Development Research about the Power Battery Management System of Pure Electric Vehicle

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Abstract: Battery management system can provide accurate and reliable power battery information to electric vehicle, as well as carry on real-time monitoring to the various functions of battery management system itself operated. And it also can carry on acquisition and analysis to battery running data. The electric vehicle power battery management system designed in this paper has solved the real-time accurate collection problem of battery monomer voltage, which lays a good foundation for accurate judging the battery status and accurate measuring state of charge (SOC).

1. Preface

The key to the industrialization of electric vehicles is the development of power battery and application technology industrialization. At present, the main bottlenecks that restrict the electric vehicle development are battery and its application technology. The intelligence management system not only can carry on the site management to the power battery pack, but also can carry on the monitor and the control to each battery. Besides, it can joint with the host system easily, realize the centralized monitoring and the data transmission. It can real-time monitor power battery performance parameters, timing measure a single battery's terminal voltage, as well as battery temperature and working current. These parameters will be shown on LCD, and when the battery voltage, current, temperature, anyone over standard, control circuit of battery pack will be cut off. The battery's SOC (State of Charge) will be calculated, and shown through the liquid crystal display[1].

The electric vehicle operating conditions is quite complex, such as environmental temperature and humidity changes, load capacity changes, air pressure changes, atmospheric corrosion, vibration, shock, sudden changes of input/output power, static place, etc., which determines the battery condition is also more complicated. To make electric vehicle with good performance characteristics under various working conditions, it needs to plan and design for battery management system structure, which to ensure management system reliability and safety practical application, avoid over charging and discharging, extend battery service life and to improve the comprehensive property of battery.

2. The overall scheme of pure electric vehicle battery management system design

2.1 The main functions of the battery management system

1) Monitoring the various operating parameters of battery pack accurately, such as the module voltage, the total battery voltage, battery temperature, battery, and pressure. etc;

2) Forecasting battery SOC , maximum allowable charging and discharging current, discharge depth through the measured battery parameters;

3) Controlling the battery’s charging, decide electric quantity which may be released or emitted according to the state of battery to avoid damaging battery;

4) Module voltage using high distributed collection program, transmits the collecting data with the CAN-bus;

5) The battery management system uses high-speed CAN bus communicating with the vehicle to

control system to achieve real-time and reliability requirements;

6) Real-time obtain various states of the battery pack, send out different levels alarm message when the breakdown presents, and take appropriate measures to protect the safety of the battery pack;

7) SOC of all single battery within the battery pack and voltage balanced control[2] ;

8) Battery pack thermal management.

2.2 The basic structure of the battery management system

The battery management system structure is shown in Figure 1, as in [3].

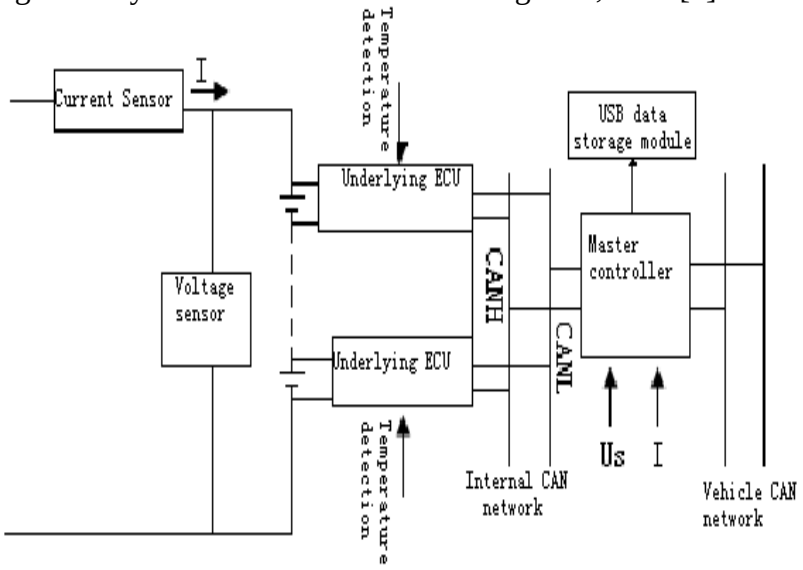

Figure.1 battery management system structure

3. System hardware design

Battery management system circuit is consists of power module, DSP chip TMS320LF2407A and data acquisition module based on multiple OZ890,I^2C communication module, SCI communication module and CAN communication module.

3.1 Power Module

Power provided by vehicle is +12 V, the voltage management system needed include: +3.3 V (DSP, isolating circuit), +5 V (the bus driver and other chips used), ± 15V (current sensor), which can be obtained through converting DC-DC, by which not only can satisfy the power demands of each chip, but also can play the role of isolation anti-interference.

3.2 Data Acquisition Module

The acquisition of total voltage, current and temperature are completed by DSP. Single voltage battery acquisition and balanced are completed by the OZ890 chip and sent to DSP by I2C bus. This module circuit mainly includes front-end acquisition processing and equalization circuit.

3.3 I2C Communication Module

The acquisition and processing data sent to LF2407 through the I^2C bus by OZ890 sampling module. As LF2407 itself without the I^2C interface, this design uses PCA9564 to expand its I^2C interface. In order to prevent the data transmission on I^2C bus from electromagnetic interference, isolation is necessary to bus signal. Considering the I^2C bus is bidirectional transmission, isolation is carried on by using the AduM1250 bidirectional isolation chip.

3.4 Serial Communication Module

Battery management system sent the acquisition and processing data to PC interface through

serial, realizing human-machine interaction. Through serial interface, parameters, such as battery's total voltage, monomer voltage, current, SOC, fault state, charging and discharging power and so on can be observed, and can also be sent through serial to realize on-line calibration of management system.

MAX232 is + 5V power transceiver, connected with computer serial, realizing the level conversion between the RS-232 interface signal and TTL signal, carrying on asynchronous serial communication between BMS and PC machine.

In order to prevent the data transmission on serial from electromagnetic interference, it is necessary to isolation to bus signal. As serial is one-way transmission, it is more convenient to use 6N137 photoelectric coupling.

3.5 CAN communication module [4]

The CAN communication is the information bridge joint battery management system (BMS) with vehicle HCU. BMS sends battery state parameters to HCU through the CAN bus. HCU makes decisions by judging current battery state and assigns the power between the motor and engine, to control charge-discharge current. Meanwhile BMS can also receive relational commands from HCU and make corresponding processing. The hardware mainly provides differential sending ability to bus data and differential receiving ability to communication bus data through PCA82C250 general CAN transceiver.

4. System Software Design

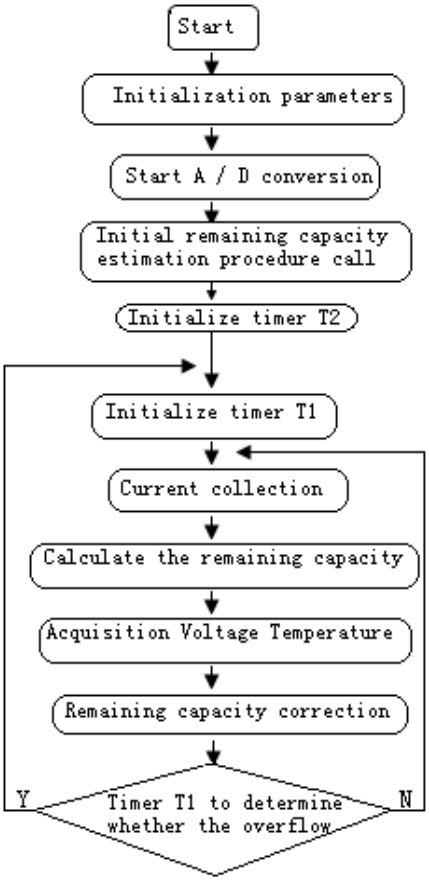

Figure.2 flow chart of the remaining capacity calculation program

From the function battery pack comprehensive management software system is divided into five program modules: system initialization, human-computer interface, data processing, fault diagnosis, communication and network. The system initialization module is to implement the diagnosis and start of the central processing circuit as well as the initial definitions and settings of system

variables; human-computer interface module is responsible for processing the input commands and displaying the output; data processing module is to achieve data collection and conversion, battery group's remaining capacity prediction algorithm implementation and other functions; fault detection and diagnosis module gives the alarms of the abnormal state of the battery; communication and network module provides protection within the system, and makes real-time, high-speed and reliable information exchange between systems and other vehicle control units.

Battery state of charge SOC, describing the number of remaining battery power, is an important parameter in the use of battery. Therefore, SOC estimation is an important function of the management system of electric vehicle battery. In this system, when CAN sends a message, the central processor (CPU) must send it to the sending buffer and command the sending and requesting flag in the register. When the vehicle controller requires the current remaining capacity, a remote frame requesting the battery management system to send the remaining charge is sent, then the CAN transmit module is invoked, and at this time battery management system sends the data frames[5] of the remaining capacity. The flow diagram of remaining power calculation program is shown in Figure 2; the flow diagram of CAN transmission is shown in Figure 3.

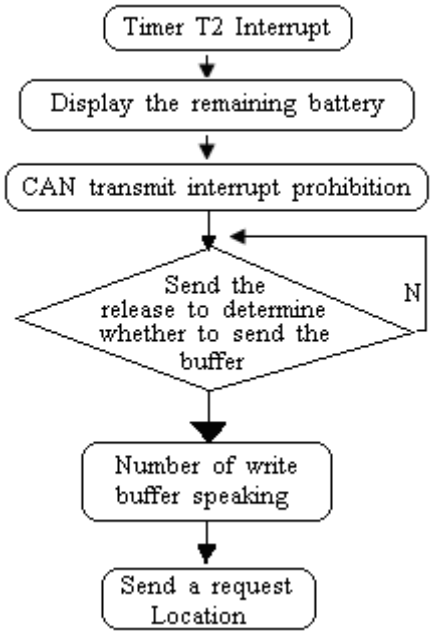

Figure.3 CAN send a flow chart

5. Conclusion

Battery management system is always a key technology in the development of electric vehicles. The most basic role of battery management system is to monitor the working states of the battery (the battery voltage, current and temperature), through the measurement of these parameters to predict the battery's SOC and the corresponding residual mileage, managing the working condition of the battery in order to maximize utilize the battery's storage capacity and cycle life. At present, in the battery operating parameters measurement, what mostly used to measure is mechanical relay or optical relay strobe, as there is a lot of battery and a certain distance between control board and battery, and finally it is inevitable to oversize rattail and easy to make a mistake when wiring, which causes the malfunction and safety potential.

Therefore we designed an intelligent measuring node with CAN interface to measure battery parameters, and then using the CAN bus to connect the each node and managed by an upper computer. The wiring is simple and reliability is high. What more important is connecting with other CAN control units on the vehicle to share the information.

Acknowledgment

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