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# RESEARCH ARTICLE

## DESIGN OF MOBILE BATTERY INTELLIGENT CONTROL SYSTEM

***Juan SONG, Qingqing ZHU, Ruiying SHAO and Peifen JIN**

Qingdao Huanghai University, Qingdao, China

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****Corresponding author:*** **Juan SONG**

**ABSTRACT**

According to the working environment and conditions of mobile battery, an intelligent control system is proposed. The system can complete the detection, communication, display, early warning and storage of battery-related information to ensure the stability of the working status of each battery. The system is based on single chip computer and has high performance-price ratio. In terms of function, the designed system has many functional modules, besides basic data detection, it can also realize fault diagnosis, storage and early warning, with high efficiency. In terms of effect, the system can effectively improve the reliability of the whole battery pack, without abnormal power supply, and has high economic and social benefits.

## INTRODUCTION

The automation capability of equipment is an important standard to measure the whole automation production capacity. However, in many industries, the recognition of the importance of battery charge and discharge characteristics monitoring is still insufficient, and the way of manual management is not in line with the long-term development direction. With the application of information sensing technology, communication means and signal acquisition equipment, it provides a good foundation and precondition for the realization of battery intelligent control system. Through signal acquisition and processing of multiple controllers, the relevant parameters can be obtained in real time. The evaluation of the working state of the parameters can not only effectively ensure the smooth operation of the work, but also predict and judge the induced or forthcoming faults, and reduce the failure rate of mechanical and electrical equipment. Battery pack is composed of many single batteries. Probability analysis shows that failure of one battery may lead to the working state of the whole battery pack. Therefore, it is necessary to monitor each single battery. Under long working conditions, the probability of abnormal charging and discharging is relatively large, which requires timely detection of single battery failure through monitoring system and timely replacement in the maintenance process. Under the same working conditions, single batteries with abnormal or faults often complete their work by charging and discharging ahead of time. In addition to charging and discharging time, heat is also an important parameter to measure whether the battery is working properly. If the design of the battery itself is defective or the battery pack layout is defective, it may cause insufficient heat dissipation, making the temperature too high, which will not only affect the normal charging and discharging performance, but also cause internal resistance failure and damage the battery chip in serious cases.

### Functional Design of Control System

***Basic composition of the system:*** In order to achieve the optimal design of battery management system, this paper fully draws on the experience of relevant research at home and abroad, and fully considers the requirements of equipment in case of emergency, which makes the hardware improved greatly. The whole system consists of several parts, including a battery management system composed of multiple single batteries in series. The battery management system is divided into many parts, including the master controller, the controller of each battery group, the display screen and the voltage controller. All the battery modules are managed by the assembly controller, and the voltage detection is managed by the battery module. By compiling the CAN protocol and connecting all the modules into a whole, the single current, voltage and the voltage and current of the whole battery group can be better measured. In addition, the system can also achieve a series of functions, such as regular maintenance of batteries, protection of batteries and so on. The parameters of the battery pack in the working state can be displayed by the display screen in the system, and the function of early warning and alarm can also be realized. After the battery discharges, if the module voltage is less than 22.4V or the voltage of a single cell is less than 2.7V, the whole system will start to be in a protective state, leading to the cut-off of the whole discharge state. When the module is discharging, if the motor is not detected to be in an effective state, the master controller will give the discharge instructions to the whole battery pack. Once the system detects that the charger is valid, the master controller will issue the charge indication command. After that, the controller of the battery pack will feedback the charging application order, and the master controller will issue the authorized charging order after receiving the instruction. When the module receives the charging instruction, it begins to

charge. Once the charging is completed, the system repeats the previous instructions to ensure that all modules are fully charged. When the current value collected by the current sensor of the module in the whole system is larger than the set value, the waiting state begins. When charging, there is no under voltage. In addition, when the battery is discharging, if there is overvoltage, the discharging will be invalid. This is because by default, the maintenance of discharge state can be guaranteed by hardware. So, as long as you don't run the software, you can keep the state of electricity. If the circuit board fails, no matter what state the battery pack and detector are in, they are electrified.

***Structural layout scheme:*** In the design process of the system, multiple batteries must be controlled independently and as a whole. The whole system is controlled by the master controller, and each component can work independently. In the whole battery power management system, the transmission of information is completed by CAN bus. The battery management system designed in this paper has many functions, such as system protection, alarm and so on. In order to realize the communication between each module, the bus must be isolated. The isolated bus connects the communication between the block controller and the master controller. When designing the system controller, it is necessary to ensure that the voltages at both ends of the detection unit are balanced. The CAN bus connects the master controller with each battery controller. The battery controller and the master controller balance the whole system according to all the signals collected. Battery pack controller must have effective control of battery charging and discharging, be able to start and stop at any time, and be able to effectively collect all signals during charging and discharging, such as temperature signal, short circuit signal, over current signal, over voltage signal, etc. Acquisition and analysis of equalization data are realized, and the corresponding equalization instructions can be issued after signal analysis. It can realize the interconnection and signal transmission and sharing among display screen, battery module controller and master controller. In addition, the system can process the collected signals and the related parameters of detection, and store and analyze them. The charging and discharging process of each battery group can be well managed by the system, which ensures that the charging and discharging process will not occur in abnormal conditions, and when encountering unexpected situations, it can also deal with the problems in time and play a protective role for the battery. The system can realize the effective detection of the charger, and can judge whether it works in real time. The display screen mainly receives and displays the relevant parameters.

**Specific Design of Control System**

***Design of Voltage detection equalization controller:*** Nowadays, it is possible to measure the voltage of batteries in series with the help of dedicated chips, centralized and distributed methods. The centralized method only needs a complete set of detection circuits to realize the detection of series single battery. This method relies on floating technology. It refers to the use of scanning method to collect the total voltage and single battery voltage data in a relatively short period of time, and then time-sharing multiplexing hardware. Although this method has the advantage of low cost, it also has some shortcomings such as low precision and difficult development. Generally speaking, distributed detection means that each cell has its own unique detection circuit. They have nothing to do with each other but exchange data by means of isolated communication. In addition, there is a special chip which can collect the voltage information of single battery. As shown in Fig.1, in the process of designing the voltage acquisition circuit, centralized measurement is usually adopted. However, through the analysis of the collected data, it can be seen that the measurement accuracy of this method is not ideal. However, after adjusting the collected signals with the help of budget amplifier and precision resistance, the accuracy will be improved to 1.2%. However, there are still many disadvantages such as troublesome signal adjustment and poor anti-interference ability. Next, the distributed method is adopted. As shown in Fig.2, it has a high precision of 0.1%. It does not need to adjust the signal and has a high anti-interference ability. In view of the above analysis, the distributed measurement scheme and C8T6 MCU are applied in the circuit design process. Because the above circuit is used to collect the voltage signal, the obtained signal reflects the voltage of a single battery in the battery pack. The battery pack consists of eight single batteries in series and one MCU in a single cell. In order to realize MCU independence in a battery, the optocoupler isolation CAN communication technology as shown in Fig.3 is applied in the system.

***Design of battery controller:*** In order to avoid the interference of power buses on battery pack controllers, when DC/DC modules are set up, the isolation and separate power supply mode is applied in the system. In addition, the modular wiring diagram of WD5-24S05 is shown in Fig.4 below. If there are problems in the working process, the module can play the role of recovery protection. The working principle of this module is that, with the help of AMS1117, the 5V voltage of isolated power supply is converted into 3V, and the power supply of STM32F107VCT6 is supplied.

***Design of temperature detection circuit:*** In the design of the system, each single cell needs to set up a DS18B20. When using 18B20 to realize the transmission of information, it has a unique way. In the process of multi-temperature detection, it can effectively simplify the system wires. The DQ port of 18B20 is connected with the I/O port of the controller. Each 18B20 is connected to 3.3V power supply voltage. The internal structure diagram of DS18B20 is shown in Fig.5. For multiple unequal temperature measurements, there are several DS18B20 connected on the single bus. Its main function is to recognize different serial numbers 18B20. Each 18B20 has a 64-bit serial number and is set in ROM. Only after the corresponding serial number is obtained, can the sensor be operated in a series of ways. Battery controller should read the serial number of product in 18B20 first, and then match it with single battery one by one, search all 18B20 involved, and finally read the temperature data. Model 18B20 has the advantages of reliable operation and accurate number selection.

***Design of assembly controller:*** In order to improve the exploitability, the function of MCU is realized with the help of MCU when determining the MCU of battery pack controller. At the same time, according to the actual requirements of the assembly controller, STM32F103RBT6 built-in processor is adopted. In the working process of the assembly controller, the first step is to collect the information related to the battery pack. The function is realized by CAN_1 bus. The second step is to identify the collected information and issue specific instructions to realize the control of battery charging and

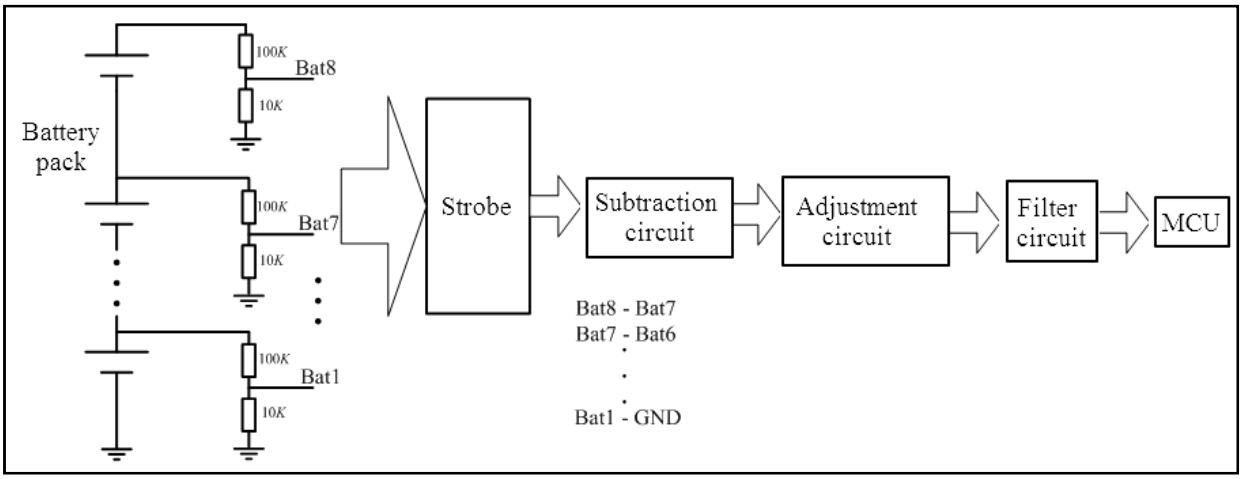


**Fig. 1. Centralized voltage acquisition system**

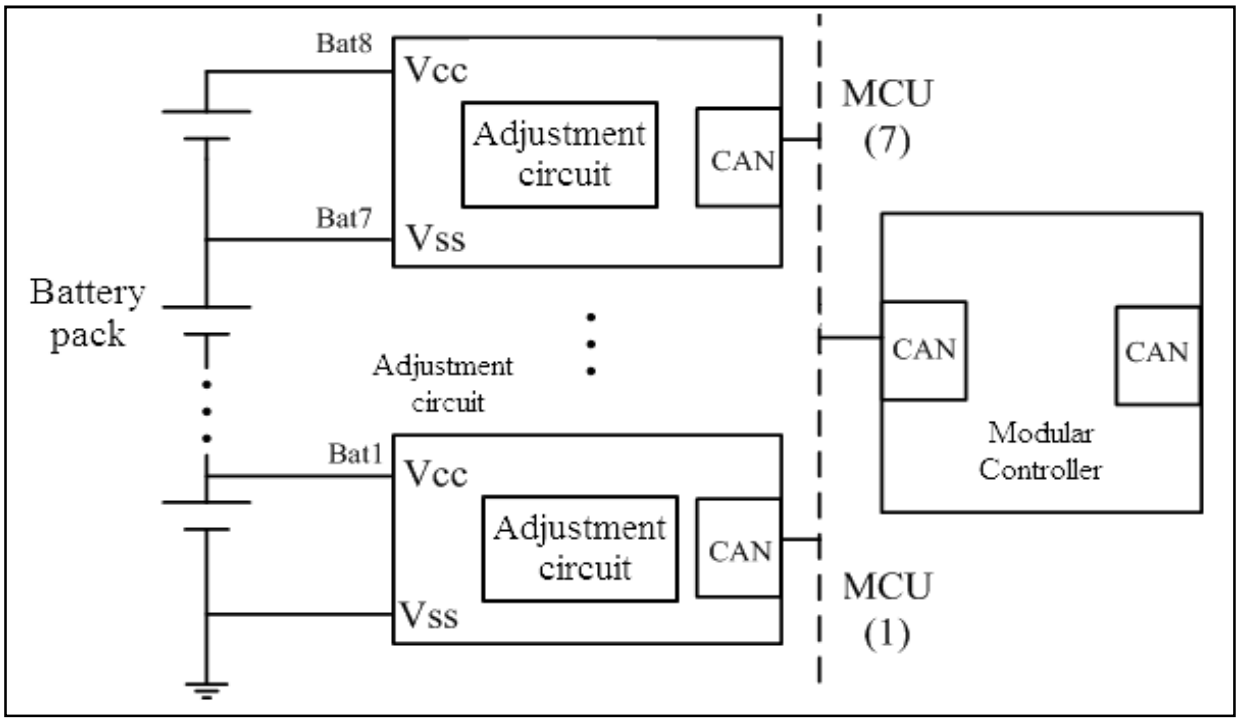


**Fig. 2. Distributed voltage detection system**

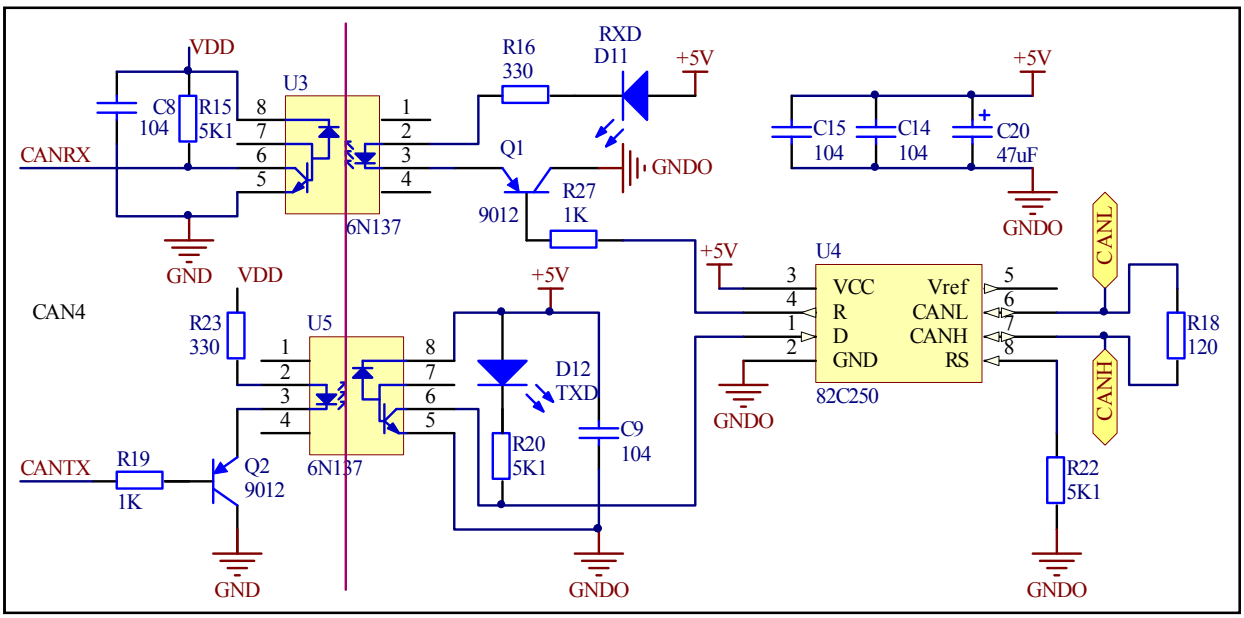


**Fig. 3. Isolation circuit of can bus communication**

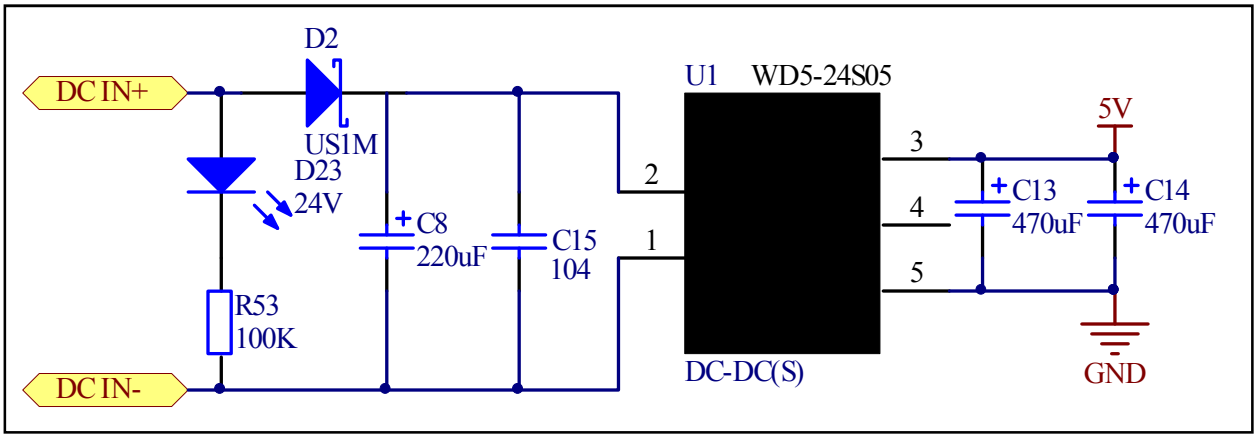


**Fig. 4. Modular wiring diagram**

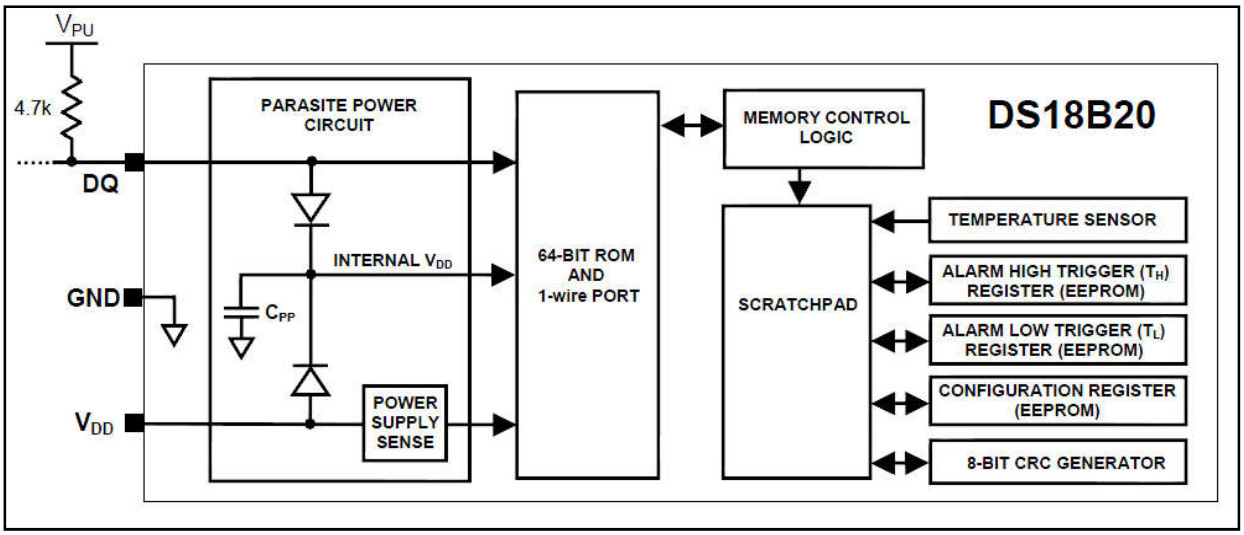


**Fig. 5. The internal structure diagram of DS18B20**

discharging and the related protection. According to the design rules of storage battery, if the battery is not discharged for a period of time after charging, it should be charged and discharged at one time. While ensuring the normal operation of the charger, the discharge of the battery pack is realized by means of the relays in the control system.

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***Conclusion:*** Battery control technology has an important impact on the charging and discharging stability and service life of power supply. This paper mainly designs the hardware of the mobile battery control system. Aiming at the current method of voltage acquisition for single cell batteries, STM32F103C8T6 processor is used as voltage detection controller. In the battery control module, the corresponding detection circuit and protection circuit are designed to ensure the reliability of the system.

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