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A Hybrid System of 7 Level Inverter Based Novel ZVT-ZCT-PWM Boost Converter System

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Abstract- We propose here a new boost converter with an active snubber cell is proposed. The active snubber cell provides main switch to turn ON with zero-voltage transition (ZVT) and to turn OFF with zero-current transition (ZCT). The proposed converter incorporating this snubber cell can operate with soft switching at high frequencies. Also, in this converter all semiconductor devices operate with soft switching. There is no additional voltage stress across the main and auxiliary components. The converter has a simple structure, minimum number of components, and ease of control as well. The operation principle and detailed steady-state analysis of the novel ZVT-ZCT-PWM boost converter are given. The presented theoretical analysis is verified exactly by a prototype of 100 kHz and 1 kW converter. Also, the overall efficiency of the new converter has reached a value of 97.8% at nominal output power.
Index Terms— Snubber Cell, ZCT,ZVT, PWM.

I. INTRODUCTION

The ever-increasing energy consumption, fossil fuels' soaring costs and exhaustible nature, and worsening global environment have created a booming interest in renewable energy generation systems, one of which is photovoltaic. Such a system generates electricity by converting the Sun's energy directly into electricity. Photovoltaic-generated energy can be delivered to power system networks through grid-connected inverters. A single-phase grid-connected inverter is usually used for residential or low-power applications of power ranges that are less than 10 kW [1]. Types of single-phase grid-connected inverters have been investigated [2]. A common topology of this inverter is full-bridge three-level.

The three-level inverter can satisfy specifications through its very high switching, but it could also unfortunately increase switching losses, acoustic noise, and level of interference to other equipment. Improving its output waveform reduces its harmonic content and, hence, also the size of the filter used and the level of electromagnetic interference (EMI) generated by the inverter's switching operation [3]. Multilevel inverters are promising; they have nearly sinusoidal output-voltage waveforms, output current with better harmonic profile, less stressing of electronic components owing to decreased voltages, switching losses that are lower than those of conventional two-level inverters, a smaller filter size, and lower EMI, all of which make them cheaper, lighter, and more compact [3], [4]. Various topologies for multilevel inverters have been proposed over the years. Common ones are diode-clamped [5]– [10], flying capacitor or multi cell [11]–[17], cascaded H-bridge [18]–[24], and modified H-bridge multilevel [25]–[29]. This paper recounts the development of a novel modified H-bridge single-phase multilevel inverter that has two diode embedded bidirectional switches and a novel pulse width modulated (PWM) technique. The topology was applied to a grid-connected photovoltaic system with considerations for a maximum-power-point tracker MPPT) and a current-control algorithm.

II. PWM MODULATION

A. Introduction about PWM Modulation Techniques

A novel PWM modulation technique was introduced to generate the PWM switching signals. Three reference signals (*V*ref1, *V*ref2, and *V*ref3) were compared with a carrier signal (*Vcarrier*). The reference signals had the same frequency and amplitude and were in phase with an offset value that was equivalent to the amplitude of the carrier signal. The reference signals were each compared with the carrier signal. If *V*ref1 had exceeded the peak amplitude of *V*carrier, *V*ref2 was compared with *V*carrier until it had exceeded the peak amplitude of *V*carrier. Then, onward, *V*ref3 would take charge and would be compared with *V*carrier until it reached zero. Once *V*ref3 had reached zero, *V*ref2 would be compared until it reached zero. Then, onward, *V*ref1 would be compared with *V*carrier.

B. Control System

The control system comprises a MPPT algorithm, a dc-bus voltage controller, reference-current generation, and a current controller.

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The two main tasks of the control system are maximization of the energy transferred from the PV arrays to the grid, and generation of a sinusoidal current with minimum harmonic distortion, also under the presence of grid voltage harmonics. The proposed inverter utilizes the perturb-and-observe (P&O) algorithm for its wide usage in MPPT owing to its simple structure and requirement of only a few measured parameters. It periodically perturbs (i.e., increment or decrement) the array terminal voltage and compares the PV output power with that of the previous perturbation cycle. If the power was increasing, the perturbation would continue in the same direction in the next cycle; otherwise, the direction would be reversed. This means that the array terminal voltage is perturbed every MPPT cycle; therefore, when the MPP is reached, the P&O algorithm will oscillate around it.

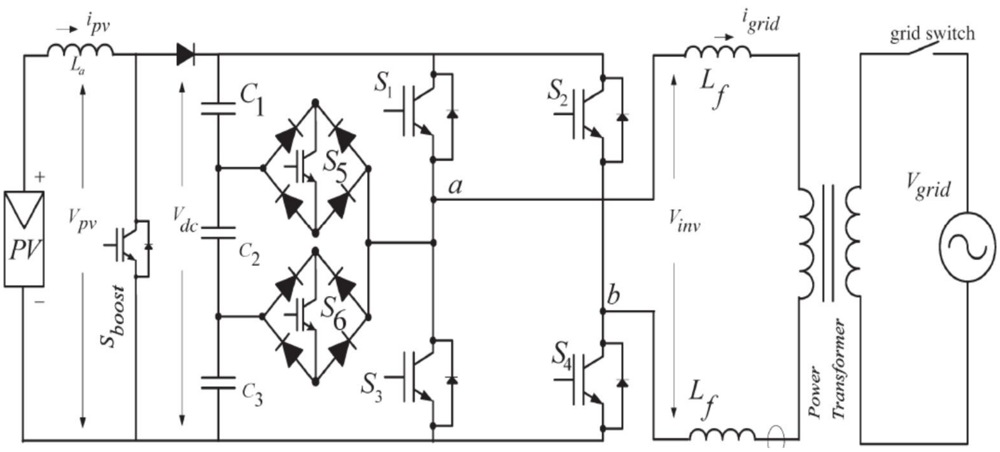

Fig.2.1.
Boost Power Factor Corrector

III. WORKING OPERATION

A. Introduction about Design Procedure

In order to design the proposed ZVT-ZCT-PWM boost converter, the characteristic curves are obtained by simulations and given in Figs. 4–7. The component values used in snubber cell can be determined from these curves

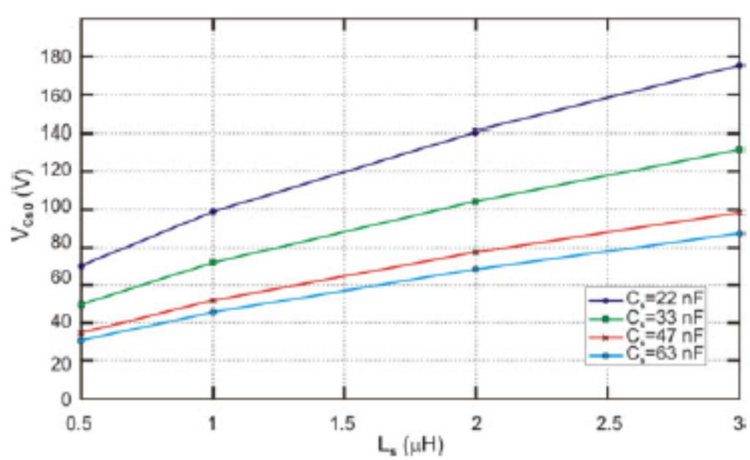

Fig 3.1Variation of *VC s*0 with *Ls* for different *Cs* values.

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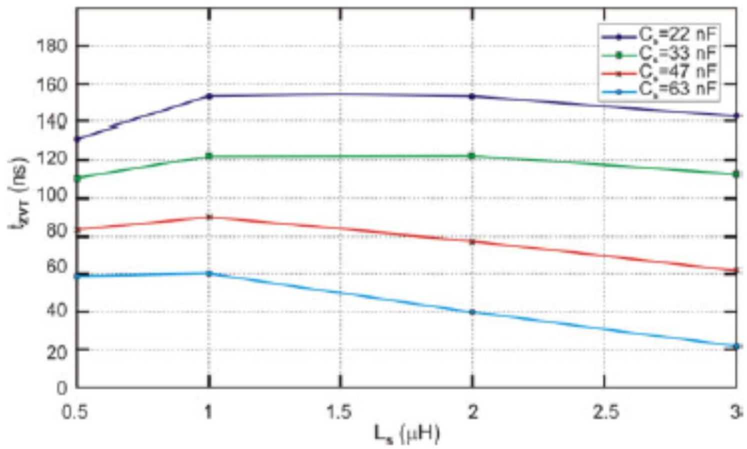


Fig.3.2 Variation of the *t*ZVT with *Ls* for different *Cs* values.

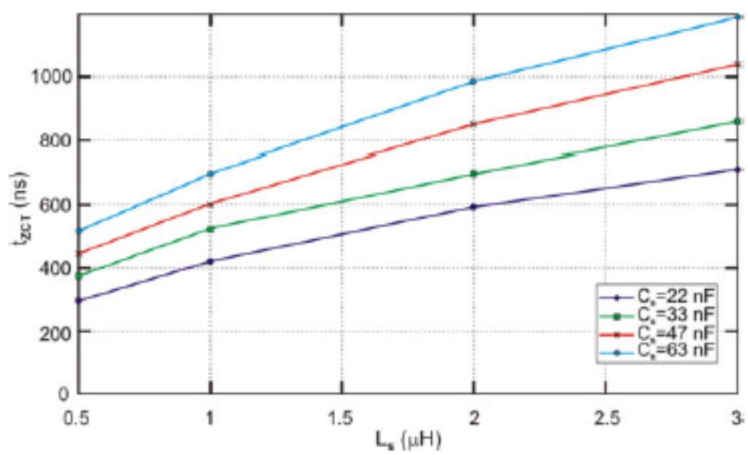
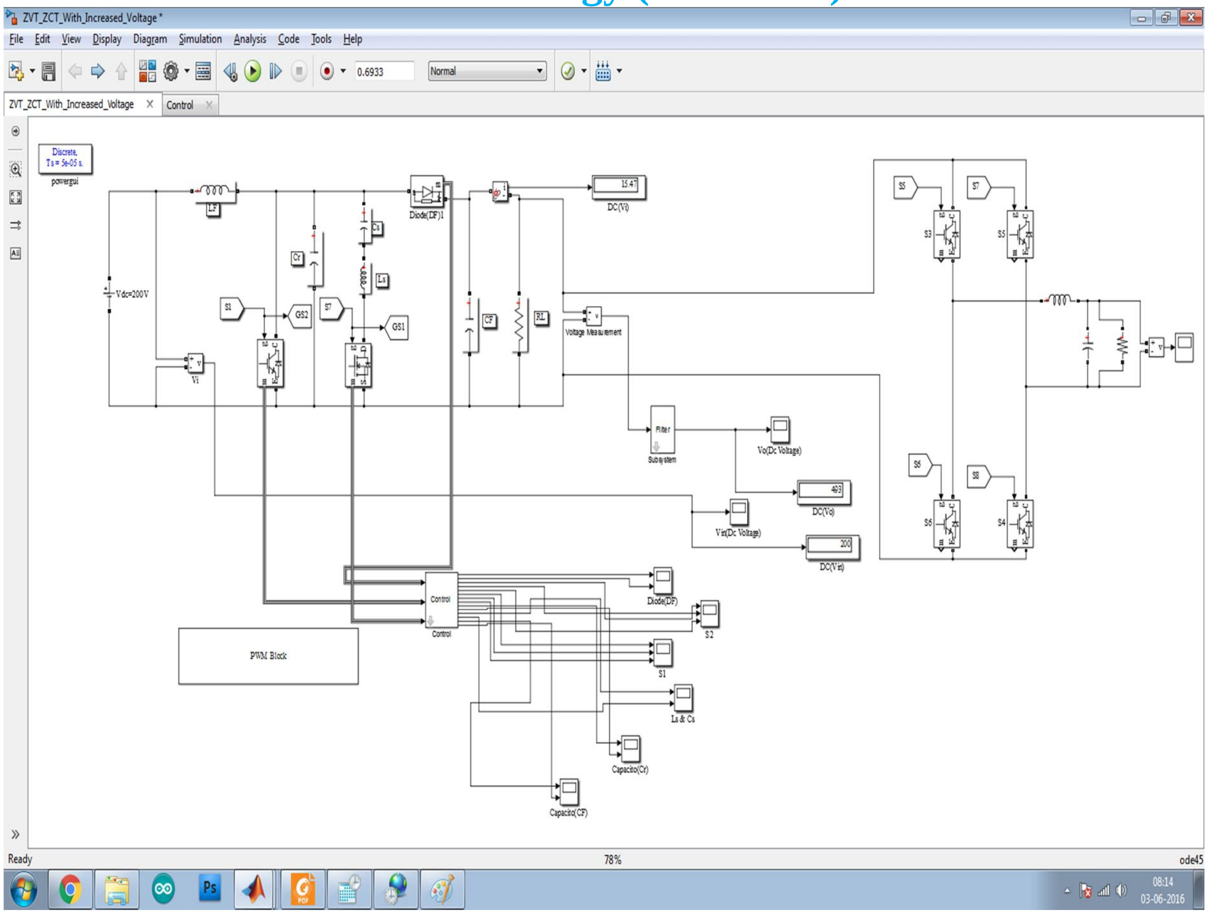


Fig.3.3 Variation of *t*ZCT with *Ls* for different *Cs* values.

The characteristic curves are obtained depending on *Ls* and *Cs* at nominal output power. From Fig. 4, it is seen that the maximum value of the main switch current *IS*1max decreases when the value of *Ls* snubber inductance increases. It decreases slightly when the value of *Cs* snubber capacitance increases. In Fig. 5, the initial voltage of the snubber capacitor decreases with increasing *Cs* , and increases with increasing *Ls* . In Fig. 6, the ZVT duration of the main switch is shown depending on *Ls* and *Cs* . From the figure, it is seen that the ZVT interval decreases when *Ls* and *Cs* increases. In Fig. 7, the variation of the ZCT duration of the main switch is given. The ZCT duration increases when *Cs* and *Ls* increases. The ZCT duration strongly depends on the resonance between *Ls* and *Cs* . The smallest values of *Ls* and *Cs* components are preferred from the characteristic curves. If the selected component values are high, the sum of the transient intervals and conduction losses increase. We have to take into account that current stress of the main switch should remain at reasonable level.

IV. OUTPUT

A. Simulation Diagram



B. Input Waveforms

Input Voltage

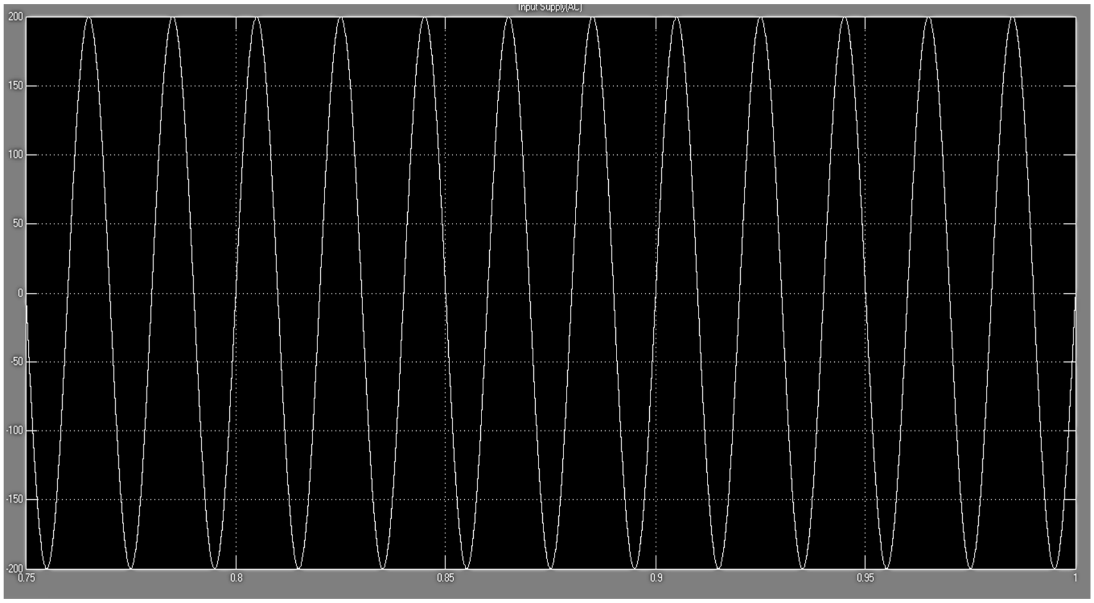


Fig.4.1.Input AC Voltage- 200Vac

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C. Corresponding Improvement In Voltage And Current

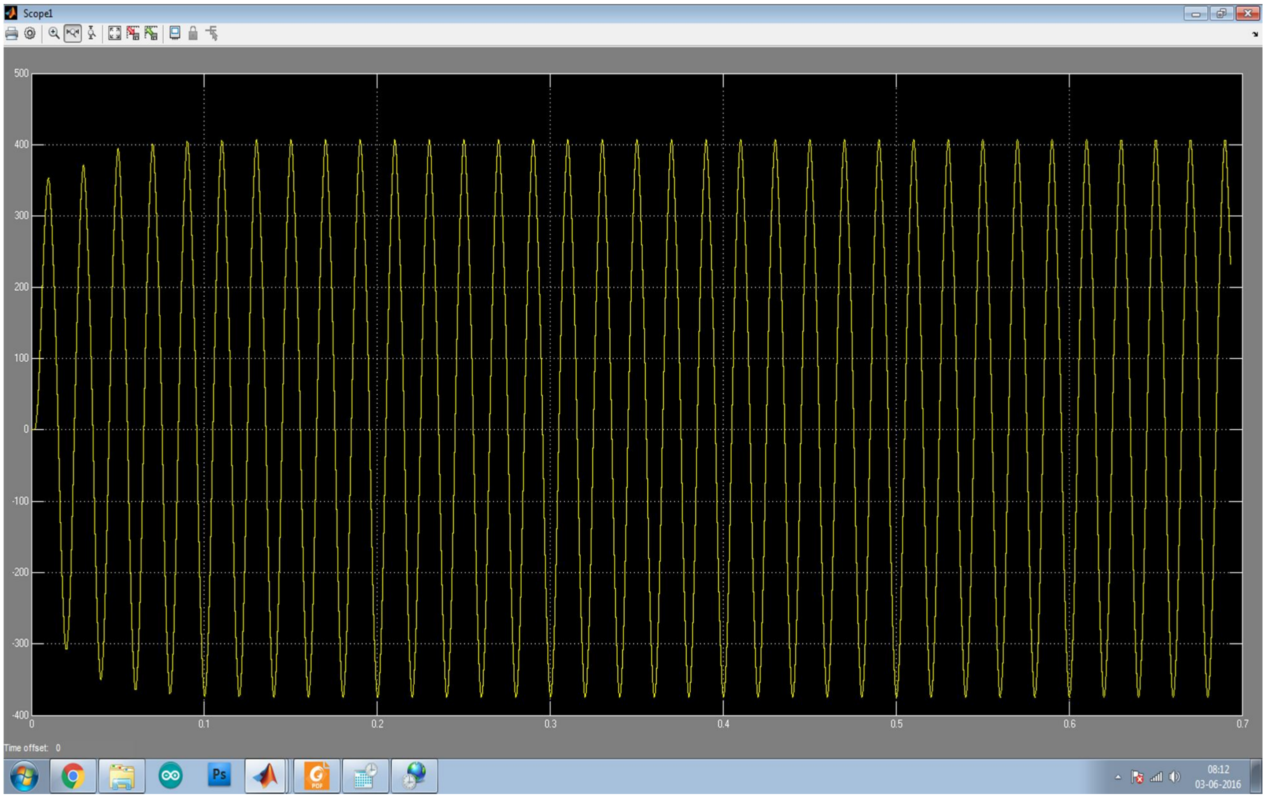

Fig.4.2.Output AC Voltage- 400Vac

V. CONCLUSION

The proposed converter, all semiconductor devices are switched under soft switching. In the ZVT and ZCT processes, the auxiliary switch is turned ON under ZCS and is turned OFF with ZCT and near ZCS, respectively. There is no additional voltage stress across the main and auxiliary switches. The main diode is not subjected to any additional voltage and current stresses. The operation principles and steady-state analysis of the proposed converter are presented. In order to verify the theoretical analysis, a prototype of the proposed circuit is realized in the laboratory. The novel ZVT-ZCT-PWM boost converter using the proposed snubber cell has desired features of the ZVT and ZCT converters. At nominal output power, the converter efficiency reaches approximately to 97.8%.The modifications done from the phase 1 is the ripples from the Converter Outputs is reduced by using filter circuit.The corresponding Voltage is increased by 493V dc output from the converter.The Diode ripple voltage is reduced and the Output from the inverter is increased by 30% up to 400V ac.The Harmonics is maintained at 10%.

VI. ACKNOWLEDGEMENT

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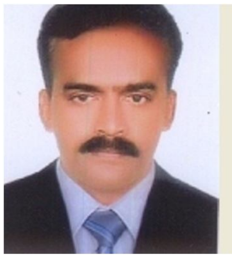

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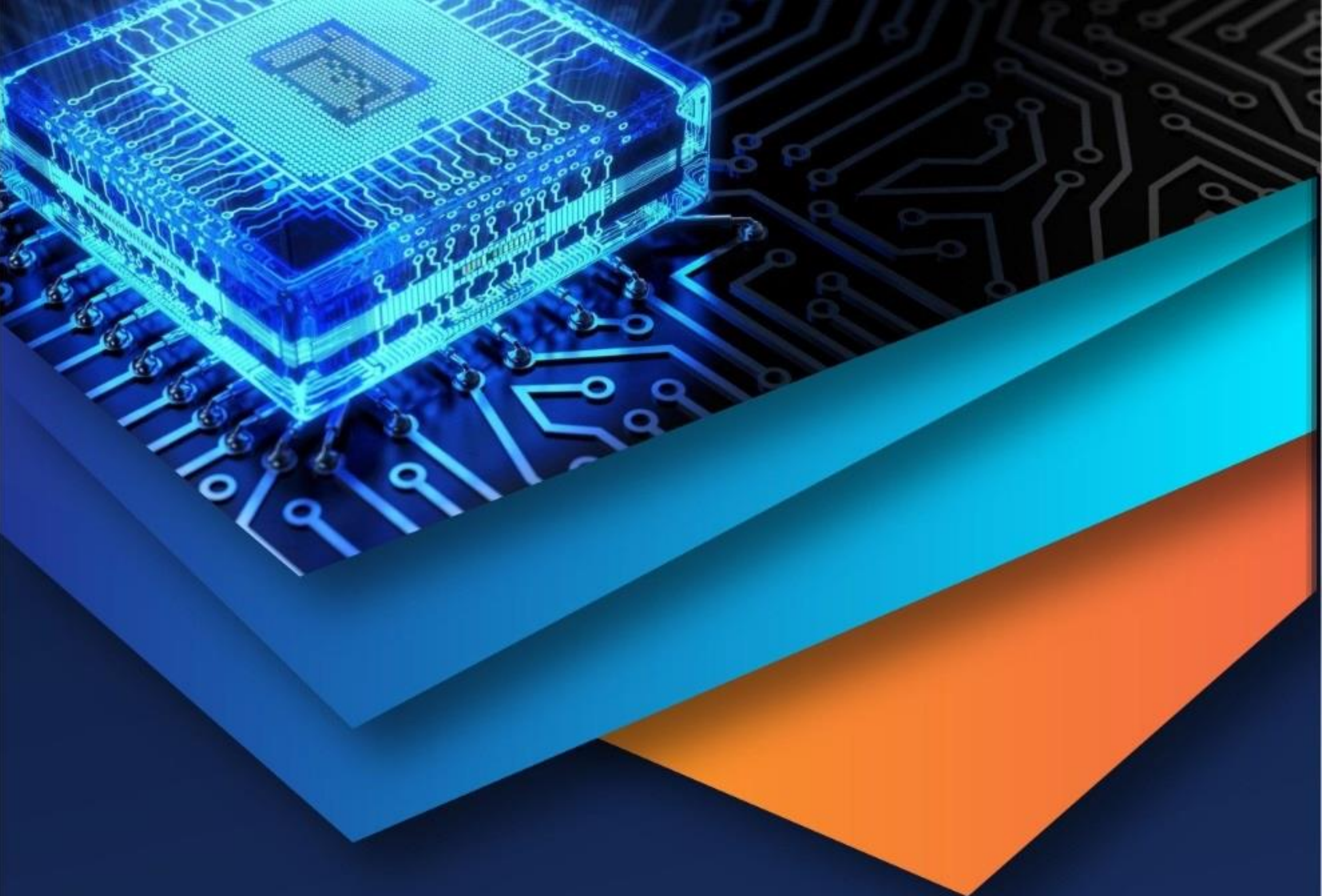

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