RBK04U04GN

BMS Shunt-less Short-circuit

About this document

This document will discuss the importance of the Renesas BMS Shunt-Less short circuit test for battery management systems (BMS). This will demonstrate some functionality tests with the internal BMS evaluation board.

Target Device

MOSFET: RBK04U04GN

Contents

1. Introduction

1.1 Overview

Short-circuit current detection refers to the ability of a circuit or system to identify and respond to the occurrence of a short circuit promptly and effectively. Detecting short circuits is crucial in preventing damage to components, ensuring safety, and maintaining reliable operation of electrical and electronic devices.

In this application note, we will discuss the short-circuit test using the Sense MOS with the Renesas BMS shunt-less evaluation board. For a detailed overview of the evaluation board and its specifications, please refer to the related application note available on the Renesas website (R07AN0021EJ0100).

Below is the diagram of the EVB that will be used for the short-circuit test measurements.

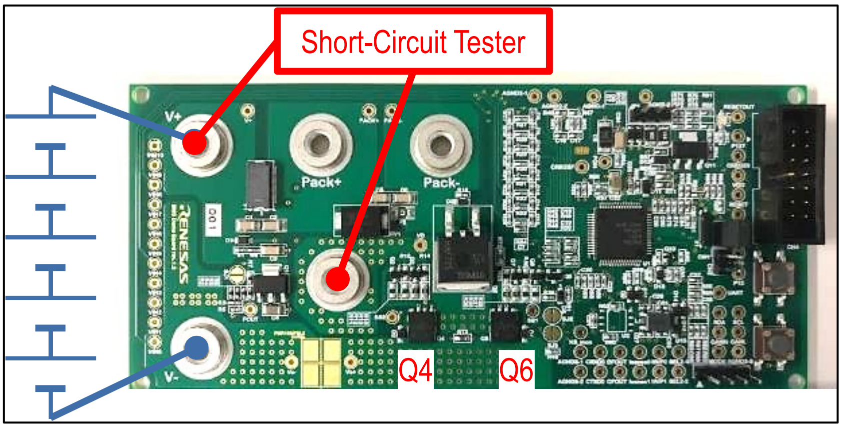

Figure 1-1 Renesas BMS Eva. board “WS (0)”

2. Short Circuit Test & Detection

This section highlights the features of the evaluation board that are part of the Renesas solution. It is important to ensure that these features function correctly to protect both the user and the battery pack from potential hazards. The key features include short circuit testing of the evaluation board and battery pack, over-current detection, and short-circuit current detection. These functions are crucial for preventing damage and ensuring safety.

2.1 Battery pack short circuit durability test

The figure below shows the short circuit test performed with the evaluation board connected to a battery pack. This test monitors the board's safety protection during a short circuit. The waveform indicates that when a short-circuit current is applied for 160 milliseconds, the battery pack voltage turns off. The voltage remains off until the short-circuit current is removed, at which point the voltage turns back on.

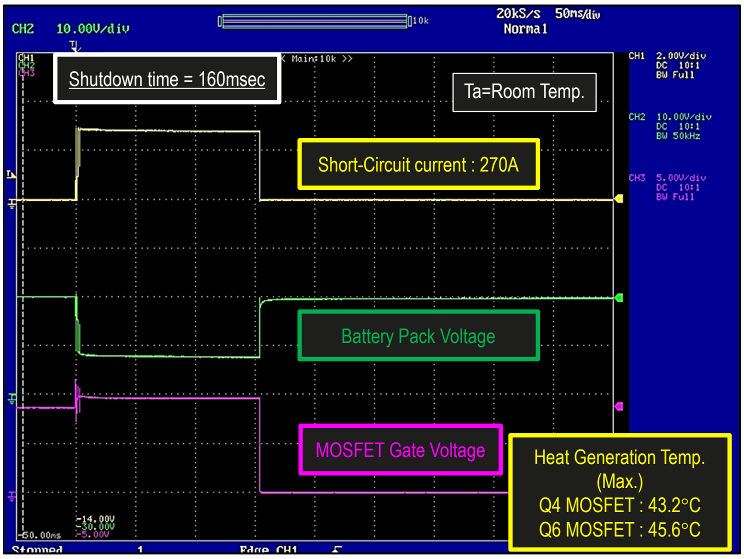

Figure 2-1 Waveform of Board Short-Circuit test

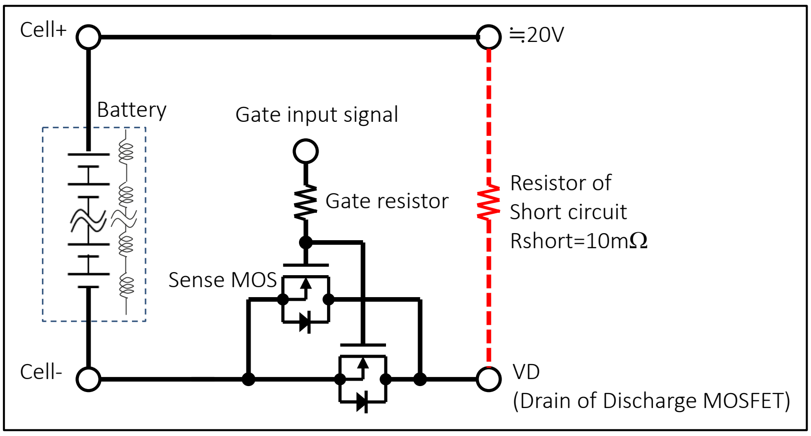

Figure 2-2 Circuits diagram of Short-Circuit test

2.2 Over-current Detection

The waveform below shows how the over-current detection works. The MOSFET responds by shutting down the operation within 0.6ms when the current exceeds the overcurrent detection point. The Load Current shuts down in 0.9ms.

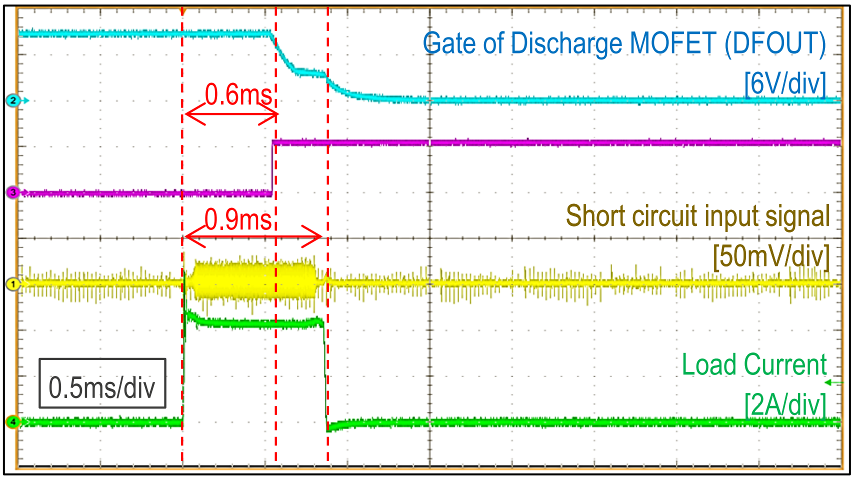

Figure 2-3 Waveform of Over-current Detection

2.3 Short-circuit Current Detection

The waveform below shows how the short-circuit current detection works. When a short-circuit signal is applied, the Sense MOS detects the current and quickly shuts down the circuit by turning off the discharge MOSFET. This happens within the short-circuit withstand time to protect the system. The system detected the short-circuit input signal by 0.1ms, the MOSFET has responded by shutting down the operation.

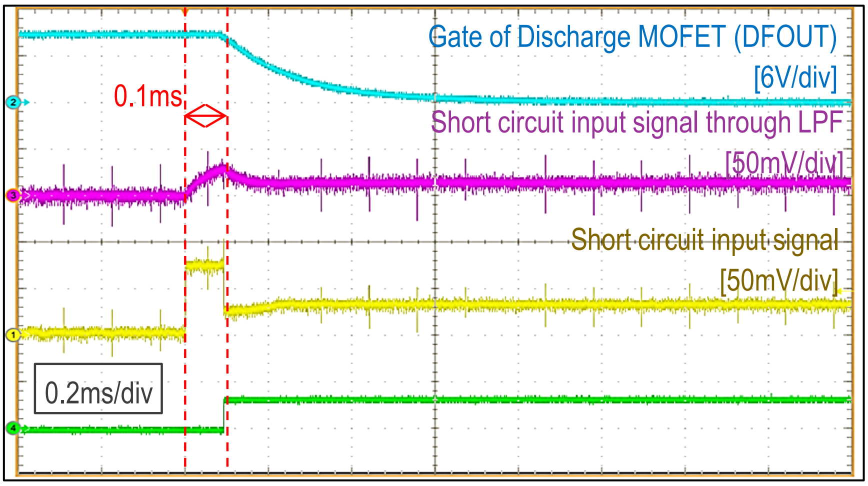

Figure 2-4 Waveform of Short-circuit current Detection

3. MOSFET Introduction

The MOSFET (RBK04U04GNS) selected for this solution is suitable for use in Li-ion battery management systems. This MOSFET has a capability of 40V with 35A N-Channel Power MOSFET.

The main reasons for selecting this MOSFET are its features:

- Low on-state resistance R_{DS} (on) of 1.2mΩ typ. (at VGS = 10V, ID = 18A)
- Built-in current sensing feature, useful for:
  - Over Current Detection
  - Static current monitoring
- HSON-8 pin, surface mount package (5 x 6 mm)

This MOSFET targets mid-voltage products such as power tools, cleaners, e-bikes, drones, and other industrial products. It is suitable for use as a low-side protection switch for BMS, BLDC inverters, and DC-DC inverters.

3.1 Product Outline

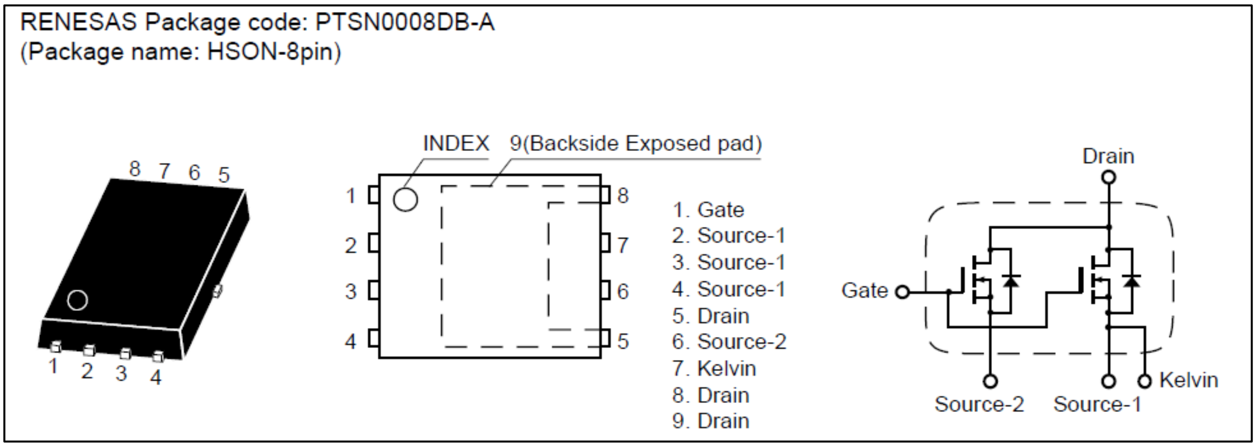

Figure 3-1 RBK04U04GNS MOSFET outline

3.2 Introduction for RBK04U04GNS

MOSFETs are commonly used in power systems to control switching and current flow. They can also function as current sensors by detecting the voltage drop across the drain-source terminals (V_DS), which is directly related to the current flowing through the MOSFET, based on its internal resistance, R_DS(on).

In current-sensing applications, MOSFETs play two key roles:

- **Switching Role**: MOSFETs control current flow to the load, acting as a switch between the power supply and the load.
- **Sensing Role**: MOSFETs can provide a voltage signal that reflects the current flowing through them by leveraging the voltage drop across the drain and source terminals.

3.2.1 Dual MOSFET Topology

The RBK04U04GNS MOSFET incorporates a dual MOSFET topology with Kelvin sensing pins to improve current-sensing accuracy. This design integrates two MOSFETs within a single package, which helps reduce conduction losses and enhance current measurement precision.

The Kelvin pin is connected to the source and ground, it is used to provide a low-resistance, isolated path for sensing the voltage drop across the MOSFET. This setup allows for precise current measurement, which is important for managing short-circuit conditions and power control.

This dual MOSFET setup makes the RBK04U04GNS ideal for applications requiring high accuracy, such as motor control system and automotive power application.

3.2.2 Benefits

- **Reduced Component Count**: By integrating the switching and sensing functions into a single package, the overall system design is simplifying and reducing the need for additional components.
- **Improved Accuracy**: The integration of dual MOSFETs allows for better control over device characteristics and improving efficiency in current-sensing applications by eliminating parasitic resistances.

By integrating a dual-source configuration with Kelvin pins, the RBK04U04GNS offers a highly efficient and accurate solution for power-sensitive applications where precision is critical.

4. Conclusion

The short-circuit and overcurrent detection in the battery management system (BMS) proved to be highly effective during testing. The results demonstrated that the system can reliably detect short circuits and overcurrent conditions, triggering the shutdown of the MOSFET (RBK04U04GNS) to prevent potential damage to the battery pack and ensure user safety.

The built-in sensing feature of the MOSFET simplified the design and contributed to the overall performance, showing that the integration of these features helps reduce the design complexity and cost while maintaining a high level of protection.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	10.10.2024	-	First edition

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