

Power Quality Improvement Performance of PV and Grid Connected System

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Abstract- This Paper introduced for regulating the load voltage through DVR pulses at different abnormal operating conditions, and accordingly convert the static optimized PI controller into adaptive one based ANN. The system performance with the proposed ANN-DVR controller is enhanced through improving the current, voltage, and power waveforms of each generating source. With compensation of the faulty line voltage, the system retains an uninterrupted operation of the three renewable sources during fault events and the total harmonic distortion is reduced. an Artificial Neural Network (ANN) controller based MPPT controller and Dynamic Volt-age Restorer (DVR) utilization to improve the performance of a stand-alone hybrid renewable energy system. The renewable energy system consists of three renewable energy sources, namely, solar PV cells, battery system and fuel cells. These three sources are tied to a common DC link by three boost converters, one for each source. The common DC link is connected to the AC side via a DC/AC inverter. The optimal size of the three proposed renewable sources is calculated using the MATLAB Software. The DVR control is attained through regulating the load voltage at different anomalous working conditions. These conditions are three-phase fault, voltage sag/swell, and unbalanced loading. to control DVR by regulating the D-Q axes voltage signals. The input/output data used for training ANNs are obtained by two optimized PI controllers.

Keywords- Grid, MPPT, Battery, fuel cell ANN-DVR, PV.

I. INTRODUCTION

Renewable energy systems (RESs) are one of the most suitable and environmentally friendly solutions to provide electricity within urban and rural areas. On-grid and off-grid electrification based on the generation of power through the installation of renewable energy power systems in urban and rural households have been proven to be capable of delivering high quality and reliable electricity for heating, lighting, and demands alike.

Using RESs have many advantages over conventional sources including the following [2]: Wind-solar hybrid systems can provide a steady community-level electricity service, such as residential electrification, also offering the possibility to rural areas to be upgraded through grid connection in the future. Furthermore, in case of installation and use in rural areas, due to their high levels of efficiency, reliability and long term performance, these systems can also be used as an effective backup solution to the public grid in case of natural disasters, emergencies, sudden blackouts or weak grids.

The main disadvantage of wind turbines and PV-systems is that naturally variable wind speed and variable solar irradiation cause voltage and power fluctuation problems

at the load side. These problems can be solved by using appropriate power converters and proper controllers both for the PV and the wind turbine system. Another significant point is to store the energy generated by wind turbines and PV-systems for future use when no wind and/or no irradiation is available but the user demand exists. For this, an energy storage bank can be incorporated in such a way that the battery stores energy whenever there is excess supply and discharges when there is more demand than supply.

The power system is a complex consisting of power generation, delivery or transmission systems. It uses forms of power (such as coal and diesel) or exchanges it into power. The power arrangement comprises equipment related to classification, such as synchronous producer, motors, transformers, switches, conductors, etc.

Power plants, transformers, transmission lines, substations, allocation lines, and distribution transformers are the electricity system's six main apparatus. The power generated by the power plant is increased or stepped down through the transformer. Transmission lines transmit power to various transformer stations. The current is transferred to the distribution this work presents a new method of detection to protect

distributed generator feed systems. The technique has been tested on allotment buses of 25 kV or below.

The current interest in installing dispersed generators in low-voltage buses near customers has created new security engineers' disputes, which differ from traditional radial-based security methods. Therefore, it is necessary to reconsider typical protection configurations, such as closed sleepless monitoring, impedance relay security areas, and the discovery of unexpected islands in circulated generator systems. The island situation is defined as when part of the unusable energy production system is isolated from an effective supply system.

It is generally measured undesirable because it can cause potential to injure to existing equipment, cause charge to public utilities, and reduce reliability and power quality.

Current island detection methods usually passively and actively monitor over voltage/under voltage and overvoltage / under frequency ratios. However, each technique has ideal sensitive working conditions and insensitive working conditions, and its degree of deterioration in power quality is different, which is called the non-detection zone (NDZ). Transformer through a substation, which reduces the current to a suitable value that suits the user.

II. RELATED WORK

Manoj Hans et al. (2020) Renewable energy is the future of power generation in the coming years. The network-related upgrade system has caused power outages in the plate during the process of inserting electricity into the plate from multiple locations. This reduces the quality of power provided to the customer. Strengthening stability is the only option the system can rely on. At the point of contact of renewable energy the static compensator (STATCOM) must be used.

It responds quickly and tries to improve the quality of the power by preventing power outages. Recent technological advances show the use of STATCOM hybrid models and mechanical capacitors. The author has developed the simulation of the STATCOM hybrid in the Simulink world. This paper examines and presents the effectiveness of coordination manipulation.

Subarni Pradhan et al. (2019) introduced a speed-based control controller (OASC) and a control-based control system (MAF) based on grid-related hybrid photovoltaic power systems. The solution to these two major problems is to maximize power generation and alleviate the problem of power quality. OASC is an adaptive control that is strong in skepticism (organized and unstructured). The highest power generation goal is achieved through cascade control. Cascade control includes internal hysteresis control based on OASC and

external speed control. The OASC proposal includes a mediator interface with spinal control. In addition, it incorporates a perceptual assessment in accordance with the law of continuous estimation, and then generates a sense of hybrid control.

The external speed control loop provides the current stator indicator to the internal cable to monitor the maximum power supply. To improve the reliability of the system, other renewable energy sources (solar photovoltaic energy) are included in the DC link. The relationship between the hybrid system and the grid is based on an inverter that incorporates MAF-based control. Here, by using the vector method to remove the essential sequence elements from a non-progressive wave to achieve a period of basic non-harmonic reference of the wire electricity, the influence of unbalanced and unbalanced loads can be overcome.

The controls provided are customized and compared to conventional technology. Execution controls and performance tests are performed on a hybrid system set up in the laboratory.

Zeng Xiang et.al (2019) this paper offers a new hybrid quality miner (HPQC) for quality compensation and power supply. According to traditional methods, the combined quality control system (UPQC) is often used in the current related energy and power quality (PQ) compensation. By integrating renewable energy, UPQC is able to operate in island mode. However, UPQC suffers from high DC link costs, which increases system costs and losses. To reduce the cost of DC links, the UPQC has been upgraded to compensate for the quality of the power supply and the power injection.

However, when the application is not effective, the modified UPQC cannot work on the island mode. So, a suggestion for a new HPQC topology, which can work in the event of a technological failure in the traditional way. In this article, we will first give an overview of the proposed HPQC topology process. Then, the HPQC basic control idea is given. Finally, to validate the HPQC proposal, compared to UPQC and modified UPQC, PSCAD chemical analysis is given for HPQC.

III. PROPOSED SYSTEM

The proposed method provides a fast response and effective sag compensation capabilities. In addition, in order to detect voltage sag, a Space Vector Modulation (SVM) is employed to estimate three-phase voltages. By using SVM, the voltage sag can be detected faster than other conventional methods.

Therefore DVR can compensate voltage sag quickly and accurately. The obtained results that are simulated in Matlab/Simulink indicate that the proposed method can

mitigate the balanced and unbalanced voltage sag types efficiently in the distribution networks.

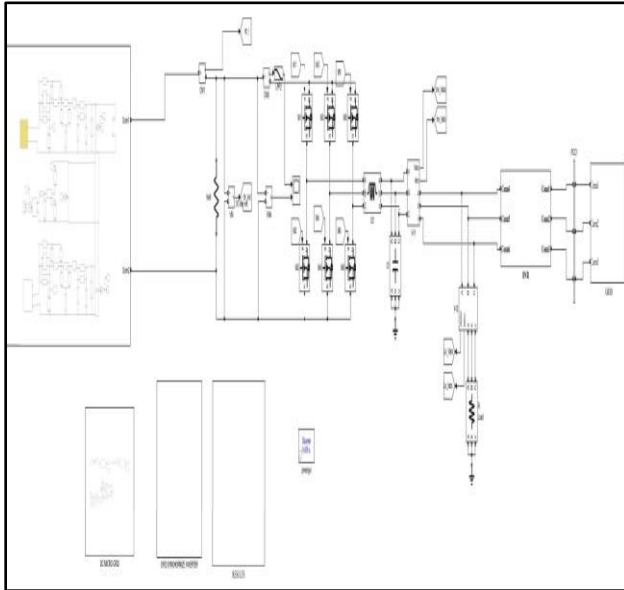


Fig 1. Proposed simulink model .

This converter consists of a coupled inductor with low leakage inductance in comparison with the conventional converters. In this coupled inductor, the secondary winding is connected in series to a capacitor. The coupled inductor is used to develop the converter operating range, and increase the efficiency and reliability.

In order to generate different output voltage levels, it is possible to change turns ratio, inductance value, coupling coefficient and time interval of turning on of the switch. The secondary winding of the coupled inductor is series with a capacitor. In order to decrease the output voltage ripple, a large is connected in parallel with the load.

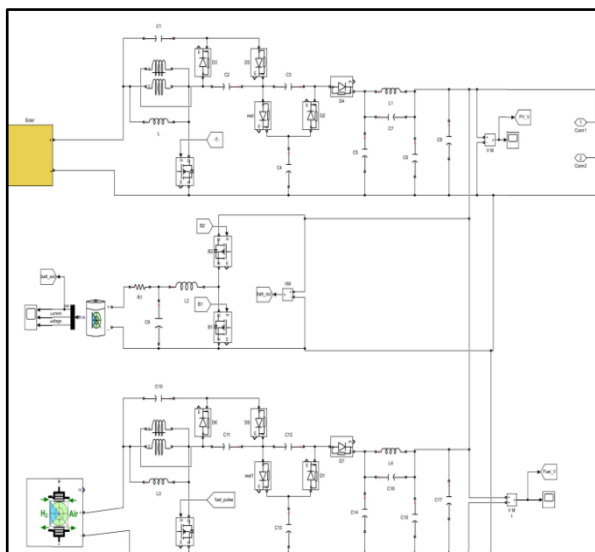


Fig 2. Solar, battery and fuel.

In the proposed boost converter, the power switch of S and diode D are used as a circuit switching elements and rectification. The proposed system consists of a hybrid PV/Battery /FC/grid, the system consists of PV system tied to the first DC-DC boost converter.

The solar Microgrid system is designed to operate in two modes: network interaction and island mode. In the interactive state of the network, the battery system and the photovoltaic system operate in parallel. Solar cell systems are usually used as grid-connected solar cell systems. During peak hours during the day, the battery system is not as active, but when the photovoltaic system does not use most of the inverter power (that is, at night), it can actively participate in the rapid response of frequency adjustment

1. Solar:

This block models a solar cell as a parallel combination of a current source, two exponential diodes and a parallel resistor, R_p , that are connected in series with a resistance R_s . The output current I is given by:

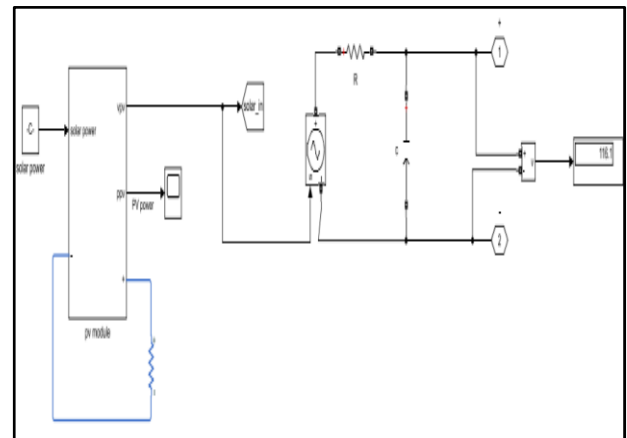


Fig 3. Solar equivalent circuit.

$$I = I_{ph} - I_s \left(e^{\left(\frac{V + I R_s}{N V_t} \right)} - 1 \right) - I_{s2} \left(e^{\left(\frac{V + I R_s}{N_2 V_t} \right)} - 1 \right) - \frac{(V + I R_s)}{R_p}$$

where I_s and I_{s2} are the diode saturation currents, V_t is the thermal voltage, N and N_2 are the quality factors (diode emission coefficients) and I_{ph} is the solar-generated current.

Models of reduced complexity can be specified in the mask. The quality factor varies for amorphous cells, and typically has a value in the range of 1 to 2. The PS input I_r is the irradiance (light intensity) in W/m^2 falling on the cell. The solar-generated current I_{ph} is given by $I_r \cdot (I_{ph0}/I_{r0})$ where I_{ph0} is the measured solar-generated current for irradiance I_{r0} .

Operationally the solar cell array is there to fulfill a defined electrical function. This can usually be reduced to a specified operating voltage and an expected peak

daily or annual current output. Where the solar cell is used as a trigger to switch the product on in the dark.

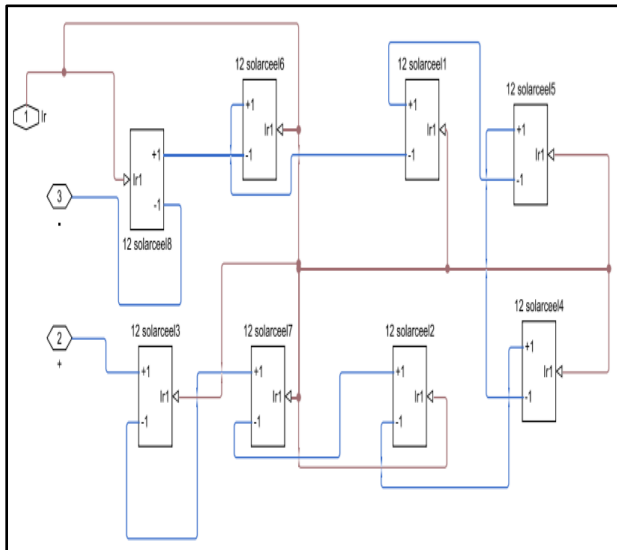


Fig 4. Solar cell subsystem.

The electrical characteristic at low light level is also important. The voltage is proportional to the number of series-connected cells, while the current is related to the cell area. In monolithically interconnected thin-film arrays, these factors can bear a direct relationship to the dimensions of the solar cell array.

2. Battery:

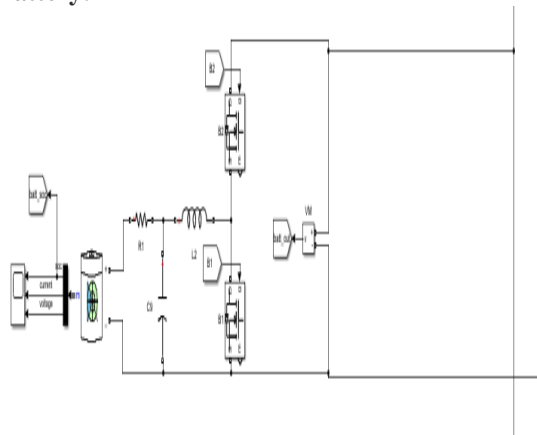


Fig 5. Battery model.

Implements a generic battery model for most popular battery types. Temperature and aging (due to cycling) effects can be specified for Lithium-Ion battery type.

3. Fuel Cell

Implements a generic hydrogen fuel cell model which allows the simulation for the following types of cells:

- Proton Exchange Membrane Fuel Cell (PEMFC)
- Solid Oxide Fuel Cell (SOFC)
- Alkaline Fuel Cell (AFC)
- FUEL CELL

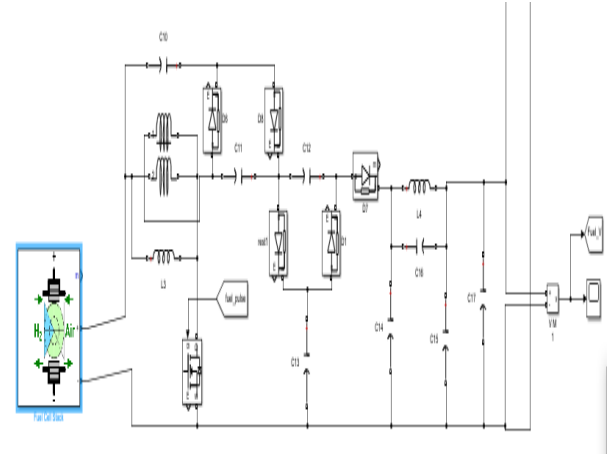


Fig 6. Fuel cell subsystem.

4. ANN Controller:

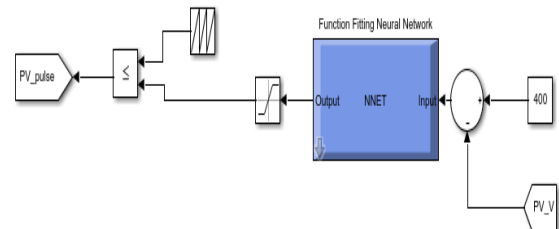


Fig 7. ANN Controller.

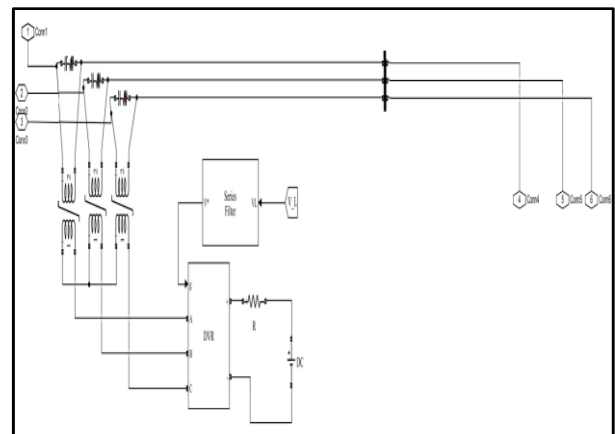


Fig 8. DVR Subsystem.

5. DVR:

(Dynamic Voltage Restorer) is a series of printers integrated with a large power supply system. The schematic figure of the DVR is shown in Figure 9 which includes a VSC (19-20) with a DC power supply. The main principle of a DVR is to compensate for power drop / expansion of the flow cable to the converter. DVR is a connected custom power supply Connect in series to inject the required voltage into the truck to maintain the voltage level. Composition The voltage is injected by three single-phase transformers. The voltage is synchronized with the load voltage.

Implements a three windings saturable transformer. Click the Apply or the OK button after a change to the Units popup to confirm the conversion of parameters. This block implements a three-phase zero-impedance voltage source. The common node (neutral) of the three sources is accessible via input 1 (N) of the block.

Time variation for the amplitude, phase and frequency of the fundamental can be pre-programmed. In addition, two harmonics can be superimposed on the fundamental. Phasor simulation, frequency variation and harmonic injection are not allowed. Specify Order =1 and Seq=1,2 or 0 to inject additional fundamental components A and B in any sequence.

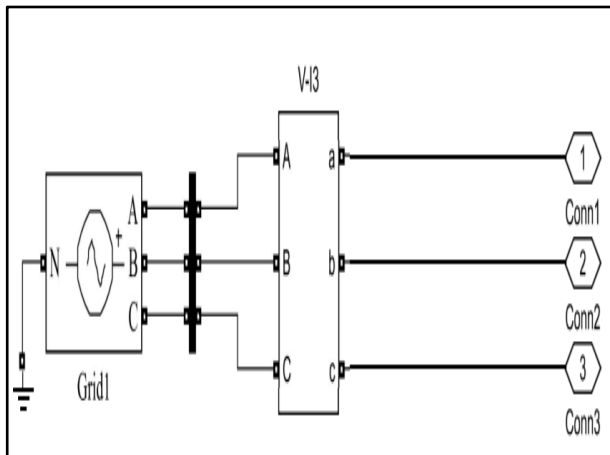


Fig 9. Grid subsystem.

The supply voltage taken from the DC to DC converter is applied across the battery as well as across the residential AC load or to the power grid via PWM inverter. ... The inverter is utilized to change over direct present (DC) to alternating current (AC).

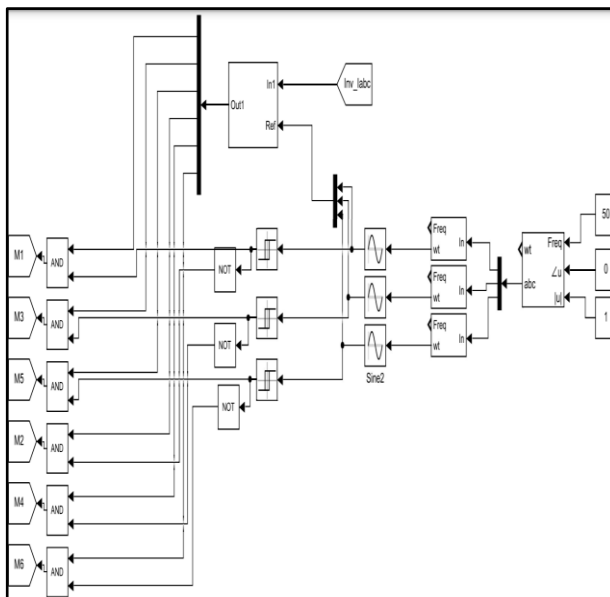


Fig 10. Grid inverter synchronization subsystem.

IV. SIMULATION RESULT

The simulation of the proposed model has been performed on MATLAB software.

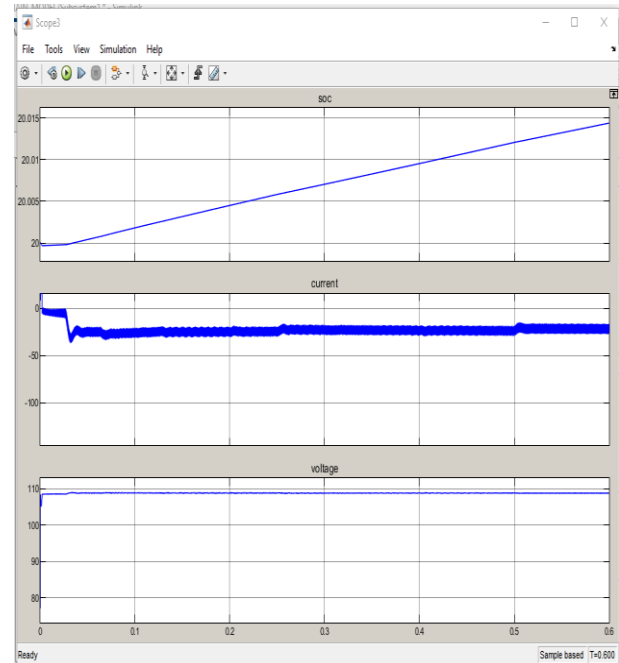


Fig 11. Battery voltage and current.

The fig 12 showing the battery current, voltage and battery state of charging.

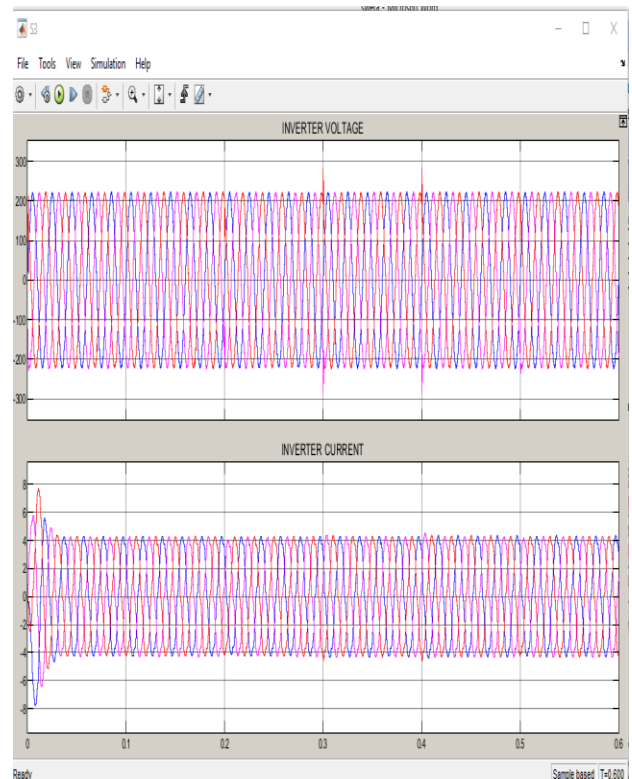


Fig 12. Inverter current and voltage.

Fig 13 showing the inverter current and voltage where y axis showing the current and voltage of the inverter and x axis showing simulation time.

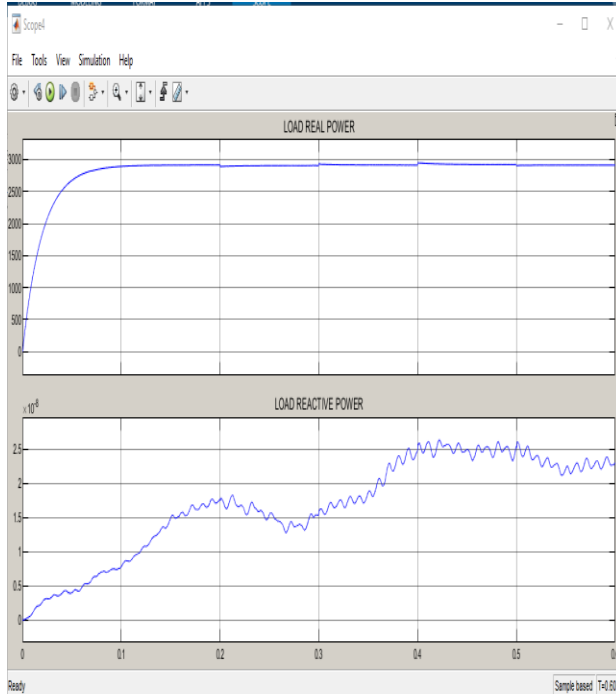


Fig 13. Load real power and reactive power.

Fig 14 showing the load real power and reactive power Active power is the active power consumed by the load. The reactive force is useless power. Active power is a product of voltage, current and cosine of the angle between them. The reactive effect is the product of the sine of voltage and current and the angle between them.

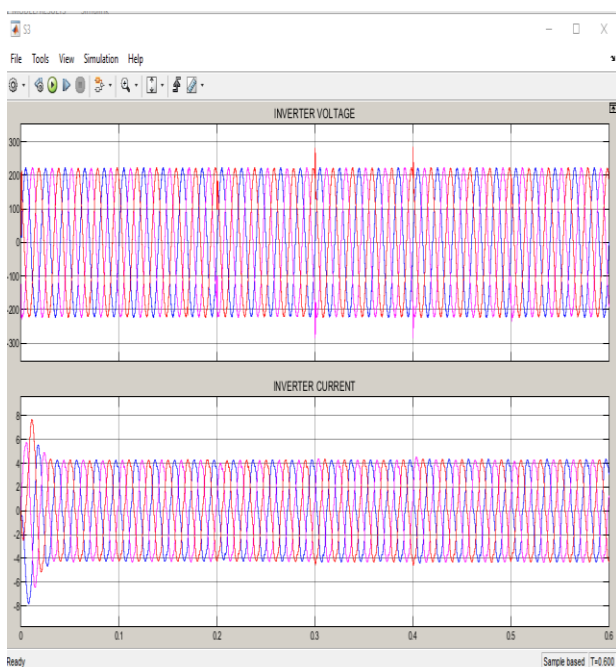


Fig 14. Inverter current and voltage.

Fig 15 showing the inverter current and voltage where y axis showing the current and voltage of the inverter and x axis showing simulation time

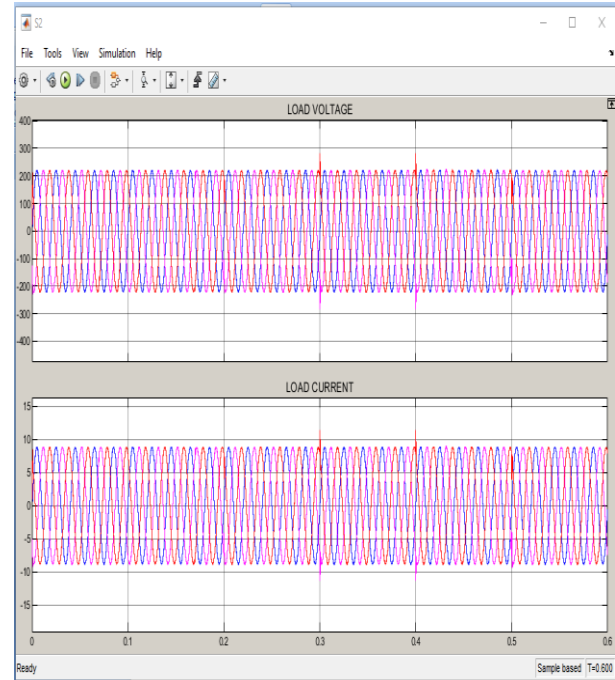


Fig 15. Load voltage and load current.

After the compensation, the load voltage is as shown in fig 16 the total simulation time is 0.6 s and circuit breaker operated at 0.55 sec , circuit breaker operated the grid is turned off so the voltage is dropped showing in the load voltage.

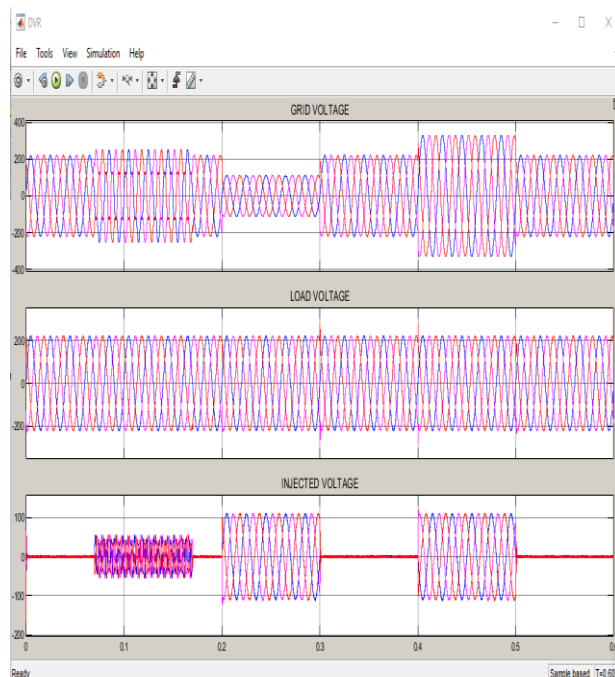


Fig 16. Grid disturbance as swell, sag, harmonics, and load voltage and injected voltage.

Control strategies of synchronous reference frame based DVR were modeled in MATLAB Simulink and its performance is observed under various grid conditions. The voltage swell, sag, harmonics is simulated during the time of 0 to 0.5 sec as DVR will inject required voltage during this period, After the compensation, the load voltage showing.

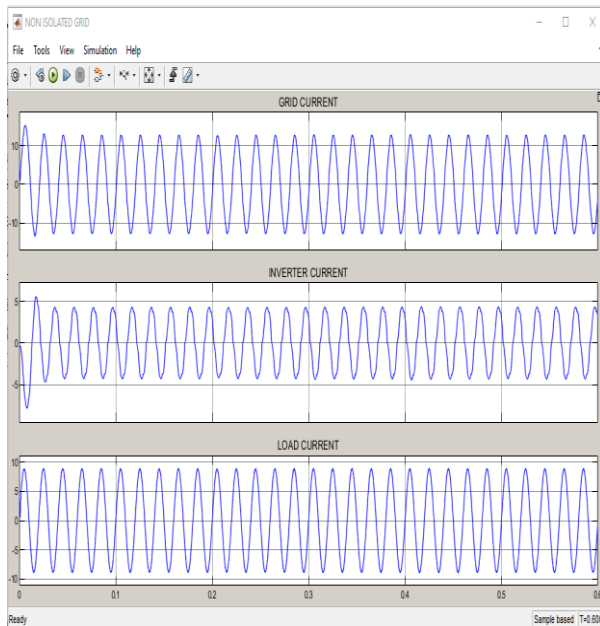


Fig 17. Inverter current, grid current, load current.

Fig 18 showing the inverter current, grid current, load current, the x axis showing simulation time, When the mains frequency changes from 50 Hz to 49 Hz and from 50 Hz to 51 Hz, as shown in Figure 4.16, the PLL quickly detects the mains frequency change and accurately compensates for the mains frequency change in a short time. Less than 10 milliseconds, no effect on mains power.

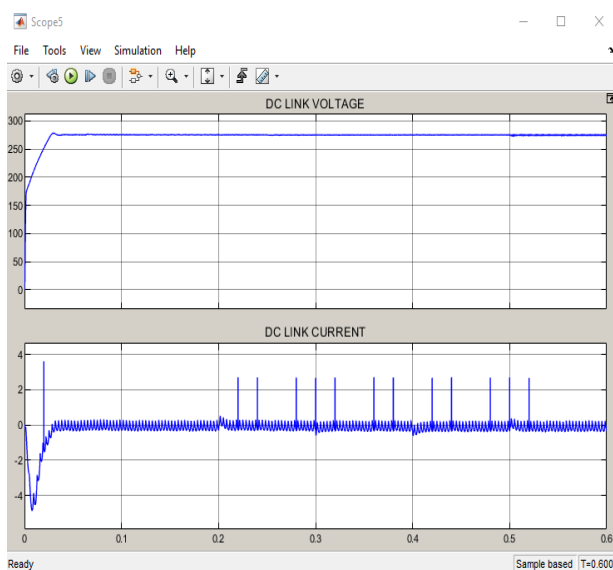


Fig 18. DC link output.

Fig 19 Showing the DC link current and voltage where y axis showing the voltage and current and x axis showing simulation.

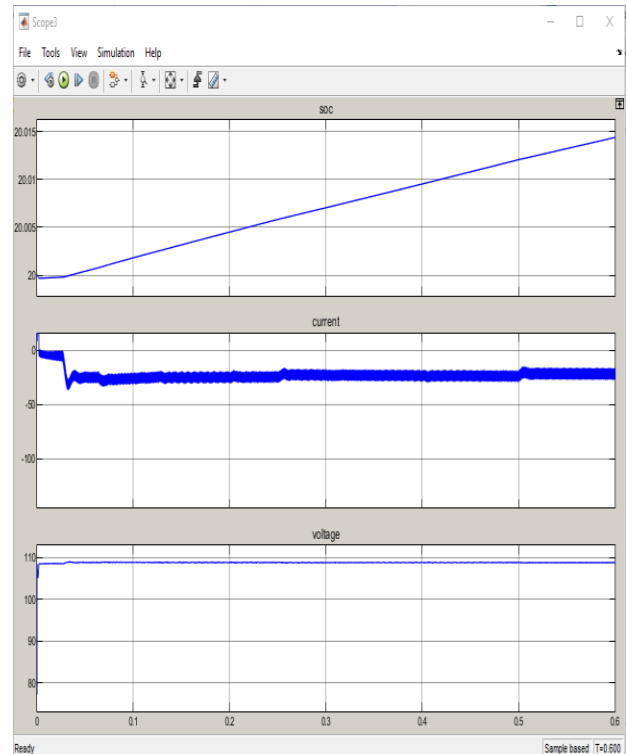


Fig 19. Battery current and voltage.

V. CONCLUSION

High numbers of changeable parameters to reduce inductor current ripple is one of the main advantages of the proposed converter that leads to select optimum value to control current ripple and avoid of increasing losses. In other word, it is possible to choose a suitable value for coupling coefficient to get zero ripples in input current of converter. In this thesis, including control, the island detection mode for island mode of operation is proposed and the mode of network limitation mode is verified by the MATLAB Simulink software.

Here, the two modes of operation are mainly controlled by detection technology. It also supports switching from constant present control mode to constant voltage control mode. The output of the imitation diagram clearly shows the island situation and its detection.

The advantage of planned DVR organization is that it can save energy in compensation mode by compensating only for the phases and voltage drop. In standby mode, the IGBT of the inverter is used to bypass the secondary side circuit of serial transformer, so no other bypass switch is required. The results are confirmed in the Matlab / Simulink simulation model. This simulates balanced voltage drop and unbalanced voltage drop to test the presentation of the planned DVR.

The replication results show that projected DVR can ensure compensation of power drop and thereby continue load power at nominal voltage. A new boost dc-dc converter is proposed. This converter is same as the conventional boost converter however the coupled inductor is used instead of the inductor in the conventional converter. In the proposed converter, the secondary winding of the coupled inductor is connected in series to a capacitor.

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