Application Report

Optimizing Battery Management Systems with Logic and Voltage Translation

Dylan Hubbard

ABSTRACT

Battery Management Systems (BMS) are tasked with providing efficient control over the battery in an electric vehicle. Along with efficiency, these systems also require robust safety measures to avoid catastrophic failure when working with such high voltage and current. This is a key area in which Logic and Voltage Translation devices can optimize system robustness by providing simple redundant safety monitoring. All of the use cases shown in the Block Diagram, Logic, and Translation Use Cases sections of this document are commonly seen in wired and wireless BMS designs.

Logic gates, voltage translators, and other logic devices are utilized for many purposes throughout modern electronic systems. This document provides example solutions for common design challenges that can be solved using logic and translation. Not all of the solutions here appear in every system, however all solutions shown are commonly used and effective.

Table of Contents

List of Tables

Trademarks

All trademarks are the property of their respective owners.

1 Block Diagram

For the purpose of this report, a simplified Battery Management System block diagram is used to illustrate the logic and translation use cases, see Figure 1-1. Each red block has an associated use-case document. Links are provided in Logic and Translation Use Cases. For a more complete block diagram, see the interactive online End Equipment Reference Diagram for *Battery Management Systems*.

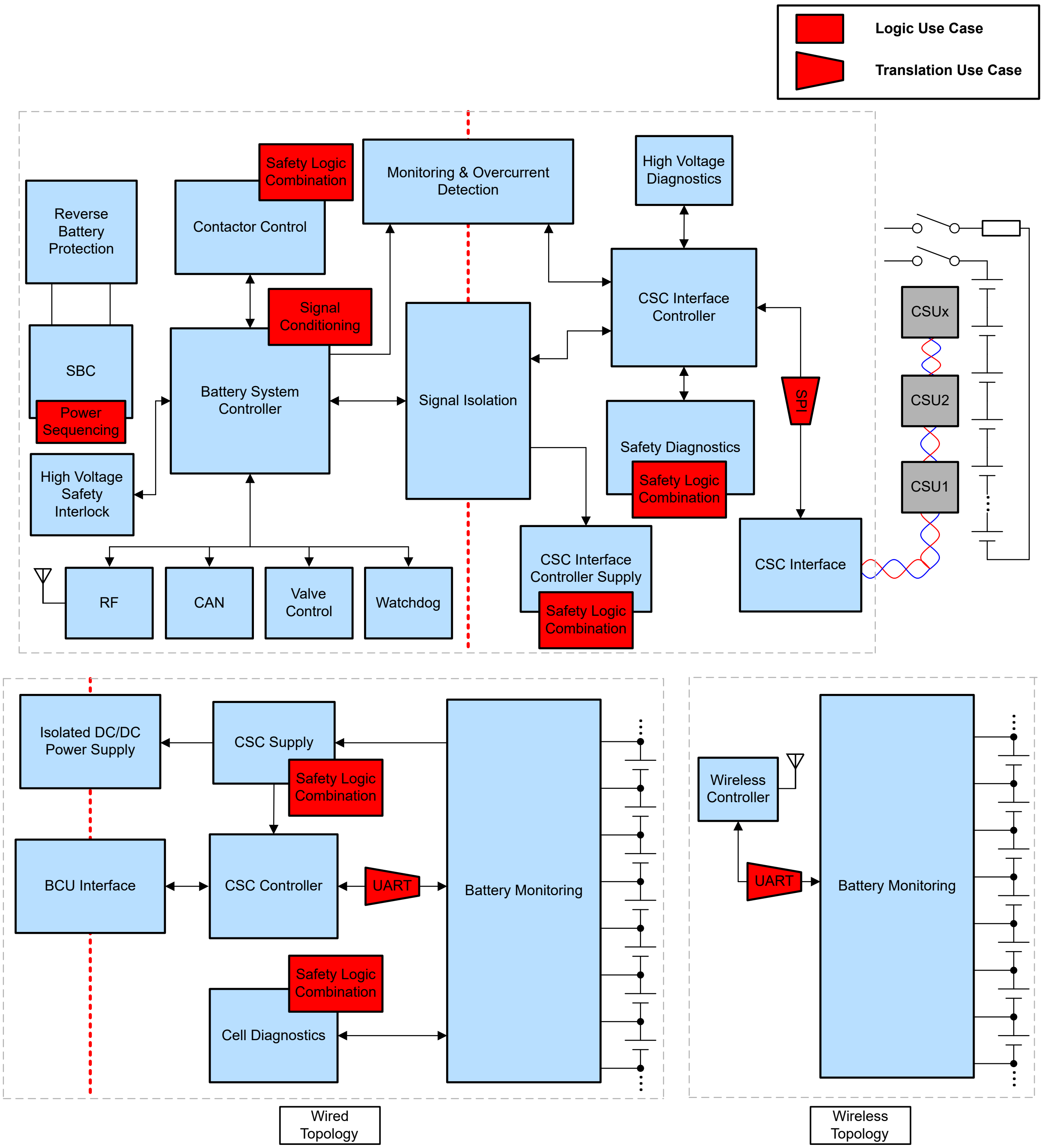

Figure 1-1. Simplified Block Diagram for Wired and Wireless Battery Management Systems

2 Optimizing Safety Signal Management

The Battery Management System performs a great amount of voltage, current, and temperature monitoring in order to keep the battery healthy and provide efficient control. It is also important to keep the end user safe around these high voltages and currents associated with electric vehicles, which makes safety and robustness key design goals in Battery Management Systems.

Logic is often seen handling safety signals such as over-current (OC), over-voltage (OV), and over-temperature (OT) signals to help indicate fault conditions. These logic circuits, however, are typically used as a reduntant path to help reach the safety metric target set by the OEM. Figure 2-1 illustrates how Logic and Translation can be utilized in this manner to help meet these targets.

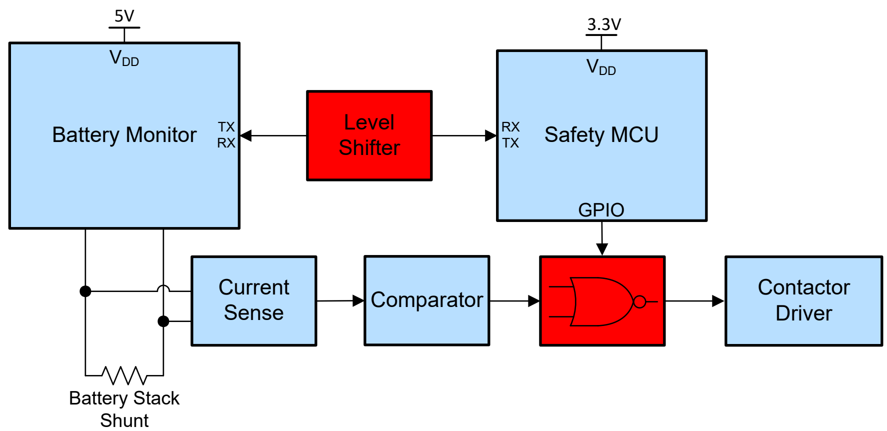

Figure 2-1. Example of Logic and Translation Improving System Robustness

In the example above, the battery monitor device has its own current sensing capabilities to monitor the current through the battery stack. When it senses an OC fault condition it can then communicate this to the safety MCU using a level shifter to match the different I/O voltages. The safety MCU will then address the fault by changing the state of the contactor or relay. This main path may not meet the required safety metric due to the compexity of the devices involved. A second path is then created to perform the same task, but this path includes simple devices with lower failure risk.

Discrete logic devices do not have complex internals, making them ideal for this application. Though simple in design, these devices can be packed with features like back drive protection and schmitt-trigger inputs that can improve design robustness even more. The following sections will help with selecting the right function and features to best optimize system performance.

3 Logic and Translation Use Cases

Each use case is linked to a separate short document that provides additional details including a block diagram, design tips, and part recommendations. The nearest block and use-case identifiers are listed to match up exactly to the use-cases shown in the provided *Simplified Block Diagram*.

Table 3-1. Logic Use Cases

Nearest Block	Use-Case Identifier	Use Case
SBC	Power Sequencing	*Combine Power Good Signals*
Battery System Controller	Signal Conditioning	*Drive Transmission Lines With Logic*
Contactor Control, Safety Diagnostics, CSC Interface Controller Supply, CSC Supply, Cell Diagnostics	Safety Logic Combination	*Enable or Disable a Digital Signal*

Table 3-2. Translation Use Cases

Nearest Block	Use-Case Identifier	Use Case
CSC Controller, Wireless Controller	UART	*Translate Voltages for UART*
CSC Interface Controller	SPI	*Translate Voltages for SPI*

4 References

- Texas Instruments, *Combine Power Good Signals* application brief
- Texas Instruments, *Drive Transmission Lines With Logic* application brief
- Texas Instruments, *Enable or Disable a Digital Signal* application brief
- Texas Instruments, *Translate Voltages for UART* application brief
- Texas Instruments, *Translate Voltages for SPI* application brief