DESIGNING SOLAR POWER INVERTER USING MATLAB/SIMULINK

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Abstract

This paper deals with the design of the of a solar powered inverter by using MATLAB DC-DC boost converter system. For effective use of solar renewable power resources, power converters are most essential elements. DC-DC boost converter is used to draw maximum power from the solar panel for various solar radiation levels and various temperature. The output of the solar panel is fed to the DC-DC boost converter to step up the voltage of solar panel. The proposed system consists of MATLAB simulation of solar panel, DC-DC boost converter, PWM voltage source inverter. These results provide opportunity for utilization of this algorithm and its hardware implementation.

Keywords: DC-DC boost converter, PWM inverter.

1. Introduction

The usage of electricity plays a crucial role in our day to day life. On the other side, the grid supply in a grid connected area has become cessation, because of the rapid reduction of Non-renewable resources. so we depend upon renewable energy sources like solar, wind power etc. However, power generated through solar panel faces losses. Losses can be due to hostile weather conditions in rainy season, due to decrease in irradiance levels, change in temperature etc. Solar designs require refinement to produce maximum power output from solar panels at all the time. The solar panel is designed using the MATLAB. DC-DC boost converter design for boosting up the voltage of solar panel output and PWM inverter for converting DC-AC for supplying to the loads.

Fig1: Block diagram.
II. PV Panel

The equivalent circuit of a solar cell is a current source which is parallel with the diode. The output of the current source is directly proportional to the photons that strikes on the solar cell (Iph). During darkness, the solar cell is will be not active device; it will work as a diode, i.e. a p-n junction diode. It generates neither a current nor a voltage. However, if it is allowable to connect to an external source it generates a current called Id, called diode (D) current or dark current which determines the IV characteristics of the solar cell.

The circuit diagram of a solar cell is shown above in Fig1. Accurate circuit is obtained after considering the following parameters:

1. Temperature dependence of the reverse saturation current of the diode Is.
2. Temperature dependence of the current due to photons Iph.
3. Resistance in series Rs which gives a more accurate shape between the open circuit voltage and maximum power point.
4. Resistance in parallel Rsh, which resembles to the leakage current to the ground. I-V characteristics

A overall I-V characteristic of the solar panel for a given irradiation and fixed cell temperature is shown in Fig 3. For a certain resistive load, the load characteristic will be a straight line with slope Power delivered to the load hinge on on the value of the resistance only. If the Resistance load is very small; the PV cell operates in the M-N region (Fig), the PV cell will be at constant current source, which is nearly equivalent to a short circuit current. If the Resistance load is large, the PV cell operates in the P-S region, the PV cell act as a constant voltage source nearly equal to the open circuit voltage.

![Fig3: I-V characteristics of solar panel.](image)

III. DC-DC Boost Converter

DC-DC boost converter is designed in order to obtain maximum output from the solar panel. The DC-DC boost converter is a high efficiency step-up DC/DC converting converter. The converter uses a transistor switch which is MOSFET, to pulse width modulate input voltage into an inductor, which result in a triangular current waveform.
The inductor's main purpose is to limit the current flow rate through the power switch. This action limits the high-peak current that would be restricted by the switch resistance alone. The key benefit for using an inductor in switching regulators is that an inductor stores energy. This energy can be expressed in Joules as a function of the current by:

\[ E = \frac{1}{2} \times L \times I^2 \]

To regulate the voltage a linear regulator uses a resistive voltage drop, losing power in the form of heat. These type of regulator's inductor will have a voltage drop and an associated current but the current will be 90 degrees out of phase with the voltage. There will be two phase of operation in DC-DC boost converter operation.

1. Charge phase
2. Discharge phase

**1) Charge Phase:**

A basic boost configuration is described in Figure 5. We assume that the switch has been open for a long duration and that the voltage drop across the diode is tend to be negative, the voltage across the capacitor \( V_c \) is equal to the input voltage \( V_{in} \). When the switch closes, the input voltage, \( +V_{IN} \), is fascinated across the inductor and the diode avoids the capacitor from discharging \( +V_{OUT} \) to ground. Since the input voltage is DC, current through the inductor rises linearly with time.

**2) Discharge Phase**

When the switch opens once again, the inductor current will continue the flow of current into the rectification diode to charge the output. As the output voltage increases, the slope of the current, \( di/dt \), though the inductor converses. The output voltage increases until equilibrium is reached or,

\[ V_L = L \times di/dt \]

In other words, inductor voltage is inversely proportional to current drop

Output voltage boost converter can be found by

\[ V_{OUT} = V_{IN} \times D/(1-D) \]

Where \( V_{OUT} \): output voltage, \( V_{in} \): input voltage, \( D \): duty cycle

**3) PWM Inverter:** The next key part of this system is Inverter. At the Maximum Power Point the battery is charged. The objective of the system illustrated here is to supply three phase as well as single phase loads of any instant with constant amplitude quasi sinusoidal voltage and constant frequency.
There are several control methods and circuit topologies which is used to convert DC input to a 3-phase output. A common circuit topology which we use is voltage source inverter. In this method the switches in each leg are not operated or ON/OFF at the same time. By controlling the switches we can obtain line-line inverter output voltage as AC, with the frequency which corresponds to the frequency of sinusoidal control voltage. The amplitude of the inverter output voltages is controlled by adjusting amplitude of sinusoidal control voltages.

IV. Implementation:

![Circuit of solar powered inverter](image)

The solar power is obtained from the solar panel. Solar panel produces 11v volts of output. This output is fed to the DC-DC boost converter. DC-DC boost converter is designed in order to obtain maximum output from the solar panel. The DC-DC boost converter is a high efficiency step-up DC/DC converting converter. Maximum output can be obtained by giving pwm pulses to boost converter. The boosted DC output is given to the PWM inverter, so it converts DC to AC and ripple content is reduced by PWM technique, and fed to the loads.

V. Results:

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</thead>
<tbody>
<tr>
<td><strong>Output voltage</strong></td>
<td>11v</td>
</tr>
<tr>
<td><strong>Output current</strong></td>
<td>0.6v</td>
</tr>
<tr>
<td><strong>Input voltage</strong></td>
<td>11v</td>
</tr>
<tr>
<td><strong>Output voltage</strong></td>
<td>22v</td>
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<tr>
<td><strong>Output current</strong></td>
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<tr>
<td><strong>Input voltage</strong></td>
<td>22v</td>
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<tr>
<td><strong>Output voltage</strong></td>
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VI. Conclusion:

The photovoltaic system in solar cell doesn’t produce any ecological effects, since it has no moving parts and consume renewable energy. This paper describes the functioning of PV system using MATLAB simulation. And DC-DC boost converter is used for charging the battery. PWM inverter is used to covert the DC to AC which will be fed to the loads.
VII. References:

1. M. Azab, A New Maximum Power Point Tracking for Photovoltaic Systems, in WASET.ORG, 2008; vol. 34, 571-574.


