ABSTRACT
In order to display the amount of charge within the battery packs, a fuel gauge algorithm must be employed. This memo discusses some of the available methods and which one we have chosen for the LPRDS system.

TECHNICAL FINDINGS
This simplest method for determining the amount of charge in a cell is to measure the voltage across the terminals of the cell. This is effective for some cells but because of the characteristics of LiFePO₄ cells, it cannot be implemented in our system. Our cells have a relatively constant voltage between 15 and 80% as shown in Figure 1 below. Another method for determining cell charge is Coulomb counting. This requires measuring the current into or out of the cell and keeping track of the charge flux. More advanced methods include taking temperature, number of charge cycles, current level, and age of the cells into account. All these factors can affect the amount of charge a cell can hold.

Figure 1: Typical Charge Curve for LiFePO₄ cell
RECOMMENDATIONS AND DECISIONS

Since our cells are all the same age, and remain at a relatively constant temperature, we can eliminate these factors from our fuel gauge algorithm. Also, we have insufficient data on the affects of many charge cycles on the capacity of our cells. Therefore, we can eliminate this from our calculations as well. This leaves us with a simple Coulomb counting method of just measuring charge in and out of the cell. We will use ACS714 current sensor since it is easily available. It is a robust and accurate sensor which is already integrated with the microcontroller. Our fuel gauge will only approximate the battery pack as a whole. Individual cell fuel gauge would require too much overhead to relay the information from the OBPP boards to the master ESS control board.

Our algorithm will be implemented in software on the ESS control board microcontroller. It will first require the cells to be fully charged. It will use the full voltage threshold as the indication of full charge. Then it will use this point as a reference and monitor the current out of the cell. Our cells have a specified capacity 10 Amp-Hours. Using this we can estimate the amount of charge in the cell as current flows in or out by simply multiplying the current by the amount of time it has been flowing. Each time the cell reaches the full voltage threshold, the full point will be redefined.

ATTACHED DOCUMENTS

SOC Algorithm.pdf
Adds the value of the current sensor to a register in the PIC's memory. Depending on the direction of the current through the current sensor, the integrated current will either be incremented (charging) or decremented (discharging) because the current sensor returns a positive value when charging and a negative value when discharging.