International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 7 ǁ July 2022 ǁ PP. 476-483

Hybrid Converter for DC Grid

Megha C M*[1], Abhirami Sajan P[1], Anusree K Das[1], Nayana S R[1]
[1]Mar Athanasius College of Engineering , Kothamangalam ,Kerala, India
*CorrespondingAuthor:*meghamurali21@gmail.com*

Abstract
The application of DC output is increasing in day to day basis. This project discusses the solar powered source fused with a fuel cell connected to multi input Luo converter which can work on boosting from the single sources as well as from the dual sources. The modified LUO converter inherits the advantages compared to other DC-DC to converter topologies. The main purpose of this project is to design an converter that will have hybrid DC power source, supplied by Photovoltaic (PV) Cells and fuel cell either used to supply a dc load or connected directly to the dc utility grid. The system will be controlled to operate at maximum efficiency using Maximum Power Point Tracking (MPPT) algorithm. This algorithm will be installed on a controller. The MATLAB simulated model of the solar panel followed by the dc –dc converter is presented and waveforms obtained are discussed. The dc to dc converter model is programmed in MPPT mode using optimal duty ratio to achieve maximum output. The performance of the complete system model under varying insolation levels of solar panel is discussed.
Keywords: *Hybrid Converters, DC Grid ,LUO Converter,MPPT.*

Date of Submission: 05-07-2022 Date of acceptance: 19-07-2022

I. INTRODUCTION

The DC-microgrid integrates local DC generators and loads and can show significant advantages over ACpower systems in buildings, data centers, aircrafts and special mission deployment applications. The main advantages include: 1) higher power system efficiency when generation sources and loads are primarily DC, requiring fewer DC/AC or AC/DC converters; 2) higher reliability because reducing the number of converters lowers the potential for failures; 3) fewer power electronic components and reduced capital cost; 4) reduced control system complexity and higher survivability when subject to disturbances because the synchronization requirements of AC systems are eliminated. A DC-microgrid is able to operate in both the grid-connected and islanded modes. A benchmark example of DC-microgrid is the power system onboard the International Space Station (ISS) that operates in the islanded mode with solar arrays and batteries used to manage the power supply for the entire spacecraft. The DC-DC converters provide important control functions such as voltage conversion and regulation. This paper studies a class of DC-microgrids with solar PV generation and batteries that operate in the islanded mode where effective control strategies are required to manage currents and voltage while supporting the maximum power point tracking (MPPT) of the solar PV. The application of DC output is increasing in day to day basis. This paper discusses the solar powered source fused with a fuel cell connected to multi input Luo converter which can work on boosting from the single sources as well as from the dual sources. The modified LUO converter inherits the advantages compared to other DC-DC to converter topologies. The main purpose of this project is to design a converter that will have hybrid DC power source, supplied by Photovoltaic (PV) Cells and fuel cell either used to supply a dc load or connected directly to the dc utility grid. The system will be controlled to operate at maximum efficiency using Maximum Power Point Tracking (MPPT) algorithm. This algorithm will be installed on a controller. The MATLAB simulated model of the solar panel followed by the dc –dc converter is presented and waveforms obtained are discussed. The dc to dc converter model is programmed in MPPT mode using optimal duty ratio to achieve maximum output. The performance of the complete system model under varying insolation levels of solar panel is discussed.

II. METHEDOLOGY

In the Figure1 shows the block diagram of hybrid converter.Two inputs are given to the system, a renewable and a non renewable source.Renewable source can be a solar input, it is further treated with MPPT algorithm so that output can be obtained with maximum power.Non renewable source can be a fuel cell or a battery, it is directly fed to the microcontroller.

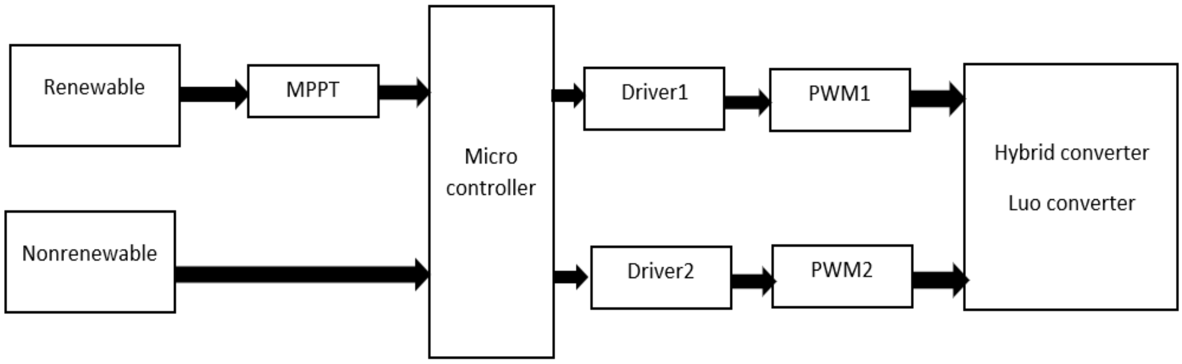

Figure 1: Block diagram of multi-input luo converter

Proposed technology make use of modified luo converter.Using the microcontroller the inputfrom the pv and fuel cell is controlled and the output will be stable from ripples.The input PV is avariable source therefore it cannot be trusted for steady state output.By the utilization of anothersource like fuel cell a reliable output can be obtained.When the PV input goes below a certainlimit the fuell cell will come into picture, the two source outputs will be fused together to form astable output.The fuell cell will be compensating the dip in voltage.These are established with thehelp of a microcontroller IC Dspic30f2010.PV and fuel cell outputs are given as two inputs to themicrocontroller.MPPT P and O algorithm is added into the microcontroller(embedded c).

Positive Luo converters perform positive to positive DC-DC voltage increasing conversion whileNegative Luo converters perform positive to negative DC-DC voltage-increasing conversion withhigh power density, high efficiency and in a simple structure. They are different from other existingDC-DC step-up converters and possess many advantages including the high output voltage withsmall ripples. Switch S is a P-channel power MOSFET device (PMOS). It is controlled by apulsewidth-modulated (PWM) switching signal with repeating frequency f and conduction duty k. In this paper the switch repeating period is T = 1 / f, so that the switch-on period is kT andswitch-off period is (1 - k)T. For all circuits, the load is usually resistive, R = Vo/Io. Photovoltaic(PV) systems have been used for many decades. Today, with the focus on greener sources of power,PV has become an important source of power for a wide range of applications.The hybrid converter uses 3 modes of opertation based on the compatibility of the voltageproduced from the dc sources. The dc source used here is PV along with a fuel cell.Since the PVis stochastic in nature,the fuell cell is used in situation only when PV voltage cannot be utilisedeffectively.Hence this model utilises mainly the free energy source.

The modes are:

1.Boosting of PV voltage

2.Boosting of fuell cell.

3.Boosting of both PV and fuell cell simultaneously

The proposed system consists of a PV and a fuel cell connected to a Luo converter.luo converteris thedeveloped converter derived from the buck-boost converter. In this proposed model theadditional filter elements in the luo-converter eliminate the output ripples and effectively enhancethe output voltage level.

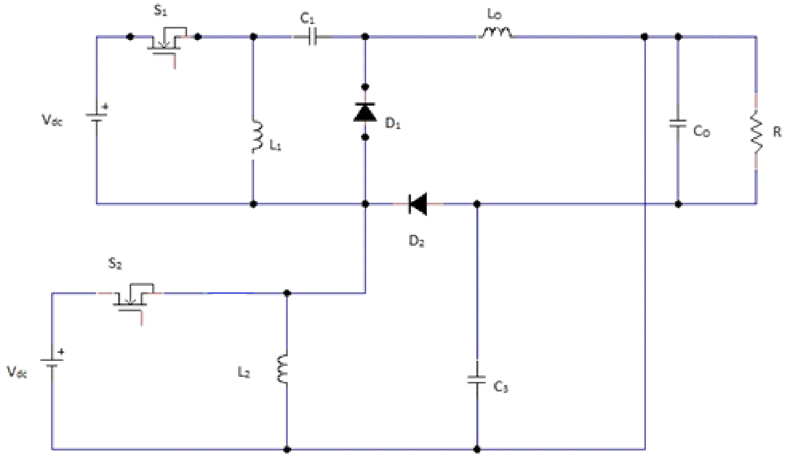

Figure 2: Luo converter

The proposed system is a fusion of Positive output Luo converter and Negative output Luo converter.The main purpose of this hybrid is to meet our daily demand effectively and to get an uninterruptedpower supply. Bycombining these two intermittent sources, the system's power transfer efficiencyand reliability can be improved significantly. For the same value of duty cycle, the values ofinductance and capacitance are less for Fused Luo converter. The proposed Luo Converter is givenin the figure 2

III. MPPT

Maximum power point tracking (MPPT) or sometimes just power point tracking (PPT), is atechnique used with variable power sources to maximize energy extraction as conditions vary. Thetechnique is most commonly used with photovoltaic (PV) solar systems, but can also be used withwind turbines, optical power transmission and thermophotovoltaics.PV solar systems have varying relationships to inverter systems, external grids, battery banks,and other electrical loads.The central problem addressed by MPPT is that the efficiency of powertransfer from the solar cell depends on the amount of available sunlight, shading, solar paneltemperature and the load's electrical characteristics. As these conditions vary, the load characteristicthat gives the highest power transfer changes. Block diagram of MPPT controller is given in Figure3.

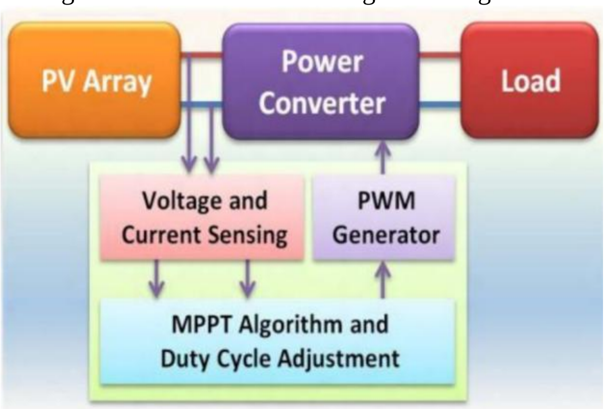

Figure 3: Block diagram of MPPT controller

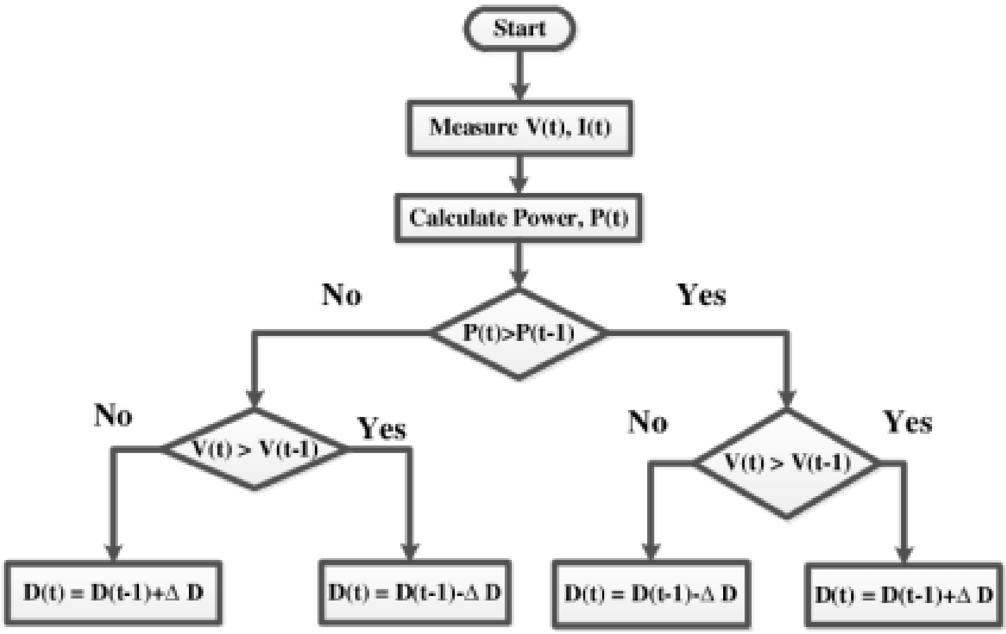

Figure 4:Flow chart of PO algorithm used in MPPT charge controller

The system is optimized when the load characteristic changes to keep power transfer at highest efficiency. This optimal load characteristic is called the maximum power point (MPP). MPPT is the process of adjusting the load characteristic as the conditions change. Circuits can be designed to present optimal loads to the photovoltaic cells and then convert the voltage, current, or frequency to suit other devices or systems.Solar cells' non-linear relationship between temperature and total resistance can be analyzed based on the Current-voltage (I-V) curve and the power-voltage (P-V) curves.MPPT samples cell output and applies the proper resistance (load) to obtain maximum power.MPPT devices are typically integrated into an electric power converter system that provides voltage or current conversion, filtering, and regulation for driving various loads, including power grids, batteries, or motors. Solar inverters convert DC power to AC power and may incorporate MPPT. The power at the MPP (Pmpp) is the product of the MPP voltage (Vmpp) and MPP current (Impp). In general, the P-V curve of a partially shaded solar array can have multiple peaks, and some algorithms can get stuck in a local maximum rather than the global maximum of the curve.Typically, PO method is used for tracking the MPP. In this technique, a minor perturbation isintroduced to, cause the power variation of the PV module. The PV output power is periodicallymeasured and compared with the previous power. If the output power increases, the same processis continued otherwise perturbation is reversed. In this algorithm perturbation is provided to thePV module or the array voltage.The PV module voltage is increased or decreased to check whether the power is increased ordecreased. When an increase in voltage leads to an increase in power, this means the operatingpoint of the PV module is on the left of the MPP . Hence further perturbation is required towardsthe right to reach MPP. Conversely, if an increase in voltage leads to a decrease in power, this meansthe operating point of the PV module is on the right of the MPP and hence further perturbationtowards the left is required to reach MPP. The graph of power v/s voltage of PO algorithm.When the MPPT charge controller is connected between the PV module and battery, it measuresthe PV and battery voltages. After measuring the battery voltage, it determines whether thebattery is fully charged or not. If the battery is fully charged (12.6 V at the battery terminal) itstops charging to prevent battery over charging If the battery is not fully charged, it starts chargingby activating the DC/DC converter. The microcontroller will then calculate the existing powerPnew at the output by measuring the voltage and current, and compare this calculated power tothe previous measured power Pold. If Pnew is greater than Pold, the PWM duty cycle is increasedto extract maximum power from the PV panel. If Pnew is less than Pold, the duty cycle is reducedto ensure the system to move back to the previous maximum power. This MPPT algorithm issimple, easy to implement, and low cost with high accuracy.The flowchart of PO algorithm used inMMPT charge controllerThe flowchart of PO algorithm used inMMPT charge controller. Flow chart of PO algorithm used in MPPT charge controller is given inFigure 4.

IV. SIMULATION

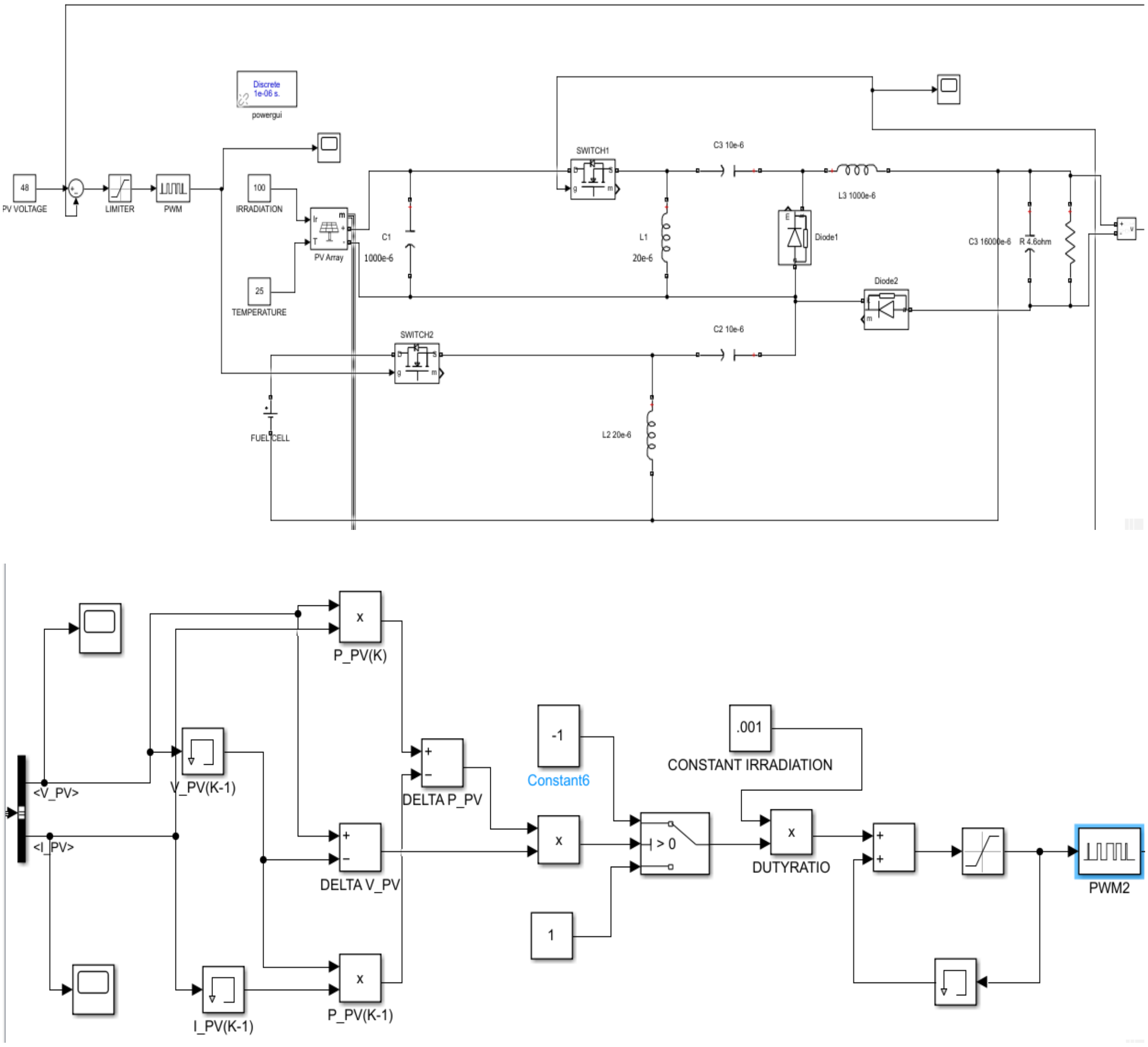

Figure 5:Simulation circuit

V. SIMULATION RESULTS

The simulation results of MPPT PWM, converter ,inverter SPWM and the grid tied inverter are shown in the figure 6, figure 7 and figure 8 and figure 9 respectively.

Figure 6: simulation result on simultanous input

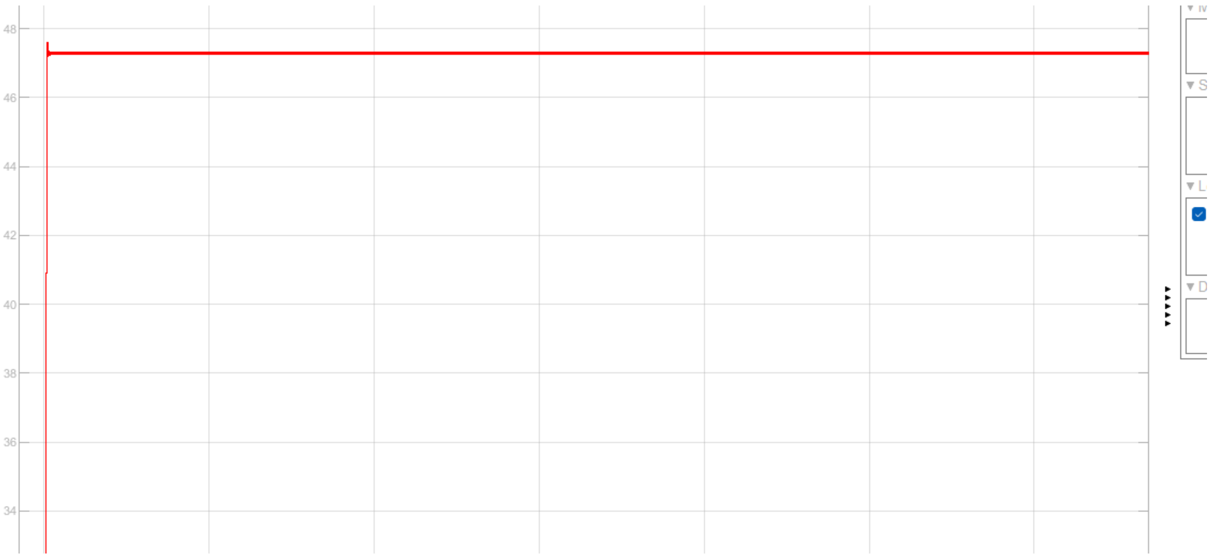

Figure 7:simulation result on only dc input

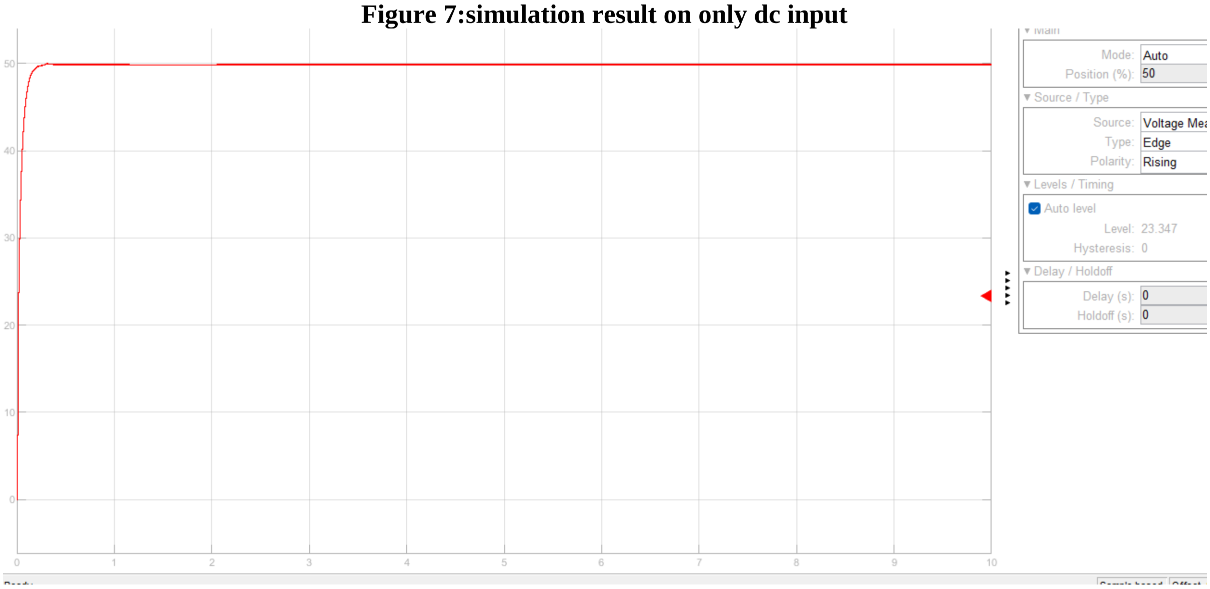

Figure 8: simulation result on only solar source input

VI. HARDWARE IMPLIMENTATION

The hardware implementation of the grid tied inverter was done using dspic30f2010 microcontroller .SPWM and PWM signals were generated for the control of mosfet switches in the inverter and converter part.IR2110 optocouplour IC was used to supply the strengthened signals to inverter switches. TLP250 was used to provide the strengthened PWM signal to boost converter switch to control it using MPPT P&O algorithm.The circuit was formed and a 12v supply was given using a adapter from the renewable source and using a regulator IC microcontroller was powered. The sync signal from grid was given with the help of a step down transformer and a cycle detection circuit.The output of MPPT converter provided to the inverter.Inverter output was filtered and given to a step up transformer and connected to grid.Hardware working was checked and waveform from the system was monitored with the help of a cathode ray oscilloscope. It was observed that the output waveform was in phase with grid voltage with 50 Hz frequency and 240v amplitude.Further modifications can be done inthis low cost system to improve the stability and reliability of inverte

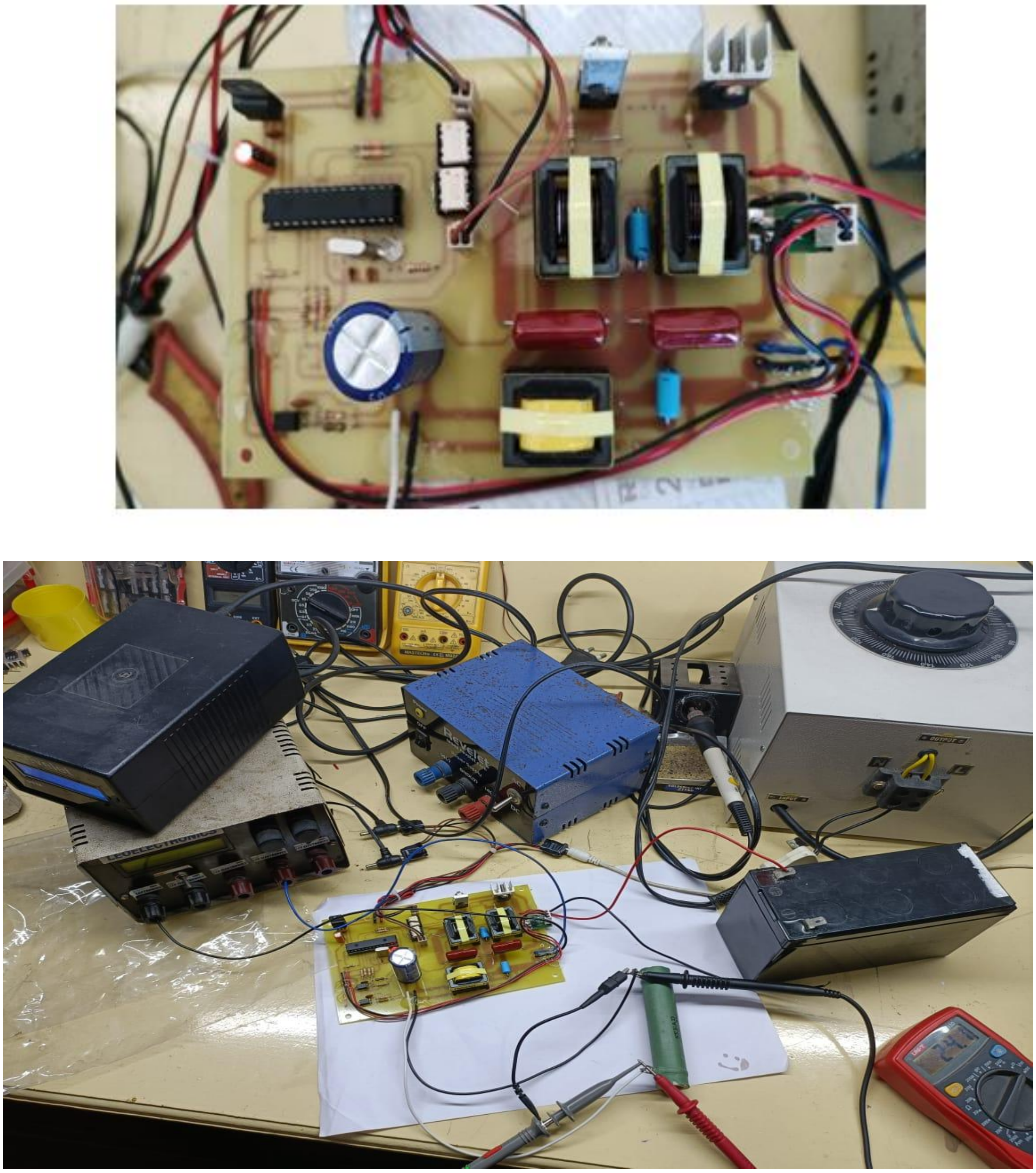

Figure 9:Hardware

VII.CONCLUSION

Hybrid generation system based on renewable and constant dc LUO converter has been successfully implemented. The performance of the system has analyzed using matlab simulation. From the results the proposed system can work both simultaneously or separately. As we know that many dc sources available give unstable DC output.Our project mainly focus on providing a stable DC output from multiple sources .The peculiarity of the input sources are one of them can be a variable power source like PV or Wind energy system , and the other a backup dc sorce.The power output from variable source are unreliable.But in our project using a modified Luo converter and MPPT algorithm, from two sources (one variable and the other a constant DC source) a stable DC output is generated.A simulation is also done for the same.Another main ocus is on utilization of green energy sources as conventional sources are depleting nowadays.Overall the sysem structure is smaller even after accomodating this complex circuit.System efficiency is improved through using Luo converter.Some of the applications of our project include computer peripheral equipmenta and industrial applications,traction motor control in electric automobiles, marine hoists, forklift truck and mine haulers.etc

REFERENCES

[1]. A. Karafil, H. Ozbay and S. Oncu, "Design and Analysis of Single-Phase Grid-Tied Inverter With PDM MPPT-ControlledConverter,"in ***IEEE Transactions on Power Electronics***, vol. 35, no. 5 , pp. 4756-4766, May 2020,doi:10.1109/TPEL.2019.2944617

[2]. M.B.Cheema, S.A.Hasnain, "Comparative Analysis of SPWM and Square WaveOutput Filtration based Pure Sine Wave Inverters", ***IEEE 15th International Conference*** on Environment and Electrical Engineering, 2019.

[3]. M.A.Ghalib, Y.S.Abdalla, R.M.Mostafa, "Design and Implementation of a Pure Sine Wave Single Phase Inverter for Photovoltaic Applications," Zone 1 Conference of the ***American Society for Engineering Education***, pp. 1-8, April, 2014, U.S.A.