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MATLAB based Simulations model for three phases Power System Network

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Abstract: ***The primary aim of this research work is to build up a MATLAB based Simulation model for 3 phase symmetrical and unsymmetrical faults. This paper ways to deal with the MATLAB programming in which transmission line model is composed and different issues has been reenacted utilizing tool compartment. Fault Analysis for different sorts of faults has been done and it impacts are appeared in simulation output, for example, voltage, current, control alongside the positive, negative and zero grouping segments of voltage and current output as far as waveforms.***
Keywords: L-L –Line to Line fault, Single Line to Ground fault, 2L-G Double Line to Ground fault, MATLAB Simulations.

I. INTRODUCTION

Presently a-days the requests of power are builds step by step this outcomes to transmit more power by expanding the transmission line limit from one place to the next place. Be that as it may, amid the transmission a few faults are happened in the framework, for example, L-L fault (line to line), L-G fault (single line to ground) and 2L-G fault (twofold line to ground). These faults influence the power framework types of gear which are associated with it. Now –a – days due to continuous expansion of Power System Network, controlling and monitoring of Power systems is unavoidable. Solutions through advanced data communications model are in evident. [1-26] When different types of fault occurs in power system then in the process of transmission line fault analysis, determination of bus voltage and the rms line current are possible. While consulting with the power system the terms bus voltage and rms current of line are very important. In case of three phase power system mainly two faults occurs, three phase balance fault and unbalance fault on transmission line of power system, such as double line to ground fault, line to ground fault and double line fault. The transmission line fault analysis helps to select and develop a better for protection purpose. For the insurance of transmission line has been placed the circuit breakers and its rating is depends on triple line fault. The reason behind is that the triple line fault current is very high as compare to other fault current. Hence by using MATLAB simulation in computer, the analysis of transmission line fault can be easily carried out. The principle reason for this paper is to study the general fault types which are balance and unbalance faults of transmission line in the power system. Also to perform the analysis and obtain the result of various parameters (voltage, current, power etc) from simulation on those types of fault using MATLAB [27].A new modeling framework for analysis and simulation of unbalance fault in power system is procedure includes the frequency information in dynamical models and produces approximate non linear models that are well adopted for analysis and simulation[28] .

The transformer display incorporates saturation. The parameters have been acquired from reasonable or exploratory estimations. From the study it is seen that sags can create transformer saturation when voltage recovers [29]. This prompts deliver an inrush current that is like inrush current created amid the transformer energizing. The study call attention to that the voltage recovery moment can take just discrete value, since the fault clearing is delivered if there should arise an occurrence of regular current zeros. The moment of voltage recovery compares to the moment of fault clearing. For phase to phase fault and single phase fault, a solitary point-on-wave of voltage recovery can be defined [30]. Then again for two-phase to-ground and three-phase fault, the recovery happens in a few stages. In petrochemical industry, the establishing and ground fault security are critical factors [31]. For that first it is essential to have the correct framework establishing for the specific framework application, and alongside this it is similarly critical to have the best possible assurance against the ground-fault.

A. Methodology MATLAB

Lattice research facility is a multi-world view numerical registering environment and fourth era programming dialect created by Math-Works, MATLAB permits grid controls, plotting of capacities and information, execution of calculations, sure of UIs and interfacing with projects written in different dialects. In spite of the fact that MATLAB is proposed fundamentally for numerical registering a discretionary tool compartment utilizes the MuPAD typical processing capacities. An extra bundle, Simulink, includes

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graphical multi-space recreation and model based plan for dynamic and installed framework. MATLAB clients originate from different foundations of designing, science and financial aspects. MATLAB is broadly utilized as a part of scholarly and research organizations and also mechanical ventures. Additionally MATLAB gives an alluring domain with several dependable and precise inherent capacities. MATLAB family cooperate with Simulink programming to display electrical, mechanical and control systems[32].A result of The Math-Works, Inc. MATLAB began life as a program intended to perform framework science, yet throughout the years it has developed into an adaptable processing framework equipped for taking care of basically any specialized issue. MATLAB can control and transform huge frameworks and can be utilized as a part of numerous numerical applications. MATLAB's capacities can be reached out with expansion called SIMULINK, a program which is ordinarily utilized as a part of the investigation and combination of present day systems [33].

1) *Standards In MATLAB:* When MATLAB/SIMULINK has been analyzed with EMTP/ATP, it has been proved that it is better for the power systems simulations. The accompanying things condense their most critical contrasts in insurance frameworks simulations [34]

a) The EMTP/ATP is particular programming to recreate control framework transient issue, though the MATLAB/SIMULINK can be utilized to simulate power system faults and defensive relay calculation in the meantime. SIMULINK, now consolidated into MATLAB, can likewise be utilized to examine and design of power systems. Amid most recent four decade's simulation of power systems have increased more significance. As of late distributed IEEE paper talking about various ways to deal with displaying defensive transfers and related power system shows an assortment of conceivable programming devices that might be utilized for this reason. But instead than MATLAB/SIMULINK programming it is hard to include the modeling and simulation to show particular defensive transferring ideas that go past the level of detail initially gave by the product. The MATLAB programming bundle with SIMULINK support and Power system Block set (PSB) is used to create tweaked show libraries for educating protective relaying ideas.

b) ATP/EMTP is intended to reenact the physical procedures of transmission lines and transformers rapidly and helpfully however MATLAB/SIMULINK offers more conceivable outcomes in power electronics, signal processing and control.

c) Clients can without much of a stretch make new relay model with MATLAB/SIMULINK, though EMTP/ATP doesn't have such limit.

d) MATLAB/SIMULINK envelops preferable realistic capacity apparatuses over EMTP/ATP of pc plot, plot xy etc.

B. Elements OF MATLAB Tool Box

The components of the MATLAB tool stash utilized as a part of the analysis of power systems are, encouraging future amendment and extension of programming. This is imperative for looks into that are intriguing in creating and testing new for different power system applications. It gives a road to effectively get ready information records in ordinarily acknowledged organizations for systems that are made and the outcomes created by one application can be effortlessly utilized either completely or in part by some other application bolstered by the bundle.

MATLAB/SIMULINK tool compartment comprises of:

1) Mat Power Tool compartment
2) Power System Analysis Tool kit and
3) Voltage Stability Tool kit.

Application libraries comprises of Dispersed assets library, Electric drives library and Adaptable Air conditioning transmission library. Electrical Sources assemble contains A.C. current source, A.C. furthermore, D.C. voltage source, Controlled voltage and current source, Three-phase programmable voltage source, Three phase source and Battery. The Components gather contains single-phase models RLC branches and loads, linear and saturable transformers, shared inductances, n-area lines, MOV sort surge arrester, circuit breaker and n-phase distributed parameter line display. Utilizing the covering office of SIMULINK, the client can undoubtedly include more mind boggling components worked from the essential PSB building pieces and partner an dialog box. This strategy has been utilized to build up a three-phase library which is additionally given. The Power Electronics aggregate contains basic semiconductor devices. Every component in this gathering (with the exception of Diode) has a SIMULINK gating control input and a SIMULINK output returning switch current and voltage. Mat Power Tool kit is a bundle for explaining power stream and ideal power stream issues. This bundle is intended to give the most ideal execution while keeping the code easy to comprehend and change. Power System Analysis Tool stash is for electric power framework investigation and control. It

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incorporates control stream, ceaseless power stream, ideal power stream, little flag security investigation and time area reproduction. Voltage stability Tool stash breaks down voltage security issues and gives data to power system arranging, operation and control. Additional library comprise of Control squares, discrete control pieces, discrete estimations and phasor library.

1) *Block Libraries:* The PSB is a realistic device that permits building schematics and recreation of force frameworks in the SIMULINK environment. The block set uses the SIMULINK environment to speak to basic segments and networks found in electrical power systems. It comprises of a block library that incorporates electrical models, for example, RLC branches and loads, transformers, lines, surge arrester, electric machines, control devices, and so on. Outlines can be gathered just by utilizing snap and drag strategies into SIMULINK windows. The Power system Block set utilizes a similar drawing and intelligent discourse boxes to enter parameters as in standard SIMULINK pieces. The Machines groups contain simplified and detail models of synchronous machine, asynchronous machine, a permanent magnet synchronous machine, a model of hydraulic turbine governor, and an excitation system. Every machine block has a SIMULINK output returning estimations of inside factors. The PSB graphical interface (Powergui) incorporates an intuitive instrument to set introductory conditions. This permits reproduction with beginning conditions, or to begin the recreation with enduring state. A heap stream computational motor permits instating three-stage circuits containing synchronous and asynchronous machine, so that the recreation specifically begins in enduring state. Reproduction results can be envisioned with SIMULINK scopes associated with yields of estimation pieces accessible in the PSB library. This estimation block goes about as an interface between the electrical pieces and the SIMULINK squares. The voltage and current estimation blocks can be utilized at chose focuses as a part of the circuit to change over electrical signs into SIMULINK signals.

II. TRANSMISSION LINE FAULTS

As discuss above in three-phase transmission line of power system mainly two types of fault occurs, balance fault which is also called symmetrical fault and unbalance fault called as unsymmetrical fault. But this paper only deals with the unsymmetrical fault which mainly occurs between two or three conductors of the three-phase system or some time in between conductor and ground.
Contingent on this the unsymmetrical faults can be characterized into fundamental three sorts:-

Single Line to Ground fault.
Double Line fault.
Double Line to Ground fault.

The frequency of occurrence of the single line to ground fault is more in the three phase system followed by the L-L fault, 2L-G fault and three phase fault. During electrical storms these types of fault are occurs which may results to insulator flashover and ultimately affect the power system. To study and analyze the unsymmetrical fault in MATLAB there is a need of develop a network of positive, negative and zero sequence. In this paper us analysis positive, negative and zero sequence voltage and current of buses at different fault situation. In addition to this we analyze the active and reactive power and rms bus current and voltage of the system at various fault condition.

A. *Protective Relays*

A standout amongst the most vital segments of a power protection system is the relay which is a gadget that treks the circuit breakers when the information voltage and current signs relate to the fault conditions intended for the relay operation.
Relays when all is said in done can be grouped into the accompanying classes:

1) *Directional Relays:* They react to the distinction in phase angle between two contributions to the relay.
2) *Differential Relays:* They react to the magnitude of the logarithmic whole of its various sources of info.
3) *Size Relays:* They react to the magnitude of the input amount.
4) *Pilot Relays:* They react to the information flags that are sent to the relay from a remote area.
5) *Remove Relays*: They react to the proportion of two information phasor signals.Over the years the relay technology has developed and the classification based on generations is as follows:
6) *Electromechanical Relays:* They are the first generation of relays. They use the principle of electromechanical conversion. They are rugged & immune to electromagnetic interference. But with recent advancements, they have been turned obsolete in most areas.
7) *Solid State Relay:* They make use of transistors, op-amps, etc. They are more flexible with a self-check facility, consuming less

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power and having improved dynamic performance than the electromechanical relays. They also were smaller in size requiring less panel space.

8) *Numerical Relays:* Operation involves Analog to Digital conversion of currents and voltages, which are acquired from the CTs and VT which is fed to the DSP or microprocessor. These signals are then processed using the protection algorithms and the necessary decisions are taken. The advantages of a Numerical Relay are:

a) High flexibility.
b) Multiple functionalities.
c) Self-checking and communication facility.
d) Can be adaptive.

III. CIRCUIT MODEL FOR THREE PHASE FAULTS IN POWER SYSTEM NETWORK

The implementation deals with the model made in MATLAB using the Sim Power Systems® Tool, the GUI. Through this advanced data simulation model fault analysis of any power system network can be simulated with ease and its fault analysis can be carried out. [33-43].

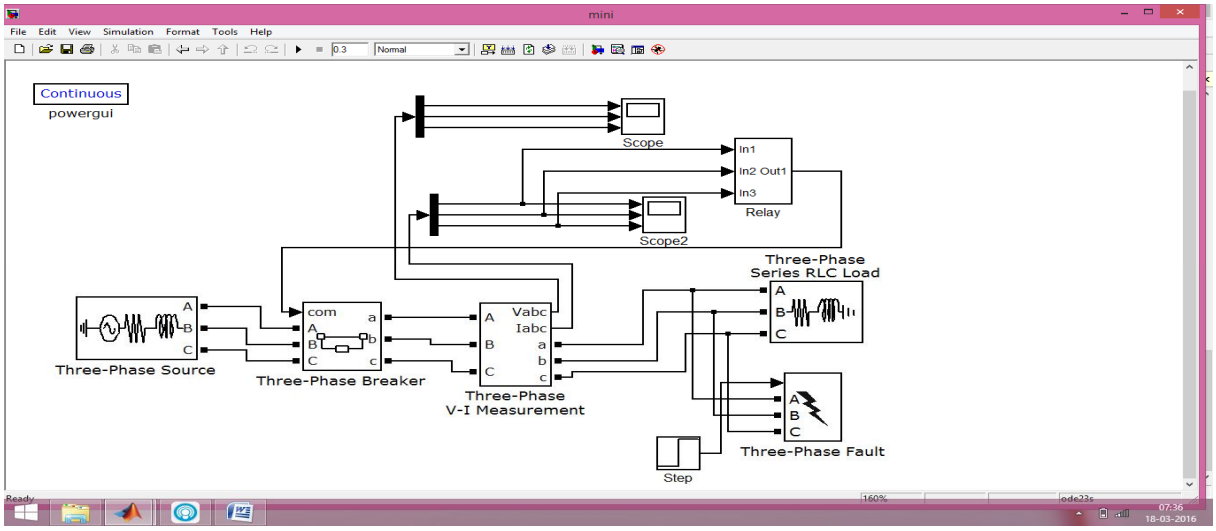

Fig 1: The Distribution Model

A. *Step By Step Procedure On Development Of Circuit Model*

1) Start
2) Run the model file (.mdl/.slx)
3) Define CT & PT Ratio
4) Define no. of samples, phases, sampling time(frequency)
5) Define fault & circuit breaker operating times
6) Define system voltage, & line lengths
7) Allocate memory for Current & Voltage data from the three phases
8) Check Max & Min values of Current & Voltage in each phase & if abs(min)>max, abs(min)=max
9) Normalize max Current & Voltage value to 32767 & change matrix to array
10) Separate phase wise Current & Voltage data into different commands
11) Initialize buffer to calculate the trip time
12) Create user defined Current & Voltage waveform
13) Run Test & get the trip status & trip time of the relay
14) Save the generated plots
15) Generate report by creating another server for Excel & passing data from MATLAB to Excel
16) Convert the file into a pdf & save the report
17) End

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Figure 2 indicates the relay circuit sub system for the proposed three phase model in a matlab environment.

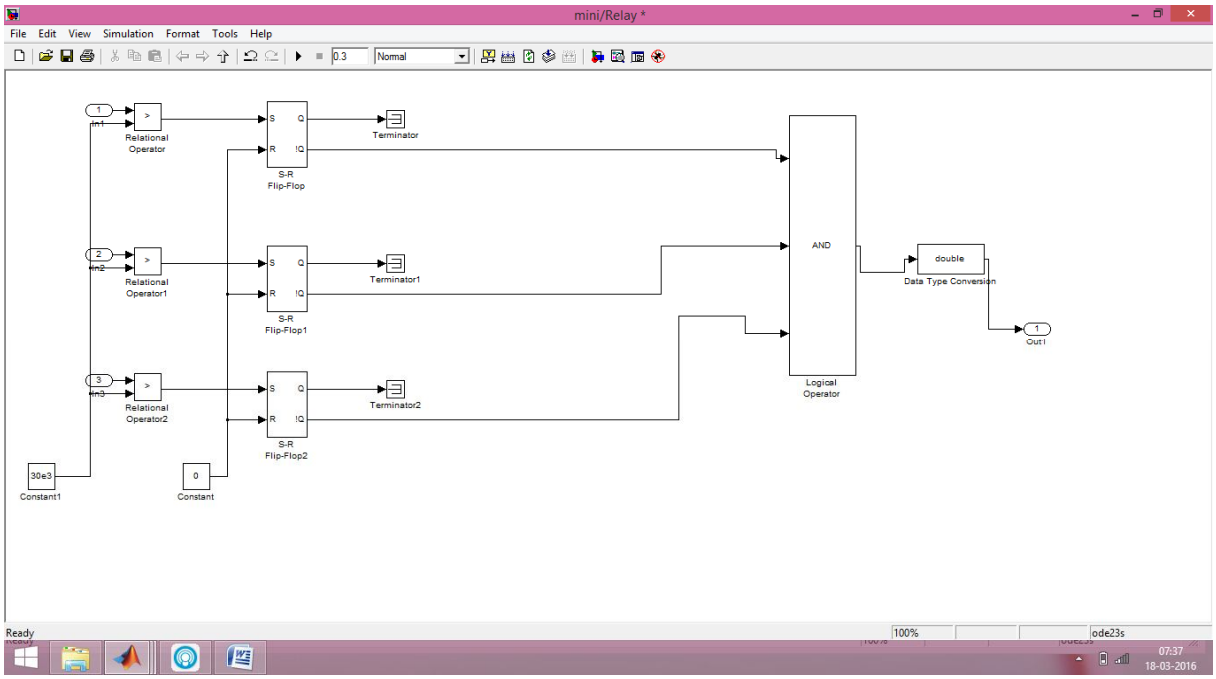

Figure 2 : Relay subsystem

B. Simulation Results

In this particular case, the Distribution system model is runs for a Three Phase to Ground Fault. The simulation is done for 1 sec, so that the waveforms can be seen more clearly. The sampling frequency is taken to be 10 kHz. The system voltage is taken as 33 kV and the line length is taken as 10 kms, with fault occurring at 5 kms. Fault is started at 0.2 secs and cleared at 0.7 secs as shown in Figure 3. These parameters have been kept constant for other test cases as well. Fig.3 and Fig 4, indicates the current and voltage waveforms for the given specifications. Upon injecting these signals to the relay it has been seen that the relay trips after 47.51 ms and the status of its coil is shown in the simulated results. As this is a self-reset relay, the trip status comes back to 0 upon clearing the fault, but for a manual reset relay, it stays 1 till the reset button is pressed manually. The proposed matlab model can be ran standalone or on the GUI to view the plots.

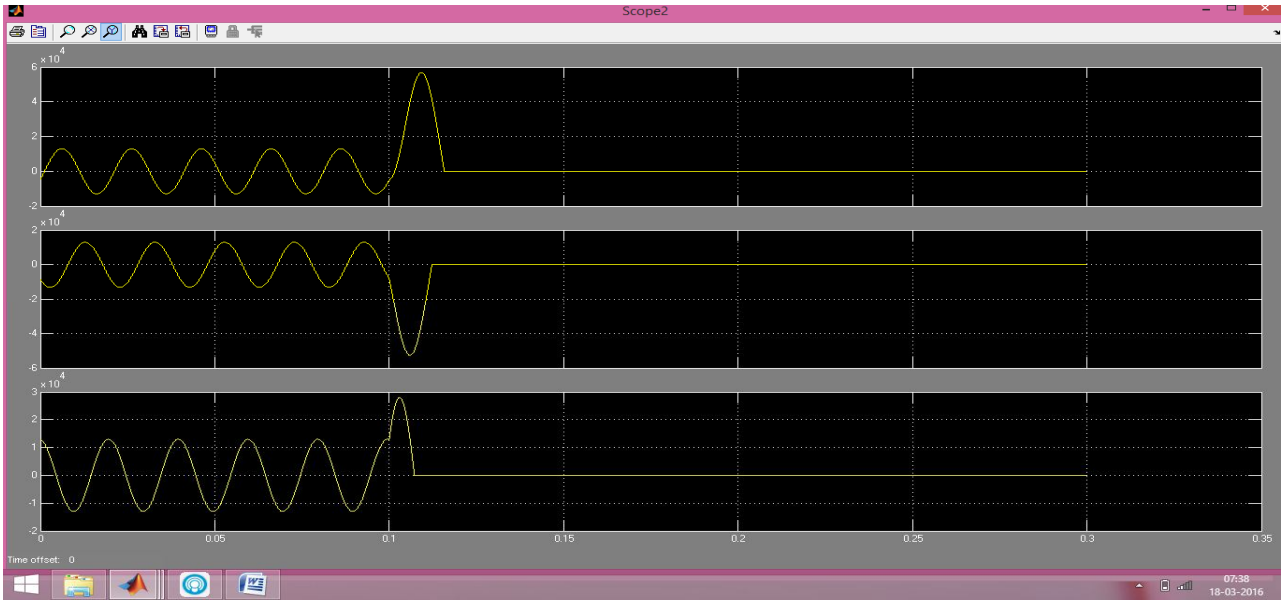

Figure 3 : Three phase fault current waveform.

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Figure 4 : Three phase fault voltage waveform.

In this proposed research work is extended by simulating the unsymmetrical fault such as Double Line to Ground fault, Line to Line fault and Single Line to ground fault.

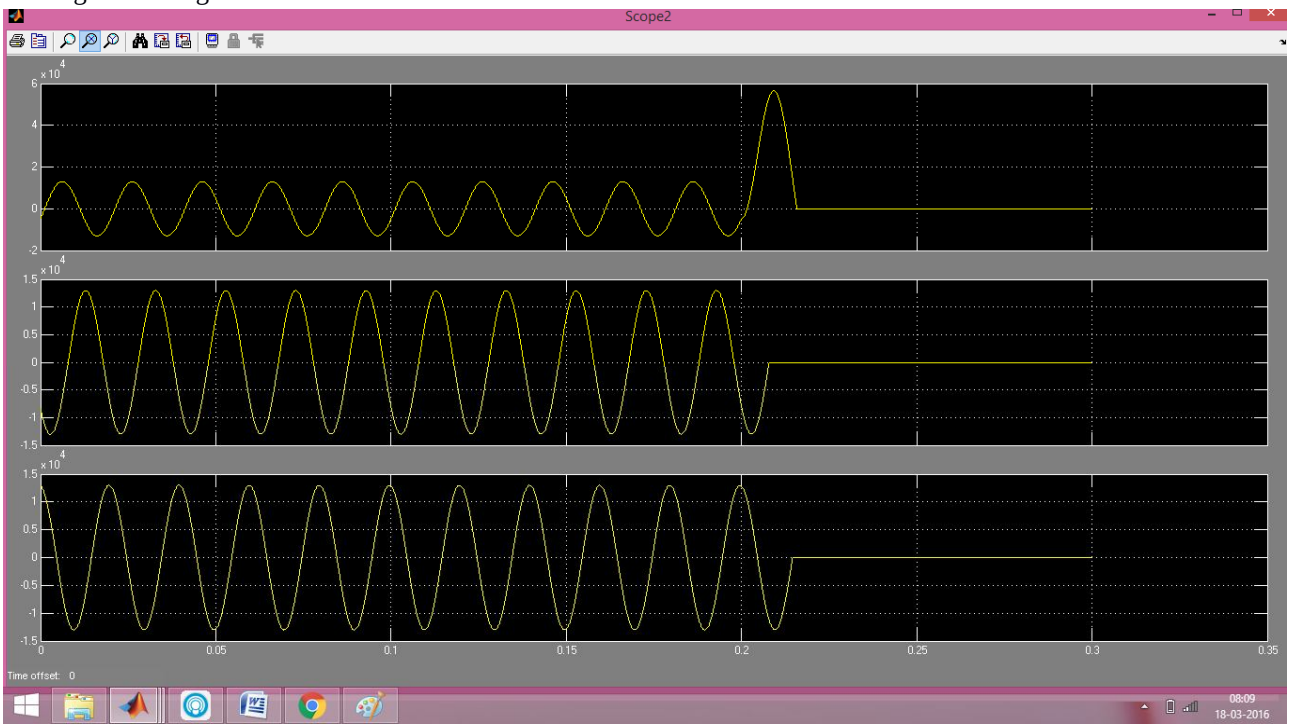

Figure 5 shows the simulation results of current wave form for the induced double line to ground fault in the proposed model.

IV. CONCLUSION

The simulation and analysis of three phase fault to achieve results of the transmission line parameter is convenient by using MATLAB software. In this paper simulation of three phase transmission line fault analysis system is proposed. Single Line to Ground fault, Double Line fault etc in transmission line is also simulated. This system opens the way to redesign the bus system of the power system according to its results. The proposed work can able to implement for a larger power systems geographically apart.

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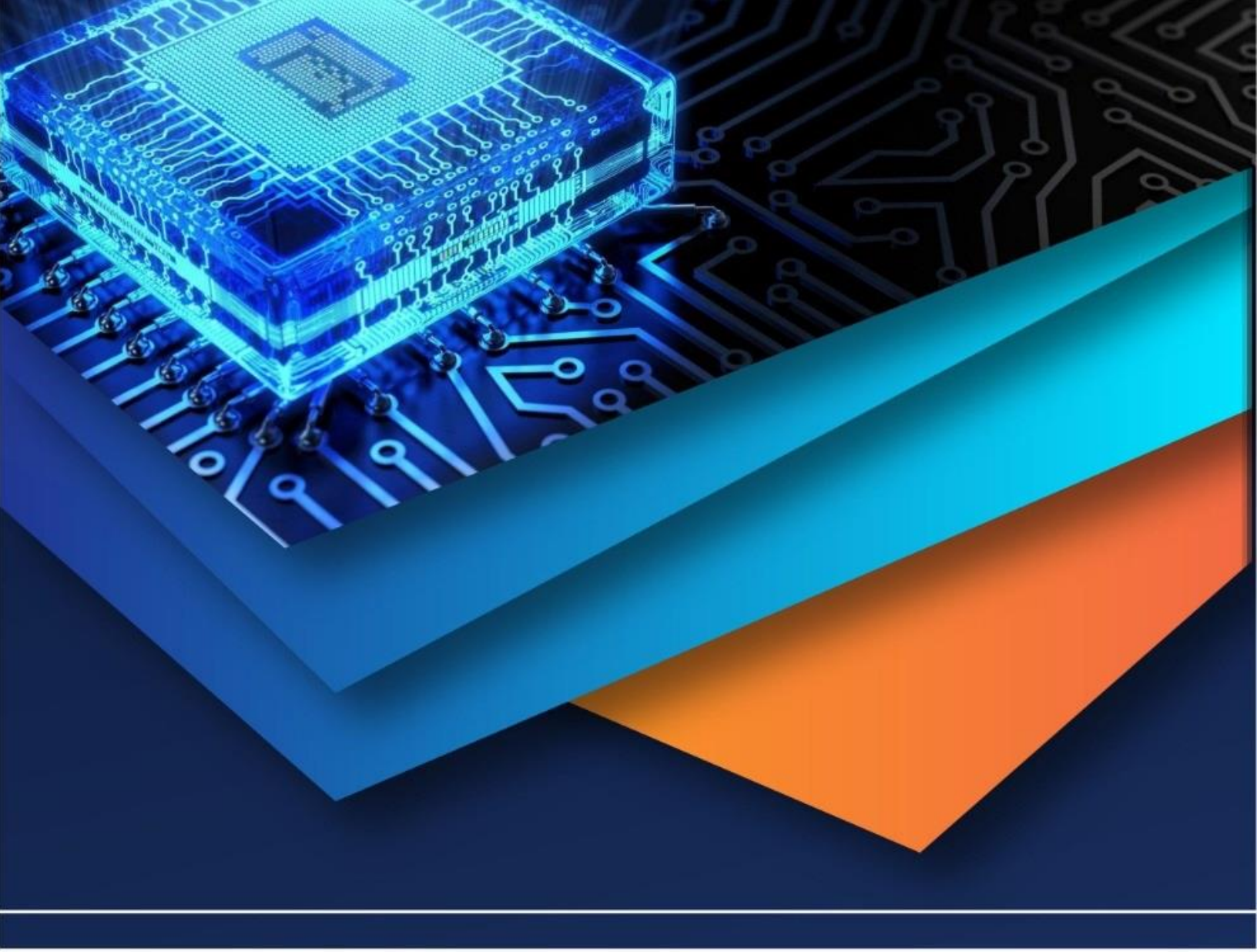

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