Design on Test Platform of BMS System based on dSPACE

Dongmei He[1, a], Enguang Hou[1, b], Guangmin Liu[1, c], Jie Yu[2, d]

[1]Automatic Institute, Shandong Key Laboratory of automotive electronic technology Qilu University of Technology (Shandong Academy of Sciences) Shandong Ji'nan, China

[2]School of transportation and vehicle engineering Shandong University of Technology Shandong Zibo, China

[a]he.ferry@163.com, [b]hngauto@163.com, [c]liugm@sdas.com, [d]1206674681@qq.com

Abstract. Introduces the scheme of dSPACE real-time simulation system and its application in the BMS test platform system. Combined with the pure electric vehicle BMS, expounds the design method of BMS system based on dSPACE. Designs the BMS system test platform by using the rapid control prototype RCP and hardware in the loop simulation HILS technology application of RCP.

Keywords: dSPACE; Battery Management System (BMS); Hardware-in-the-loop Simulation (HILS).

1. Introduction

At present, with the development of new energy vehicles, batteries have become one of the main power sources of new energy vehicles. BMS (BATTERY MANAGEMENT SYSTEM) as an important part for the protection and management of power batteries, its function is outstanding day by day [1]. The battery management system (BMS) is closely linked with the power batteries, and the distribution and running environment of batteries in electric vehicles are very complex. This requires a high degree of reliability for the battery management system (BMS), which poses greater difficulties and challenges for the design and testing of the battery management system (BMS).

In the design process of the test-bed of BMS system based on dSPACE, By RCP (Rapid Control Prototyping), BMS monitoring object model is built quickly, the dSPACE real-time simulation system is applied to the development and test platform of MATLAB/Simulink control system, and HILS (Hardware-, in-, the-Loop, Simulation) testing is introduced.

The following is a further introduction to the Design on Test-bed of BMS System Based on dSPACE.

2. BMS System Profile

Battery management system (BMS) is used for intelligent management and maintenance of battery units, and The BMS for electric vehicle batteries needs to monitor the battery status to prevent the battery overcharge and over discharge, to calculate SOC, SOH to extend battery life. BMS would control battery charging and discharging circuit relay when necessary, in order to use the battery safely, and also, provide communication function, to communicate with charger and Vehicle Control Unit [2, 3].

Specifically, according to the structure, BMS can be classified as integral BMS and distributed BMS. The integral BMS concentrates the system on one circuit board, and the distributed BMS is divided into main control board and collecting board, and some distributed BMS contains high voltage switch board.

Take the distributed BMS as an example, the connection and communication relationship between all parts of the BMS and the whole vehicle controller and charging equipment in the actual work process is shown in Figure 1. The main control board in the distributed BMS is mainly used to gather the electric core voltage signals, temperature signals and battery pack signals, when necessary it can open battery pack heating control relay or fan control relay. The high voltage board (HV board) is used for high voltage relay control and state feedback, collecting the total voltage, total current and other high voltage data. Through the external bus interface and I/O, the main control board receives voltage signals, temperature sensor signals and the external CAN bus data signals, and carries out the

warning, alarm and control management after the data is processed and calculated by the controller MCU. The main board is also responsible for communication with the Vehicle Control Unit (VCU), charging and other devices, to achieve control logic, through the drive relay to achieve high voltage loop relay control.

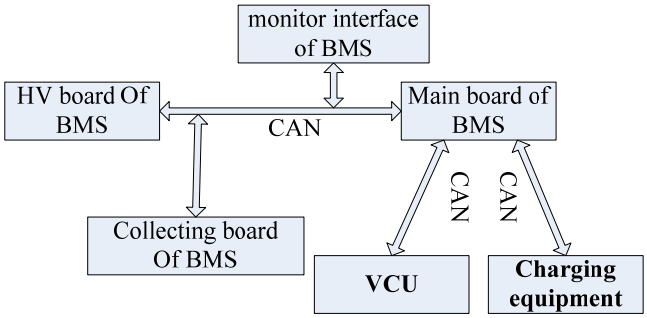

Fig 1. BMS system connection and communication

3. dSPACE Real Time Simulation System

DSPACE real time simulation system is a hardware and software platform based on MATLAB/Simulink developed by dSPACE company of Germany. It is a hardware and software platform for control system development and hardware in the loop simulation platform, which has implemented a fully seamless connection with MATLAB/Simulink/RTW [3].

Compared with the traditional development process, DSPACE system has the advantages of strong real-time, high reliability and good expansibility. When using dSPACE real time simulation system, we can make many combinations of simulation system by using its standard component system to meet the requirements of different test environment and working conditions. The seamless connection between dSPACE and MATLAB, so that MATLAB users can easily master the use of dSPACE, which is convenient for analysis and design of real-time, real-time on the parameters of the model were modified to perform the test. We can repeatedly change and test the designed control system through hardware in loop simulation, and save time and cost greatly by parallel development, thus speeding up the development and testing process of new products.

3.1 dSPACE based BMS System Test Platform

For electric vehicles, BMS (battery management system) as an important part of the protection and management of power battery, its efficiency, safety and reliability are very important, which requires a thorough test in the development process. Using dSPACE based BMS system test platform, through hardware in the loop simulation, products can be tested repeatedly, in different environments, with vehicle controllers and charging equipment of different manufacturers.

The hardware environment of the test platform is composed of DS1005 board, DS2211 board and DS4330 I/O board of dSPACE. The motherboard processor of DS1005 is PowerPC750, and DS2211 has 16 14 bits A /D channels, 20 12 bits D /A channels, 24 PWM inputs and 9 PWM outputs, 16 digital input/output (I/O) channels, 2 CAN and other digital signal processors. The software environment is modeled by Mat lab /Simulink, and the input and output settings related to BMS are simulated. Control Desk is used to manage the interaction between user and hardware environment, and the testing function is realized. The input / output channels on the dSPACE board are connected with the tested BMS on the test platform through a dedicated wiring harness, and the physical connection of the electrical input / output signals during the simulation test is achieved.

3.2 dSPACE Hardware Interface and Hardware Connection with BMS

All the input and output signals of the BMS should be modeled and simulated by the test platform. And after the analysis of the specific function of vehicle controllers, charging equipment's, by application of Rapid prototyping design, the BMS related signal is modeled and simulated by using the input / output channel of the I/O dSPACE card, and the dSPACE card of the I/O is connected with

the BMS to be tested by a dedicated wiring harness. So, the hardware environment of the test platform is built.

In order to simulate various of operating conditions of the electric vehicle batteries, dSPACE is used to provide the I/O signals, temperature analog signals, current analog signals, to measure the relay control signals outputted by BMS, to provide charging device PWM signal and CC, CP connection confirmation signals. Take one temperature input interface as an example, BMS uses NTC (Negative, Temperature, Coefficient) for temperature sampling, therefore, we use the DS2211RES_B1_C1 channel (P2B_34 pin) of DS2211 board to simulate NTC for sampling, simulate the temperature changes by changing the output resistance signals, and test the temperature related functions of BMS.

Use 0805 SMD NTC B57401V2103 to monitor temperature on board, TABLE 1 is the NTC parameter table.

Table 1. The NTC parameter table

R25Ω	**B25/50 K**	**B25/85 K**	**B25/100 K**	**Ordering code**
10k	3590	3635	3650±3%	B57401V2103

According to the resistance characteristics of NTC, the corresponding resistance values at different temperatures are calculated. For the convenience of description, several typical temperature points are selected, and the resistance values are listed TABLE 2.

Table 2. The resistance values at different temprature

T (℃)	**-40**	**0**	**25**	**60**	**85**
Rt(Ω)	286999	30103.09	10000	2822.415	1330.293

When simulating the working condition of 0 DEG C, the DS2211RES_B1_C1 channel of the DS2211 board is controlled so that the output resistance is 30103.09 ohms, and the temperature is changed to test the BMS. When simulating the working condition of 25 DEG C, the DS2211RES_B1_C1 channel of the DS2211 board is controlled so that the output resistance is 10000 ohms, and the temperature is changed to test the BMS.

According to the actual test requirement, after the concrete function analysis of the Vehicle Control Units and the charging equipment, by using Rapid prototyping design, the physical quantities need simulation analysis would be determined. By connection the input / output channels on the dSPACE I/O card through the dedicated wiring harness to the BMS being tested, the physical connection between the electrical input / output signals during the simulation test can be achieved, and Real time hardware in loop simulation is performed. Figure 2 is a block diagram of the BMS based dSPACE system test platform.

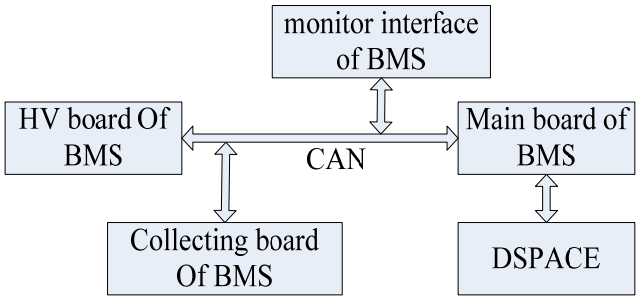

Fig 2. block diagram of BMS system test platform based on dSPACE

In practical application when testing the BMS system, for the BMS master board is responsible for the main computing control tasks, the software interrupts, priorities, various alarms and logic control functions, etc should be tested specially. BMS high voltage board and acquisition boards need to be simulated so as to test the function of BMS under different working conditions of the electric

vehicle batteries. Figure 3 is the block diagram of the BMS system mainboard test platform based on dSPACE.

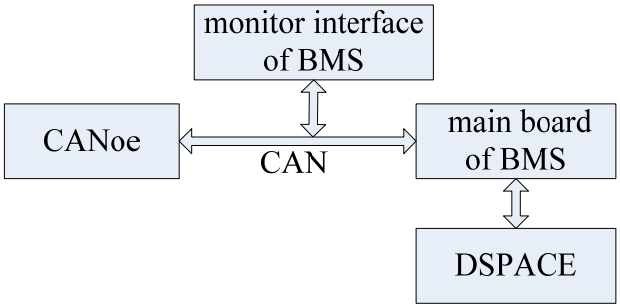

Fig 3. block diagram of BMS system mainboard test platform based on dSPACE

3.3 Test Interface Implemented by ControlDesk

The test interface was designed by using dSPACE's test management software, Control Desk, and in operation mode, the tester can input data for testing, and the hardware runs according to the working condition and returns the execution result. Figure 4 is the BMS system test interface, and figure 5 is the CANoe parameter input interface for the master board test.

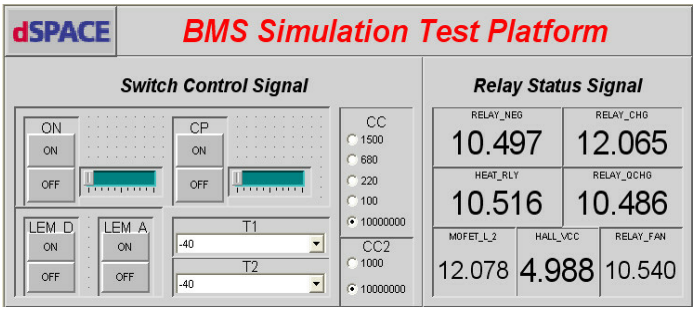

Fig 4. BMS system test interface based on dSPACE

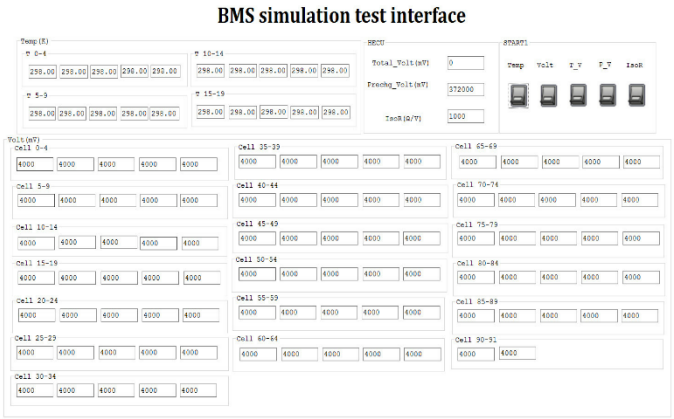

Fig 5. the CANoe parameter input interface for the master board test

In the process of testing, according to different operation conditions, we can input variable and test different conditions of hardware operation, so as to judge whether the test hardware and software are running correctly, whether test software interrupts and hardware interrupts performed correctly whether sensor measurements and relay control signals are correct, so as to provide reference for hardware and software design improvement.

4. Summary

Using BMS test platform based on dSPACE, during the development and test process of the BMS test, we can simulate the different working conditions of various batteries realistically, and complete the design process, debug process and improve the upgrade process of BMS system easily. During the test, electric vehicle batteries work at a variety of conditions such as high temperature, low temperature, charging, discharge, and all kinds of other protection is simulated and the response of BMS (software and hardware) is validated based on the it's behaviors. And also, the connection communication simulation between BMS and different charging devices and Vehicle Control Units would be verified.

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