Design of Aircraft Engine Speed Detection System Based on AT89C51 MCU

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Abstract

In order to detect aircraft engine speed, an aircraft engine speed detection system based on MCU is designed. Its hardware structure is mainly composed of AT89C51 MCU and its minimum system, the design module of Holzer component circuit, clock circuit design module, reset circuit design module, data transmission circuit design, display circuit design module and so on. The Holzer wheel speed sensor collects the speed signal and converts the pulse signal into the MCU, and uses the MCU to complete the control, data processing and display output of the measurement system. On this basis, the overall scheme of the system is designed. The measuring system has the advantages of small volume, low cost, high degree of test, easy operation and good stability.

Keywords

AT89C51 MCU; LED digital tube; Aircraft engine; Speed detection.

1. Introduction

Aircraft engines are the heart of an airplane, and the performance of the aircraft depends largely on the engine[1]. If the aircraft engine fails during the flight, it is likely to lead to the occurrence of major accidents, so the real-time monitoring and testing of the engine condition of the aircraft is particularly important, and the engine speed of the aircraft is an important indicator to show the operating conditions of the aircraft engine, and the operation of the aircraft engine must be mastered. In order to understand the speed of the aircraft engine first, we must have a reliable engine speed detection system, which can monitor the operating condition of the aircraft engine in real time, and take the necessary measures to avoid or reduce the possible danger in the case of abnormal engine running state[2].

In the early days, most of the aircraft engine speed detection equipment was adopted such as friction wheel speed regulation and instrument separation. There are some problems in the speed adjustment mode of friction wheel, which is cumbersome and low precision. Instrument separation is more complicated. Once it is malfunction, it is difficult to maintain and repair. Since the 20 period of 70s, the world aviation industry has developed rapidly, and the control and detection technology of aero engine is also increasing, and the developed countries such as Britain and America have been in the leading position in the world[3]. Since 1980s, China has begun to develop the research on aero engine control and monitoring technology. At present, the key technology has been mastered, but in general, it is still behind the world leading level, and many technologies have not been broken[4, 5].

This paper designs an aircraft engine speed real-time detection system with AT89C51 MCU as the core. The pulse signal collected by Holzer wheel speed sensor is transmitted to the AT89C51 microcontroller. The MCU calculates the speed of the motor to LED display according to the external interruption and the internal timer, thus the change of speed is displayed intuitively.

2. System Overall Design

The hardware structure of the aircraft engine detection system mainly includes the AT89C51 microchip processor, the minimum system, the clock circuit design module, the reset circuit design module, and the display circuit design module. From the whole, the aircraft engine speed detection is mainly divided into two parts of speed measurement and display. Micro processor is the control center of the whole system. The pulse signal transmitted by Holzer wheel speed sensor is sent to the MCU. The single chip computer then counts the external interrupts and internal timers to calculate the engine speed of the aircraft most. Finally to the LED display. The schematic diagram of the system whole hardware circuit is shown in Fig. 1.

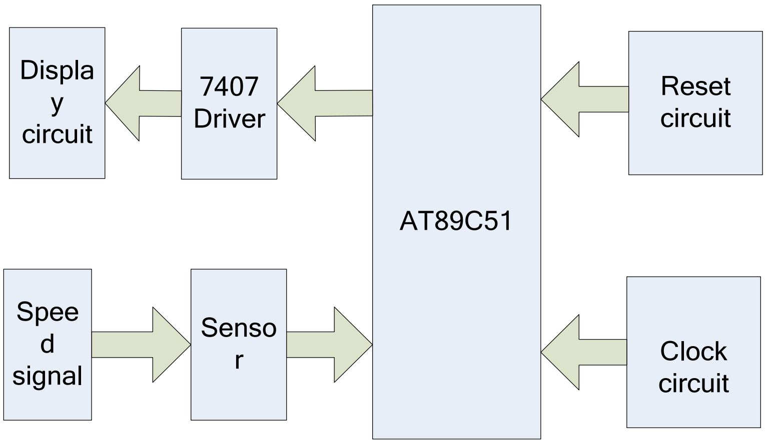

Fig. 1 System hardware circuit

3. Holzer sensor circuit design

In this paper, the Holzer wheel speed sensor is used to collect data. The method of measuring the magnetic field by the Holzer wheel speed sensor is very simple. The Holzer device is made into various forms of probe, and it is placed in the magnetic field that needs to be detected. Because the Holzer device is sensitive to the magnetic induction intensity perpendicular to the Holzer surface, it is necessary to make the surface of the device and the surface of the device. The magnetic line of force is perpendicular. After energizing, the magnetic flux density of the measured magnetic field can be obtained from the output voltage. If it is not vertical, the vertical component of the magnetic field should be calculated to calculate the magnetic induction intensity of the measured magnetic field. Therefore, because the size of the Holzer element is very small and can be detected by multiple points, the field distribution state can be obtained by the computer, and the magnetic field in the slit and small holes can be detected. When the magnetic field is used as the carrier of the motion and position information of the sensing object, the permanent magnetic steel is used to produce the working magnetic field. In order to ensure reliable operation of Holzer devices, especially Holzer switches, the effective length of air gap should be considered in application. When calculating the total effective working air gap, we should start from the surface of the Holzer chip. In the already encapsulated Holzer circuit, the depth of the Holzer chip will be given in the product manual.

Because the Holzer device needs to work, it usually makes the magnet move along with the detected object for movement or position sensing. The appropriate location of the Holzer device is fixed and the working system is used to detect the working magnetic field, and then the detected information is extracted from the results of the test. The Holzer sensor circuit diagram is shown in Fig. 2.

Fig. 2 Circuit diagram of the Holzer sensor

4. Clock circuit design

The allowable clock frequency of MCU is different because of model difference, its typical value is 12MHz. Inside the microcontroller, there is an inverting amplifier. XTAL1 and XTAL2 are input to the output of the inverting amplifier respectively. After the external feedback element is added, the oscillator is formed, and the generated clock serves the various components inside the microcontroller. AT89C51 microcontroller belongs to CMOS8 bit microprocessor. Its clock circuit is different from NMOS MCU.

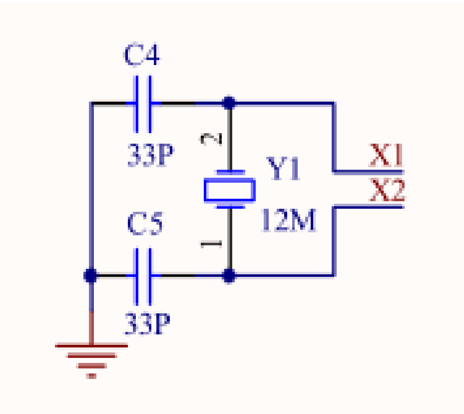

Fig. 3 Block diagram of clock circuit

5. Reset circuit design

Reset is a necessary program for a computer to run every time it starts. It makes the central processor CPU and the other components in the system in a determined initial state and start working from this state. The 51 single chip has a reset pin RST, which acts as a Schmitt trigger input (on the CHMOS single chip, there is a low resistance inside the RST pin). The pin will have 2 machine cycles (24 clock cycles) above the high level after the oscillator is excited to make the device relocate. As long as the RST remains at a high level, then the MCS-51 remains in the reset state, and the PSEN, P0, P1, P2, P3, and ALE ports all output high levels, and exit the reset state when the RST turns to a low level. CPU begins to work in the initial state.

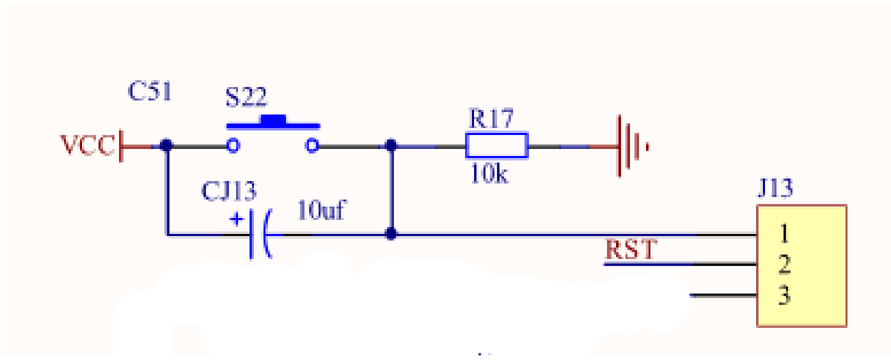

Fig. 4 Electric reset circuit

6. Display circuit design

The driver of the digital tube used in this paper is 7407, and the full name is 7407 TTL collector open six positive phase high voltage driver. Its structure is simple and easy to use. In order to save I/O line, the display mode used in this paper is dynamic display.

For 5 bit displays, five display buffer units, 30H 35H, are stored in the AT89C51RAM memory to store the display data of 5 bits of display respectively. AT89C51 microcontroller's P2 port scan output is always only one bit for low level, that is, only one common cathode is low in 5 bit display, the rest is high level, the P0 port of AT89C51 single chip corresponding bit (low cathode) display data of data, make this bit display a character, others are dark, change P2 in turn. The port output is high, and the P0 port outputs the corresponding segment data. The 5 bit display will display the characters determined by the display data in the buffer.

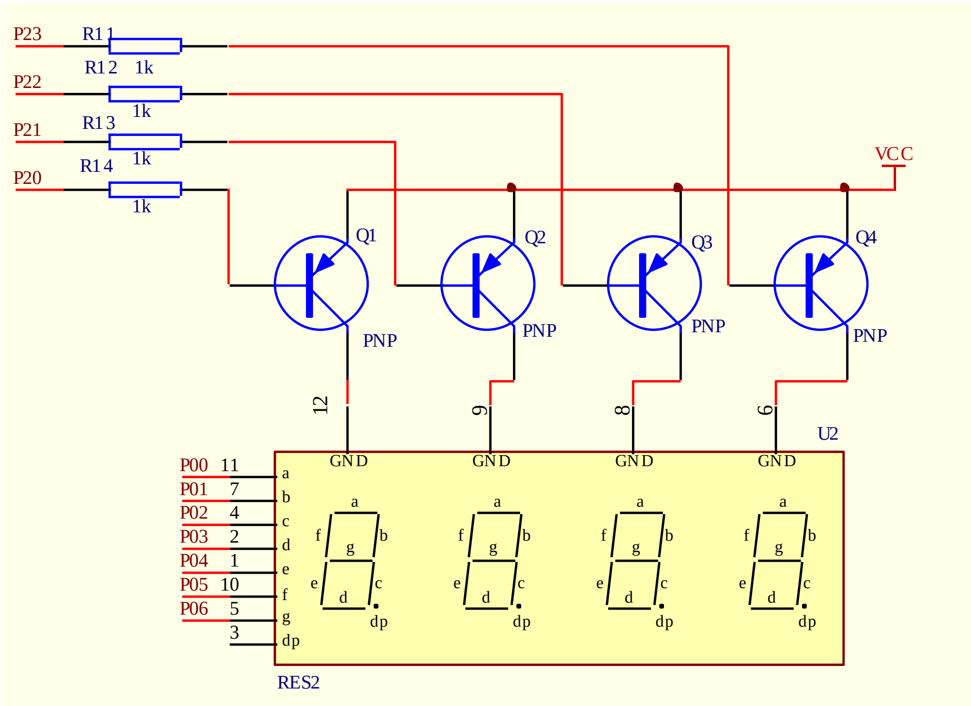

Fig. 5 Speed display circuit

7. Conclusion

This system makes full use of the superior programmable and controllable performance of the MCU, and gives full play to the superiority of the MCU as the core of the system. It integrates the mechatronics technology, the computer application and the LED display technology to make the whole system highly integrated. The error of the system is small and the control error is up to the requirement. Because the hardware circuit design of the system is relatively small on the circuit board, the volume is greatly reduced. The hardware structure of the system is simple and reasonable. It is suitable for the application of aircraft, and the system has the characteristics of high detection precision, high reliability, low cost, high practicality, convenient operation and higher intelligence. It can fully meet the needs of speed detection in machinery, electronics and transportation industries.

Acknowledgements

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