

# Design and Research of Intelligent Alcohol Detector Based on Single Chip Microcomputer

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**Abstract:** In order to prevent drunk driving timely and protect personal safety, a kind of vehicle-loaded alcohol concentration detector based on single chip microcomputer control is designed. The detector uses AT89C51 microcontroller as the core, makes use of the gas sensor, A/D converter to detect the alcohol concentration of the breath of the driver, can set different thresholds according to the space of the car model, automatically cut off the ignition circuit for the exceeded threshold, and has the sound and light alarm function, which fundamentally solve the problem of drunk driving. The instrument is compact in size, stable in performance, convenient in installation and debugging, and of practical significance.

**Keywords:** Single Chip Microcomputer; Alcohol Sensor; A/D converter; detector

## 1 Introduction

In recent years, with the rapid development of China's economy and the rapid improvement of people's living standards, more and more people have their own private cars, and traffic accidents caused by drunk driving also occur frequently. Traffic accidents caused by drunk driving are due to the driver's excessive drinking which brings about high alcohol concentration inside the body, paralyzes the nerves and results in slow brain response, uncontrolled limbs and other symptoms. Small amounts of alcohol do not show these symptoms, which are when the body's alcohol level is low, and when the body's alcohol level exceeds a certain level, which is dangerous. To do this, an intelligent device needs to be designed to monitor the driver's alcohol level. Currently, most countries around the world use breathalyzers to conduct on-site tests on drivers to determine the amount of alcohol in the measured body, so as to ensure the safety of the driver's life and property [1–3].

Drinking a small amount of alcohol does not have the above symptoms, that is, when the body's alcohol concentration is relatively low, and the body's alcohol exceeds a certain value, it will cause danger. Therefore, it is necessary to design a smart instrument to monitor the alcohol content of the drivers. At present, most countries in the world use a breath alcohol tester to conduct on-site testing of the driver to determine the amount of alcohol in the body of the person being measured to ensure the safety of the driver's life and property [4–7].

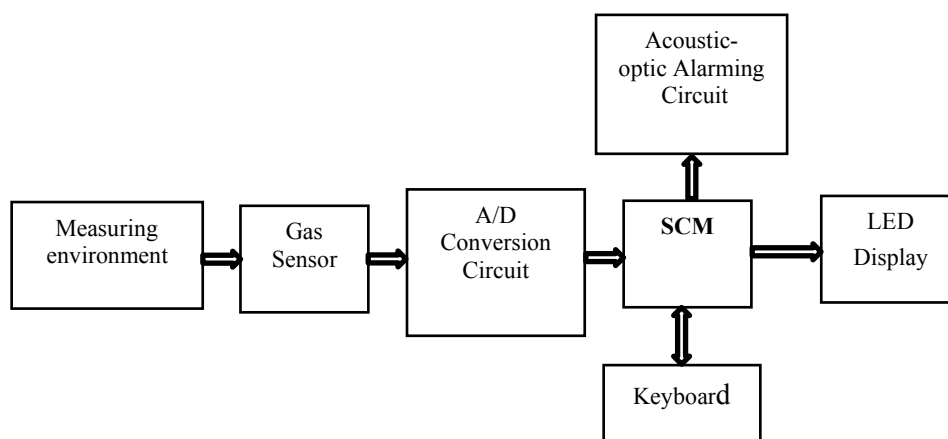
This design is based on a single-chip microcomputer as the core device. Its hardware circuit uses a special alcohol sensor to detect the alcohol concentration in the gas [8–10]. The collected data is optimized by software and hardware technology at the same time, which can accurately detect the alcohol in the gas of the car. In addition, the detector can also be used in industrial environments to monitor the alcohol concentration in a specific environment such as the alcohol production workshop and industrial sites to avoid fires, explosions, alcoholism and other serious accidents to ensure environmental safety.



## 2 The Overall Program Design of the Alcohol Tester

The design mainly consists of two parts: the hardware design part and the software design part [11–13]. The hardware part uses the MQ3 gas sensor to measure the concentration of alcohol in the air and converts it into a voltage signal. After being converted into a digital signal by the A/D converter, it is transmitted to the single-chip system, and the signal is processed by the single-chip microcomputer and its corresponding peripheral circuit to display the alcohol concentration value and super-threshold sound and light alarm; the program design of the software design part adopts the modular design idea, and the functions of each sub-program are relatively independent, which is convenient for debugging and modification [14–15].

The whole hardware circuit part can be divided into single-chip small system circuit, A/D conversion circuit, sound and light alarm circuit, LED display circuit, and button circuit, as shown in Fig. 1. The design and principles of each part of the circuit will be described in detail in the hardware circuit design section.



**Figure 1:** The block diagram of the system

When designing, considering the alcohol concentration is the sensor to convert the non-electricity into electricity, the sensor output is 0–5V voltage value and the voltage value is stable and the external interference is small, etc. Therefore, the sensor output voltage value can be directly converted by the A/D converter to be sent to the MCU for processing, the LED is used to display alcohol concentration and the sound and light alarm signal, various parameters can be adjusted through the 4\*4 keyboard for online upgrade maintenance. Its overall block diagram is shown in Fig. 1.

## 3 Hardware Design

### 3.1 Sensor Selection

The system directly measures the alcohol concentration in exhalation and then converts it into the concentration of alcohol in the blood, so the gas sensor with high sensitivity, good selectivity, high reliability and long service life is adopted [16–17]. At the same time, considering that the gas composition in the surrounding air may affect the accuracy of the sensor measurement, so an MQ3 type gas sensor that is only sensitive to alcohol gas is selected.

There are two cases to the standard loop of the sensor. For one thing, it can accurately reflect the change of the surface resistance value of the sensor, mainly using the signal output loop. At the same time, a 200K variable resistor is connected in series with the 4 and 6 pins of the sensor to ensure that the heating voltage is 5V. In addition, in order to maximize the accuracy of the measurement and minimize the errors, it is necessary to find a suitable temperature. Generally, the sensor needs to be preheated for 5 minutes before measurement.

### 3.2 A/D Conversion Circuit

In the application system of the single chip microcomputer, the relevant changes of the measured object, such as temperature, pressure, flow, speed and other non-electrical physical quantities, must be converted into continuously changing analog electrical signals (voltage or current) by the sensor. These analog electrical signals must be converted into digital quantities before the MCU software processing. A device that converts analog quantities into digital quantities is called an A/D converter (ADC).

The ADC0809 converter with successive approximation is selected in the design. It has eight analog signal input ports and is powered by a single +5V power supply. The 8-channel 1-in-1 analog switch with latch function on the chip determines the selected channel by the functions of the C, B, and A pins, and can be directly connected to the system data bus. The ADC0809 can convert the 0-5V alcohol concentration signal through an appropriate external circuit. The connection diagram of ADC0809 and MCU in this system is shown in Fig. 2.

### 3.3 LED Display Circuit

LED display usually has two display modes: static display and dynamic display. This design uses parallel input hardware to decode the static display circuit, and each bit can be displayed independently. As long as the segment code level is maintained on the segment code line of the bit, the bit can maintain the corresponding display character. The latch decoder CC4511 is adopted to translate the BCD code of the lower 4 bits of the P1 port into a seven-segment font code in this circuit and uses the higher 4 bits of the P1 port are used as the stored signals of each latch decoder to achieve stable display. Among them, the LED uses a common cathode 7-segment digital tube. The digital tube display circuit is shown in Fig. 2.

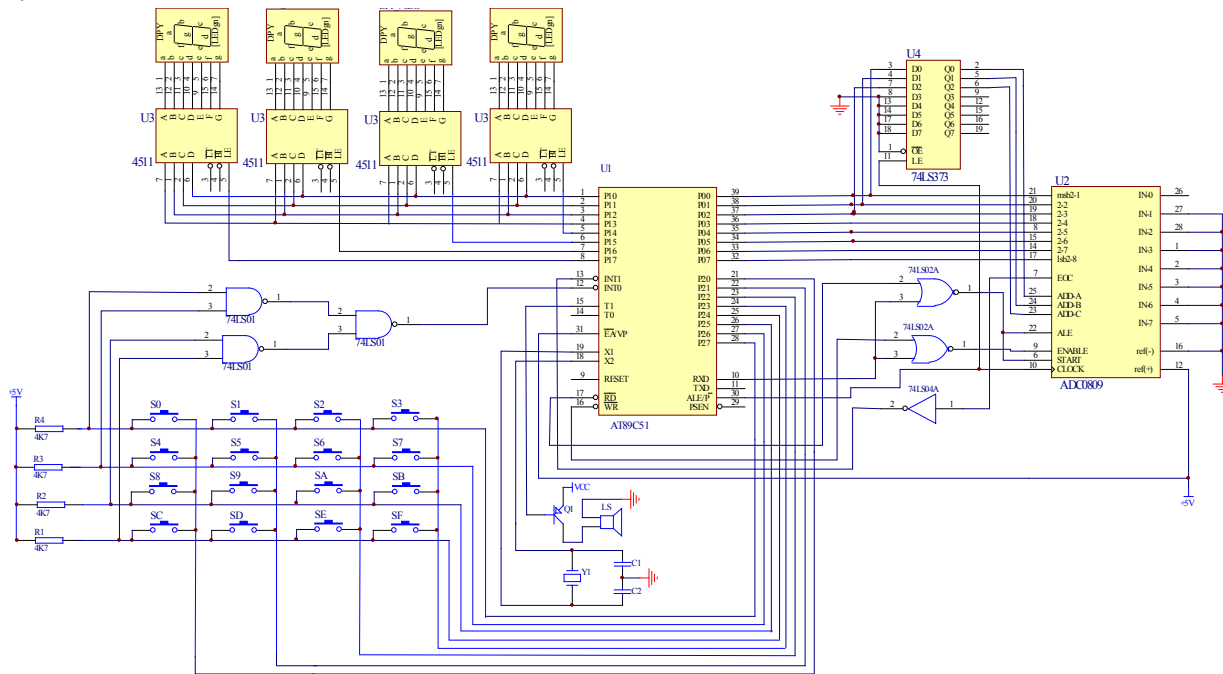


Figure 2: General schematic diagram of the system

### 3.4 Keyboard Circuit

The keyboard works in two ways: a coded keyboard and a non-coded keyboard. There are scanning methods and line inversion methods. This design uses a non-encoded keyboard and the scanning method to process the buttons. Debounce is implemented by software. Its circuit is shown in Fig. 2.

**3.5 A/D Conversion Circuit**

The alarm circuit mainly consists of a triode Q3, a resistor R5 and a speaker LS. When the alcohol sensor detects the alcohol concentration, after the A/D conversion, the MCU sends a control signal via the pin P3.5 (T1) to drive the alarm circuit to work and send an alarm signal to remind the relevant personnel that the alcohol concentration exceeds the standard to automatically cut off the electronic ignition unit of the car.

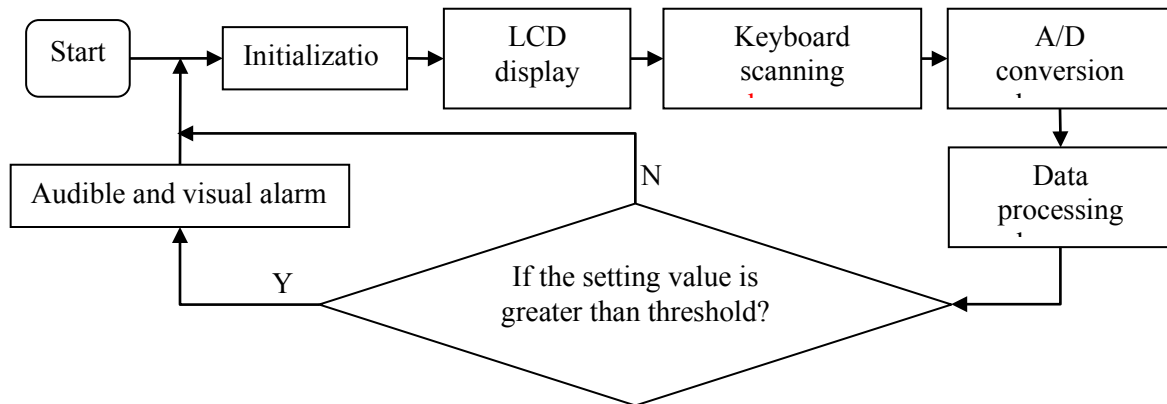
**4 Software Design**

**4.1 Main Program Block Diagram**

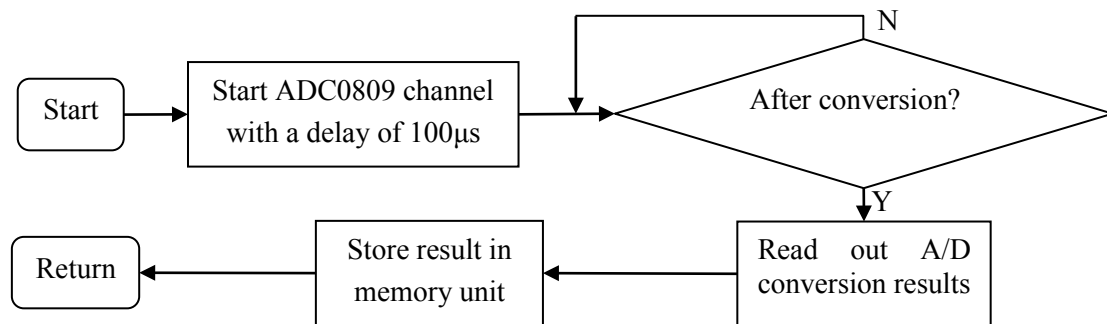
The main program flow chart is shown in Fig. 3.

**4.2 Data Acquisition Subprogram Block Diagram**

The flowchart of the A/D conversion subroutine is shown in Fig. 3. After ADC0809 is initialized, the 0-5V analog signals input through channel 0 are converted into the corresponding digital quantity 00H-FFH, and the corresponding value is stored in the memory unit. The block diagram is shown in Fig. 4.



**Figure 3:** Block diagram of main program



**Figure 4:** Block diagram of data acquisition subprogram

**4.3 Alarm Subroutine Block Diagram**

The system sets the threshold and saves it in 3 units starting at 50H. For comparison and display, the thousands of thresholds are placed in 50H, the hundreds and ten places are placed in 51H, and the single digits are placed in 52H. The alarm circuit is composed of a buzzer alarm circuit and an LED illumination alarm circuit. When the input terminal P3.5 is low level, a current passes through the buzzer, and the buzzer sounds an alarm. When the input is high level, it does not alarm [18–19].

Before the alarm subroutine is executed, the alarm threshold is converted to a compressed BCD code

and stored in two storage units. After the sensor input value is converted by A/D, the comparison program is called, and the measured value displayed after the data processing is compared with the threshold value, and if the threshold value is less than the threshold value, the display program is continued. If it is greater than the threshold, clear the P3.5 port of the MCU for sound and light alarm. The 40H, 41H, and 42H units are stored after A/D conversion and the outcome of performing decimal conversion. 40H and 50H are respectively stored as the measured value after processing and the compressed BCD code of thousands of bits of the threshold value. 41H and 51H are stored respectively as the measured value after processing and the threshold value of the hundred-digit, ten-bit compressed BCD code. 42H and 52H are stored separately as the processed measured values and the compressed BCD codes of the single digital of the threshold. The program first compares the values in 40H and 50H. If the value in 40H is greater than the value in 50H, an alarm is issued. And so on, compare 41H and 51H, 42H and 52H. The block diagram is shown in Fig. 5.

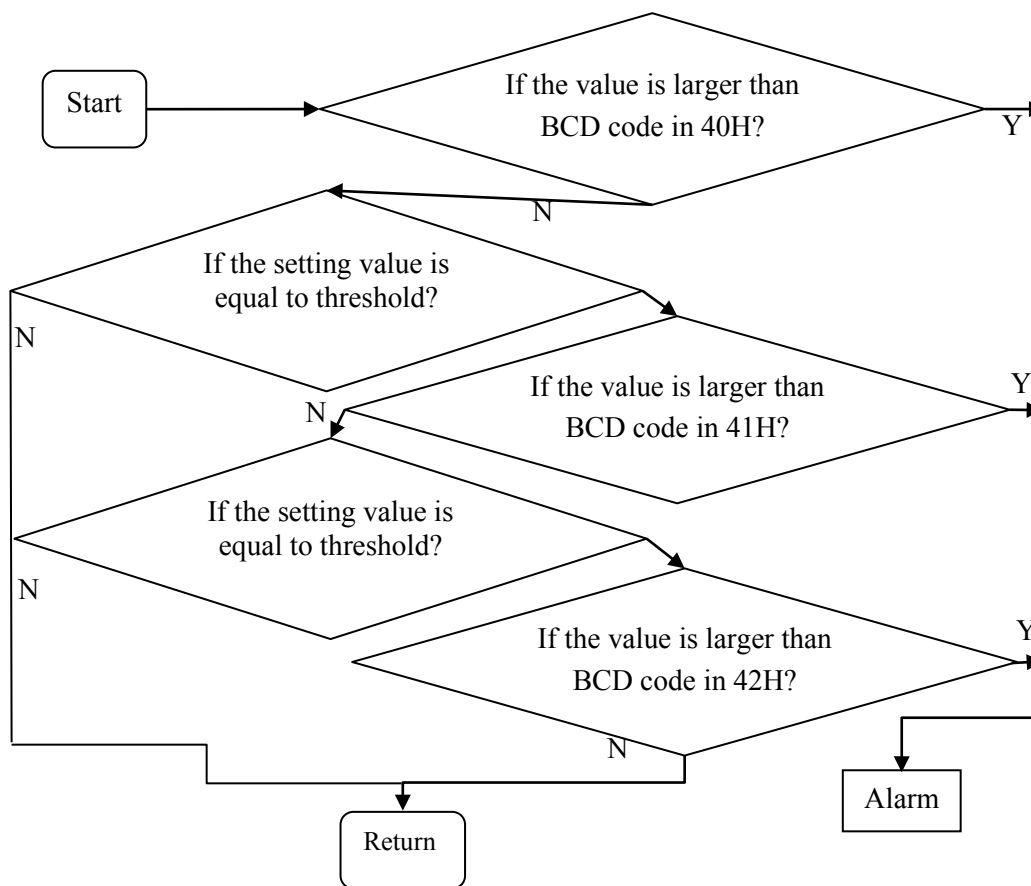


Figure 5: Flow chart of alarm subprogram

### 5 Summary and Outlook

The data acquisition system of the alcohol concentration detector adopts a single chip as a control core, and the peripheral circuit has an LED display and a keyboard response circuit [20–22], and no other computer is needed; the single chip system controls the keyboard and the LED display to realize human-computer interaction operation, and the user can interact with it to complete the process of data collection, storage, calculation, analysis, etc.; software design is simple and easy to understand. Therefore, the entire system has the characteristics of low power consumption, miniaturization, and high cost performance. Through the joint debugging of software and hardware, the experimental results meet the basic requirements of the design and reach the design indicators. The alcohol concentration detector designed in

this paper can not only be used to detect the alcohol concentration of the vehicle safety control system and prevent traffic accidents, but also can be used in other environments where alcohol concentration detection is required. Therefore, it has a good promotion value in practical applications.

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**Conflicts of Interest:** The authors declare that they have no conflicts of interest to report regarding the present study.

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