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Automatic Fault Detection and Wireless Remote Monitoring for EB Transformer using Embedded System

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***Abstract*— This paper discusses about the techniques that are to be followed to save the expensive transformer by identifying the fault and monitor the parameters of the transformer with the wireless technology. In India Power Distribution is done through Step-Down and Step-Up Transformers. So Transformers plays a crucial role in Electricity Board for Power Distribution. Every street consists of a Transformer (Step-Down) for the end user distribution. Nowadays, the computer and microcontroller plays very important role everywhere to reduce the human error and to increase the productivity, utility of resources and usage. We cannot monitor all the transformers manually; we need a healthy man power do it. This might be a risky task too. So to monitor the transformer routinely and inform us when it gets into problem will be an effective System. This paper facilitates the purpose of using the microcontroller to monitor the parameters of the transformer using the RF signal and to control it in the abnormal conditions. Different types of faults can be monitored and identified by means of an intelligent microcontroller in the Transformer unit side. The identified faults can be transmitted through RF signal to the monitoring Unit. In the monitoring Unit side the received signals are interfaced with the Lab view which helps to keep track on the working of transformer and the controlling actions are taken place once when it goes to the abnormal conditions.**

***Keywords*— Transformer, Sensors, RF, signal conditioning unit, PIC Microcontroller, Lab view.**

I. INTRODUCTION

A transformer is an electrical device that transfers energy between two or more circuits through electromagnetic induction. These transformers play a vital role in the generation of power and their different types have been used in different sections like generation unit, substation unit and distribution unit based on their need and requirements. Hence it is necessary to keep a track on these transformers to check its working by means of different types of sensors. Various factors may affect the normal working condition of the transformers, such as factors due to ageing, increase in temperature, pressure and environmental conditions. These variations can be sensed by means of different types of sensors which are given as input to the Microcontroller. This controller is also used to control the load connected to this unit. The signals are transmitted through the RF waves to the receiver unit in the monitoring & control section.

In the receiver end, the RF waves are received by the microcontroller which is then interfaced with the PC through RS232cable which is predominantly used for Serial Communication. The RF signals are interfaced with the Lab View application which facilitates the human to visualize the happenings of signals graphically. Through these means the faulty conditions can be monitored by usage of different sensors and controlled them effectively.

II. FAULT DETECTION IN TRANSFORMER

The transformer should be protected from the faults to avoid break down of the transformer which may lead to major interruption in power transformation. To protect it from the faulty conditions, the typical faults should be known.

A. PIC Microcontroller

PIC 16F877A is an 8-bit microcontroller which has a performance capability of 10 MIPS. It has 8 channel,10-bit resolution Analog to Digital Converter (ADC).the sensor unit output is connected to the analog channel of the controller which then converts to the appropriate digital value by its in-built ADC unit. It collects the data from the corresponding sensors. For every particular amount of time, microcontroller preprocesses the sensed data and it will update the parameter values to the central database. This controller which acts as the intelligent core of the system controls the load when maximum or minimum voltage is consumed by it.

B. Sensor Unit

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1) Oil Level Sensor: An oil level sensor is required so that the correct oil level can be maintained. The transformer should maintain the 25°C level, which is the proper oil level at that temperature. Maintaining the exact oil level is much more important because if the oil level falls below the level of the radiator input level, flow inside the radiator will stop and the transformer will overheat. A very low oil level can expose energized and current-carrying components that are designed to operate in oil and could result in overheating or an electrical flipping. If the oil level of the is too high, it could cause over pressurization when the oil expands..

2) Temperature Sensor: Temperature controls are required in order to turn on and off the cooling equipment. It measures a temperature gradient produced by a small heater surrounding the thermometer end point of the bulb. This heating element is connected to a current transformer on one of the phases of the secondary leads, so by this means load increases, so does the current flowing through the resistance increases. The heater then becomes a mimic of the actual transformer winding with the winding temperature gauge measuring a temperature that is roughly equivalent to the true winding temperature. The LM35 series are high precision integrated-circuit temperature sensors Low cost is guaranteed by precision and calibration from the bottom level. The LM35's low impedance of the output and precise calibration make interfacing to readout or control circuitry especially easy. It can be used with different kinds of single power supplies. The LM35 is graded to operate over a −55˚ to +150˚C temperature scope. These signals are converted into digital signal through the ADC and feed to the microcontroller.

C. Voltage and Current Measurements

The voltage and the current are sensed by the potential and current transformer respectively. Potential transformers (PT) are a parallel connected type of instrument transformer, used for metering purpose and protection operations in high-voltage circuits or phasor phase shift isolation. These transformers make the ordinary low voltage instruments suitable for the measurement of high voltages and isolate them for high voltage. Current transformers are used extensively for measuring current and monitoring the operation of the power grid and the transformers. A current transformer isolates the measuring instruments from what may be very high voltage in the monitored circuit. The output of this current transformer and the potential transformer are passed to the signal conditioning unit (SCU).

D. Signal Conditioning Unit

In electronics, signal conditioning means manipulating an analog signal in such a way that it meets the requirements of the next stage for further processing purposes. Most commonly used is in analog-to-digital converters. In various field of engineering especially in control engineering applications, it is common to have a sensing stage (which consists of a sensor), a signal conditioning stage (where usually amplification of the signal is done) and a processing stage (normally carried out by an ADC and a micro-controller). Operational amplifiers (op-amps) are commonly employed to carry out the amplification of the signal in the signal conditioning stage.

1) *Signal Conditioning Processes:* Signal conditioning can include amplification process, filtering the signal with different filtering techniques as low pass, high pass, etc., converting, range matching, isolating the signal and any other processes needed to make sensor output signal suitable for process after conditioning. Commonly used amplifiers on signal conditioning include Sample and hold kind of amplifiers, Peak Detectors amplifiers, Log amplifications, Antilog amplifiers, Instrumentation type of amplifiers or programmable gain amplifiers.

E. RF Communication

Radio frequency (RF) is a rate of oscillation in the range of around 3 kHz to 300 GHz, which points to the frequency of radio signal waves, and the AC(alternating current) which carry radio signals. RF usually signifies the electrical rather than mechanical oscillations. The distance over which radio communications is useful depends significantly on things other than wavelength, such as power during transmission, receiver power quality, type, size, weight and height of antenna, transmission mode, noise ratio and interfering signals. The output signals from the microcontroller are transmitted to the monitoring side through RF Transmitter module.

F. Design Flow

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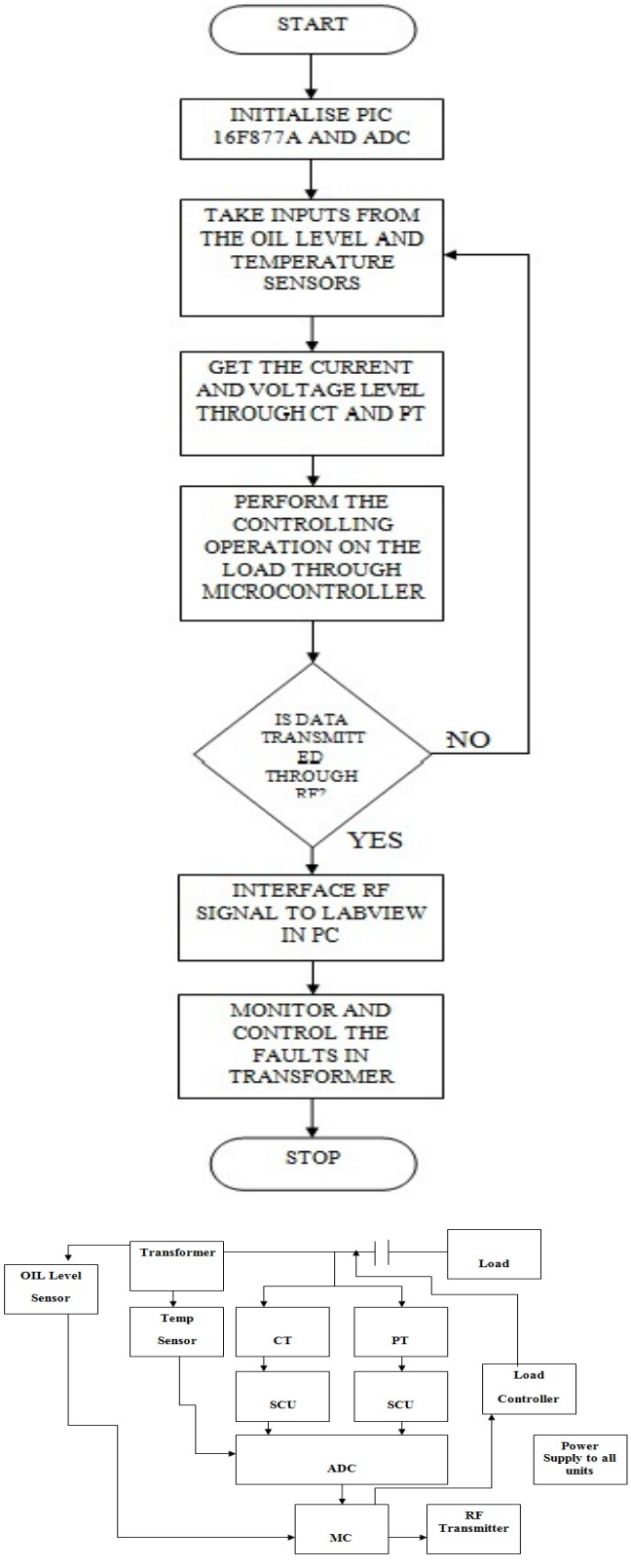

Fig. 1 Module in the Fault Detection Unit

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III. MONITORING AND CONTROL UNIT

A. Serial Interfacing

In order to make two devices communicate, whether they belong to desktop computers, notebooks, microcontrollers, or any other integrated circuit, we need a method to communicate and an agreed language. The most common method of communication between electronic devices is serial communication. Communicating serially is done through sending a series of digital pulses back and forth between devices at a mutually agreed-upon rate. The Transmitter sends pulses indicating the data to be sent at the agreed-upon data rate, and the receiver obtains the pulses at that same rate. The signals from the microcontroller are transmitted to the PC through RS232 serial interfacing cable.

1) Advantages

a) Serial Cables can be longer than Parallel cables. Therefore cable loss is not going to be as much of a problem for serial cables as they are for parallel
b) Wires are less than parallel transmission.
c) Serial transmission is used where one bit is sent at a time.

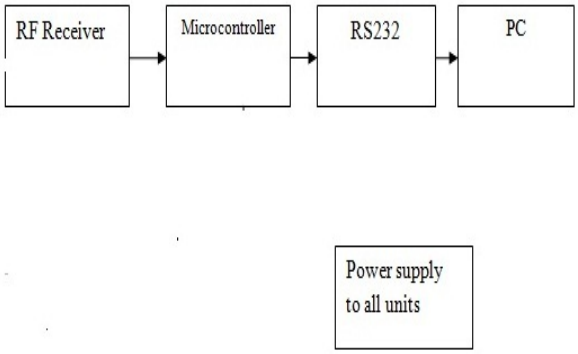

Fig. 2 Module in the Monitoring and Control Unit

C. LABVIEW Interfacing With Received Signals

This can be done by interfacing the PIC controller with PC using USB to serial converter. Here the amount of power the load consumed is monitored and controlled if it deviates from the optimal level.

Lab view design

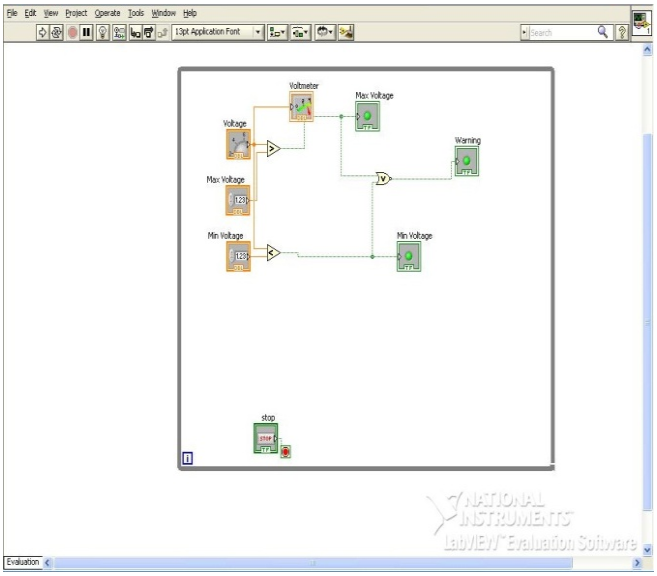

Fig.3 Labview Monitoring

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IV. LABVIEW SIMULATION RESULT

A. *Optimal Load Voltage*

When the Load consumes normal optimal voltage, it is considered as operational voltage and no warning signal is indicated. The signal is obtained from the consumed load voltage and it is transmitted through RF waves to the monitoring and control unit PC which has been interfaced with this software to visualize graphically.

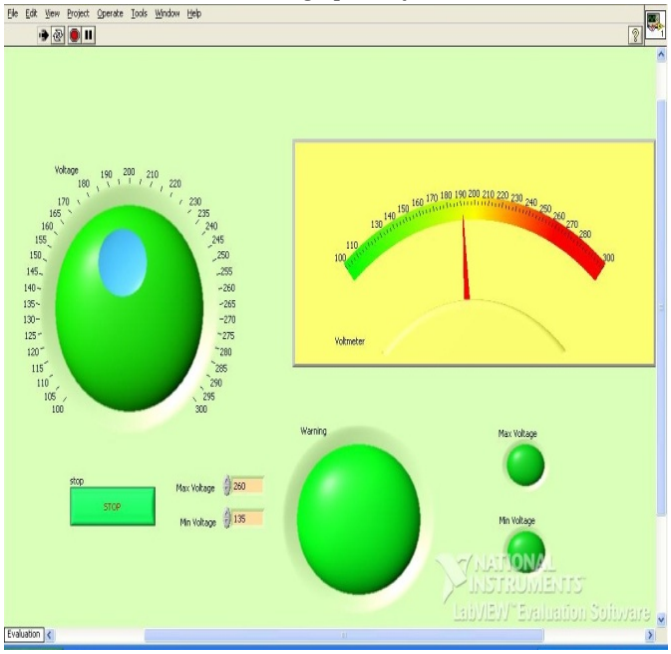

Fig.4 Optimal Load Voltage Controlling

B. *Minimum Load Voltage*

When the load consumes less voltage from the Transformer irrespective of its regular consumption due to the Transformer Faulty Conditions, it is then triggered to the normal voltage consumption. it is also then indicated as the warning symbol in the graphical visualization.

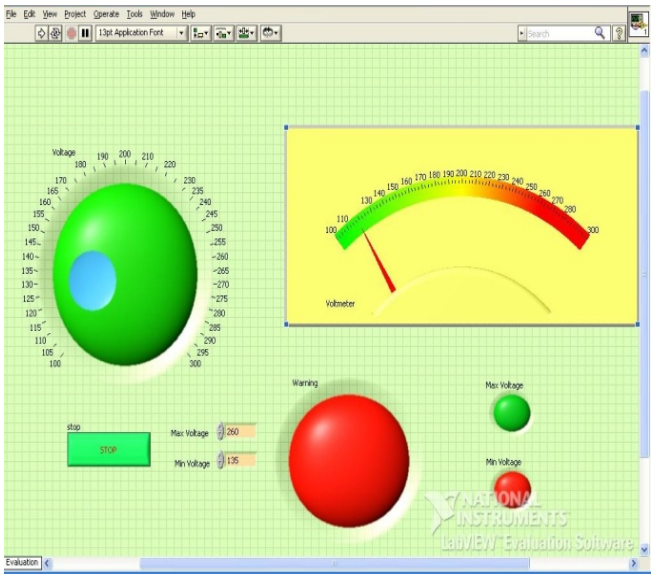

Fig.5 Minimum Load Voltage Controlling

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C. Maximum Load Voltage

When the load consumes more voltage from the Transformer irrespective of its regular consumption due to the Transformer Faulty Conditions, it is then triggered to the normal voltage consumption. It is also then indicated as the warning symbol in the graphical visualization.

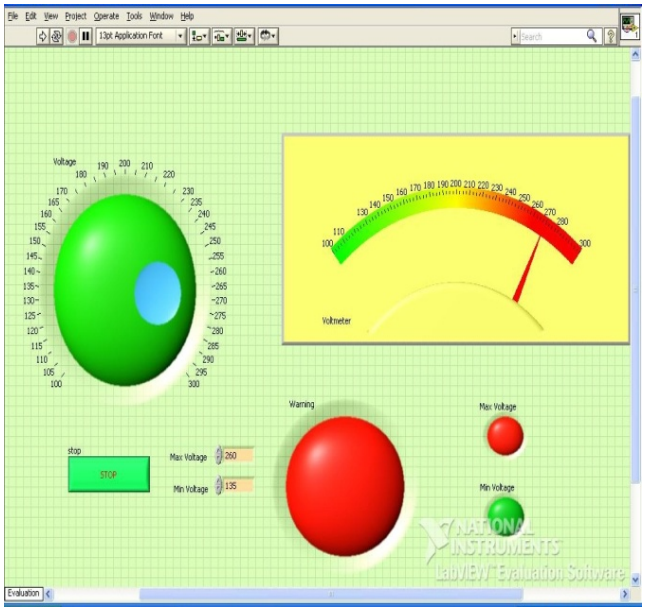

Fig.6 Maximum Load Voltage Controlling

V. CONCLUSION AND FUTURE SCOPE

Thus the various Faulty conditions and load voltage is been monitored and if any deviations in the above leads to controlling the required parameters through means of wireless techniques, thus saving the man power and helps humans to stay away from the catastrophic conditions. The LabView interfacing facilitates the controller graphically and helps them to understand the situations prevailing.

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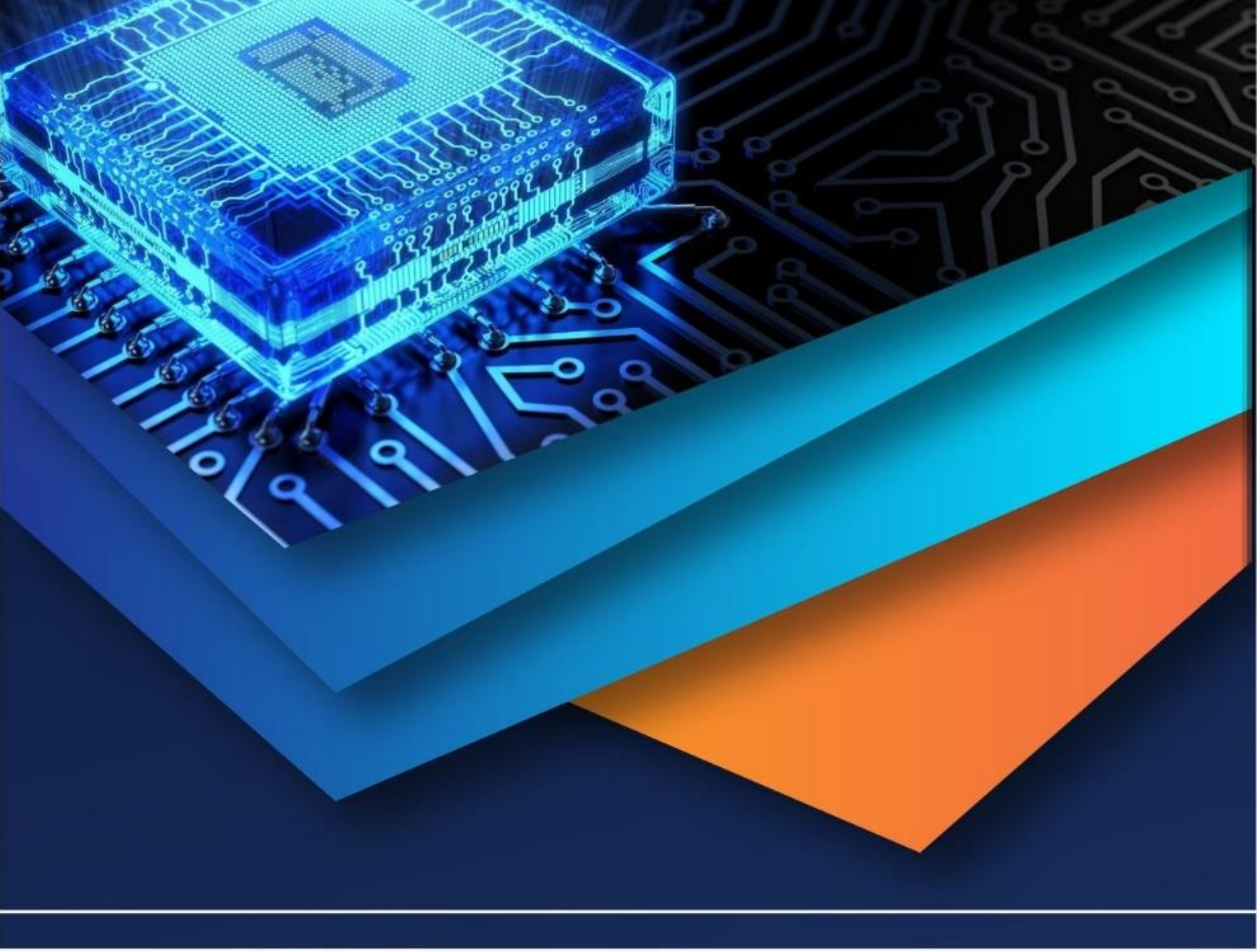

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