution, as their capital for storage devices are expected to decrease. In addition, PV systems convert light energy directly into electricity and should not be interrupt with other technologies, such as solar power of concentrated used for cooling and steaming. The MPPT is designed and is applied to boost converter which increases the solar PV's efficiency. Then the output of boost converter which is dc voltage is given to 3 phase inverter. The 3 phase inverter which is connected to output of boost converter will convert the dc voltage into ac and we get sinusoidal ac.

II. METHODOLOGY

A. Boost Converter

A boost converter (step-up converter) is a DC-to-DC converter that steps up voltage while stepping down current from its input supply to its output load. It is a class of switched mode power supply (SMPS) containing at least two semiconductors a diode and a transistor and at least one energy storage Element a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors sometimes in combination with inductors are normally added to such a converters output and input.

Fig. 1 Boost Converter

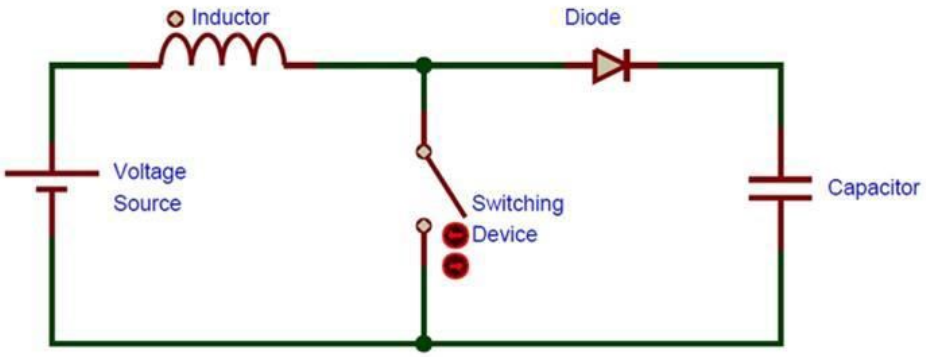

Fig.2 Circuit Diagram of Boost Converter

B. 3-Phase Inverter

It is a static power electronic circuit. Which converts DC to variable AC. i.e., Variation in magnitude of voltage, frequency and no. of phases. This is a 120 degree phase shift. Conduction of each SCR's is 120 degree. The phase angle between two sequential thyristors either from top group or from bottom group is 120 degree. At any time one of the phases is neither connected to positive plate that particular phase voltage in that interval is uncertain if the load is unbalanced.

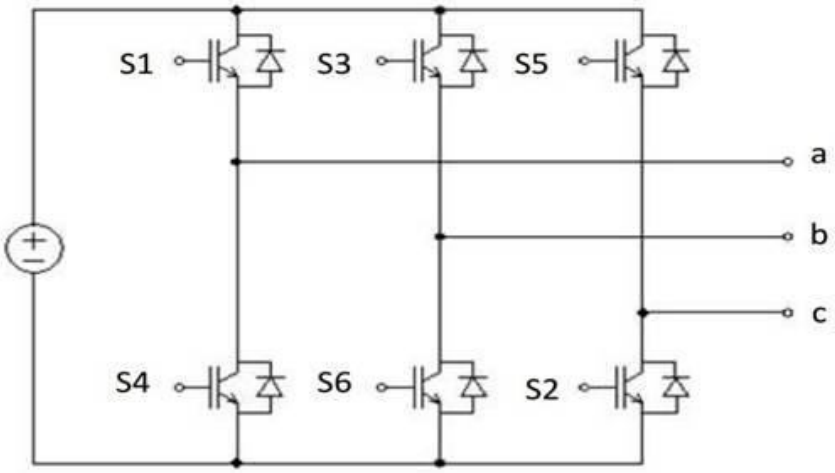

Fig. 3 Three Phase Inverter

C. MPPT (Maximum Power Point Tracking)

MPPT is a technique which is used to enhance the power and increase the efficiency of system which is applying on a boost converter. Here we use perturb and observer method (P & O method). In this method less amount of sensor may be used.

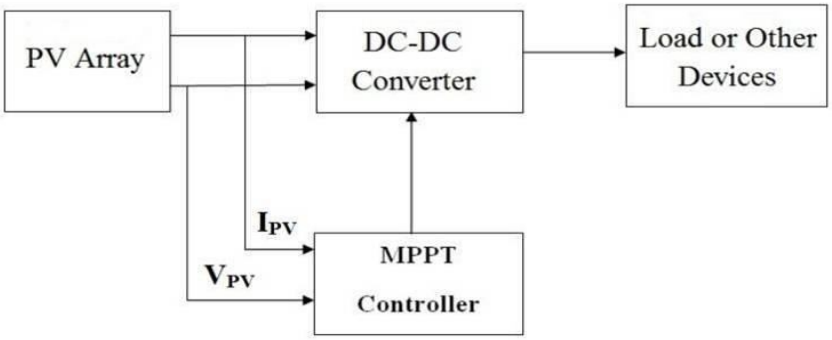

Fig. 4 General block diagram of MPPT technique

D. Solar Photovoltaic

A Photovoltaic cell getting the incident photon or light energy which is coming from sunlight and due to this, it creates the electrons holes and the PN junction which separates this charge carriers. Due to the photovoltaic effect, forward bias voltage is being creates.

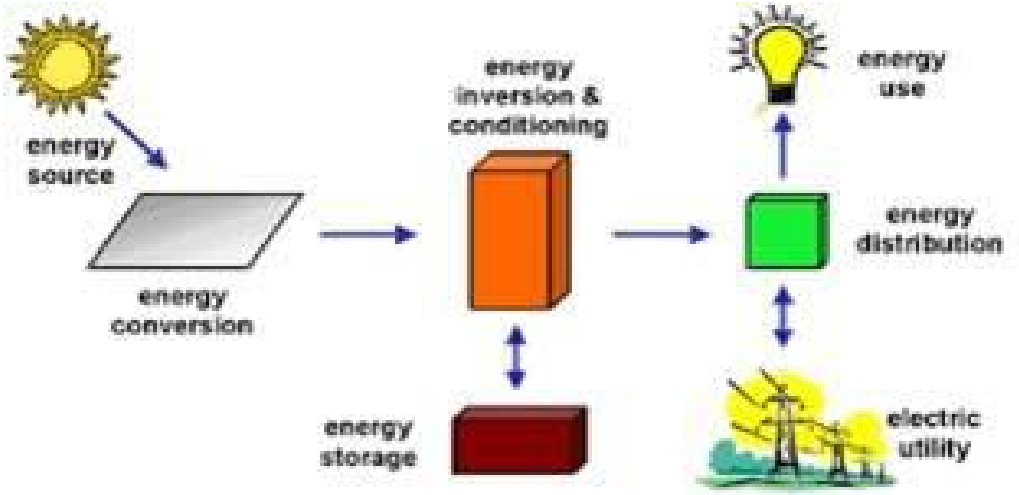

Fig. 5 Photovoltaic schematic System

Fig.6 Grid Connected Roof-Top(GCRT) Solar PV system

III. BLOCK DIAGRAM

The block diagram involves solar PV having variable DC voltage which is to be boosted by boost converter i.e., step up chopper and then after it is to be converted into AC by 3 phase two level inverter and getting appropriate AC output. For removing the unwanted harmonics it is necessary to connect a filter to a 3 phase inverter. Due to this the variable AC which is coming from the output of inverter is getting pure. Generally, we use low pass filter for removing the unwanted harmonic by connecting the filter to inverter. After getting the AC sinusoidal waveform we transform that power by connecting transformer and feeding to 3 phase load.

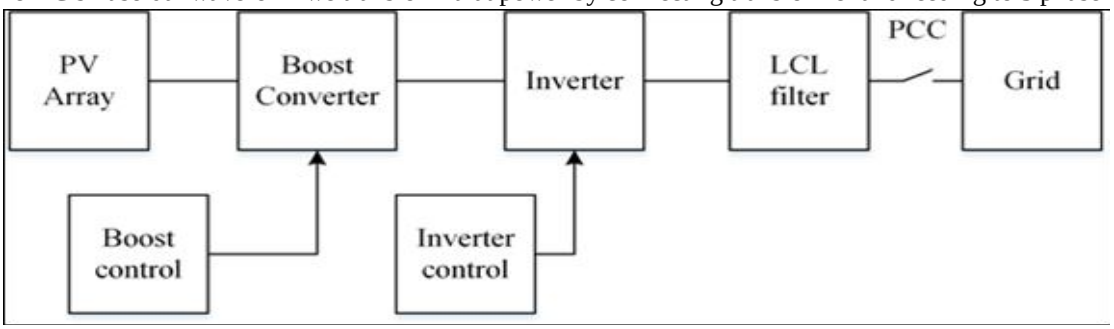

Fig. 7 Block diagram of a grid-connected PV system

IV. DEMONSTRATION

A. Boost Converter

When separately Simulink the BC taking the assuming input voltage as 280V DC and get it to boost up to 1000V DC. The IGBT is used in a Boost converter. Diode, inductor, resistor, are necessary to connect to form a Chopper. After regulate or adjusting the duty ratio we make it as Boost converter. The RMS value is also being calculated, scope are giving wherever necessary to observing the appropriate output of the step up chopper.

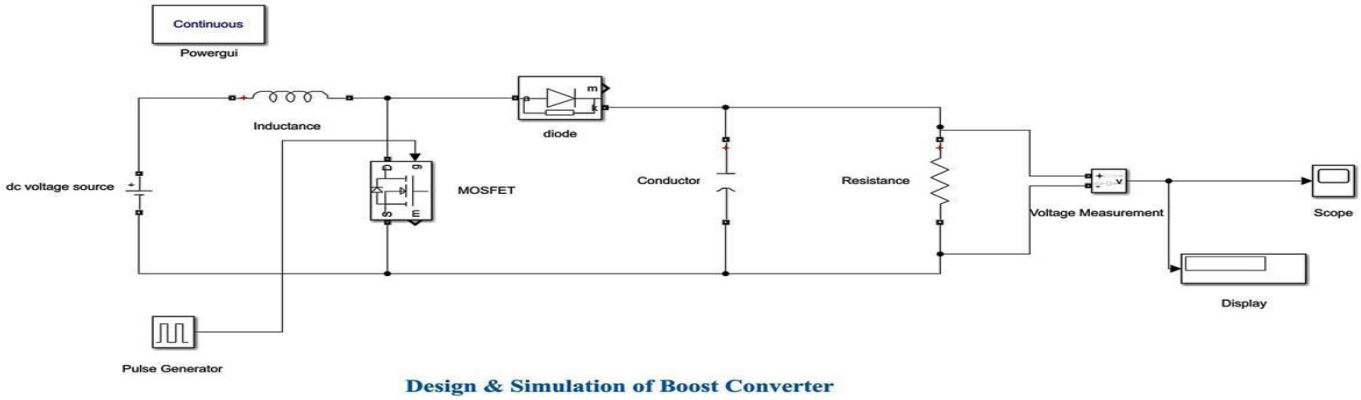

Fig. 8 Simulation & Designing of Boost Converter

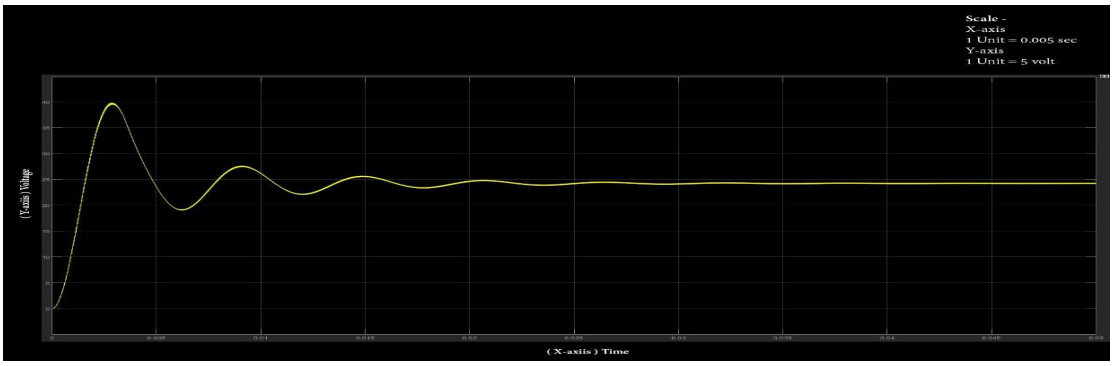

Fig. 9 Result of Simulation & Designing of Boost Converter

B. 3-Phase Inverter

Take a DC Voltage Source is 500V, Integrated Gate Bipolar Transistor (IGBT) is applied & take Internal resistance is 1mΩ, Snubber Resistance is 0.1MΩ, Snubber Capacitance is Infinity, Gate Pulses is gives to all IGBT, Voltage Measurement blocks is used to measure the Voltage of Phases.

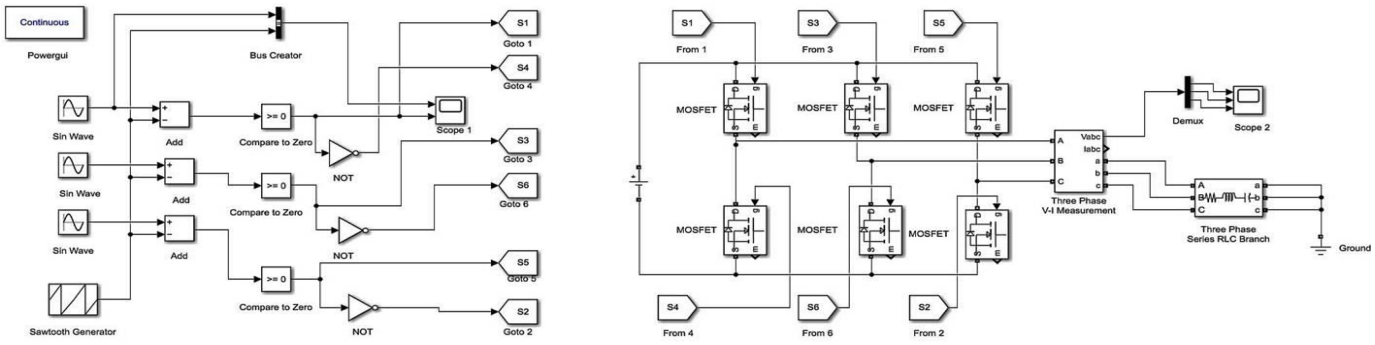

Fig.10 Design and Simulation of Three Phase Inverter

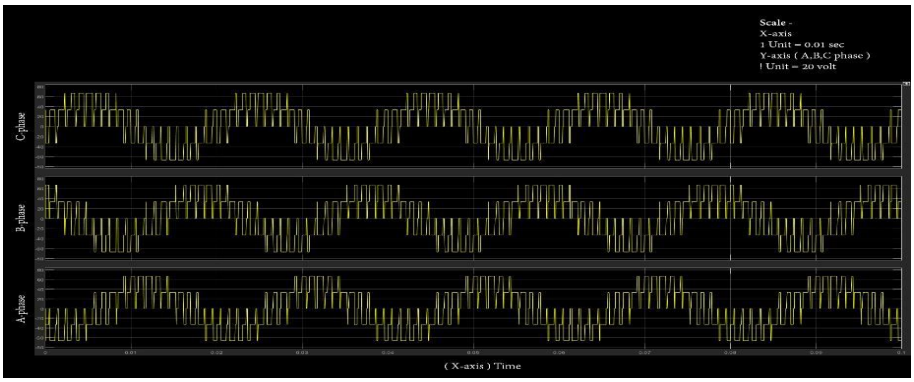

Fig. 11 Simulation Results

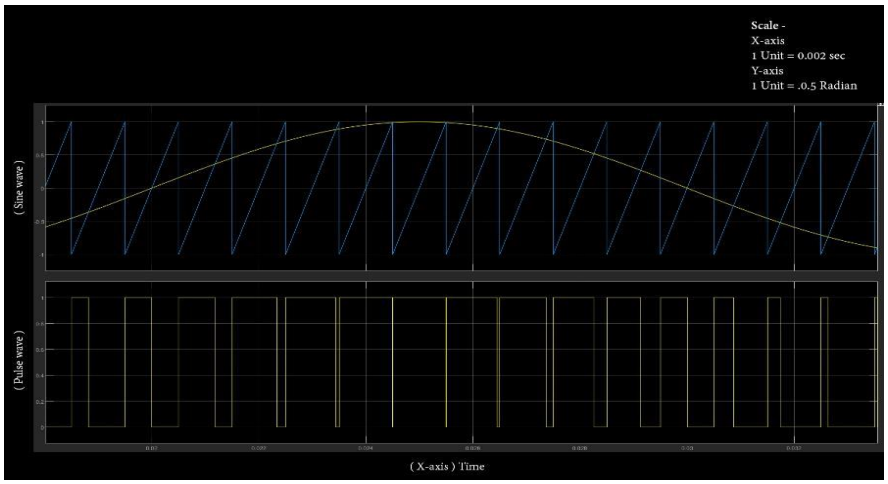

Fig. 12 Results of Simulation of Three Phase Inverter

C. Solar PV MPPT System

Feeding input Voltage & Current from Solar PV, take First-Order Voltage & Current Filter's time Constant is 1ms, Zero-Order hold Voltage(Vn) & Current(In) sample time is 0.1ms, take the Repeating Sequence time Values are [0 4ms 4ms], then Multiply delta P & delta V where delta P having (Pn - Pb) & delta V having (Vn-Vb), Applying two Switches in MPPT, For making D state take Delta D as constant value as 0.001, taking Saturation Value is 0.8 as Upper limit & 0 as lower limit.

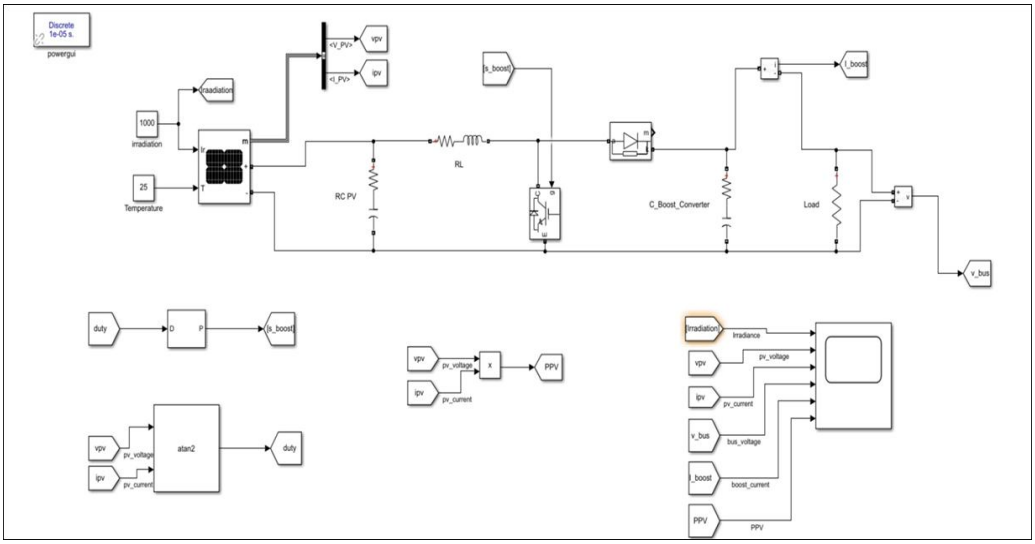

Fig.13 Simulation and design of solar PV MPPT system

D. Solar Photovoltaic MPPT System

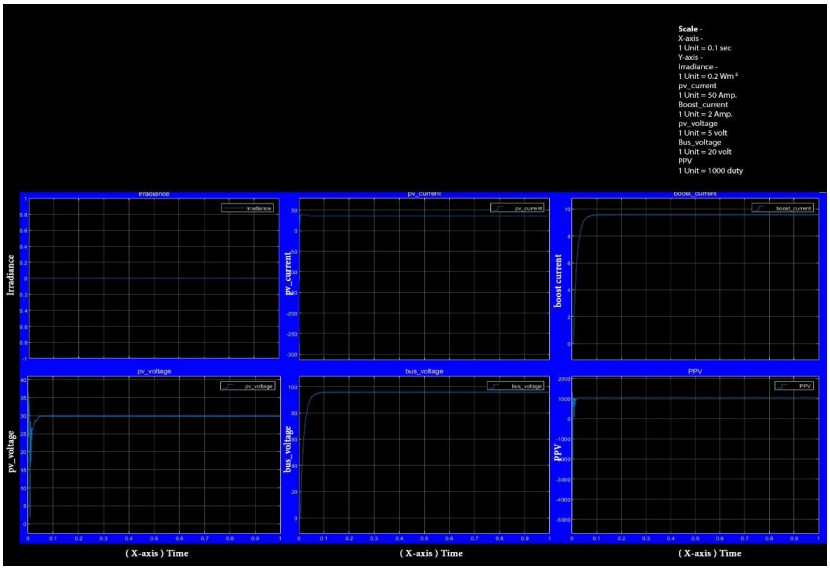

Fig.14 Graph of Solar photovoltaic MPPT system

V. CONCLUSIONS

After the total simulation of all parameters and designing the necessary devices for the conversion of DC to AC. After making all designing and simulation work the main task is to synchronize all the component and devices together by combining. Solar PV to boost converter to form boosted output and giving to the input of the 3 phase Inverter. Before Synchronized, the solar PV output voltage is constant 60V DC then by designing a Boost converter, Boost converter itself the Boosted output is 1000V when it having the input voltage is 280V DC. By the consideration of Solar PV to boost converter, design a 3 phase inverter. After Synchronized The output of Solar PV voltage is 60V DC and when synchronized with boost converter it get boosted up to 422V DC at that duration the MPPT having the output power is approximately 500W then the boosted output of solar PV is giving to the input of 3 phase inverter and it get conversion to AC up to - 400 to +400V AC.

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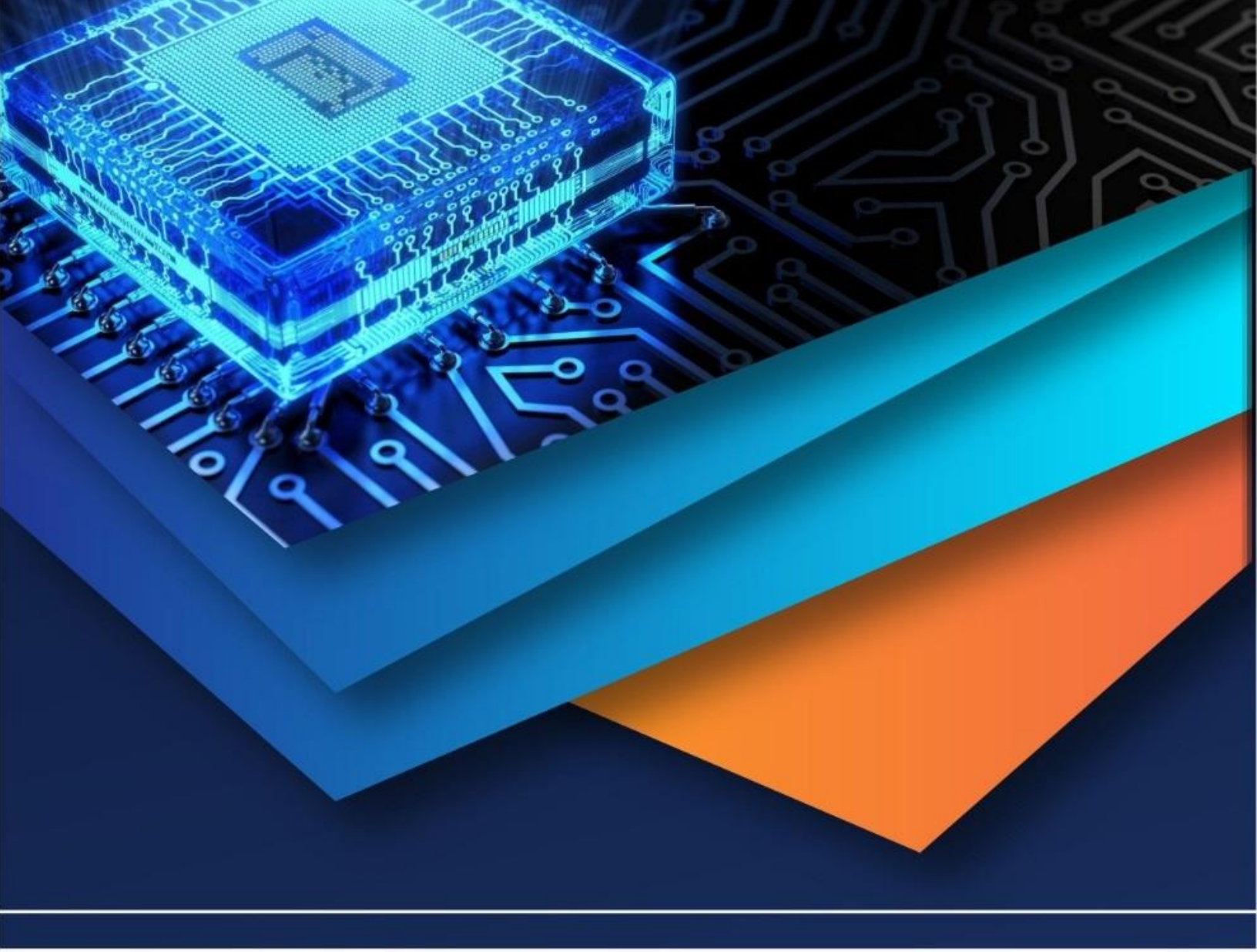

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