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Low Cost and Low Power Consuming Water Pump Controller Module. An Efficient Replacement for The Modern Automated Water Pump Controllers.

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Abstract: ***Most of the water pumps used in homes are still controlled manually to pump water to the overhead water tanks in the building. Although there are many automated water pump controllers in market, still they are very costly and have many connection complexities. With this module, the internal circuit is intentionally reduced thereby it reduces the power consumption and the manufacturing cost. This module doesn't contain a microcontroller, rather it only uses a single latching circuit to control the pump. Hence it eliminates the need for programming the module. Due to its modular design, the consumer can easily upgrade, modify and simplify the connection complexities.***
Keywords: Microcontroller, latch, module, connection

I. INTRODUCTION

Ever since the microcontrollers have flooded the electronics industry, almost even a basic circuit which can be implemented by using simple logic are being replaced. This is because the price as well as the form factor of the microcontrollers have been reduced drastically since the past couple of decades. Although microcontrollers have many advantages than using a combinational logic, but still in many applications it is advisable to use combinational logic as it removes the need of programming. Even after so many advances in electronics industry, still in many homes which have an overhead water tanks are pumped with water by a manual control of the water pump. Though there are many automated systems available, they are either unaffordable for the masses or have many complicated connections. To make this system further simpler, we went for this simple model of combinational logic which makes it more affordable and is easy to use.

II. THEORY

A. SR Latch

Latch is a device which has two stable states. In other word we call it as a bistable device. In electronics, the basic latching device is the SR Latch. SR Latch can only be used for Set and Reset Configurations, thereby it requires two inputs. [1]

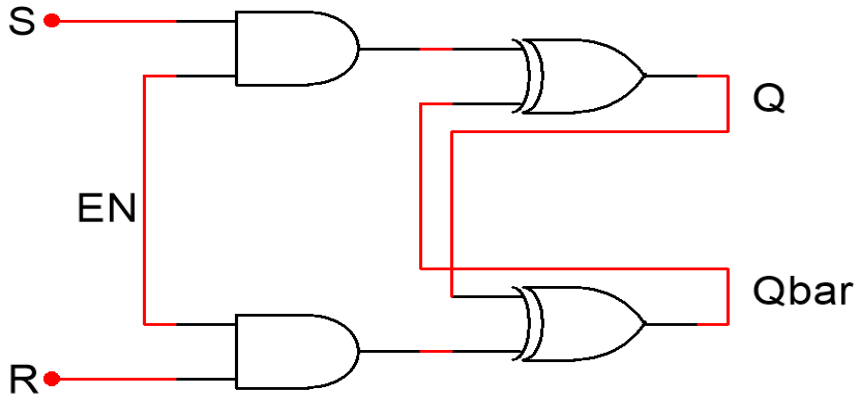

Fig. 1.A basic logic diagram of an SR Latch.

TABLE I. EXCITATION TABLE OF SR LATCH

SET	RESET	Q	Qbar
0	0	latch	latch
0	1	0	1
1	0	1	0
1	1	0	0

B. Relay

A relay maybe an electromechanical or electronic device which is used to switch larger loads by applying relatively smaller voltage as input. [2]

Considering electromechanical relay, they are again of two types:

1) *Non-Latching Type*- This relay turns back to its original state once the input signals are removed.
2) *Latching Type*- This relay retains its state even after the input signals are removed. They are again classified into two types such as dual coil and single coil latching relay.

Latching type relay is the same as the electronic latches. The only difference is that they have mechanical function and a latch serves electronic function. For example: A dual coil latching relay performs the exact function of an SR Latch and has the same excitation table.

III. BLOCK DIAGRAM AND WORKING PRINCIPLE

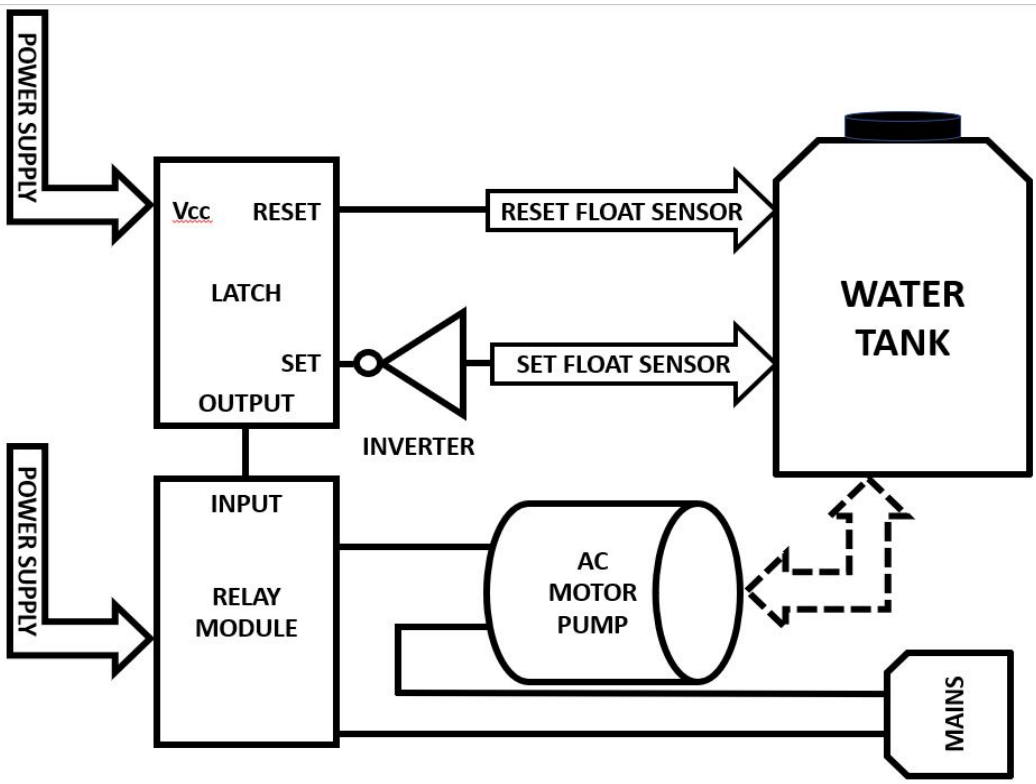

Fig. 2. Functioning block diagram of the water pump module.

The Fig.2 is the working representation of the module. The dashed arrow line indicates the internal water pipe connection to the motor pump and the water tank. The detailed explanation of some blocks is explained as follows:

A. Float Sensors

Float sensor is usually a simple SPST switch which turns ON and OFF depending upon the buoyant force exerted by the liquid. [3]

B. Regional Classification of the Water Tank after Installation of the Float Sensors

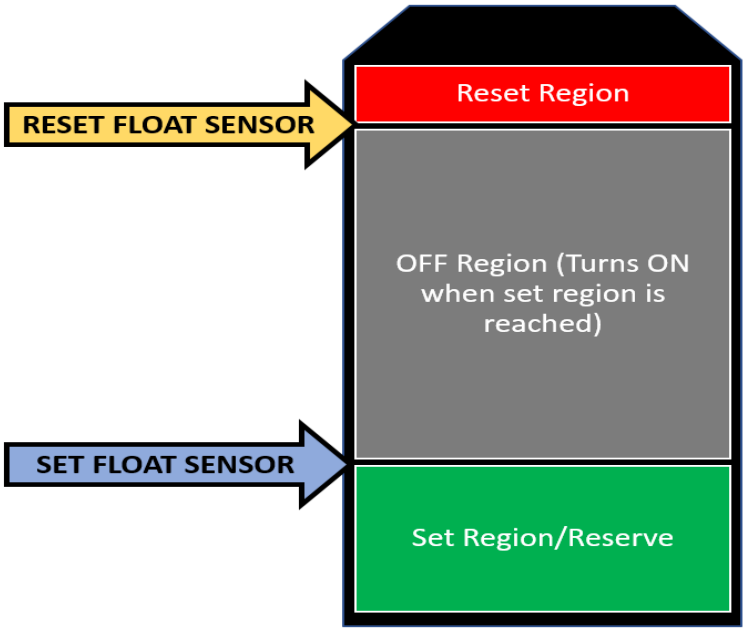

Fig. 3.Regional Classification of the water tank with installed float sensors.

1) In this model we are using two float sensors, one for reset and other for set condition. Then the Set Float sensor will decide the threshold point to turn ON the motor pump and the Reset Float sensor will turn OFF the motor pump once when the water level reaches its region.

2) So whatever level of water is present in the reserve region will never get reduced as that region is set as the threshold point to turn ON the motor pump.

3) The whole water level inside the tank will only vary between the OFF region only. Refer Fig[4].

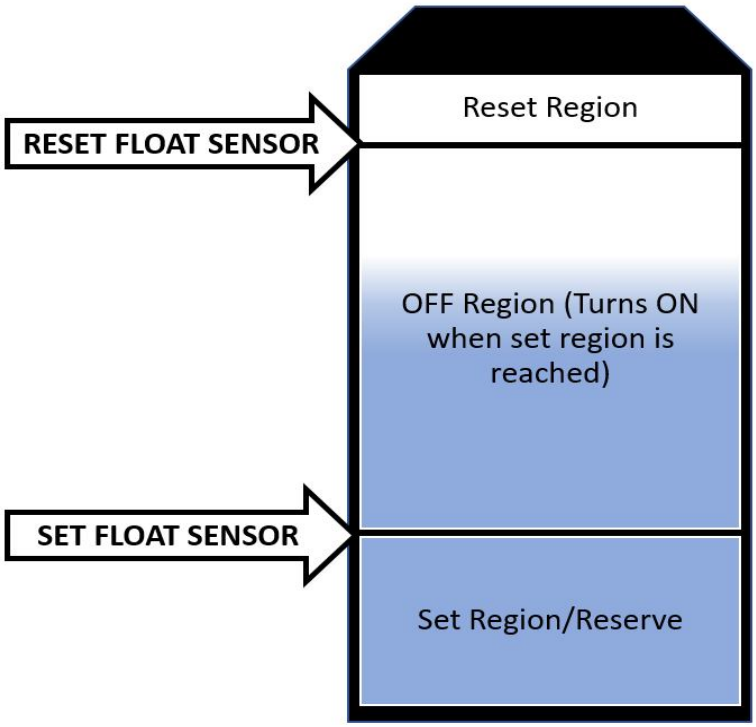

Fig. 4.The water level inside the tank never exceeds the RESET Region and never goes less than the SET or Reserve Region.

C. Latch

As mentioned earlier, the latch circuit used is a SR Latch. Though for our practical implementation, we used 555 timer IC in its bistable configuration.

D. The Important Role of Inverter

The inverter or the NOT Gate attached to the Set Float Sensor plays a major role in the circuit. This has to be implemented due to the unidirectional switching of the float sensor. In other words, the float sensor will only turn ON when the water level pushes the switch terminal upwards. But for our application the set float sensor should turn ON the motor pump, when the water level goes below the Set Float Sensor's threshold level. This can be either achieved by changing the orientation of the float sensor which is not advisable, or by inverting the output which is the best option available.

E. Relay Module

The relay module is a simple all in one module which controls a main relay with a power transistor or a optoisolated circuit. But in the model the Relay module is embedded with the latch circuit which makes it more compact. This relay module drives the heavy load such as the motor pump connected to the mains power supply. The small voltage used for switching is obtained by the output (Q) from the SR latch. The input of the relay module is connected to the output of the SR Latch.

IV. SIMULATION RESULTS

The whole circuit was simulated in Multi SIM Software developed by National Instruments. The simulation was processed successfully and positive results were obtained in each case.
We can divide this into three separate cases in a sequence:
Full Tank (Reset Level Reached)
Low Tank (Threshold level Reached)
Medium tank (Water Level in the OFF Region)

A. Case-1 (Full Tank)

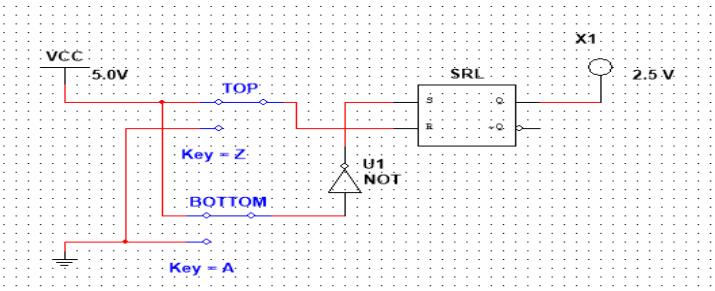

Fig. 5. Simulation result when tank is full (Motor Pump is OFF)

B. Case-2 (Threshold Level Reached)

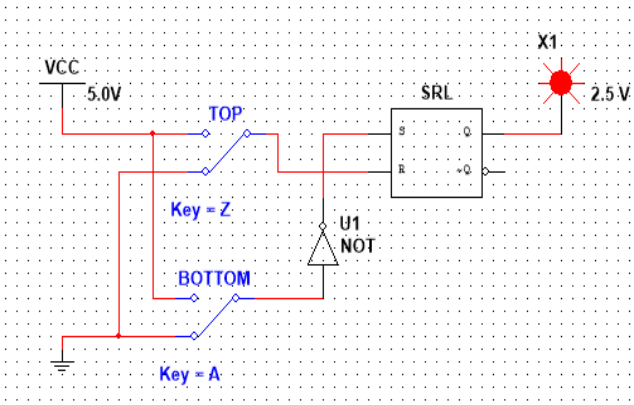

Fig. 6. Simulation result when water level has reached the reserve region (Motor Pump is ON)

C. Case-3 (Water level increased from the threshold region but hasn't reached the reset region)

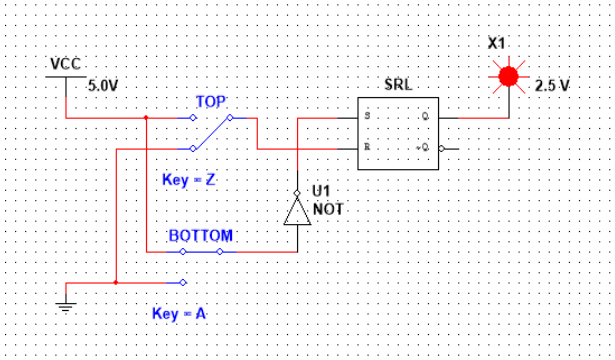

Fig. 7. Simulation result when water level is in the OFF Region after SET Region is touched (Motor Pump is ON)

TABLE II. EXCITATION TABLE OF THE SETUP

SET(bar)	RESET	Q	Qbar
0	0	latch	latch
0	1	0	1
1	0	1	0
1	1	0	0

V. NEED FOR PULL-UP NETWORK AT THE INPUTS

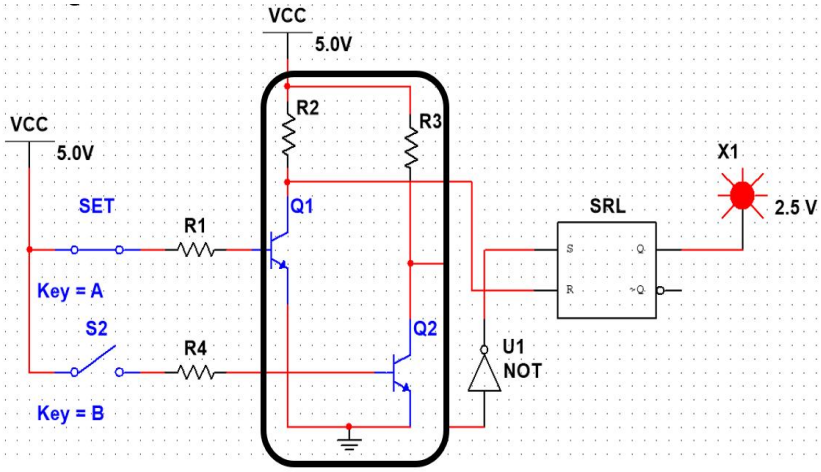

Fig. 8. Transistor-Resistor Pull-Up Network installed circuit.

As mentioned earlier, the Float Sensor can only switch in SPST configuration. However in order to achieve absolute ground and high values, we need a SPDT switch. As it is now unavailable in our model, so we need to use a pull up network which can keep the inputs at normally high condition. When input is received from the float sensor, the transistor switches ON and the input gets grounded.

VI. ADVANTAGES

The major advantage of this setup is that it gives the user to set his/her own reserve water level. The user even gets an option to vary each of the levels depending upon the need.

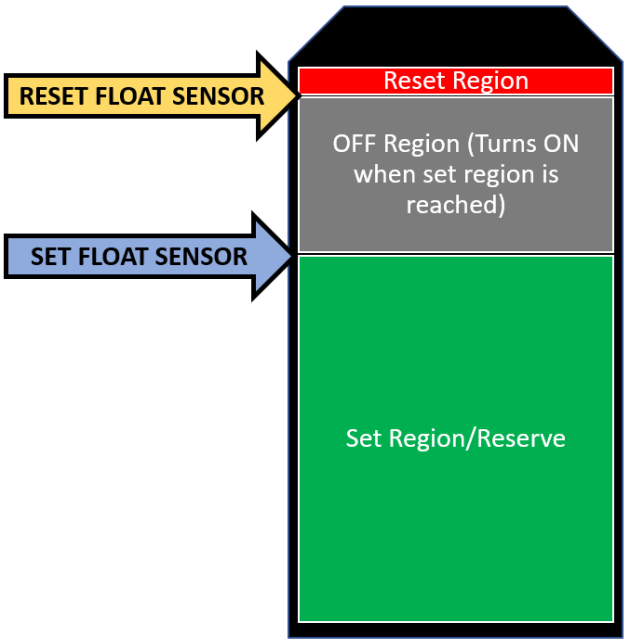

Fig. 9.Reserve Region Increased

For Example, in places where power cuts are prominent, the water pumps cannot be turned ON. So one can easily solve this problem by increasing the threshold region or the reserve region so that whenever there is power cut, the water level in the tank will be maintained enough for emergency use.

A. There is no microprocessor used in the circuit, hence it eliminates the need of programming.

B. This setup can be used for any type of water pumps including single phase and three phase.

C. The circuit is simple and easy to manufacture.

D. The setup can be easily modified or customized by the user.

E. This setup consumes so less power that it can even be powered by a battery.

VII. CONCLUSION

The only way most of the designs can achieve a good power efficiency and can be made user friendly is by keeping it simple. The same is followed in this setup in addition to the choice of upgradability and customization to the users.

VIII.ACKNOWLEDGMENT

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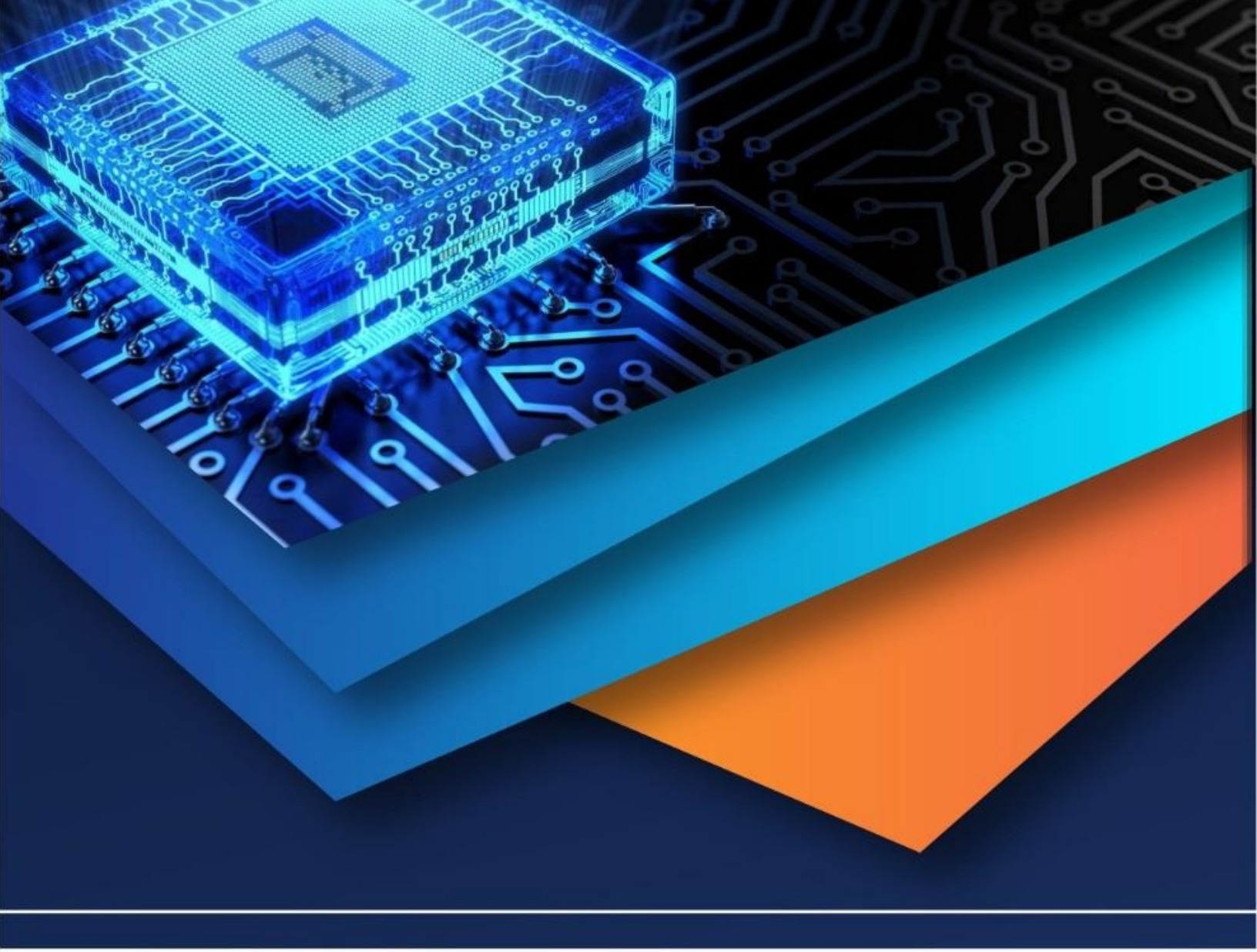

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