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PV Cells Monitoring with Maximum Power Output Analysis

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Abstract: ***Solar energy is the heat and light radiations received from the Sun. It is one of the most abundant forms of non-conventional, renewable energy source found on the Earth. It is readily available, free of cost and is pollution free. Solar energy can be harnessed to be changed into electricity and power by the use of devices like solar panels which consists of photovoltaic cells. Photovoltaic cell is an electrical device which converts sun's light into electricity by the property of photoelectric effect. By the use of solar panels we can harness sunlight to generate electricity free of cost. The efficiency of the solar panel is dependent on the atmospheric conditions. The changes in temperature, humidity, etc affect the output from the cells. In this project we study the effect of temperature and humidity on photovoltaic cells. In this project we monitor the relative changes in the output of pv cells due to changes in temperature and humidity of a place. Real time monitoring system is employed for the analysis of the outputs of pv cell. The power output of PV cells is dependent on various conditions. Maximum power output of PV cell is decided by MPPT, Maximum Power Point Tracking. The maximum power which can be produced in a PV cell due to voltage is the peak power voltage called as Maximum Power Point. This paper is the overview of Maximum Power Point Tracking by use of Matlab software of study and analysis. The maximum power output of PV cells varies with intensity of solar rays, temperature, humidity, current flow etc***

Keywords: Pv cells, mppt, matlab, temperature, humidity

I. INTRODUCTION

Solar energy is one of the most abundant forms of energy present on Earth whose efficient utilization can reduce the burden of the fossil fuels. Solar energy is pollution free thus it has no negative effect on the solar system.

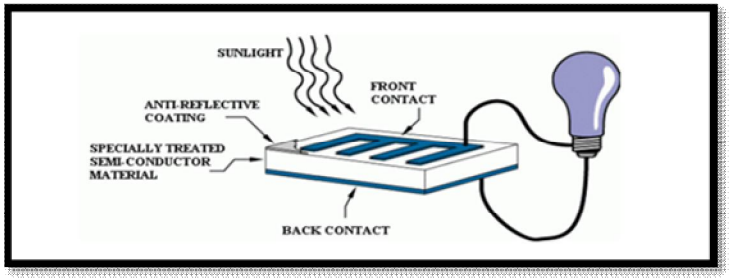
Photovoltaic cells or solar cells are used to convert sun's heat and light into electricity. Solar cells work on the principle of photoelectric effect. The photovoltaic cells are made of semiconductor materials like Silicion. These semiconductor materials emit electrons when hit by the solar light consisting of protons. These free electrons when captured result into electricity.

Climate changes affect the working of Solar panels be it atmospheric temperature, humidity, wind speed etc. The designing aspect of solar panels thus play a great role in providing optimum output power and also provide ways to improve the factors dependent efficiency of solar panels. Thus this project helps in the analysis of the atmospheric factors like temperature and humidity.

MPPT or Maximum Power Point Tracking is the method which is used for obtaining the maximum power from PV cell at specific conditions. The peak voltage which produces the maximum power in a PV module is called maximum power point. Maximum power varies with solar radiation, ambient temperature and solar cell temperature.

II. PHOTOVOLTAICS

The conversion of sun's light into electricity is called as Photovoltaics. This photovoltaic is exhibited by some materials like Silicon . these materials absorb energy from the sun , photons of light and release electrons. These electrons are then captured and tuned to give electric current. This property of absorption of light energy and release of electron is called as photoelectric effect.



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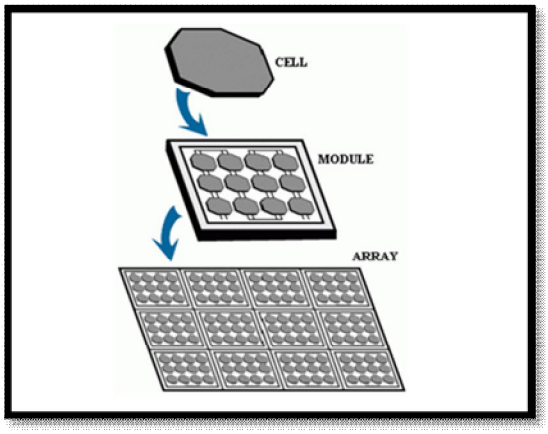
A simple photovoltaic cell or a solar cell is shown in the figure above. Solar cells are built some special kind of materials called as semiconductor materials. Examples of semiconductor materials are silicon, germanium etc as per specific requirements. The solar cells have a thin semiconductor wafer which forms an electric field, with both positive and negative sides. When sun's energy hits the solar cell, free electrons are released from the atoms in the semiconductor material. The released electrons are captured with the conductors completing the circuit of positive and negative and the electrons flow as electric current , constituting the flow of electricity . This generated electricity from sun's energy can be used to power the load, or light the house appliances, water heaters etc.

Multiple solar cells which are electrically connected to each other and mounted in a support structure or frame is called a photovoltaic module. Modules are designed to for specific requirements and voltages for generation of electricity, such as a common 12 volts system. The current produced is directly dependent on how much sun's light strikes the module.



III. TECHNICAL DESCRPITION

ATMEGA 328 is a single-chip microcontroller created by Atmel in the megaAVR family. It is the main controlling unit of the system. ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed.

Temperature Sensors measure the amount of heat energy or even coldness that is generated by an object or system, allowing us to sense or detect any physical change to that temperature producing either an analogue or digital output. There are many different types of Temperature Sensor available and all have different characteristics depending upon their actual application.

Temperature and humidity sensors are usually designed in two major variations. In one, the sensor acts as a trigger or a switch when a certain level of temperature or humidity is reached, then the sensor is triggered and a specific circuit is activated. Other more complex versions are used to measure the actual momentary temperature or humidity in the ambient air.

A simple temperature sensor relies on the metallic expansion principles of thermodynamics. As the temperature changes, the metal bends until contact is made or removed from a switching mechanism. This would imply the desired temperature has been reached. More complex temperature sensors, especially for electronic circuits, rely on the voltage drop across a transistor to determine the current temperature. Since the voltage delta of transistor devices is well known as a factor of temperature, it is very easy to determine what the temperature is by measuring base to emitter voltage.

Humidity sensors usually also have a way of measuring the temperature in the air since humidity is the relation of moisture in the air to the current air temperature. Humidity sensors typically rely on a capacitor to determine moisture content. The dielectric element

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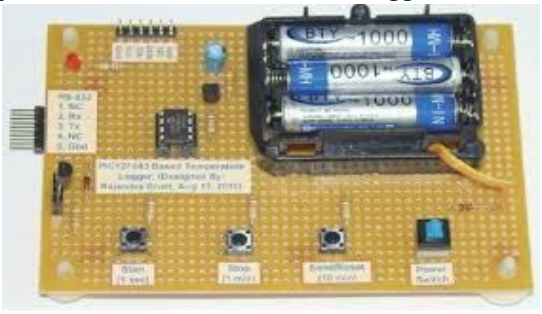
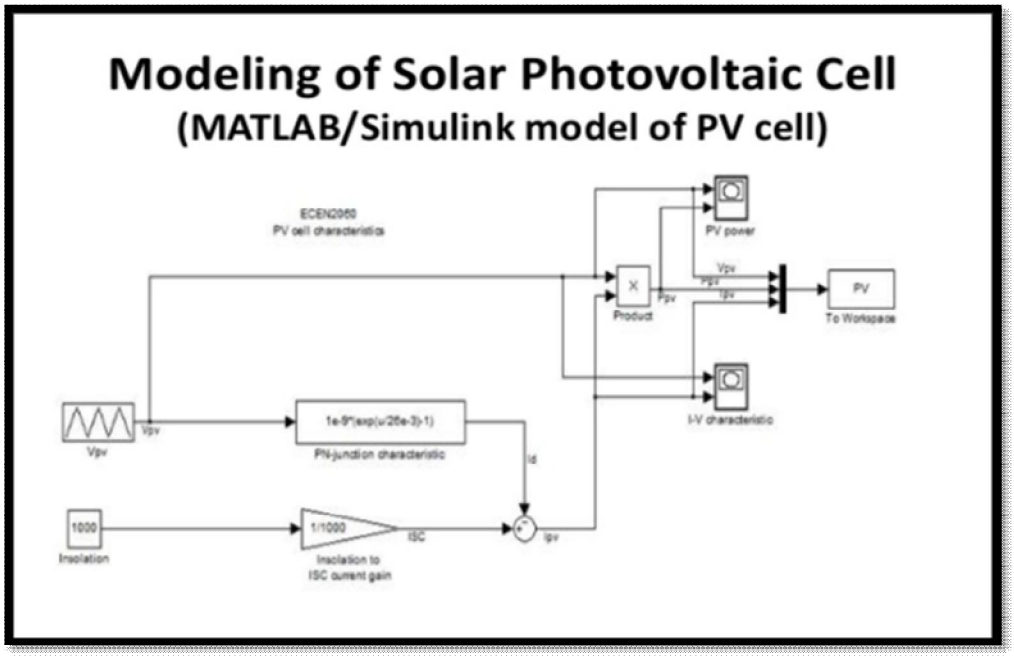
between the two capacitive plates can collect water molecules and have the k-value adjusted according to a known pattern. This affects the voltage in a way that can be sensed and reported.

A data logger is a device that records measurements over time. The measurements could be any physical variable like temperature, pressure, voltage, humidity, etc. This project describes how to build a mini logger that records surrounding temperature values.



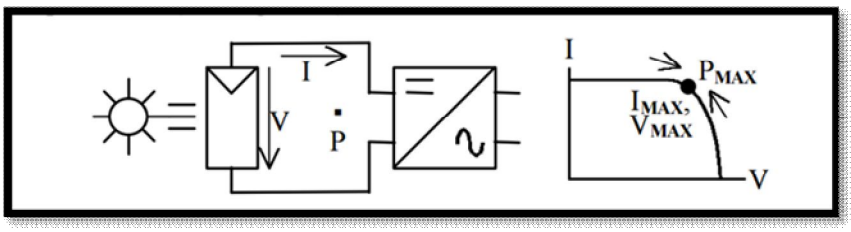
IV. MATLAB SOFTWARE

MATLAB software is used for the development of this project. The system is modeled in matlab and is the simulink model of the PV cell



MPPT Algorithms

Maximum power point tracking (MPPT) is the algorithm which is performed by some battery charge controllers and by most grid connected PV inverters. The governing condition is the adjustment of the operating voltage of the pv cell to produce maximum and optimum power output closely related to theoretical value of pmax.



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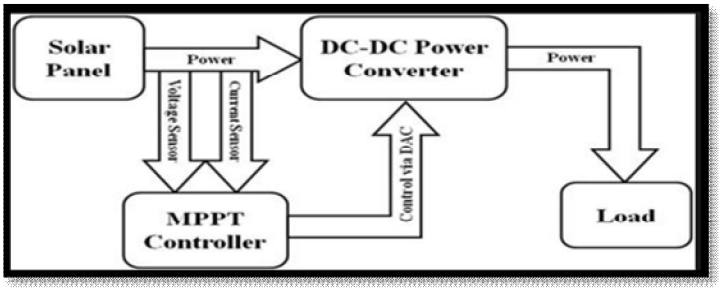
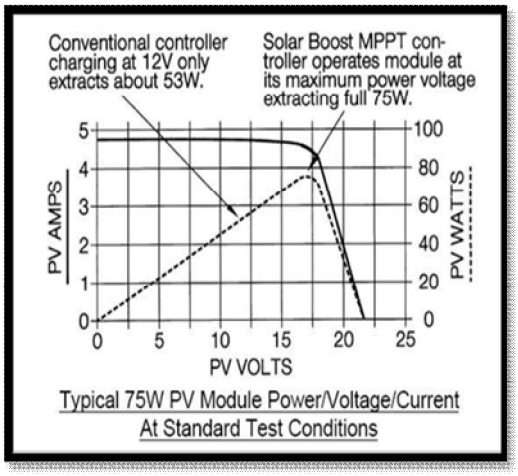
There are different methods – direct and indirect method for the tracking of maximum power point . the direct methods uses the calculated values of AC output power values or DC input voltage and current and by varying the operational points of the Pv cells , actual maximum power point is determined. There could be continuous or intermittent Mpp adjustments and the algorithms may or maynot include mpp which is artifical for search. The methods which use an external signal to measure and calculate mpp are the indirect methods. The measurement of radiance, cell temperature, current in short circuit condition or voltage in open circuit conditions are such outside or external signals. Mpp set point is calculated and monitored under a given set of physical parameters.The simple block diagram shows the solar panel, mppt controller, dc-dc power converter and supply of power to load through the solar energy conversion mechanism with mppt in consideration.



MPPT Principle

The mppt works on the principle of derivation of maximum power from pv cell or pv module by allowing the operation of pv module at the optimum voltage. The ouput of pv module is checked by the mppt and then compared to the battery voltage and then analysed the maximum power pv module can produce at the voltage which supplies battery maximum current. The mppt can be used to power a dc load which is connected to the battery.

To ensure that maximum current reaches the battery from pv module, mppt has an addition charge controller embedded in it.. MPPT takes dc input from the pv cell , converts it to ac and the reconverts the ac to different dc voltage and current to ensure maximum supply of pv cell power to the battery. These mppt solar charge controllers are useful in various applications in home or offices etc be it water system, light system etc.



Typical 75W PV Module Power/Voltage/Current
At Standard Test Conditions

V. RESULT AND CONCLUSIONS

Temperature and humidity are the governing factors that have been discussed in this paper. The power output of pv cells change with temperature fluctuations. As the temperature increases, the pv cell output voltage decreases. Similarly the humidity also governs the performance of the pv cells. When humidity is high the power output decreases. Sufficiently high humid weather of a region can affect about 0.15-0.30 factor of power output. Thus increases of both factors of atmosphere, temperature and humidity

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decreases the efficiency of solar panel. Here comes in the designing parameters of pv cells , panels and modules in a manner to lessen the atmospheric variations and for the purpose of providing maximum efficiency.

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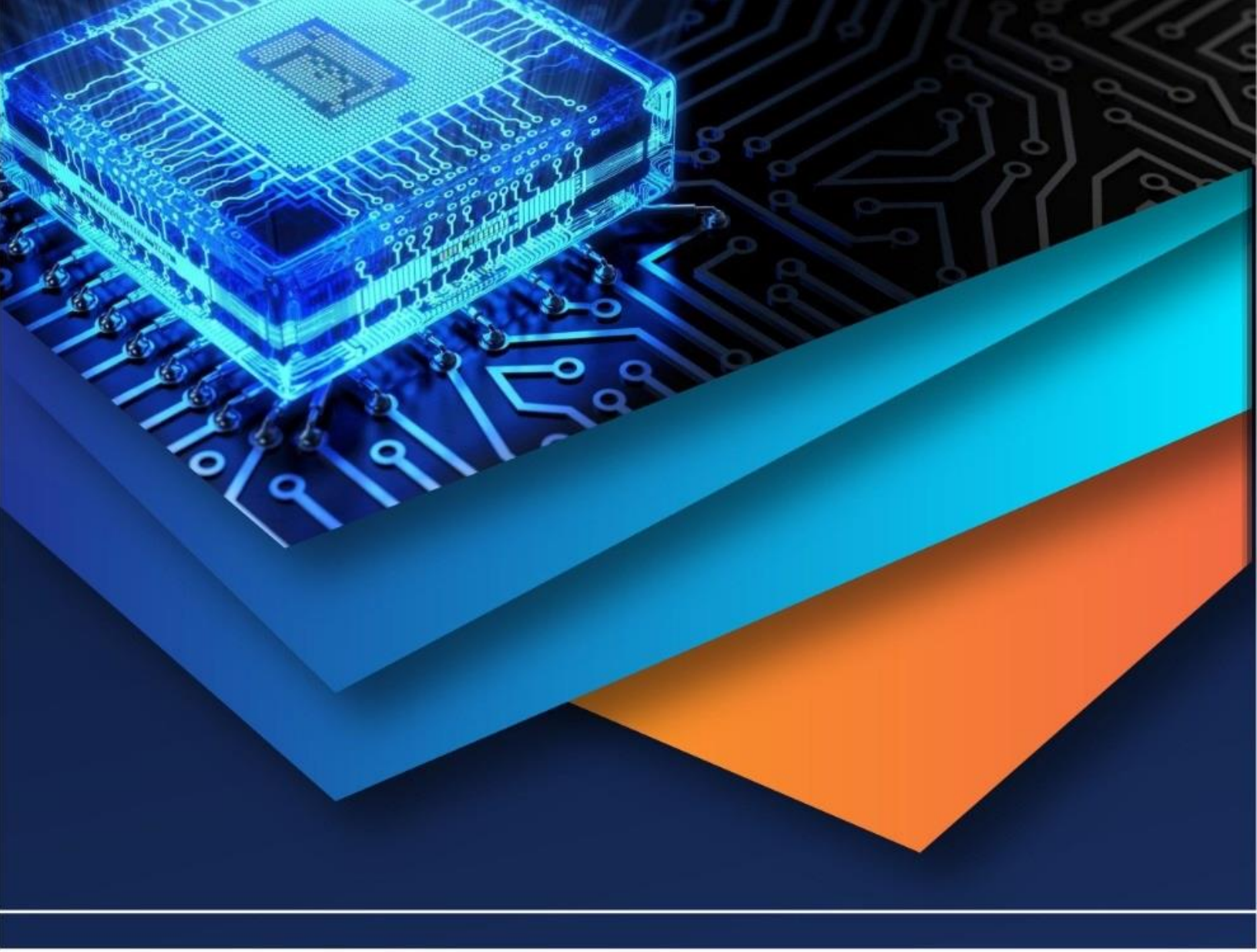

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