MPPT CHARGE CONTROLLER WITH BATTERY PROTECTION
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ABSTRACT
Solar-energy utilization is growing in demand since the past decade due to the increase in energy needs and depletion of non-renewable sources. But the problem with solar energy is that it’s not constant; it keeps on fluctuating depending upon the weather conditions such as, solar irradiation, temperature, thus a battery is always connected between the load and the solar panel so as to act as a secondary source. Since, brighter the sunlight, more voltage the solar cells would produce and excessive voltage could damage the batteries. MPPT is a method for extracting maximum power from PV module and also to protect the battery from overcharging. MPPT charge controller serves two main purpose battery protection and energy metering. This paper provides details of maximum power point tracking solar charge controller device and dc energy-meter.

Keywords: Battery, MPPT, Solar PV System, Buck-Converter, Hill Climb Algorithm.

I. INTRODUCTION
As we all see today's world with a lot population and to fulfill all requirements regarding electricity. The only source is renewable energy resource which directly occurs from natural assets like sunrays, air, rain, tide. All sources naturally available and can be refilled. Hence for every type practicals these sources are used due to their natural availability rather than any regular fossil. The world power situation introduce a renewed credit for development and development of clean and non conventional energy sources. In now a days the Clean Development Mechanism (CDM) are adopted by different organizations all over world. The reserves of fossil fuels is decreases very rapidly in the world, and also the major factor which affect the decrease in fossil fuels is the pollution. Contrastingly as renewable energy sources are the one who known as pure and which creates the power not releasing the dangerous gases in environment. The need for renewable energy sources is on the rise because of the acute energy crisis in the world today. India plans to produce 20 Gigawatts Solar power by the year 2020, whereas we have only realized less than half a Gigawatt of our potential as of March 2010. Solar energy is a vital untapped resource in a tropical country like ours. The main hindrance for the penetration and reach of solar PV systems is their low efficiency and high capital cost. In this thesis, we examine a schematic to extract maximum obtainable solar power from a PV module and use the energy for a DC application. This project investigates in detail the concept of Maximum Power Point Tracking (MPPT) which significantly increases the efficiency of the solar photovoltaic system.

II. METHODOLOGY
Hill climbing technique (technique for ascending hills)
According to the hill-climbing technique, a tiny disturbance can affect the PV panel’s working voltage. The MPP is where we move. When there is a positive change in the power and we continue to move in the same direction. move away from the direction of the peak power.
PV characteristics displaying MPP & working points A and B

Figure above displays a graph of component output power vs component voltage for PV panels operating at a stated level of available illumination. Greatest power point (MPP), a highlighted point in red, is the highest output which a solar panel can produce, in theory. Assume that A & B are the two working locations displayed in the given picture. Point A, which is blue, is located on left margin of an MPP. As a result, we may proceed toward MPP with perturbing the voltage in a positive way. Right beside the highest power point on the opposite side is blue point B. (MPP). An algorithm for ascending hills is shown in figure as a flowchart when a positive perturbation is applied and the value of P (change in power) turns negative.
III. MODELING AND ANALYSIS

Model and Material which are used is presented in this section. Table and model should be in prescribed format.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value taken for simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Solar Module Temperature (T)</td>
<td>28°C</td>
</tr>
<tr>
<td>Number of cells in series (NS)</td>
<td>60</td>
</tr>
<tr>
<td>Number of horizontal lines of panel in parallel (NP)</td>
<td>4</td>
</tr>
<tr>
<td>Load Resistance (R)</td>
<td>300 Ω</td>
</tr>
<tr>
<td>Boost converter capacitance (C)</td>
<td>0.611 µF</td>
</tr>
<tr>
<td>Boost converter inductance (L)</td>
<td>0.763 Mh</td>
</tr>
<tr>
<td>PWM Switching frequency</td>
<td>100 KHz</td>
</tr>
<tr>
<td>PI controllers Proportional gain (KP)</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Fig 1: MPPT charge controller kit

Fig 2: Lcd result
Adjusted voltage source and current source inverter is utilized for interfacing the modeler panel using rest of system and boost converter which is made with SimPower Systems module of MATLAB. In figure 5.4 the block diagram of model is shown in which simulation for the case where we can achieve the varying voltage output. This model is used for highlighting the difference between power received with MPPT flowchart and power got without using MPPT flowchart. For comparing output power in both cases stated above the model is came with a switch which is manual switch. If switch is pushed towards left the circuit bypass the MPPT flowchart and we get required power, voltage and current outputs through respective scopes. When switch is pushed towards right hand side, a embedded MPPT function block is inserted in a circuit and we get output which we want from respective scopes.

**Boost Converter**

In our simulation the boost converter is used. It discovers applications in different actual life conditions like battery bank charging, DC motor running, solar water pumping etc. For resistive load of 300 Ohm the simulation is done. For efficient motor running, we can undergo load resistance matching methods. 0.764mH rated inductor and 0.611uF rated capacitor is taken for a ripple free current in a boost converter.
PI Controller

PI controller is also used in this system. A function of MPPT algorithm is only calculating a reference voltage \( V_{ref} \) towards which operating voltage of PV should move next for getting maximum power output. After some time a process is repeated periodically with slower rate of about 1 to 10 samples per second. PI controller is an external loop in which a input voltage of converter is controlled. PWM block carries pulse width Modulation with faster switching frequency about 100KHz. \( K_P \) is taken 0.006 in our simulation and \( K_I \) is taken about 7. System stabilizes at a faster rate with high \( K_I \) value. This controller works for minimizing error between reference voltage and measured voltage by varying duty cycle with the help of switch. A switch is realized with a MOSFET with gate voltage controlled by duty cycle.

IV. RESULTS AND DISCUSSION

![SIMULINK™ Model of MPPT system using P&O algorithm](image1)

**Figure 4:** SIMULINK™ Model of MPPT system using P&O algorithm

![Plot of Output voltage of PV panel v/s time without MPPT](image2)

**Figure 5:** Plot of Output voltage of PV panel v/s time without MPPT
Simulink and MATLAB were used to simulate the model, and the plots from the various scopes are displayed. MPPT algorithm box in a circuit was first skipped during the simulation by setting the switch to no MPPT mode. It was observed that for a sun rays illumination value of 85 Watts per sq. centimeter, if we don’t employ a MPPT algorithm, power gained at load side was approximately 95 Watts (Figure 6.5). It should be mentioned that solar panel produced about 250 Watts of power for this range of sunray illumination (Figure 6.2). The transformation contained a MPPT box in a circuit and feeding $V_{ref}$ determined by H&C algorithm to the PSO controller. The PV panel continued to provide about 250 Watts of power in similar irradiation situation (Figure 6.8). A power gained at the load side in this instance, however, was discovered to be approximately 215 Watts (Figure 6.12), boosting overall transformation efficiency of solar system. A switching losses in a more frequency PWM switching circuit and an inductive & capacitive losses in Boost Converter can be used for explaining the power loss from the 250 Watts of usable power provided by the PV panel. Therefore, it was determined that the solar system’s efficiency was raised by roughly 126% by applying the Hill & Climb MPPT technique, out of an earlier output power of about 95 Watts to gained output power of about 215 Watts.

VI. REFERENCE

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