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Design of Solar Based Electric Vehicle Charging System

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***Abstract:** Solar-powered system for charging designed for electric vehicle recharging, addressing the primary issues of fuel consumption and environmental pollution. Electric vehicles have been introduced globally and are gradually increasing in popularity. Beyond their environmental advantages, EVs cut travel costs by replacing fuel with electricity, which is significantly more affordableWe introduce an innovative electric vehicle charging system that revolutionizes the charging process. Unlike traditional methods requiring physical connections, our system enables vehicles to charge while in motion without the need for cables. By harnessing the power of the sun, we have developed a solar-powered system that eliminates the dependency on external power sources. This groundbreaking technology incorporates an LCD display, Atmega controller, copper coils, AC-to-DC converter, solar panel, battery, transformer, and regulator circuitry. This intricate assembly allows for wireless energy transfer to electric vehicles, eliminating the inconvenience of charging stops. Consequently, our system seamlessly integrates into existing road infrastructure, providing a sustainable and efficient solution for electric vehicle charging.This paradigm shift in charging technology offers numerous advantages. Drivers can enjoy uninterrupted journeys without range anxiety, as vehicles continuously replenish their energy supply. Moreover, the utilization of solar power promotes clean energy consumption and reduces reliance on fossil fuels. By combining wireless charging with renewable energy, we contribute to a greener and more sustainable transportation ecosystem. This system holds the potential to accelerate the adoption of electric vehicles and drive advancements in electric mobility*
***Keywords:** Electric vehicle, electromotive force, wireless power transfer, efficiency, dynamic charging, direct current.*

I. INTRODUCTION

When General Motors unveiled the first electric car in history in 1996, the path of electric vehicles officially began. Since then, makers of electric vehicles have undergone an incredible technological adventure, and consumers have come to accept them because they don't hurt the environment, thanks to the introduction of models like Nissan and Chevrolet.

Additionally, switching to electric vehicles is seen as a big step toward enhancing sustainability in transportation, lessening reliance on petroleum, and safeguarding the environment. Because of this fantastic benefit, numerous automakers have started to invest heavily in advancing the technology of electric vehicles. The Wireless Charging System (WCS) functions on the basis of Sir Nikola Tesla's 1887 introduction of the Mutual Induction principle. In this phenomena, the first coil, referred to as the transmitter coil, generates electrical energy when a specific current flows through the second coil, referred to as the receiver coil, causing an induced electromotive force (Emf). According to recent developments in this field by research institutions and automakers, this will happen in ten to twenty years, infrastructure for drive while charging might be developed for general application. Consequently, numerous businesses are exploring ways in addition to improve the variety of electric cars not only to effortlessly automate the charging process using wireless charging. The cost of electric automobiles is getting lower than that of engines with combustion being conventional vehicles, primarily because of less carbon dioxide emissions and the rising costs of fossil fuels. Despite these advantages, electric vehicles (EVs) have not been extensively used in the marketplace as a result of various restrictions, including vehicle cost is more, constrained all-electric driving range and a limited infrastructure for charging. EVs are automobiles that run totally or mostly on electricity.They offer lower operating costs because they are more ecologically friendly and require less servicing from moving parts, using normal or not using Petroleum and petroleum products.

II. POWERED AUTOMOBILES (EV's)

A vehicle classified as an electric vehicle (EV) is one that is utilizes a number of engines powered by electricity for its propulsion. A vehicle powered by electricity May be powered by external power sources via a network system, it can have its own energy system comprising a fuel cell, battery, solar panel, or electrical generator that transforms fuel into electrical energy it's shown in fig.1 [4].

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Electric vehicles encompass a wide range of types, including vehicles used on roads and railways, ships on land and sea, electric aircraft, and electric spacecraft Electric vehicles (EVs) have a rich history dating back to the 19th century when electricity first emerged as a viable power source for automobiles. These early EVs offered a quiet, comfortable driving experience that surpassed the capabilities of contemporary gasoline-powered cars. However, the dominance of internal combustion engines in the 20th century overshadowed electric vehicles, relegating them to niche markets like trains and smaller utility vehicles. Despite this, electric power continued to be a reliable and efficient choice for specific transportation needs.

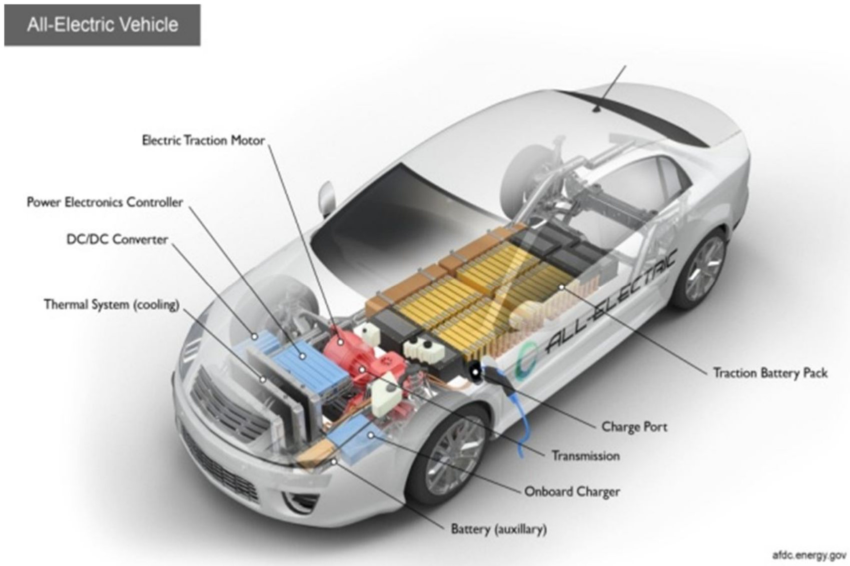


Fig.1. Electric vehicle

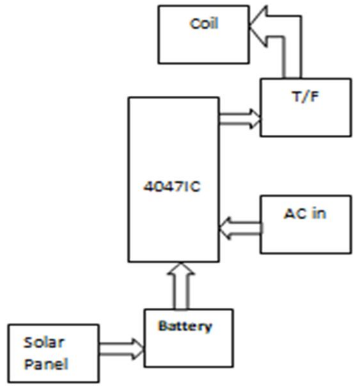
III. OVERVIEW OF EMBEDDED SYSTEM

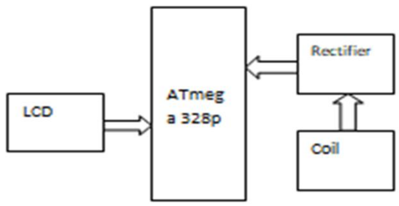
An embedded system is a system made up of a microprocessor or microcontroller, along with its associated hardware and software, specifically created to carry out specialized tasks as part of a bigger either an electrical or mechanical system. It is a reliable real-time control system powered by software that can be operated by human beings, self-governing, or interactive over a network. Embedded systems operate on various physical characteristics and in a various settings. They are typically offered to economical and competitive markets. Main objective is to manage the gadget and make it possible for users to engage with it.

An embedded system is a specialized computer system designed for a specific task within a larger device or system. Unlike general-purpose computers, it doesn't operate as a standalone unit. It's not a software application running on a PC or a traditional business system. Instead, it's tightly integrated into the hardware and performs dedicated functions, often without direct user interaction. Applications for embedded systems include computer networking, smart cards, vehicles, telephones, missiles, satellites, and digital consumer electronics.Some of the devices are shown in the below fig.2.

Fig.2. embedded system

A. Block Diagram





IV. HARDWARE MISSIONS

A. Hardware Elements

1) Solar Panel
2) Atmega 328p
3) 4047 Integrated Chip
4) 1N4007 Diode
5) Wire
6) Light Emitting Diode
7) 16*2 (Liquid crystal display) Screen

a) Solar Panel

A solar panel, also known as a solar electric panel, photo-voltaic (PV) module, PV panel, or solar panel, is a group of photovoltaic solar cells placed in a frame, often in a rectangular shape, and a group of these panels is referred to as a photovoltaic system or solar array. These panels capture the sun's light as radiant energy, converting it into direct current (DC) electricity, which is an electrical energy source. Photovoltaic systems can be arranged to produce solar power that directly powers devices or to send electricity back into the electrical grid through an inverter system. Photovoltaic modules harness the power of through the photovoltaic effect, light energy (photons) from the Sun can be used to generate electricity. Thin-film or wafer-based crystalline silicon cells are used in the majority of modules. The component that supports the weight of the module can be either the top layer or the back layer. It's crucial for the cells to be shielded from physical damage and moisture. It is made by some layers (or) sheets i.e. shown in the fig 3.1.1.

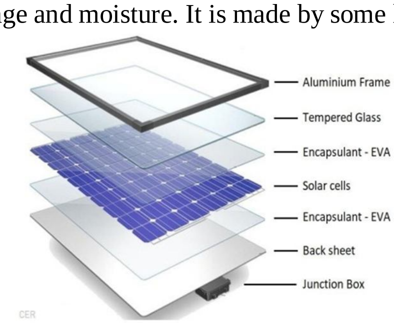


Fig.3.1.1. Solar panel

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b) Atmega 328p

The Atmel ATmega328P is a versatile 8-bit microcontroller built on the AVR architecture. Renowned for its efficiency, it can execute multiple commands in a single clock cycle, achieving impressive processing speeds of nearly 20 million instructions per second when operating at 20 MHz. Packaged in a 28-pin PDIP, it seamlessly integrates with our 28-pin AVR development board. Unlike general-purpose computers designed for a wide range of tasks, such as calculations, multimedia, or web browsing, microcontrollers like the ATmega328P excel in specialized applications.

For instance, it can be programmed to precisely control devices based on environmental factors. A common use case involves regulating an air conditioner: automatically switching it off when the room temperature drops below a set point and reactivating it when the temperature rises above it. This demonstrates the microcontroller's ability to perform specific functions autonomously.

c) 4047 Integrated Chip

The CD 4047 IC is a type of multi vibrator that also includes a high voltage component shown in the Fig3.1.3. It functions in two distinct states: Monostable and Astable. The duration of the output pulse in the Monostable state and the frequency in the Astable state control is done by this IC needs an external resistor and capacitor. It operates at voltages of 5V, 10V, 15V, and 20V. The 4047 IC is a CMOS multi vibrator capable of operating in both Monostable and Astable modes. Its uses span a broad spectrum, from generating pulse and sine waves to converting DC signals to AC signals, among others.

Fig.3.1.3. 4047 IC

d) IN4007 Diode

Fig.3.1.4 shows the IN4007 Diode. The 1N4007 is a versatile rectifier diode commonly utilized in electronic devices to convert AC voltage to DC voltage within the power supply section. It is typically paired with filter capacitors for optimal performance. Additionally, this diode is suitable for a wide range of general applications that require the functionality of a standard diode. They can function as either full-wave or half-wave rectifiers. Three important factors need to be taken into account while utilizing any kind of diode.

- Maximum capability for forward current
- Maximum capability for reverse voltage
- Maximum capability for forward voltage

Fig.3.1.4. IN4007 Diode

e) Wire

A coil is formed by winding a length of rope or wire into a sequence of loops, creating a cylindrical shape shown in the below fig.3.1.5. Each loop of wire is typically known as a turn, and a coil is made up of one or more of these turns. A current coil is essentially a coil, consisting of a wire wrapped around an electrical conductor. Typically, the coil is made of insulated copper wire, while the conductor is a soft iron core.

Fig.3.1.5. Wire

f) Light Emitting Diode

LEDs, similar to transistors and other diodes, are semiconductor devices typically composed of silicon. The emission of light in an LED is facilitated by the introduction of minute amounts of chemical impurities like nitride, gallium, arsenide, and indium into the silicon matrix. Photons are released from the LED when an electric current passes across it.In contrast to traditional light bulbs that generate light through heating a metal filament, LEDs are significantly more efficient as they directly produce photons without relying on heat. LED and its parts are shown in below fig.3.1.6.

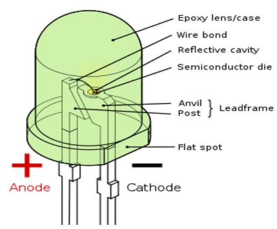


Fig.3.1.6. LED

*g) 16*2 Liquid Crystal Display*

Liquid Crystal Display (LCD) shown in fig.3.1.7. Is a type of flat-panel display that utilizes liquid crystals to manipulate light. Unlike technologies that emit light directly, LCDs require an external backlight or reflector to produce images. These displays are widely used in a vast array of devices, from smartphones and televisions to computer monitors and instrument panels. Their versatility has made them indispensable in both consumer electronics and industrial applications.

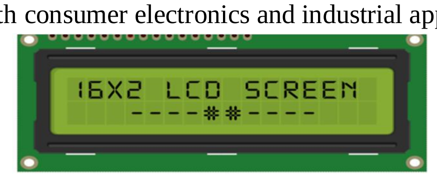


Fig.3.1.7. 16*2 LCD Display

V. HARDWARE OUTPUTS

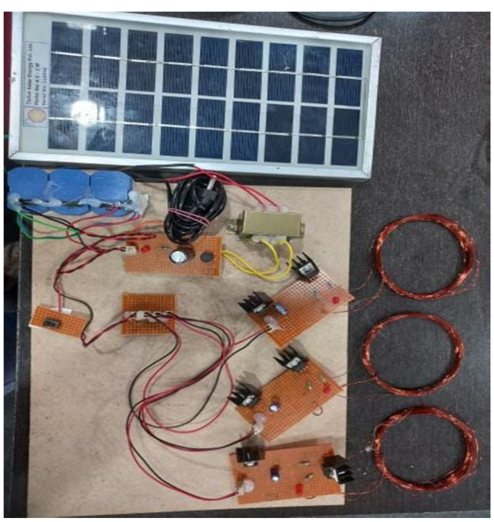


Fig4.1. Transimitter side

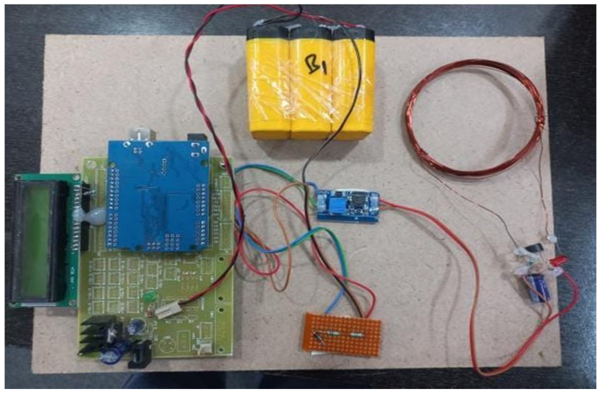


Fig.4.2 Receiver side

The system integrates an LCD screen, battery, transformer, regulator circuits, copper coils, AC-to-DC converter, and Atmega microcontroller. Its core function is to enable wireless charging of electric vehicles while in motion. Solar energy captured by the panel is converted into DC power by a charge controller and stored in the battery. To facilitate wireless transmission, this DC power is transformed into AC using a transformer and then converted back to DC using regulator circuits. The resulting DC current powers the copper coils, creating an electromagnetic field. A second coil, embedded in the electric vehicle, intercepts this field and converts it back to DC for battery charging. This innovative approach eliminates the need for physical charging connections, offering a convenient and sustainable solution for electric vehicle power replenishment.

To revert the AC to DC current, an AC to DC conversion circuit is employed. Furthermore, the voltage of the incoming power is measured by a microcontroller i.e. atmega, and information is displayed on a 16*2 Liquid Crystal Display. Therefore, the structure presents a wireless charging system for electric cars that runs on solar power and can be easily incorporated into existing road infrastructure.

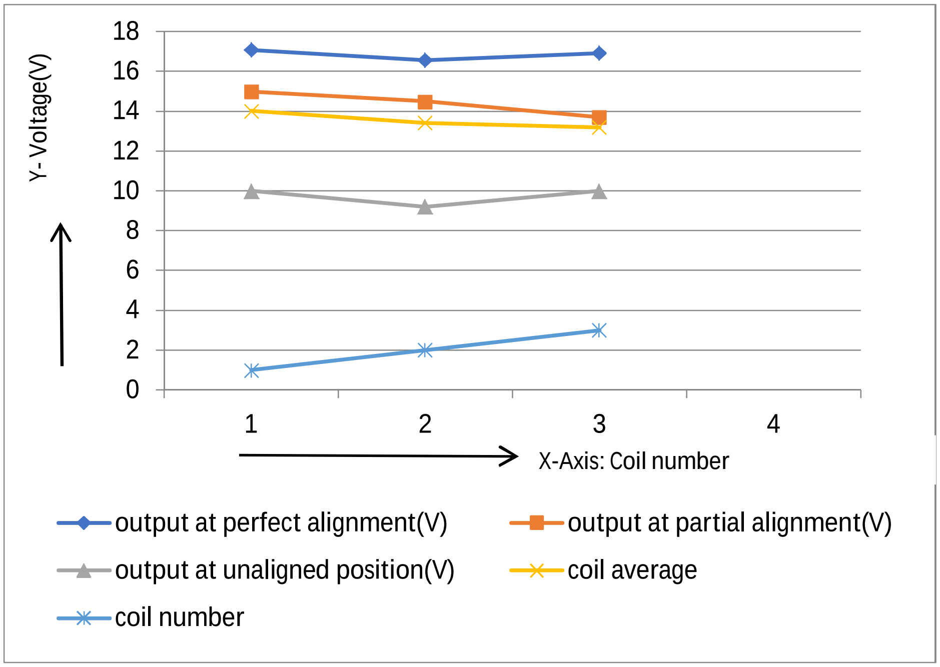
VI. RESULTS

Solar based electric vehicle charging system prototype was developed and works with respect to the given input source. Output voltage values are taken from various positions of the coil alignments are perfect, partial and unaligned positions shown in tables and graphs 1 and 2.

Battery capacity = 1.3Ah
Wattage of solar panel =100W
Battery voltage = 12v
Current = Wattage of solar panel / Battery voltage
= 10W/12V = 0.833A
Therefore theoretical charging time
=battery capacity / current
= 1.3/0.833= 1.56 Hrs =93 min. 38 sec

Table.1. Output Voltage in the Receiver Coils at Various Positions:

Coil no	Output at perfect alignment (V)	Output at partial alignment (V)	Output at unaligned position (V)	Coil average (avg)
1	17.08	15	10	14.02
2	16.56	14.5	9.2	13.42
3	16.92	13.7	10	13.2
avg	16.85	14.4	9.73	

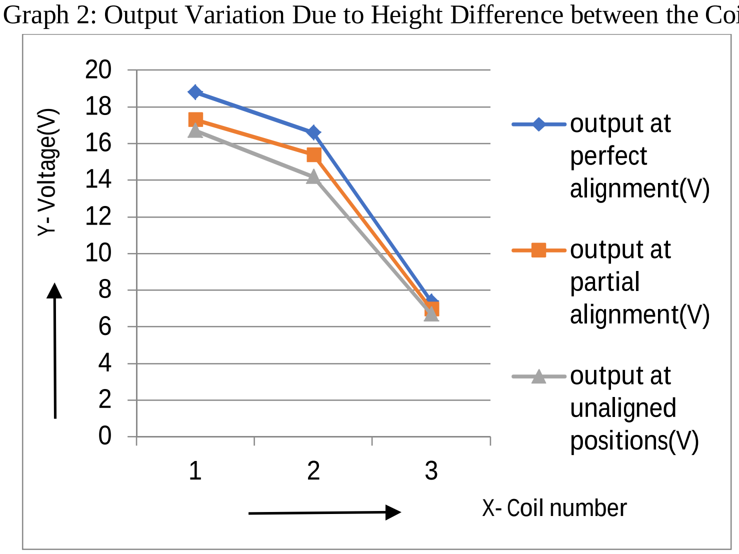


Graph1: Output variation at different alignment of coils

Table.2. Output values at Different Distances between Coils

Height of receiver coil	Output at perfect alignment(v)	Output at partial alignment(v)	Output at unaligned position(v)
5 mm	18.8	17.3	16.7
10 mm	16.6	15.4	14.2
15 mm	7.4	6.98	6.7

Graph 2: Output Variation Due to Height Difference between the Coils.



A clear decreasing trend is noticed as the receivers coil distance is increased from the transmitter coil, showing that the electromagnetic field weakness as distance increases and efficiency depends on this factor as well.

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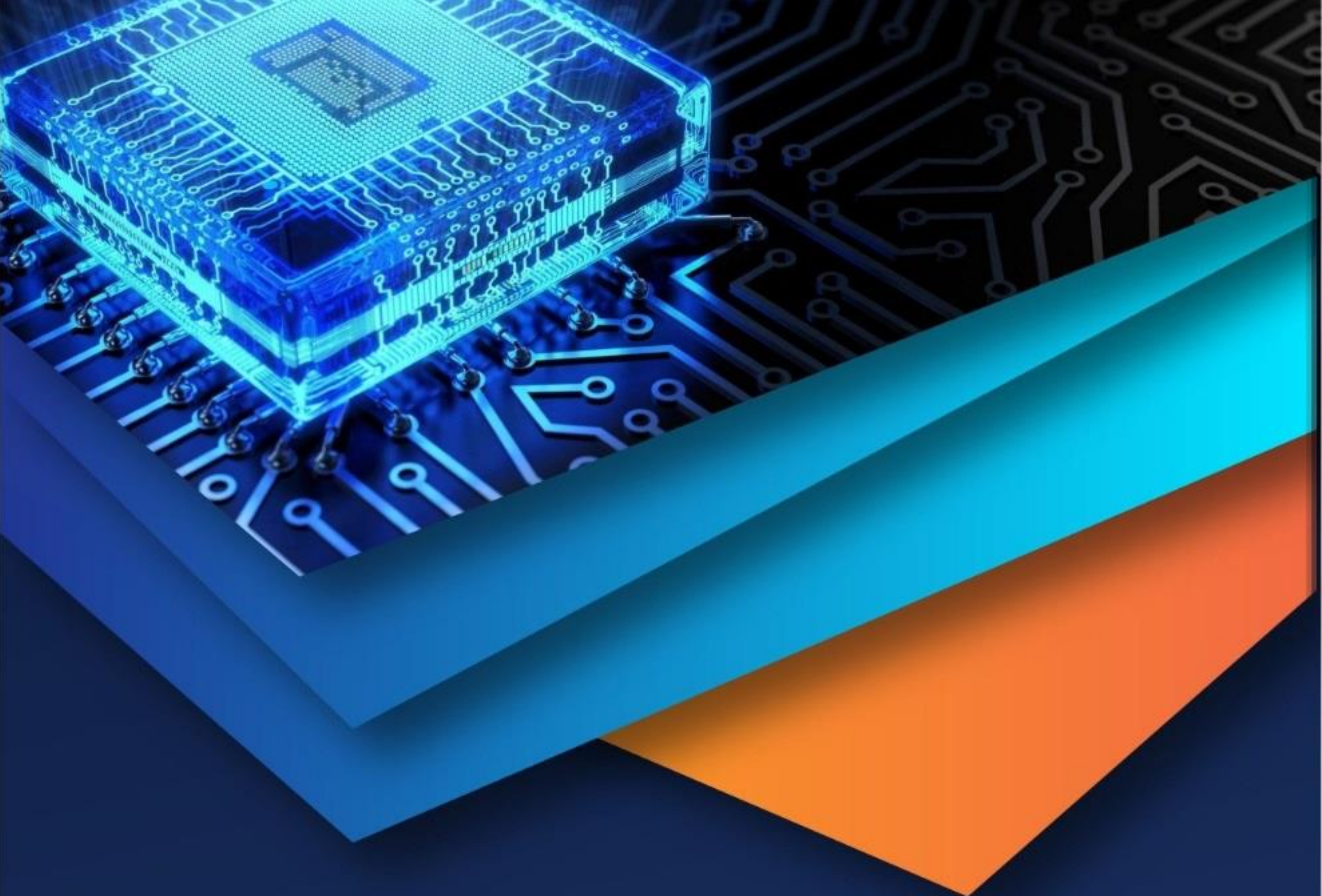

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