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Design and Implementation of Smart Energy Meter

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Abstract: ***In this paper we are presents the design and implementation of a smart energy meter using an PIC16F886 microcontroller and a liquid crystal display (LCD). It is used in residential consumer. It is an electric device having energy meter chip for measuring the electric energy consumed. It is also allowing the meter owner to have a meter utilized and the corresponding amount will be displayed on the LCD continuously. Also they can monitor the meter reading regularly without the person visiting each house. Microcontroller PIC16F886 to prevent and control the energy meter from power theft. In the voltage system whenever occurring of under voltage and over voltage condition then meter should be given a constant voltage.***
Keywords: Smart meter, PIC16F886 microcontroller, Power consumption, Voltage stabilizer and LCD display.

I. INTRODUCTION

In economically developing countries like India, power theft is very common issues which is not only economic losses but also irregular supply of electricity.

Smart energy meter is more capable, more reliable than existing energy meter. Smart electricity meter track energy consumption and energy meter measured the total electrical energy in units used by the appliances which consume electrical energy from the main power supply. Smart energy meter can take reading from the energy meter and is used for calculating cost. This system works with an AT Mega PIC16F886 microcontroller.

In our project the amount of electrical energy consumed in the given period of time. It gives just the number of units consumed in KWH and related the cost. In our project additional part is that which is capable of handling the higher voltage greater than 230V as well as lower voltage less than 230V passed by substation for a sometimes and it maintain constant voltage by using voltage stabilizer. In our project, for billing purposes we have used Visual studio for GUI (Graphical User Interface).

II. LITERATURE REVIEW

A new concept of energy meter will be discussed, when the occurring of over voltage and under voltage meter should be given a constant voltage. The system consists of the electricity meter which measures the electricity bill and inform the consumer about the number of units consumed and related cost with it. The microcontroller communicates the whole system with the help of its different components connected to it. The system gives high mobility, low cost and easy maintenances of the total system. Smart energy meter is used for monitor the energy usage of different applications and provide other features like advanced billing system and high accuracy. Meter can control energy supply and energy based on load requirement. A smart meter is an electronic device to measure and manage the power consumption. The energy meter consists of dedicated 8bit PIC microcontroller PIC16F886.

III. SMART METER FOR POWER TEMPERING

The energy meter tempering can be reduced to far extent by using advanced smart meter. These smart meter are capable of handling higher loads that are transferred by sub power station several times during the day and maintaining constant voltage of 230v across the appliances.

In this meter tempering prevention method we have provided the facility called meter temper. The smart meter immediately gives tripping signal to the relay and relay then trip to the smart meter to off condition. The meter could reset only by the professional person who is send by the electricity power service provider. That's why electricity service provider comes to know has interfered with the smart meter.

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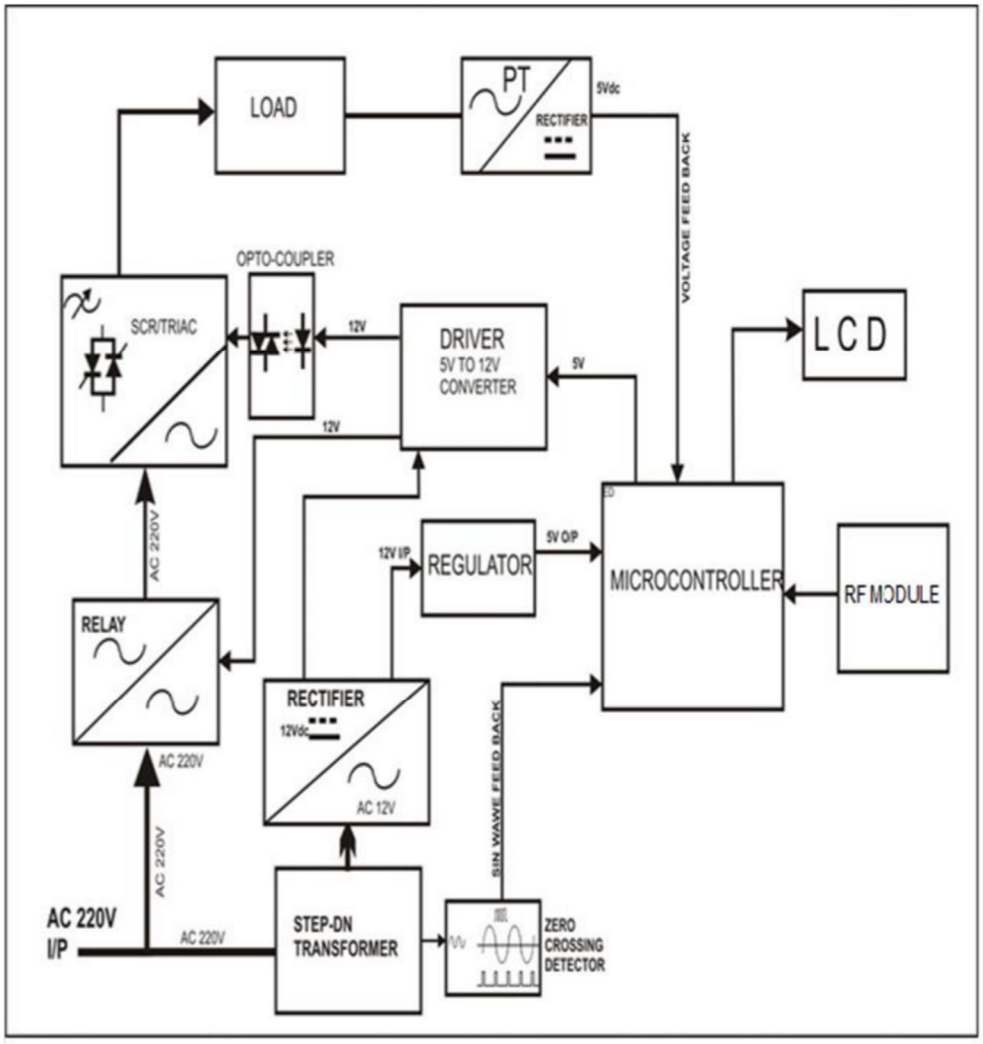

Fig 1. Block diagram of smart energy meter

IV. WORKING OF BLOCK DIAGRAM

In the above block diagram, the main goal is to control and constant the voltage across the load. Initially controller check the incoming voltage coming from the line with the help of analog to digital converter (ADC) present inside the microcontroller. To control a +ve as well as -ve half cycle of incoming AC for that a firing angle control method is used. For controlling a firing angle of any AC voltage it is necessary to monitor every +ve/-ve half cycle, hence a sine wave cycle monitor zero crossing detector (ZCD) block is used in our project. Controller calculate the firing angle and gives firing pulse to the AC to AC converter (cycloconveter) in which a static switch form by SCR/TRIAC is used.

The output of cycloconverter is further give to reactor which is nothing but a type of single core step-up transformer. 220v to 300v transformer is used in our project, which gives 220v output at 140v AC input. Potential transformer is used to step down the voltage across the load to be measure and rectified to DC, because microcontroller can read a voltage up to 5v dc only.

In our project we are using a relay (SPDT) for tripping the input voltage in case of very high voltage and low voltage which is beyond controllable limits. The rating of the relay is used in our project 12v and controller can give maximum of 5v, hence it is necessary to amplify the 5v to 12v for which a driver circuit is used. Microcontroller operates on 5v DC to work, and same will be generated with the help of power supply which comprises of a step down transformer, rectifier, filter and regulator. Transformer step down the 220v AC to 12v AC, rectifier and filter convert this 12v AC to 12v DC, and regulator converts a 12v DC to a constant of 5v DC.

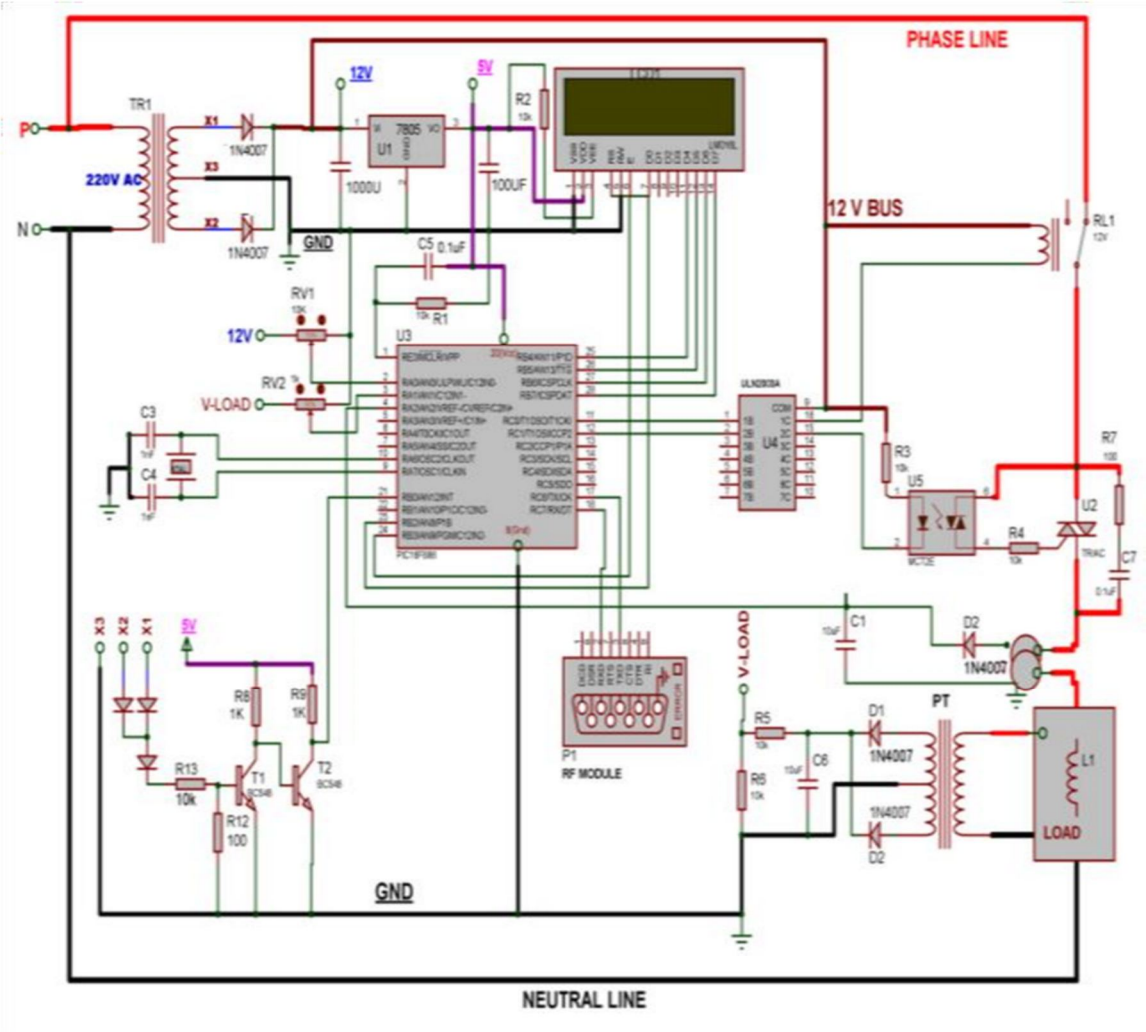

Fig 2. Circuit diagram of smart energy meter

V. WORKING OF CIRCUIT DIAGRAM

In our project we used step down transformer of 220v/12v AC. Then the rectifier and diode through the 12v AC converted to 12v DC. We used the filter capacitor for the purity of DC voltage. This 12v DC gives to the input of regulator IC and through this it convert in the 5v DC. here, all the components are work on 5v DC.

Zero crossing detector circuit made by transistor is used in our circuit, which informs a controller about start point of every cycle. Once controller gets the input voltage across the load and signal from sine wave cycle monitor, controller calculate the firing angle and gives firing pulse to the cycloconverter in which a static switch formed by a SCR/TRIAC is used. In the circuit TRIAC operated on high voltage and comparatively high frequency as compared to the mechanical switches like relay. The output of cycloconverter is further give to load.

In our project we use capacitor on 5v dc as a storage capacitor. We use one capacitor and resistance for starts operating and to reset microcontroller. Microcontroller measures the input and output voltage but in our project we measure only output voltage so that we use here potential transformer. The rating of potential transformer is 220v/6v. To convert 6v ac into 6v dc we use filter and rectifier. As optocoupler gets signal through the microcontroller it helps to TRIAC turn ON. After turn on the TRIAC it continuous with the load.

An RC snubber circuit is also used to protect TRIAC from reverse/ back emf caused by inductive load. All the parameters like input/output voltage firing angle will be displayed on the LCD which is 16*2 alphanumeric type in our project.

VI. COMPONENTS DISCRIPTION

A. *PIC16F886 Micro-Controller*

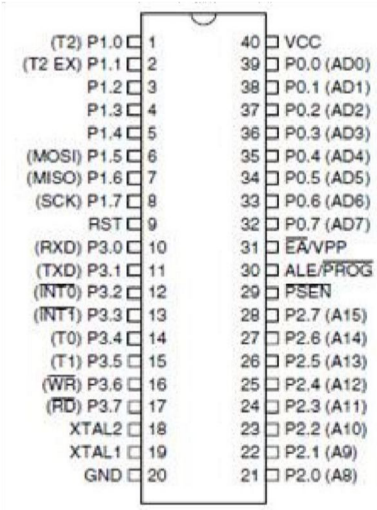

Fig 3.Pin Diagram PIC16F886 MICRO-CONTROLLE

In this project we are using a PIC(16F886) microcontroller. The whole process of the device is done by using a microcontroller. The microcontroller 89S52 is a small but powerful microcontroller. These controller is manufactured using Atmel's high density non-volatile memory technology. In this project, we are using a 28 pin microcontroller having 16K/b of FLASH ROM, 1.2KB RAM, and 256 bytes of EEPROM. In these microcontroller 10bit ADC which requires measuring input and output analogs voltages.
AT89S52 is one of the popular microcontroller from the Atmel family. This microcontroller has 40 pins, out of which 32 are GPIO pins.AT89S52 also has an inbuilt watchdog timer to operate microcontroller low power mode.

B. *Zero Crossing Detector (ZCD)*

In this project, ZCD is used to generate a synchronous pulse related to the AC voltage phase angle often used in power control circuit. The pulse occurs at 0,180 & 360 degrees. 5v regulator is also used as biasing voltage for both transistors (Q1& Q2) and the control section. When the pulsating voltage goes to zero then the collector of transistor Q1 goes high. ZCD is used for detecting the pulse when the voltage is zero.

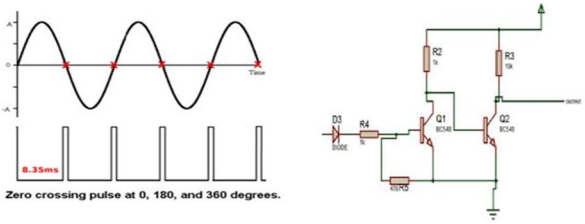

Fig 4. Zero crossing detector

C. *LCD (Liquid Crystal Display)*

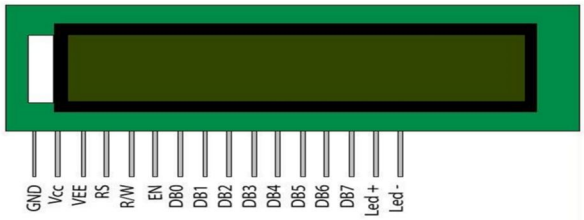

Fig 5. Pin configuration of LCD display

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In this project we are using a (16*2) LCD. It can display a 16 characters per line and there are two such lines. In this type of LCD each character is displayed in 5*7 pixel matrix. This LCD has two register, which are command and data. The command register stores the command and gives instruction to the LCD. The data register stores the data which are displayed on the LCD.

D. Snubber Circuit

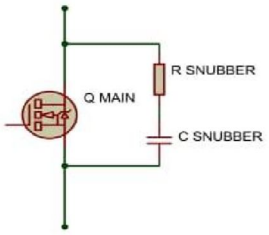

fig 6. Snubber circuit

Snubber circuit is a circuit consisting of series combination of resistance and capacitance in parallel with SCR. A zener diode snubber and a resistor –capacitor (RC) snubber. A snubber circuit works by absorbing excess energy due to the leakage inductance I_L. Thereby protecting the IC from potentially dangerous high voltages or excessive ranging.

E. Optocoupler

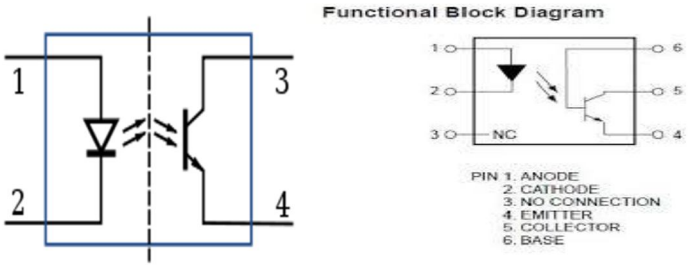

Fig 7. Circuit and pin diagram of optocoupler

The opto-isolator is also called an optocoupler, photocoupler, or optical isolator. Opto-coupler that transfer electrical signal between two isolated circuits by using light. Opto-coupler prevent high voltages from affecting the system receiving the signal from input. An opto-coupler is designed to provide complete electrical isolation between an input and output high voltage side (SCR/TRIAC) circuit.

F. IR Regulator IC LM7805

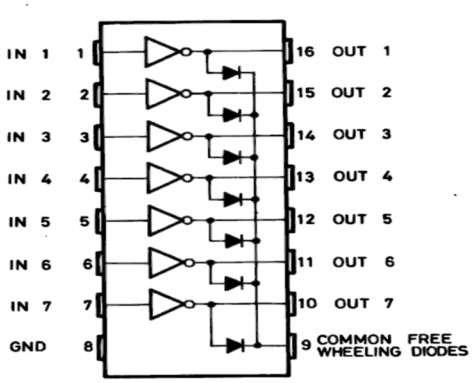

Fig 6. IR REGULATOR IC LM7805

In our project we are using a IR regulator IC LM7805 electronic device such transistor, IC's etc. Generally requires DC for their operation. So stepped down AC is converted to DC supply by rectification process. The 12v supply given to the LM7805 regulator. Now as microcontroller , LCD module, relays and other certain IC's requires 5Vdc supply for their operation we need a regulated uninterrupted 5vdc supply. The block involves production of 5v dc supply for whole circuit.

VII. RESULT & CONCLUSION REFRENCES

In this project smart energy meter is a device which communicates with both the customer and distribution network in a bidirectional way. Energy saving, proper balancing of the load, energy management studies, energy data analytics and new electrical products. The propose the smart energy meter technology shows the consumer and the energy consumed of the electrical energy without creating any stress to the distribution network. The smart energy meter to control over voltage and under voltage. The lower range of under voltage and higher range of over voltage and result should be constant between 220v-240v continuously. For example., under voltage is 170v and over voltage is 300v then meter should given range between 220v to 240v

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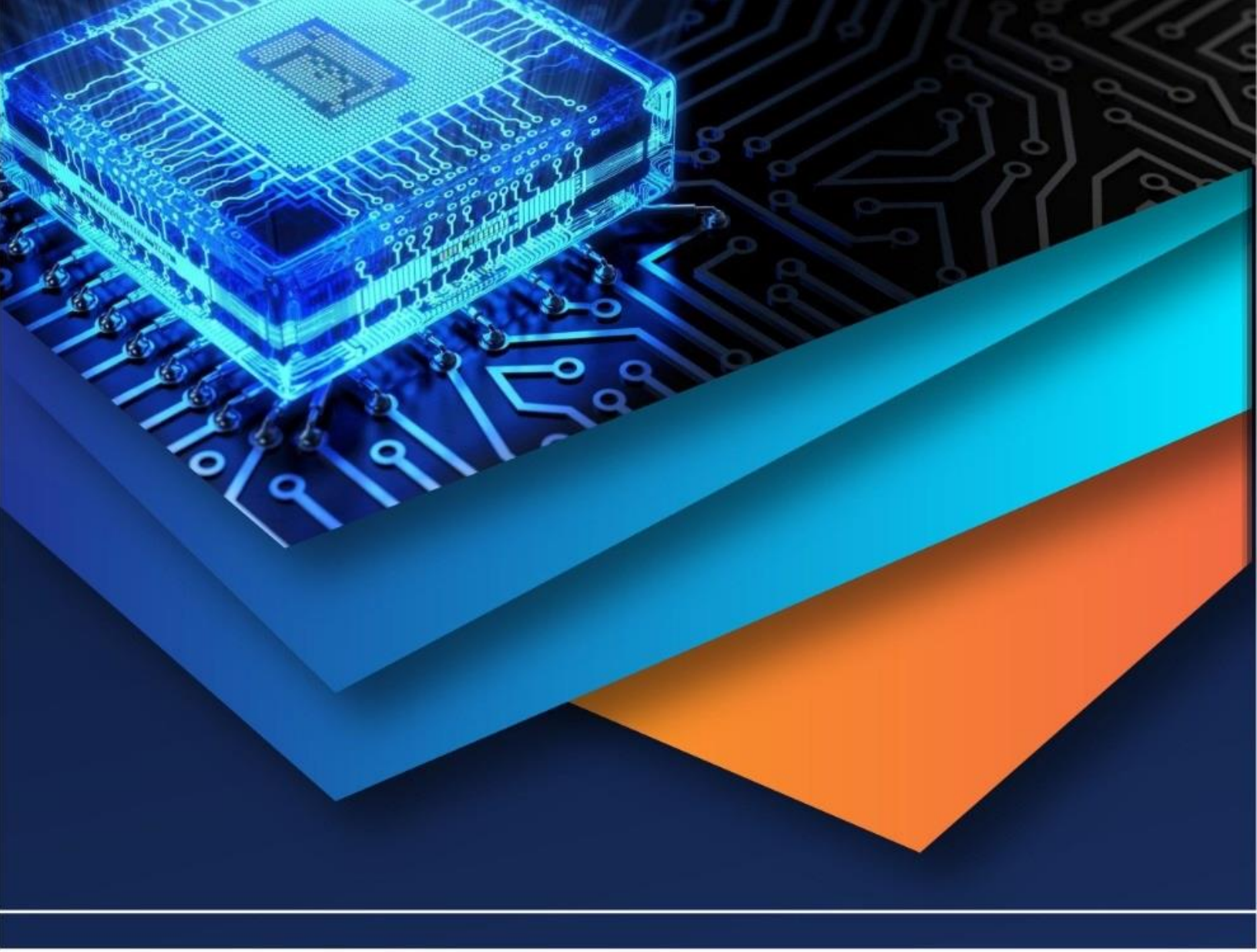

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