Multilevel Non-Inverting Inverter Based Smart Green Charger System

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Abstract
This paper discusses about the development of low cost efficient battery charging system using PIC Microcontroller. The demand of efficient battery charging system are going increase day by day, because of its usage in various applications such as it use in Hybrid electric cars, PV solar electric generation system, other energy storage systems and many more. In this paper an efficient and cost effective battery charging system is presented that use buck-boost converter topology. First, the software (PIC Programming) simulation is performed using Micro C software and then hardware is developed and tested to check the performance of the developed battery charger system. The efficiency of circuit is 85.66% and it can be use in any battery charging application

Keywords: Battery, Solar Cells, Microcontroller and Battery Charger.

1. Introduction
The Fossil Fuel is the conventional source of energy which is going to be exhausted day by day. According to the energy information administration (EIA) department of energy United States, “the world will face shortage of liquid fossil fuels in the next few years”. In the light of forecasting of EIA, in upcoming future fossil fuel may not able to cover the requirement of world. Therefore the alternate energy systems are needed to fill the upcoming shortage (Ahmed K, Abbas, 2014). The buck-boost is used to do both of the operations same like step up and down the output voltage depending on the duty cycle (Abadal-Salam T. Hussain, 2015). The economical battery charger controller for solar panel will be beneficial to optimize the output power as per load requirement. In this paper a PIC Microcontroller based battery charging system is presented that use PIC16F877A microcontroller as the main processor used in the circuit to control on the whole events and to be developed and efficient. As well as the PIC 16F877A is used to control on the input voltage by fixing it to selected level.

2. Related Works
The renewable energy in the resent years is the solution for the problems to produce the clean electrical energy, such as the photovoltaic (PV) technology. The PV technology is based on the conversion of the sunlight into electricity (Abadal-Salam T. Hussain, 2015). Now, the researchers are worked on PV and solar penal systems that trade on this energy (Abadal-Salam T. Hussain, 2015). Lee, Young-Joo Khaligh, one who introduced and do the experimental about the buck-boost non-inverting converter or can called a positive buck-boost converter in 2009 (Syed Faiz Ahmed, 2014). He has done a highly efficient control technique by using pulse width modulation (PWM) controlling dc/dc positive buck-
boost converter. In his proposed control scheme, can control the output voltage for an input voltage, which changes based on the charge status of the power supply. There are many techniques to charge the battery are proposed according to the (Abadal-Salam T. Hussain, 2015).

3. Application and Result

M The microcontroller is main control unit of the circuit which is programmed using Micro C software. First of all, the input voltage coming from solar cell is divided by using voltage divider to decrease the voltage and provide a protection to the PIC. The output voltage from the voltage divider is connected to ADC that including inside the PIC microcontroller. The PWM that producing from the PIC is depended on the input voltage that coming from the voltage dividers. Shown in Fig. 1. simulation circuit at proteus software.

![Fig. 1. Buck- Boost Simulation Circuit](image)

The PWM waveform is generated by using PIC microcontroller, depend on the variation of the duty cycle, and input voltage as shown in Fig. 2. The output voltage and current from buck-boost non-inverting converter controlled by using pic microcontroller (PWM) and system loaded with different resistive load are presented in the Table 1 shows the I/O voltages results.

<table>
<thead>
<tr>
<th>VIN (V)</th>
<th>RESISTIVE LOAD(Ω)</th>
<th>Vout (V)</th>
<th>Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>8</td>
<td>11.83</td>
<td>1.478</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>11.9</td>
<td>0.989</td>
</tr>
<tr>
<td>6</td>
<td>18</td>
<td>11.92</td>
<td>0.66</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>11.6</td>
<td>1.437</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>11.67</td>
<td>0.967</td>
</tr>
<tr>
<td>8</td>
<td>18</td>
<td>11.72</td>
<td>0.65</td>
</tr>
<tr>
<td>14</td>
<td>8</td>
<td>11.85</td>
<td>1.48</td>
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<tr>
<td>14</td>
<td>12</td>
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<td>0.9911</td>
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<tr>
<td>16</td>
<td>8</td>
<td>11.86</td>
<td>1.4811</td>
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<tr>
<td>16</td>
<td>12</td>
<td>11.889</td>
<td>0.99</td>
</tr>
<tr>
<td>16</td>
<td>18</td>
<td>11.921</td>
<td>0.666</td>
</tr>
</tbody>
</table>

As have been below at Fig. 3. and Fig. 4.: shown the result of hardware implementation at buck and boost non-inverting converter.

![Fig. 3. Shown the result at buck converter.](image)

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The current and voltage have followed from the converter to the battery across relay (RL). The yellow and red LED is used to give alarm when the battery is charged fully or when an overload is occurred. The Analog to digital converter ADC had been modeled in the PIC16F877A to convert the analog battery voltage to digital. The battery sense voltage is reduced by using some resistors and sent to the ADC input as show in the Fig. 5. simulation circuit.

Resolution = 5V/1024
= 4.887 mV
Therefore, 4.887 mV is the step for each change in input voltage. The programming of ADC’s converter is to convert the analog input voltage to digital number.

\[ V = \frac{(v \times 4.89)}{20} \times 120 \]  

(1)

Voltage across 0.8 ohm resistor = V, The load current = Current across 0.8 ohm resistor = V/0.8
Thus,

\[ I = \frac{i}{0.8} \]  

(2)

The reduced voltage from divider is used as a sense voltage from the load to the PIC16F877A to be displayed on the LCD as shown in the FIGURE (4). The one of the main objective was to design an efficient battery charger device based PIC microcontroller that would able to charge the battery with variable dc source as well as to protect the battery from the overcharging by cutting off the supply voltage when the battery is charged fully. The charger circuit was tested by using Proteus simulation software.

The data is collected from the simulation and lap to describe the drawn charging current per the battery voltage until cutoff as show in Fig. 7 and Fig. 8.

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Fig. 8. Charging Current and Battery Voltage

4. Conclusion

In this paper buck-boost inverter based an efficient battery charger system for solar cell application is presented which is based on PIC microcontroller, it is programmed, simulated and design to control on the charging process and to protect the battery against the overvoltage that might occur during the charging process. It automatically cutoff the voltage when the battery is charged fully. When a battery voltage reaches the regulation set point, the charging algorithm slowly reduces the charging current to avoid heating. The circuit is tested and it performed well.

References


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