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Design of an Aircraft Data Recording Device

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Abstract: A data recording device was designed for high-speed rotating aircraft, with a focus on designing low-voltage signal acquisition circuits and high-voltage isolation acquisition circuits according to the characteristics of the device. It can collect effective signals reflecting flight and control status at all times, achieving comprehensive signal acquisition, easy operation, and stable performance.

Keywords: Flight device; Data recording; Signal acquisition.

1. Introduction

During the operation of high-speed rotating aircraft, it is necessary to collect and record key parameters. The recorded data can provide a basis for data management of flight results in daily life, and also provide data support for technical status analysis and fault analysis after device flight failure. Therefore, the recording of flight data plays an important role in the health management of its status [1].

2. Composition of data recording device

This device design includes the main control module, low-voltage signal acquisition circuit, high-voltage isolation acquisition circuit, USB communication circuit, real-time clock circuit, TF storage circuit, etc. (as shown in Figure 1). The main control module collects serial port signals, low-voltage signals, and high-voltage signals from the control box, and stores them on a TF card (8G). The serial signal is directly collected from the aircraft control box, and the low-voltage and high-voltage signals are processed by the low-voltage and high-voltage signal acquisition circuits before being sent to the sampling port of the main control module. The clock circuit provides a clock for the main control module and names the data files of a single flight with the clock display time for easy reading [2]. Design USB communication circuits (USB circuit, USB HUB circuit) for communication between devices and computers.

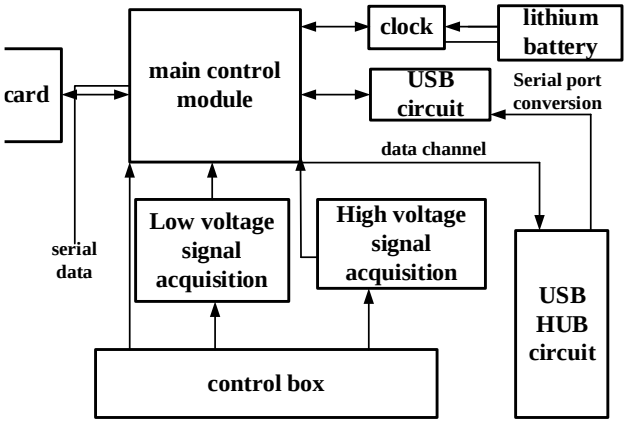


Fig.1 Composition diagram of data recording device

2.1. Main control module

The main control chip in the main control circuit adopts a domestic GD32 microprocessor, configured with external circuits to complete data acquisition and storage functions.

2.2. Low voltage signal acquisition circuit

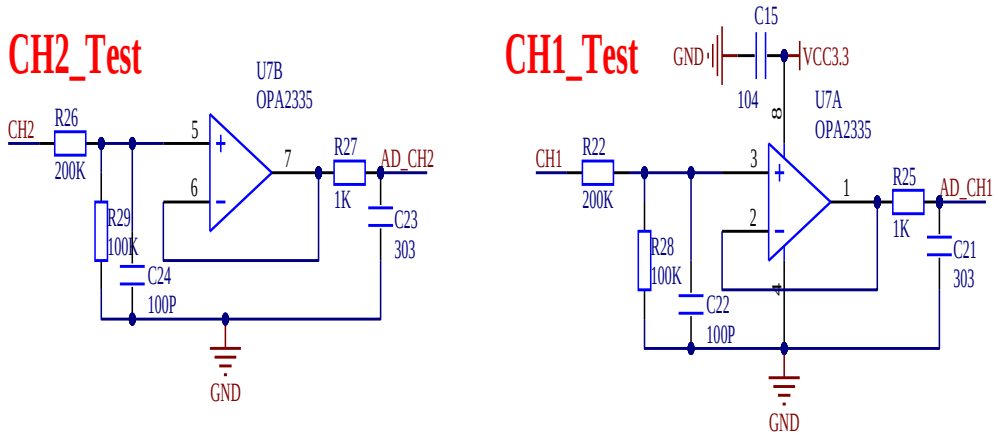


Fig.2 Low voltage signal acquisition circuit diagram

After the flight of the aircraft, a stepped wave signal is transmitted back, which enters the control box and is processed by a differential circuit to form two differential signals CH1 and CH2. The waveform formed by these two signals can fully reflect the flight status of the aircraft. For these two low-voltage signals, a low-voltage signal acquisition circuit is used for processing (as shown in Figure 2). The low-voltage signal acquisition circuit is centered on

the OPA2335 operational amplifier. After attenuation, the signal enters OPA2335 to achieve impedance matching, and then is sent to the AD port of the main control module. The AD is continuously collected and stored in real-time on the TF card [3].

2.3. High voltage signal acquisition circuit

Due to the fact that the command signals output from the control box to the aircraft control circuit are high-voltage and isolated signals, in order to ensure that this signal is not affected during data acquisition and avoid affecting the flight status of the aircraft after launch, a high-voltage isolation acquisition circuit is designed with the ACPL-C79B isolation amplifier as the core. The electrical circuit principle is shown in Figure 3. After the high-voltage signal is divided by the voltage divider circuit, it forms a low-voltage signal and enters the isolation amplifier ACPL-C79B, which is then output to the instrument amplifier AD623. The differential signal is converted into a single ended signal and output to the main control module AD acquisition port.

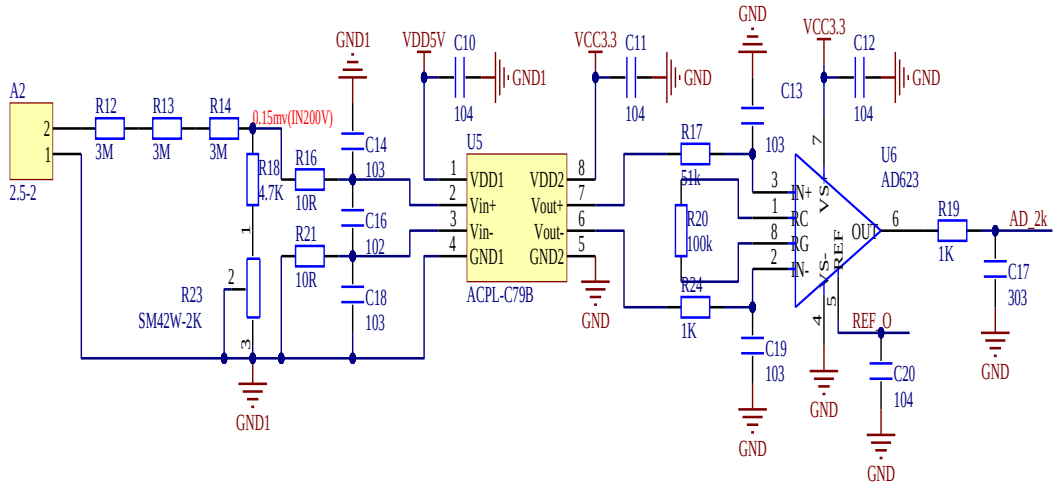


Fig.3 Schematic diagram of high-voltage signal acquisition circuit

2.4. USB communication circuit

The USB communication circuit is used for communication between the device and the computer, uploading and storing test data. The accompanying computer software can reconstruct the entire flight control process and control signal waveform based on the test data. The USB communication circuit includes a USB to serial port circuit and a USB HUB circuit. The USB to serial port circuit design is based on the FT231XS chip to achieve the conversion from a computer USB interface to a universal serial port, achieving functions such as parameter matching and clock synchronization; The USB HUB circuit is designed with the GL850G chip as the core (as shown in Figure 4), meeting the basic requirements of low power consumption, fewer pins, and stable low-temperature performance for detection equipment.

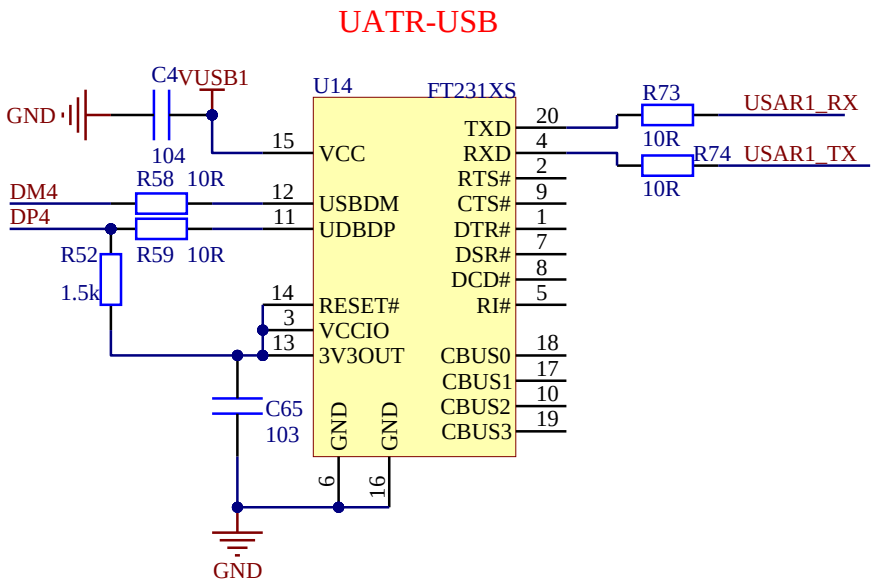


Fig.4 Schematic diagram of USB communication circuit

2.5. Clock circuit

The clock circuit provides accurate time for data storage. The recorded data files are named after the time, and the computer can read the data according to the recorded time. The clock power is provided by a lithium battery. And a clock calibration circuit is set up. When the computer reads data, the clock is calibrated through the USB interface circuit and the main control module to ensure the accuracy of data recording time.

3. Use of data recording devices

The sampling data of this device includes the serial port data signal of the aircraft control box, the control box control signal, and the aircraft feedback signal. These important signals can comprehensively reflect the control status of the transmission and control system and the flight status of the flight device. Before the device is launched, the device is connected, and after the control box is powered on, power is supplied to the device. The device enters an automatic recording state. After the aircraft is launched, a data file for the launch is formed, named the time of the launch, ensuring the timeliness of data recording.

4. Conclusion

This device has the characteristics of comprehensive recording and convenient application. Due to the comprehensive recording of data, when a fault occurs, the fault point of the aircraft control box can be directly located by comparing the serial port signal of the control box with the control signal data. By observing the curves formed by the recorded differential signals, it is easy to determine whether the flight status of the aircraft is normal, which provides effective support for fault analysis and prevention. 2. When designing the device, full consideration was given to the operating environment of the aircraft. Following the design concept of easy portability and operation, the structural size was optimized, the equipment volume was reduced, and the installation of the device was facilitated; When in use, the operator only needs to connect the device to the detection port of the aircraft control box. After the aircraft is launched, the connection line and device can be removed. It belongs to the plug and play type equipment and does not affect the operation of the aircraft or the launch of the aircraft.

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