Battery Management Unit with Cell Balancing for Micro-grid Solar Powered Energy Storage System

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Abstract. This paper describes Battery management Unit with cell balancing for micro-grid solar powered energy storage system. This system include MPPT (increase efficiency of solar cell), BMU (Control battery charge/discharge). Use power semiconductor switch, sense solar cell generate power, load consume power, SOC (State of Charge) Control power flow and battery charge/discharge. BMU also increases total battery capacity and prevent accident.

Introduction

To solve environment problem variable renewable energies are developed. Above all, Solar cell is most popular renewable energies. Solar powered system’s major problem is output is unstable. So ESS is good answer.

Energy Storage System

![Diagram of Energy Storage System](image_url)

Figure 1. Diagram of Energy Storage System.

Energy Storage System (ESS) is the storage of energy at one time for use other time. Solar cell convert solar lay to electric energy. Maximum power point tracker (MPPT) controls solar cell’s
voltage to optimize the electric energy. Battery Management Unit (BMU) controls charge/discharge battery and cell balancing.

**Battery Management Unit**

Battery Management Unit (BMU) sense solar cell generate power and load consume power and SOC of battery. Power Semiconductor switch can control power flow. Tab. 1 shows variable power flow condition.

<table>
<thead>
<tr>
<th>Condition (Battery SOC High)</th>
<th>Power Flow</th>
<th>Condition (Battery SOC Low)</th>
<th>Power Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar cell power &gt; Load power</td>
<td>Solar cell to Load</td>
<td>Solar cell power &gt; Load power</td>
<td>Solar cell to Load</td>
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<tr>
<td></td>
<td>Battery no Charge</td>
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<td>Battery Charge</td>
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<tr>
<td>Solar cell power = Load power</td>
<td>Solar cell to Load</td>
<td>Solar cell power = Load power</td>
<td>Solar cell to Load</td>
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<tr>
<td>Solar cell power &lt; Load power</td>
<td>Battery to Load</td>
<td>Solar cell power &lt; Load power</td>
<td>Battery to Load</td>
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<td></td>
<td>Battery Discharge</td>
<td></td>
<td>Until Battery full</td>
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<tr>
<td>No Solar cell power</td>
<td>Battery to Load</td>
<td>No Solar cell power</td>
<td>Stop</td>
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<tr>
<td></td>
<td>Battery Discharge</td>
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</tbody>
</table>

**Cell Balancing**

**Cell Imbalancing**

Cell Imbalancing makes problem on multi-cell battery pack. For example, reduce maximum battery capacity, make explosion.

Cell Imbalancing cause by various reason. Such as difference in each cell’s SOC, Impedance variation, different of each cell’s temperature.
Cell Balancing Method

Cell balancing reduces problem which occurred by cell imbalancing and operate battery pack longer. There are many criterions to balance battery cell. For example SOC, Cell Voltage, Cell capacity. In Li-ion battery pack, Cell voltage is most common criterion. Fig. 3 shows balancing circuit and simulation.
Summary
ESS means system that storage the generate energy to use later time. Most popular storage device is Li-ion battery. Control power flow and increase battery capacity, it needs BMU (battery management unit). BMU sense the solar cell power and load consume power and battery SOC for control power flow. For increase battery capacity and safety BMU also do battery cell balancing.

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References

