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# Three-Port Integrated Topology to Interface Electric Vehicles and Renewables with the Electrical Grid

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***Abstract:*** ***This paper presents the associate degree analysis and also the experimental validation of an off-board three-port integrated topology (TPIT) wont to interface electrical vehicles (EVs) and renewable from solar electrical phenomenon (PV) panels with the power grid. The TPIT consists of three power converters sharing one common dc link, and it will operate in four completely different modes toward the long run sensible grids: 1) the heat unit batteries area unit charged with energy from the power grid through the grid-to-vehicle operation mode; 2) the heat unit batteries deliver a part of the hold on energy back to the facility grid through the vehicle-to-grid operation mode; 3) the energy created by the PV panels is delivered to the electrical grid through the renewable-to-grid operation mode; and 4) the energy created by the PV panels is employed to charge the heat unit batteries through the renewable-to-vehicle operation mode. Additionally to individual action, the reorganization of those modes leads to new military operation modes. The paper presents the planned power theory to regulate the TPIT, this management ways to manage the currents in ac and dc sides of the TPIT, and also the details of the developed TPIT example, as well as the hard-ware and also the digital system. Experimental results that validate the TPIT operation modes also are conferred.***
***Index Terms: Electric vehicle (EV), integrated topology, power converters, renewables, smart grid.***

## I. INTRODUCTION

Electric mobility represents a significant contribution to increase the sustainability and efficiency in the transport sector, including the use of electric vehicles (EVs), hybrid EVs, fuel cell vehicles and electric bicycles. Nevertheless, the huge introduction of EVs into the electrical grid ought to be controlled so as to stop power quality issues to optimize its interaction with alternative electrical appliances, also on take benefits of their use within the new paradigms of micro-grids, smart grids, and smart homes. In this context, the optimized EV charging process considering the customer perspective, the power demand and the revenue of the aggregator.
In this project, a single-phase on-board bidirectional charger with capability to operate in Grid to Vehicle and Vehicle to Grid modes is proposed. A balancing power demand using the EV in Vehicle to Grid operation for demand response management in smart grids is proposed, a hierarchical energy management strategy to introduce EVs in smart grid is analyzed.

## II. THESIS ORGANIZATION

The following area unit the most important objectives of this project.

*A.* To implement three port converter topology for integrating the Photovoltaic, Grid and Vehicle.
*B.* To track the maximum power from the Photovoltaic system using Fuzzy based MPPT algorithm.
*C.* To achieve grid synchronization using PI controller.
*D.* To increase the Vehicle efficiency using Brushless DC motor within 83% to 89%.

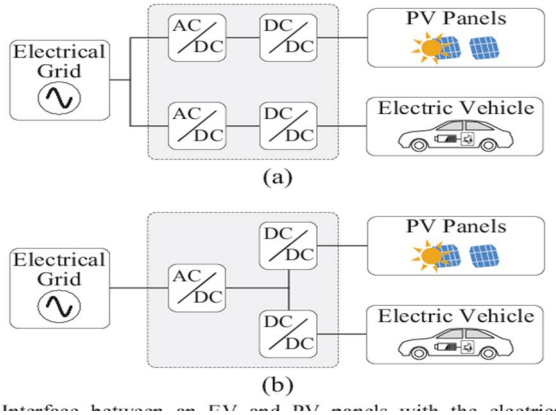



Fig.1.Interface between an EV and PV panels with the electrical grid. (a) Classical topology (b) Proposed topology

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(a) Classical topology; (b) Proposed topology.

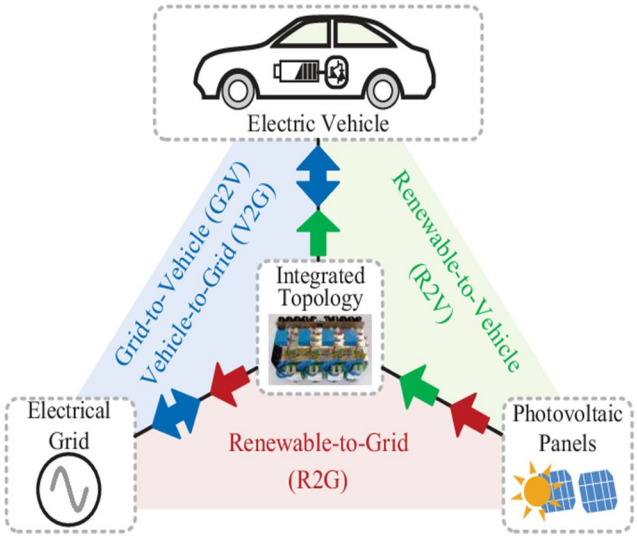



Fig. 2. Proposed three-port integrated topology (TPIT) used to interface

Fig.2.Proposed three port integrated topology

## III. PV SYSTEM

In 1839, a French physicist Edmund Becquerel proposed few materials have the ability to produce electricity, when he exposed to sunlight. But Albert Einstein explained photoelectric effect and the nature of light in 1905. Photoelectric effect state that the photons or sunlight strikes to a metal surface flow of electrons will take place. Later, photoelectric effect for the technology of photovoltaic power generation. The first photovoltaic module was manufactured by Bell laboratories in 1954.

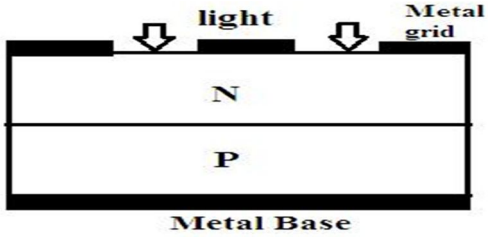



Fig.3.Structure of PV cell

## IV. PV CELL

Photovoltaic cell is that the building block of the PV system. The semiconductor also block of the PV system. Silicon is employed for cell because of its benefits over atomic number 32 (Germanium). When light-weight energy strikes the cell (PV cell), electrons is knocked loose from the atoms within the semiconductor material. If electrical conductors area unit connected to the positive and negative sides, forming associate in nursing electric circuit, the electrons may be captured within the variety of an electrical current, that's electricity.

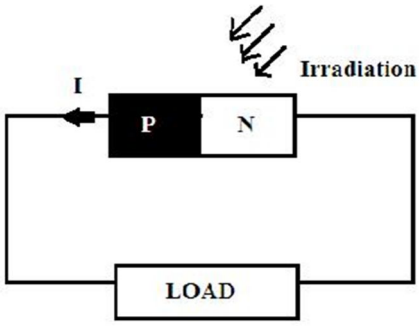



Fig.4.Working of PV cell

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## V. PV MODULE

When PV cells (present within the solar modules) absorb daylight, the energy gift within the photons of sunshine is transferred to the semiconductor material. The electrons are created to flow through the semiconductor material as current. Generally, every solar PV module is rated within the vary of 50W to 350W.

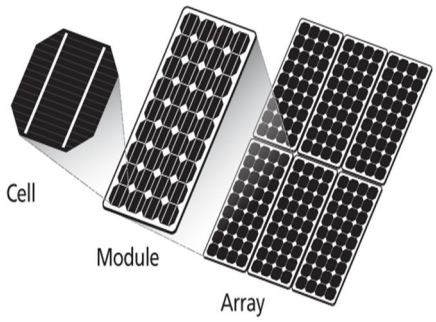



Fig.5.Cell, module and array

## VI. PV ARRAY

An electrical phenomenon array is just associate in nursing interconnection of many PV modules asynchronous and parallel. It is designed to provide usable solar energy by means that of photovoltaics. It consists of an appointment of many parts, as well as solar panels to soak up and convert daylight into electricity, a solar electrical converter to convert the output from direct to AC, moreover as mounting, cabling and different electrical accessories to line up an operating system. It is going to additionally use a solar trailing system to boost the system's overall performance associate in nursing the embrace an integrated battery answer. The building blocks of an electrical phenomenon system are solar cells. An electric cell is that the device which will directly convert photons energy into electricity.

There are 3 technological generations of solar cells:

*A.* The first generation of crystalline silicon cells
*B.* The second generation of thin-film cells such as CdTe, CIGS and GaAs.
*C.* The third generation of organic, dye-sensitized, Perovskite and multi-junction cells.

## VII. ELECTRICAL GRID

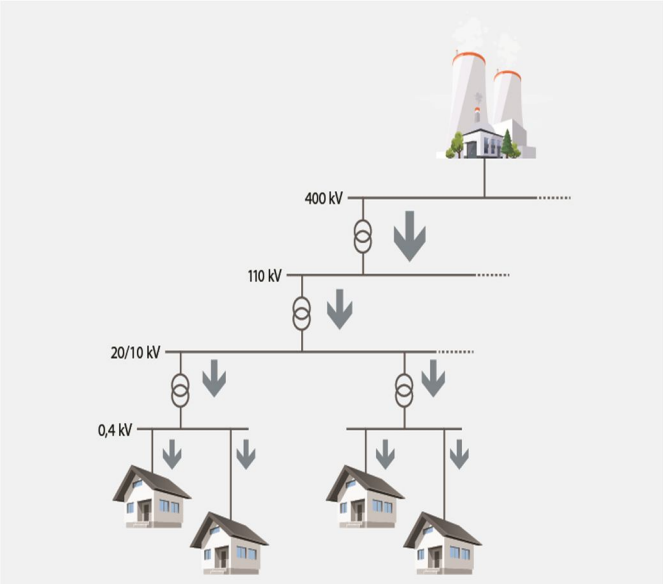



Fig.6.General layout of electricity networks

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An electrical grid is an interconnected network for delivering electricity from producers to customers. It consists of

*A.* Generating stations that manufacture wattage.
*B.* Electrical substations for stepping electrical voltage up for transmission, or down for distribution.
*C.* High voltage transmission lines that carry power from distant sources to demand centers.
*D.* Distribution lines that connect individual customers.

Power stations connected to grids square measure typically settled close to energy resources like a supply of fuel or to require advantage of renewable resources and aloof from heavily-populated areas.

## VIII. ELECTRIC VEHICLES

EV is also a vehicle that uses one or plenty of electrical motors or traction motors for propulsion. An electrical vehicle could also be powered through a collector system by electricity from off-vehicle sources, or could also be self-contained with electric battery, solar panels or an electrical generator to convert fuel to electricity.

In Full Electrical Vehicles (FEV), power storage strategies include:

*1)* Chemical energy kept on the vehicle in on-board batteries: Battery electrical vehicle (BEV) generally with a lithium-ion battery.
*2)* Kinetic energy storage: flywheels.
*3)* Static energy kept on the vehicle in on-board electrical double-layer capacitors.
*4)* EVs convert over 59 to 62% of grid energy to the wheels.



Fig.7.Solar electric vehicles

## IX. FUZZY BASED MPPT ALGORITHM

Maximum electrical outlet trackers square measure so necessary in electrical phenomenon systems to extend their potency. Several ways are projected to realize the most power that the PV modules square measure capable of manufacturing underneath totally different atmospheric condition. This paper projected associate in nursing intelligent methodology for max outlet chase supported formal logic controller. The system consists of an electrical phenomenon solar module connected to an alphabetic character device. Comparison of various performance parameters such as: chase potency and latent period of the system shows that the projected methodology offers higher potency and higher performance than the traditional perturbation and observation methodology.
The objective of the instructed theme focuses on enhancing the potency of the solar array. The symbolic logic controller uses code tree format and perturb and observe algorithmic program to follow the most power from the panel. The alphabetic character convertor is employed to improve the input voltage and fed to the load and thus the alphabetic character convertor will increase the voltage and potency of the system. Mistreatment symbolic logic controller the $64000 scalar worth is modified to fuzzy worth known as fuzzification in code tree format. The most wall plug pursuit has several algorithms within the existing system, perturb and observe algorithmic program is employed wherever the voltage is sporadically flustered and therefore the output voltage is

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endlessly compared with the previous perturbation cycle. In perturb and observe algorithmic program, the slight perturbation is applied to the system. The ability is developed within the perturbation method. The voltage is hyperbolic during this perturbation method then the perturbation is sustained within the same direction. When the height power is reached then most wall plug becomes zero and next instantly decreases so perturbation method reverses. During this paper, most wall plug pursuit uses symbolic logic controller that continually add rule format. Depends upon the rule format, the symbolic logic controller performs. The symbolic logic controller uses code tree format and fis file that is that the system for symbolic logic controller. While not the fis management file the symbolic logic controller doesn't ready to perform its operation. In system the sun is dynamic its direction from one place disagreement place so the voltage generated is can differ and not constant. To trace the best voltage the most wall plug pursuit is employed. In solar module every cell has completely different voltage. The typical voltage is fed to the load. In most wall plug pursuit tracks the most voltage within the solar module so the potency will increase.

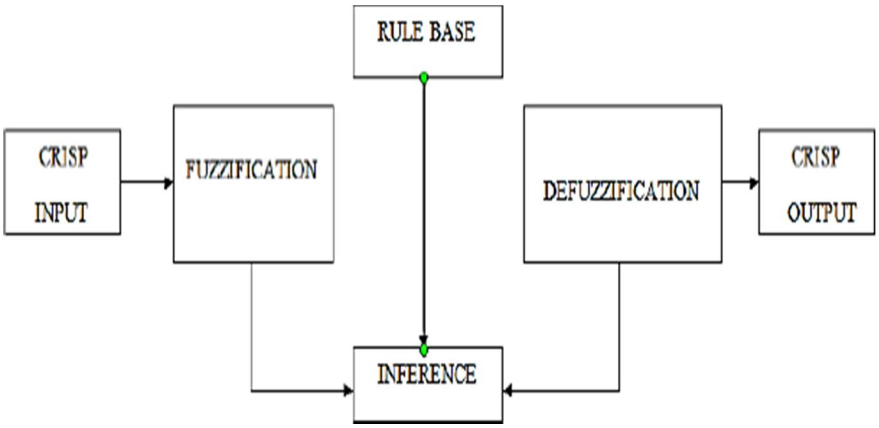



Fig.8.Block diagram of MPPT controller

## X. ZETA CONVERTER

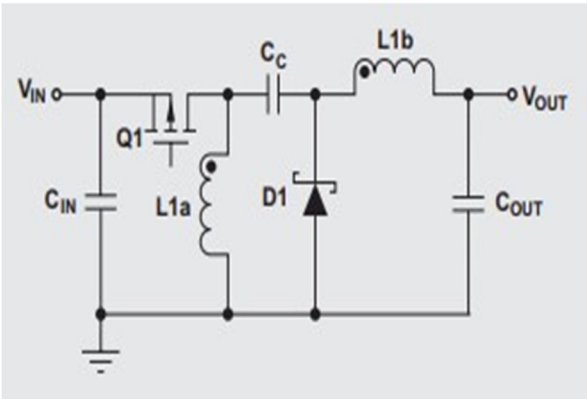



Fig.9.Circuit diagram of Zeta converter

The Zeta converter is that the DC-DC converter almost like traditional buck boost converter wont to step down and maximize the input voltages. The Zeta converter has high potency, higher characteristics and quicker response than buck boost convertor. The most advantage of Zeta converter is employed for power issue correction. The Zeta converter uses MOSFET (Metal Oxide Semiconductor Field Effect Transistor) switch that has high shift speed.

The controller is fed to the gate pulse in order that the MOSFET switch is employed for on and off method. The improvement p-channel MOSFET is employed in Zeta converter. The switch has rhythmic input and continuous output. For low power application, MOSFET is employed as a switch and for top power application IGBT (Insulated Gate Bipolar Transistor) is employed for switch rather than MOSFET. Once the switch is closed the diode is OFF and also the current through the electrical device are drawn from the voltage supply that is that the charging amount. Once the switch is opened the diode is ON and also the energy keep in electrical device L1b is transfer to the load that is that the discharging amount. This is often the operation of Zeta converter.

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## XI. PROPOSED SYSTEM

*A.* This project proposes three-port converter Design for integrating PV, Vehicle and Grid system.
*B.* The Fuzzy based MPPT algorithm with Zeta converter is used to track the maximum power from the PV system.
*C.* PI controller with PLL is used to achieve grid synchronization.
*D.* Conventional DC and AC motors are replaced by BLDC motor for electric vehicle and constant speed operation is achieved by PI controller.
*E.* Other applications such as electric train, micro-grid, electric vehicles etc.
*F.* This project is implemented using MATLAB simulation.

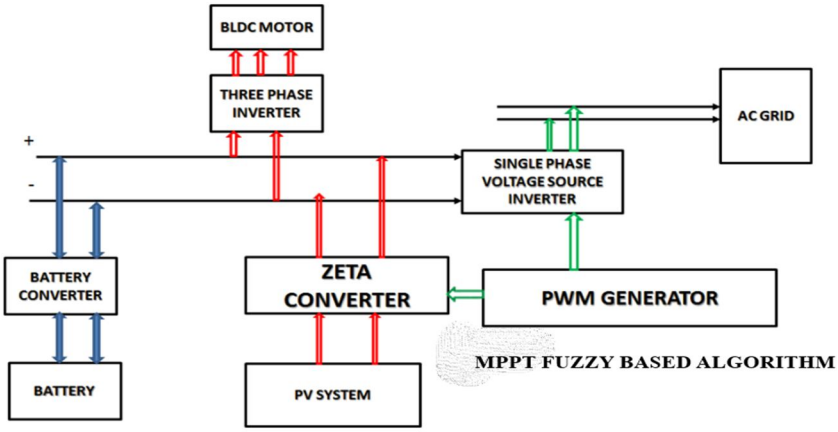



Fig.10.Block diagram of Proposed system

TPIT: THREE-PORT INTEGRATED TOPOLOGY

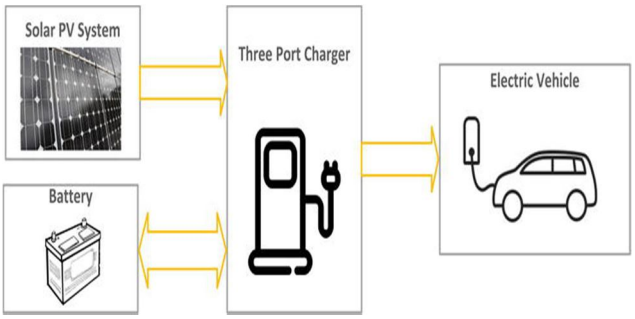



Fig.11.Real time simulation of efficient energy management

BLDC MOTOR

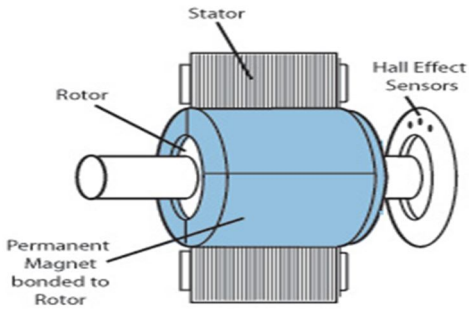



Fig.12.Brushless DC Motor

Brushless motors notice applications in such places as laptop peripherals (disk drives, printers), hand-held power tools, and vehicles starting from model craft to cars. The benefits of a brushless motor over brushed motors area unit high power-to-weight quantitative relation, high speed, electronic management, and low maintenance.

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## XII. SYSTEM SIMULATION RESULTS

The converter system was simulated using Zeta converter. This method has enforced in MATLAB. The projected new management on PV solar system can facilitate accomplishing the subsequent objectives:

*A.* Increasing the utility of the top side solar PV system.
*B.* Power issue improvement through reactive power compensation.

For the simulation of the projected theme, the Simulink models of PV array and therefore the MPPT formula square measure to be developed on an individual basis and integrated to get the general model. Simulation plays the foremost role in analysis and organic process space. Before manufacture the projected plan, the simulation has been disbursed therefore the damages are often reduced and if any more modification needed may also be done.

1) *PV Array:* This section presents an influence system block set-based simulation model of PV array. The PV array within the projected theme consists of one solar array of 21V, 5.17A. To develop an entire solar electrical phenomenon power conversion system in simulation and to permit the interaction between a projected convertor and therefore the PV array and it is necessary to develop a simulation model for a PV cell.

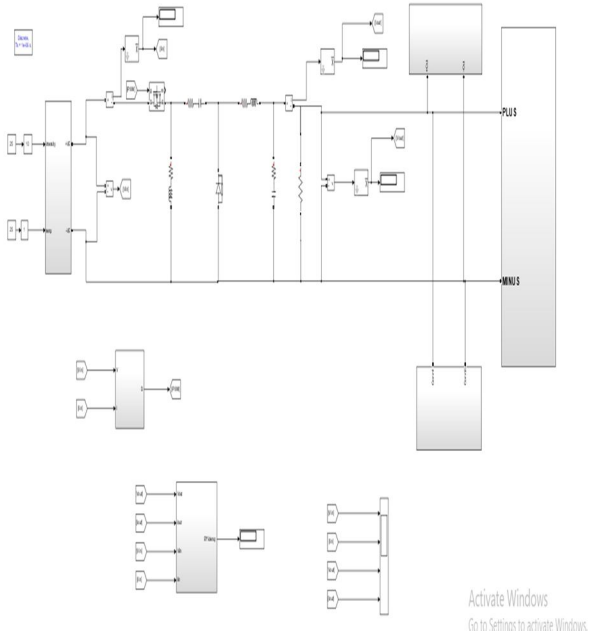



Fig.13.Simulation model

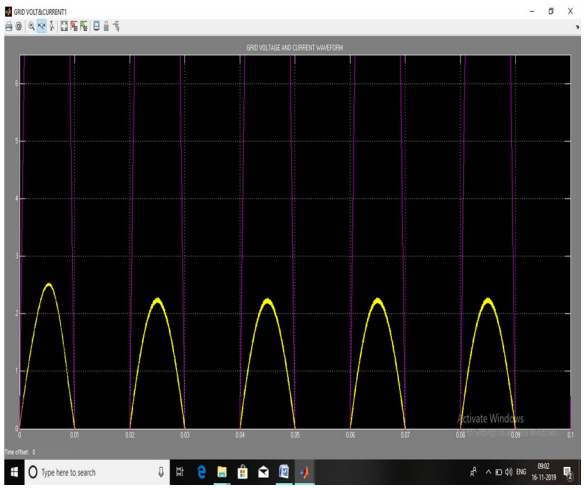



Fig.14.Grid voltage and current waveforms

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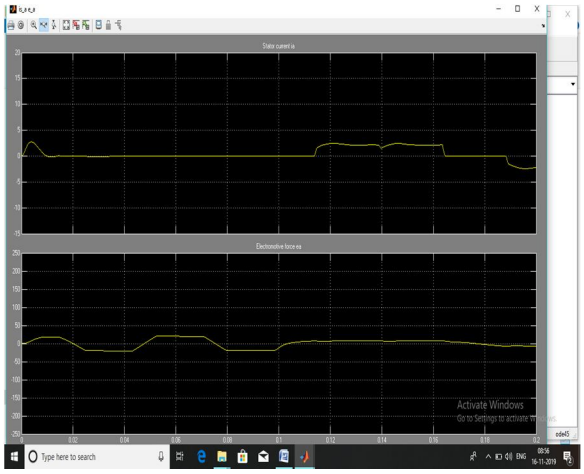


Fig.15.Battery output

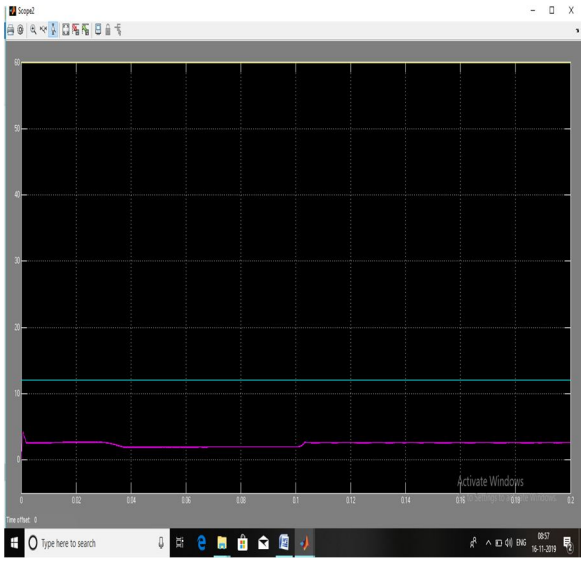


Fig.16.BLDC motor output

## XIII. CONCLUSION

*A.* The SPV array, Wind primarily based Zeta device fed VSI-BLDC car has been planned and its quality has been incontestable by simulated results using MATLAB/Simulink and its Sim-power-system chest.

*B.* First, the planned system has been designed logically to meet the varied desired objectives then shapely and simulated to look at the varied performances beneath beginning, dynamic and steady state conditions.

*C.* The performance analysis has even the mix of Zeta device and BLDC motor drive for SPV array primarily based water vehicleing.

*D.* The system beneath study availed the varied desired functions like MPP extraction of the SPV array, soft beginning of the BLDC motor, first harmonic shift of the VSI leading to a reduced shift losses, reduced switch stress and also the parts of Zeta device by in operation it in continuous conductivity mode and stable operation.

*E.* Moreover, the planned system has operated with success even beneath the minimum solar irradiance. The Fuzzy algorithmic rule extracts most power from the input system compared to different MPPT algorithms. The experimental results valid with the simulated results.

*F.* The existing Zeta device will be replaced with interleaved Zeta device to boost the output gain and ripples mitigation.

*G.* BLDC motor will run with sensing element less speed management techniques.

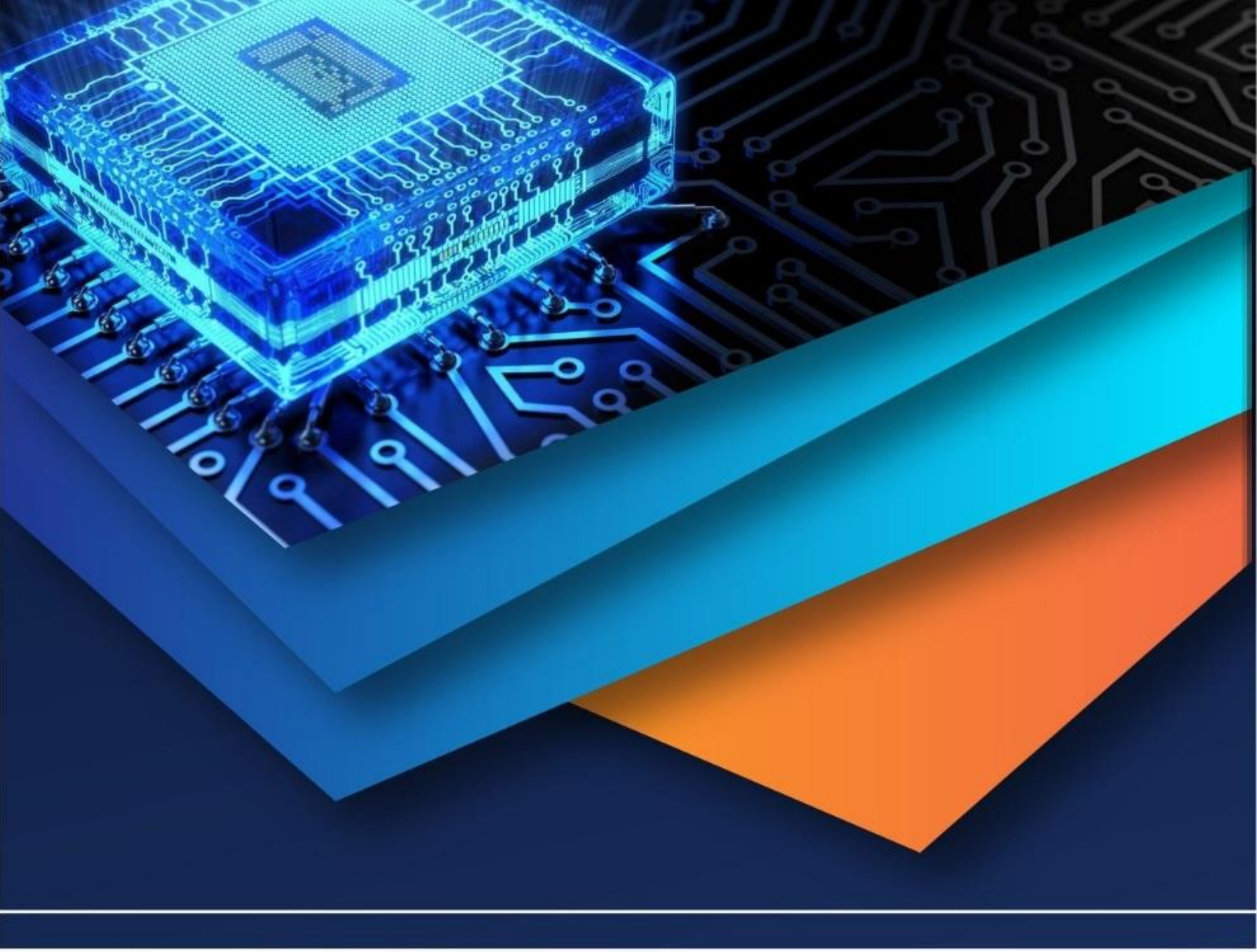
*H.* To achieve grid synchronization using ANN technique.

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