Electronic weighing instrument based on microcontroller

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Abstract

The design is based on SCM weighing instrument, and its hardware design, including minimum system microcontroller, A/D converter circuit, the load cell, LED display circuit, ± 5V power supply circuit and alarm circuit and circuit design content of several parts. Pressure sensor output response in which the analog voltage signals, after A/D converter obtained after the digital D. However, the digital D is not the actual weight of the value of weight W, W needed by the digital D controller through a series of operations inside - the data processing to get. The design system produced 51 series You Atmel 89S51 Microcontroller control; the software of the system has completed the design of the main program, the A/D conversion program and the display program chart.

Keywords

Weighing instrument, SCM, A/D convertor, LED display

1. Introduction

The application of weighing equipment has spread to different domain of national economy closely connected to people's life. With the development of automatic testing technology, it is hard for the traditional weighing equipment to satisfy people's demand in the function, accuracy and cost performance, especially powerless in Intelligent, portable measuring and the measurement on tiny masses.

It can be fount out that the trend of the overall development of electronic weighing instrument is miniaturization, modularization, and integration and intelligentialize by analyzing the development situation of electronic weighing instrument products and demands in domestic and foreign markets in recent years. The tendency of its technical characteristics is high rate, high degree of accuracy, high stability, and high reliability. [1] Its functional tendency is intelligentialize which pays attention to the controlled messages weighed and measured together with the non-controlled messages. Its application performance tends to be with comprehensiveness and modularity.

2. Overall system design scheme

The block diagram of general system formula is shown in graph 1.

The system applies SCM as the master controller firstly using the weighing sensor to detect the pressure signal so as to obtain weak signal. Later the signal will be processed by the signal amplification conditioning circuit and sent to A/D convertor, and the analog quantity will be transformed into digital quantity for output. The SCM control segment converts the digital signal to the actual weight signal of objects through complicated operation and then stores it into the storage location. The data display section will realize its display function according to requirements. The power circuit section mainly converts power frequency voltage directly to the required voltage ±5V so as to provide stable and convenient power supply for the circuit. Besides, when the SCM's sensor measuring object surpasses the range of measurement, SCM will initiate the warning device. There remains large overload capacity in the design for security so there will be no damage to measurement devices when the system alarms from overloaded.

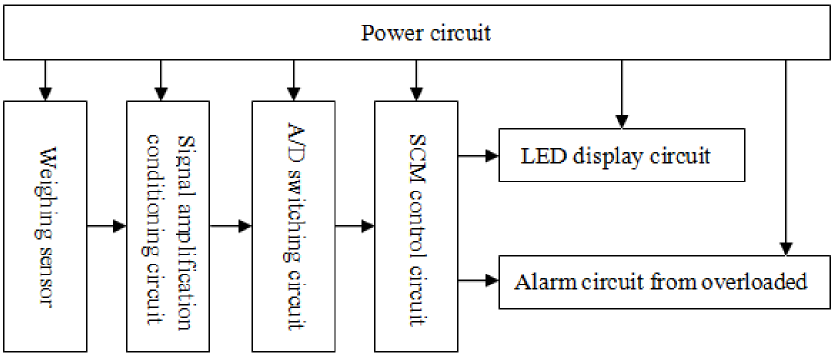

Fig. 1 Structural diagram of overall system control scheme

3. Design of system hardware

3.1 The SCM control circuit.

Considering the functional requirements of the system and maximization of its cost performance, we select AT89S51 SCM as the master controller. The control circuit of SCM is shown in graph 2.

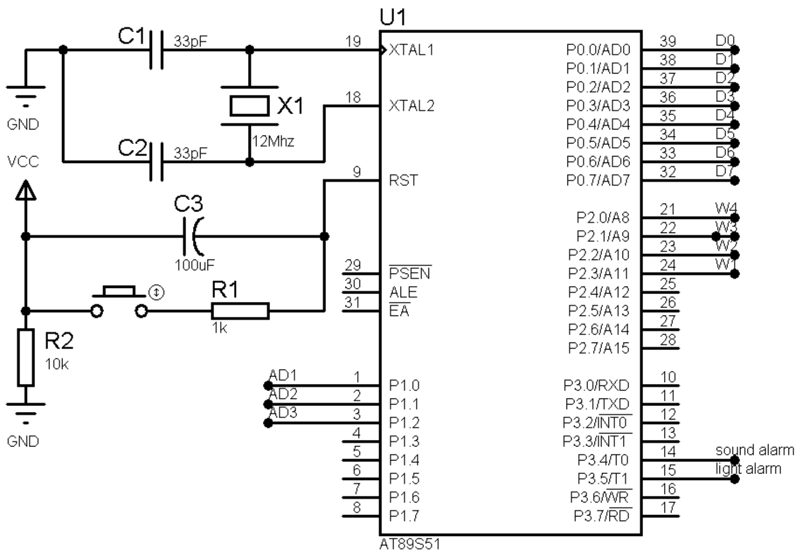

Fig. 2 The SCM control circuit

In above graph, the oscillating circuit applies 12MHz crystal oscillator which is the time reference of the working SCM and decides the operating speed of SCM. Because in SCM operation process the disturbance from itself and external disturbance will lead to malfunctions and errors. For the convenience of system circuit's operation and debugging, the reset circuit applies to power on reset mode together with key level reset mode. Port P0 and P2 will be used for display of LED nixie tube. P1.0~P1.2 will be used to connect with A/D switching circuit. P3.4~P3.5 will be used to connect with sound-light alarm circuit.

3.2 The power circuit.

The power circuit of this system is mainly composed by three parts: transformer, rectifier filter and three-terminal voltage regulator circuit. Alternating current of 220V passes through the transformer and output ±9V voltage. After the rectifier filter circuit and through LM7805 and LM7905, ±5V is obtained after conversion from DC/DC for the use of pressure sensor and other chips in the system. The power circuit is shown in graph 3.

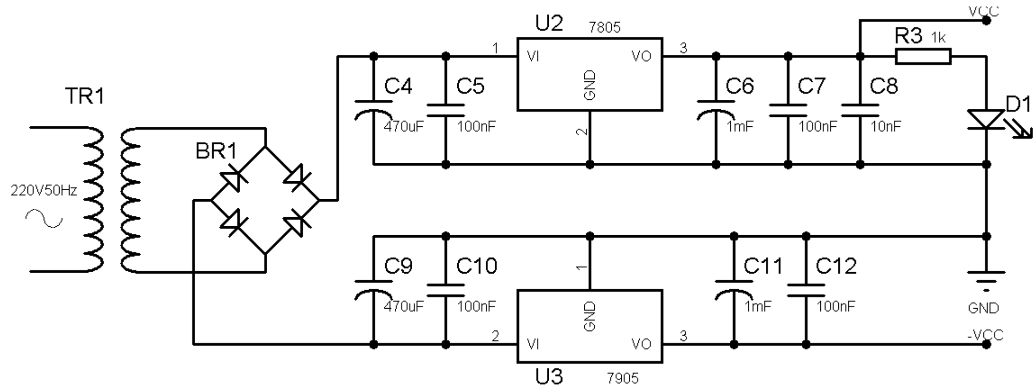

Fig. 3 The power circuit

3.3 The weighing sensor and the signal amplification conditioning circuit.

Resistance strain sensor is mainly made up of the elastomer, resistance strain gage and detection circuit. The elastomer comes into elastic deformation under the action of external force making the resistance strain gage which sticks to its surface get deformed. After the deformation of resistance strain gage, its value of resistance will change. Then the corresponding detection circuit will convert the change of value of resistance into electrical signal so that the process that external force is converted into electrical signal has been completed. In this system we select L-PSII-10 model pressure sensor produced by Jinzhong Electronic Weighing Apparatus Co., Ltd as the sensor with two-hole cantilever beam for special use in electronic price computing scale.

The output voltage signal of weighing sensor is millivolt grade so that it has high requirement on the operational amplifier. [2] We applies to special instrumentation amplifier INA133I and differential input is used inside of this kind of chip with high common mode rejection ratio, strong resistance of difference-mode input, huge and changeable transmission gain, high precision and simple external interface. The signal amplification conditioning circuit is shown in graph 4.

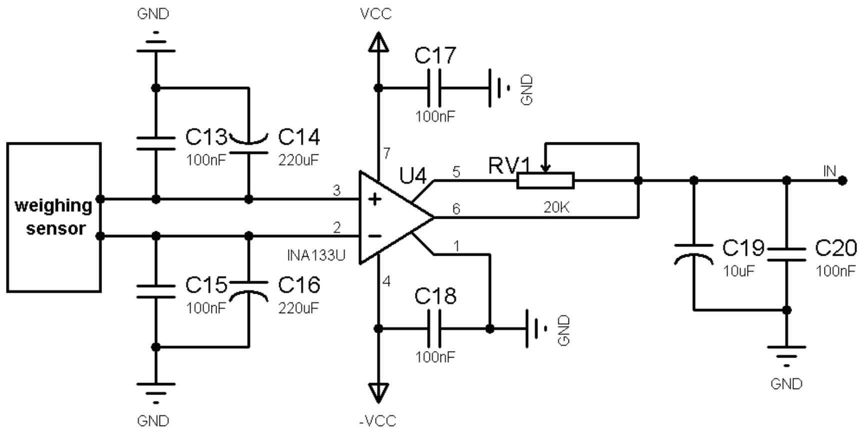

Fig. 4 The signal amplification conditioning circuit

3.4 The A/D switching circuit.

We apply MAX1284 chip produced by MAXIM in this design with the convenience that a complete high-speed data acquisition system can be formed without any external devices. MAX1284 uses sampling/ retaining appliance and successive approximation register circuit to convert a mimic input signal into a 12-bit digital output with the input signal between0V~ Vref and conversion time including sampling time of 10us. Three digital lines can form the serial interface: SCLK, CS and DOUT and the microprocessor interface is very simple. The A/D switching circuit is shown in graph 5.

When CS changes to low electricity the switching starts and at this time the output of DOUT is low electricity. [3]When DOUT's high electricity is detected, the switching ends and the conversion data can be read out. Inputting a pulse in SCLK, the top digit B11 appears in DOUT and after 11 pulses, B10～B0 data is respectively shifting output. Entering another pulse, a switching cycle finishes.

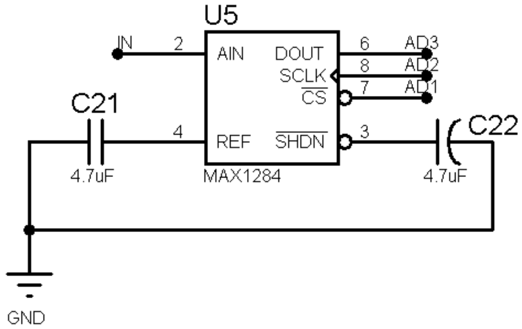

Fig. 5 The A/D switching circuit

3.5 The LED display circuit.

The display circuit applies 4 pieces of eight-segment common-cathode nixie tubes for dynamic display. [4]Using drive r 74LS240 to control the segment selection of 4-bit nixie tube and the control bit selection of driver 74LS04. Four-bit LED respectively displays kilobit, hundreds place, tens, and unit's digit of the weighting results with the unit of gram. The display circuit is shown in graph 6.

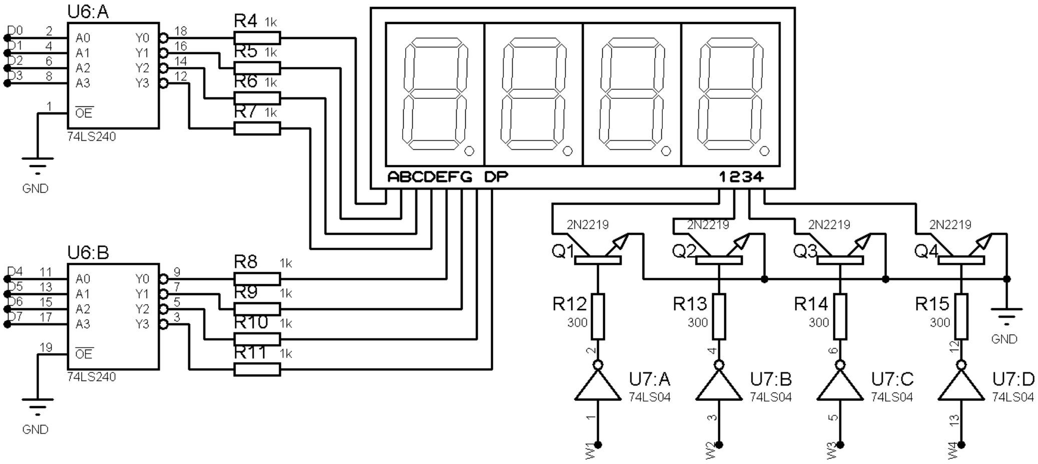

Fig. 6 The LED display circuit

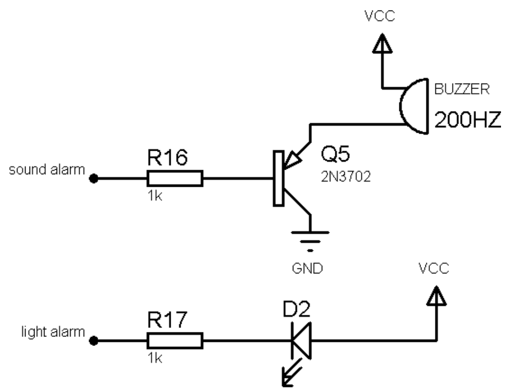

Fig. 7 The sound-light alarm circuit

3.6 The sound-light alarm circuit.

The sound-light alarm circuit can only be driven by driven by SCM when the real object surpasses the artificial value as the reminder for users. The circuit is shown in graph 7. The lead of alarm circuit connects to SCM P3.4 port and the lead of luminous diode connects to SCM P3.5 port. When the sensor detects that signals is bigger than the system's weighing range after analog-digital conversion and SCM's processing, the luminous diode starts lighting up and sending the alarm signal.

4. Software design of electronic weighing instrument

4.1 Design of main program.

The main program flow chart is shown in graph 8 based on the functional requirement achieved by the weighing instrument.

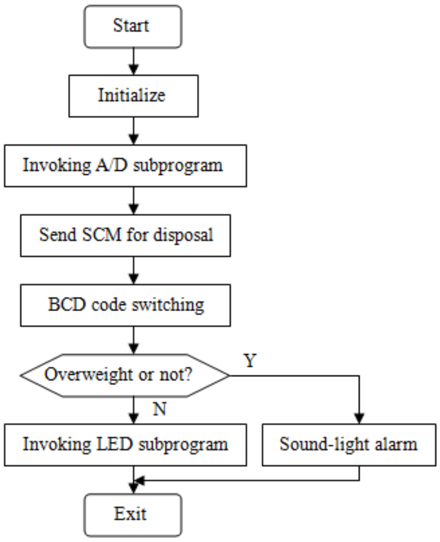

Fig. 8 Main program flow chart

4.2 Design of A/D conversion subroutine.

The working process of A/D conversion: in the falling edge of CS, MAX1284 initializes and starts switching. After 8.5μs, the output of DOUT is high electricity, which marks the finish of conversion. At this time, in SCLK end, a series of pulses can be input to shift out the DOUT end data into SCM for processing. The flow chart of A/D conversion subroutine is shown in graph 9.

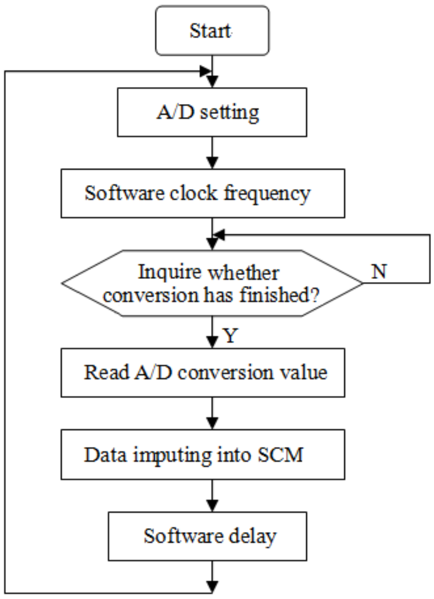

Fig. 9 A/D conversion subroutine flow chart

4.3 Design of LED display subroutine.

The LED program flow chart is shown in graph 10.

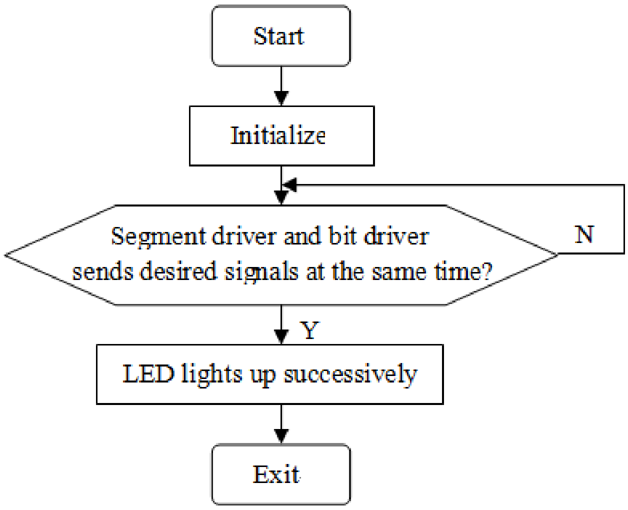

Fig. 10 LED display subroutine flow chart

5. Conclusion

This article sets AT89S51 SCM as the controlling core and completes the electronic weighing instrument's overall structure and the design of software and hardware by combining high-sensitivity resistance-type strain pressure transducer with high-precision A/D converter, so as to finally realize the electrification and intelligentialize of object mass control and display. But because each electron device is influenced by temperature and external disturbance, there exists certain random error. Therefore, it needs further improvement.

References

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