JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

PORTABLE POWER DISTRIBUTION SYSTEM

[1]Dr Sheila H, [2]Dr Zuhaib Baig, [3]Dr Kaveri K B, [3]Prof Pushpalatha M S, [3]Prof Spoorthi S N

[1]Associate Professor, [2]Assistant Professor, [3]Assistant Professor,[4] Assistant Professor, [5]Assistant Professor
[1]Electrical and Electronics Engineering,
[1]Vidya Vikas Institute of Engineering and Technology, Mysuru, India.

Abstract: The current challenge faced by organizations and individuals providing temporary shelters in emergency situations is the lack of adequate and portable power distribution equipment to meet the energy need of the shelter occupants. In most cases, the shelter occupants rely on generators or inadequate power sources that are reliable and could be unsafe**.** To address this challenge, there is a need for a portable power distribution equipment that is safe, reliable and easy to transport. The equipment should be able to provide sufficient power to run essential appliances such as lighting, heating/cooling systems and communication devices among others. In this work a modified P&O algorithm based MPPT control for standalone PV application is offered. It is aimed to obtain the maximum power from the PV system by regulating the switching signal of the boost converter with the variable step-size modified P&O-based MPPT .

IndexTerms **– MPPT, P&O model, PV**

I. INTRODUCTION

Due Fossil fuels had been widely used in most of the industrial revolution; therefore, the combustion is required, which is caused the store energy liberation. Besides, this process causes a release of emissions into the atmosphere, and then it produces environmental pollution. For this reason, renewable energy is earning more visibility, while the power demand of the world is growing due to its clean and free. Moreover, the renewable energy harvested by photovoltaic (PV) systems is readily available in most applications. Mainly, the PV systems applications can be divided into two applications; grid-connected applications and standalone applications. In grid-connected applications, the PV system is integrated into the utility grid to inject Alternating Current (AC) to the grid with the same phase and frequency of the utility grid voltage. Sold-state inverters are to be the qualifying technology for setting PV systems into the utility grid. Connection of the PV power generation systems into the grid plays a significant role in ensuring the electric power supply in an environmentally friendly way. Besides, these inverters have been used in a standalone or hybrid system depending on the application and requirements of the PV system. The conventional PV inverter with the help of batteries can be operated in standalone mode. This inverter store the energy during the day and transferred it to the load during the night where the solar energy is absent. This inverter is more expensive due to it required a charge controller for batteries, a power step-up transformer, and more maintenance labor. On the other hand, the standalone inverter works without a battery for a local load is cheaper than that works with a battery. It is able to supply the surplus power that extracted from the PV system during the day to the local load for few kilowatts. In recent years, a large number of inverter configurations that could be used of standalone PV inverters are proposed and reviewed. Type of the control strategies, use of the step-up transformer, and different switching could be adopted with each one of those configurations. Present a step-up transformer in the configuration of the PV inverter may increase the total system cost. Some inverters have been designed with a high frequency (HF) or a low frequency (LF) transformer such as a single-phase inverter works with fly back converter is presented. The proposed inverter was operated with a HF transformer to raising the output. Voltage of the PV system into a high voltage level, which is converted to AC voltage using the DC/AC converter. This inverter is required more mathematical analysis to obtain the transformer parameters. Besides, the additional cost of the transformer is required and then the total system cost is increased. Therefore, the transformer-less inverter is a suitable choice for the standalone PV system due to having a low cost and high reliability with higher efficiency.

II. METHODOLOGY

The structure of proposed system is provided below:

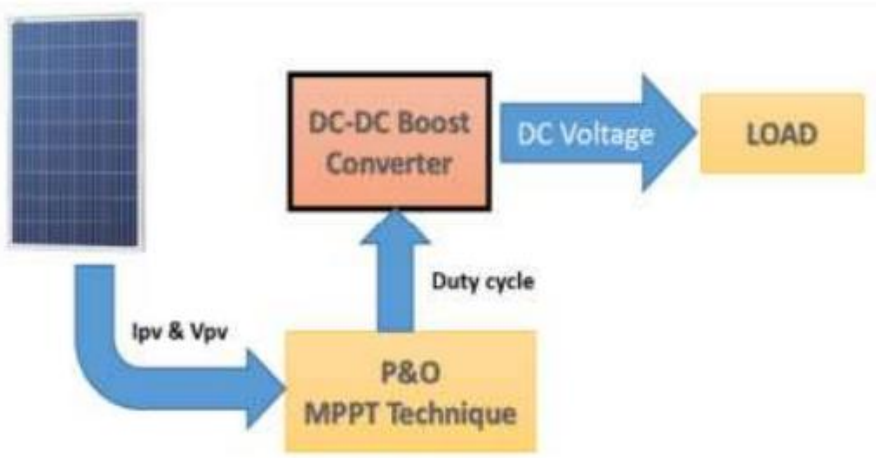

Fig 1.1 Block Diagram of System Structure

The current and voltage of the PV system are sensed and then provided to the modified P&O algorithm to extract the MPP from the PV system for given irradiation and cell temperature. Hence, the duty cycle of the boost converter is controlled. The MOSFET switch of the boost converter is turned ON or OFF state based on the given PWM signal that produced by comparison the duty cycle with the triangular carrier signal for the switching frequency about (10 kHz). The output of the boost converter is provided to the load.

III. MODELING OF PV

An initial understanding of the performance of a solar cell may be obtained by considering it as a diode in which the light energy, in form of photons with the appropriate energy level, falls on the cell and generates electron-hole pairs. The electrons and holes are separated by the electric field established at the junction of the diode and are then driven around an external circuit by this junction potential. There are losses associated with the series and shunt resistance of the cell as well as leakage of some of the current back across the p-n junction. This leads to the equivalent circuit given below:

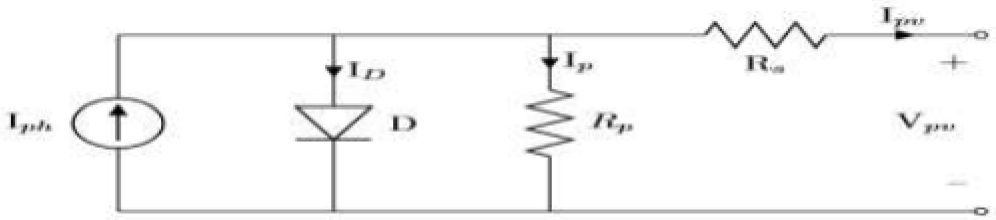

Fig 1.2 : Equivalent Circuit

The PV cell can be modeled as a diode in parallel with a constant current source and a shunt resistor. These three components are in series with the series resistor. The output-terminal current I is equal to the light-generated current Iph, less than the diode current ID and the shunt-leakage current Ip .The series resistance Rs represents the internal resistance to the current flow, and depends on the p-n junction depth, the impurities and the contact resistance. The shunt resistance Rsh is inversely related to the leakage current to the ground. In an ideal PV cell, Rs = 0 (no series loss), and Rp =1(no leakage to ground). The PV cell conversion efficiency is sensitive to small variations in Rs , but is insensitive to variations in Rp. A small increase in Rs can decrease the PV output significantly. In the equivalent circuit, the current delivered to the external load equals the currentIph generated by the illumination, less than the diode current ID and the ground-shunt currentIsh. The fundamental equation of PV cell can be derived from the theory of Shockley diode equation and semiconductor theory. The fundamental equations needed to design a PV cell are given below: Using KCL we get

$$Ipv = Iph - I_D - I_P$$

As we know Shockley diode equation

$$I_D = I_0 - \exp\left(\frac{e(V_p + R_s I)}{nK_b T}\right) - 1$$

Now putting this value into equation we get

$$I_{pv} = I_{ph} - I_0\left[\exp\left(\frac{e(V_p + R_s I)}{nK_b T}\right)\right] - I_p$$

Finally, putting the value of Ipin equation

$$I_{pv} = I_{ph} - I_0 \left[\exp\left(\frac{e(V_p + R_s I)}{n K_b T} \right) \right] - \frac{V_p + R_s I}{R_p}$$

Now the output current at the standard test conditions (STC) is given as

$$I_{pv} = I_{ph,ref} - I_{0,ref} \left[\exp\left(\frac{V_p}{a_{ref}} \right) - 1 \right]$$

If we consider short circuit condition, V=0 we get

$$I_{pv} = I_{ph,ref} - I_{0,ref} \left[\exp\left(\frac{0}{a_{ref}} \right) - 1 \right] = I_{ph,ref}$$

But photo current depends on light intensity and temperature. Therefore, equation of photocurrent may be defined as

$$I_{ph} = \frac{G}{G_{ref}} \left(I_{ph,ref} + \mu_{sc}.\Delta T \right)$$

Where, G=Irradiance,Gref= Irradiance at STC, $\Delta T = Tc - Tref$, $Tref$= Cell temperature at STC = 25 + 273 =298, μsc is the Coefficient temperature of short circuit current(A/K), provided by the manufacturer, Iph,ref is the Photocurrent (A) at STC. Finally, by simplification we get reverse saturation current

$$I_0 = I_{0,ref} \left(\frac{T_c}{T_{ref}} \right)^3 \exp\left[\frac{-q \sum_g}{AK} \right] \left(\frac{1}{T_c} - \frac{1}{T_{ref}} \right)$$

.

IV. MPPT CONTROLLER

Maximum power point tracking is an efficient method of extracting generated power from the generating systems used by grid connected inverters, solar battery chargers, wind energy conversion system. The MPPT controller implements the modified P&O control technique in order to provide the required duty cycle to the boost converter. Which produces optimized DC link voltage and hence maximum power is generated by the PV array.

FLOW CHART FOR MPPT ALGORITHM

Flow chart describes the step by step working of a MPPT controller based on the describe algorithm. As shown below, the inputs taken are the dc link voltage and current and output is the required duty cycle .In the second step, the controller is computing the dc link power by multiplying mathematically the input dc link voltage and current. The next step explains (n-1)th value of dc link power which is obtained by using a delay function in Simulink. If the difference in nth and (n-1)th value of dc link power is greater than zero then the algorithm goes forward and computes the difference in dc link voltage. Accordingly the difference in dc link voltage generates new duty cycle by adjusting delta D which is added or subtracted asper the conditions applied.

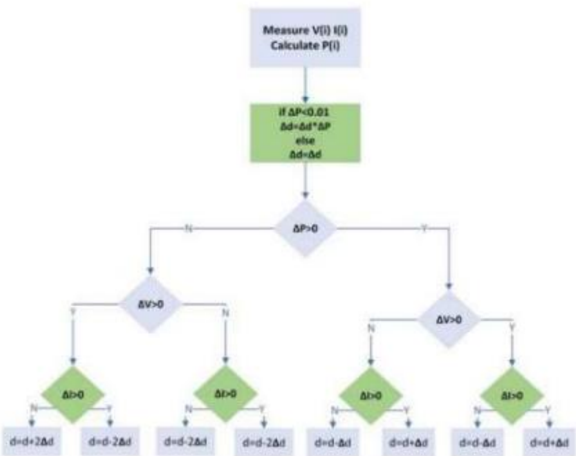

Fig 1.3 Flow Chart for Modified P&O MPPT Control

V. IMPLEMENTATION OF MPPT USING A BOOST CONVERTER

Boost converter is used often for practical purpose in order to step up low dc voltage to high dc voltage. The output voltage is a function of duty cycle which is the ratio of ON time period and total time period of the pulse used to trigger the operating switch. The block diagram shown below gives an overview of the required implementation.

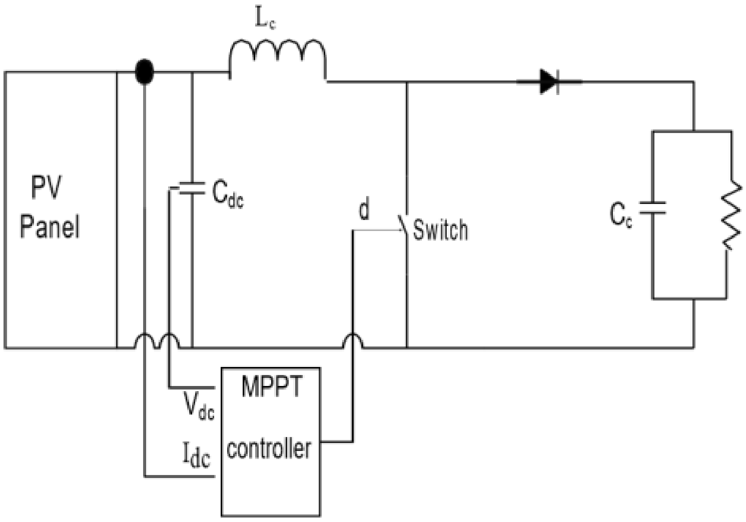

Fig 1.4 CircuitDiagramforBoost ConverterwithMPPTController

The key principle that drives the boost converter is the tendency of an inductor to resist changes in current. When being charged it acts as a load and absorbs energy (somewhat like a resistor); when being discharged it acts as an energy source (somewhat like a battery). The voltage it produces during the discharge phase is related to the rate of change of current, and not to the original charging voltage, thus allowing different input and output voltages.

VI. SIMULATION RESULTS

The simulation circuit is of the proposed system is provided below

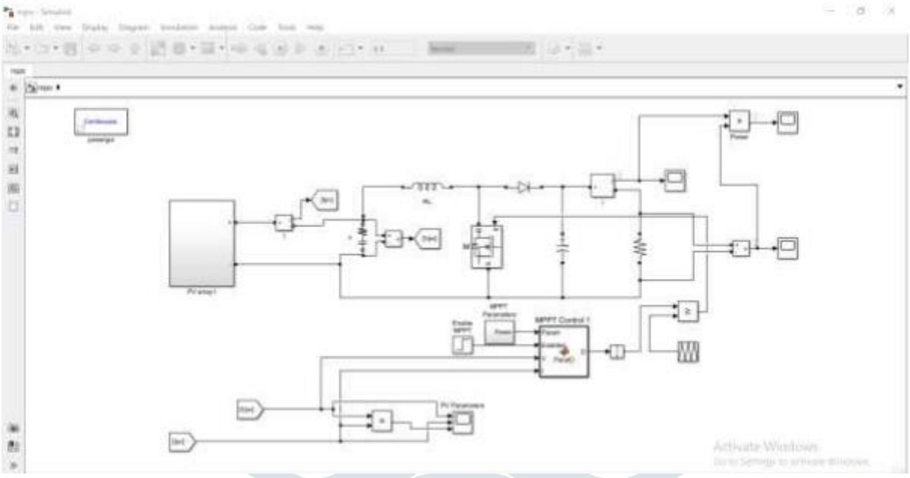

Fig 1.5 Simulation Circuit

In this, PV source is used for power generation. The PV voltage is 26V and power is 400W. It is connected with boost converter which operates using modified P&O algorithm based MPPT in order to extract maximum power from PV source. It is connected to inverter and then provided to R load of 40Ω. The irradiation is around 500 W/m2 from t=0 to 0.2s and 800 W/m2 from t=0.2s to 0.35s and 1000W/m2 from t=0.35s to 0.5s

The Power graph for PV source is provided below:

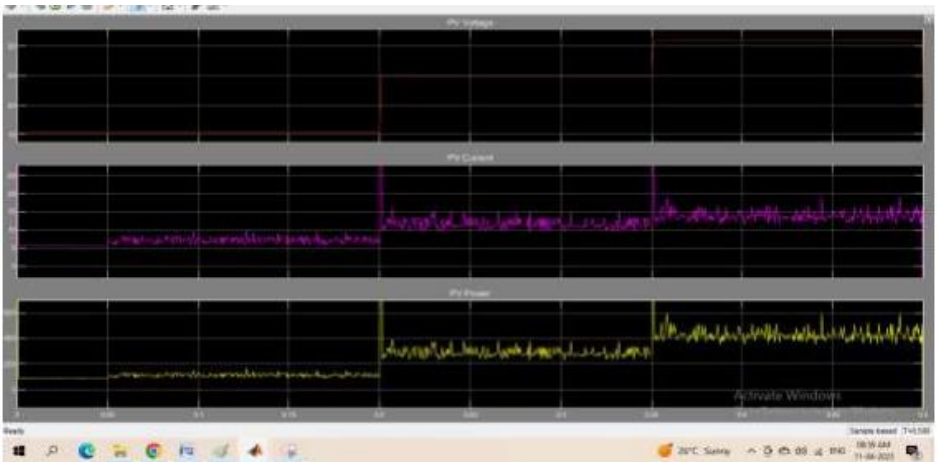

Fig 1.6 Power generation curves from PV

In this, the power generated from PV is reduced around 100W for 500 W/m2 and 270W for 800 W/m2 and 400W for 1000W/m2. it is provided to boost converter in order to step up the PV voltage. The output voltage of boost converter is provided below:

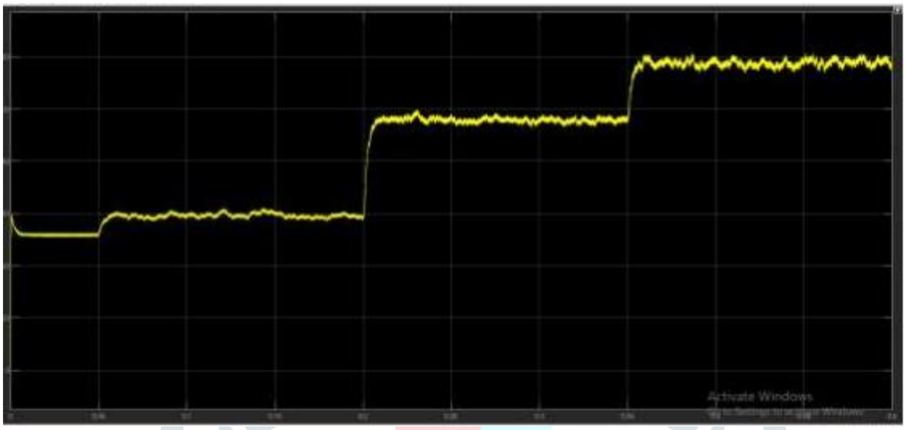

Fig 1.7 Output Voltage of Boost Convertor

The voltage output of the boost converter is around 120V and it is provided the R load. The load power is provided below:

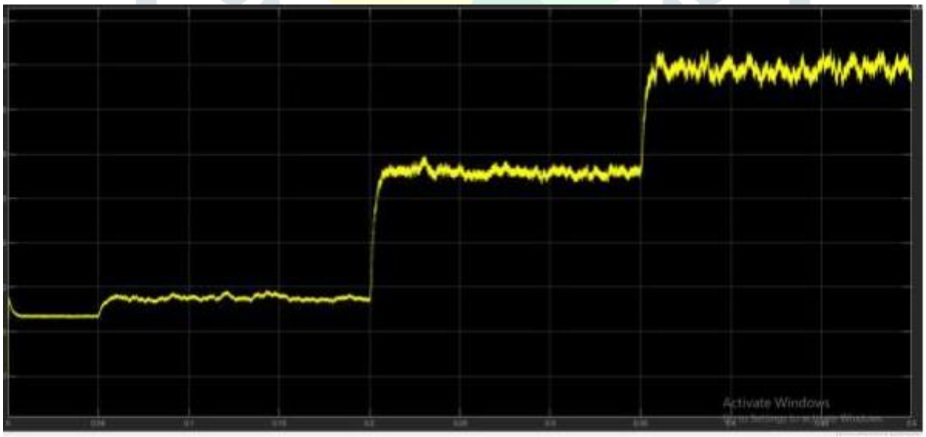

Fig 1.8 Load Power Curve

In this, the load power is 350W for 1000W/m2 and the efficiency of the MPPT is around 87.5%.

IV. CONCLUSION

Portable power distribution equipment is an essential tool for providing power to temporary shelters in a wide range of applications. From emergency response and disaster relief to construction sites and outdoor events, portable power distribution equipment provides a flexible, safe, and reliable source of power that can be customized to meet the specific needs of each application. Portable power distribution equipment can help ensure that temporary shelters have access to critical resources such as lighting, heating and cooling, medical equipment, and communication tools, which are essential for providing safety, comfort, and support during times of crisis. Given the numerous benefits and applications of portable power distribution equipment, it is clear that this technology plays a crucial role in supporting emergency responders, disaster relief organizations, and other groups that provide temporary shelter and support during times of crisis.

REFERENCES

[1] H. T. Dinh, J. Yun, D. M. Kim, K. Lee, and D. Kim, ‘‘A home energy management system with renewable energy and energy storage utilizing main grid and electricity selling,’’ IEEE Access, vol. 8, pp. 49436–49450, 2020.

[2] C. Byers and A. Botterud, ‘‘Additional capacity value from synergy of variable renewable energy and energy storage,’’ IEEE Trans. Sustain. Energy, vol. 11, no. 2, pp. 1106–1109, Apr. 2020.

[3] H. Kakigano, Y. Miura, and T. Ise, ‘‘Distribution voltage control for DC microgrids using fuzzy control and gain-scheduling technique,’’ IEEE Trans. Power Electron., vol. 28, no. 5, pp. 2246–2258, May 2013.

[4] M. Kumar, S. C. Srivastava, and S. N. Singh, ‘‘Control strategies of a DC microgrid for grid connected and islanded operations,’’ IEEE Trans. Smart Grid, vol. 6, no. 4, pp. 1588– 1601, Jul. 2015

[5] H. Hajebrahimim, S. M. Kaviri, S. Eren, and A. Bakhshai, ‘‘A new energy management control method for energy storage systems in microgrids,’’ IEEE Trans. Power Electron., vol. 35, no. 11, pp. 11612–11624, Mar. 2020.