A microcontroller based intelligent switch mode regulated power supply

Xiaohang Wu [a], Haifeng Chen [b], Kunpeng Chen [c] and Le Da [d]

School of mechatronic engineering, Southwest Petroleum University, Chengdu 610000, China

[a]369035233@qq.com, [b]1935215243@qq.com, [c]759552942@qq.com, [d]378274776@qq.com

Abstract

This paper introduces an intelligent switch voltage stabilized power supply based on single chip microcomputer, and its core technology is output through the single-chip microcomputer to control the analog to digital conversion to change the voltage regulator module subsequent, we detect the output voltage by using single chip microcomputer, according to the output voltage of the power source and the set value of difference, using the on-chip PMW PMW module output wave, direct control of the Buck circuit.

Keywords

Single chip microcomputer; switching power supply; Buck circuit; analog to digital conversion.

1. Introduction

With the progress of social science and technology, electronic equipment is increasingly close relationship with everyone's life and work, all electronic equipment cannot leave the power supply. Switching power supply for various types of devices is not most important, but is absolutely indispensable, is the basis of various systems and devices. So we need to continue research and development of switch power supply, make this technology unceasing progress, based on the current to increase its reliability, that prompted the progress of the electronics industry. In the early eighty's, the power of the computer in a variety of efforts to achieve the full power, lead to complete the computer power generation. After entering the ninety’s, switching power supply into a variety of electronic equipment, all sides began using this makes switch power supply technology obtained the rapid development of switch power supply.

2. System design

This system adopts the button type input, link button with single chip microcomputer, the key is divided into upshift, downshift, precision gear shifting gear. After the single chip receives the voltage value of the key, after calculation, the corresponding duty cycle of the rectangular pulse wave is generated, a rectangular wave is connected with the driving chip to drive the MOS tube, and the MOS tube controls the switch on or off in the Buck circuit. The Buck circuit is used to reduce the voltage in the circuit, when the voltage value is reduced to the set value, the circuit is disconnected. In the whole process, the liquid crystal display screen is adopted, and the setting value of the voltage is displayed. After the output is stable, the output value of the output voltage is displayed. The basic structure of the system is shown in Fig.1.

Button and MCU I/O port connection, the high and low level information can be transmitted to the MCU internal, after the information processing and computing, the I/O port output the corresponding rectangular pulse wave. Pulse wave through the MOS tube drive chip, drive MOS, control DC-DC circuit to reduce the voltage to the desired value, by the ADC0809 after converting and gave it to the MCU. During this period by the MCU control LCD display.

The hardware in this design includes MC9S12XS128MAA, AT89C52, ADC0809, MOS tube, LCD display, TLP250 and so on.

The design of the power supply circuit of the switching regulator includes several parts: the key input circuit, SCM control circuit, liquid crystal display circuit, MOS tube driver chip circuit, Buck chopper circuit, analog digital conversion circuit.

After calculation, because the maximum voltage of the Buck circuit is 20V, the maximum current is 0.6A, so the decision system in the MOS tube using IR510A.

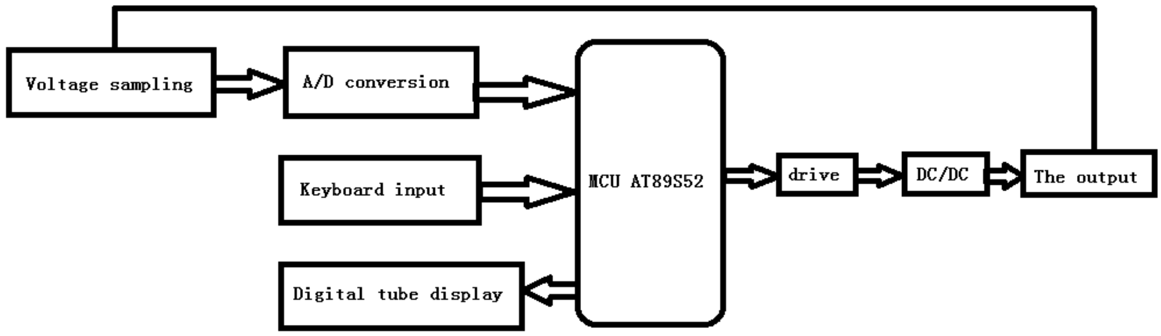

Fig. 1 basic structure of system

3. System circuit introduction

The global circuit diagram of the whole system is shown in Fig.2.

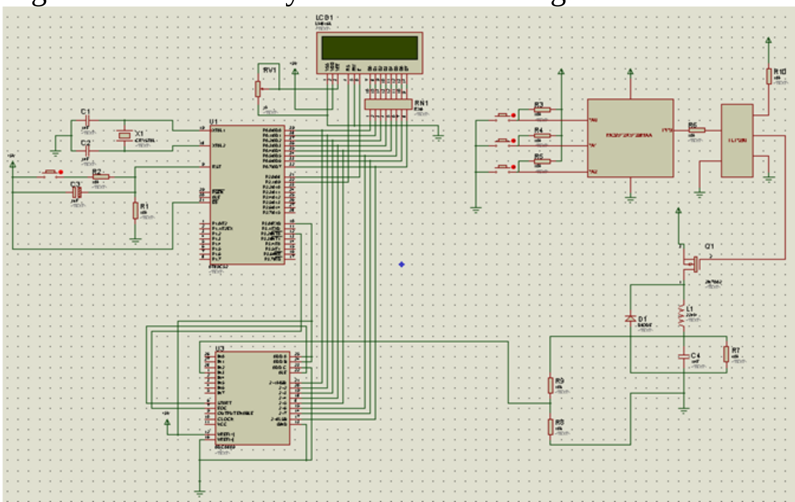

Fig. 2 total circuit diagram

3.1 BUCK chopper

Circuit power supply using 20V power rather than before the use of two 9V batteries composed of 18V power supply. Because in the actual use of 18V power, a lot of calculation results are not an integer, the system has a lot of obstacles to the regulation. As the voltage of the ADC0809 converter is the highest value of 5V, and our system requires voltage value between zero to twelve volts, so in the output voltage of the circuit when the two resistors are used for partial pressure. The two resistance values are 1K and 3K, respectively, and the voltage value is reduced by four times.

3.2 Circuit element calculation

Performance index of Buck converter:

Input voltage: standard DC voltage 18V, range: 16V~20V

Output voltage: DC voltage 0V~12V, 0.5A

Output voltage ripple: 100mV

Current ripple: 0.25A

Switching frequency: fs = 4kHz

Phase margin: 60

Amplitude margin: 10dB

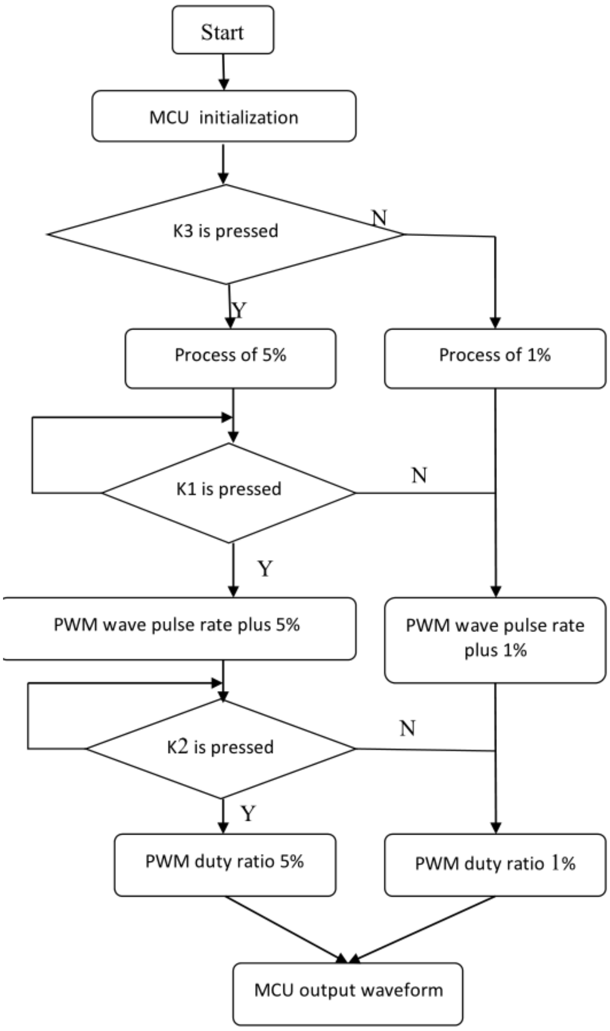

Fig. 3 flow chart of PWM wave generation

1. Duty cycle D calculation

According to the relationship between the input and output voltage of the Buck converter, the range of the duty cycle D is obtained.

$$D_{max} = \frac{U_o}{U_{inmin}} = \frac{12V}{16V} = 0.750 \tag{1}$$

$$D_{min} = \frac{U_o}{U_{inmax}} = \frac{12V}{20V} = 0.600 \tag{2}$$

$$D_{nom} = \frac{U_o}{U_{innom}} = \frac{12V}{18V} = 0.667 \tag{3}$$

2. Inductance L calculation

$$L = \frac{(U_{inmax} - U_o)T_{on(min)}}{2\Delta i_L} = \frac{(U_{inmax} - U_o)D_{min}}{2\Delta i_L f_s} = 6mH \tag{4}$$

2. Capacitance C calculation

$$C = \frac{\Delta i_L}{8\Delta v f_s} = \frac{0.1}{8*0.1*4} = 31.25nF \quad (5)$$

Capacitance voltage: because the maximum output voltage is 12V, then the capacitor voltage resistance value should be greater than 12V.

4. The selection of switching element Q

The maximum voltage in the circuit is 20V and the maximum current is 0.6A. After access to the relevant information, the decision to use the MOS model of the IRF510A tube, the pressure value of 100V, allowing the maximum value of the current 5.6A, to meet the needs of the circuit.

In order to ensure the effect of the actual operation, the software is used to simulate the software before welding. According to the results of the simulation, the parameters of some elements in the circuit are slightly changed, the inductance is reduced to 2mH, and the capacitance is raised to 120nF.

Flow chart introduction

PWM wave generated flow chart is shown in Figure 3.

The flow chart of the Buck circuit is shown in Figure 4.

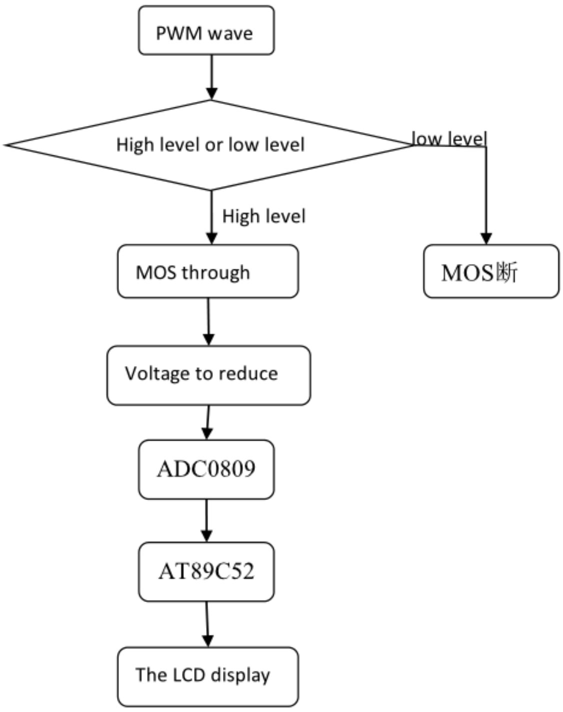

Fig. 4 flow chart of Buck circuit

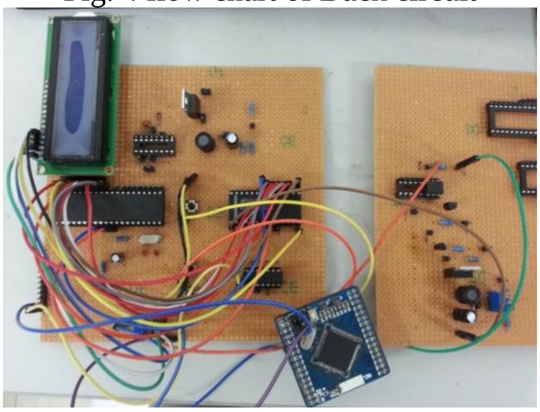

Fig. 5 circuit board

4. Debug result

The actual welding of the circuit board as shown in Fig.5.

The debugging results are shown in the following Table.1:

Table 1 Debugging results

	Transformation process (V)	Add / subtract	Press the number of keys	Theoretical output value(V)	Actual output value(V)
The start			0	0	0.07
The first time	1	Add	8	8	8.43
The second time	0.2	Add	2	8.4	9.42
The third time	1	subtract	2	6.4	6.84
The fourth times	0.2	subtract	3	5.8	5.24
The end				12	12.38

When the conversion process is set to 0.2V, the 128 single chip on the indicator light only one. When the conversion process is set to 1V, the 128 single chip on the indicator light. As shown in Fig.6 and Fig.7.

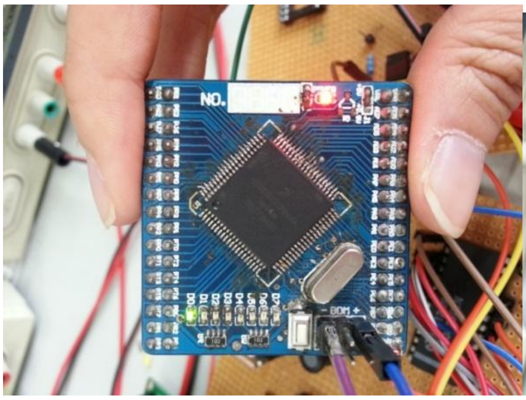

Fig. 6 process for the 0.2V

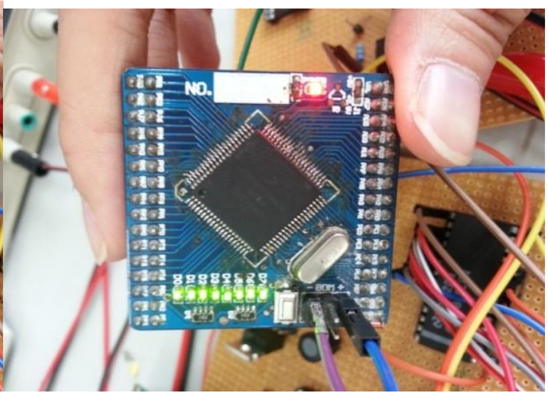

Fig. 7 process for the 1V

5. Conclusion

(1). Design: the system uses touchtone input, key and SCM links, buttons according to the function points to add files, reduction gear, precision gear shifting gear. Microcontroller receives the key input voltage value, through calculation, resulting in corresponding duty ratio of the rectangular pulse wave, through rectangular wave is connected with the driving chip to drive the MOS tube, and MOS tube control of buck circuit switch is turned on or off. Buck circuit is used to reduce the voltage of the circuit, the voltage value will be reduced to the set value, the circuit is disconnected. In the whole process, the liquid crystal display screen is adopted, and the setting value of the voltage is displayed. After the output is stable, the output value of the output voltage is displayed.

(2). Hardware Design: the system consists of the key input part, MCU control part, liquid crystal display part, drive part, Buck circuit part, analog digital conversion part. The regulated power supply can be continuously adjusted and displayed in real time. The buck PMW and DC-DC conversion, through the MCU output rectangular pulse wave, controlling the duty ratio, repeated turn-on and disconnect the buck circuit MOS switch, by PMW wave change duty ratio of the change in the output voltage of the buck circuit.

(3). Software design: This design through the Protues software to carry out the circuit design, Keil software programming, simulation on the Protues software. The use of Keil software programming, including the key input part, MCU control LCD display part, the MCU control output PWM wave part, feedback part. The key part of the need to pay attention to anti shake.

(4). Experimental test: after welding the physical test, found that the output in the normal conversion between 0-12V, the accuracy of 0.2V. The system can operate normally.

References

[1] Du chunshu: C language and assembly language mixed programming practice. Beihang University press(2007),p.220-233;
[2] Du chunshu: Design and Simulation of single chip microcomputer based on Protues and C51 Keil.Electronic Industry Publishing House(2011),p.1-48
[3] Wang xinzhi, Zhong aiqin: Principle and interface technology of AT89 series single chip microcomputer.Beihang University press(2004),p.118-129
[4] Wang zhaoan, Lui jinjun:Power Electronic Technology.Machinery Industry Press (2009), p. 119-179
[5] Zhang jingwu, Zhou lingbin.:Design and Simulation of single chip microcomputer system. Electronic Industry Publishing House(2007),p.97-126
[6] Li jianzhong:Principle and application of single chip microcomputer. Xidian University Press(2008),p.147-208
[7] Ma jianming:Data acquisition and processing technology.Xi'an Jiao Tong University press (2011),p.96-137