Application Report
SLUA990–September 2019

BQ75614-Q1 – The Highest Functional Safety Level and Performance for 48-V Systems

ABSTRACT

This application note showcases the benefits of using the BQ75614-Q1 14S Precision Battery Monitor, with Current Sense and Hardware Protector for 48-V designs.

Several features are highlighted, such as

- Device-level ASIL-D rating
- Enhanced SoC and SoH estimates
- High measurement accuracy
- Bill of material (BOM) advantages
- "Family" approach to devices

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Trademarks

1 ASIL-D

The BQ75614-Q1 is a pioneer in the battery monitor market with ASIL-D-rated current measurement. The device uses a dedicated current sense, 16-bit, sigma-delta ADC and a redundant ADC to achieve this feat.

The device also features the ASIL-D rated systems inherent to the BQ7961x-Q1 family:

- Communications
- Voltage
- Temperature measurement

All of the features listed above, along with the current sense ADC, allow for a device-level ASIL-D rating with minimal software requirements from the host microcontroller.

The device also features the capability to complete FDTI within 100 ms by using several built-in diagnostics. This significantly reduces the amount of processing and communications required by the host, and frees up the host to complete other tasks during the diagnostics.

2 Enhanced SoC and SoH

The BQ75614-Q1 has easy and helpful features for providing better SoC and SoH estimates.

2.1 Synchronized Voltage and Current Measurements

The BQ75614-Q1 allows for current and voltage measurements to have synchronized starts to allow for improved SoC and SoH estimates. This can be done without the microcontroller having to manually synchronize each measurement with precise timings.

2.2 Current Measurement Notification

The device optionally allows for a GPIO line to be used to notify the microcontroller when a conversion is complete. This can act as an external interrupt for the microcontroller to assist with coulomb counting calculations.

By combining these features, the developer is provided with the tools necessary to provide the best SoC and SoH estimation possible.

3 Fuse and Relay Monitoring

Using two additional voltage measurement channels on the device, the BQ75614-Q1 is capable of monitoring the fuse and relay of a battery management system with no additional components. This allows for simplified development and communications for the microcontroller, as the monitoring system for the fuse and relay is integrated.

4 Accuracy

4.1 Current Measurement

The current-sense ADC in the BQ75614-Q1 offers a high-accuracy integrated ADC.

Details:

- Full scale voltage range: ± 250 mV
- Temperature range: -40°C to 105°C
- LSB resolution: 7.63 uV
- Conversion time options from 1 ms to 25 ms

These features allow for consistent and accurate SoC measurements for the battery system.

4.2 Voltage Measurement

The SAR ADC cell voltage measurement channels inherited from the BQ7961x-Q1 family allow for high post-solder accuracy across temperature on all 14 channels. These channels have integrated front-end RC filters, which assist in achieving this accuracy. The integrated filters also:

- Eliminate the need for external ESD diodes
- Allow for significantly reduced external RC filter requirements

The customizable, post-ADC, low-pass filters (with cutoff frequencies as low as 6 Hz) further assist in accuracy and noise suppression.

5 BOM Advantages

The BQ75614-Q1 provides several features that reduce the overall BOM cost of the device.

5.1 Current Sense Cost Advantages

By integrating the current sense ADC into the device, significant cost savings are available. These cost savings (when compared to a stand-alone current sense ADC) come in many forms:

- Reduced quantity of components (no external current sense ADC or redundant ADC)

- PCB area required reduced significantly
- No additional UART or SPI lines required from microcontroller to current-sense ADC
- Development time significantly reduced (only need to program one device)
- Voltage and current sense ADCs easily synchronized for simplified SoH and SoC estimations (see Section 2)
- Device-level ASIL-D rating assists with further reduced development time

The difference in required components can be easily seen by a system-level block diagram comparison between integrated current sense and external current sense:

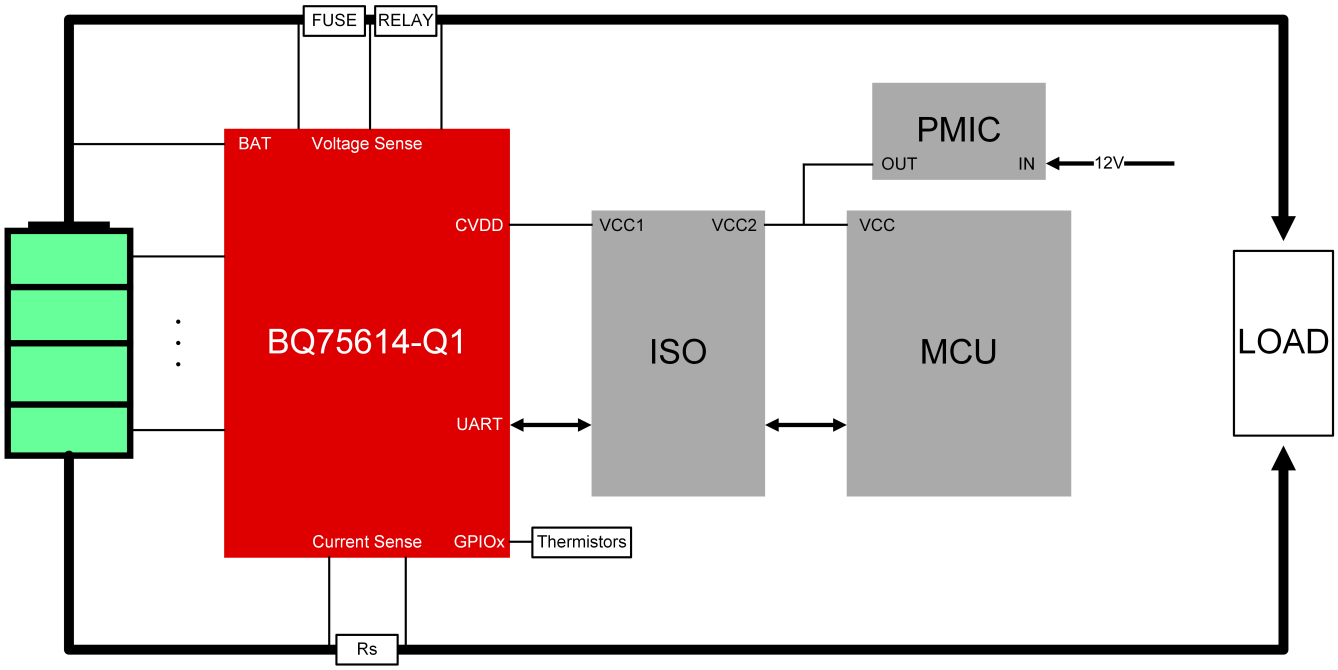

Figure 1. BQ75614-Q1 With Integrated Current Sense

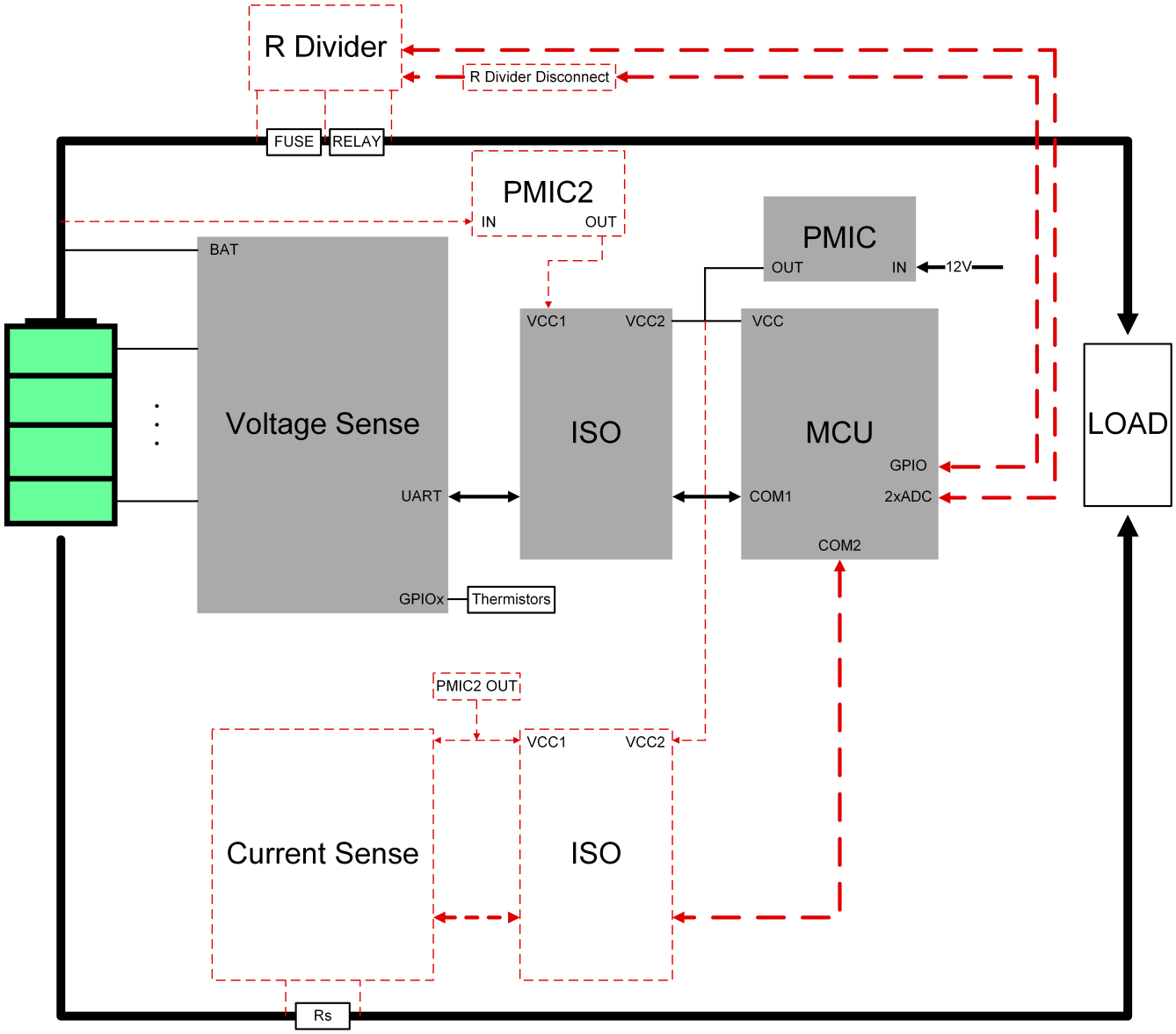

Figure 2. External Current Sense

5.2 Voltage Measurement Cost Advantages

The voltage measurement channels inherited from the BQ7961x-Q1 family maintain the highly cost-effective features of the rest of the product family:

- Integrated ADC filters for significant reduction in size and quantity of components
- Easy diagnostic checks for fewer components (external redundant ADCs not needed for ASIL-D) and simplified software development
- Integrated passive balancing FETs for cost savings and smaller footprint (reducing PCB cost)
- Internal LDO can support 10 mA loads for digital isolators, to remove the need for additional PMIC

These features, among many others found in the BQ7961x-Q1 family, assist in overall BOM and production cost reduction.

6 BQ7961x-Q1 Family

With a “family” approach to devices, TI is able to deliver additional development time reduction. The ASIL-D BQ7961x-Q1 family (including the 16S, 14S, and 12S monitors for HV systems) share several features with the BQ75614-Q1, including the same:

- Package
- Pinout
- Functional control
- Register map

Development for one device is easily ported to other devices in the family. This allows for similar firmware between high voltage and 48V systems.

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