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Design of Parameter Testing System of Secondary Dc Power Supply based on ARM

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Abstract

In view of the present secondary dc power technology poor precision, the problem of low efficiency, the second dc power supply parameters test system is designed. The system USES the electronic load to realize the continuous adjustable secondary power load, USES the Lab Windows/CVI software development platform to complete the upper computer program development, and USES the ARM7 microprocessor to realize signal acquisition, processing and control of the electronic load, and its processing results are displayed and stored by the upper computer. By analyzing the experimental results, it is shown that the system can automatically test the technical parameters of secondary power supply, such as voltage deviation, load stability, voltage stability, efficiency, transient response and ripple coefficient.

Keywords

ARM7; Load stability; Transient response; Ripple coefficien.

1. INTRODUCTION

With the rapid development of aerospace, industrial control and other fields, higher requirements have been put forward for the working stability of key equipment such as instruments, measurement and control systems and communication equipment. Whether the equipment can work continuously and stably, one of the key factors depends on the power supply system of the equipment. If a parameter of the power supply fails to meet the power supply standard of the equipment, the equipment may not work properly [1].At present, the test of secondary power supply is generally conducted by manually operating various measuring instruments. Manual test has disadvantages such as low test efficiency, complex process, and manual judgment of test data. Therefore, this paper designs a test system of secondary dc power supply parameters based on ARM microprocessor to meet the requirements of comprehensive test of multiple technical indicators of secondary power supply.

2. SYSTEM OVERALL SCHEME DESIGN

The secondary dc power supply test system includes software design of upper computer and software and hardware design of lower computer. The main role of the upper computer software is to send measurement and control commands and receive display and store data sent by the lower computer. The hardware of the lower computer is mainly designed for signal conditioning board, which includes electronic load module, current detection module, D/A conversion module, electrical isolation module, voltage detection module, ripple detection module, voltage conditioning module.

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The system works as follows: the input voltage signal of the measured object and the 4-way output voltage signal are connected to the electronic load module. After the isolation of the current detection module and the electrical isolation module, the input current and 4 output current are sent to the ARM microprocessor for collection and processing, and the processed data are sent to the upper computer for display and storage. The input voltage and 4-channel output voltage signals of the tested object are respectively processed by voltage conditioning module and ripple detection module for voltage conditioning, ripple detection and electrical isolation, and then sent to ARM microprocessor for collection and processing, and the processed data are sent to the upper computer for display and storage. In to the second dc power load stability, voltage stability and transient response during the test, the ARM microprocessor to receive the first PC test the corresponding parameter measurement and control command by D/A conversion and the command transmitted to the electronic load, electrical isolation module, electronic load corresponding adjustment after the operation, the microprocessor through the corresponding voltage regulating circuit and electrical isolation circuit for signal acquisition and processing and the results are sent to the PC display and storage.

3. SYSTEM HARDWARE CIRCUIT DESIGN

3.1. LPC2138 Microcontroller

This system selects NXP company's LPC2138 ARM microprocessor as the core control chip, LPC2138 is based on a 16/32-bit arm7tdmi-s CPU that supports real-time simulation and tracking, and has 512K bytes of high speed Flash. It adopts LQFP64 package and can use up to 47 GPIO. The maximum CPU operating frequency of 60MHz can be achieved through the PLL (Phase Locked Loop), and two 8-channel, 10-bit A/D converters are integrated in the chip. Two 32-bit timers, two 16C550 industrial standard UART, real-time clock, etc.[2].The system peripherals are rich, fully meet the needs of the system.

3.2. Data Acquisition Circuit

LPC2138 chip is used to integrate two 8-channel and 10-bit multiplexing A/D converters.

3.3. Voltage Control Circuit

The function of voltage conditioning module is to reduce the linear ratio of voltage signal to be measured to the range of voltage signal collected by ADC. Figure 2 and figure 3 are the circuit schematic diagram of each signal attenuation.

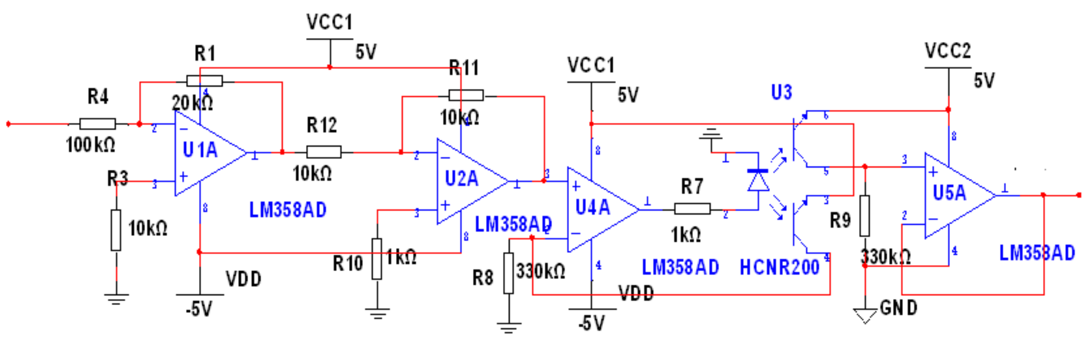

Figure 1. +5V voltage signal conditioning circuit principle diagram

In figure 1, the operational amplifiers U1A and U2A are inversely proportional connections, whose purpose is to attenuate the signal to be tested to the required range.U4A and U5A, together with optocoupler HCNR200, form a linear optocoupler, whose purpose is to conduct

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1:1 electrical isolation of signals. Finally, the output signal of operational amplifier U5A is sent to A/D collector. To adjust the voltage of +27V, only the ratio of R1 to R4 needs to be changed to 1:9.To regulate the voltage signal of +5V, the voltage +5V voltage attenuation can be achieved by removing U1A and U2A of the operational amplifiers in figure 1 and selecting the resistance values of R8 and R9 in the linear optocoupler as 165K and 330K.

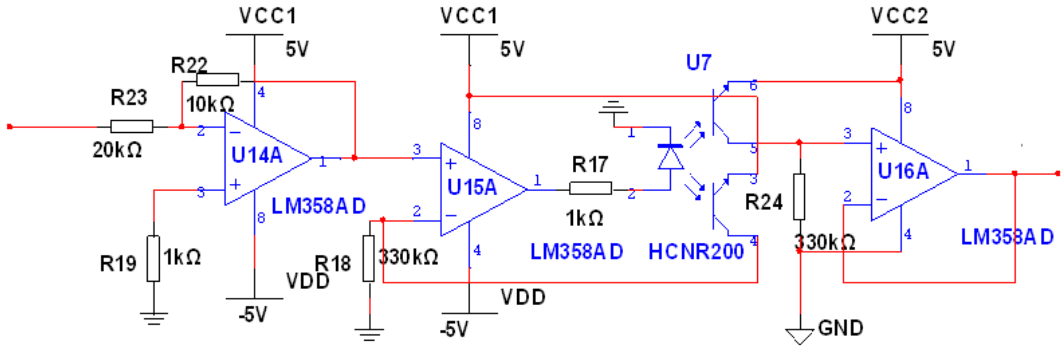

Figure 2. -5V voltage signal conditioning circuit schematic diagram

In figure 2, the voltage signal of -5v is reduced and reversed to achieve signal attenuation from -5v to + 2.5v.The +2.5v signal is isolated by a 1:1 linear optocoupler and transmitted to the AD collector for data collection. When adjusting the voltage signal of -15v,the resistance values of resistance R22 and R23 in figure 3 can only be set to 20K and 100K respectively[3].

3.4. Current Detecting Circuit

The current detection module USES multiple current sensors for measurement. The circuit consists of two parts, current sensor chip ACS712 and linear optocoupler HCNR200.ACS712 is a linear current sensor from Allegro. The device is built with a precise low-offset linear hall sensor circuit that outputs a voltage proportional to the detected ac or dc current. The relationship between its output voltage and input current: V = 2.5-0.2i.Figure 3 is the circuit diagram of current detection.

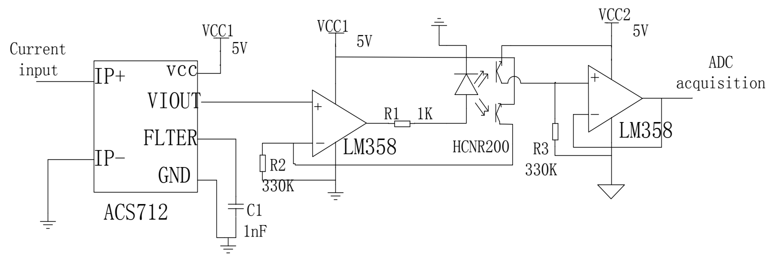

Figure 3. Current detection circuit principle diagram

3.5. Electronic Load Circuit

When the load stability of the secondary dc power supply is tested, the load of the power supply should be adjusted by program control. When testing the voltage stability, the input voltage of the secondary power supply should be programmed adjusted. Therefore this design needs to design the electronic load circuit. An electronic load is a device that can absorb electrical energy in a controlled or programmed way. It ACTS as a variable current absorber, variable power resistor or shunt voltage regulator. When it absorbs a variable current, it maintains a fixed voltage. It mainly works in three working modes: constant voltage, constant

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current, and constant resistance, which are widely used in ac-dc power supply testing. The electronic loads involved in this system mainly work in constant voltage and constant current modes.

(1)Constant pressure mode

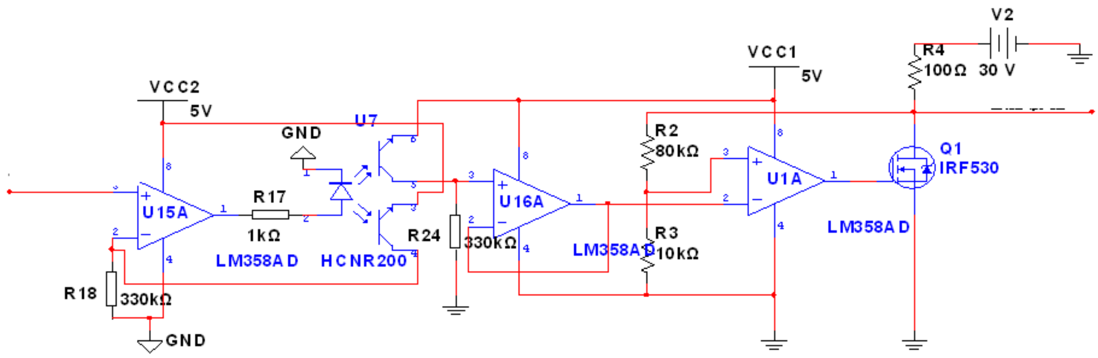

Figure 4. Electronic load work in constant voltage mode circuit principle diagram

In figure 4, the control signal of D/A output is isolated to the V- of U1A through optocoupler, and the output signal of operational amplifier U1A makes the field effect tube Q1 conduct. After the conduction of Q1, V+ and V- tend to be equal, so that the voltage at both ends of Q1 reaches constant.

(2)Constant current mode

In figure 5, the control signal of D/A output is isolated and amplified by linear optocoupler to control the V+ of U1A, and the output signal of U1A makes Q1 conduction. And then, V minus tends to be equal to V plus, so that the current flowing through R6 is a specific current.

For the constant current mode of the electronic load that outputs 5V voltage from the secondary dc power supply, simply connect the power supply 5V voltage to the grid of IRF530 power tube in FIG.6.For the constant current mode of electronic load with secondary dc power output voltage of -5v and -15v voltage, just replace Q1 in FIG.5 with the power tube with IRF9543 model.

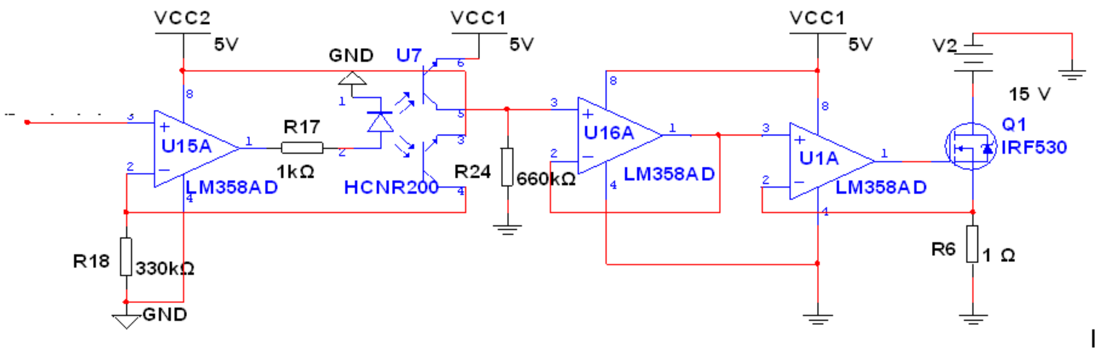

Figure 5. In the input voltage of the electronic load constant current mode circuit principle diagram

3.6. Ripple Detection Circuit

The main function of ripple detection circuit is to detect the effective value of ripple. This circuit mainly includes four parts: capacitor C2,programmable operational amplifier PGA206P,ripple RMS detection chip AD536AJD and linear optocoupler [4].The function of C2 is to cross and separate, block the dc voltage signal, and make ripple signal pass through.

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Programmed operational amplifier amplifies ripple signal as needed. The function of the AD536AJD chip is to detect the effective value of ripple. The input end is the amplified ripple signal and the output end is the effective value of amplified ripple signal.

4. SYSTEM SOFTWARE DESIGN

The software design of the system mainly includes the design of the firmware program of the lower computer and the design of the application program of the upper computer.

4.1. lower Computer Software Design

The function of the lower computer software is to receive the measurement and control commands from the upper computer and transfer the test data to the upper computer. For the firmware program of the lower computer, it is written by IAR Embedded Workbench integrated development environment, which supports hardware and software debugging and JTAG simulation debugging [5].The software flow chart of the lower computer is shown in figure 6.

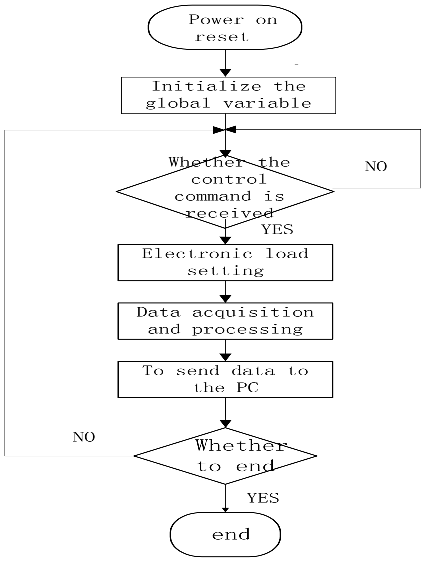

Figure 6. Software flow chart of the next computer

4.2. Upper Computer Software Design

The upper computer software programming environment is Lab Windows/CVI. It is a 32-bit virtual instrument in the field of computer measurement and control software development platform, the powerful C language and the organic integration of measurement and control technology of [4], with flexible interactive programming method and the rich library function, to establish a monitoring system for developers, automatic test environment, such as data acquisition system provides a good software development environment.

Figure 7 is the upper computer program flow chart that starts configuring and opening the serial port. If the opening fails, an error message is displayed. If successful, continue to open test mode. Then, wait to receive the data. If you accept failure, continue to accept it. After receiving the data successfully, display and store the data. Receive and display data in a loop until you close the receive after receiving the end command.

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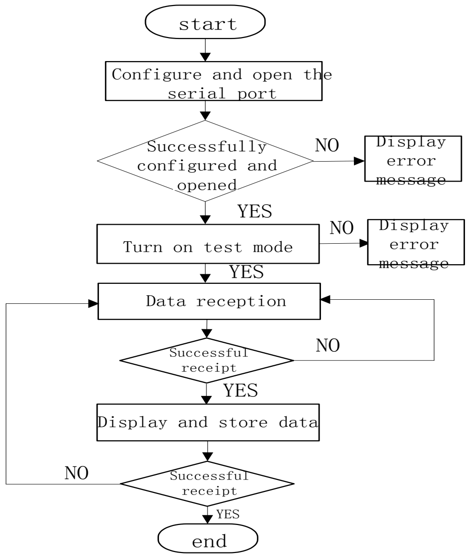

Figure 7. Upper computer program flow chart

5. RESULTS

Download the lower computer program to LPC2138,connect the hardware, open the upper computer application, configure and open the serial port (click "open serial port"),then open single test mode (click "single test mode"),finally open the +5V test mode (click "open +5V single test mode").Receive dialog displays +5V voltage signal of the test results. Through experimental verification, the system can test the technical indexes of ±5V and ±15V voltage, and the experimental results fully meet the 1% error range. Table 1 shows the test results of 3-way output voltage signals.

Table 1. 4-way output signal test results

parameter	+5V		-5V		+15V	
	Set value	Measured value	Set value	Measured value	Set value	Measured value
Voltage deviation	1%	0.8%	0.9%	0.8%	0.8%	0.7%
Load regulation	4.5%	4.0%	4.5%	4.3%	4%	4.2%
Voltage regulation	0.8%	1.2%	1%	1.4%	1%	1.6%
Ripple coefficient	0.7%	0.9%	2%	2.7%	1%	1.8%
efficiency	51.5%	52%	50%	50.5%	50%	50.7%
Transient response	15000μs	15090μs	15000μs	15095μs	15000μs	15080μs

6. DATA ERROR ANALYSIS

(1) Analysis of voltage deviation, load adjustment rate, voltage adjustment rate, conversion efficiency and ripple coefficient error

It involves the measurement of voltage deviation, load adjustment rate, voltage adjustment rate, conversion efficiency and ripple coefficient of the 4-channel voltage signal. The five technical indexes of the 4-channel signal are essentially the detection of voltage and current. The detection errors of voltage and current mainly depend on the accuracy of signal attenuation and ADC resolution. In order to reduce measurement errors: on the one hand, multiple voltage and current collection and average value are adopted in software programming to reduce system errors. On the other hand, high precision devices are used in hardware, and the error of

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resistance is 0.1% in the signal attenuation circuit. When controlling the electronic load, A 10-bit D/A converter with resolution is selected. The accuracy of the D/A converter is about 0.1%, which theoretically meets the design requirements of the system. The test results meet the system error requirement of 1%.

(2) Transient response error analysis

The sampling frequency and accuracy of A/D converter determine the transient response measurement. The error of transient response mainly depends on the acquisition rate of ADC. According to the characteristics of dc power transient process, the sampling frequency is required to be about 200KHz (sampling period 5us) and 2047 points are collected, which can ensure the measurement of transient process with the minimum duration of 10ms.The basic clock of the A/D converter is provided by the VPB clock, which can adjust the clock up to 4.5mhz.When the clock frequency is maximum, the conversion time of the A/D converter is 2.44us.Therefore,the ADC meets the test requirements of the system. The result meets the error requirement of 1%.

7. CONCLUSION

In this paper, a comprehensive test system is designed which can detect the technical parameters of secondary power supply in real time by digital method and display in the upper computer. This paper discusses how to attenuate each signal to the required range of A/D converter and how to detect ripple, current and voltage. The design of electronic load and the software design of upper and lower computer; The system has the characteristics of strong comprehensiveness, simple hardware and easy operation,etc.,which solves the problem of tedious and inefficient testing of secondary dc power supply. The defect does not adopt the PID algorithm to control the electronic load for feedback control. All the experiments on the progress achieved by the system are based on the principle that they can exactly meet the system precision requirements, and no further study is conducted to further improve the system precision. More follow-up tests are needed to continue to put forward higher requirements on the accuracy.

ACKNOWLEDGMENTS

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REFERENCES:

[1] Huili Sun.On ripple voltage and ripple coefficient [J].Journal of liaoning normal university, 2009, 11 (4):62-64.

[2] Jingdong Zhou.Design and implementation of dc ripple tester based on STC89C52 single chip microcomputer [J].Modern electronic technology, 2012, 35 (3): 27-35.

[3] Xinyu Gu,Ji Guo,Shao Huashi.Development of multi-channel precision time interval measurement system [J].Journal of electronic measurement and instrumentation,2013,15(3):69-74.

[4] Ligong Zhou.Arm7-lpc213x/214X (I)[M].Beijing:Beijing university of aeronautics and astronautics press,2005.

[5] Xiaoyun Sun, Liwei Guo, Huiqin Sun.Design and application of virtual instrument based on Lab Windows/CVI [M].Beijing: electronic industry press, 2005.

[6] Qian Wang, Helei Wu.Dc voltage and ripple measurement system based on C8051F350 [J].Chemical automation and instrumentation, 2010, 37 (8):72- 74.