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ARDUINO BASED BUCK BOOST CONVERTER FOR EFFECTUAL SOLAR PANEL APPLICATIONS

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ABSTRACT

Recently, photovoltaic systems (PV) have been the most popular and promising technology in the field of Renewable Energy. But we know the solar irradiance is varying in nature this causes fluctuation in the output voltage with time. This is one of the major demerits of the PV System. Thus, here in this paper we propose a buck boost converter based on Arduino microcontroller to obtain constant output voltage by controlling the duty cycle of the gate pulse of the converter using PWM Techniques. The prototype of the system has been developed and tested and the performance of the system is verified. The system performance is verified in the simulation also. We obtained a constant 12V in both modes (buck and boost).

KEYWORDS: *Photovoltaic Systems (PV)*

INTRODUCTION

The Environmental issues of fossil fuels and nuclear fuels causes the rise in demand of renewable energy sources. Those are sustainable and cheap with less emission. Solar energy is the most popular and promising technology in the field of renewable energy, It is considered as cheaper and sustainable. However, the varying nature of the solar irradiance is the major drawback of the technology.

Photovoltaic systems (PV) is module that built in a form of array solar panel where harnessing solar energy take place. PV cell consists of thin layers of silicon which is a semiconductor material, when it get exposed to light, generate electrical charges. It converts light energy directly to DC electrical Energy. The generated voltage in the terminals of the PV Module can directly feed various loads.

PROPOSED SYSTEM

As the Sun irradiance is varying in nature, Solar inverters output power is varying and it effects the functioning of electrical equipments negatively. So, it is necessary to limit the voltage variation in a particular limit to ensure the proper functioning of the equipments.

PV SOLAR SYSTEM

Design and fabrication of a buck boost converter for PV solar system

Implementation of Arduino-based controller for controlling the duty cycle of the developed converter to continuously adapt the mode of operation based on the variation of PV voltage

Evaluating the performance of the developed system using both simulation and prototype and analysis of the obtained results to assure the switching between the operation modes of the converter (buck and boost) according to the input voltage.

REVIEW OF LITERATURE

Short-term solar irradiance forecasting (STSIF) is of great significance for the optimal operation and power predication of grid-connected photovoltaic (PV) plants. However, STSIF is very complex to handle due to the random and nonlinear characteristics of solar irradiance under changeable weather conditions. Artificial Neural Network (ANN) is suitable for STSIF modelling and many researches works on this topic are presented, but the conciseness and robustness of the existing models still need to be improved. After discussing the relation between weather variations and irradiance, the characteristics of the statistical feature parameters of irradiance under different weather conditions are figured out. A novel ANN model using statistical feature parameters (ANN-SFP) for STSIF is proposed in this paper. The input vector is reconstructed with several statistical feature parameters of irradiance and ambient temperature. Thus sufficient information can be effectively extracted from relatively few inputs and the model complexity is reduced. The model structure is determined by cross-validation (CV), and the Levenberg-Marquardt algorithm (LMA) is used for the network training. Simulations are carried out to validate and compare the proposed model with the conventional ANN model using historical data series (ANN-HDS), and the results indicated that the forecast accuracy is obviously improved under variable weather conditions.

RESULTS AND DISCUSSION

This section presents results of buck-boost converter operation in simulation prototype. The purpose of this part is to evaluate the performance of the buck boost converter circuit in performing buck and boost processes, the desired output from the buck boost converter is 12V. The objective is to obtain the desired output voltage which is 12 V. The results represent three mode of operation based on two different input voltage used in these experiments, (8 V, 17.4 V). Firstly, Boost Mode, where the input voltage is less than the desired voltage (12 V) due to lower sun irradiance. Then, Buck Mode, where the input voltage is higher than 12 V (up to 17.4 V), thus the converter needs to stepdown the voltage to the preferred value. A control loop is provided to the Arduino microcontroller as part of the feedback system.

Boost Mode

Boost mode of buck-boost converter started when the duty cycle, k is more than 0.5, thus the converter steps-up the output voltage to be higher than input voltage and achieving the desired output. In order to test the developed converter in boost mode, 8 V input voltage was applied at the input terminal of the converter, thus Arduino PWM increased the duty cycle to become more than 0.5 which resulting in increasing the output voltage to 12 V. Simulation results are displayed in Fig.10, when the input voltage is 6 V, the duty cycle is adjusted by set up the pulse width of switching voltage to 10.35 μs for a period of 16.6667 µs, the duty cycle became 0.6. At this duty cycle, the buck-boost converter converts 6 V input voltage to 12 V output. Figure shows the practical result for boost mode for the same input voltage (8 V). Herein Arduino has adjusted the duty cycle automatically via PWM output to attain the required output voltage (12 V) at all-time based on the feedback measured voltage. It is obvious that the buck-boost converter able to perform boost voltage process to ensure a fixed output voltage. Consequently, our converter can boost the lowest output voltage generated by the solar panel at lower radiation due to changing the angle of the sunlight to the solar panel plate during day time.

Buck Mode

The second voltage input that has been tested was 17.4 V, as the maximum expected output of the PV solar panel according to the tested solar panel ratings. In this situation, the process that involve in obtaining the desired output voltage is buck process. the output results from the buck-boost converter recorded is 12 V with duty cycle of 0.42 (Less than 0.5) at pulse width of 7.02 µs. This duty cycle is a little bit higher than the theory calculation of k which was 0.408 as estimated before. This mode of operation for buck-boost converter is useful during pick time when the angle of the sunlight can be considered as almost 900 to the solar panel plate and the generated voltage output by the PV solar system is maximum. In such cases, the Arduino decreases the PWM duty cycle, thereby reducing the output voltage to the desired value (12 V). 42

Overall, the voltage output generated by PV system was changing overtime. This is because of the solar radiation received by the solar panel, and it is influenced by the weather condition at that specific time. Basically, in Malaysia, the amount of radiation of sunlight received is high as it located near the equator. Thus, during day time (10 am – 2 pm), the buck-boost converter will operate in buck-mode to step-down output voltage of solar cell. However, the cloud formation that influenced by the natural land structure can limit the amount of solar radiation received, and decreases the output voltage, thus the converter will easily switch to boost mood to rise the output voltage using auto-adjusted PWM output from Arduino.

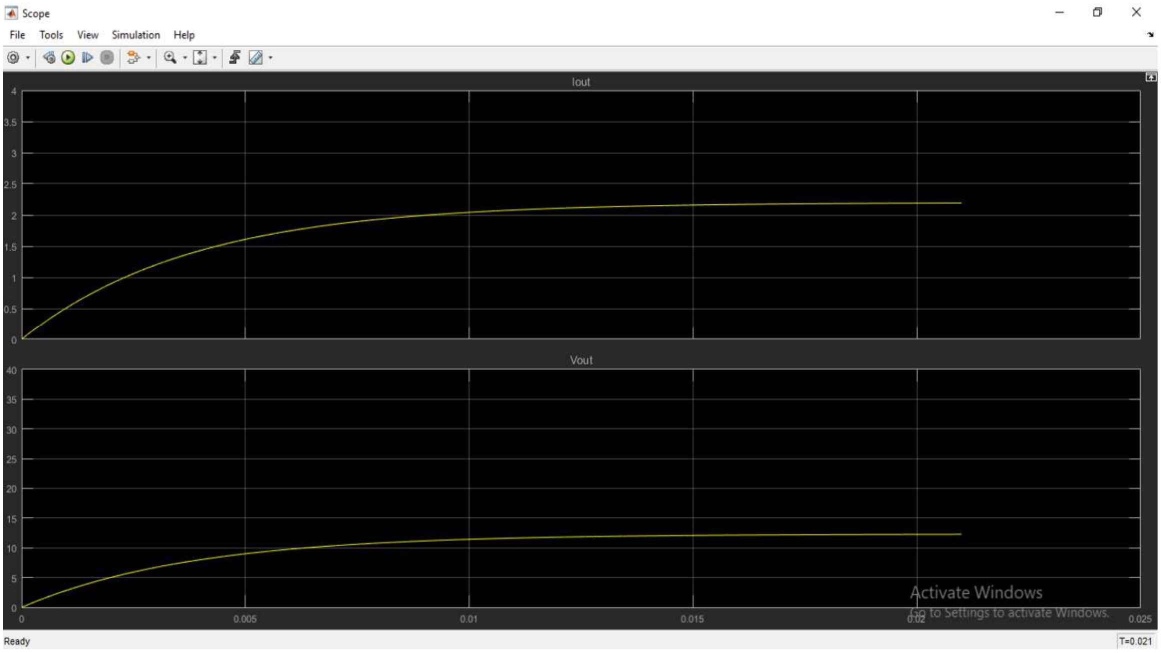

Figure 1

CONCLUSION

We have developed an Arduino-based Buck- Boost converter to avoid the high thermal losses and poor efficiency of the existing linear voltage regulators. The designed converter can provide sensitive instrumentations with a fixed output voltage from the PV solar system at all times. The design and fabrication of the converter were carried out using simulation and prototype. The obtained results prove the system efficiency, accuracy and cost effectiveness. The potential market of the developed voltage controller including but not limited to renewable energy industry, DC motors drive circuits and battery power systems.

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