A REPORT

ON

Firmware verification for Automotive Wireless Battery Monitoring Systems

BY

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Abstract Sheet
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Abstract

The goal of this project is to thoroughly assess the configuration of a Wireless Battery Management System (wBMS) that is meant to be used in automotive settings.
Of the various wBMS solutions ADI offers, the specific wBMS solution under consideration, which the author has thoroughly evaluated, is designed to comply with criteria that hold high regard for functional safety. This study provides an examination of the techniques used to verify the firmware against said functional safety standards which govern microcontroller operations at the embedded level.

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Contents

Abbreviations

API	**A**pplication **P**rogram **I**nterface
OEM	**O**riginal **E**quipment **M**anufacturer
wBMS	**w**ireless **B**attery **M**onitoring **S**ystem

Chapter 1

Introduction

1.1 Motive

There is a growing demand for advanced cockpit electronic systems as a result of the automotive industry's ongoing shift towards electric mobility. These technologies are essential for enabling comprehensive vehicle component monitoring and for providing the occupants with a clear, comprehensive overview of the current state and overall health of the vehicle.
The battery of the car is by far the most important of the crucial factors that need constant monitoring. This is particularly important for battery packs made mostly of Li-ion substrates because of the potential for severe, potentially dangerous consequences if their health and charge states are not strictly monitored.
Given these factors, Analog Devices Inc. provides a wBMS solution that is simple to integrate into the automotive setting with certain OEMs.

1.2 Contribution to the project

This project has provided the chance to significantly advance the implementation and verification of functional safety, particularly at the level of battery monitoring sensors, the exact details of which will be discussed in the later sections.

Chapter 2

Product walkthrough

2.1 Hardware setup

In the overarching architecture of the wBMS, the fundamental structure comprises two primary components: a device to monitor battery data and a device that collects the relevant data (battery monitor sensors).

To facilitate seamless utilization of this collected data by client microcontrollers, a specialized software tool is employed which is designed to run parallel with compiled applications of said microcontroller that expose this data to be easily monitored via external methods.

It is important to recognise that the integrity of transmitted data may be vulnerable to numerous errors along its path due to the complex system architecture. Keeping in mind the various faults that could occur while transmitting data from one end to another, various safety guidelines have been agreed upon to be followed by the multiple components in the system.

The safety guidelines outline certain measures that must be adhered to. These techniques are intended to guarantee that, even in the presence of defects, the system can continue to warn relevant parts about the presence of a fault while supporting the ultimate goal of adhering to set functional safety requirements

2.2 Software setup

Given the multiple pieces of hardware present in this setup, there has to be relevant software that runs on each of them.

The sensor that essentially gathers the battery data is given certain instructions (through software) at certain intervals of time, which are then collected and ultimately reported to the client microcontroller that requests the data.

A methodical approach is used, with these instructions serving as a key instrument, to ensure that the monitoring sensor complies with the safety regulations.

In order to ensure the utmost stability of the sensor and compliance with established safety protocols, two potential approaches can be employed. Firstly, the sensor can be subjected to the injection of erroneous and unreliable instructions. Alternatively, the sensor's output can be intentionally corrupted, and the resulting responses at the monitoring end can be compared to a pre-existing baseline. This comparative analysis serves to evaluate the sensor's performance.

To aid in this process of cleanly monitoring the sensors, multiple test frameworks for the various components in the system have been designed and tested.

Chapter 3

Testing methodologies

3.1 Initial testing methods

The original execution of this procedure was conducted utilising the Python programming language, employing a hybrid methodology that integrates scripting techniques with the principles of Object-Oriented Programming (OOP).

Although this particular methodology has proven to be effective in achieving the intended outcomes, it has posed several difficulties in terms of sustainability and flexibility. As the system has undergone development, it has been evident that the introduction of new needs entails making many modifications dispersed throughout different files, resulting in a codebase that is more vulnerable to errors and less modular.

In response to the challenges identified, a decision has been made to pivot toward an alternative approach, more centred on OOP principles and modularity of the codebase.

3.2 Current testing methods

To further evaluate the functionalities of the sensors in a phased approach, we use certain APIs exposed by ADI's (internally developed) software. These APIs allow us to directly communicate with the wBMS system and monitor all important aspects of the system.

These API calls are bundled together across the codebase and exposed to users to be called easily, eliminating any faults that may be caused by the software's UI. This will also help the developers of the test frameworks to keep things modular and easy to maintain in the long run

Chapter 4

Conclusion and future work

4.1 Conclusion

To conclude, our comprehensive validation of the wBMS system has encompassed diverse approaches. Additionally, various software tools, including version control through Git and supplementary utilities, have played pivotal roles in expediting the development of diverse testing frameworks. The advantages of modularizing our test framework, as demonstrated, not only facilitate the process for developers but also enhance user experience in crafting robust frameworks. This modular approach serves as our guiding principle for extending similar strategies to other sensor families in future endeavours.

4.2 Future work

Our forthcoming objectives mainly revolve around extending the testing capabilities to be compatible with different sensor families and implementing analogous resilient frameworks. This approach will remain rooted in the core principles of modularity and user-friendliness, with a constant focus on enhancing the overall user experience.