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Grid-Tied Single Phase Inverter for Renewable Energy Sources

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Abstract
Conventional Energy Sources are depleting day by day. In the present scenario switching to renewable energy sources (RES) like wind, solar, tidal energy etc. are of high need. Micro grid systems Smart grids system is areas of high interests in today's world. By connecting the renewable energy producing facilities to grid we can ensure maximum reliability and stability to the system. This project intends to design and develop a single phase inverter for grid tied renewable energy sources. This system incorporates a DC-DC boost convertor with maximum power point tracking(MPPT) to ensure maximum power being transferred from the RES and Full bridge inverter with Sinusoidal Pulse Width Modulation(SPWM) control for grid connection .Here PV modules are used as the input renewable energy sources. The performance of the proposed system is simulated using MATLAB.

Keywords: *MPPT, SPWM, Single phase grid tied inverter, Boost converter, PV array.*

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I. INTRODUCTION

The present world is trying to increase the utilisation of renewable energy sources because of the rapid depletion of fossil fuels and conventional energy resources. RES also helps to resist global warming and environmental pollution .Solar energy is most relevant because of its abundance and its conversion to electricity is environmental friendly compared to other RES. Nowadays many researches and developments are taking place in photovoltaic systems to improve the reliability and efficiency of PV system considering all the positive impacts of solar energy. Studies are made in the development of technologies like power electronics interfaces, power quality improving mechanisms that makes the operation of PV system more convenient. Due to the change in conditions like temperature, irradiance etc. the power from PV array vary. To ensure the maximum power tracking many systems make use of MPPT technology. Many types of MPPT techniques are available like Perturb and Observers method, Incremental conductance, constant voltage method etc. . . . In these methods P and O method is comparatively simple and easy to implement. A MPPT controlled DC-DC boost converter is interconnected with PV module for optimal operation. A full bridge inverter is incorporated to convert the dc voltage to 50 Hz ac line voltage. SPWM technique is used to control the inverter for grid connection. To filter out the noise from the output signal an LC filter is connected at the output side.

A Karafil et al. (2019), says that in this study, a novel method is presented for maximum power point tracker (MPPT) system to increase efficiency.

S Barua et al. (2019) in this paper represent the fabrication and implementation of 50Hz SPWM inverter to convert the direct current to alternating current.

II. METHEDOLOGY

The block diagram of the proposed model is shown in the figure below. The input source can be any renewable energy source and here we are using PV arrays as the renewable energy source. The voltage and current measured from the PV array is given to the control unit, a microprocessor. A reference voltage from the grid is also given to the control unit. According to the programme written inside the control unit PWM and SPWM Pulses are produced and are given to the converter and inverter respectively. The boost converter step up the input voltage to the desired voltage and inverter produces AC Voltage which is in phase with the Grid. The inverter output is passed through an LC filter in order to filter out the noise in the signal.

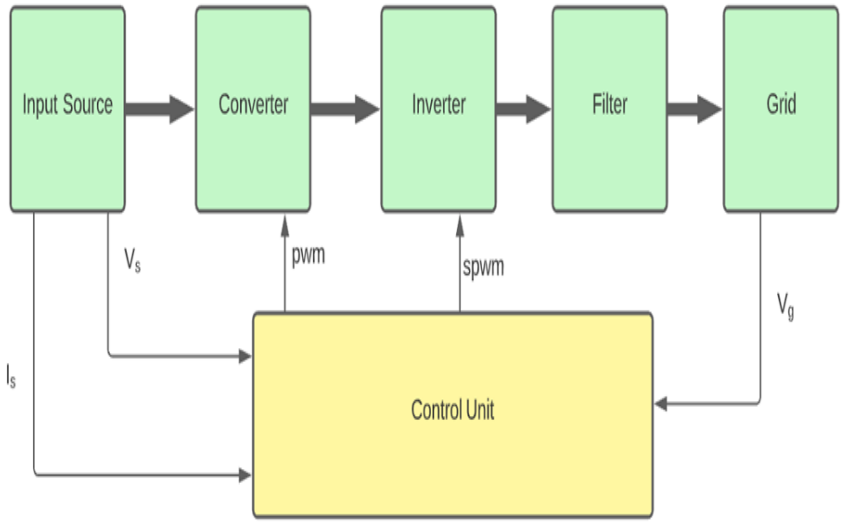

Figure 1: Flow chart of P&O algorithm

The flow chart of the MPPT algorithm, P&O algorithm is shown in the figure below. Here the voltage and the current at each and every instant are measured and compared with the previous instant. Also the power at every instant is calculated. The difference in the power is compared with zero and accordingly the difference in voltage is also compared with zero. With respect to the comparison the duty ratios are varied and with respect to the duty ratio the opening and closing of the switch is controlled.

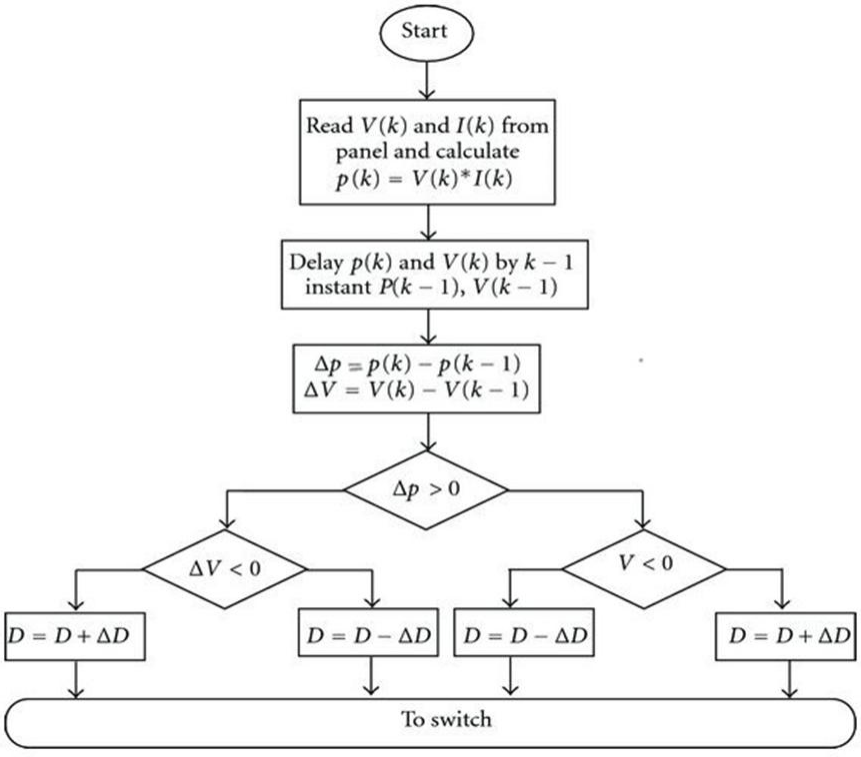

Figure 2: Flow chart of P&O algorithm

III. THE SIMULATION

The Simulink models of the inverter with SPWM, MPPT converter and the grid tied inverter with PV array are shown in figure 3, figure 4 and figure 5 respectively.

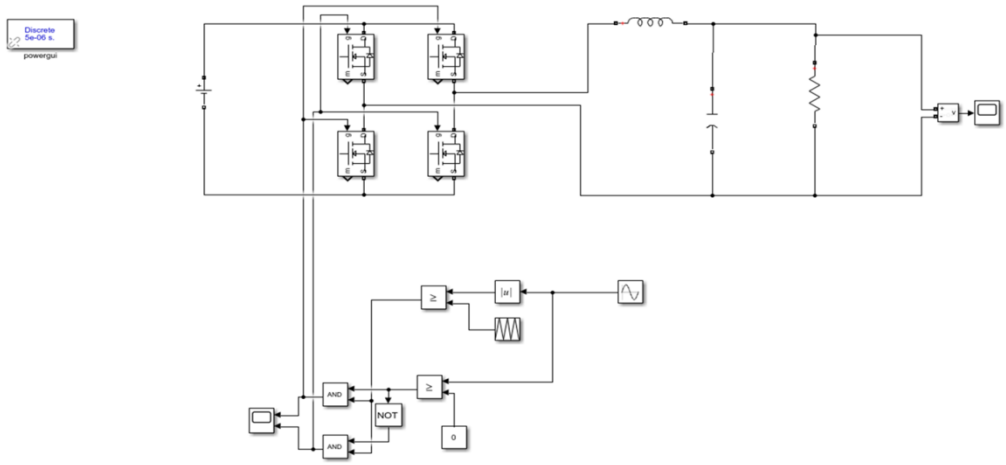

Figure 3: Inverter with SPWM

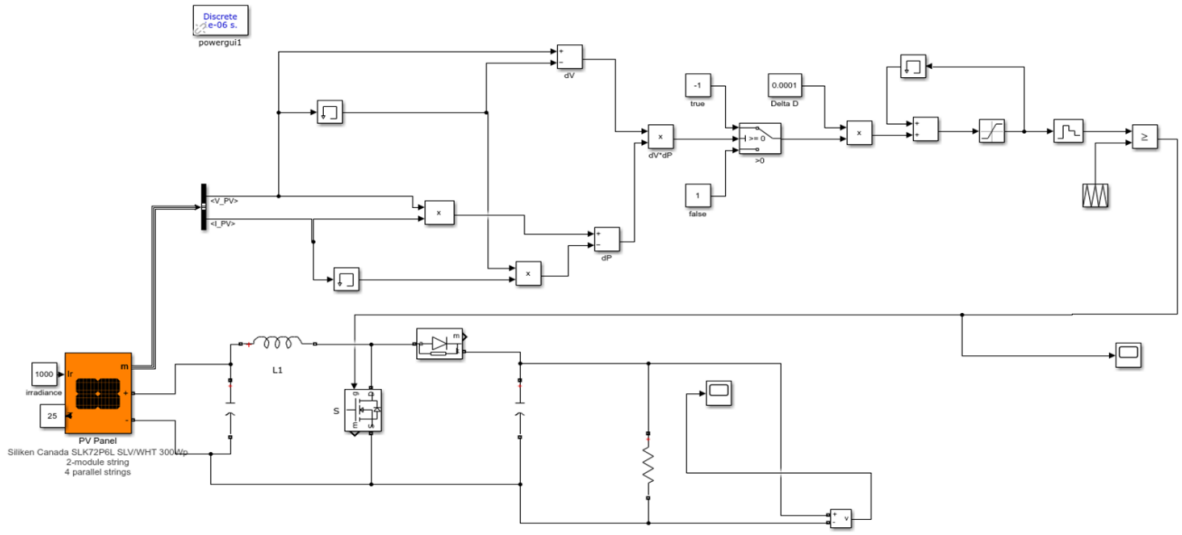

Figure 4: MPPT Converter

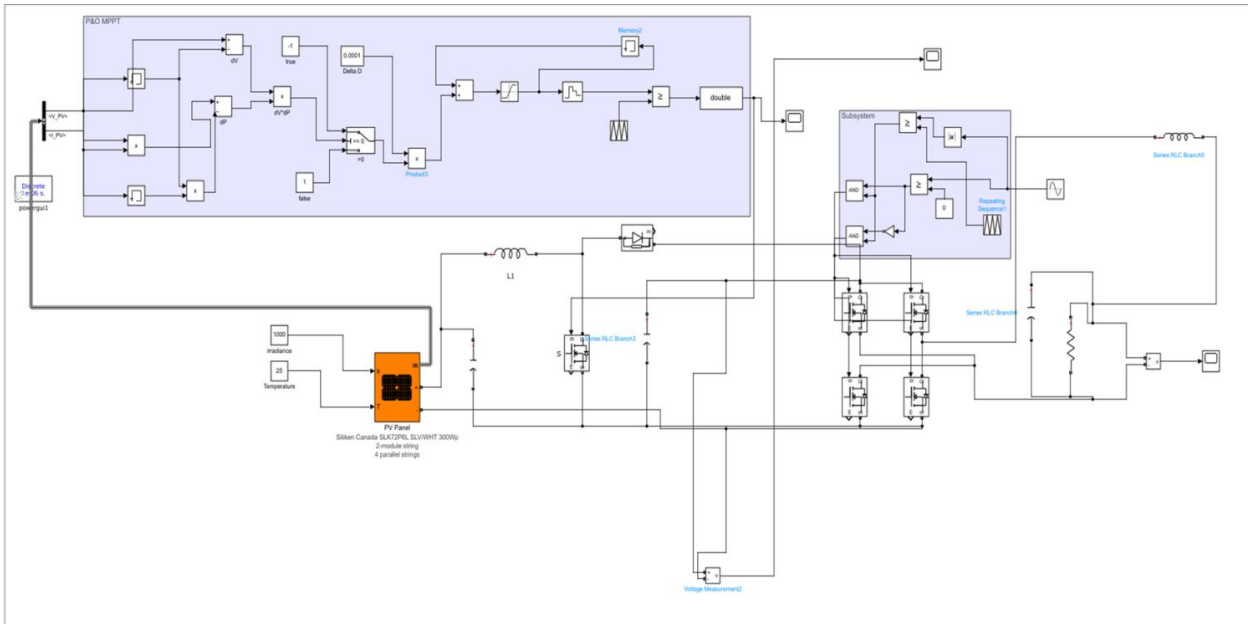

Figure 5: Simulink Model of Grid Tied Inverter

IV. 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.

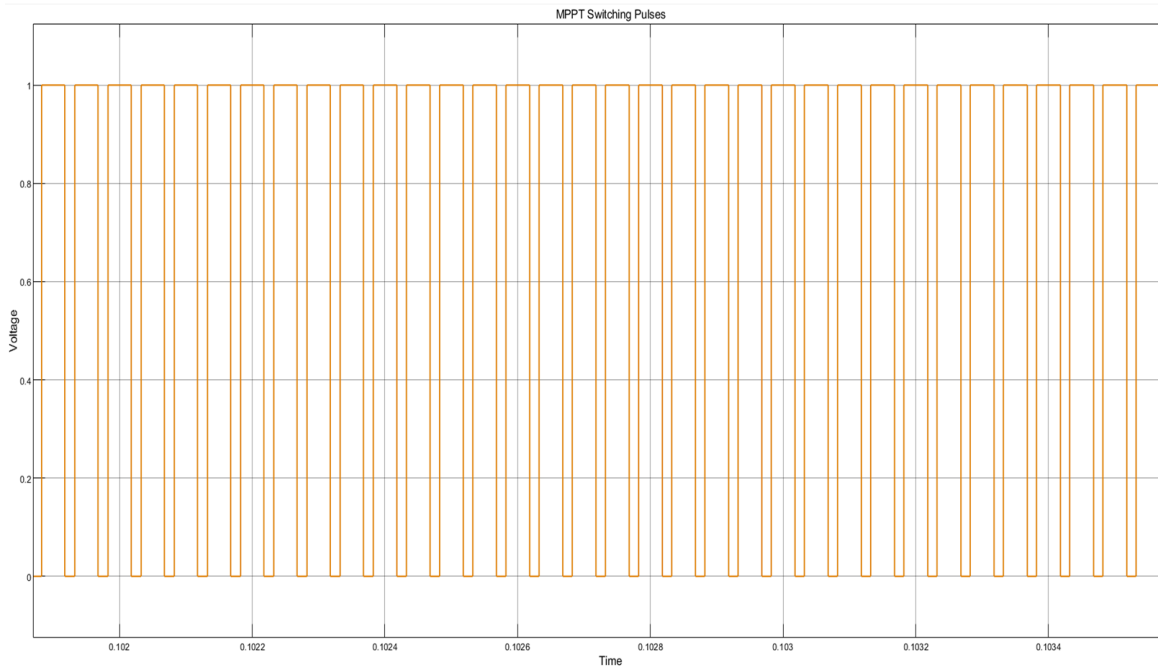

Fig.6: MPPT PWM

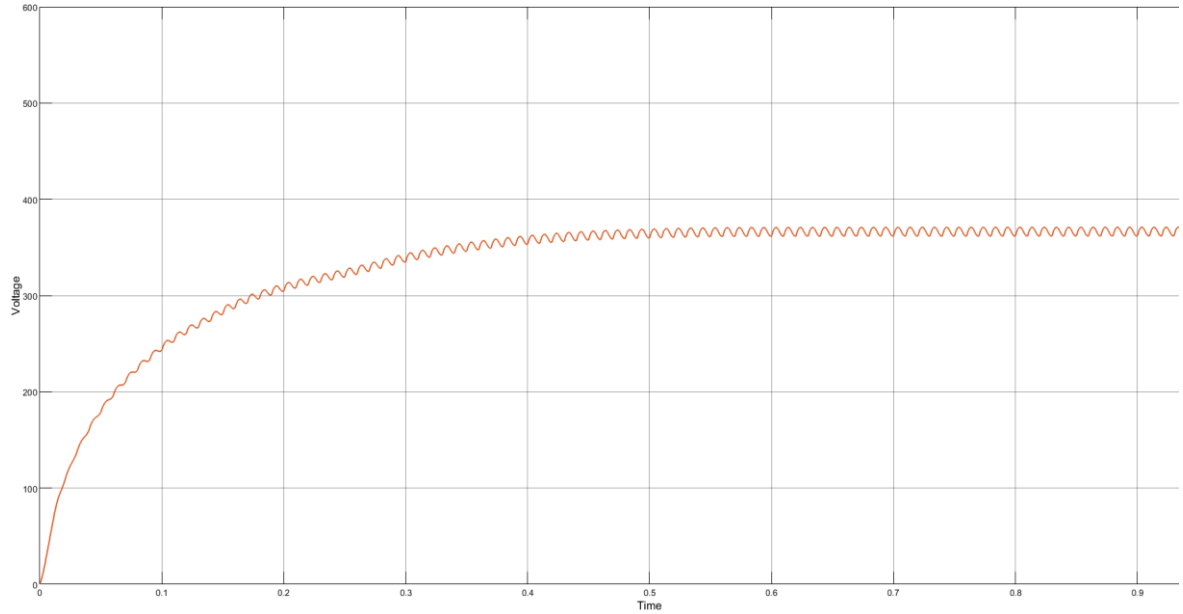

Figure 7: Converter Waveform

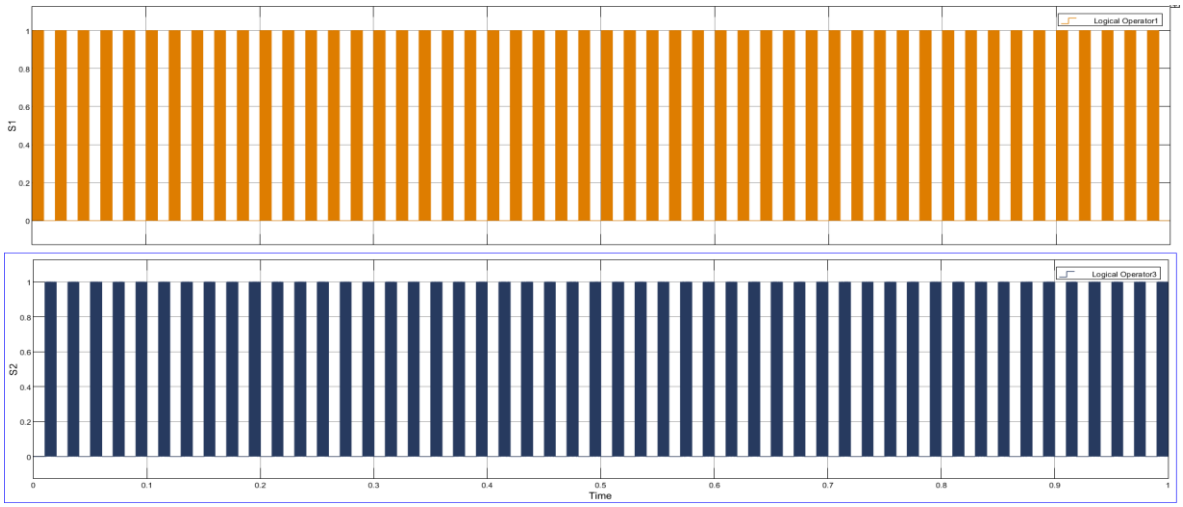

Figure 8: SPWM Pulse

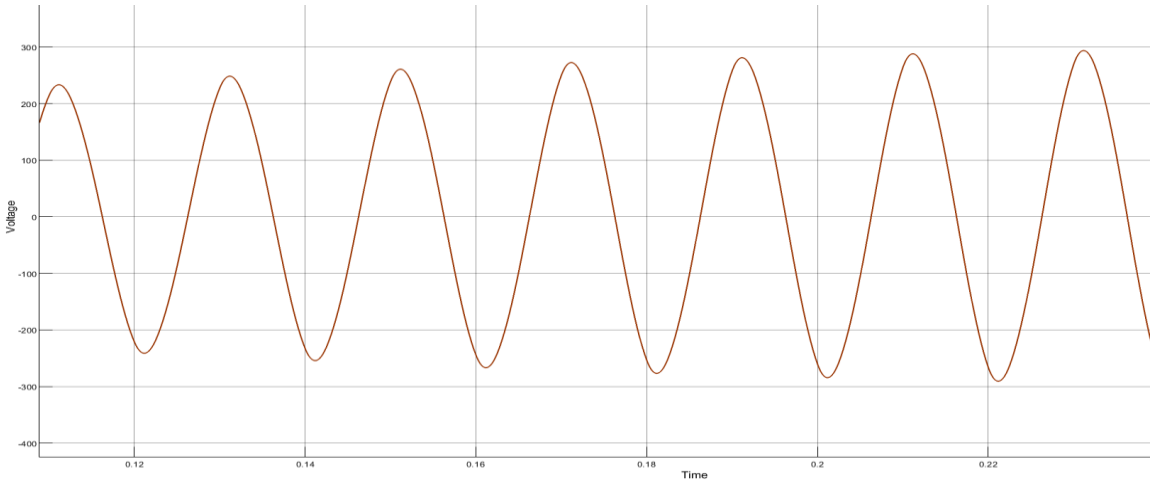

Figure 9: Inverter Output

V. 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 opto-couplour 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 an 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 in this low cost system to improve the stability and reliability of inverter.

Figure 10: Hardware

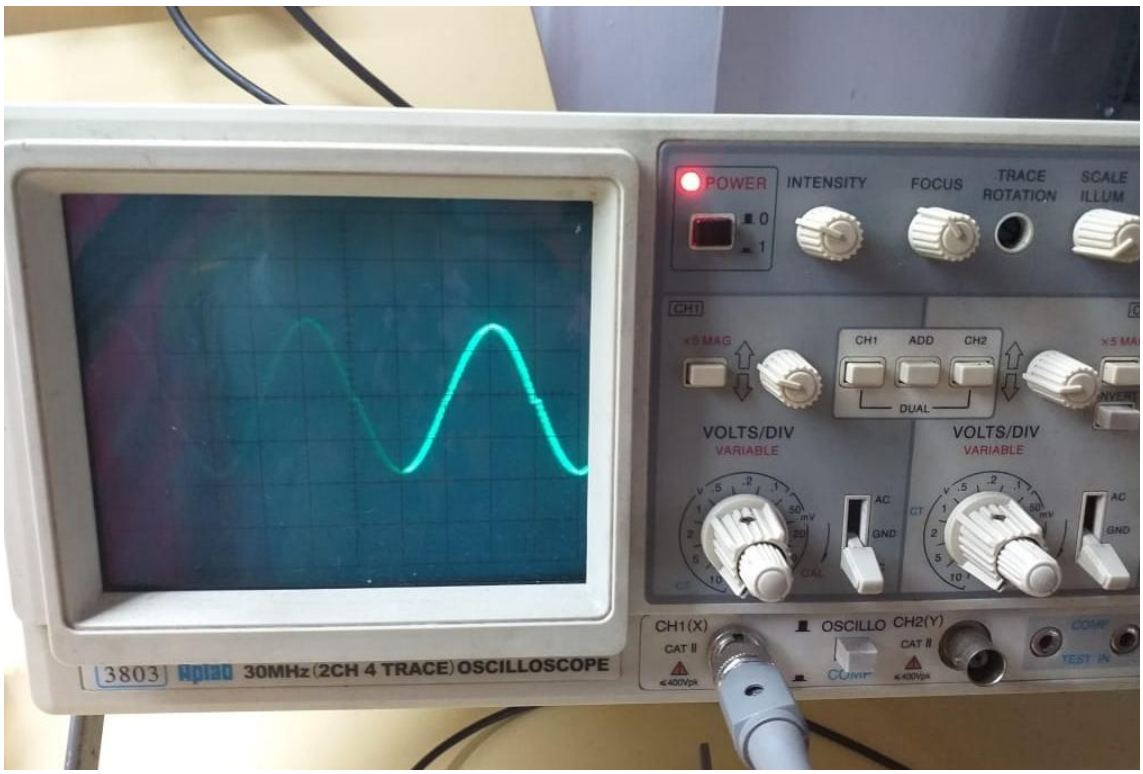

Figure 11: Hardware output wave

VI. CONCLUSION

Grid tied inverter model was designed and the performance was observed with the help of MATLAB software. For MPPT control a boost converter was designed and added to the system .SPWM was added to the Simulink model with the help of logical operators in MATLAB. The simulation for MPPT controlled boost converter connected to SPWM controlled inverter was implemented in MATLAB Simulink and the waveforms were analyzed. The converter output was increased irrespective of the variation in the environmental conditions and the inverter output was matching with grid parameters (amplitude, phase).The hardware implementation of grid tied inverter was done using dspic30f2010 microcontroller and the output was observed in CRO. Studying the implemental model was observed that the output of the implemented system traces the maximum power from the pv module and produced high quality ripple free AC voltage.

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