iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** VIII **Month of publication:** August 2018

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue VIII, August 2018- Available at www.ijraset.com

Detection of Power Grid Synchronization Failure

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Abstract: In an alternating current electric power system, synchronization is the process of matching the speed and frequency of a generator or other source to a running network. An AC generator cannot deliver power to an electrical grid unless it is running at the same frequency as the network. There are several power generation units connected to the grid such as hydra, thermal, solar etc., to supply power to the load. These generating units need to supply power according to the rules of the grid. These rules involve maintaining a voltage variation within limits and also the frequency. If any deviation from the acceptable limit of the grid, it is mandatory that the same feeder should automatically get disconnected from the grid which by effect is termed as islanding. This prevents in large scale brown out or black out of the grid power. So, it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure. In this paper hardware controller based system to identify the abnormalities and to disconnect the faulted part from the grid is proposed. MATALB/SIMULINK model is developed to justify the results.
Keywords: Frequency, Grid, Power, synchronization, Voltage

I. INTRODUCTION

Power grids are vast complex networks that make up a large part of an infrastructure. Many precautions are taken by operators hired to maintain reliability, however three fourths of power outages are caused by operator errors. These errors can be avoided by automatic adjustments based on models of the grid system. The model explored is ensuring generator synchronization within the system. Finally, the grid will not have destructive interference; constructive interference will occur which increases the total power the grid can produce which optimizes the grid.

This is a demonstration devised to provide such kind of a system that could detect the failure in synchronous working of the power grid in case any external supply source that is supplying to the grid is encountering any kind of abnormalities may be in frequency and voltage. Synchronization means the minimization of difference in voltage, frequency and phase angle between the corresponding phases of the generator output and grid supply This system is more compact and reliable as compared to the manually operated system and less expensive.

For synchronization of all power generating station with State as well as National power grid we have selected three parameters voltage, frequency and phase angle between voltage and current if any of these parameters is violated due to any abnormality or fault the power station will not be able to fulfill all the three condition for synchronizations so it will get a synchronized with grid and its called situation of ISLANDING. Islanding state occurs when one or many sources continue to feed power to a part of the grid that is disconnected from the main utility.

Islanding situations can damage the grid itself or equipments connected to the grid and can even compromise the security of the maintenance personnel that service the grid. Therefore, according to IEEE1547 standard, islanding state should be identified and disconnected in 2 seconds. In this paper hardware controller based system to identify the abnormalities and to disconnect the faulted part from the grid is proposed. MATALB/SIMULINK model is developed to justify the results.

II. GRID SYNCHRONIZING TECHNIQUES

A. *Zero Crossing Detector (ZCD)*

Zero-crossing detector is an applied form of a comparator. Either of the op-amp based circuits discussed can be employed as zero-crossing detector. In some applications the input signal may be low frequency one (i.e. input may be a slowly changing waveform). In such a case output voltage may not switch quickly from one saturation state to another. Because of the noise at the input terminals of op-amp, there may be fluctuation in output voltage between two saturation states (+ Vsat and – Vsat voltages) [7]. Thus zero crossing may be detected for noise voltages as well as input signal. Both problems can be overcome if we use regenerative or positive feeding causing the output voltage to change faster and eliminating the false output transitions that may be caused due to noise at the input of the op-amp. Thus we prefer PLL based methods for the detection of Phase angle when compared to Zero Crossing Detector [7].

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B. Phase Locked Loop (PLL)

A phase-locked loop is a control system that generates an output signal whose phase is related to
the phase of an input "reference" signal [5].This circuit compares the phase of the input signal with the phase of the signal derived from its output oscillator and adjusts the frequency of its oscillator to keep the phases matched. The output signal from the phase detector is used to control the oscillator in a feedback loop. Frequency is the time derivative of phase. Keeping both the input and output phase in lock step implies keeping the input and output frequencies in lock step. Consequently it can track an input frequency or it can generate a frequency that is a multiple of the input frequency.

C. Synchronous Reference Frame (SRF) PLL

In the conventional PLL, three-phase voltage vector is translated from the abc natural reference frame to the αβ stationary reference frame by using Clarke's transformation, and then translated to dq rotating frame by Park's transformation. The angular position of this dq reference is controlled by a feedback loop which makes the q-axis component equal to zero in steady state. Therefore, under steady state condition, the d-axis component will be the voltage vector amplitude

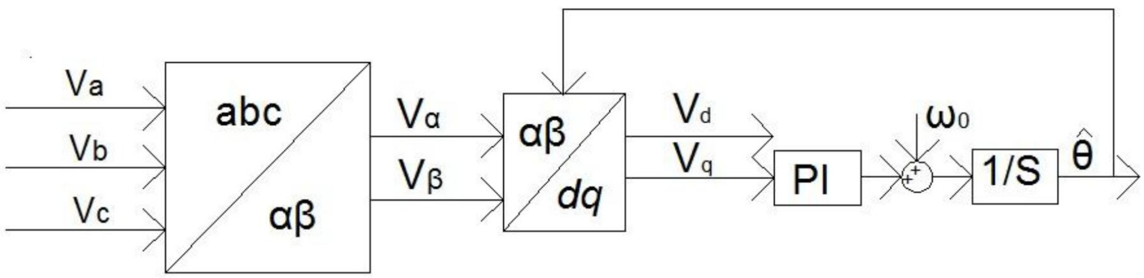

Fig.1 conventional PLL

III. RESULTS

To Study the Detection of power grid synchronization failure simulation model is developed based on MATLAB/SUMULINK.

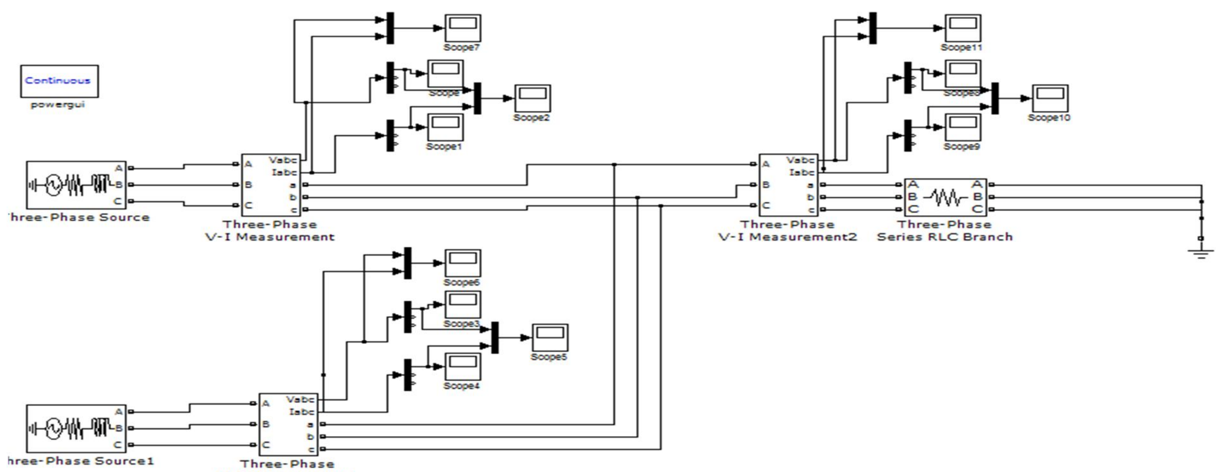

Fig.2.Interconnection of Power Systems

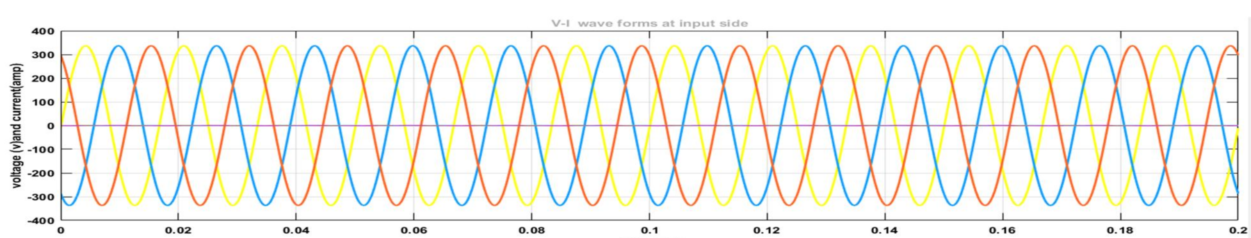

Fig.2.Three Phase Source Voltages (When both systems frequency is same)

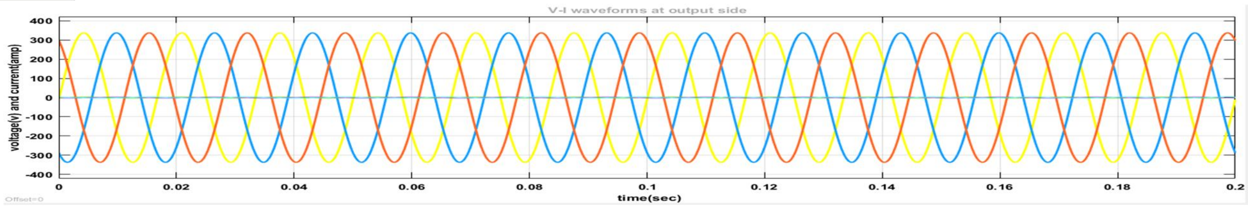

Fig.2.Three Phase Load Voltages (When both systems frequency is same)

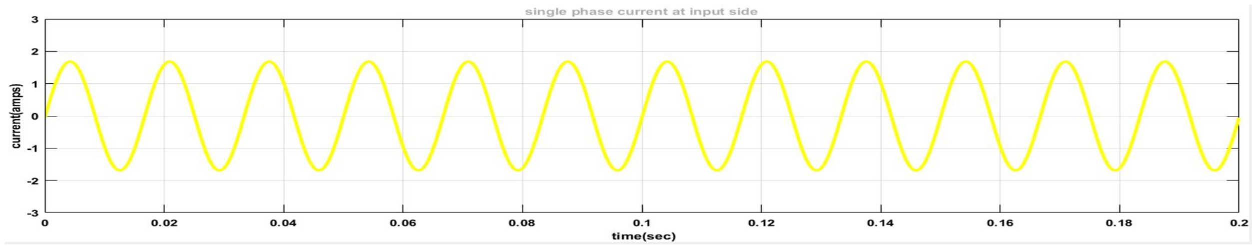

Fig.2.Single Phase Source Current (When both systems frequency is same)

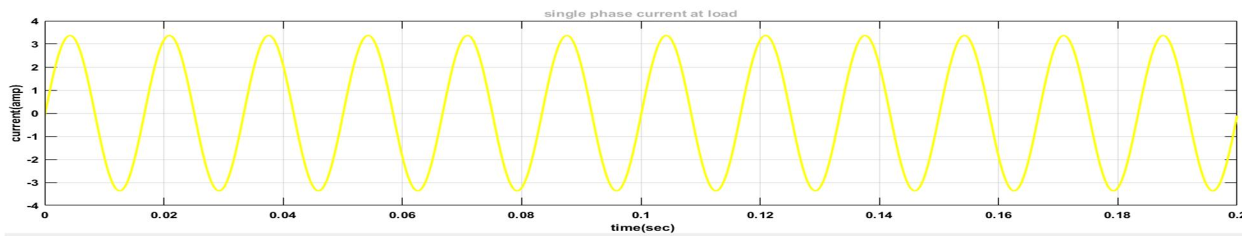

Fig.2. Single Phase Load Current (When both systems frequency is same)

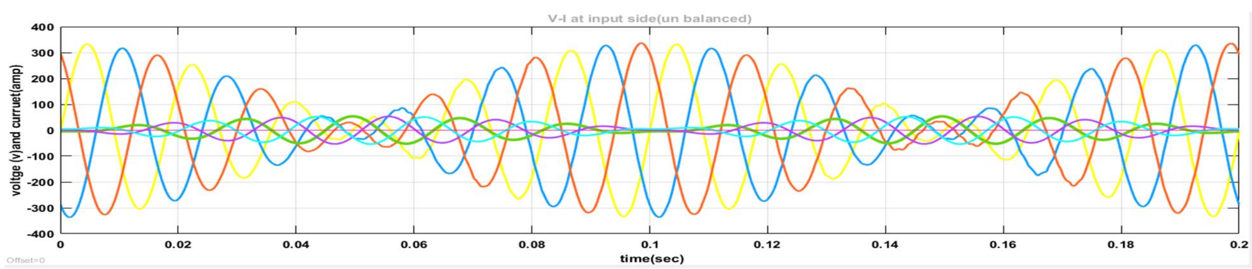

Fig.2.Three Phase Source Voltages (When both systems frequency is different)

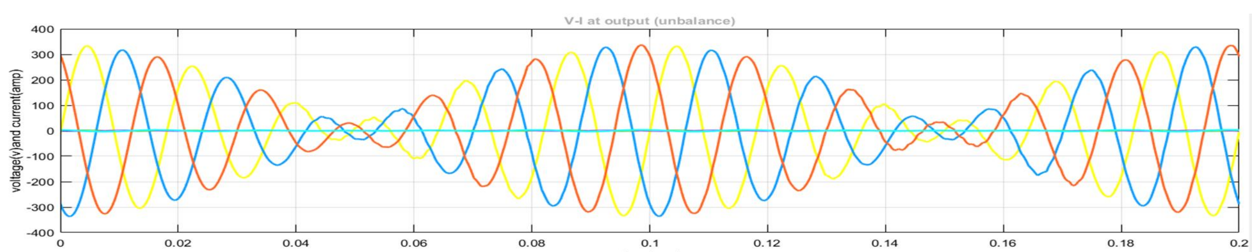

Fig.2.Three Phase Load Voltages (When both systems frequency is different)

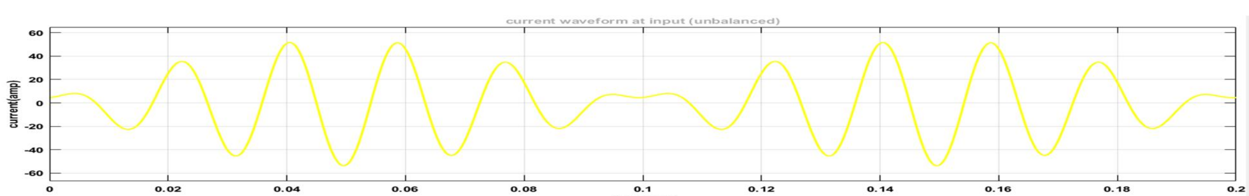

Fig.2.Single Phase Source Current (When both systems frequency is different)

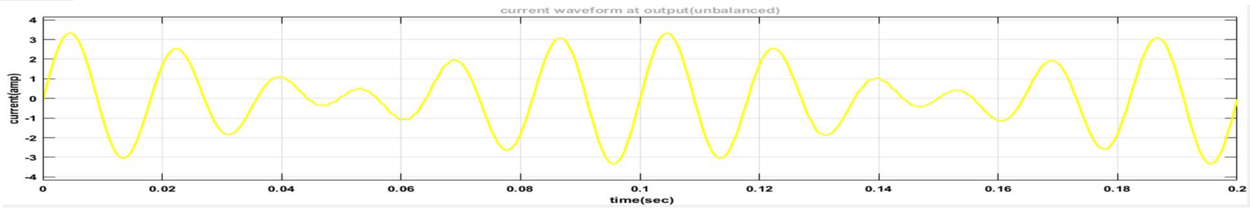

Fig.2.Single Phase Load Current (When both systems frequency is different)

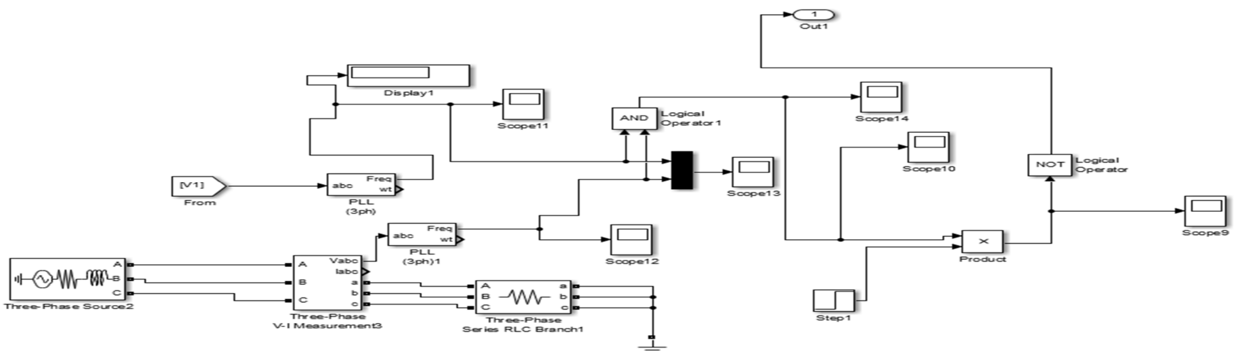

Fig.2.Control Circuit to disconnect the faulty system

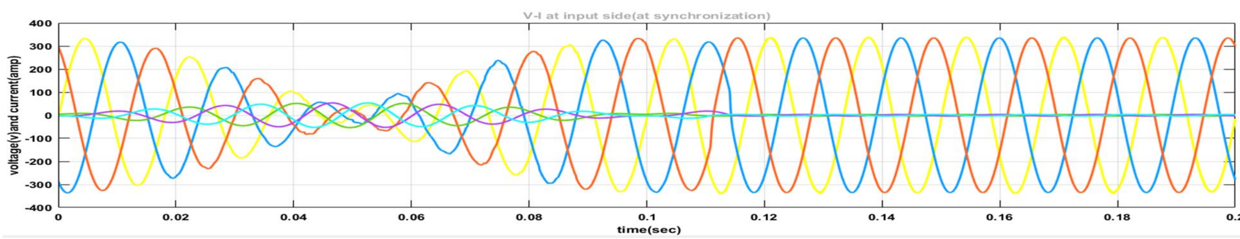

Fig.2.Three Phase Source Voltages with controller (When both systems frequency is different)

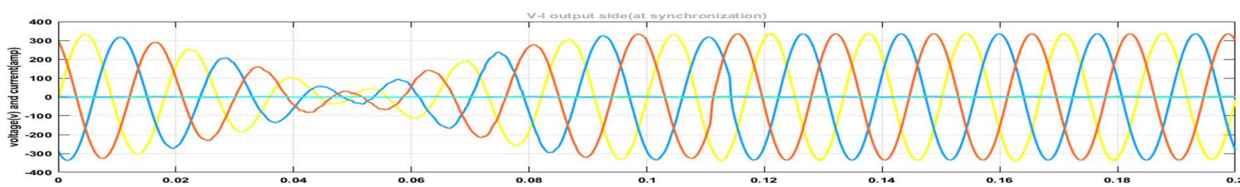

Fig.2.Three Phase Load Voltages with controller (When both systems frequency is different)

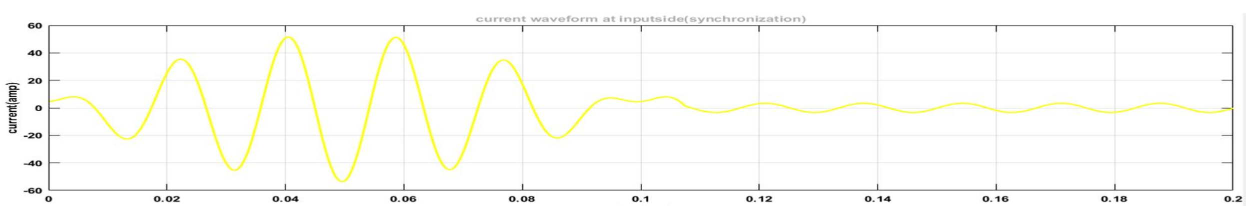

Fig.2.Single Phase Source Current with controller (When both systems frequency is different)

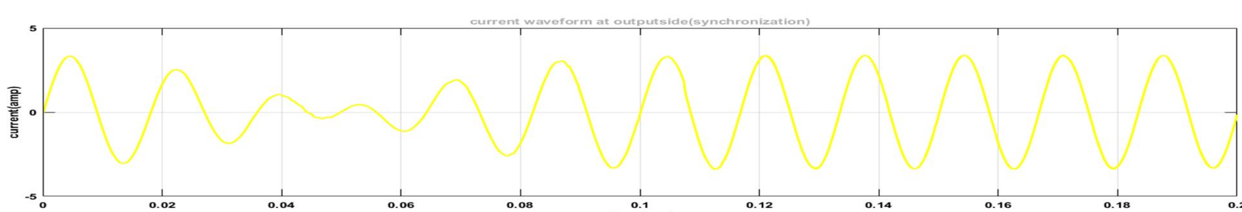

Fig.2.Single Phase Load Current with controller (When both systems frequency is different)

IV. CONCLUSION

The detection synchronization failure in the grid system is presented paper. The method Synchronous Reference Frame PLL (SRF-PLL) with has been designed and simulations in SIMULINK have been made. For supporting the research MATLAB simulation is utilized.

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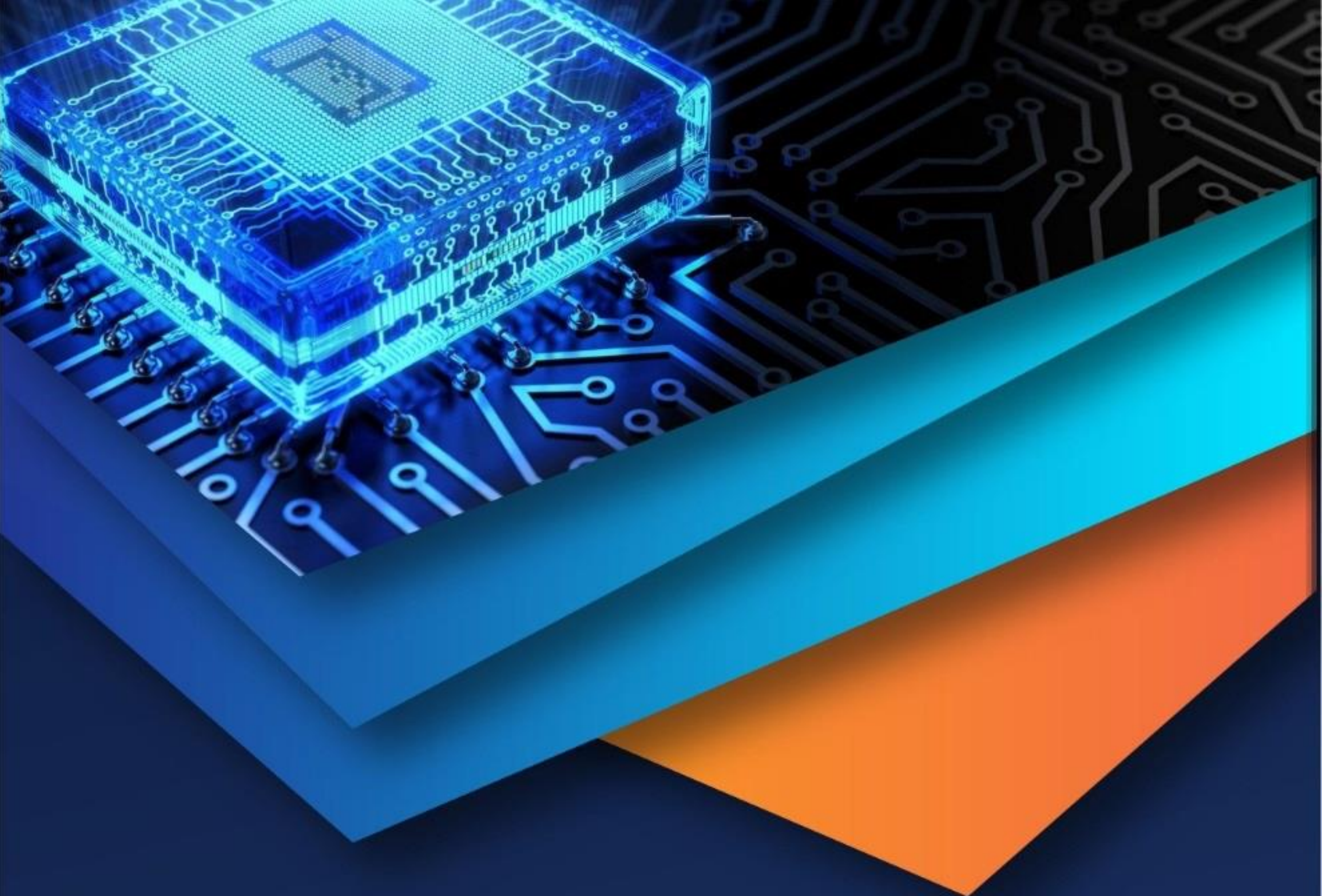

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