# Algorithm for sensor fault diagnosis in battery management system

Umar Jamil*, Dania Batool* and Jonghoon Kim*
Energy Storage Conversion Lab., Chungnam National University*

ABSTRACT

In a battery management system, the sensors are interfaced to get the information of the voltage, current and temperature. The faults under focus are short circuit, over-voltage, under-voltage, overshoot current and under current. These faults are being tested with the issues such as sensor failure, sensor drift and sensor saturation. A new route of sensor failure is being introduced in which includes hardware based BMS is under test.

Addition of sensor fault scheme to the conventional Battery Management System increase the battery life and make the hardware reliable. This proposal is based on the conventional Battery Management System with addition of fault diagnosis. So to handle the things in an intellectual based diagnosis the algorithm is developed in the simulation to test the variation detection in the sensor. The uniqueness in this work is based on the over-shooting current and voltage which makes the battery to degrade. This degradation is avoided by developing the software in which have to detect the fault.

## 1. Introduction

World is moving towards the lack of natural resources. Due to which energy and environmental crisis is going to increase rapidly in the coming era. That's the reason to overcome the energy and environmental disasters, electric vehicles (EVs) are being developed speedily in the world. Batteries with long life and high energy density are being extensively used to carry good power on vehicles. They play a vital role in the routine of EVs such as long-distance driving and act as clean energy source. There are several battery monitors in big battery systems that requires the BMS regarding their present specifications and operating modes. Because of the high voltages, sensors might become noisy due to electromagnetic interference (EMI)[1], resulting in communication errors. Sensors errors or delays can cause major problems in the battery system since crucial information must be reported to the BMS so that important choices can be made immediately. It is important to implement fault detection so that safety commands of battery should be reported timely [2]. The purposed system approach adds improvements in the conventional system in terms of fault detection and reduce hardware complexity. This paper aims to integrate sensors faults in the conventional energy system which required less development and testing time. For effective productivity of the battery, suitable ambient and conditions plays a great role. Which includes the information e.g., state-of-charge (SoC), temperature, state-of-health (SoH) and other liabilities, needs to monitored or analyzed for Battery management system (BMS).

## 2. Proposed Algorithm approach

In this paper, a new hardware design and fault detection approach is proposed to the conventional Battery Management System (BMS). The BMS hardware includes the features of temperature measurements, current sensing, voltage sensing, cell balancing, over-current protection, over-voltage protection, under-voltage protection, on-board memory and user-display interface. The sensors over-shooting normally makes the battery to degrade and results in the failure of the BMS.

Temperature has direct effects on the health and efficiency of the battery. Battery performance varies change in temperature. Temperature will be measured by thermocouple as it can measure from distance. Thermocouple PT100 will be attached with the amplifier MAX3185 for precise amplification. PT100 has strip of Platinum which resistance change with temperature e.g., at 0 ºC it has 100-ohm resistance. The communication protocol of MAX3185 is I2C, which provide us an easy to add or remove any temperature sensor. Fig. 1 shows the connection diagram of the temperature sensor with the microcontroller.

The current of the battery pack, will be measured by ACS758 current sensor, this sensor has current arrange of 200A. When car is starting, it takes up-to 450A, so for meeting this current range we can modify this current sensor with the shunt resistance. We have to add more than one to take the average to have best results of current. Fig. 2 shows the ACS758 current sensor with the microcontroller. Fig. 4 shows the pseudo code for the algorithm which involves the initialization of the sensor, sensor calibration, measurements,

checking the scheme of the limitations where have to take the action by reporting to the server so that the battery should be saved.


Fig. 1 Block diagram of temperature sensor with BMS

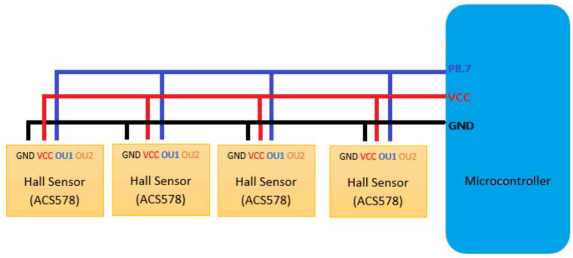


Fig. 2 Block diagram of current sensor with BMS

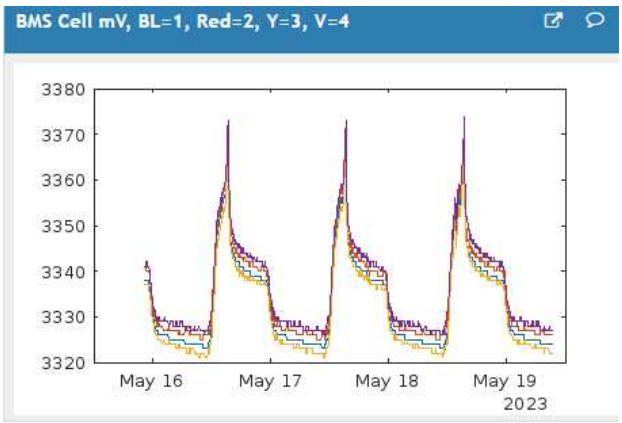


Fig.3 Results of the BMS cell

## 3. Results analysis

This results indicates that initially measurement of sensor is taken then it is further analyzed for the limitations. As it can be seen from the Fig. 4 that which presents the block diagram of this work firmware development. Initially the measurement of the sensor is taken which is further checked for the limitations of the upper and lower. The test for the algorithm is performed on the hardware. Which presents in the Fig. 3 that the current and voltage of the battery cell is taken then executed to deal with detection of the faults.

```
initialize inputs
initialize variables
calibrateSensors()
 (BMS)
startMeasurement()
if current > upperLimitCurrent:
    handleUpperLimitCurrent()
// Check the lower limitations
if current < lowerLimitCurrent:
    handleLowerLimitCurrent()
// Check the sensor noises
if hasNoise():
    reportNoiseToServer()
// End the process
endProcess()
```

Fig.4 Algorithm of the firmware

## 4. Conclusion

In this research work, the easy way to add sensors faults in conventional BMS by using a simple hardware approach is proposed. The proposed approach removes the complexity in the design as it removes the diagnosis. Moreover, the proposed technique helps in increasing the battery life by removing the errors. As this approach do not require redesigning of complete new hardware so it take less time in upgrading the existing BMS systems.

This research was supported by a research project (R21XO02-09, V1G and V2G charge/discharge patterns development and Korea Electric Power Corporation. (Grant number: R22XO01-2, design of PCSAC-side unbalanced compensation and DC-side quality improvement algorithm and proposed cooling method to eliminate cell degradation causes).

## References

[1] Shirai, "Time domain analysis of transmission failure on CAN system due to differential-mode noise emitted from a buck converter." IEEJ Journal of Industry Applications Vol. 4, No. 4, pp. 608-614, 2019

[2] Sakya, S. "Design of hybrid energy management system for wireless sensor networks in remote areas." Journal of Electrical Engineering and Automation (EEA) Vol. 2, No. 1, pp. 13-24 2020