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Solar Wireless Electric Vehicle Charging

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Abstract: The paper describes about the dynamic electric vehicle charging system from solar. It reduces fuel and pollution. Nowadays electric vehicle are growing in numbers because of high rates of fuel Electric vehicle has now hit the road worldwide and are slowly growing in numbers.

Also it is proven that electric vehicle helpful in reducing cost of travel and which is cheaper than fuel. So we have developed an electric charging system with unique ideas for solving charging system problem. In this electric vehicle no need of any wire, no need of external power supply, no need to stop vehicle for charging, we can charge EV in moving condition. In this system we use, battery, transformer, Atmega controller, LCD display, regulatory circuit, solar panel, coils of copper, AC to DC converters to develop the system more accurate.

This whole system describes that how an electric vehicle can be charged in moving condition and also eliminating the need to stop the vehicle and charge it. Thus, insulating in the copper coil in the road, we can charge the electric vehicle in the moving condition.

Keywords: Battery, Micro controller, embedded system, transformer, microprocessor, electric vehicle.

I. INTRODUCTION

The on-going climate condition has led to research and development of electric vehicle over the past decade. The increasing global warming has causes awareness among the people to switch to electric vehicles. The time required to wait at charging station while the battery is being charged will be reduce by the considerable amount of time when the charging will be done on road while driving the vehicle.

Even though electric vehicles are an alternative, there need to be development in its charging system to make it the prime option for transport for this purpose, the charging system should be developed. Dynamic charging system are more reliable user friendly and time is efficient.

Also, the battery size can be reduced and range can be improved. This charging system can also be implemented in the travel routes, traffic signal, bus station.

A. Principle of Operation

This wireless technology charging system is based on Qi Standard which was driven by wireless power consumption. This standard is used globally for wireless charging of smartphone. However, it can also be implemented on charging of electric vehicle wireless and this wireless charging system is based on electro-magnetic induction. The transmitting coils located in the base unit act as a primary winding and when current passed through the coil, it creates a magnetic field. This field induces a current in the adjacent coil without touching it. Now, if we used this adjacent coil as secondary winding, wireless charging is obtained by connecting it to a charging unit.

The electrical vehicle charging system is still in the development phase due to many aspects such as safety, cost, infrastructure etc. In this paper, we only try to describe the dynamically wireless electric vehicle charging system from solar panel as a prototype which can be beneficial and used in future.

B. Fundamental Circuit

Fig.1 shows the block diagram of the wireless EV charger. Thus, the transformer is used to step down AC source voltage and then converted to DC using rectifier circuit. Using an inverter, this voltage is converted to AC voltage of the required frequency. The voltage of desired frequency is fed to a transmitter coil of the system which is mounted on the base unit. In the case of dynamic wireless charging this base unit will be mounted on the road. On the base of car, the receiver unit is mounted and through inductive coupling, power is transmitted from transmitter coil to receiver coil. To suit battery specification, the power is then rectified and regulated to battery specification. Through this the charging of battery takes place.

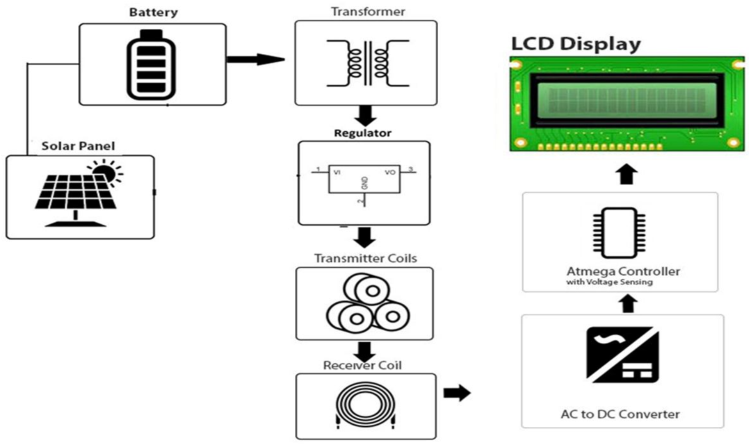

Fig.1 Block diagram of wireless EV charger.

II. IMPLEMENTATION OF WIRELESS CHARGING

Wireless charging is useful in eliminating the need of conductive wires and thus conduction losses which can takes place through wire can be completely cut out. Also, the human handling of wired during the charging process for plug in and plug out can sometimes be hazardous if not done correctly. For safety purpose, the human intervention can be avoided. Even through wireless charging seems to be time saving and effective, it comes with certain limitation. The development in infrastructure is the main aspect need to be done to suit the purpose. This will require a huge investment of capital during all stages of the work and hence it is costly affair. The first wireless electric vehicle charging technology to be developed was stationary, when the vehicle is not operating for an extended this system have been designed to charge any EVs at charging station or garages or public parking. Because a wire or any physical connection is not required, every person has major interest in the charging possibility of EVs while they are in transit. Dynamic EV Charging is charging EVs when they are in motion.

A. Dynamic wireless charging system (DWCS)

DWCS (dynamic wireless charging system) is the system in which EV is charged when they are in motion. The development in power and range is the main concern for charging the electric vehicle. It will be beneficial if we try to improve the range for wireless charging of an electric vehicle. “On road charging” is also termed as dynamic wireless electric vehicle charging. A large capacity of battery is not required, if the charging is done in proper interval and this make the vehicle more reliable, economical and lighter.

DWCS provide a better option for the charging of electrical vehicle to improve its range. The base unit will be placed below the road on predefined route and the car will have the battery bank. When the car is in motion, the car will pass over the road and charging will be done.. This will require a lot of investment and infrastructure modification at the initial stage but slowly the system will help in gaining market for electric vehicle making better option over company conventional means of transport. It is the latest technique for charging and discharging the electric vehicle without any wire or any physical contact between load and source. WPT transfer electrical energy through electromagnetic they are several advantages of WPT such as-

(1) The physical connection requirement is avoided which lead to less fault in charging equipment. Also, it help to start the charging using the software interface (mobile phone, tablet in vehicle application).

(2) The charging equipment is installed under the ground, which helps to facilitate high number of EV charging simultaneously in the same size station. In additional, charging equipment is protected from environmental hazard.

In united states many winds and solar power plant are built along the highways in which the dynamic WPT technology can be integrated with the renewable energy technology. For such situation, the electric energy used for the charging EVs mainly comes from the wind turbine (during the night) and solar photovoltaic array (during the day) on both side of road, the power from the main grid can be used as a reserve. This system provides an electric energy source of EVs right close to where the electricity is generated, which help to reduce the transmission network congestion, reduce power transmission losses, improve the utilization rate of renewable energies, improve power system control and management, and greatly reduce carbon emission from the transportation system. This diagrammatic representation of the DWCS shown in figure 2.

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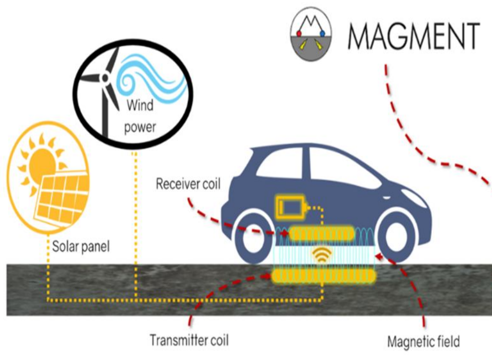

Fig-2: Dynamic wireless charging system

B. Static Wireless Charging System (SWCS)

Wireless charging system creates an different way to provide a eco-friendly environment for user and when plug-in charging system it prevent from safety related problems. The SWCS can easily replace the plug-in charging system with driver application and at the time of trip and electric shock it is able to solve all the safety issues. The primary coil is usually installed below the electric vehicles front, back or centre. The energy received from the electric vehicle is first converted from AC to DC by using a power converter and then it is transferred and store in the battery bank. Power control and battery management system are link with a wireless communication network to receive any feedback from the primary side, thus it is able to overcome any safety issues. The charging time of the electric vehicle depends upon the charging level of the source, size of the charging pad and air-gap distance between the two winding. In lightweight vehicles the average air gap distance between the two coil is about 150-300 mm. Through the mechanism it is found that the distance between coils can be reduced to applicable level.

Fig-3: Static wireless charging system

III. CHALLENGES AND HANDLES TO THE DEVELOPMENT OF WEVCS:

Prior to the creation of a wireless electric vehicle charging system, issues with infrastructure development and maintenance, financing, power range restrictions, and public health and safety should be resolved. The current standard must be marked on health and safety-related issues like EMC, fire, and electrical hazard. Another obstacle to the acceptability of the WEVCS system is the power range restrictions in comparison to the conventional charging technology..

It can deliver a range of 60 to 80 miles in 20 minutes using the DC quick charging method. This technology is still in its research and development stages today. To solve these problems, a sophisticated network of static and dynamic wireless charging stations must be deployed on the road. This type of network requires a redesigned infrastructure construction due to incompatibility with the current setup. The maintenance of the structure becomes extremely important because it is an expensive investment, thus it is important to prevent any significant losses caused by inappropriate handling, wear and tear, and limitations of foreign object detection. To successfully deploy WEVCS, a wide range of simulation-oriented experiments are recommended in order to create user-friendly standards that can guarantee global consistency.

IV. MERITS AND DEMERITS OF WIRELESS CHARGING SYSTEM

A. Merits

1) *Environment-Friendly* - The biggest and best reason to use an electric vehicle is that it is environment-friendly. Vicious gases are not release that leads to pollution in air as against the fossil fuel powered cars.
2) *No Fuel or Gas Cost* - Since electric vehicle need no fuel or gas to power them, and user can steep rise in price of these commodities. Mainly all we need to plugged-in and ready to go for another 100 miles.
3) *Convenient* – The wireless electric vehicle is easy to recharge. From this, we have no longer need to run for the fuel station for charging the car. Even we can use regular electric socket for charging an electric car..

B. Demerits

1) *Quieter* – Electric car cut noise pollution as they have fewer moving part than a conventional vehicle. They are much quieter when in operation. An electric car is very quiet and very smooth compared to a petroleum powered internal com bustion engine vehicle.
2) *Dynamic* – The electric car will charge while moving there is no need to stop the car, it saves our time.

V. WORKING

A. Solar Panel

Solar energy is transformed into electrical energy by solar panels. They make advantage of the photoelectric effect theory, which states that when light strikes a solar panel, electrons are emitted. Silicon cells are used to make solar panels. Since silicon has an atomic number of 14, when light strikes a silicon cell, two of its outermost electrons are present. This starts the flow of electricity that I started. Two separate sales structures exist for silicon. both single-crystalline and multicrystalline Monocrystalline solar panels are produced in silicon wafer format from the final silicon block. In the same way that monocrystalline silicon cells are more effective but more expensive than polycrystalline ones, polycrystalline silicon cells are likewise silicon cells made through melting many of the silicon crystals together.

B. Batteries (Power Supply)

Batteries are particularly useful as a power supply in situations where a stable source of power is not available or where mobility is important. To use a battery as a power supply, the device being powered must be designed to use the specific type of battery being used. The device must also be designed to operate within the voltage range and current output capabilities of the battery. When using batteries as a power supply, it is important to monitor the battery level and recharge or replace the battery when necessary. Over time, batteries can lose their capacity to hold a charge and may need to be replaced. Overall, batteries are a versatile and convenient way to provide power in a wide range of applications where a portable or backup power source is needed.

C. Step Up Transformer

The low voltage (LV) and high current from the primary side of the transformer are converted to the high voltage (HV) and low current value on the secondary side of the transformer by a step-up transformer. Known as a step down transformer, this is how it works in reverse. The transformer in daily definition is a piece of stationary electrical machinery which can converts electrical energy from primary side windings to magnetic energy which is located in the magnetic core of the transformer and then back to electrical energy (on secondary side). There are numerous uses for step-up transformers in transmission lines and electrical systems. Although the voltage and current numbers are typically different, the operating frequency and nominal power are roughly identical on the primary and secondary transformer sides due to the transformer's high efficiency.

D. MOSFET

The metal–oxide–semiconductor field-effect transistor. Multiple outputs and overcurrent and overvoltage features are possible with an AC/DC converter. The majority of high frequency transformers are used in machinery or equipment that needs a certain level of voltage or current. The transformer's original design called for it to be coupled to an H bridge, which delivers high frequency voltage pulses to the primary coil for conversion into higher voltages and transport to rectifier units. In addition to the traction battery specialist systems used for commercial (or recreational) vehicles, an electric vehicle battery (EVB) is a battery intended to power a battery electric vehicle (BEV) system. Usually secondary (rechargeable) batteries, these batteries are. Batteries used in electric vehicles, commonly referred to as traction batteries, power the electric motors.

E. Transmission Coil

This coil is employed to transfer power to the wireless power receiver coil in CAR SYSTEM. This gets power from Grid and solar panels. The transmitting coil is 28 gauge and 32 gauge.

F. Receiving Coil

The fundamental components of the receiver section are the receiving inductor coil, the bridge rectifier, the voltage regulator, and the rechargeable battery. Bridge rectifiers are used to convert the AC signal received by the coil into a DC signal. The voltage produced by the bridge rectifiers is unregulated and needs to be changed into a regulated constant voltage.

G. Bridge Rectifier

Alternating current is changed into direct current using a bridge rectifier. When compared to a centre tapped full wave rectifier, it offers excellent rectification efficiency (82%) and cheap implementation costs. It uses a 1N4007 diode.

- Electric Cars
- Heating and Ventilation
- Transportation
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H. DC Battery

The electric vehicle battery or hybrid electric vehicle's electric motors are mainly powered by a re-chargeable battery which is known as electric vehicle battery also referred to as a traction battery. They are made especially for high electric charge (or energy) capacity lithium-ion batteries. Mainly lighter and smaller batteries are more preferable because they reduce the weight of the vehicle and also increase its performance. We can distinguish electric vehicle batteries by their high power-to-weight ratio, energy density and from their specific energy. From their high energy density weight, lithium polymer batteries and lithium-ion are the most popular battery types in electric vehicles. Most of the batteries we can also include for charging the electric vehicles are nickel-cadmium, lead-acid and nickel-metal hydride (valve-regulated lead acid and many more lead batteries). Batteries can store electricity in the form of coulombs or ampere hours, with the total energy often measured in kilowatt-hours (kWh). As compare to energy storage methods, they have high energy mass, batteries like lithium-ion are currently implanted in the majority of portable gadgets and electric vehicle, including mobile and laptops. They also have highly power-weight ratio, high-temperature performance, high energy efficiency, and less self-discharge.

I. ATMEGA Controller

A 32K 8-bit microcontroller based on the AVR architecture is the Atmel ATmega328P. At 20MHz, a lot of instructions are processed in a single clock cycle, yielding a throughput of almost 20 MIPS. The ATMEGA328-PU is compatible with our 28 pin AVR Development Board and is available in a PDIP 28 pin package. The computer, on the other hand, is made to accomplish all general-purpose activities on a single device, such as running software to perform calculations, storing multimedia files, or accessing the internet through a browser, whereas microcontrollers are made to execute only certain tasks. A straightforward, inexpensive, low-powered micro-controller is frequently required for a variety of applications and autonomous systems. The Arduino Uno, Arduino Pro Mini, and Arduino Nano models are perhaps the most popular examples of this chip's use in development environments.

J. LCD Display

A flat panel display, electronic visual display, or video display that makes advantage of the light-modulating capabilities of liquid crystals is known as a liquid-crystal display (LCD). From liquid crystals light cannot be emitted. There are LCDs that can show random images (as on a general-purpose computer display) or fixed graphics that can be shown or hidden, including pre-programmed words, numbers, and 7-segment displays like those found in digital clocks. They both make use of the same fundamental technology; however different displays have larger elements whereas random images are made up of a lot of tiny pixels. The major wide-ranging applications for LCD display can include computer monitors, televisions, mobile phones, instrument panels, cockpit displays in aircraft, and signs and many more.
In this project, the LCD displays the voltage % of charging and discharging of electric vehicle.

VI. CALCULATION AND ANALYSIS

It is typically referred to as a loosely coupled transformer for electromagnetic induction-based coils that are weakly coupled. The mutual inductance between them for a concentric single-turn circular coil is as follows:

$$M = \mu * \sqrt{r1 * r2} * \frac{2}{f}\left[\left(1 - \frac{f^2}{2}\right) * K(f) - E(f)\right]$$

We can be obtained f with the formula:

$$f = \sqrt{\frac{4 * r1 * r2}{z^{2} + (r1 + r2)^{2}}}$$

μ is the permeability of vacuum (μ = 4 · π · 10−7H/m). r1,r2 is the effective radius of the circular coil, and z is the distance between two concentric circular coils, K(f), E(f) are the first and second type incomplete elliptic integrals. Whenever two single-turn of concentric coils it have the same effective radius.

The mutual inductance b/w the two coils rewritten as:

$$M = \mu 0 \cdot r f \cdot [(2 - f^{2}) \cdot K(f) - 2 \cdot E(f)]$$

$$f = 2 \cdot a * \sqrt{\frac{1}{z^{2} + 4a^{2}}}$$

Similarly, for the concentric single-turn rectangular coil, the mutual inductance formula can be written as follows:

$$M = \frac{2\mu 0}{\pi}\left[\sqrt{2(a+c)^2 + z2} + \sqrt{2(a+c)^2 + z2} - 2\sqrt{2a^{2} + 2c^{2} + z^{2}} - (a+c)\cdot \operatorname{arctan}h\frac{a+c}{\sqrt{2(a+c)^{2} + z^{2}}} - (a-c)\cdot \operatorname{arctan}h\frac{a-c}{\sqrt{2(a-c)^{2} + z^{2}}} + (a+c)\cdot \operatorname{arctan}h\frac{a+c}{\sqrt{2a^{2} + 2c^{2} + z^{2}}} + (a-c)\cdot \operatorname{arctan}h\frac{a-c}{\sqrt{2a^{2} + 2c^{2} + z^{2}}}\right]$$

The coupling coefficient can be calculated, by calculating the mutual inductance,

$$K = \frac{M}{\sqrt{L1 \times L2}}$$

Where M is the mutual inductance between the two coils, L1 and L2 are the self-inductance of primary coil and secondary coil. In the Conventional transformers the coupling coefficient is essential but in loosely coupled transformer it is not essential because it is approximately around 0.2. This improvement for the coupling coefficient, it represents the improvement of overall system efficiency. By doing comparison between the mutual inductance of two cases, it also represents about the relationship and the coupling coefficient. So, we had to take the same effective radius, put all the data into the MATLAB so that we can calculate the efficiency of them.

VII. CONCLUSION

The above study effectively demonstrated about the construction of wireless electric vehicle charging system using solar panel. The electric vehicle charging wirelessly reduces the need of transmission wire and reduces the fuel consumption, making it a simple and more practical way. This method reduces the rid of hardware components wear and tear. This wireless charging system can be implementing through dynamic electrical vehicle charging system.

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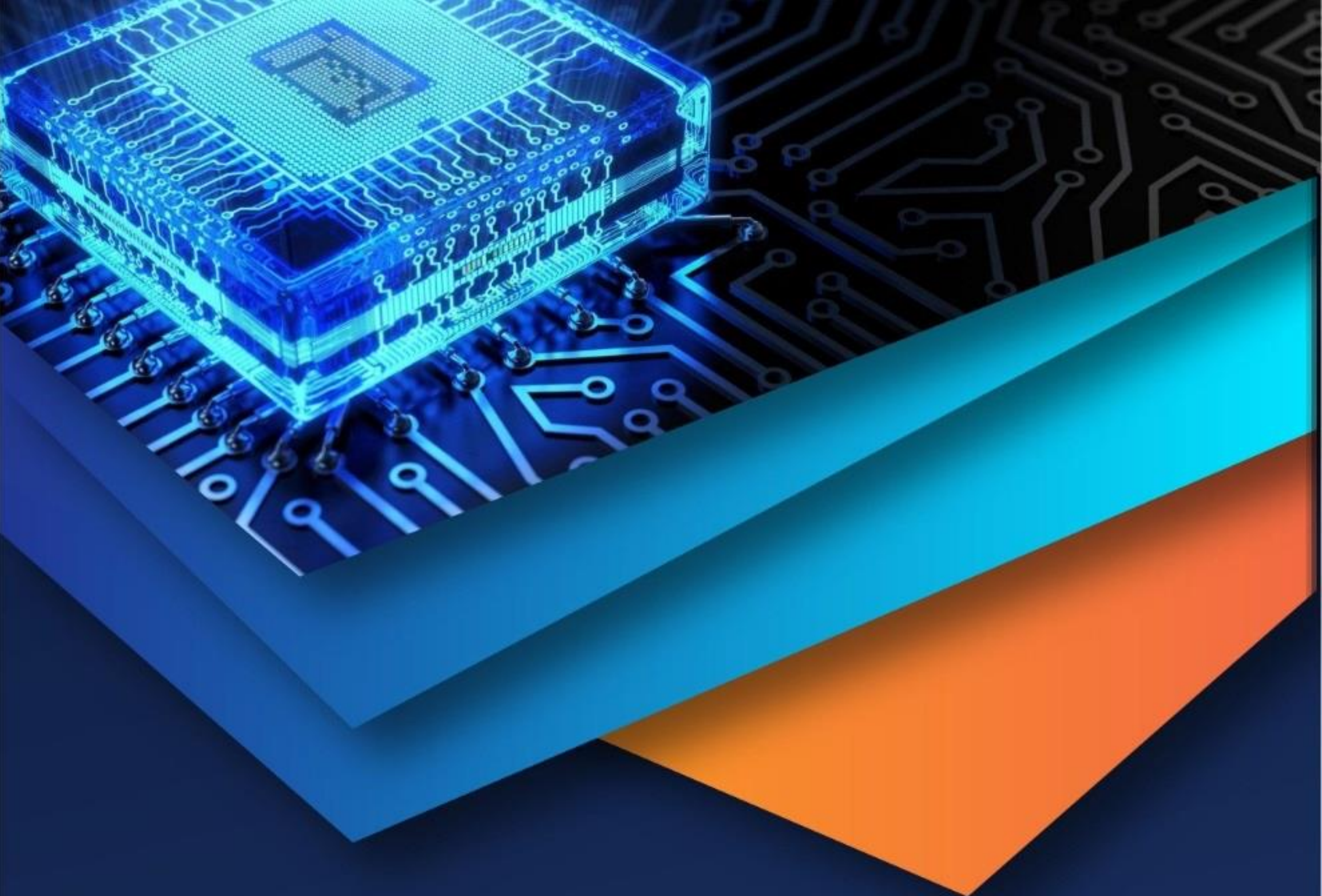

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