A Novel Methodology to Stabilize DC Micro-Grid System for Smart Energy Delivery

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ABSTRACT

This paper proposes a Novel Methodology to Stabilize DC Micro-grid System for smart Energy delivery .The novel DC micro grid consist different sources such as PV system, Wind system, the AC source , The battery and ultra capacitor are used as the main energy storage sources all together, form DC micro grid for smart energy delivery. Therefore grid provide good quality of power to three different load namely 110V AC single-phase output, 100V DC output and 48V DC output,. The grid is at 230Vrms with 50Hz connected to a isolator in connection with the DC bus. The Three phase output of the grid is converted to rippled DC by the use of DBR (Diode bridge rectifier) The converted DC voltage is fed to ZETA converter which is a DC-DC converter, making the rippled DC to constant DC with the use of a buck inductor. This paper Explain comparative performance DC microgrid using Buck and Zeta converter to stabilize the DC voltage . Proposed system analyse in MATLAB Simulink environment.

Keywords:-DC Microgrid, Zeta Converter, PV System ,Ultracapacitor, EV.

Introduction

In present Scenario, role of DC smart grid important role on Traditional Power system [1]. The DC micro-grid system, as a subsystem of the smart grid system, can also incorporate the smart concept into the DC power distribution for smart energy delivery [2].Proposed micro-grid system is connected with the 230V AC power source, sources such as PV system, Wind system, the AC source , The battery and ultra capacitor are used as the main energy storage sources all together, form DC micro grid for smart energy delivery.. Hence, the proposed DC micro-grid system can not only provide the high quality power for three types of DC and AC loads, but also achieve many special features and characteristics for smart energy delivery. [4].

However, since the smart concept for modern grid is under development, the DC micro-grid system still limits in the traditional configuration. Also, there are very few reports on the new DC micro-grid for practical application. [5]. Although the presents a new DC micro-grid for high power quality distribution, the renewable energy is not modeled into the grid system. Hence, it is still a conventional model for the DC grid system. A new DC micro-grid system is proposed for the smart energy delivery.

The proposed micro-grid system is connected with the 230V AC power source, and integrates the renewable energy sources of wind power and photovoltaic(PV) power, as well as the electric vehicle together. In addition, the proposed DC grid system adopts the battery,ultracapacitor and EV for the energy storage. [7]. proposed test system with Buck converter and Zeta converter connected to the three phase grid, it is clear that the test system with Zeta converter has better performance as compared to conventional Buck converter. This project will give a detail discussion of the system configuration, system control strategy for smart energy delivery, and the corresponding simulation performance. [9].

Research Objectives

The objectives of this project are as follows**:**

1. Design a DC micro-grids system for flexible ability to accomplish smart energy delivery.
2. Design a DC micro-grids for getting constant and smooth DC output.
3. DC power link inherently has no the harmonic factor,so the DC micro-grid can achieve a higher quality power than the traditional AC grid system.
4. The DC micro-grid totally removes the transformer, hence improving the power transmission efficiency**.**
5.

Proposed Methodology

The grid is at 230Vrms with 50Hz connected to a isolator in connection with the DC bus. The Three phase output of the grid is converted to rippled DC by the use of DBR (Diode bridge rectifier) The converted DC voltage is fed to ZETA converter which is a DC-DC converter, making the rippled DC to constant DC with the use of a buck inductor. The MOSFET switch provide in the ZETA converter switches according to the duty ratio given by the PI controller for which the input is given from the error value of the reference and measured output DC value of the ZETA converter. It a closed loop control system with feedback PI controller circuit and the switching frequency of the ZETA converter is 45kHz.
The converted DC voltage form the ZETA converter is fed to the DC bus where all the other modules are connected. On the load side we have three loads, one AC load which has to be 110Vrms and 50Hz. Second 100V DC load, and third is 48V DC load.
The AC load consists of a PWM inverter employing Simple sinusoidal PWM technique converting DC to PWM AC with 110Vrms 50Hz output in turn connected to a AC load.

The 100V DC load is connected to a DC-DC buck boost converter with two MOSFET switches each operating with NOT operation. The switching frequency is 20kHz and the duty ratio is 0.2 The 48V DC load is connected to another DC-DC buck-boost converter with two MOSFET switches each operating with NOT operation. The switching frequency is 20kHz and the duty ratio is 0.1In both the DC-DC buck boost converters when the MOSFET Q1 is OFF Q2 is ON charging the inductor. After a cycle of time period 50usec the MOSFET Q1 is ON and Q2 is OFF and the charge present in the inductor discharges through the MOSFET Q1

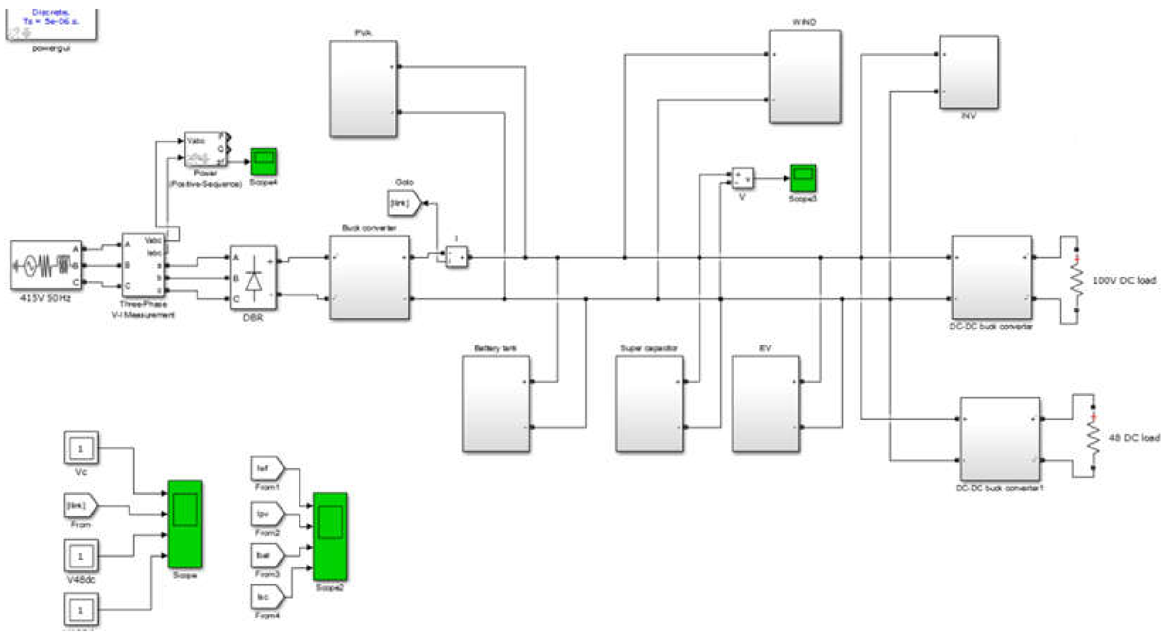

Fig -1 Block diagram of Proposed System

Comparative Output of Zeta And Boost Converter for DC Micro Grid

Fig. 1: Simulink modelling of proposed test system of the DC micro grid system with PVA, wind farm, loads ,Boost converter and Zeta converter is designed in MATLAB Simulink environment

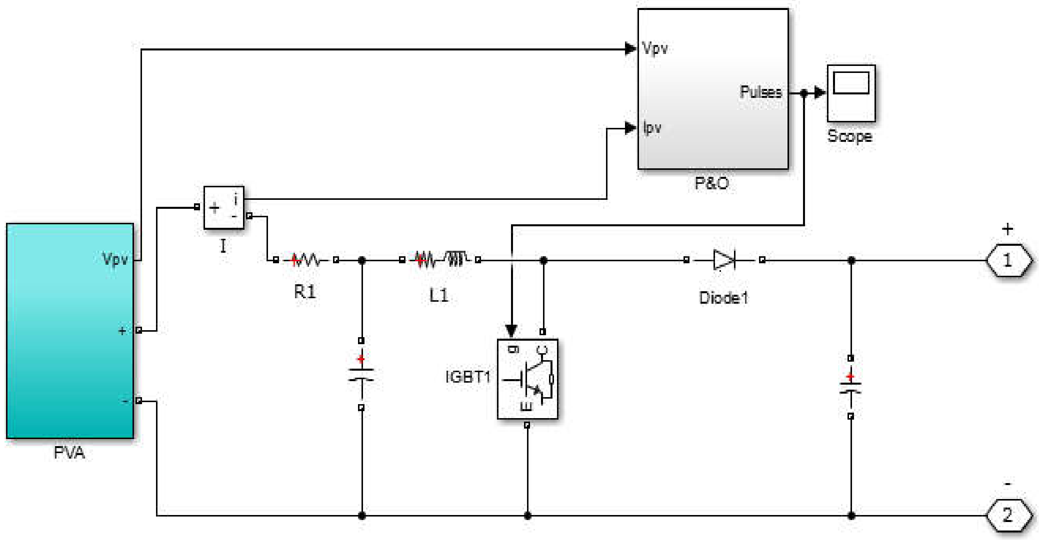

Fig. 2: Internal Modelling of PVA with DC-DC booster converter

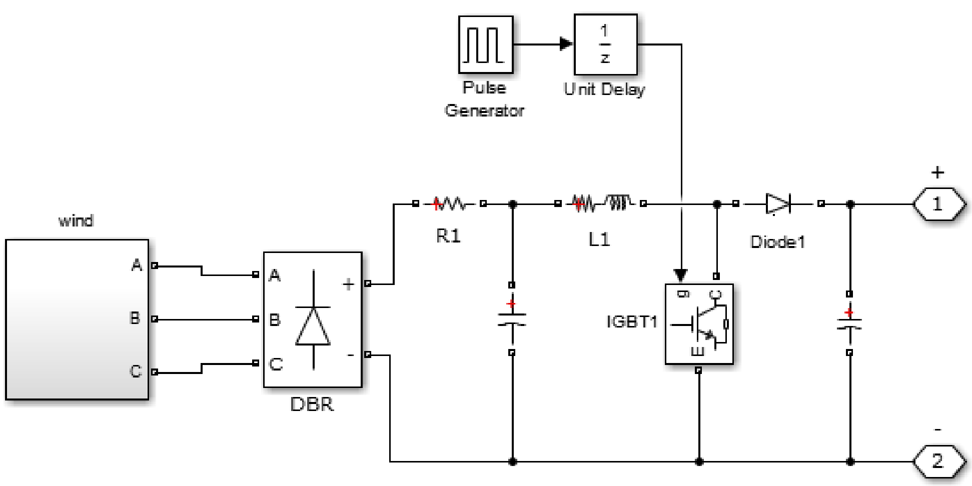

Fig. 3: Internal Modelling of wind farm with DC-DC booster converter

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In the model there are three loads connected in which the first load is an AC load with inverter and other two loads are low voltage DC loads. The low voltages (100V and 48V) is generated using conventional buck converters. The simulation is run out for 0.1sec and voltages of all devices are recorded in graph using GUI environment available in MATLAB. All graphs are plotted with respect to time.

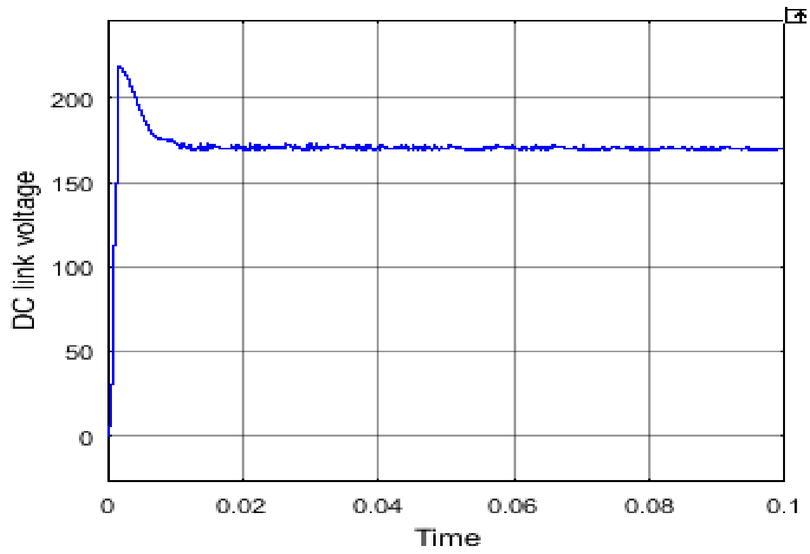

Fig. 4: DC link voltage

The reference DC link voltage is set to 170V which is the peak value of 110Vrms AC load connected to the DC link.

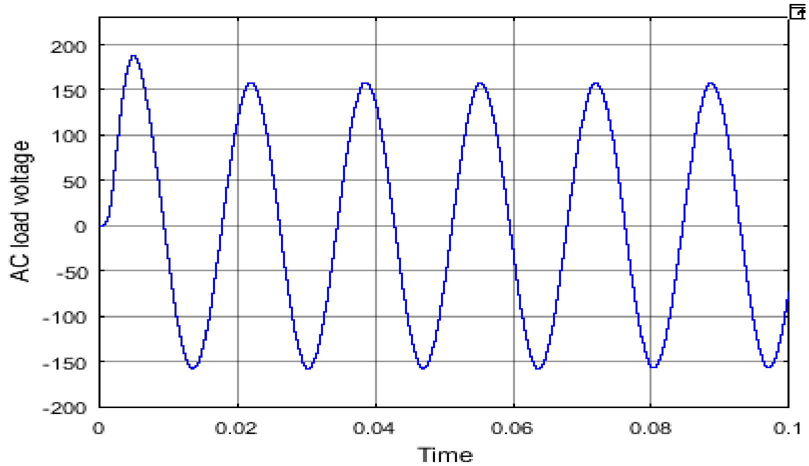

Fig. 5: Inverter output voltage for AC load

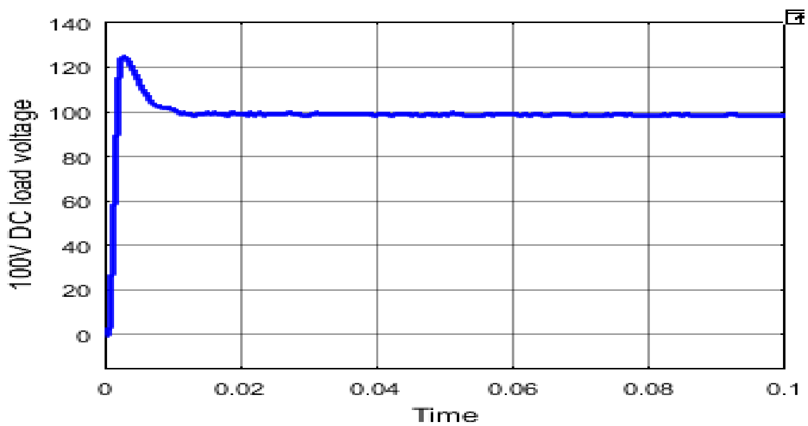

Fig. 6: 100V DC load voltage measured after buck converter

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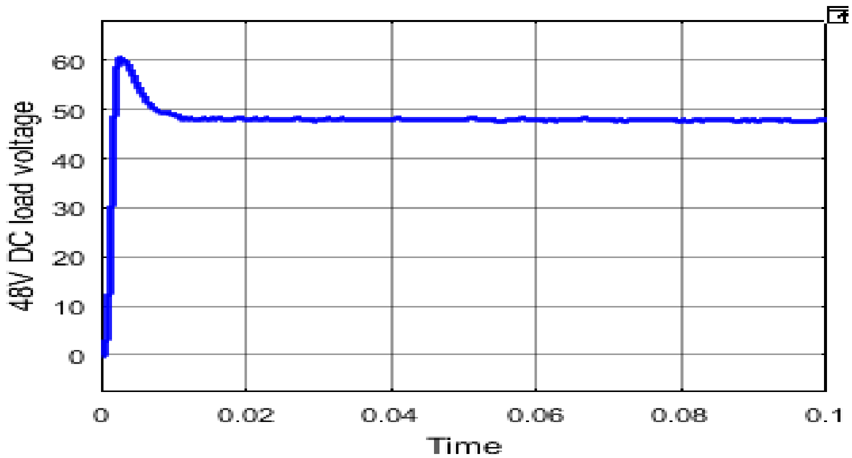

Fig. :7. 48 V DC load voltage measured after buck converter

The MOSFET switch provide in the ZETA converter switches according to the duty ratio given by the PI controller for which the input is given from the error value of the reference and measured output DC value of the ZETA converter. It a closed loop control system with feedback PI controller circuit and the switching frequency of the ZETA converter is 45kHz.

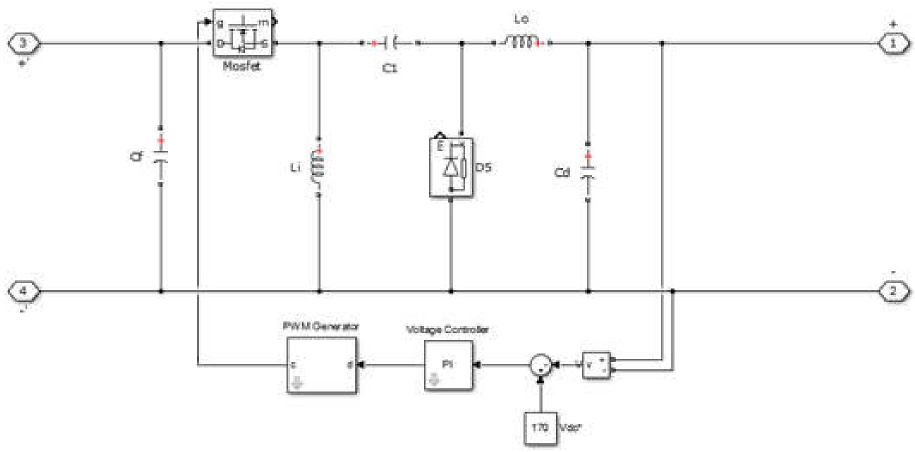

Fig.8. Zeta Converter

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Simulation And Result

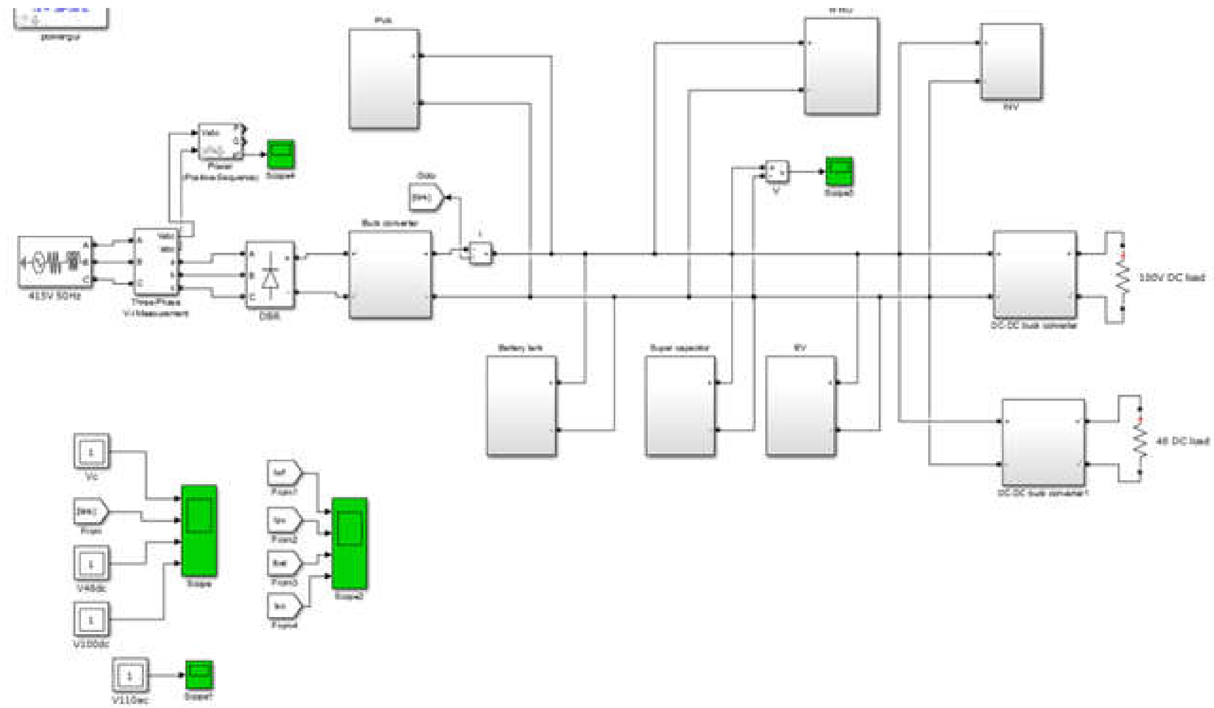

Fig. 9: MATLAB modeling of proposed test system with Buck converter at grid

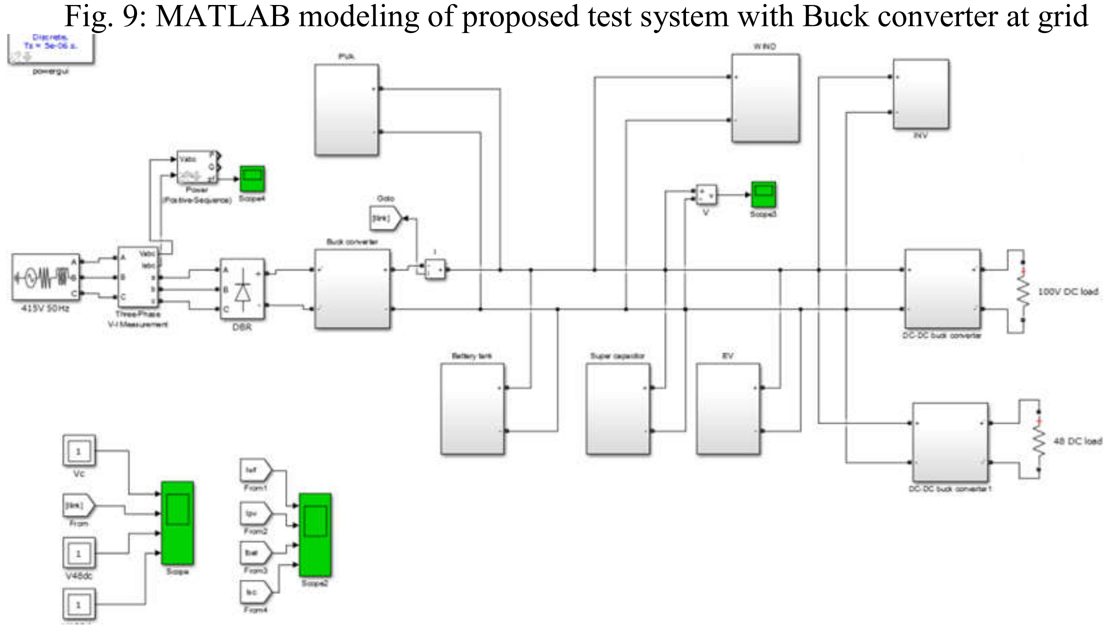

Fig.10 : MATLAB modeling of proposed test system with Zeta converter at grid

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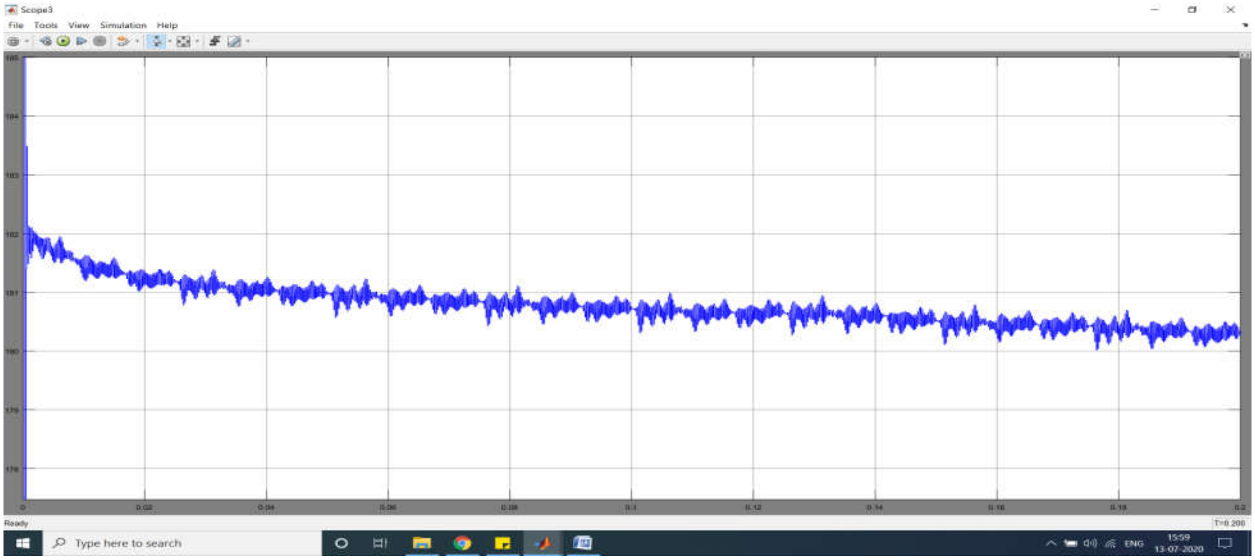

Fig.11 : DC link voltage at PCC with Buck converter

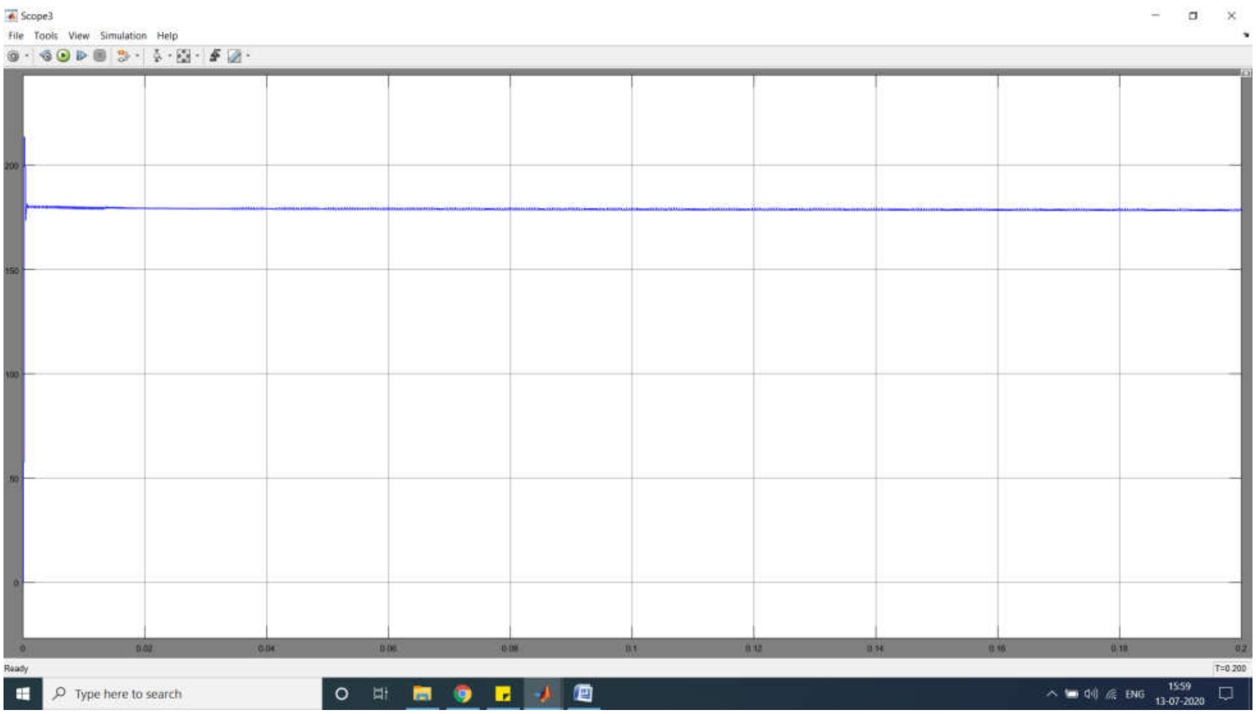

Fig. 12: DC link voltage at PCC with Zeta converter

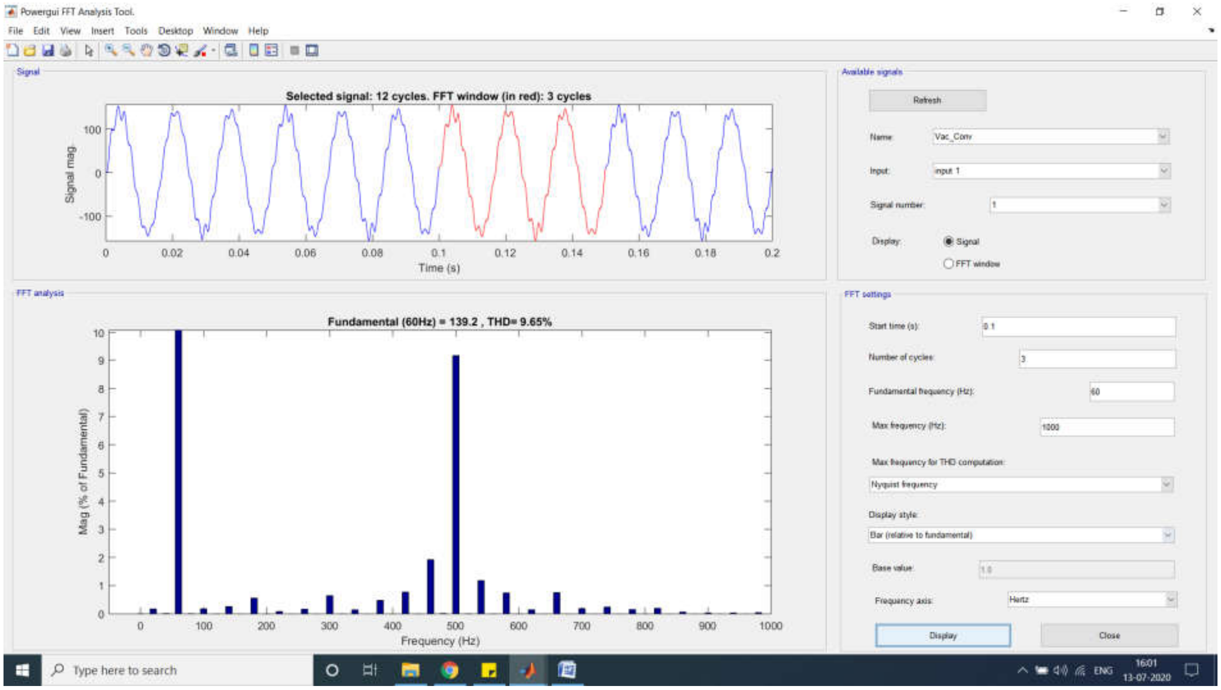

Fig. 13: THD of AC load with Buck converter

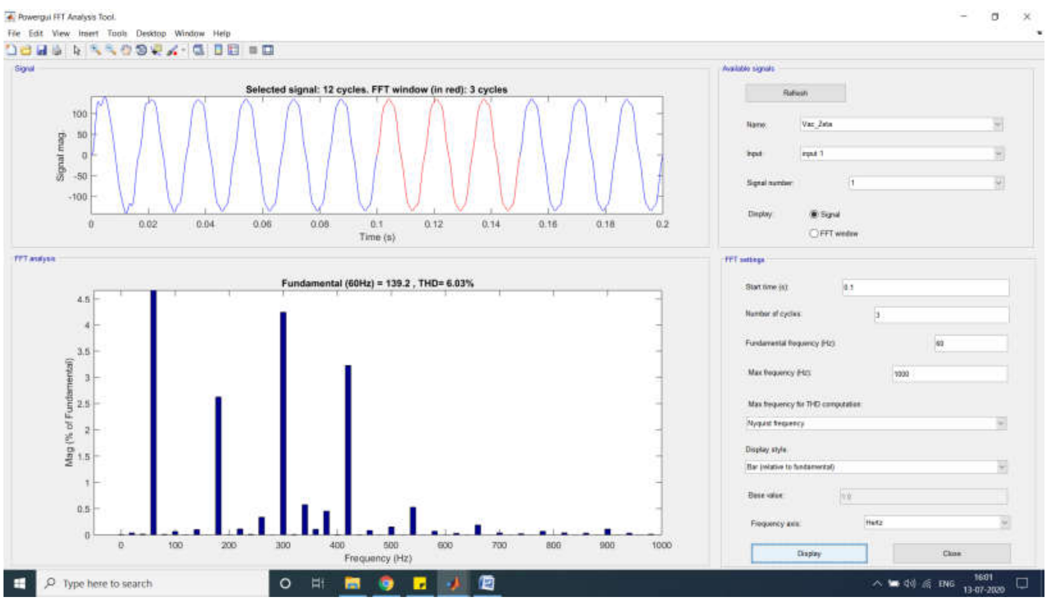

Fig. :14 THD of AC load with Zeta converter

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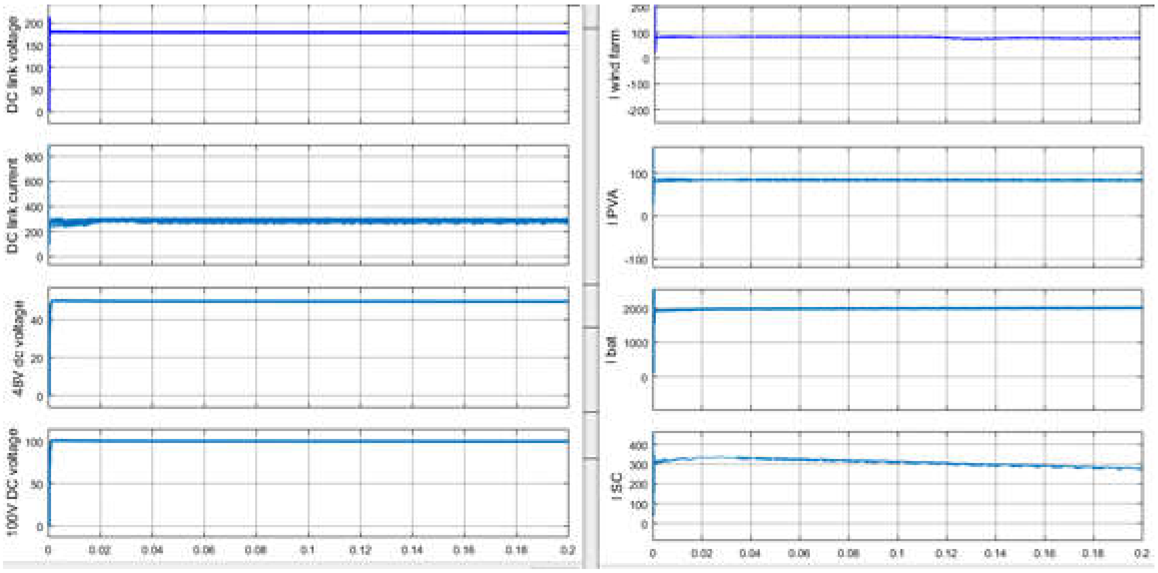

Fig. :15 Voltages and current of all modules of the test system

Conclusion

As seen in the given graphs and FFT analysis comparison of the proposed test system with Buck converter and Zeta converter connected to the three phase grid, it is clear that the test system with Zeta converter has better performance as compared to conventional Buck converter. The ripple in the DC link voltage at PCC is less in Zeta converter in the range of below 1% along with improved power factor of the three phase source maintained above 0.96. Whereas with Buck converter the power factor of the source is 0.8. The THD of the AC load voltage is also improved from 9.65% to 6% with Zeta converter reducing the harmonics in the voltage waveform. All the graphs are represented with time defined analysis using powergui block available in MATLAB Simulink environment.

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