Improving Battery Safety with the MP2797

Introduction

Modern life has become more convenient due to battery-powered applications for electric tools, vacuum cleaners, electric bikes, and outdoor power supplies for camping. As wireless charging continues to be more widely used in applications, lithium battery safety is a growing concern, so designers are looking to develop battery monitoring and protection solutions.

A battery pack is made up of multiple lithium batteries connected in series. Lithium-ion batteries have three different types of failure events: internal short circuit, high temperature, and over-voltage (OV). If any of these events occur, the cell temperature may reach a threshold that triggers a series of internal chemical reactions. These reactions generate heat and gas, which can result in fires or explosions.

The MP2797 is a robust battery management device that supports 7-cell to 16-cell battery management systems (BMS) to help prevent these failures and maintain battery safety. The MP2797 provides complete analog front-end (AFE) monitoring and protection, I^2C or SPI communication, and supports an 8-bit cyclic redundancy check (CRC).

Battery Voltage and Current Monitoring

High-precision battery voltage and current monitoring are critical to obtaining the battery pack's status in real-time and allowing the battery to be used safely. The MP2797 integrates two separate analog-to-digital converters (ADCs): a 15-bit ADC and 16-bit ADC.

The 15-bit ADC monitors the cell voltages by measuring the differential battery voltage of each channel (up to 16 channels). The ADC voltage measurement error is ±5mV at room temperature.

Meanwhile, the 16-bit ADC monitors the current by measuring the charge/discharge currents through an external current-sense resistor. The ADC measurement error does not exceed 0.5% at room temperature.

Figure 1 shows the cell voltage measurement and current measurement error curves.

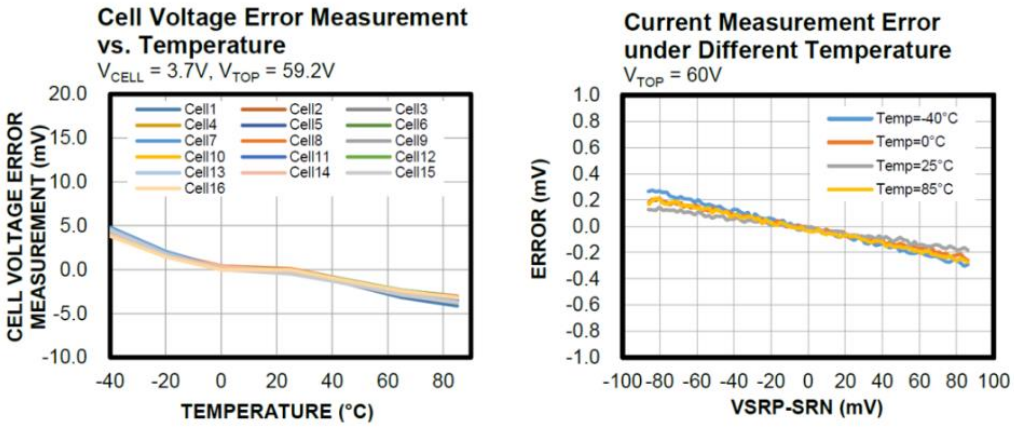

Figure 1: Cell Voltage Measurement and Current Measurement Error Curves

Battery Temperature Monitoring

During the battery's charging and discharging process, the internal resistance, battery layout, and other factors can cause differences between the battery temperature and ambient temperature. Since batteries have different lifespans at varying temperatures, it is useful to know the temperature of the cells inside the multi-string battery pack.

In addition to measuring the chip's temperature, the MP2797 multiplexes the 15-bit ADC to provide four channels that can sample the temperature of an external NTC thermistor.

Figure 2 shows the four-channel NTC sampling.

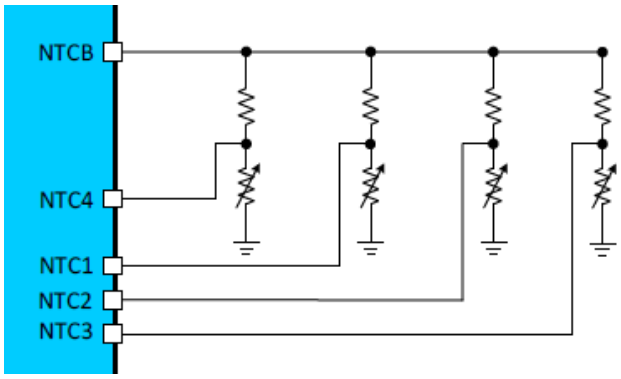

Figure 2: Four-Channel NTC Sampling

Cell Balancing Management

If the battery pack is charged and discharged for a long time, this can lead to an unbalanced voltage in each cell, as well as a deviated chemical impedance. The battery pack's lifespan may be shorted if the pack continues to operate with unbalanced cells. If the difference between cell voltages is significant, it is crucial to implement cell balancing to reduce inconsistencies between cells.

The MP2797 integrates a cell-balancing MOSFET that can support internal balancing with a current of up to 50mA. A larger balancing current can be achieved by driving an externally balanced MOSFET.

Figure 3 shows a reference circuit for external balancing.

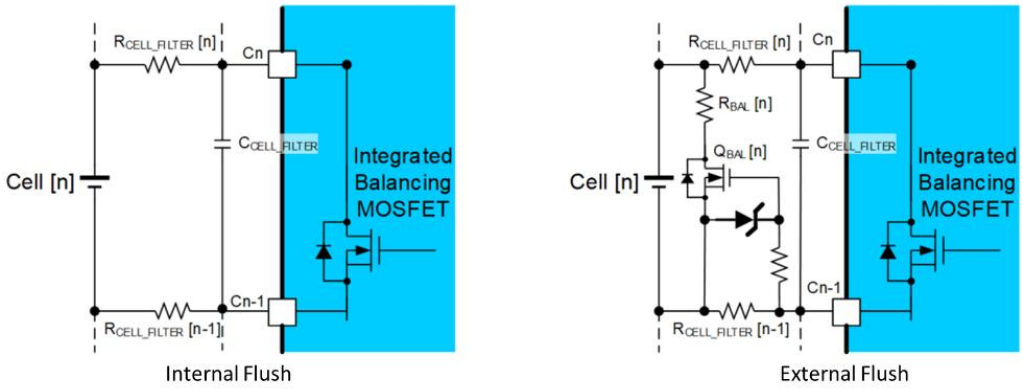

Figure 3: Cell Balancing Reference Circuit

Battery Protection

The MP2797 provides comprehensive and reliable protection for battery packs, where all protection thresholds are configurable. Some of the robust protections are listed below:

- Charge/discharge over-current protection (OCP)
- Charge/discharge short-circuit protection (SCP)
- Single cell under-voltage protection (UVP) and over-voltage protection (OVP)
- Battery UVP and OVP
- Cell low/high temperature protection
- Die high temperature protection

The MP2797 also integrates a high-side (HS) drive that can drive multiple, parallel N-channel MOSFETs. Compared to the low-side (LS) drive, the HS drive can trigger a protection while maintaining communication with the microcontroller unit (MCU), ensuring that the system continuously obtains the real-time status of the battery pack.

Furthermore, the MP2797 can soft start the discharge MOSFET without using a pre-biased circuit.

Figure 4 shows the typical application circuit of the MP2797.

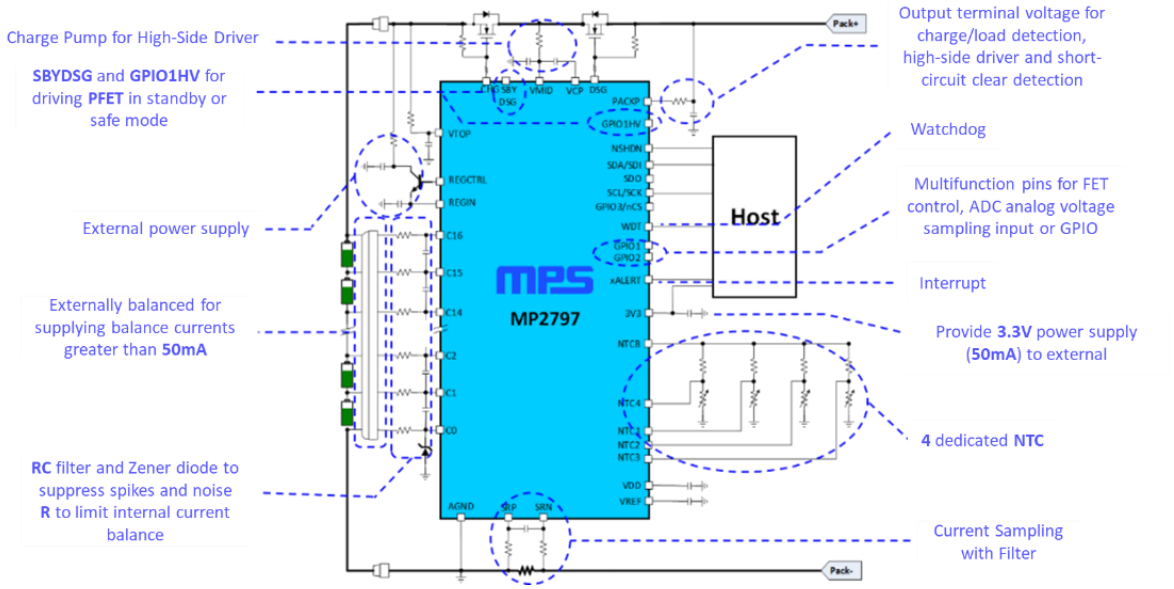

Figure 4: MP2797 Typical Application Circuit

Additional Features and Benefits

The MP2797's dedicated features include a low-current standby mode, load/charger insertion detection, high-voltage and low-voltage GPIO, open-circuit detection, and a continuous battery failure marker. The device also provides lockable multiple-time programmable (MTP) memory for protection thresholds and support random battery connection. It is available in a TQFP-48 (7mmx7mm) package (see Figure 5).

Figure 5: MP2797 IC

Design Scheme

The MP2797 is compatible with the MPF42790, a 2 to 16 stacked-cell battery pack fuel gauge (see Figure 6). The MPF42790 has a flexible design scheme that can be paired with any type of AFE by leveraging the system's MCU to provide the battery pack readings.

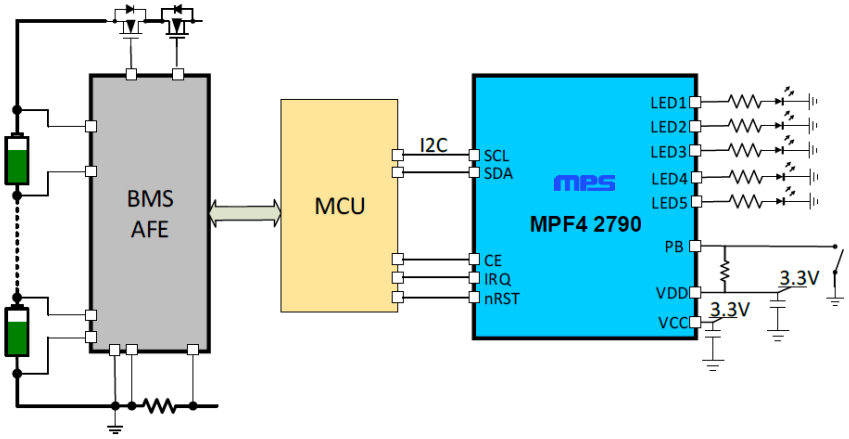

Figure 6: MPF42790 Typical Application Circuit

Conclusion

The MP2797 offers high-precision battery voltage and current monitoring, temperature monitoring, cell balancing, and comprehensive protection features. As lithium battery safety becomes more important for battery-powered applications, MPS will continue to provide a wide range of battery management system monitoring and protection solutions that guarantee safety and boost battery lifespan.