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NOVEL VOLTAGE STABILITY ANALYSIS OF A GRID CONNECTED – PHOTOVOLTIC SYSTEM

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Abstract: In the recent decades to meet the future energy demands and to give quality and pollution free supply to the growing environment conscious population, the present world attention is to go in for natural energy sources. The problem will be compounded due to fast depletion of fossil fuel deposits, quality of fuels and above all the environmental degradation caused by the use of conventional energy sources. The alternatives to the conventional energy sources are environment friendly and pollution free renewable energy sources. A conventional grid connected photo voltaic system with a battery energy storage system uses a maximum power point tracker for extracting maximum solar power. The dc/ac inverter translates the input dc voltage into an ac voltage. Thus the system structure and control becomes complicated. The proposed method is a grid connected photovoltaic system with a simpler structure that provides the function of a parallel power factor corrector. The maximum power point tracker serves as a charger too, tracking the maximum solar power controlled by fuzzy logic controller. The dc/ac inverter is capable of bidirectional power transfer. When either the solar power or the stored energy of the batteries is sufficient, the inverter provides all or a part of the load power. Solar electricity is not produced at night and is much reduced in cloudy conditions. Thus a storage or complementary power system is required. Solar power is pollution-free, production end-wastes and emissions are manageable using existing pollution controls. PV installations can operate for many years with little maintenance or intervention after their initial set-up and their operating costs are low when compared to existing power technologies.

Key words : Photo voltaic system (PVS), Power factor corrector (PFC), Fuzzy logic controller (FLC), Maximum power point tracking (MPPT), Inverter,

INTRODUCTION

Solar energy is clean and an alternative to fossil fuels and nuclear power and it will never run out. It can be captured anywhere without creating noise pollution that might otherwise up set neighbors and wildlife. Thus, no danger of damaging our environment further and can save our planet from harmful greenhouse gases. Although the technology to tap solar energy has existed since the 1970s, it presents several challenges. With the help of solar tracking and maximum power point tracking, engineers are working to meet the main challenge of improving the efficiency of solar energy systems. In the recent decades to meet the future energy demands and to give quality and pollution free supply to the growing environment conscious population, the present world attention is to go in for natural energy sources. The problem will be compounded due to fast depletion of fossil fuel deposits, quality of fuels, heavy price to be paid for basic materials plus their transportation cost and above all the environmental degradation caused by the use of conventional energy sources.

The alternatives to the conventional energy sources are environment friendly and pollution free non- conventional and renewable energy sources. In order to extract maximum power from the panel, a maximum power point tracker (MPPT), which is a dc/dc converter, is usually connected between the panel and the load. Various maximum-power-point (MPP) tracking methods are replaced by intelligent controllers, due to the fast response, flexibility in operation and reliability. This structure performs high efficiency and the proposed digital control allows reducing the production costs. The paper is organized as follows. In section II the system structure is presented. In section III and IV the DC/DC and DC/AC converters are analyzed and modeled. Simulations of the DC/AC converter and conclusions end the paper.

OBJECTIVE OF THE WORK AND BLOCK DIAGRAM

The main of the project is to achieve regulated voltage at the utility side. Maximum power is trapped using a dc/dc converter to which fuzzy logic control is applied. The isolation level and the intensity of sunlight falling on the earth surface vary, thereby input voltage and current varies. As a result, the maximum power point is tracked and produces a constant output voltage. This improves the energy conversion efficiency since more power is generated by photovoltaic array.

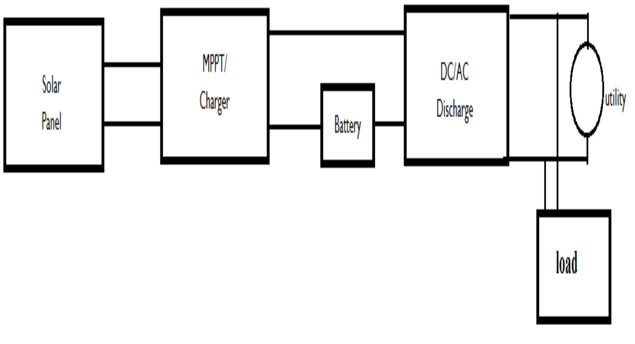


Figure 2 Grid Connected Block Diagram

The phase-shift control between the input bridge legs and the output bridge legs of the DC/DC converter is determined by a Maximum Power Point Tracking (MPPT) algorithm, in order to extract the maximum possible power from the PV panels in all the irradiation conditions. The control of the DC/AC converter is designed to supply current into the utility line by regulating the bus voltage $V_b$to 450V

SYSTEM CONTROLLERS

The renewable system model implemented was tested both using simulation and hardware. The simulation was carried using a high performance language MATLAB for computing. It integrates computation, visualization and programming in an easy to use environment where problems are expressed in mathematical notation and the results were obtained. The hardware implementation was carried using various components such as the Power supply, Boost Converter and Microcontroller unit

Simulation of PI Controller:

The PI controller is used to provide gating pulses to the single phase inverter. The PI controller gets two inputs, one is the output current and the other is the reference signal. The Relational Operator block compares two inputs using the Relational operator. The first input corresponds to the top input port and the second input to the bottom input port. If the first input is greater than the second the gating pulses are provided to thyristor 1 and thyristor 4. If the first input is lesser than the second the gating pulses are provided to thyristor 2 and thyristor 3 .

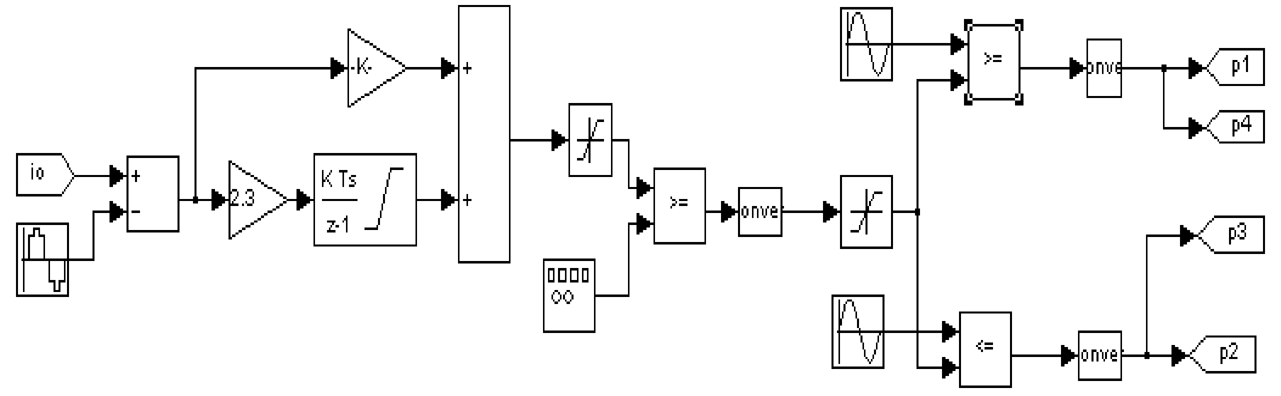


Figure 2 MATLAB\ SIMULINK Diagram of PI Based Controller

Simulation Fuzzy logic Controller:

The simulation of the fuzzy logic controller has been done by selecting the methods for the elements, such as fuzzification, defuzzification, implication operations, aggregation operations of antecedents and scaling factors. The FLC gets two inputs, one is the input voltage signal and the other is the input current signal of the solar panel. The two signals are applied to the FLC as shown in Figure 5.2. The FLC gives output as duty cycle which is applied to the boost converter switch to control the output voltage for various temperatures. The converter converts the fixed DC to variable DC boosting to a level of 325V.

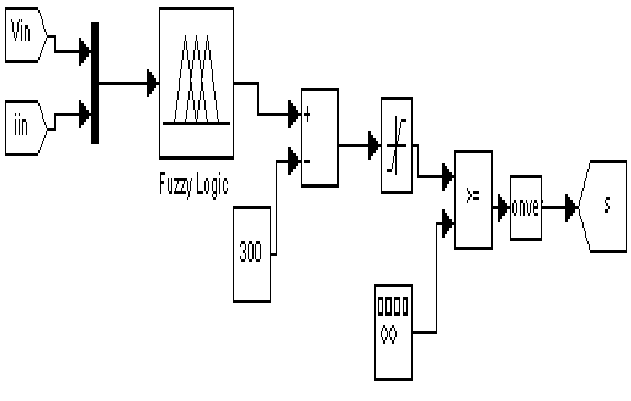


Figure 3.2 MATLAB\ SIMULINK Diagram of FLC Based Controller

The main characteristics steps of the fuzzy logic controller are:

a) Five fuzzy sets for each of the two inputs voltage and current. Voltage ranges from [0 25] and current interval ranges from [0 1].
b) Five fuzzy sets for the output duty cycle [0.1]
c) Triangular membership functions.
d) Rule base was formed using a 5*5 matrix.
e) Fuzzify the inputs to the controller.
f) Inference mechanism based on fuzzy implication.
g) Defuzzyfication using the “centre of area” method.

SIMULATION DIAGRAM

The renewable system model implemented was tested both using simulation and hardware. The simulation was carried using a high performance language MATLAB for computing. It integrates computation, visualization and programming in an easy to use environment where problems are expressed in mathematical notation and the results were obtained. The hardware implementation was carried using various components such as the Power supply, Boost Converter and Microcontroller Unit

It became popular for both teaching and research and evolved into a commercial software package written in C. For many years now, MATLAB has been widely used in universities and industries. MATLAB has several advantages over more traditional means of numerical computing.

a. It allows quick and easy coding in a very high level language.
b. Data structures require minimal attention arrays need not be declared.
c. The interactive interface allows rapid experimentation.
d. High quality graphics and visualization facilities are available.
e. MATLAB M-files are completely portable across a wide range of platforms.
f. Toolboxes can be added to extend the system.

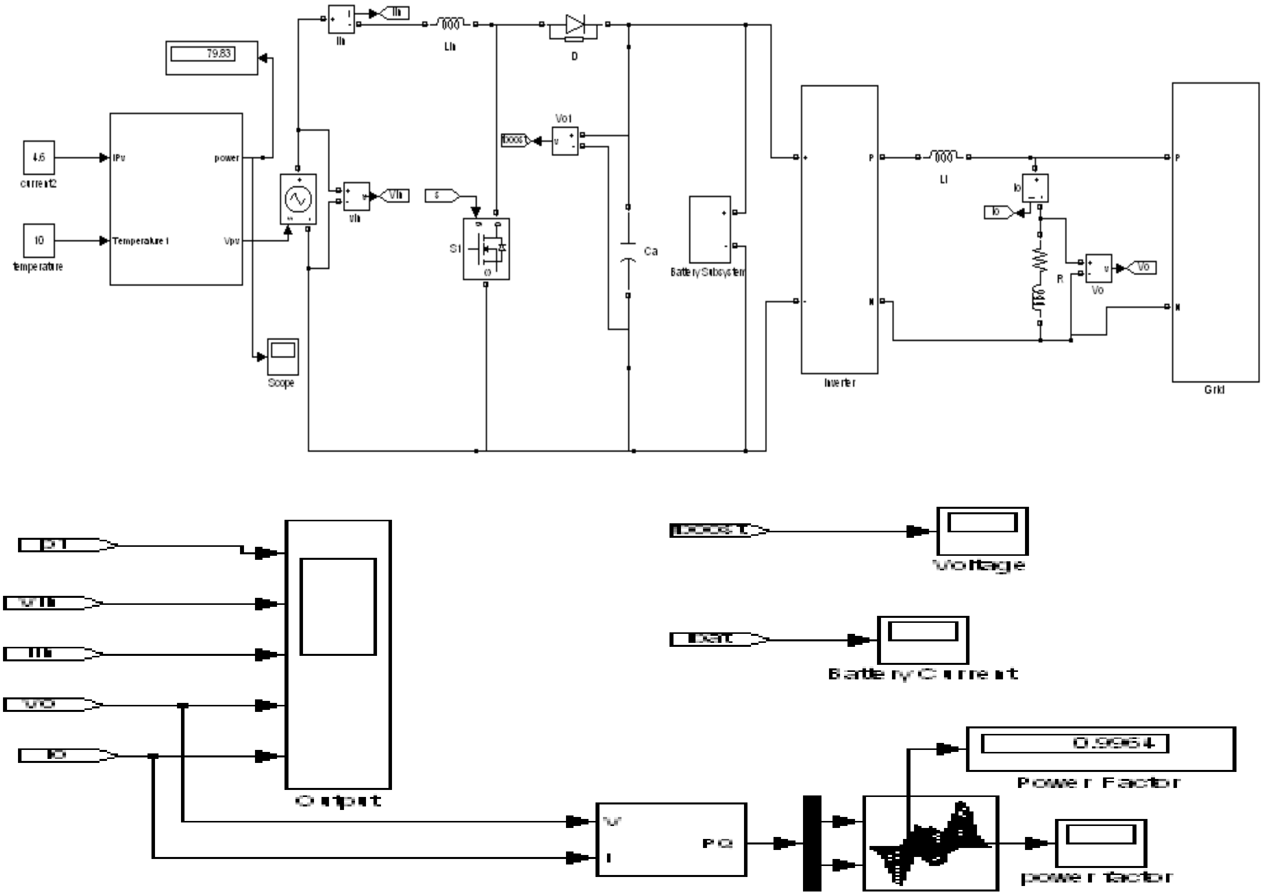


Figure 4.1 Simulation Diagram of Photovoltaic System

SIMULATION RESULT AND ANALYSIS

Voltage Response: The voltage response was obtained for various temperatures and a constant AC output was obtained.

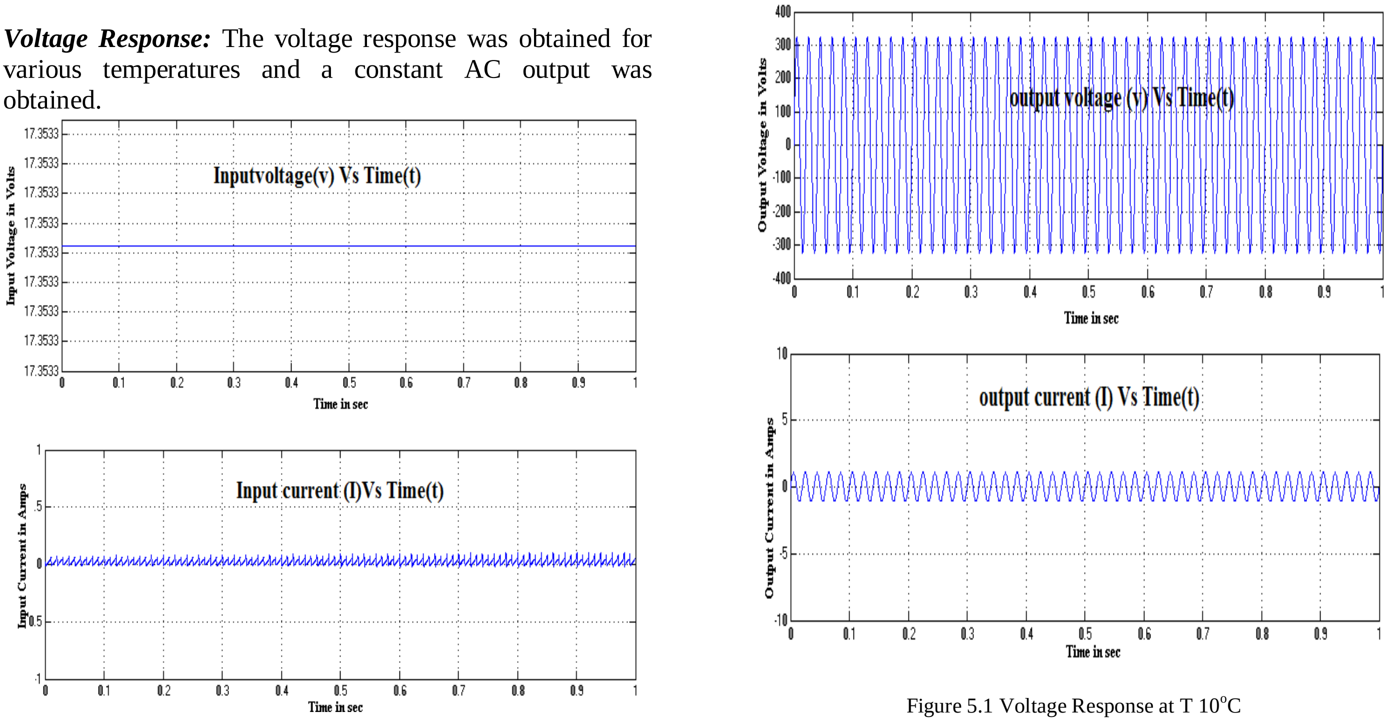


Figure 5.1 Voltage Response at T 10^{o}C

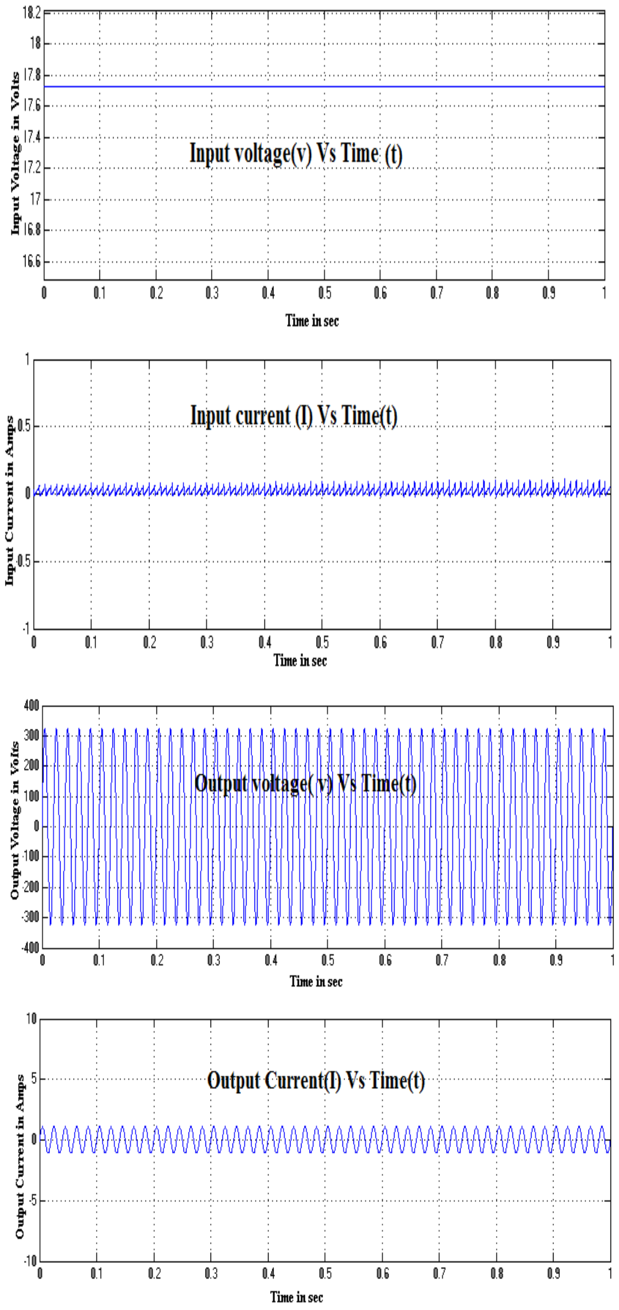


Figure 5.2 Voltage Response at T 18^{o}C

Analysis:

The voltage response obtained at T=10^0 C, Figure 5.1 had an input voltage of 17.3 Volts, the input current at 0.06 Amps, the output voltage remained constant boosted to a level of 325 Volts and output current of 1.05 Amps. The voltage response obtained at T=18^{0}C, Figure 5.2 had an input voltage of 17.7 Volts, the input current at 0.07 Amps, the output voltage remained constant boosted to a level of 325 Volts and output current of 1.05 Amps. The voltage response at T=25^{0}C, Figure 5.6 had an input voltage of 18 Volts, the input current at 0.08 Amps, the output voltage remained constant boosted to a level of 325 Volts and output current of 1.05 Amps. Power factor was maintained near to unity Figure 5.3, approximately 0.99 at the grid connected photovoltaic system. Thus voltage regulation was achieved at the utility side for rapidly varying atmospheric conditions

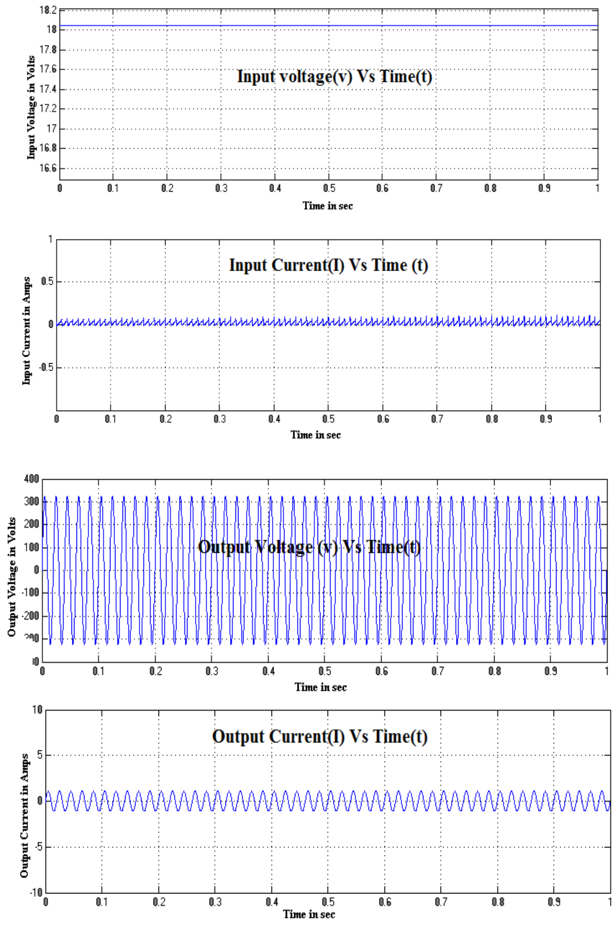


Figure 5.3 Voltage Response at T=25^{o}C

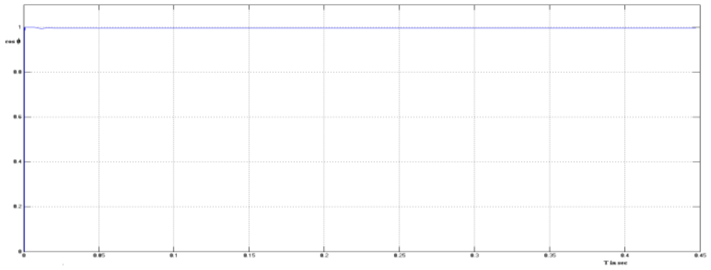


Figure 5.4 Power Factor

HARDWARE

This explains the result analysis of renewable energy systems for an alternate form of power under their hardware implementation. At different intensities of sunlight, provides different levels of input voltage to the boost converter which thereby provides a constant output. This is further converted to AC using a single phase inverter which feeds the load

Result Analysis:

The designed Boost Converter uses a Fuzzy Logic Controller which was implemented using a PIC16F877A. The input to the boost converter is ranging from 8V to 14V. Boost Converter is implemented by using MOSFET IRFZ44 switch. The duty cycle for boost converter is shown in Figure 6.1.

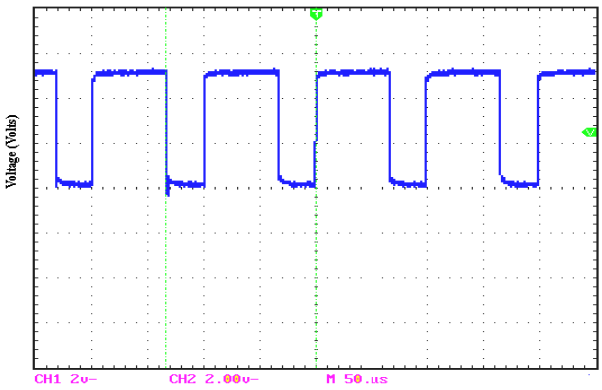


Figure 6..1 Duty Cycle Output from Microcontroller

The voltage levels for various operating conditions are given by

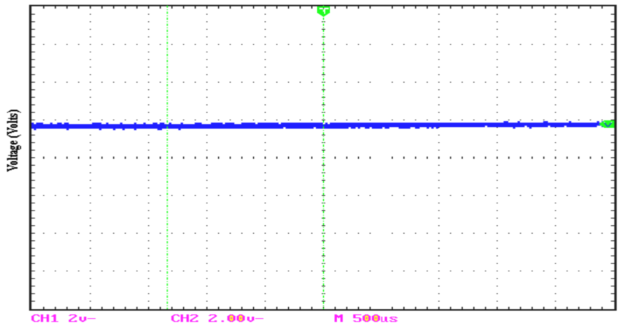
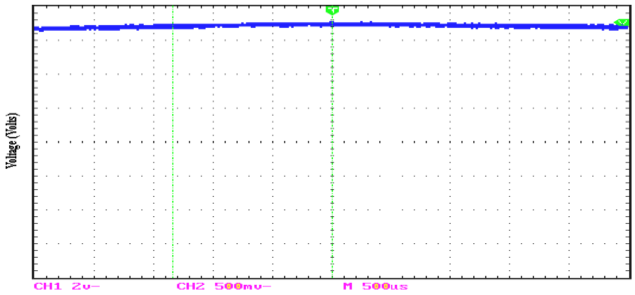


Figure 6.2 Input Voltage below 8V



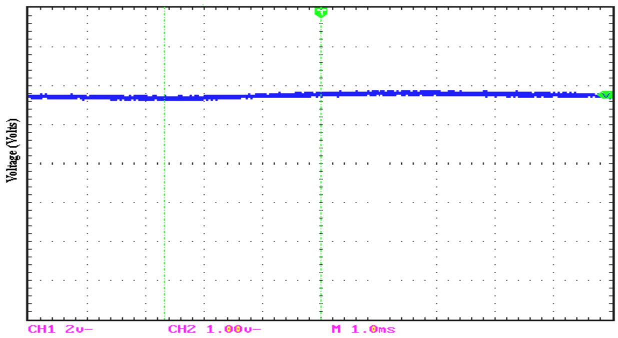


Figure 6.4 Input Voltage above 14V

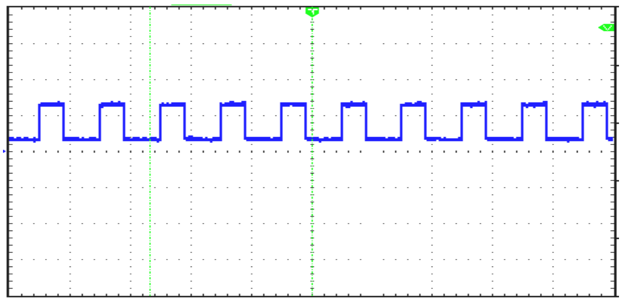


Figure6.5 SwitchingPulsesforThyristors1 2

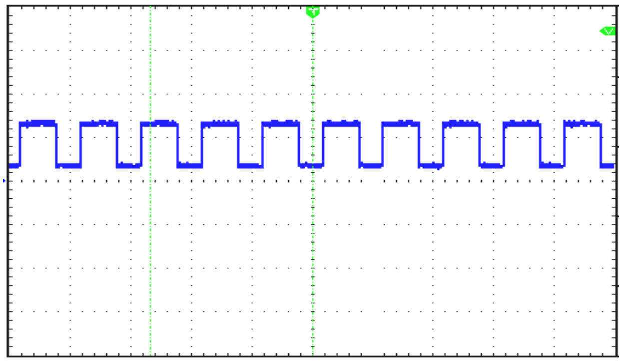


Figure 6.6SwitchingPulsesforThyristors3 4

The Figure 6.5, 6.6 indicate the switching pulses for the single phase inverter

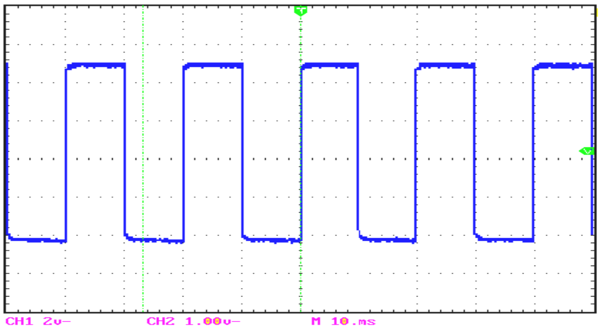


Figure 6.7 Output Voltage of Inverter

The Figure 6.7 shows the output voltage of single phase inverter with a voltage level around 24V. The result analysis observed on 12-4-2011 proved that maximum tracking was obtained around 2 pm with hour to hour duration. This proved that maximum tracking was possible at slanting sunlight. The Figure 6.8 shows the voltage to time variations

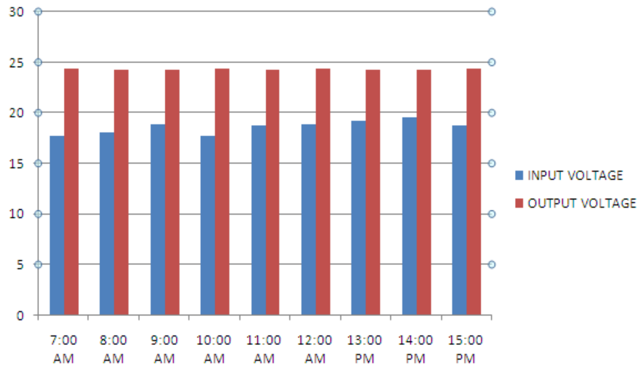


Figure:.6.8 Hour to Hour Duration of Solar Intensity

Time Interval	Input Voltage	Output Voltage
7.00 a.m.	17.7V	24.4V
8.00 a.m.	18.1V	24.2V
9.00 a.m.	18.8V	24.3V
10.00 a.m.	17.7V	24.4V
11.00 a.m.	18.7V	24.3V
12.00 a.m.	18.9V	24.4V
1.00 p.m.	19.2V	24.3V
2.00 p.m.	19.5V	24.3V
3.00 p.m.	18.7V	24.4V

Figure 6.9 Voltage Vs Time

CONCLUSION

Photovoltaic (PV) energy utilization has increased interest in Electrical Power applications. It is crucial to operate the PV energy conversion systems near the Maximum Power Point to increase the efficiency of the PV system. However, the nonlinear nature of PV system is apparent, i.e. the current and power of the PV array depends on the array terminal operating voltage. In addition, the maximum power operating point of the solar cell varies with insolation level and operating temperature. Therefore, the tracking control of the maximum power point is a complicated non-linear problem. The FLC is appropriate for non-linear control and it does not use complex mathematics. Behaviors of FLC depend on the shape of membership functions and rule base. This approach helps in effective utilization of PV systems for larger Electrical Power Distribution Systems. Fuzzy logic controls for MPPT have the advantages of working with imprecise inputs, not needing an accurate mathematical model, and handling nonlinearity In this thesis, a fuzzy logic controller was implemented for maximum power point tracking in DC/DC converters. Fuzzy logic techniques were applied to the Boost Converter to produce constant voltage at various temperatures. MATLAB/ SIMULINK were used for the controller design and for the simulation of the entire system. Simulation and hardware results confirm maximum power point tracking producing a desired voltage level.

REFERENCES

[1]. EIA, 2011, Levelized cost of new generation resources in the Annual Energy Outlook 2011. U.S. Energy Information Administration.

[2]. K. Zweibel, Should solar photovoltaics be deployed sooner because of long operating life at low, predictable cost? Energy Policy, 38:7519-7530,2010.

[3]. Review of PV inverter technology cost and performance projections. Nat. Renewable Lab. Energy, Golden, CO, NREL Report SR-620-38771, 2006.

[4]. M. Cacciato, A. Casoli, R. Attanasio and F. Gennaro Soft Soft-switchingconverter with HF transformer for grid-connected photovoltaic systems,IEEE Transactions on Industrial Electronics, 57(5):1678-86,2010.

[5]. R. Zanasi, “The Power-Oriented Graphs technique: System modeling and basic properties”, Vehicle Power and Propulsion Conference (VPPC), 2010 IEEE, Lille, France, 1-3 Sept. 2010

[6]. R. Zanasi, “Power Oriented Modelling of Dynamical System for Simulation”, IMACS Symp. on Modelling and Control, Lille, France, May1991.

Short Bio Data for the Author

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