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Research Article

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Novel numerical control stabilized power supply

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ABSTRACT

With the development of industry, modern numerical control productions require low ripple, wide adjustment range power supply, especially in high energy physics. In order to solve the difficulties such as low numerical control level, low power density and poor reliability, a novel number control power supply was proposed. First, the AT89S52 was adopted as core control chip to carry out the function of number controls stabilized power supply. Second, DA converter TLC5615, three-adjustable regulators LM317 and OP07 were utilized to constitute regulator source. Third, LCD1602 was adopted to display output voltage value. This power supply can output voltage from +1.5V to +20 V, and step voltage is 0.1V, it has high precision and stability and has the biggest ripple of 100 mV. Compared with traditional stabilized power supply, this power supply has the characteristics of simple operation, high stability.

Key words: Numerical control, stabilized power supply, step, SCM

INTRODUCTION

Traditional DC voltage source usually adopts potentiometers and band switch to achieve voltage regulation, utilizes voltmeter to indicate the voltage values. Therefore, the voltage adjustment accuracy is low, display is not intuitive, and potentiometers are easy to wear. While the numerical control DC stabilized power supply based on microprocessor controlled can solve the shortcomings of traditional power supply. With the development of industry, modern numerical control productions require low ripple, wide adjustment range power supply[1], especially in high energy physics[2]. In order to solve the difficulties such as low numerical control level, low power density and poor reliability, a novel number control power supply was proposed.

EXPERIMENTAL SECTION

According to the practical requirement, this power supply utilized SCM as main control unit, and utilized boost converter to adjust output voltage[3]. Besides, collate output voltage real-time by sampling on load so as to stabilize output voltage[4]. Moreover, utilized software to achieve step control, thus, the hardware system was simpler[5]. The frame of power supply was shown in figure 1.

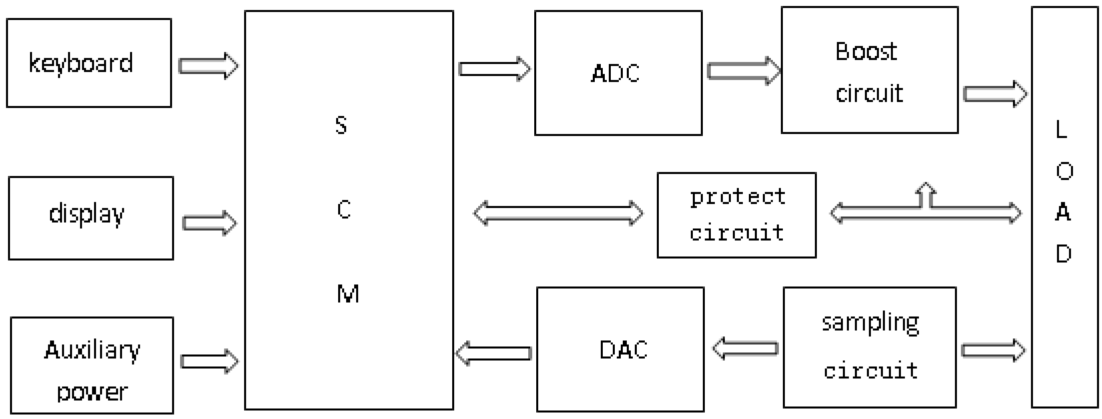

Fig.1: Diagram of hydraulic meter system

The design power supply was constituted by hardware system and software system. The hardware system mainly achieved output voltage setup, voltage output and control, system protect, output voltage display, real-time feedback on output voltage and main control. The software system could be divided into main program and subprograms. Subprograms included voltage conversion, voltage sampling, voltage display, read keyboard and protect on hardware. Hardware and software were designed as following.

Hardware Design

1. Single chip microcomputer (SCM) module

In this system, the AT89S52 was adopted as main controller. AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. Because of above characteristics, the adoption of AT89S52 can reduce the complex level and the amount of peripheral devices to a great extent, the circuit was shown in figure 2.

2. Auxiliary module

In this system, operational amplifiers and SCM require power supply, so auxiliary power supply module was designed, which could output $\pm$5V and $\pm$12V DC voltage. In this module, LM78xx and LM79xx were main components. The output voltage from transformer was rectified by full-wave rectification circuit, and was filtered by capacitor filtering circuit, then was stabilized by LM7805, LM7905 and LM7812, LM7912 to supply power for system.

Besides above mentioned, LM317 was adopted to adjust output voltage. LM317 is an adjustable 3-terminal positive voltage regulator designed to supply more than 1.5 A of load current with an output voltage adjustable over a 1.2 V to 37 V. It employs internal current limiting, thermal shut-down and area compensation. In this design, LM317 was adopted to supply 30 V voltage. The auxiliary power circuit was shown in figure 3.

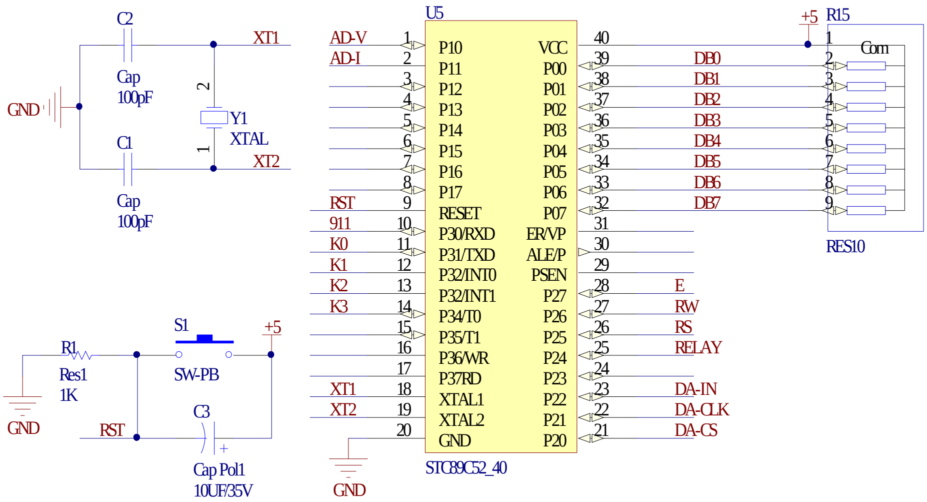

Fig.2: Principle of SCM module for power supply

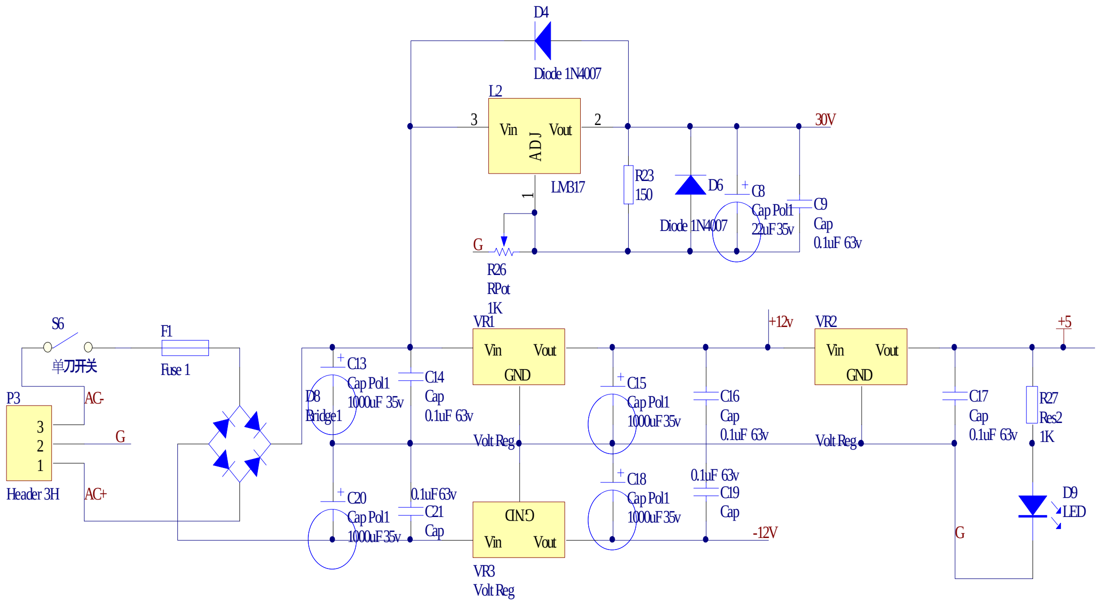

Fig.3: Circuit of auxiliary power supply

3. DAC and voltage adjustment module

In this system, TLC5615 was adopted to achieve DA conversion. The TLC5615 is a 10-bit voltage output digital-to-analog converter (DAC) with a buffered reference input (high impedance). The DAC has an output voltage range that is two times the reference voltage, and the DAC is monotonic. The device is simple to use, running from a single supply of 5 V. A power-on-reset function is incorporated to ensure repeatable start-up conditions. DAC circuit was shown in figure 4.

In voltage adjustment circuit, TIP32C and TIP41C were adopted to adjust output voltage. TIP32C and TIP41C are large power triode. The maximum operation voltage as 100 V, maximum current is 5 A and 6 A. The circuit was shown in figure 5.

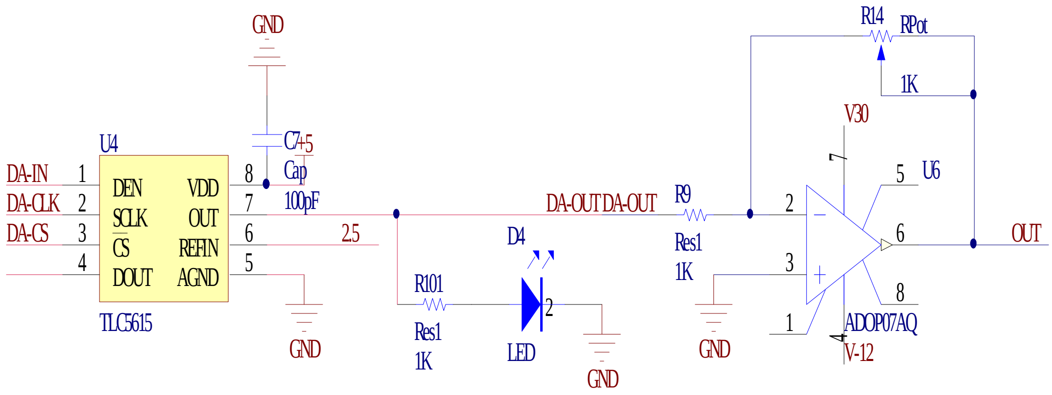

Fig.4: Circuit of DAC

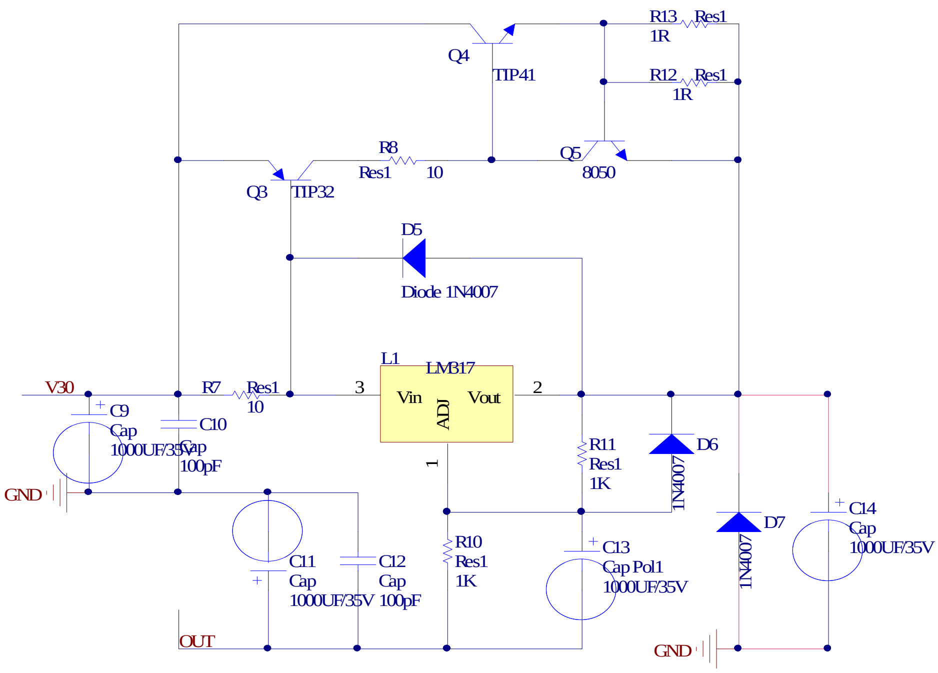

Fig.5: Circuit of adjustment voltage

Software Design

The software system could be divided into main program and subprograms. Subprograms included voltage conversion, voltage sampling, and voltage display, read keyboard and protect on hardware. The main program achieved the following functions. First, when the system was started, the main program should achieve system initialization, which includes the status setup for ADC, DAC and so on, then assign the system variables and display current output voltage value. Second, scan the buttons so as to achieve corresponding key value, and then call corresponding subprogram according to the key value. Third, if the start button was pressed, corresponding output voltage value should be calculated according to setting value, adjusting value and so on. Finally, closed loop feedback should be adjusted. The main program flow was shown in figure 6.

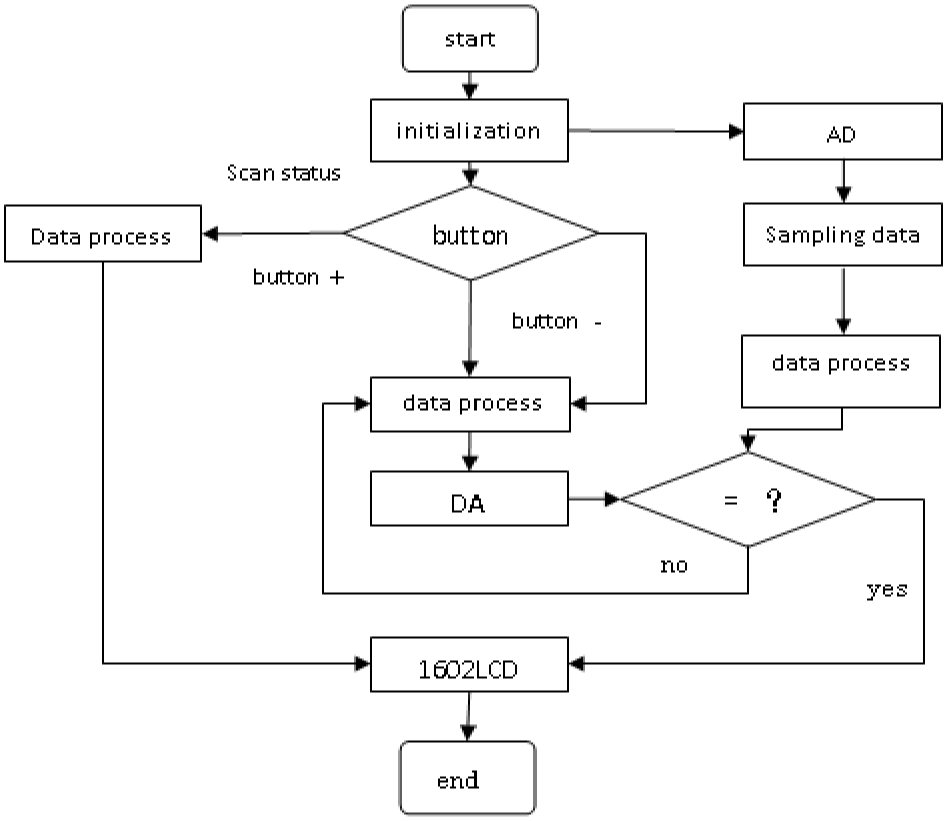

Fig. 6: The flow chart of main program

1. DAC subprogram

DAC subprogram mainly achieved the conversion from analog voltage to digital signal. First, TLC5615 was initialized. Second, detected input voltage, if there was input voltage, the conversion was started. Third, the conversion value was sent to main program to process and display subprogram to display. The flow chart was shown in figure 7.

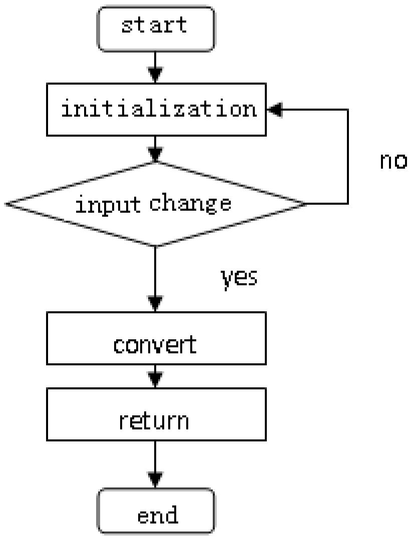

Fig.7: The flow chart of DAC subprogram

2. Protection subprogram

Protection subprogram is the security for the whole numerical control power supply. In this program, first of all, safe voltage and current should be setup. Then the sampled voltage and current were processed by SCM, and were converted to corresponding voltage and current value, which were compared with voltage and current threshold value. If any value exceed threshold value, the SCM would output the signal which could break the circuit and bright the LED to express the abnormal system. The flow chart of protection subprogram was shown as figure 8.

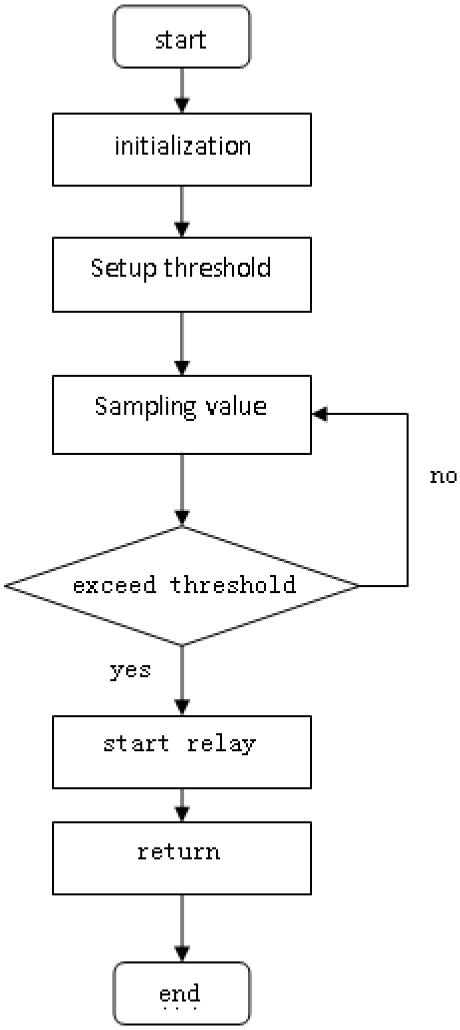

Fig. 8: The flow chart of protection subprogram

3. Display subprogram
Display subprogram mainly drove LCD1602 to display the information which was required. First, initialize the LCD, and then setup the operation mode of LCD. The flow chart of data acquisition subprogram was shown in figure 9.

RESULTS AND DISCUSSION

In order to ensure the practicability of designed system, the simulations were carried on, the whole system was shown in figure 10. The output voltage was +1.5 V ~ 20 V, voltage step value was 0.1 V, 1 V, 2 V, default value was 0.1 V. The error was less than 0.1 V.

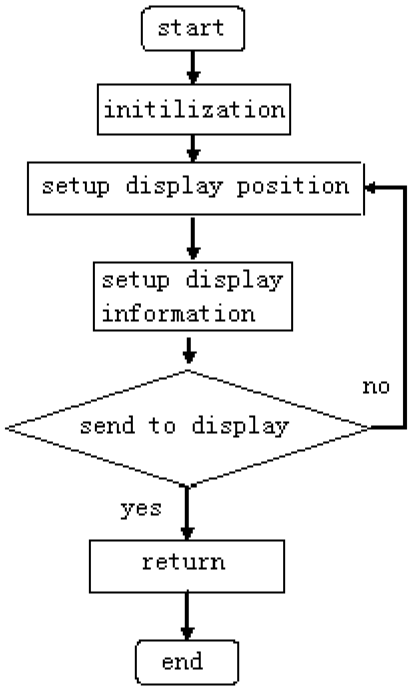

Fig. 9: The flow chart of display subprogram

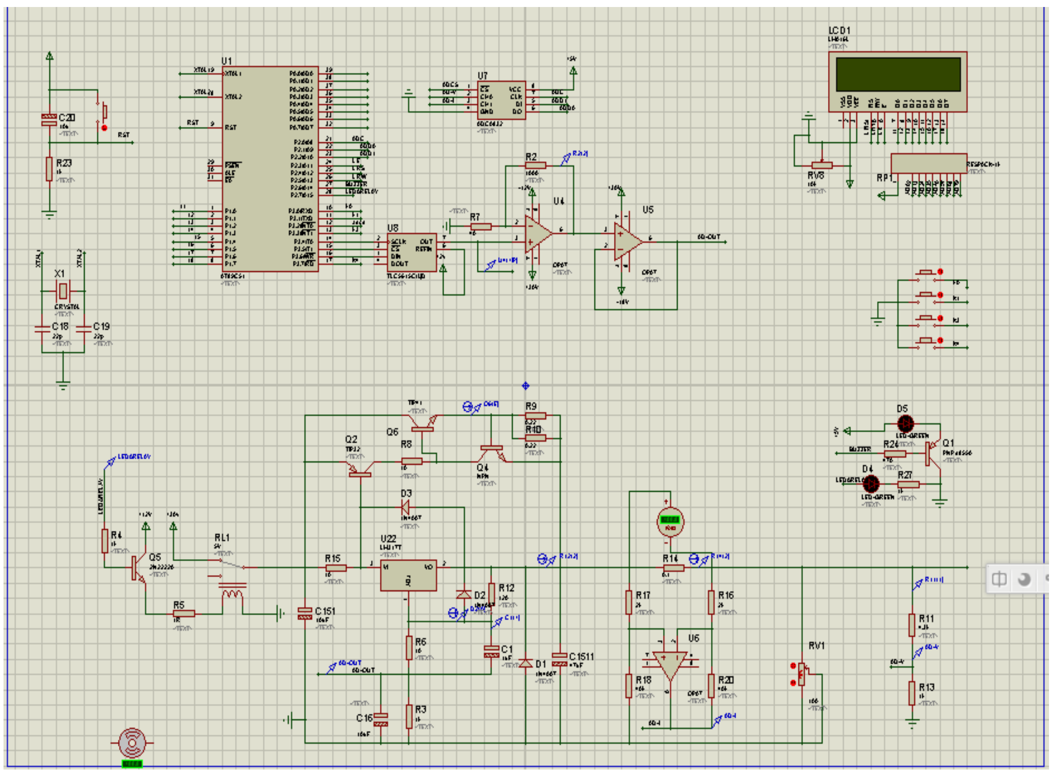

Fig.10: The simulation circuit of numerical control power supply

CONCLUSION

This article elaborated the numerical control stabilized power supply. From the results, this system can be utilized to supply DC power from +1.5 V ~ 20 V, the error is less than 0.1 V. This power can be utilized in DC equipment which has high requirement on voltage precision, also can be utilized as experiment power supply in research.

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