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Improved Power of PV Boost Converter AC Grid Connected on MPPT

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Abstract: ***An inverters are convert DC voltage into AC voltage, are crucial components of contemporary electrical systems because they enable the use of electricity for a variety of domestic and commercial applications. Research on AC grid connected universal bridge for PV generation is being established for PV system at the maximum power point tracking (MPPT) in order to increase the energy of solar generation and the quality of the power. This work presents the layout and performance of energy electronic converter that can independently set up both active and reactive for PV array power implementation with a single-phase electrical grid. This research is essentially intended to convert DC source voltage to AC voltage from a battery utilizing an inverter circuit design, and a 50Hz, 230W, 3KWh solar PV system is designed for optimal performance. Various sub-circuits are coupled for overall functioning. Additionally, the power factor & quality are increased. Furthermore, a simulation model based on MATLAB/SIMULINK is developed in accordance with the fundamental concepts of AC inverter control system and inverter analysis.***

Keywords: ***Solar Photovoltaic (PV) System, Boost converter, Inverter, MPPT, AC Grid System, L-C Filter etc.***

I. INTRODUCTION

Renewable energy generation methods produce clean, plentiful energy from naturally generated energy such as the sun and wind.Because of their ease of installation and cheap maintenance costs, photovoltaic panel systems have gained popularity. Furthermore, the power generation capacity of PV systems can be increased by industrial deployment. While PV panel systems can be either freestanding or AC load connected systems are more preferred and cost-effective. PV array are usually associated to AC grid via a rectifier and DC-DC converter. The converter is used to get the desired DC voltage level while maximizing the power of the PV array system [1].

Which accordance with the non-linear nature of photovoltaic sources, power electronic converters are required to interface between the photovoltaic source and AC grid. A simple AC load tied PV system comprises of photovoltaic and a Voltage Source Inverter (VSI) [2]. Power production systems with solar applications, as well as high-voltage DC-DC converters with step-up voltages, are increasingly in demand. In DC power systems, as opposed to AC systems, it is simpler and more effective to integrate any renewable DC generation with batteries to store energy. The usage of DC systems in households, businesses, and industrial applications is rising quickly due to the lack of concerns about harmonics, phase imbalances, and synchronization [1, 3-4].

To increase efficiency, it has been put forward to employ a DC-DC Boost converter in the PV system. The performance of the system only used one metal oxide semiconductor field effect transistor (MOSFET) on diode [5].

In Maximum Power Point Tracking (MPPT) algorithms, the duty cycle is a key factor for controlling a DC-DC converter, particularly is essential to generate the optimum amount of energy from a photovoltaic (PV) panel. The duty cycle basically represents the portion of the duration of time a switch in the converter is turned on opposed to off, and by altering it, the MPPT algorithm may modify the voltage & current observed by panel to function at its maximum power point (MPP). The perturb and observe (P&O) technique, the actual voltage level at the MPP varies according on the solar panel's properties (such as temperature and irradiance) and the load connected to it. The incremental conductance (INC) technique determines whether to increase or reduce the duty ratio in order to achieve MPPT by analyzing the power curve's slope [6].

AC inverter is a electronic device that converts direct current (DC) into alternating current (AC) at the required output voltage and resonance. When phase-controlled converters are used in an inverter mode, they are referred to as line-communicated inverters. However, line-communicated inverters require an existing alternating current source at the output terminals for commutation. Thus, line-communicated inverters are unable to function as variable frequency generators with DC power at the input or as insulated sources of AC voltage [7]. Nonetheless, this study contributes significantly to the field of solar energy by providing information on how to construct and run solar energy systems using MPPT based inverters [7-9].

This research paper presents a converter & inverter organization using MOSFET in these duty cycle. In this study, Boost converter and universal bridge are to be used as sinusoidal wave test. The simulation model are accomplished in simulink, and the results are tested against the PV panel system a working model.

II. PV MODELING SYSTEM AND CHARACTERICTICS

A photovoltaic (PV) system is an instance of a sustainable power system that transforms sunlight into electricity using materials that conduct electricity through the photovoltaic effect. The modules are connected to the inverter and the grid by electric wires, and other elements can contain charge controllers, batteries (in off-grid systems), and tracking devices. Furthermore, series & parallel resistors are added to the ideal model to highlight power losses. Figure 1 depicts the widely used equivalent circuit model for a single PV array system. The single diode model characteristics are obtained using Eq. (1) [1].

$$I = Ipv - Io\left[\exp\left(\frac{V+IRs}{aVt}\right) - 1\right] - \frac{V+IRs}{Rsh} \quad (1)$$

Where,
Ipv: PV current
Io: output current
Rs: Series resistor
Rsh: Shunt resistor
Vt: Thermal diode

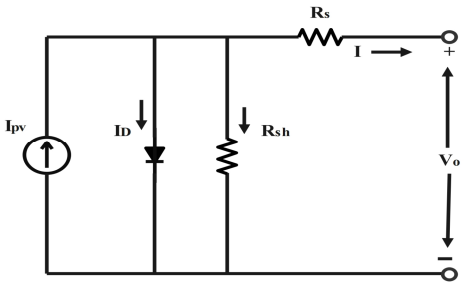


Fig. 1 PV module of euqivalent circuit [1,4]

The proposed work aims to simplify the power system by connecting numerous input power converters to a composite renewable energy system. The impact of solar temperature, radiation, and other environmental factors on cell generation of power should be use considered in the PV panel model. Regardless of the weather, When the controlling device continues specifically at MPP, the PV system's efficiency increases. To obtain maximum power generation, the PV source should be properly compatible with the load in any weather situation. It is in charge of tracking the PV array's MPP and modifying the system operating point to gather as much electricity as possible from it.

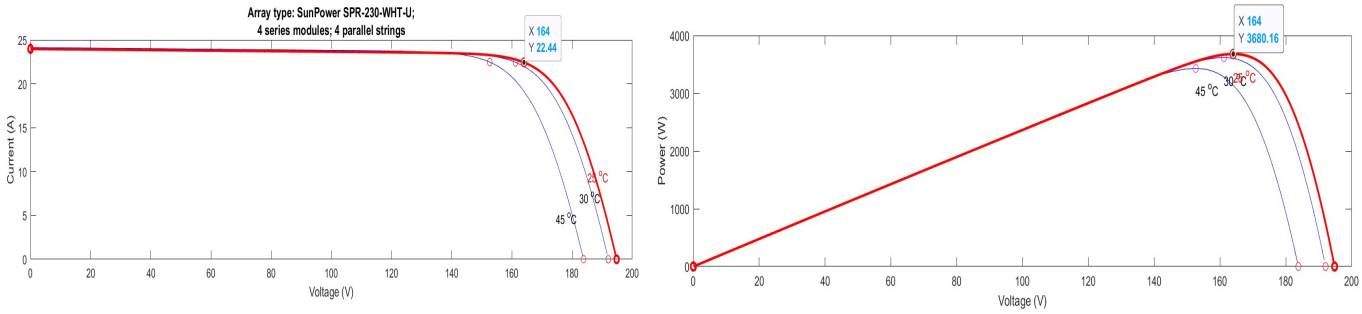
A DC-DC converter, this part transforms the lower rating of the DC output from the PV array through an increased voltage DC output that can eventually be supplied to the DC-AC converter. A DC-DC Boost converter is often used in PV systems to raise voltage levels. The AC inverter changes the DC voltage from the DC-DC converter into an AC voltage that is capable of being linked to the electric power AC grid. The AC grid also provides the control operations required for effective grid connection [8-10].

The key parameters of the PV panel are listed in Table 1. These variables modify PV current, series and shunt resistors, and rectifier saturate current. Figures 2 and 3 illustrate the model's curves for various temperature and irradiance values at 25°C.

TABLE I
Key Parameters of SunPower SPR-230-WHT-U

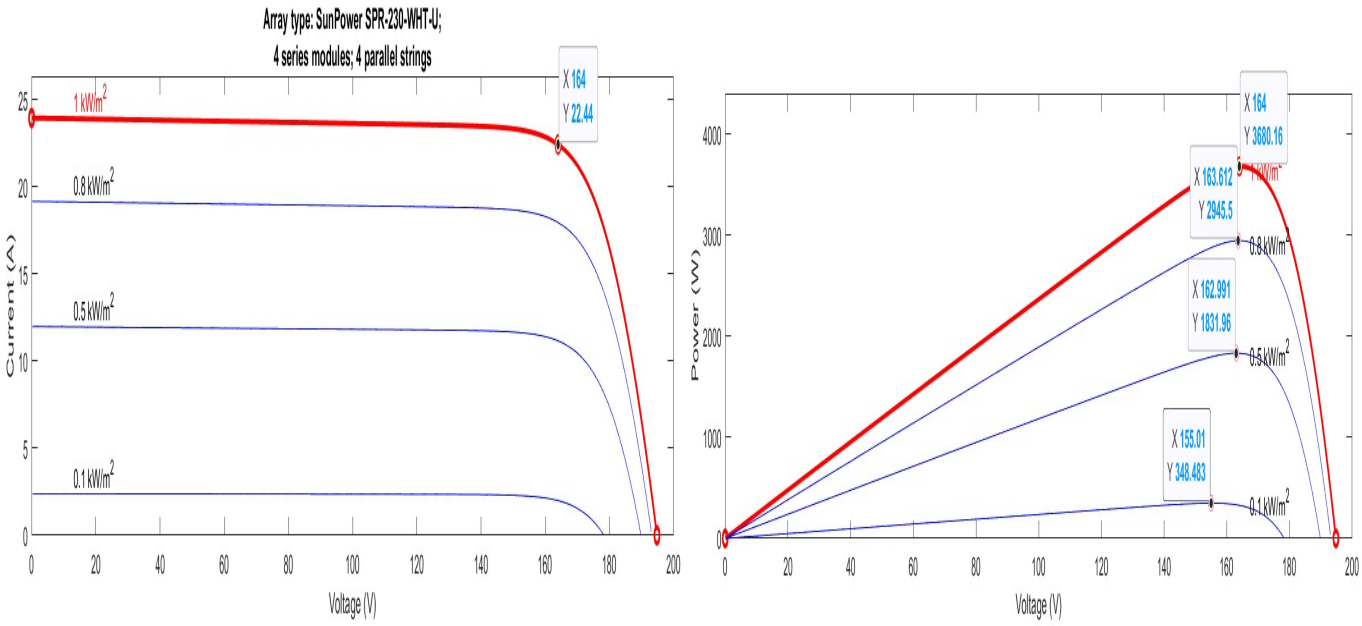
Module: SunPower SPR-230-WHT-U	
Parameters	*Values*
Maximum Power (W)	230
Cells per module (Ncell)	72

Open circuit voltage Voc (V)	48.7
Short-circuit voltage Isc (A)	5.99
Voltage at maximum power point Vmp (V)	41
Current at maximum power point Imp (A)	5.61
Temperature coefficient of Voc (%/degree C)	-0.2821
Temperature coefficient of Isc (%/deg.C)	0.035593



(a) (b)

Fig. 2 (a) & (b): I-V and P-V characteristics at constant temperature



(a) (b)

Fig. 3 (a) & (b): I-V and P-V characteristics at constant irradiance

III. DC-AC CONVERSION OF AC GRID SYSTEM

A DC-AC converter connects the PV panel system to the electrical AC grid. In this research, SPWM (single-phase pulse width modulation) is employed to transform DC voltage to AC voltage. To improve the switching components of the inverter, SPWM method is used and modulated with the simulation model. An L-C filter is connected between AC grid to efficiently reduce the ripple harmonics created by the inverter's modulations. Furthermore, a medium resistor linked in series with the filter reduces resonance.

IV. PROPOSED SIMULATION MODEL OF AC GRID SYSTEM

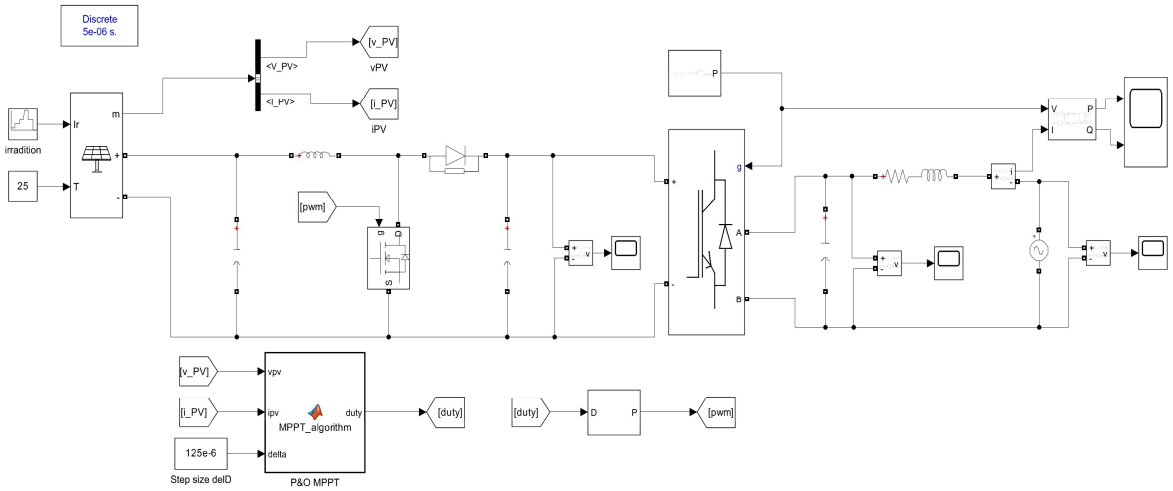


Fig. 4 Simulation model of AC grid system with connected Solar PV

PV cells are simulated in series and parallel in 4x4 matrices at 25°C, with a light intensity of 1000, 800, 500 and 100W/m2, a AC grid output voltage of 220V and 50Hz, an intermediate DC voltage of 350V, and a simulation time of 0.5 seconds. The PV array model is used for results. The PV grid linked inverter model is depicted in Figure 4. The I-V curve characteristics of the PV array system is shown in Fig. 3, for output power of 3 kWh. The MPP is gather then connected through a DC converter which reads the power supply to the universal bridge connected AC load and infers the power quality by measuring the active and reactive currents. The input stage of the system is primarily designed to track the maximum power point. The output stage adjusts the output power based on the input power, improving the control system [11].

V. RESULT

The output voltage wave-forms of the DC-DC Boost converter and the L-C filter output voltage of previous ones DC-DC converter are displayed in Figures 5 and 6. Figures 7 and 8 display the inverter's DC-link voltage, AC output active power, and reactive power wave-forms. The validity of MPPT control technique is demonstrated by Figure 6, which shows that the PV array output power is consistently within MPP.

After system consolidation, DC-link voltage is around 350V, as shown in Figure 7. In Figure 8, AC load current has the same frequency as the AC load voltage, the power factor is 1 on the line side, and the active and reactive power is approximately equivalent to PV array at output power. The power factor quality AC load supply with Boost converter in the grid system's current flow results in an AC load with an output power of 230V.

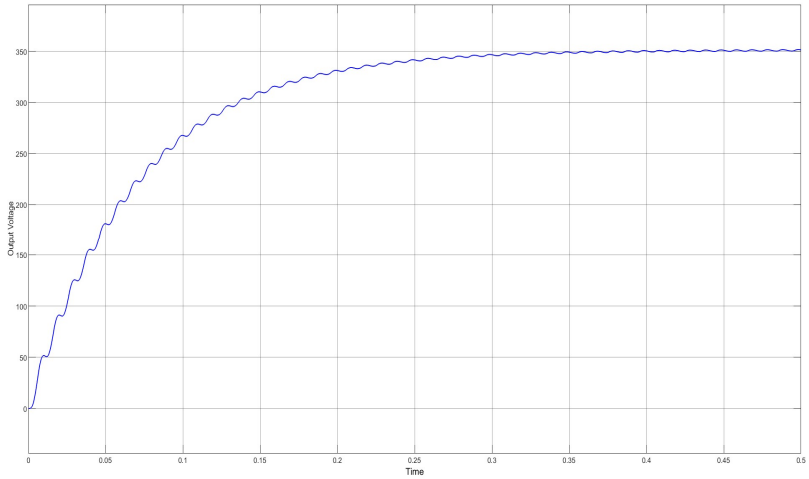


Fig. 5 Output voltage of a Boost converter

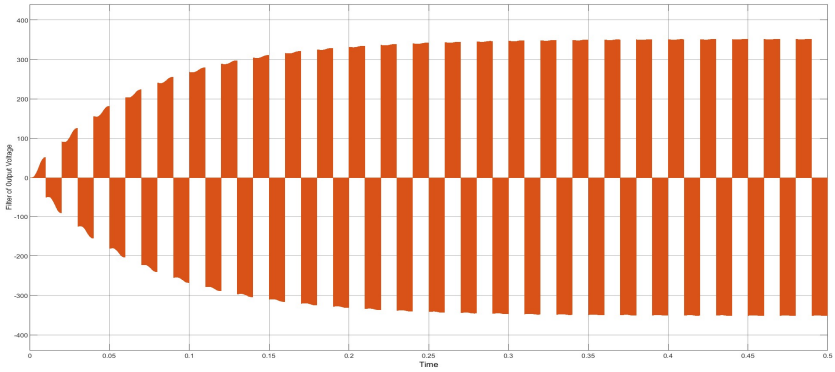
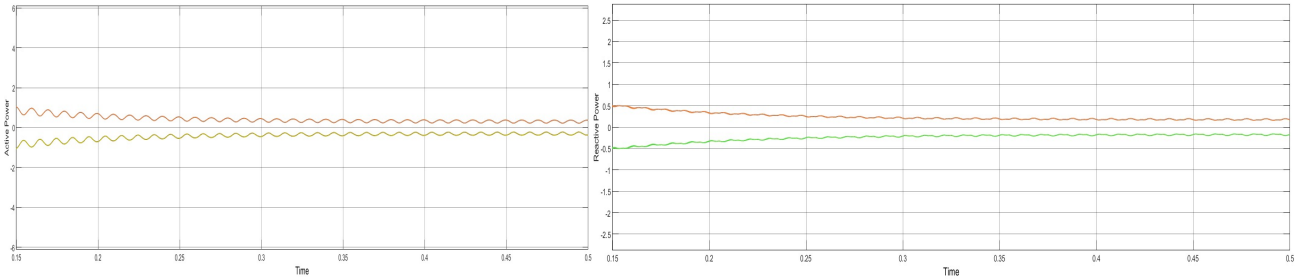


Fig. 4 Output voltage of L-C filter



(a) (b)

Fig. 4 (a) & (b) Active and reactive powers current

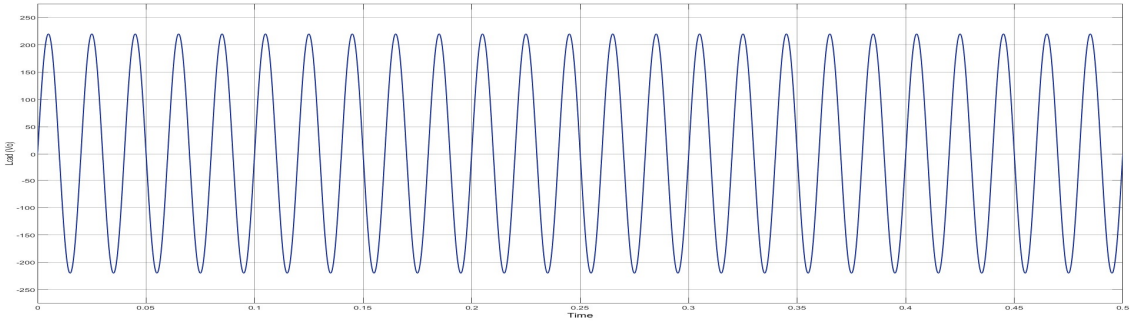


Fig. 4 Output power of AC load (Vo)

VI. CONCLUSIONS

It is concluded from this paper that by getting maximum load on solar PV on AC grid system, its efficiency and power can be improved. In the coming time, this can be done in a better way so that good prosperity can be achieved by reducing the battery capacity. By increasing the maximum power in the solar array using a Boost converter, it can be injected into the AC grid to generate energy for some good purposes in industries. This research paper helps in tracking the power at the maximum point with better incremental accuracy through its MPPT P&O method. Also this can be achieved by connecting the PV system with Boost converter to the grid with good AC load. The simulation model gives 350 V output voltage and output power at the maximum power point with DC voltage to stabilize the system, it accurately obtains the sinusoidal waveform.

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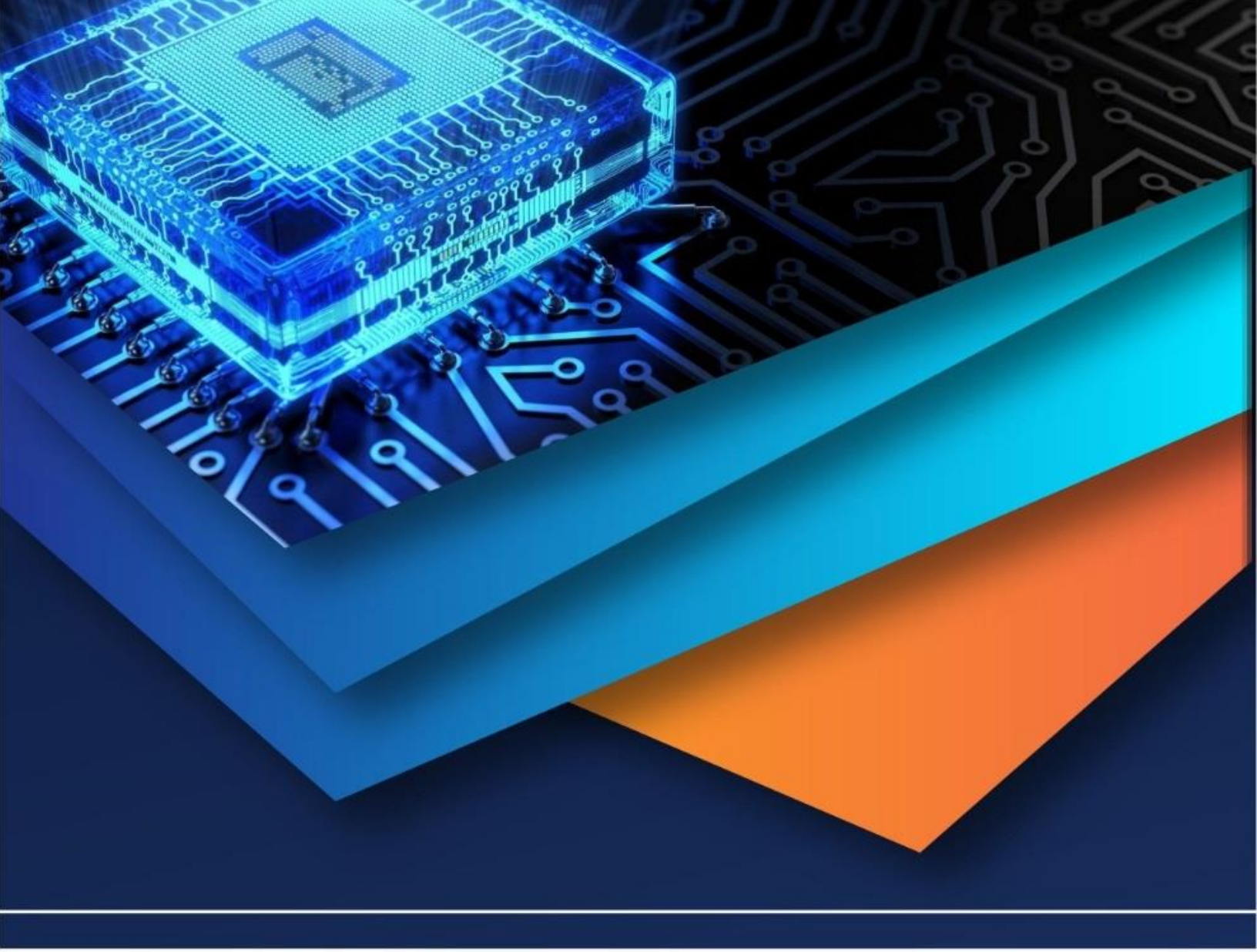

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