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PMSG Wind Energy Conversion Systems ZSI

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Abstract: Recently Permanent Magnet Synchronous Generator are mostly used in the Wind Energy Conversion System applications This work is clearly deal with the study of Wind Energy Conversion System WECS by way of Permanent Magnet Synchronous Generator PMSG with Z Source Inverters. The PMSGs and wind turbines are gradually entered in the field of power generation huge wind farms are used at constant voltage and frequency to increase capacity power supply Particularly Permanent Magnet Synchronous Generators is used in this machinery due to special characteristics such as low weight volume and high. PMSG never required the power supply at the starting time of power production PMSGs run at synchronous speed. These type of inverter are classified has Z-Source Inverter ZSI, Quasi Z Source Inverter QZSI, Trans Z Source Trans ZSI and Cascaded Multi Cell Z Source Inverter CMCTZSI etc. This inverter is operated such as shoot through state and on shoot through state previously to convert DC supply to AC supply where the DC supply side have been boosted up to required AC supply level are executed. The above mention shoot through state is not applicable to implementing in the conventional Voltage Source Inverter VSI and Current Source Inverter CSI. The PMSG and types of Z Source inverter systems are simulated in MATLAB Simulation platform.

I. INTRODUCTION

With the abundant available of renewable energy system, like solar, Wind Energy Conversion System is to reduce the environmental impact and to maintain the sustained power during power demand. The conventional plant uses fossil fuels such as coal and petroleum products to run the steam turbines and produce the thermal power generation. The fossil fuel utilization has a bad effect on the atmosphere and it is essential to reduce the polluting as well as exhausting fuel. The penetration of renewable energy system particularly wind energy has been increased rapidly during the past few years and it is expected to develop more in the future Electric power system is planned to generate and distribute electrical energy to the consumers with the defined parameters. At normal operating condition the frequency varies as an outcome of the variation of the real power generated and consumed, will leads to voltage drop in the transmission lines and distribution lines. Regulating the voltage at the desired level in the distribution system is really a task in power system operation. Maintaining a sinusoidal wave shape of voltage or current waveform is very difficult owing to the nonlinearities in several devices utilized for electric energy generation, transmission, distribution and the end users. Real power and reactive power variations will affect the entire power system operation. This unregulated power is fed to customer load side, to face severe power quality problems. As a result, the power system required keeping the quantities near to the nominal value. Active power control, frequency regulation and reactive power compensation are the highly complex issue in the wind turbine. The active power is regulated linearly with frequency difference between certain range (47 Hz -52 Hz) with a dead band (49.85 Hz - 50.15 Hz) and the regulating wind turbine speed is 10 % of the rated power per second. The wind turbine generally, operates in normal conditions (90%-105% voltage and 49-51 Hz frequency). However, it is capable to operate beyond the range within certain specified time limits. The real power generation of a wind turbine could not be synchronized; because the input power is limited by the wind speed. Still, an amount of rotating reserve may be kept if the wind power turbine is operated at a lower power level, than the available power level. Because of this reason, revenues will go down. The huge scale energy storage system may be in present, some fast response energy storage devices. It could be well technically suited for this purpose, though more work is needed to solve the solution as an economical one. From the wind power system operator the warm reserve allocation amount is generation units may be extra expenditure.

II. LITERATURE SURVEY

A study and survey on micro grids have been concentrated in the writing as a potential methodology for the reconciliation of disseminated fuel sources with fuel stockpiling frameworks in the electric organization. As of recently, the most utilized setup has been the AC micro grid, however, dc-based micro grids are picking up interest because of the favourable circumstances they give over their counterpart [1].

This paper described the biggest inexhaustible limit extension program on the planet is taken up by India. The public authority is meaning to build a portion of clean energy through a huge push in renewable. Centre drivers for advancement and sending of new and sustainable power in India have been Energy security, Electricity deficiencies, Energy Access, Climate change, etc. The government is assuming a functioning part in advancing the selection of sustainable power assets by offering different motivations, for example, age-based impetuses (GBIs), capital and interest endowments, reasonability hole subsidizing, concessional account, financial motivators, and so forth [2].

This article explained, the change in converter utilization to accomplish power stream control as two info sources share using a single inductor. The change proportion of the converter is higher than other TPCs. Along these lines, the level of the opportunity of obligation cycle is enormous. The converter can have a higher voltage gain for both low-voltage ports with a lower turn proportion and a sensible obligation proportion. The voltage stress of switches is low; accordingly, conduction misfortune can be additionally improved by receiving low Rds (on) switches [3].In this article, the converters used in the hybrid system are intriguing for hybridizing elective fuel sources and providing the yield load. The hybrid structure uses just four force switches that are autonomously controlled with four distinctive obligation proportions. Using these obligation proportions, following the greatest intensity of the PV source, setting the FC power, and managing the yield voltage. To plan the converter control framework, a little sign model is acquired in every activity mode. Because of the cooperation of converter control circles, a decoupling network is utilized to configure separate shut circle regulators [4].

This article discussed the converters behaviour of broad variation in voltages of owing to sources to a steady yield voltage. A helper circuit is utilized for accomplishing the turn-on ZVS of all switches. At different circumstances, the operational conditions of the converter can be separated into two states, including a solitary force flexibly and a double force gracefully state. In the double force gracefully express, the information circuits associated in arrangement along with the planned heartbeat width tweak can significantly lessen the conduction loss of the switches [5]. This article described converter types, methodology and its operating modes. converter parts among Cuk and SEPIC converters and it works in both individual and synchronous modes, in light of the accessibility of source and kills the need of information channel to smother the high recurrence sounds. Subsequently, it has the upside of basic structure and decreased converter parts. The converter is planned for the crossbreed wind and PV framework. The converter dependent on the accessibility of the environmentally friendly power sources [6].This paper delineated all the MPPT units that are at present utilized in crossover frameworks incorporate a few unmistakable MPPT regulators, so that, each MPPT regulator is committed to a subsystem. Utilizing an unmistakable MPPT calculation and regulator for every subsystem of a half breed framework unequivocally confounds the framework usage, builds cost, and diminishes the precision of the MPPT cycle. MPP tracker for crossbreed energy unit/photovoltaic/wind power age frameworks, the tracker is classified "general tracker" since it utilizes a brought together calculation and regulator to simultaneously follow the MPPs of the photovoltaic (PV), energy component (FC), and wind energy change (WEC) subsystems of a mixture FC/PV/wind power framework [7].

This article described about the diverse MPPT strategies appropriate to power module (FC) frameworks, however, they are not utilized in a half breed framework including an FC subsystem on the grounds that a different MPPT unit should be committed to the FC subsystem that fundamentally confuses the framework execution, and expands cost [8]. This article proposed a technic in which, it illuminates the together merging of the MPPT controllers for half and half FC/wind frameworks. The curiosity of the strategy is that it utilizes a bound together calculation to simultaneously follow the maximum power tracking's (MPPs) of the FC and wind energy change (WEC) subsystems joined to one another to shape a crossover FC/wind framework. Also, the procedure is sensor less, and tracks the MPP of the WEC subsystem, not the MPP of its wind turbine, so it extricates the most noteworthy electrical force from the WEC subsystem [9].

III. PMSG WITH Z-SOURCE INVERTER

This project deals with wind energy convention system using permanent magnet synchronous generator (PMSG) construction with operation and few types of Z-Source Inverter such as, basic Z-Source Inverter (ZSI), Quasi Z-Source Inverter (QZSI), Trans Z-Source Inverter (Tans-ZSI) circuit operation and mode of operations. The Permanent Magnet Synchronous Generator is considering as the key source of electrical energy, which are used to convert mechanical output energy of gas turbines, steam turbines, hydro turbines, wind turbines and reciprocating engines into generated electrical output power fed to the grid system. Frequently, these generators are referred to as synchronous generators as their task at a synchronous speed, which equals the speed of rotor matches by way of the supply frequency.

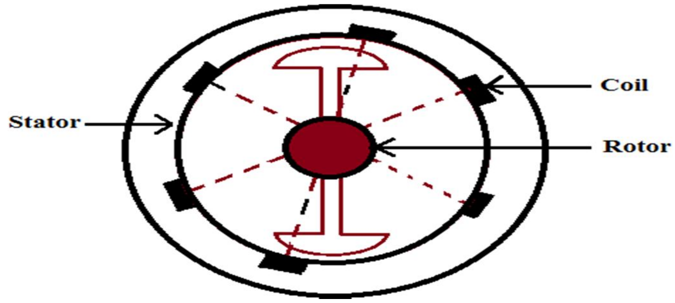

Figure.1 Block diagram representation of PMSG

A Permanent Magnet Synchronous Generator is a generator, the excitation field is provided everywhere by a permanent magnet as instead of a coil. The word synchronous refers to the fact that the rotor and magnetic field rotates in a similar speed, for the reason that magnetic field is generated through shaft mounted permanent magnet mechanism and current is developed fixed armature. The PMSG consists of a rotor and a three-phase stator like an Induction Generator. The stator and rotor have the equivalent number of poles. The stator has coils wound around them, which are accommodated within slots. The stator windings are displaced circumferentially at the same intervals.

A. Operating Principle of PMSG

The Permanent Magnet Synchronous Generator shown in Figure.1, works on the theory of Faraday's Law of electromagnetic induction that whenever a conductor is placed in a varying magnetic field emfs are induced which is called as induced emf. Rotors with permanent magnet or electromagnet can be used in this generator. Permanent magnets are expensive and they go down in their magnetic properties while working under powerful magnetic fields and also due to aging. The majority of the synchronous generators coupled with wind turbines are working with electromagnets. These electromagnets are magnetized through Direct Current (DC) to the rotor field windings. Brush type or brushless exciters may possibly use to magnetize the rotor. The magnetization current may be drawn from the electrical grid network. As the electrical grid supplies current in alternating form (i.e. AC), it is converted to Direct Current (DC) earlier than using it for magnetization. This excitation establishes strong north-south magnetic description in the rotor poles. Since the wind energy turbine turns the rotor, the magnetic field involving the stator coil varies sinusoidal through time, in section with the rotor speed. The speed of alteration of flux induces a sinusoidal voltage in the coils. The advantages of PM machines include: brushless structure, light weight, small size, high reliability, a lesser amount of frequent maintenance, and high efficiency. The inconvenience; however is that the excitation cannot be varied and hence the output voltage of the generator will vary with load system. Since practical considerations, it is attractive that the voltage regulation of the generator be minimized. This may be gifted by capacitor compensation devise, electronic voltage controller, or by using a generator with inherent voltage regulation competence. This inventory included radial or axial flux machines, longitudinal or transversal flux machines, inner rotor or outer rotor machines and inner magnet or outer magnet machines.

Air gap direction can be recognized in two different ways. Here, imaginary normal vector to the air gap is adopted along the flux direction. The axes of the Permanent Magnet machines are supposed to be along the length of the machine in the cylindrical coordinate system. Relation of the normal vector with the axis of the machine decides the radial or axial topology. If the standard vector is perpendicular to axis, machine is called radial. If the standard vector is parallel with the axis, the machine is called axial. In the transversal flux machines is flux pathway is perpendicular to the direction of rotor motion. The function of transversal flux machines can be planned in applications with high torque concentration necessity. Here, one notable property of the transversal flux machines is that the current loading and the magnetic loading. In the outer rotor type motor is coil on the inside and magnet on the outside which are functioning as a rotor. Compared with the inner rotor type the rotating shaft outer rotor type has a greater moment of inertia. The magnets are usually located on the inner circumference of the rotor. As a result, for the same outer diameter of the machine, in the outer rotor machine the rotor has better radius compared by the stator and it can be capable of with higher number of poles for the same pole pitch. The outer rotor machine is suited for small Horizontal Axis Wind turbines, where sometimes the hub carrying the blades is directly set to the rotor. But, inner rotor technologies are a new ordinary solution present on the market today. In small machines, the major losses are copper losses. As a result, the stator winding has the highest temperature increase in the active material of the machine. Hence, it is more valuable to put the stator winding, rather than the magnets, closer to the covering, where the cooling properties are good. This causes lower temperature rise for the identical amount of losses.

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B. Z-Source Inverter

The conventional Voltage Source Inverter (VSI) and Current Source Inverter (CSI) is either a buck operation otherwise a rated voltage operation converter. In addition, not a boost converter and dual mode of buck- boost converter. When it is available of output voltage range is restricted into either better or else minor than the input voltages. Except the Z-Source Inverter (ZSI) as an option of power conversion concept as it can have both the voltage buck and boost capability.

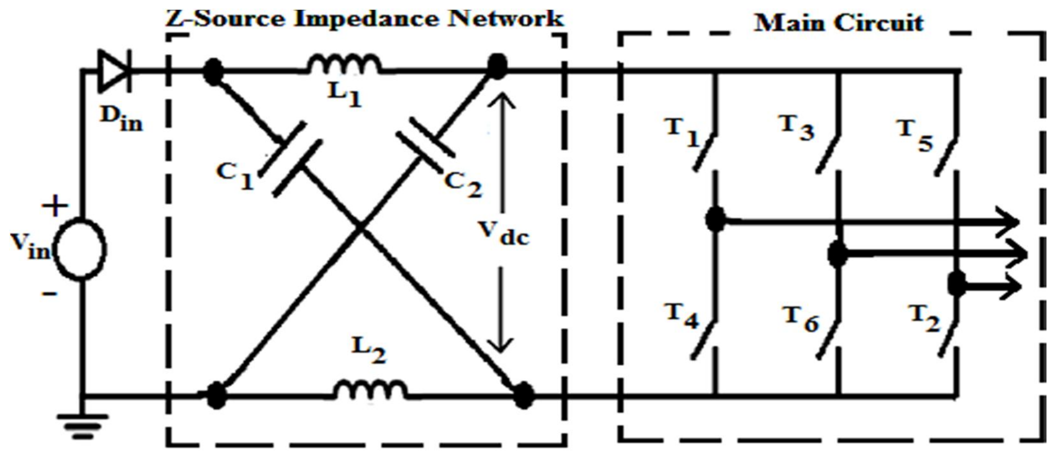

Figure 2 Block diagram of Z-Source Inverter

The Figure.2, demonstrates the major circuit of the proposed Z- Source Inverter. It makes use of limited impedance network coupled between the power source and the converter. It is consists of a split-inductor L1 and L2 and capacitors C1 and C2 connected in the X form. The X-arms couple in the inverter to a DC voltage source. The voltage source may possibly a battery output voltage, a diode rectifier output voltage or a wind generator coupled with a diodes rectifier output voltage. This impedance network allows the DC voltage, earlier than convert to Alternating Current (AC) to Direct Current (DC); Shoot through state can be put into service. Z-Source Inverter is buck or boosts its output voltage, and as well provides it with only one of its kind descriptions that cannot be realized in conventional power inverters. The Z-Source Inverter has two working modes as shown in the Figure 3(a).

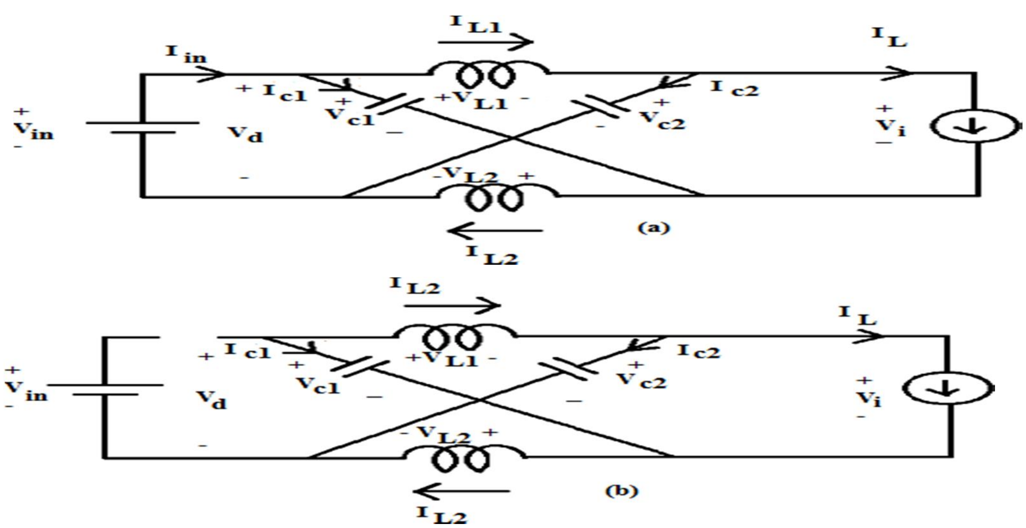

Figure 3.(a) Non Shoot through state (b) Shoot Through state.

In this Non Shoot through switching states, the input diode turns ON and the DC input voltage sources as well as the inductors are transferring energy to the load and charged the capacitors, as an outcome the DC-link voltage of the bridge is boosted. The Shoot through switching state has shown as in the Figure 3. (b), the input diode Din is reverse biased; the input DC establishment is isolated from the load, and the two capacitors discharged energy to the inductors and to the load. In stable state, the capacitor voltage is, the DC -link voltage and the output AC peak phase voltage of the Z-Source Inverter are as specified equation (1)

$$V_c = \frac{V_{in}}{1 - D_0} \qquad (1)$$

$$V_i = B.V_{in}\frac{V_{in}}{1 - 2D_0} \qquad (2)$$

$$V_{ac} = M\left(\frac{V_i}{2}\right) = M.B\left(\frac{V_i}{2}\right) \qquad (3)$$

Every place Do = To/Ts is the Shoot through duty ratio, To is the Shoot through time for each switching period, Ts, B = 1/1 – 2Do is the boost factor and M is the modulation key. From (3), the peak AC output phase voltage can be restricted, mutually by adjusting of the modulation index or Shoot through time. It can be superior to the input DC voltage by controlling the Shoot through time.

C. Quasi Z-Source Inverter

In the Z-Source Inverter, DC power side can be boosted up to minimum level. As well as their nearby output voltage collection is restricted to either better-quality or minor input voltage. But the Quasi Z-Source Inverter (QZSI) is a choice of power conversion concept, while it can be mutually voltage buck and increase capability. It has the following advantages: protected to EMI noise, rejection in-rush current plus misfiring evaluated to the Z-Source Inverter, Voltage Source Inverter and Current Source Inverter.

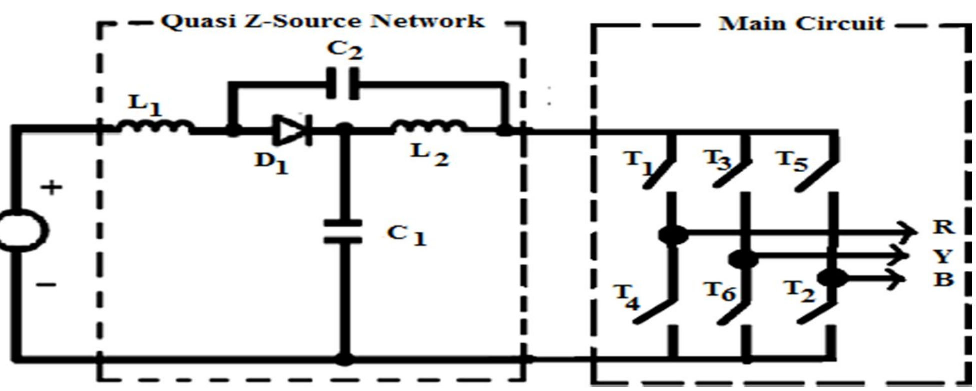

Figure.4. block diagram Quasi Z-Source Inverter

Evaluated to primary model of Z-Source Inverter and Quasi Z-Source Inverter is extra output voltage gain, a smaller amount switching stress and very less harmonics content nearby in the exacting power system network. Consequently, not including human intervention increases the power quality; particular grid connected Wind Energy Conversion System. Conventional Z-Source Inverter controlled technology and Quasi Z-Source Inverter controlled technology are perfectly altered. While compared Z-Source Inverter and Quasi Z-Source Inverter, the Quasi Z- Source inverter, Z-Source network absolutely different. The Quasi Z-Source Inverter has recorded the boost capability. The Figure.4 is the major formation of the Quasi Z-Source Inverter. It provides work for a unique impedance network preset between the power source and the circuit for converter. Those include a split-inductor L1 and L2 and capacitors C1 and C2 linked in parallel. The Quasi Z-Source network is associated from the inverter to a DC power supply. The DC power supply will be a battery or diode rectifier output power. The Quasi Z-Source Inverter a capable to boost up the input voltage introduces an unexpected Shoot through switching state. In this state, the Quasi Z-Source Inverter is an immediate performer of the identical inverter phase leg. This type of switching state is prohibited for the conventional Voltage Source Inverter and Current Source Inverter.

D. Trans Z-Source Inverter

The Z-Source Inverter and Quasi Z-Source Inverter convert DC power to AC power, boost or a buck the output voltage. Their reachable output voltage range is limited to either greater or smaller than the input voltage. In the Z-Source Inverter (ZSI) voltages, boost up level of the voltage is depends upon the Shoot through state. Power conversion is one of the concepts of conventional Quasi Z-Source Inverter (QZSI). During the buck and boost operation the harmonics are very less. When comparing Quasi Z-Source Inverter with Trans- Z Source Inverter the later has improved voltage gain and constant voltage stress.The Figure 5 shows the proposed Trans-Z Source Inverter; where as the inductors in the basic model of Z-Source Inverter is replaced by the Transformers. It consists of two Transformers (T1 and T2), two Capacitors (C1 and C2), and one Diode (Din).

The special characteristics of the proposed Trans-Z Source Inverters are as follows:

1) The fundamental X-shape arrangement is retained.
2) Only two transformers are used. By changing the turn ratio of the transformers higher boost voltage gain will be obtained.
3) Although producing a high boost factor, the proposed Trans-ZSI does not consume a few extra diodes, which reduces its range, charge and loss compared to conservative Voltage Source Inverter and Current Source Inverters.
4) It can be extended to the Quasi Z-Source Inverter topologies to get better input current outline and produces a lower voltage stress on capacitors.

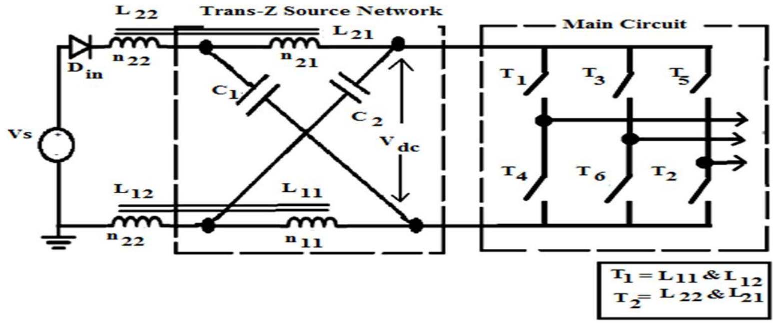

Figure.5. proposed Trans Z-Source Inverter

Parallel to the ZSI topology based on the X-shaped configuration has discontinuous input current and it requires a decoupling capacitor bank at the front end to remove current discontinuity and to protect the energy source. In addition to that, it cannot start up the suppress the resonant current and the resulting voltage and current spike can destroy the devices. The startup resonant current problem can be suppressed and discontinuous input current problem can be eliminated in the Trans-Z Source Inverter. This chapter, discussion is on basic circuit diagrams, construction and operation of PMSG and the three types of Z-Source Inverter. The discussion is on the shoot through mode and non-shoot through mode of operation with few different types of Z-Source Inverters.

IV. PMSG AND QUASI Z-SOURCE INVERTER FOR GRID CONNECTED SYSTEM

When wind turbine rotates PMSG generates in the AC power. The generated AC power is directly fed to the uncontrolled three phase bridge diode rectifier. The major utility of rectifier is which converts AC power to DC power. Subsequently, after performance of DC conversion, the DC power is given to the Quasi Z-Source Network. The QZSI, it can be boosting the input voltage by introducing Shoot through switching state. The boosted DC power is fed to the inverter section; in this inverter is convert DC power to AC power. Here the Quasi Z-Source Inverter is controlled by Fuzzy Logic based HCC technique. The basic purpose of this Fuzzy Logic based HCC to control the Quasi Z-Source Inverter; additionally real and reactive power is constantly maintained. The involvement of current measurement loop is measured by the actual three phase grid current (I RYB act). In that case the error comparator, compare the reference three phases set current (I RYB ref) and actual three phase grid current (I RYB act). At this stage, current measurement loop is produced by the three phase error current (I RYB error). Consequently, the three phase error current fed to the Fuzzy Logic Controller based HCC.

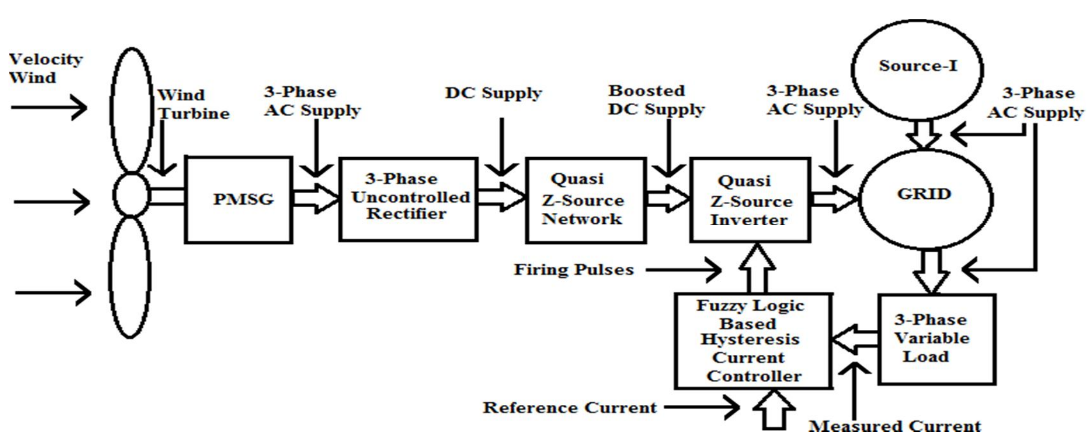

Figure 6 Schematic diagram of Proposed Wind Energy Conversion system with grid tied

Fuzzy Logic based HCC depends upon the error current signal to produces the firing pulses. Based on these firing pulses the inverter is which converts DC power supply to AC power supply. The AC power supply from the Quasi Z-Source Inverter is directly fed to the grid network. At that moment, the grid network is supplied to respective single and three phase customer loads. In between if any harmonics present in the distribution lines it will be filtered on second order low pass filter. On other hand parallel level power generating station (Source-I) is connected to the grid network. The PMSG as well as Quasi Z-Source Inverter is produced power and Source- I power has been merged to the grid effectively as shown in the Figure 6. Outstanding power is the spinning reserve, whenever the power demand occurs in the grid, at that time it can be utilized. This chapter, discuss the Wind Energy Conversion System based Simulink block diagrams with different control methodology used in PMSG and the few types of Z-Source Inverters.

V. SIMULATION RESULTS AND DISCUSSION

The Proposed method is implemented in MATLAB Simulink platform. In addition, maximum constant boost control with third harmonic injection based Z-Source Inverter is used. Permanent Magnet Synchronous Generator generated an output voltage is 50V. Figure 7.(a) represents the inverter output voltage 270V. Figure 7.(b) represents phase current 1.4A. But conventional process, phase to phase voltage is 200V, phase current is 1.2A and Permanent Magnet Synchronous Generator output voltage is 50V. The proposed method reduction in harmonics is 1.49. In the both methods reduction of harmonics is equal. As a result, maximum constant boost control and third harmonic injection based Z-Source Inverter is more efficient, compared to the conventional method.

A. Simulation Results and Discussion

Figure 8 (a) & (b) shows block diagram & Simulink block of Wind Energy Conversion System. The Permanent Magnet Synchronous Generator generated 350V AC. PMSG output voltage (350V AC) is fed to the diode rectifier.

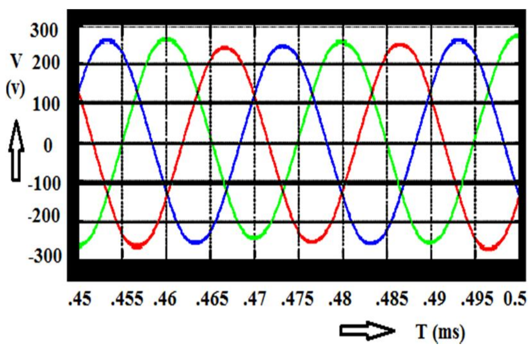

Figure 7.(a) phase voltage in Volts

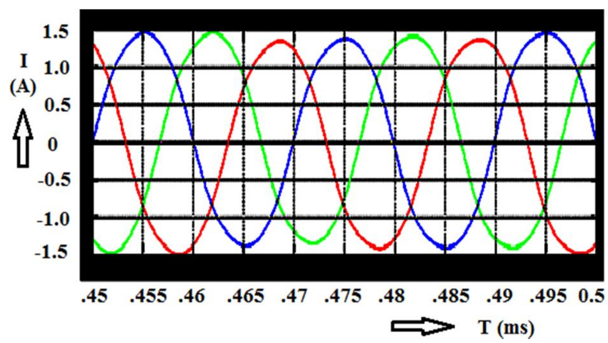

Fig 7. (b)Phase Current in Amps

The diode rectifier output voltage is directly fed to the Quasi Z- Source Network. Before converting DC to AC, the Shoot through state is carried out by Quasi Z-Source Inverter. As a result, the voltage is boosted up to 1000V DC. It is denoted as V_{dc} (Capacitor Voltage). The capacitor voltage is given in the Figure 9.

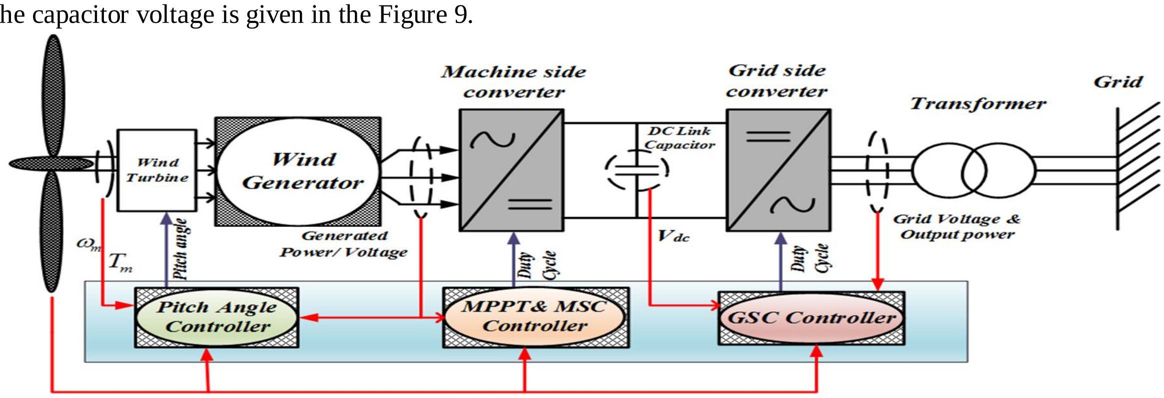

Figure 8(a) Block diagram representation of PMSG with control

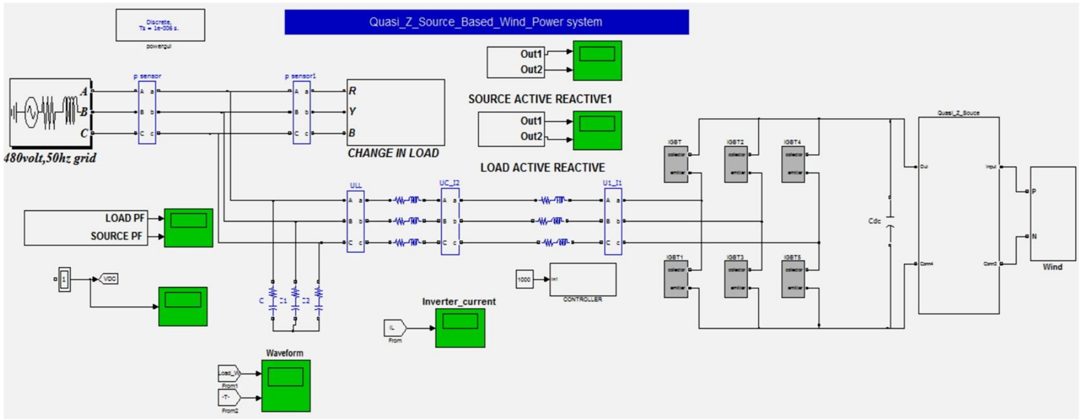

Figure 8.(b) Simulink diagram of PMSG

The Quasi Z-Source network output voltage (1000V DC) is directlyfed to the inverter circuit. The inverter converts 1000V DC to 480V AC, at same time, the current is maintained as constant by using Hysteresis current controller. The inverter output voltage is (480V AC) given to the second orderlow pass filter. The filter removes the harmonics content in the 480V AC power supply Even if there is a change in the power factor; the inverter maintains the output currents. The power factor of the load and source is given in the Figure 10. The choice of power factor inverter current is shown. Actually, the required loads are 121 KVA active powers and 118 KVAR reactive powers are given in the Figure 12. But the former generating station i.e. Source (I) produced only 120 KVA active power and 12 KVAR negative reactive power. It is given in the Figure 13.

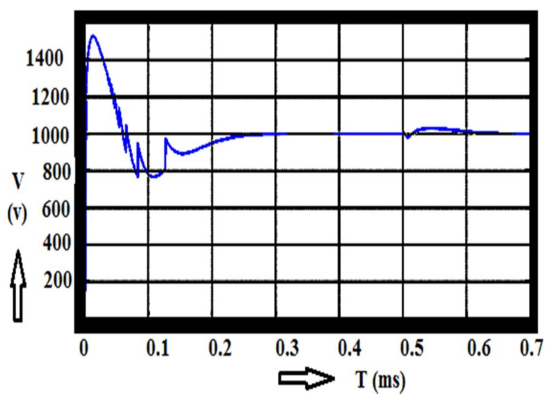

Figure 9 Capacitor Voltage

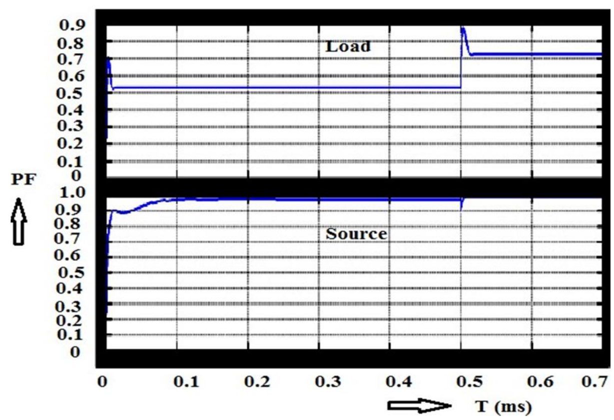

Figure 10.Power Factor for Load and Source

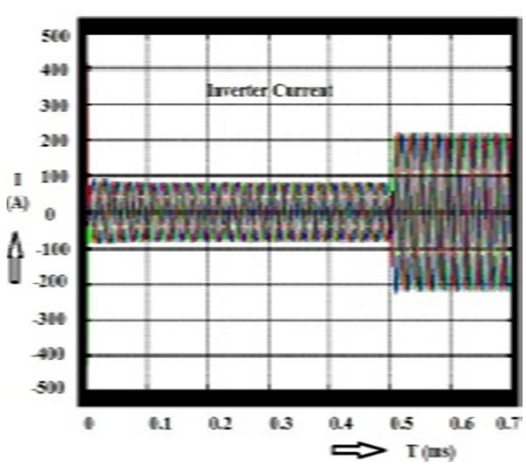

Figure 11 Inverter Current

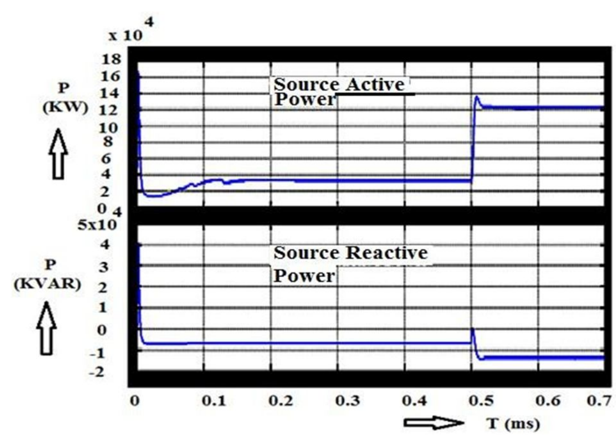

Figure 12.Active and Reactive Power for Source

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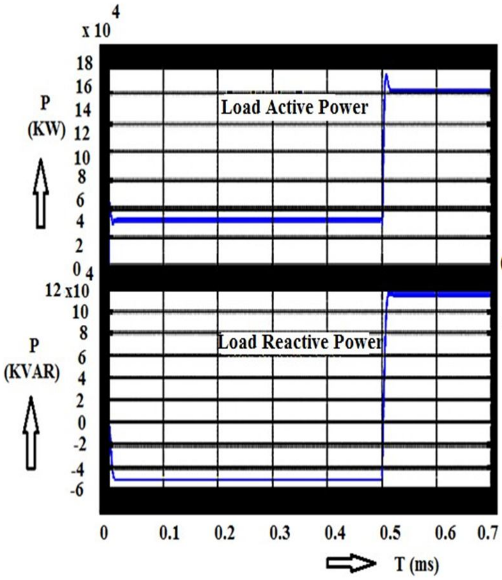


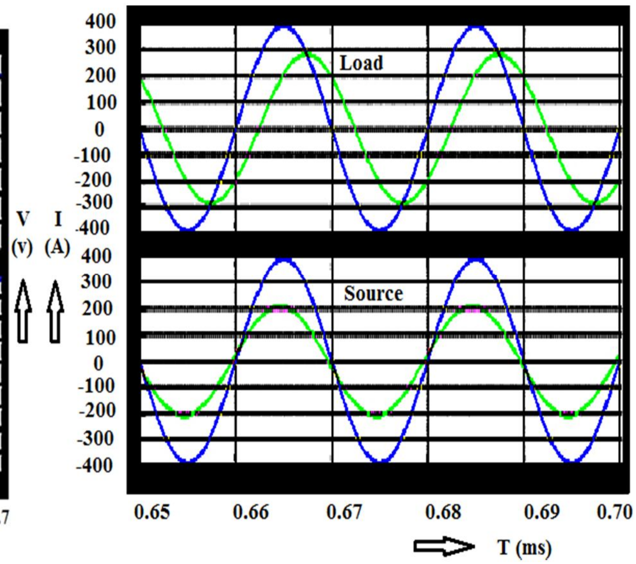


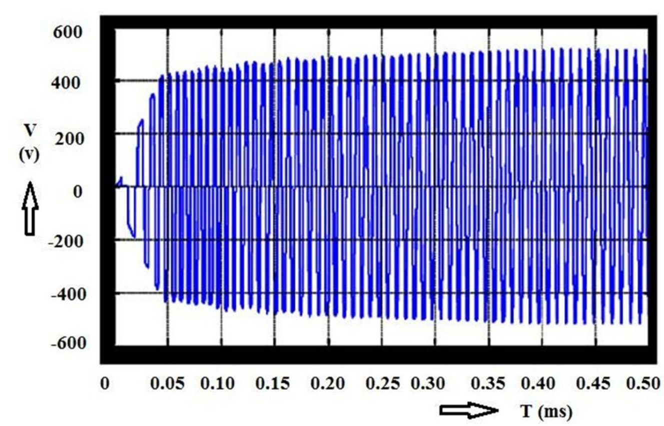
Figure.13 Active and Reactive Power for Load   Figure.14 Current and Voltage for Load.

The remaining active and reactive power lagging is managed by PMSG and Quasi Z-Source network. At the same time, load current is not maintained identical to the voltage. But in this proposed system, it is maintained equal as shown in the Figure.14 .

B. Power Quality Enhancement using Quasi Z-Source Inverter by Hysteresis Current Controller based Fuzzy Logic Control

1) Simulation Results and Discussion

The PMSG generates 580V AC as specified in the Figure 15. PMSG output is (580V AC) applied to the three phase diode rectifier. The diode rectifier is converts 580V AC to 520V DC output voltage as showing inthe Figure 16. The DC output voltage is (520V DC) fed to the Quasi Z- Source network. Before converting DC to AC voltage, the Shoot through state is carry in the Quasi Z-Source Inverter. Using shoot through state, the voltage is boosted up to 1090V DC. It is denoted as V_{dc}. In this case, DC voltage (1090V) is directly fed in to the inverter circuit.



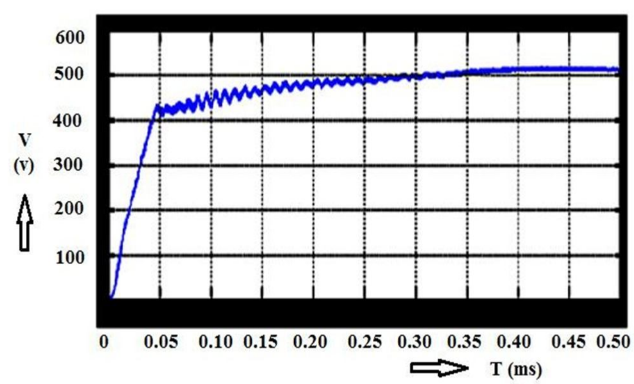


Figure 15. PMSG Output Voltage   Figure.16. Rectifier Output Voltage

The inverter converts DC (1090V) to the required 480V AC power supplied and same time, current is maintained asconstant using FLC supported HCC. The inverter output voltage is (480VAC) given to the second order low pass filter. The filter eliminates the harmonics in the 480V AC supply. The inverter is maintaining the current if there is any alteration in the grid power supply. Here, if any load demand is present, there the QZSIis capable to compensate in the load demand.

VI. CONCLUSION

This project is mainly focused on the power quality improvement of Wind Energy Conversion System (WECS) with Permanent Magnet Synchronous Generator (PMSG) and Z-Source Inverters (ZSI). The PMSG-based WECS with Z-Source Inverter and maximum constant boost control with Third harmonic injection method is proposed. The Z-Source Inverter is used for maximum power point tracking control. In addition to that, maximum power is delivered to grid system. Further Permanent Magnet Synchronous Generator and Quasi Z Source Inverter are implemented based on Wind Energy Conversion System. The Hysteresis Current Controller method and Fuzzy Logic Controller (FLC) is controlled by PMSG and Quasi Z-Source Inverter. Additionally, the proposed Hysteresis Current Control based Fuzzy Logic Controller (FLC) has more advantages, such as more flexibility, Quick control and static performances. This project is mainly focused to improve the power quality by using WECS with Trans Z-Source Inverter controlled by Fuzzy Logic Controller technology. The PMSG-based WECS using Trans Z-Source Inverter is stabilized the AC bus voltage by proposed control technique. Particularly, no additional circuits are present. Compared to conventional methods, in this proposed FLC has more advantages, such as flexibility, easy to manage and control. The simulation results are verified, the proposed FLC based Trans-ZSI is reduced the harmonics level to 0.07% with reference. Compared to conventional methods it is maintaining the pure sinusoidal bus voltage in the grid system.

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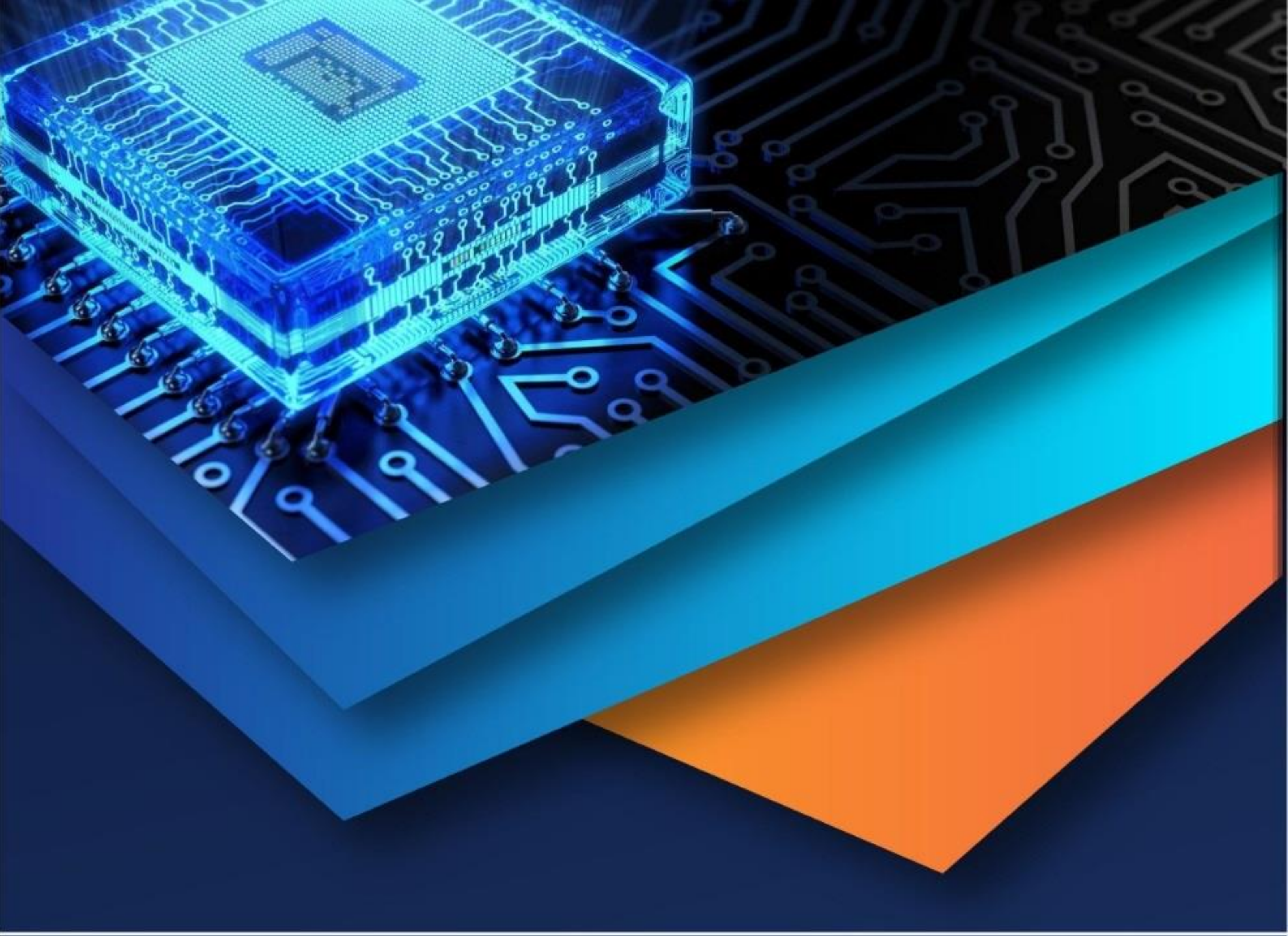

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