Developing a Battery Management System Solution for ESS

Introduction

Reliable and affordable energy sources are required to power the economy and meet daily needs. Without these energy sources, economic growth and development stalls. Dependence on foreign sources for energy can also lead to vulnerability to geopolitical conflicts. With ongoing concerns regarding climate change, ensuring energy security has environmental implications as well, with efforts to increase energy efficiency and transition to low-carbon energy sources.

To achieve energy security, every possible source of energy generation and efficiency must be exploited. Electricity is a common form of pooled energy. The recent transition from fossil fuels to electrical consumption has increased the interest in electrical energy, where storage systems are a key component.

Energy Storage System (ESS)

An energy storage system (ESS) provides electrical energy from a battery to supplement a primary source, such as the electrical grid. As an energy reservoir, ESS is charged when the primary source is available, and it is discharged when the power source is insufficient.

To exploit new sources of energy generation such as wind power and photovoltaics, it is necessary to recognize that the availability of these energy sources is unrelated to demand. Unlike a power plant that increases electrical output as needed, these new sources of energy generation provide electrical energy as it becomes available. ESS functions as a stabilizer to collect and supply electrical energy.

The demand for energy storage is exploding across all levels of the energy delivery system, including power generation sites, transmission stations, industrial sites, electrical vehicle charging stations, and individual households. The various levels of the energy delivery system ensure reliable and consistent energy availability.

Battery Management System (BMS) of ESS

The battery management system (BMS) of ESS monitors the battery's status in real time and carefully manages a large collection of high-energy battery cells, which are crucial functions for energy storage systems. The BMS must accurately measure each cell, monitor the health of each cell, and generate accurate information for the system. This allows ESS to achieve safety, reliability, capacity, and a long operating life.

MPS's BMS Energy Storage Solution

MPS offers high-performance BMS solutions for various high-voltage and low-voltage energy storage applications, such as household and large-scale energy storage, data centers, and communication base stations. This article introduces a BMS solution with three key advantages for energy storage using the MP2797, an analog front-end (AFE) monitoring and protection solution, and the MPF4279x fuel gauge series. Figure 1 shows the MP2797 battery management device.

Figure 1: MP2797 Battery Management Device

Accurate Measurements

Battery monitoring accuracy is crucial to optimize the performance of an energy storage system. This includes real-time, high-precision voltage, current, and temperature data on each cell, allowing the system to assess each cell's state-of-charge (SOC) and state-of-health (SOH).

The MP2797 ensures accuracy by integrating two independent analog-to-digital converters (ADCs) that can respectively measure each battery cell's voltage, charge/discharge current, and temperature with high precision. Each cell's voltage and current (VI) current is also measured synchronously, and can be exploited by the MPF4279x fuel gauge series via its voltage-current hybrid algorithm. This model accurately estimates the ESS battery's remaining SOC and SOH.

Accurate predictive capability maximizes the extended runtime of the energy storage batteries. Whether ESS is required for power outages or energy arbitration, runtime is the key parameter to maximize for battery monitoring accuracy.

Figure 2 shows the curves of the battery voltage and current error measurements.

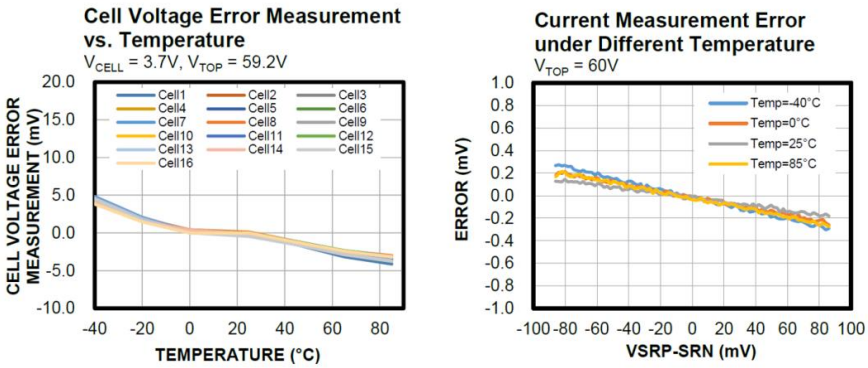

Figure 2: Battery Voltage and Current Error Measurement Curves

Fuel Gauge Algorithm

The fuel gauge algorithm drives ESS. However, developing an accurate algorithm is challenging as it requires expertise across electrochemistry, physics, electrical and electronic engineering, firmware development, and data science. Compared to the cost and time investment to design a fuel gauge algorithm, MPS provides low-risk, low-cost, fast time-to-market BMS solutions.

The MP2797 provides accurate battery measurements, balancing, monitoring, protection, and control. The MPF42791 provides peak power, calculates battery impedance, assesses battery aging, and accurately estimates battery cycle life and real-time output capability. The combined solution with the MP2797 and MPF42791 offers outstanding accuracy while saving designers from the complicated process of developing SOC algorithms independently (see Figure 3).

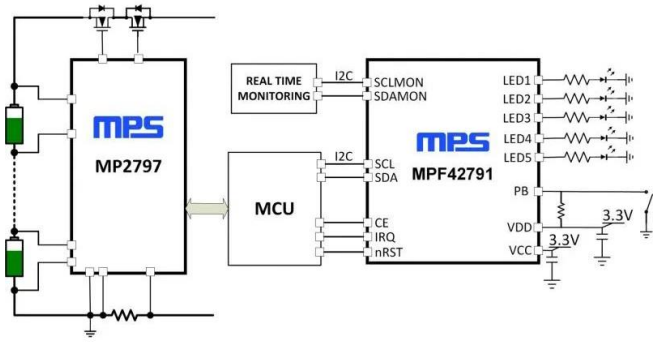

Figure 3: BMS Solution with the MP2797 and MPF42791

MPS also offers the MP4581, a synchronous step-down converter that can provide an efficient power solution for external devices. Combined with the MP276xx high-speed signal isolator series, multiple ICs can be stacked for higher channel count applications.

Battery Safety

Battery safety is critical as energy storage batteries can pose a danger if not properly managed. The MP2797 includes comprehensive safety features, such as warning the system of unsafe conditions based on accurate voltage, current, and temperature measurements. With integrated high-side (HS) charge and discharge FET drivers, the MP2797 can directly disable battery charge/discharge. The HS driver architecture ensures communication using the microcontroller unit (MCU) while triggering the protection, which avoids data loss.

Figure 4 shows the MP2797 typical application circuit.

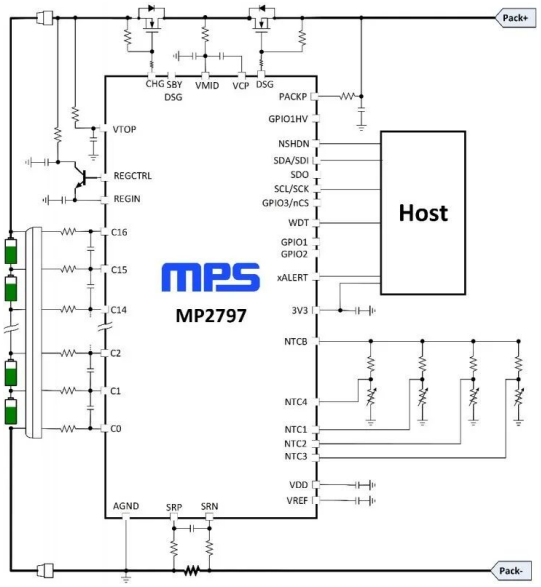

Figure 4: MP2797 Typical Application Circuit

Conclusion

Energy storage is essential to advance power systems as well as goals for reaching a carbon peak and achieving carbon neutrality. To meet the growing demands of energy storage, designers must address the limitations of the BMS such as battery monitoring accuracy, developing fuel gauge algorithms, and ensuring battery safety. Monolithic Power System provides an effective battery management solution using the MP2797 combined with the MPF4279x fuel gauge series to boost energy storage and overcome challenges with the BMS.