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Design and Monitoring of Solar Power Generation System for Domestic Applications using Matlab/Simulink

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Abstract: In recent years, it is getting attention for renewable energy sources such as solar energy, fuel cells, batteries or ultra capacitors for distributed power generation systems.solar energy maintains life on earth and it is an infinite source of clean energy.Solar radiant energy accounts for most of the usable renewable energy on this earth. Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductor that exhibit the photovoltaic effect. Since last five decades, numerous studies have been performed on different design aspects and performance characteristics of Photovoltaic (PV) cells with a common objective of producing fully integrated PV modules to compete with the traditional energy sources. There is an increasing trend for the use of solar cells in industry and domestic appliances because solar energy is expected to play substantial role in future smart grid as distributed renewable source.

The proposed model is based on a behavioral cell model for modeling solar radiance to electricity conversion and an electrical driver interface for implementing electrical characteristic of power limited systems in power simulations.

Keywords: Solar radiant, Photovoltaic(PV), power simulations, photovoltaic effect.

I. NTRODUCTION

Among several renewable energy resources, energy harvesting from the photovoltaic (PV) effect is the most essential and sustainable way because of abundance and easy accessibility of solar radiant energy around the earth. In spite of the intermittency of sunlight, solar energy is widely available during daylight and it is free to use. Recently, photovoltaic system is recognized to be in the forefront in renewable electric power generation because it can generate direct current electricity without heavy environmental impacts and contamination.PV modules are the fundamental power conversion unit of a PV generator system. The output characteristics of PV modules depend on the solar insolation, the cell temperature and the output voltage of the PV module. Since PV modules exhibit nonlinear electrical characteristics, designing and simulation of this system require reliable PV modeling.

Solar cells, come in many different shapes and sizes and are made of electricity - producing materials. When sunlight shines on a PV cell, the absorbed light generates electricity. The mono-crystalline and poly-crystalline silicon cells are the only found at commercial scale at present era. To model a solar cell, it is imperative to assess the effect of different factors on the solar panels and to consider the characteristics given by the manufacturers in the data sheet. The data sheet which gives the electrical characteristics is calculated under standard test condition.

To obtain the required power, voltage and current, the PV modules are associated in series and parallel. Thus, the mathematical models for PV array are attained while utilizing the basic description and equivalent circuit of the PV cells. From the theory of the photovoltaic, a mathematic model of the PV is presented. The simulation of the photovoltaic array is realized with SIMULINK block. The temperature and the irradiance are specified. The Simulink model uses a current source, voltage source and the value of the resistance in series and parallel of the PV. The number of modules in series and parallel are set. The result is used for the Simulink block as a current source to obtain the voltage and current delivered from PV.

Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy Future economic growth crucially depends on the long-term availability of energy from sources that are affordable accessible and environment. Demand has increased for renewable sources of energy to be utilized along with conventional systems to meet the energy demand. Renewable sources like wind energy and solar energy are the prime energy sources which are being utilized in this regard. The continuous use of fossil fuels has caused the fossil fuel deposit to be reduced and has drastically affected the environment depleting the biosphere and cumulatively adding to global warming. Solar energy is abundantly available that has made it possible to harvest it and utilize it properly.

II. LITERATURE SURVEY

Photo Voltaic systems can generate high voltages. Safety is therefore very important in order to avoid accidents and damage of expensive components and equipment. For safety reasons, solar arrays are normally earthed, either by placing a matrix of metal in the ground under the array, or by using conventional earth rods. It is normally not necessary to protect solar array from direct lightning strikes, provided that their mounting structure is well earthed. However, inverters or other electronics controls connected to the array should be protected. Blocking diodes are installed in solar arrays to prevent reverse current flows into the modules, which may damage the modules and cause energy losses. By-pass diodes are incorporated into modules to prevent damage of arrays when some cells or modules become shaded.

The only solution to overcome this problem is integrating the utility grid with the renewable energy systems like solar energy, wind energy or hydro energy. As per the availability of renewable energy sources the grid can be connected to the renewable energy system. Because of abundant availability of solar energy recently the solar power generation systems are getting more attention, more efficient and more environment friendly as compared to the conventional power generation systems such as fossil fuel, coal or nuclear energy.

III. BLOCK DIAGRAM

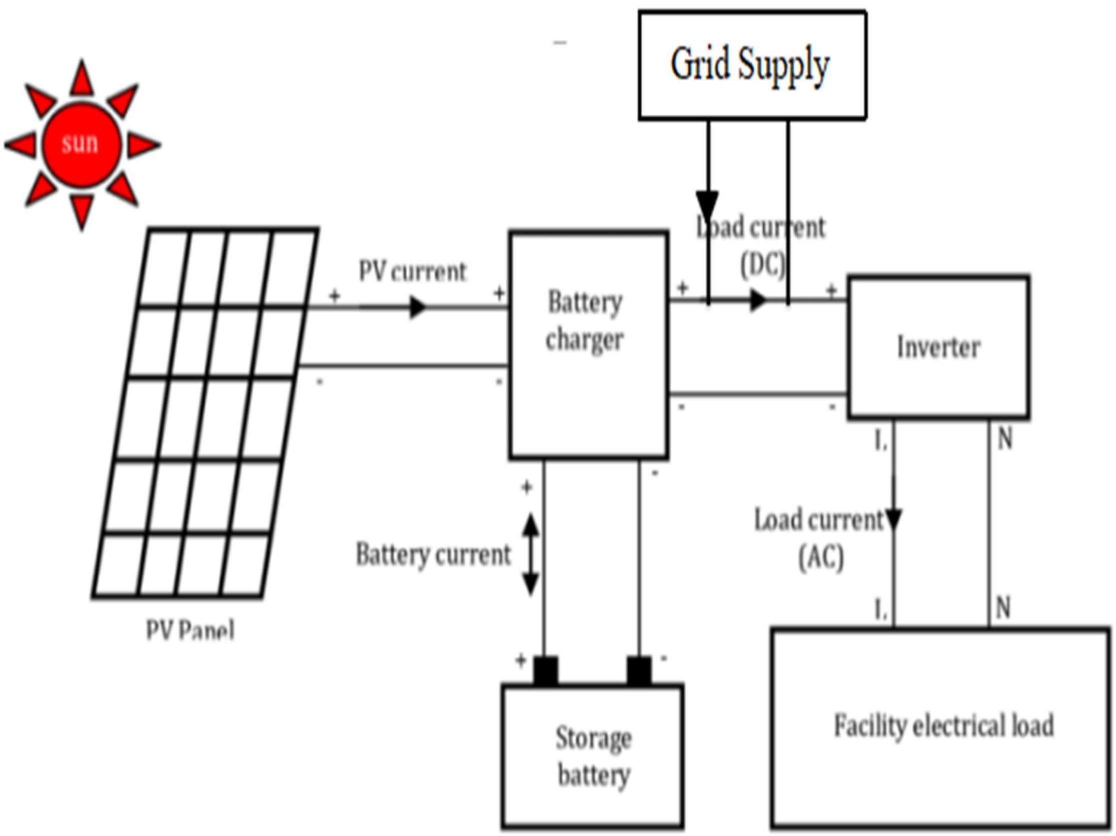

Fig 1: Block Diagram

IV. SOFTWARE REQUIREMENTS

A. *Matlab/Simulink*

Software that is used to create the Design and monitoring the model and do the simulation of the Solar Energy System.

For modeling, Simulink provides a graphical user interface (GUI) for building models as block diagrams. It includes a comprehensive library of predefined blocks to be used to construct graphical models of systems using drag-and-drop mouse operations. The user is able to produce an “up-and-running” model that would otherwise require hours to build in the laboratory environment.

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V. FLOW CHART

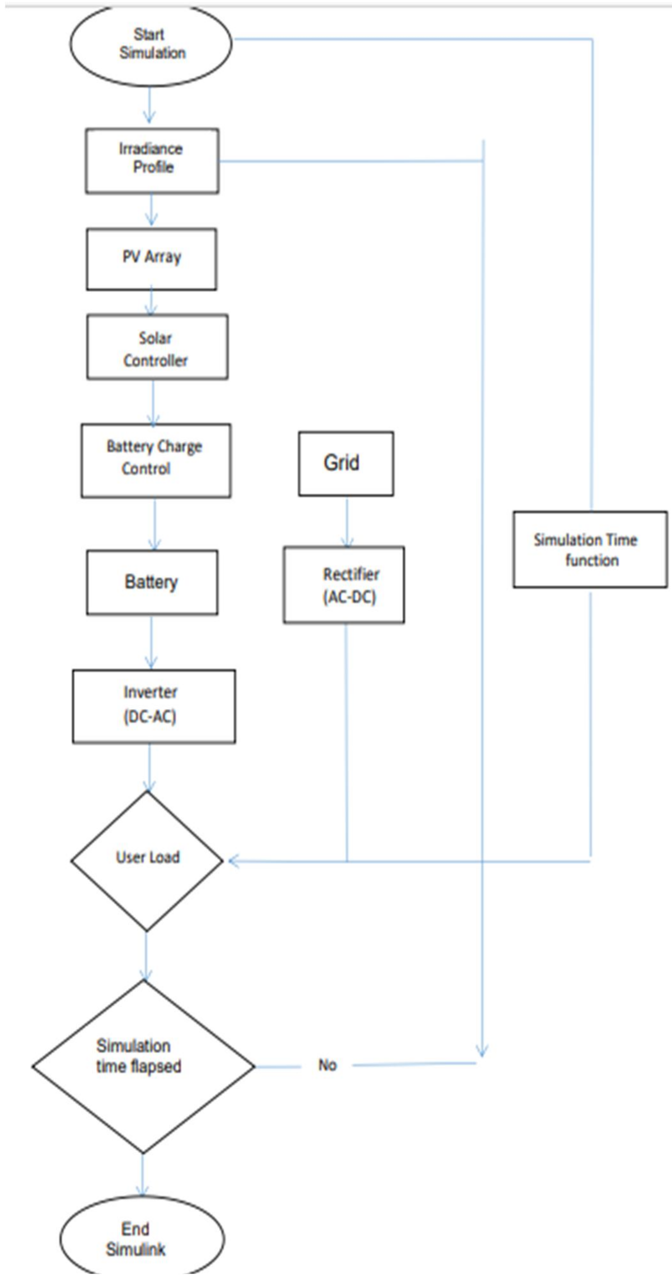

Fig 2: Algorithm

VI. MODELLING OF PV SYSTEM IN SIMULINK

A. PV Module

A PV module is an assembly of photo-voltaic cells mounted in a framework for installation. Photovoltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel, and a system of Panels is an Array.

It consists of a large number of P cells arranged in series or parallel or a mixture of both to meet the consumption demand. PV modules of various materials and enhanced efficiencies and of desired size are available in the market.

B. Converter

Single phase fully-controlled bridge rectifiers are known more commonly as AC-to-DC converters.The full-wave rectifier is more efficient than the half-wave rectifier as it uses both half-cycles of the input sine wave producing a higher average or equivalent DC output voltage.

Rectification converts an oscillating sinusoidal AC voltage source into a constant current DC voltage supply by means of diodes, thyristors, transistors, or converters. This rectifying process can take on many forms with half-wave, full-wave, uncontrolled and fully-controlled rectifiers transforming a single-phase or three-phase supply into a constant DC level.

C. Inverter

A power inverter, or inverter, is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC).The resulting AC frequency obtained depends on the particular device employed. Inverters do the opposite of "converters" which were originally large electromechanical devices converting AC to DC.

D. Charge Controller

The most essential charge controller basically controls the device voltage and opens the circuit, halting the charging, when the battery voltage ascents to a certain level.More charge controllers utilized a mechanical relay to open or shut the circuit, halting or beginning power heading off to the electric storage devices.

The solar charge controllers can also control the reverse power flow.The charge controllers can distinguish when no power is originating from the solar panels and open the circuit separating the solar panels from the battery devices and halting the reverse current flow.

VII. SIMULATION MODEL

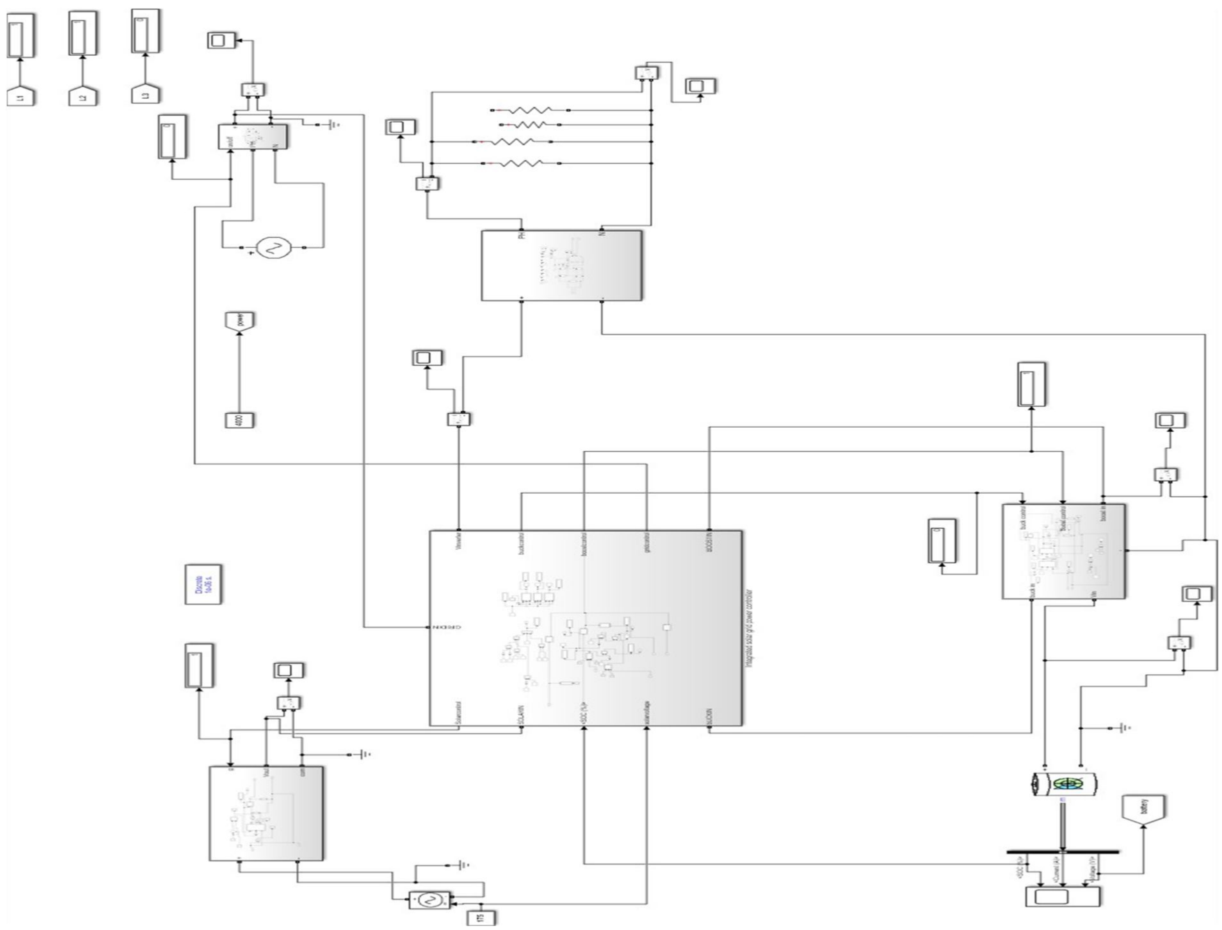

Fig 3: Simulation Model

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VIII. RESULT AND DISCUSSION

The central components of a photovoltaic system are solar panels and their solar cells. The cells consist of semiconductor material. When the tiny photon particles of sunlight hit the material, they trigger current flow. In this way, the energy of the sunlight is converted into electrical energy, or more precisely: into electricity, as you use it every day. This process is called the photoelectric process. The output current is direct current (DC). It can either be consumed directly, stored in a battery or fed into the public power grid. However, because most electrical devices and the power grid operate on alternating current (AC), the DC must be converted into AC with so-called inverters. Rectification converts an oscillating sinusoidal AC voltage source into a constant current DC voltage supply by means of diodes, thyristors, transistors, or converters. This rectifying process can take on many forms with half-wave, full-wave, uncontrolled and fully-controlled rectifiers transforming a single-phase or three-phase supply into a constant DC level. A solar inverter works by taking in the variable direct current, or 'DC' output, from your solar panels and transforming it into alternating 120V/240V current, or 'AC' output. The appliances in your home run on AC, not DC, which is why the solar inverter must change the DC output that is collected by your solar panels.

The charging and discharging of Battery is total controlled by charge controller. In this charge controller the charging of the battery is controlled by Buck converter present in it. Similarly in this charge controller the discharging of the battery is controlled by Boost converter. If the load is less than 1860 watt, then the PV module supplies the voltage to the load and charge the Battery as well at same time. This charging of Battery is controlled by Buck converter.

If the load is greater than 4000 watts as well 8000 watts ,then the PV module supplies the voltage to the load and as well as discharging the Battery as well at same time.This discharging of Battery is controlled by Boost converter.

Under level-1:When the load is less than 1500W,then the power is delivered to load only by solar panel through the solar controller and output from the solar panel is 400V.And solar panel will delivers the power to charge the battery.

1) *level-1:* When the load is greater than 2500W,then the power is delivered to load only by solar panel.
2) *level-2:* When the load is greater than 4500W,then the power is delivered to load by Solar panel & Battery(discharge).
3) *level-3:* When the load is greater than 8000W,then the power is delivered to load by Solar panel, Battery & Grid.

A. *Output Voltage From PV solar Module*

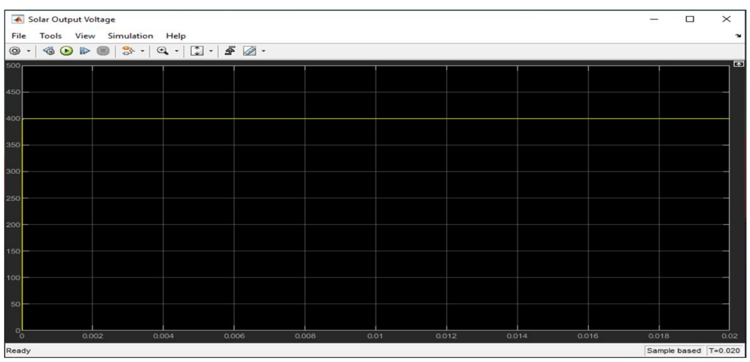

Fig 4 :Output voltage from PV solar module

B. *Output Voltage Waveform*

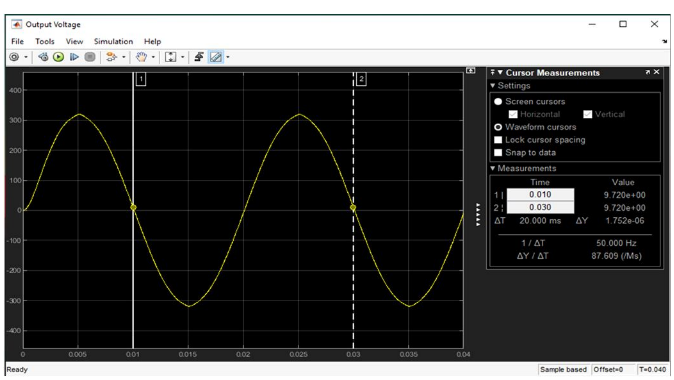

Fig 5: Output voltage waveform

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C. Output Current Waveform

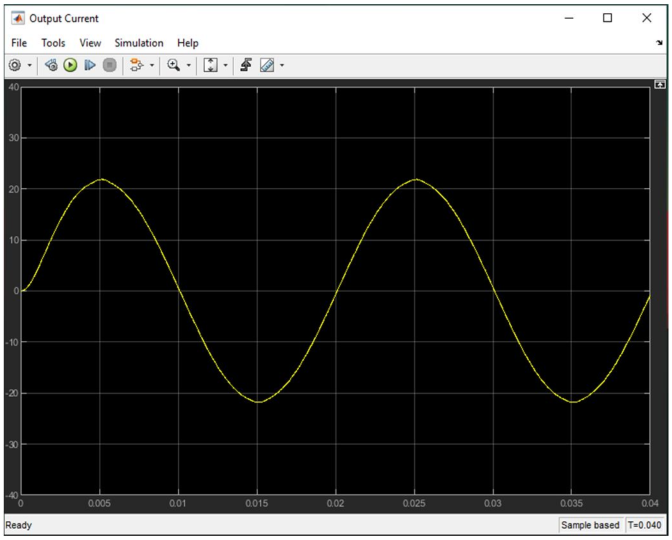

Fig 6: Output Current waveform

VII. CONCLUSION AND FUTURE WORK

In summary, this study presents a general purposes PV simulation module and its application examples in Matlab/Simulink simulation environment. This PV model is easy to configure for a desired PV response characteristics and it directly connects to SimPower Systems electrical circuit for transient response analyses. The PV module has two main parts: A behavioral model of PV cells and a power–limited electrical driver for circuit connection. The behavioral model estimates voltage and current potential of PV panel for a given solar radiation (G) and module temperature (Tc) conditions. The power–limited electrical driver implements a relevant electrical response on the load.

India, with its booming economy and humongous population of over 1 billion, has always faced shortage of energy.At present, almost 53% of India's energy requirements are met with coal; going by the predictions, the coal reserves of the country will not last beyond 2050. It is common knowledge that over 72% of the population of this third world country still resides in villages, with only about half of its rural population getting access to electricity. It is high time India moved to renewable ways to feed its population its fair-share of electricity.

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BIOGRAPHIES

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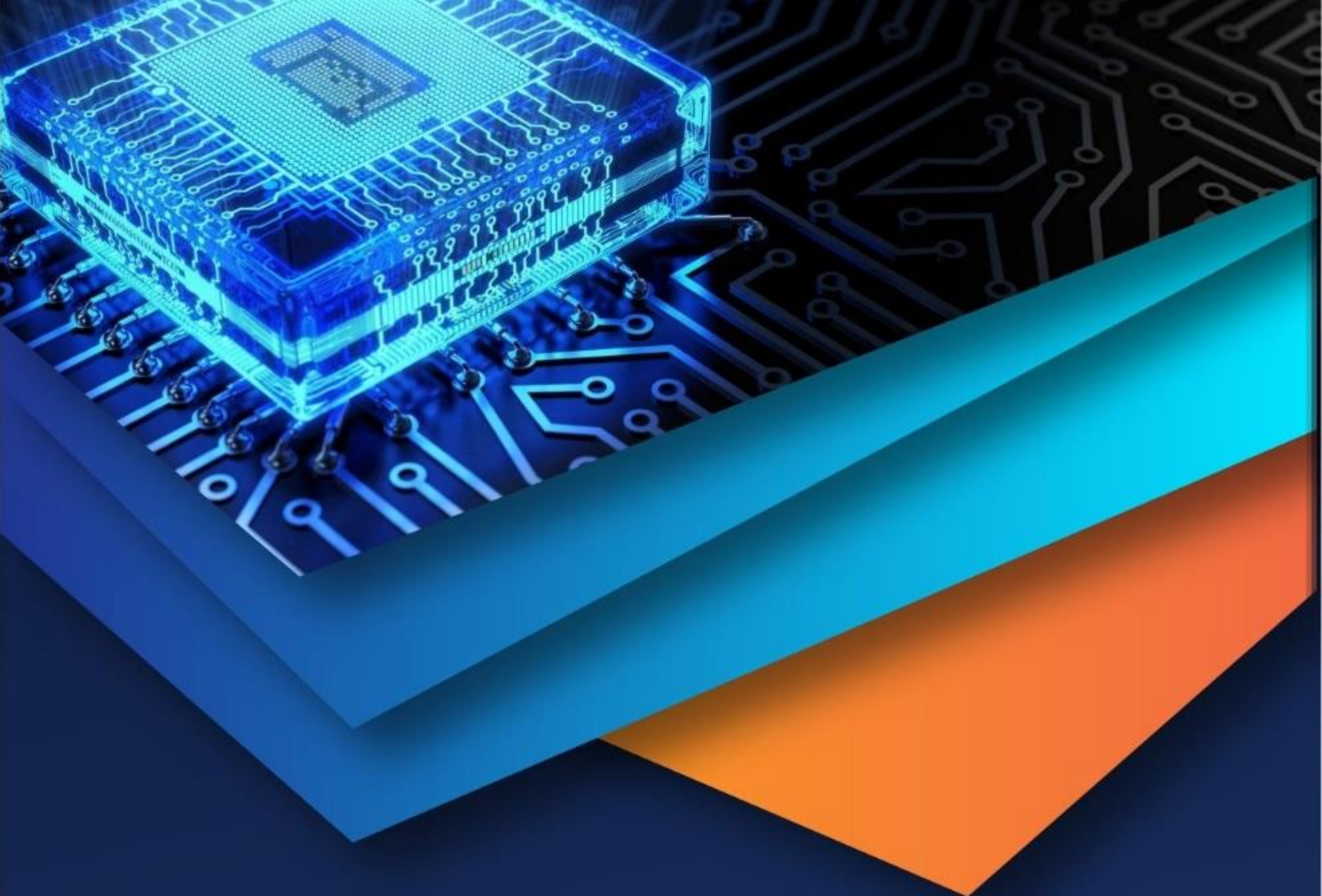

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