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Use Of Solar Mppt For Efficient Operation Of Agriculture Dc Pumping System

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***Abstract*— Use of electricity is increasing day by day. The electricity finds its application in all domains. Converting solar energy into electrical energy is one of the best ways to reduce fossil fuel consumption. Where grid is not available then there use solar water pumping system these system use photovoltaic cell (PV) cells to convert sunlight into electricity to power dc pump can be used to pump ground water. To produce maximum power of and to get maximum efficiency, the entire photovoltaic panel must operate at this particular point. Maximum Power Point of PV panel keeps on changing with change in environmental condition such as solar irradiance and cell temperature. Thus to extract maximum available power from PV module. To increase efficient irrigation used Dc supply to Ac supply by using DC-DC boost converter used in pumping system is to stabilize the voltage.**

Keywords: Maximum Power Point Tracking (MPPT), photovoltaic system, solar energy, Battery, Inverter.

I. INTRODUCTION

Solar is one of the most environment friendly renewable energy sources. The process of solar energy generation required no extra energy input and yields no harmful emission. Therefore, solar energy is considered as one of the most important primary energy sources in the future.

Even today, some remote areas cannot be covered by the utility grid; however, most of those areas are of abundant sun illumination. Therefore, standalone power system will be quite suitable for these regions. Solar cells can be used to generate electricity from sunlight. It is a device that converts light energy into electrical energy. Sometimes the term solarcell is reserved for devices intended specially to capture energy from sunlight, while the term photovoltaic cell is used when the light source is unspecified. The photovoltaic cells, which directly convert light into electricity based on solar irradiance and temperature level.

A standalone photovoltaic pumping system is nothing but the system which works independently without the support from grid. The application of standalone PV system is for pumping system there will be huge amount of solar irradiance and system is not connected to grid system. The characteristics of PV array is nonlinear in nature which produces only a single MPP, at which the PV array gives maximum output power. The output power from the PV array is proportional to the irradiance and temperature. It is necessary to design a control mechanism has to acquire maximum power from the PV panel in order to extract maximum power from the panel, a Maximum Power Point Tracker(MPPT), which is a DC/DC converter. In early cascaded converter is used for pumping, charging and discharging battery and MPPT but it is repetitive process for that require higher number of switches due to these increase size and cost. Due to these used integrated boost converter with single switch is used for pumping. If Maximum Power from the panel is not utilize for pumping then the extra power from the PV input is used to charge the battery. When PV panel is shaded or during night, battery will discharge and supply power to the pump load.

II. SYSTEM OVERVIEW

1. SOLAR POWER MANAGEMENT SYSTEM

Solar energy is the most abundant resource on the earth and is expected to become one of the primary energy supply resources in the future. Application of solar energy is widespread in industrial, commercial and military applications. However, effective use of solar energy depends on the technologies of solar power management systems. A power converter for maximum Power Point Tracking (MPPT) and voltage or current regulation is inserted between the solar cell panel and the load to control power flow. This power converter directly affects the efficiency and performance of the solar power management system.

To maximize the use of available solar power drawn from the solar panel and to widen the application of solar energy, several studies have investigated the design and application of boost converter. The solar water pumping system can be used anywhere, India has ample sunshine through the year which makes it ideal location for utilization of solar energy. The installation cost of solar power pumping system is more than that of gas, diesel or propane alkane power generator based pumping system but it is required for less maintenance cost. The demand for renewable energy sources increases as it is environment friendly and pollution free which reduces the greenhouse effect. Solar powered

electrical generation relies on photovoltaic systems and heat engine. To harvest the solar energy, the most common way is to use photovoltaic panel which will receive photon energy from sun and convert to electrical energy. The solar technologies are broadly classified as either passive solar or active solar depending on the way they detaining convert and distribute solar energy. The active solar technique includes the use of PV panels and solar thermal collectors to strap up the energy. Solar energy has a vast area of application such as electricity generation for distribution, heating water, lighting building, crop drying etc. To use the direct current (DC) by a PV array for that design the solar water pumps, although some newer version use a variable frequency motor and three phase ac pump controller that enables them to be powered directly by the solar module.

2. PHOTOVOLTAIC CELL:

Photovoltaic cells are made of semiconductor materials, such as silicon. For solar cell a thin semiconductor wafer that is pn junction layer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor materials. If electrical conductors are attached to the positive and negative sides, electrons are energized that is holes from P-type and free electrons from N-type are start now flowing when photon light comes on pn junction layer (Depletion layer), forming an electrical circuit, the electrons can be captured in the form of an electric current that is electricity. The electricity can be used to power a load.

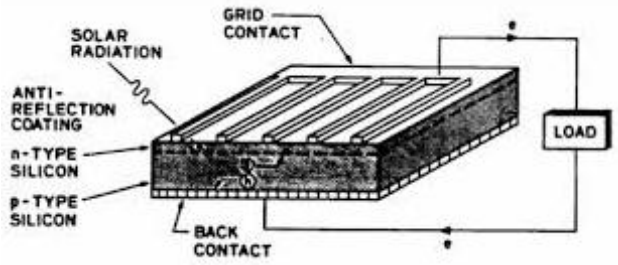


Figure1: Basic structure of PV Cell

Standalone PV systems are direct coupled PV system are designed and sized to supply DC and/or Ac electrical load. The DC output of a PV module or PV array is directly connected to a DC load due to that it is known as Direct Coupled Systems. There is no electrical energy storage such like batteries in direct coupled systems as because of that, the load only operate during maximum sunlight hours. The maximum power point tracker (MPPT) is used between the array and load to help better utilize the available array maximum power output and also for matching the impedance of electrical load. Photovoltaic is the best method of generating electric power by using solar cells to convert energy from the sun into electricity. To create electricity the Photovoltaic effect refers to photons of light knocking electrons into a higher state of energy. The term photovoltaic effect indicates the unbiased operating mode of a photodiode in which current through the device is entirely due to the transduced light energy.

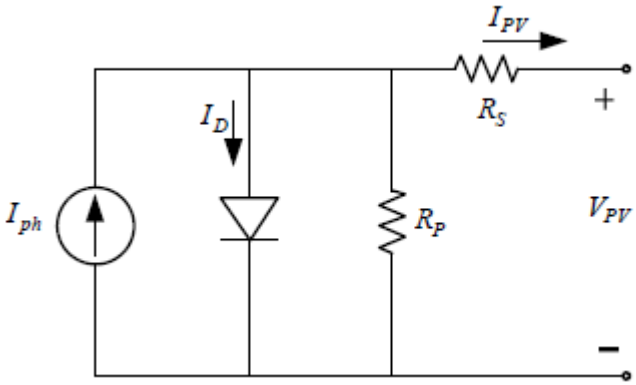


Figure2: Equivalent circuit for solar cell

An ideal solar cell is modeled by a current source in parallel with a diode. However no solar cell is ideal and thereby shunt and series resistance are added to the model. The current source Iph represents the cell photo current. Rsh and Rs are used to represent the intrinsic series and shunt resistance of the cell. Usually Rsh is very large and Rs is small.

3. DC-DC CONVERTER

DC-DC Converters developed to maximize the energy harvest for photovoltaic systems hence it is called as power optimizers, it can be used as switching mode regulator to convert an unregulated DC voltage to a regulated DC output voltage. The regulation is normally achieved by PWM at a fixed frequency and the switching device is IGBT. The minimum oscillator frequency should be above 100 times longer than the transistor switching frequency and thereby, the efficiency decreases. There are use the switching regulator as a Boost converter. The given circuit diagram of Boost Converter consist of a DC input voltage source Vin, Boost converter L, Controlled switch as IGBT, Diode D, Filter Capacitance C and the load resistance R. when the Switch S is in the ON state t=Ton, the current in the Boost inductor increases linearly and the diode D is OFF at that time.

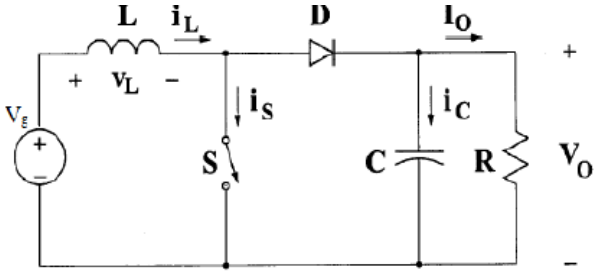


Figure3: Circuit diagram of boost converter

When the switch is OFF state t=Toff, the current that was flowing through the switch would now flow through inductor L, Diode D, Capacitor C and load R. The inductor current falls until the switch is turned on again in the next cycle. Energy stored in the inductor is then transferred to the

load. Therefore output voltage is greater than the input voltage. The control strategy lies in the manipulation of the duty cycle of the switch which causes the voltage change.

$$V_{out} = \frac{1}{(1-D)} * V_{in}$$

Where Vout is output voltage, D is Duty cycle and Vin is input voltage which in these case will be the so far panel voltage.

4. MAXIMUM POWER POINT TRACKING

The efficiency of a solar cell is very low. In order to increase the efficiency, various method are available to be undertaken to match the source and load properties one such method is the Maximum Power Point Tracking(MPPT). This is a technique used to obtain the Maximum possible power from a varying source. MPPT is that the efficiency of power transfer from the solar cell depends on both the amount of sunlight falling on the solar panels and electrical characteristics of the load. As the amount of sunlight varies, the load characteristic that gives the highest power transfer efficiency changes, so that the efficiency changes, so that the efficiency of the system is optimized when the load characteristic changes to keep the power transfer at highest efficiency. This load characteristic is called the maximum power point. MPPT is an electronic system that operates the Photovoltaic (PV) module in a manner that allows the PV module to produce all the power they are capable of producing and extracting. MPPT is not a mechanical tracking system that have physically moves the module to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are capable to produce all power and deliver maximum available power.

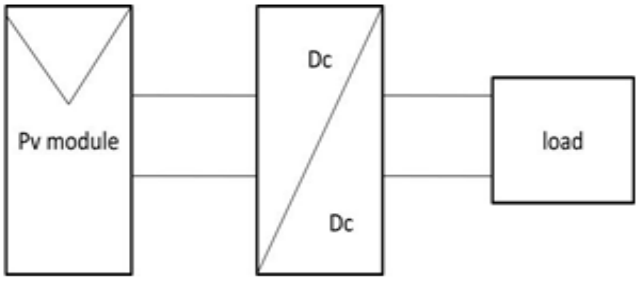


Figure4: Block diagram of typical MPPT system

Additional power extracted from the modules is then made available as increased battery charge current. MPPT can be used in conjunction with a mechanical tracking system.

Photovoltaic systems normally use a Maximum Power Point Tracking (MPPT) technique to continuously deliver the maximum possible power to the load when variation in the solar isolation and temperature occurs, Photovoltaic (PV) generation is becoming increasingly important as a renewable source since it offers many advantages such as incurring no fuel costs, not being polluting, requiring little maintance, and emmiting no noise, PV modules still have relatively low conversion efficiency; therefore controlling Maximum Power Point Tracking(MPPT) for the solar array is essential in a PV system to improve efficiency. A MPPT solar charge controller is the charge controller embedded with MPPT algorithm to maximize the amount of current going into the battery from PV module.

In photovoltaic system the I-V curve is non-linear, thereby making it difficult to be used to power a certain load. This is done by utilizing a Boost Converter whose duty cycle is varied by using MPPT algorithm. In which MPPT algorithm by Incremental Conductance algorithm. The Incremental conductance algorithm uses two voltage and current sensors to sense the output voltage and current of the PV array. In these method, according to the MPP voltage the array terminal voltage is always adjusted it is based on the incremental conductance and instantaneous conductance of the PV module.

The MPP, increasing on the left of the MPP and decreasing on the right hand side of the MPP. The basic equations of these methods are as follows.

$$\frac{dI}{dV} = -\frac{I}{V} \quad \text{At MPP}$$

$$\frac{dI}{dV} > -\frac{I}{V} \quad \text{Left of MPP}$$

$$\frac{dI}{dV} < -\frac{I}{V} \quad \text{Right of MPP}$$

Where I and V are PV array output current and voltage respectively. The left hand side of equations represent incremental conductance of the PV module and the right hand represents instantaneous conductance. When the ratio of change in output conductance is equal to negative output conductance, at that point the solar array will operate at maximum power point. This method exploits the assumption of the ratio of change in output conductance is equal to the negative output instantaneous conductance.

5. BATTERIES IN PV SYSTEM

For off grid and critical applications, storage systems are required, the most common medium of storage are the lead acid batteries. Presently researches are going on in the field of lithium ion batteries and to implement the concept of fuel cells in solar PV systems. One of the most expensive components in the PV systems is the battery. Under sizing the batteries will become more costly as the battery life cycle is significantly reduced at higher Depth of Discharge (DOD %). At a higher depth of discharge, expected average number of charge-discharge cycles of batteries. Further a higher current discharge than the rating will dramatically reduce the battery life. This can be avoid by carefully sizing of battery according to the 'C-rating' during the system design. It signifies the maximum amount of current that can be safely withdrawn from the battery to provide adequate backup and without causing any damage. Selecting the suitable battery for a PV application depend on many factor. Battery selection depends on physical properties. Consideration in battery subsystem include the number of batteries I series and parallel, over current disconnect requirement and selection of proper wire sizes and types.

The energy output from the solar PV system is generally stored in battery or in a battery bank depending on the requirements of the system. Batteries are use as backup system in grid connected system. The primary function of battery in PV system are-

1.Energy storage capability and autonomy: To store electrical energy when it is produced by the PV array and to supply energy to electrical loads as needed or when on demand.

2.Voltage and current stabilization: To supply the power to electrical load at stable voltage and current values, by suppressing or smoothing out transients that may occur in PV system.

3.Supply surge current: To supply surge or high peak operating currents to electrical loads or appliances.

6. PULSEWIDTH MODULATION (PWM):

This method uses solid states switch to apply pulses of current at reasonably high frequency but with a varying duty cycle, such that battery receives a constant voltage charge from the array. This type of controller shows in series configuration. The power dissipation is reduced with PWM technology.

7. INVERTER:

Inverters are used to convert DC current into AC current in PV system. The user must match the power quality required by load with the power quality produced by the inverter. Major discrepancies exist between power generation with PV module and requirements of the public grid.

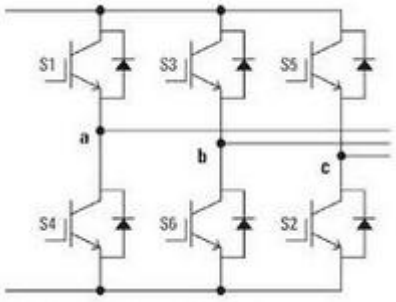
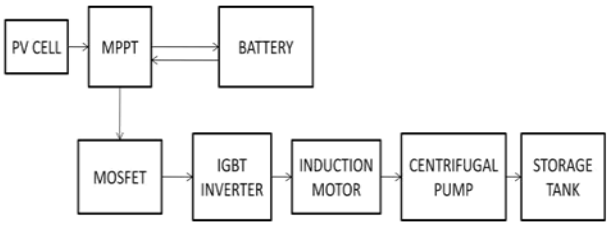


Figure5: Three phase inverter configuration

III PROPOSED APPROACH



In this proposed system we use MOSFET, IGBT inverter and battery backup system. The MOSFET is used in these system to provide the constant dc voltage. The IGBT inverter is used to convert DC to AC voltage. The battery backup method is used in this system stored energy in day time and use for night time.

Maximum Power Point Tracking is technique is commonly with wind turbines and photovoltaic solar system to, maximize power extraction under all condition. Battery backup method is to provide at all time even at cloudy days. The main aim of the system is to achieve dc supply to ac supply which can be used for pumping application.

IV CONCLUSION

In this paper, MPPT techniques are being used to improve the performance of solar power water pumping system during fluctuations in solar intensity. Incremental conductance algorithm has been used for Maximum Power Point Tracking. This technique determines when you reach MPP without having to oscillate around this value. It can perform MPPT under higher accuracy rapidly increasing and decreasing solar irradiance condition. The main aim of the system is to achieve dc supply to ac supply which can be used for pumping application.

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