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Maximum Power Point Tracking of PV Arrays

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Abstract

Nowadays electricity is one of the basic necessities of mankind. As the demand of electricity is increasing day by day, there is need to exploit renewable sources of energy. In the current era of power shortage, the use of solar energy could be beneficial to great extent. Considering the high cost of solar panels, our project addresses to analyses, design and implement an efficient algorithm for power extraction from solar panel using dc-dc converter and then utilizing that power for the electricity requirement of off-grid system. Moreover this project also address to the study of boosting efficiency of solar system by two dimensional sun tracking.
Keyword- Maximum Power Point Tracking, PV Arrays, Solar Cell, Equivalent Circuit, PV Cells

I. INTRODUCTION

Solar energy is the radiant light and heat from the Sun that has been exploiting by humans since ancient times using a range of ever-evolving technologies. Solar radiation along with secondary solar resources such as wind and wave power, hydroelectricity and biomass account for most of the available renewable energy on Earth. Only a little fraction of the available solar energy is used. Solar energy refers primarily to the use of solar radiation for practical ends. However, all renewable energies, other than geothermal and tidal, derive their energy from the sun. Solar technologies are broadly characterized as either passive or active depending on the way they capture, convert and distribute sunlight. Active solar techniques use photovoltaic panels, pumps, and fans to convert sunlight into useful outputs. Passive solar techniques include selecting materials with favourable thermal properties, designing spaces that naturally circulate air, and referencing the position of a building to the Sun. Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resources and are generally considered demand side technologies.

A solar cell or photovoltaic cell is a device that converts light directly into electricity by the photovoltaic effect. Sometimes the term solar cell is reserved for devices intended specifically to capture energy from sunlight, while the term photovoltaic cell is used when the light source is unspecified. Assemblies of cells are used to make solar panels, solar modules, or photovoltaic arrays.

II. CONSTRUCTION

Silicon solar cells have been available for a relatively long period of time. In order to increase the output from such solar cells it has been conventional to provide a single layer anti-reflection coating overlaying the solar cell. Typically, these single layer anti-reflection coatings have been formed of silicon monoxide, a titanium oxide such as titanium dioxide or gas reacted titanium monoxide as well as tantalum pentoxide. Since the tantalum pentoxide and the titanium oxide have an index of refraction which is greater than that of silicon monoxide, they form a better anti-reflection coating between the silicon solar cell and the glass cover which conventionally covers such a solar cell. The silicon solar cell construction consists of a body formed essentially of silicon and having surface with a photovoltaic junction formed thereon. First and second layers are formed on the surface of the solar cell and serve to provide an anti-reflection coating which is effective within the spectral range of 400 to 1200 nanometres. A glass solar cell cover is provided which is secured to the body having the first and second layers thereon by a cement. The first layer is, counting from the body, formed of material that has an index of refraction which isles than that of the body and which is greater than that of the glass cover. The second layer is formed of a material that has an index of refraction which is greater than that of the glass cover but which is less than that of the first layer.

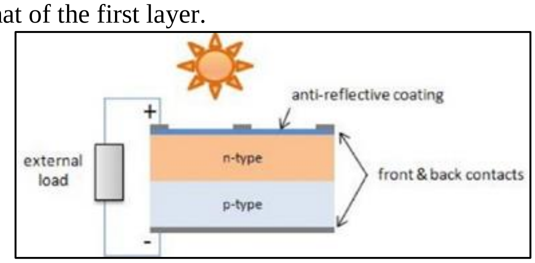


Fig. 1: Solar Cell

Solar cells are in fact large area semiconductor diodes. Due to photovoltaic effect energy of light (energy of photons) converts into electrical current. At p-n junction, an electric field is built up which leads to the separation of the charge carriers (electrons and holes). At incidence of photon stream onto semiconductor material the electrons are released, if the energy of photons is sufficient. Contact to a solar cell is realised due to metal contacts. If the circuit is closed, meaning an electrical load is connected, then direct current flows.

A. Electrical Characteristics of Solar Cells and Maximum Power Point

An ideal solar cell may be modelled by a current source in parallel with a diode; in practice no solar cell is ideal, so a shunt resistance and a series resistance component are added to the model. The resulting equivalent circuit of a solar cell is shown on the figure.

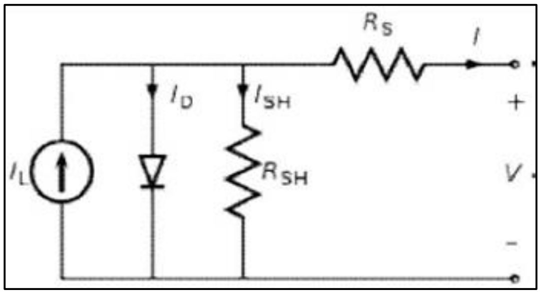


Fig. 2: Equivalent circuit

PV Cells can be modelled as a current source in parallel with a diode. When there is no light present to generate any current, the PV cell behaves like a diode. As the intensity of incident light increases, current is generated by the PV cell, as illustrated in Figure.

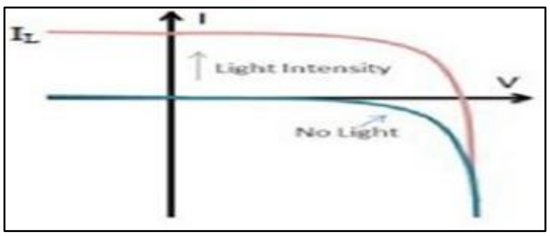
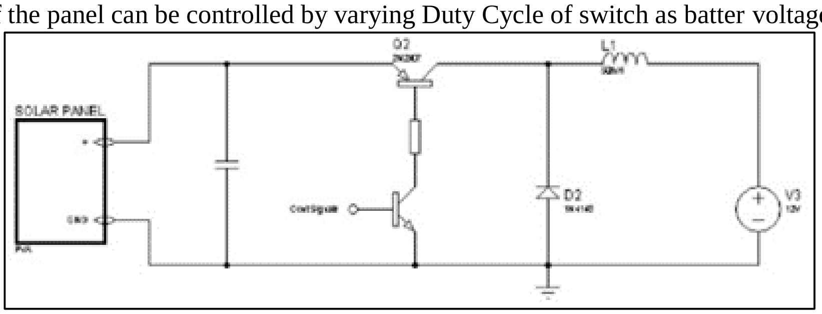


Fig. 3: I-V curve

III. IMPLEMENTATION OF MPPT

In our circuit, if inductor has sufficiently large value, converter will operate in continuous mode and following relation will hold
Panel Voltage = (Duty Cycle of Switch) * (Battery Voltage)
In this way, the Voltage of the panel can be controlled by varying Duty Cycle of switch as batter voltage remains almost constant.



A. Sun Tracking

A sun tracker or solar tracker is a device for orienting a day lighting reflector, solar photovoltaic panel or concentrating solar reflector or lens toward the sun.

B. Need of Sun Tracking

A solar tracker is a device for orienting a day lighting reflector, solar photovoltaic panel or concentrating solar reflector or lens toward the sun. The sun's position in the sky varies both with the seasons and time of day as the sun moves across the sky. Solar powered equipment works best when pointed at or near the sun, so a solar tracker can increase the effectiveness of such equipment over any fixed position, at the cost of additional system complexity. There are many types of solar trackers, of varying costs, sophistication, and performance. One well-known type of solar tracker is the heliostat, a movable mirror that reflects the moving sun to affixed location, but many other approaches are used as well.

IV. Conclusion

In the current era of power shortage in Pakistan, the use of solar energy could be beneficial to great extent. Considering the high cost of solar panels, our project addresses to analyse, design and implement an efficient algorithm for power extraction from solar panel using dc-dc converter and then utilizing that power for the electricity requirement of off-grid system.

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