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Design of UPS Battery Remote Monitoring System

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Abstract

UPS battery remote monitoring system based on MSP430 single chip microcomputer design, using modular thinking as the core to build the overall structure, to realize the battery voltage, current and temperature of the online real-time monitoring through the acquisition module in the aspect of hardware, and putting forward resistance measurement method that based on ac injection method and phase lock amplifying method; Using software to implement the UPS battery fault information alarm function through the overall process design.

Keywords*: MSP430 single chip microcomputer; monitoring system; internal resistance measurement*

1. Introduction

With the rapid development of science and technology, monitoring system using the computer and network to realize remote monitoring application level is also gradually improved, remote monitoring of UPS battery as a kind of existing technology, is widely used in medical, commercial, banking, communications, transportation and other fields. At the same time, with the development of unattended substation, power system automation level unceasing enhancement, the good performance of UPS battery monitoring and decision has become a pressing problem [1].

Battery is an important part of UPS power supply, when external electric sudden interruption or voltage instability, it can provide a stable and continuous power supply. Therefore, for UPS battery charging and discharging process control, on-line real-time monitoring of each single battery voltage, current and temperature, and according to the real-time acquisition of voltage, current value to calculate internal resistance, through than with conventional index timely find out the damage or performance significantly reduce monomer battery, and then select the fault battery, ensure the consistency of power supply system and the safety reliability [2-3].

Usually, at home and abroad, there are two types of UPS battery remote monitoring technology: one is the relay inspection monitoring technology; Secondly, a distributed monitoring based on computer technology. The former on the implementation is more complex, and it has a high reliance on hardware, now use relatively little; while, the latter has high transmission rate, at the same time realize the unattended [4].

According to the above problem, this paper based on the modular thought, build UPS battery remote monitoring system general structure, in terms of hardware, through the design of voltage, current and temperature monitoring circuit, and using based on ac injection method and phase lock amplifying method of resistance measurement method of single cells in battery voltage, current, temperature, and the internal resistance of the online real-time monitoring; In the aspect of software, based on the relevant knowledge of database and C+ +

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design process, the overall structure to achieve a friendly man-machine interface design and text message alarm function.

2. The Overall Structure Design

In this paper, through the design of software and hardware, build UPS battery remote monitoring system, operator through monitoring software on the computer platform and UPS power supply system to realize the man-machine dialogue, its overall structure is divided into the slave part design and upper computer design of two parts: the design of the next bit machine, design acquisition module and a UPS battery remote monitor, by RS485 and wan communications. In the upper computer design, combining with the relevant knowledge, database and C++ design is the PC software system of fault query, alarm prompt. Internal failure occurs when the UPS battery, can prompt the fault information and send the report to the police, at the same time dealing with important and must be saved information, UPS battery remote monitoring system for overall structure as shown in Figure 1.

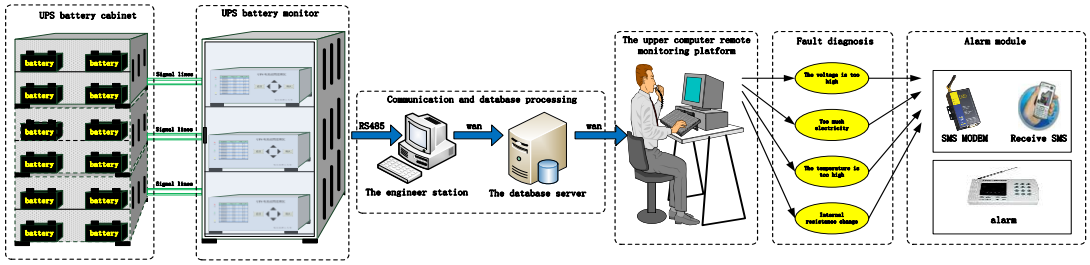

Figure 1. UPS Battery Remote Monitoring System for Overall Structure

3. The Slave Part Design

3.1. The Selection of the Master CPU

Single chip microcomputer as the master CPU monomer batteries in the battery voltage, current and temperature data signal acquisition, and then through simulation loads connected to the control relay, and adopts ac injection method and phase lock amplifying method of resistance measurement, finally using RS485 communication data real-time upload first place machine. We based on the hardware precision and function component costs, combined with the internal structure of main control module, selecting MSP430F149 ultra low power consumption micro-controller to realize the function of the main controller [5-6].

Relative to other micro controller (80C51), its advantage lies in: MSP430 MCU built-in Flash, in this way can save the hardware circuit board wiring space, reduce the power consumption of the system of five times at the same time, and combined with the hardware of MCU assembly language and C language programming, the system of the MSP430 are closely, timeliness is greatly increased.

3.2 Acquisition Module Design

1. Voltage acquisition: This design adopts the method of cycle test, will transmit the collected digital signal continuously to MSP430 single chip microcomputer. Monomer battery voltage detection accuracy of 10 mv, including selection of photoelectric coupler, compared with the general design of analog switch, to avoid the battery in the measurement circuit is not gating UPS power loss caused by the discharge. At the same time, different amplifier circuit is changed to the size of the test voltage, by adjusting the specific multiple

relationships, making the voltage conforms to the single chip microcomputer A/D converter voltage range. Filter circuit is used to filter the voltage ripple caused by the unstable sampling circuit; the voltage tends to level off, the voltage monitoring circuit as shown in Figure 2.

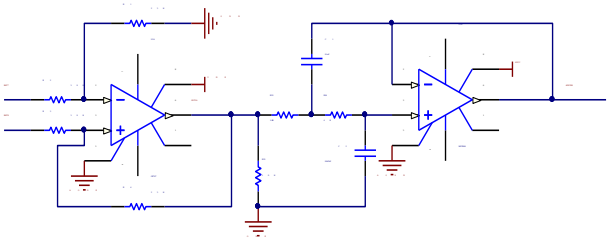

Figure 2. Monomer Battery Voltage Acquisition Circuit

2. The current collection: the design selection ASC75x current sensor series, ultra-low power consumption, low cost, 5V power supply, and, in the terminal 4, 5, and voltage isolation between 1, 2, 3, at the same time, through the design different packaging can expand the current measuring range, and expand the application scope, the current monitoring circuit as shown in Figure 3.

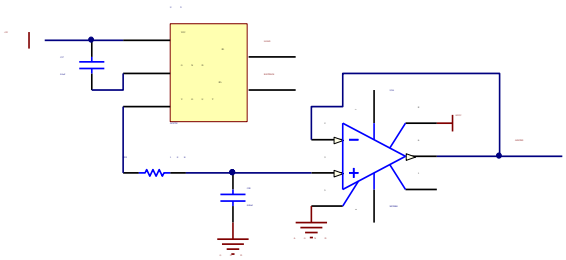

Figure 3. Single Channel Current Sampling Circuit

3. The temperature acquisition: the design selected as temperature sensor DS18B20 chip implementation of UPS battery internal and surrounding multi-point measurement of the temperature of environment, and the chip with single bus structure, which can connect to multiple temperature sensor on a bus, the range of 55℃ ~ + 125℃, in line with the battery outside environment temperature (20℃ to 60℃), monitoring circuit as shown in Figure 4.

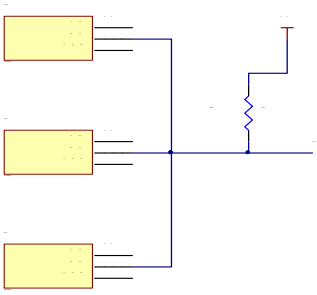

Figure 4. Temperature Monitoring Circuit

3.3 Internal Resistance Measuring Principle

This paper adopts the ac injection and phase lock amplifying way to measure the battery internal resistance [7-8], its principle analysis is shown in Figure 5.

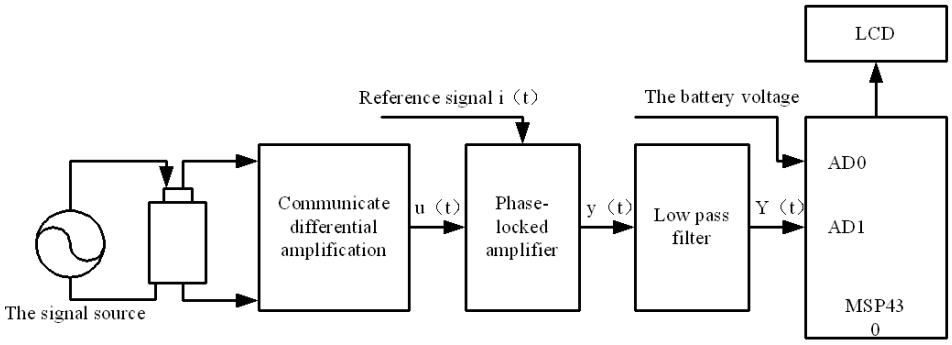

Figure 5. Internal Resistance Measuring Principle Diagrams

Overlay on the excitation signal for the square wave current signal at the ends of the battery, after partial pressure resistance of ac voltage signal $i(t)$ is:

$$i(t) = \frac{2E}{\pi} \sum_{n=0}^{\infty} \frac{1}{(2n+1)} \sin[(2n+1)\omega t + \phi_i] \tag{1}$$

Type: E as the amplitude, ω as the angular frequency, ϕ_i for the current initial Angle. Battery voltage of ac response signal is:

$$u(t) = u'(t) + n(t) = \sqrt{2}U \sin(\omega t + \phi_u) + n(t) \tag{2}$$

Type: U as the response amplitude, ϕ_u as at the beginning of the voltage phrase Angle, $n(t)$ for random noise signal.

By the principle of phase-locked amplifier, the output signal $y(t)$ is:

$$y(t) = u(t)i(t) = K_1 \sum_{0}^{\infty} \frac{1}{(2n+1)} \cos\{[1 \pm (2n+1)]\omega t + [0 \pm (2n+1)\theta]\} \tag{3}$$

Type: $K_1 = \frac{\sqrt{2}UE}{\pi}$, after low pass filter, the output is:

Type: $K_2 = \frac{\sqrt{2}UEC}{\pi}$, $\phi = \phi_a - \phi_i$, K for of undetermined coefficients, C for the low-pass filter gain value, R for internal resistance of the battery. Internal resistance of battery R is as follows:

$$y(t) = K_2 \cos\phi = KR \tag{4}$$

$$R = \mid R_Z \mid = \frac{y(t)}{K} \tag{5}$$

In practice, through the use of standard resistance R_0 to replace batteries (current value, frequency of excitation signal source remained unchanged) for the same test, undetermined coefficients K can be calculated:

$$K = \frac{y_0(t)}{R_0} \tag{6}$$

So the battery internal resistance for R :

$$R = y(t)\frac{R_0}{y_0(t)} \tag{7}$$

Type: R_0 as had been standard resistance, $y_0(t)$ and $y(t)$ can be obtained by d/a converter.

4. The Upper Computer Design

4.1 Database Design

The construction of the database platform for the whole data access speed have a vital role, this module is to create a database platform, for the system to provide strong support. To collect data in real time to upload first place machine and through the display and the Internet for the user query, so that the operator in the early days of the battery degradation timely find fault source, avoid abnormal battery performance and to prevent voltage instability caused by similar to such problems as data loss.

4.2 Software Design Process

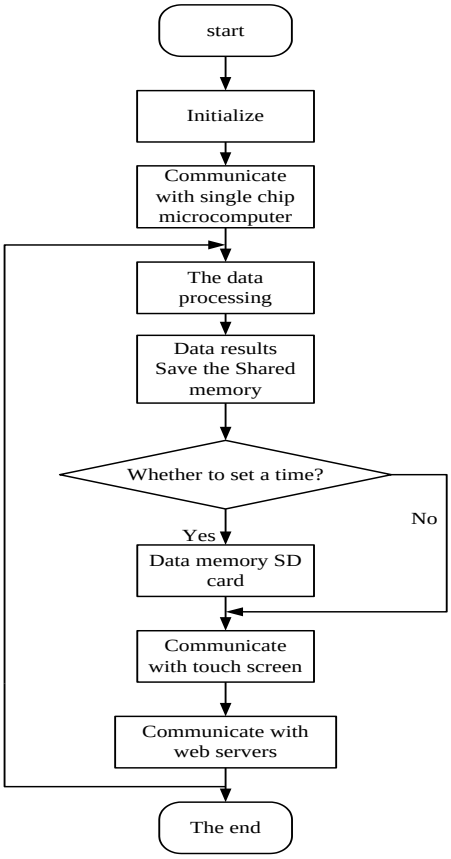

Figure 6. PC Software Design Process

In the process of UPS battery of the remote monitoring technology research, single chip microcomputer as the master CPU from the machine in the form of implementation of monomer battery in the battery voltage, current, temperature and resistance performance parameters, such as real-time acquisition, through the way of combining eight-way inspection technology and interrupt, the collection of data stored in a specific ROM, when master MCU, after sending the communication instructions received from PC, enter the interrupt service routine, begin to collect and upload on cell performance parameters, and the PC to realize the data aggregation, analysis, processing and preservation, complete with LCD display connection at the same time, the battery exception information and fault source, according to the timely for the operator to observe the battery pack in the actual running state of monomer battery, improve the efficiency of the single chip microcomputer PC software design process is shown in Figure 6.

According to the software design process, in combination with C++ and database related technologies, this paper developed a UPS remote monitoring system, to achieve a friendly man-machine interface, among them, the battery real-time data display interface as shown in Figure 7.

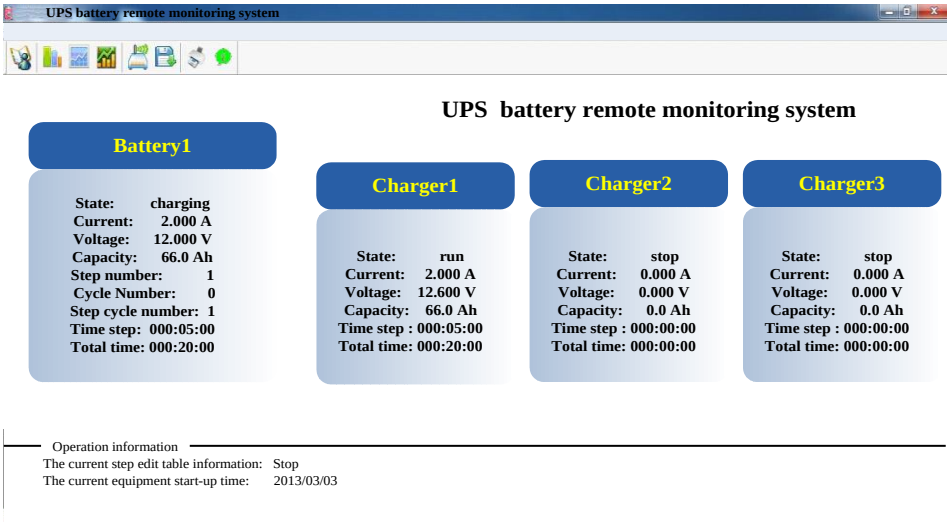

Figure 7. Software Interface

4.3. Alarm Unit Design

Cell abnormal alarm module is through the design of fault diagnosis model, and through this model to realize real-time data was compared with the control limit, then realize the function of the host alarm and send SMS at the same time.

1. Battery anomaly diagnosis design

In abnormal cells in the design of diagnosis, the host calls through the program realization and real time data in the database control limit (lower limit on voltage, current, *etc.*), if abnormal alarm host, at the same time to the designated mobile phone to send text messages, click on the alarm content in alarm module, analysis of fault type.

2. The text messaging function software design

SMS cat DLL interface provides the API function call interface, the interface completely low-level calls, no interface, suitable for the development of independent brands to the user.

Function interface simple, only a few simple function call, can achieve the function of information sending and receiving, call structure diagram as shown in Figure 8:

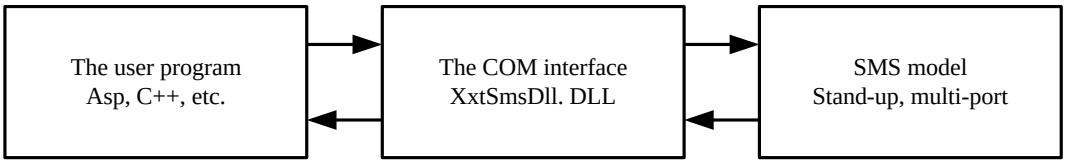

Figure 8. SMS MODEM Call Structure

SMS cat through serial port (COM) is connected to a computer, or through the USB virtual serial port is connected to a computer.

5. Conclusion

Based on the modular thought, UPS battery remote monitoring system for the overall design, solve the current real-time monitoring by a large number of human reality problem, and very good for getting failure batteries to make a report to the police. Practice has proved that through to the related hardware and software design, can achieve of monomer battery in UPS battery voltage, current, temperature and resistance monitoring, the fault information is the first time to operating personnel transfer, effectively reduce the accidents and guarantee the security, stability of power system.

In addition, the system scalability is strong, can be based on group technology and cloud module technology such as extension for a wide range of remote monitoring. In this way, it can raise the automation level of UPS battery remote monitoring technology.

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