The Research and Implementation of Electronic Device Detection System Based on STM32H7

Chao Li\textsuperscript{1,a*}, ShaoYang Zhang\textsuperscript{2,b}

\textsuperscript{1}Shipbome Equipment Research and Test Center, KunMing, YunNan, 650051, China
\textsuperscript{2}Shipbome Equipment Research and Test Center, KunMing, YunNan, 650051, China
\textsuperscript{a}Corresponding author’s e-mail: LiChao@750.com
\textsuperscript{b}Corresponding author’s e-mail: ZhangShaoYang@750.com

Abstract: In engineering practice, it is often necessary to test the performance of electronic devices. In order to provide a convenient and fast solution for the job of electronic device detect, this paper has designed and implemented an electronic device test system based on STM32H7 platform. This system can output frequency and amplitude controllable sinusoidal wave, collect and monitor the output voltage of electronic device in real time, analyze and judge the detection results automatically, and display the detection results in real time through the combination of sound and light. In this paper, through the experimental verification, the system can achieve the detect function of electronic device, it has the advantages of simple operation, high accuracy, great reliability and strong scalability.

1.Introduction

In the underwater weapon equipment test and daily equipment operation, especially in the system operation and maintenance work, in order to ensure the system works normally or when the system is abnormal, it is often necessary to quickly detect the hardware performance of the system, quickly detect and locate the system vulnerabilities in order to quickly repair the system. At this time, it is often necessary to quickly test the performance of electronic devices such as electromagnetic sensors, sonar and power supply modules to verify their reliability. However, the traditional detection of electronic devices generally uses manual operation of signal source to supply power to electronic devices, uses a multimeter or oscilloscope to detect the output voltage value of electronic devices, and judges whether its performance is normal by observing and comparing the input and output values of electronic devices with human eyes. This method is not only cumbersome and time-consuming, but also easy to produce human error through human eye observation and judgment, which affects the detection results. In order to simplify the detection process and improve the detection efficiency and accuracy, this paper has built an electronic device detection system based on STM32H7 platform. The system can realize the sine wave output with controllable frequency and amplitude, automatically collect and analyze whether the output voltage of electronic devices is in the normal range, and display the detection results in real time. The research of this paper has made the functions of signal source output, electronic device output voltage value acquisition, acquisition data analysis and processing and real-time display of detection results integrate into one system, which greatly simplifies the detection of electronic devices and improves the efficiency and accuracy. This research work has important engineering application value.
2. Materials and Methods

The electronic device detection system designed and developed in this paper needs to realize three main functions: output frequency and amplitude controllable sine wave, automatic judgment of electronic device performance according to threshold parameters and real-time display of detection results. In order to improve the efficiency and reliability of the electronic device detection system, this paper uses the development board with STM32H743IIT6 as MCU as the hardware development environment. [4-5] The chip has a main frequency of 400MHz, and is equipped with rich hardware resources such as ADC, DAC and timer, which can meet the development requirements of this paper. In order to improve the compatibility and scalability of the system, this paper uses modular thinking to design and implement the electronic device detection system. The system consists of six modules: parameter input module, sine wave output module, impedance matching and filtering module, electronic device output voltage acquisition module, sine wave output control and data analysis and processing module, and test result display module. The block diagram of electronic device detection system is shown in figure 1.

![Fig 1 The block diagram of electronic device detection system](image)

The parameter input module is used to manually input the frequency and amplitude parameters of the output sine wave and the output voltage threshold parameters of the electronic devices to be tested. This module can choose the model of input any number on the numeric keyboard or press button to input several specific values to input parameters.

The sine wave output module is a power supply module for the electronic devices to be tested. In order to output sinusoidal wave with controllable frequency and amplitude, it is necessary to control the DAC of STM32H743IIT6 to output voltage as the sine function of \( v = \sin(t) \), here \( v \) is the output voltage and \( t \) is the time. Because the analog signal is continuous and the digital signal is discrete, when DAC is used to generate sine wave, it can only output the points on the sine curve at a certain time interval. If the time interval is shortened and the number of output points in a single period is increased, the perfect continuous sine wave can be obtained. It has been proved that in a single cycle of \( \sin(t) \), taking 32 points for voltage output can restore the sine wave well. Due to the DAC output voltage range of 0-3.3V, in order to output good sine wave waveform, the DAC chooses 12 bit high-precision mode, then the range of DAC register value is [0:4096], which is used to represent 0-3.3V voltage value. According to the corresponding relationship between sine wave and DAC register value range, 128 register values can be obtained in one cycle, and sine wave table can be obtained. When controlling the DAC output, a new data is taken out from the above sine wave table at
the same time interval to output a sine wave with perfect waveform. The amplitude of output sine wave can be changed by multiplying the value of sine wave table by a coefficient in the range of 0-1. According to the amplitude and frequency parameters input by the parameter input module, the output sine wave frequency and amplitude can be controlled by changing the coefficient and the timer cycle value. The impedance matching and filtering module is used to match the appropriate impedance for the electronic devices to be tested, and filter the output sine wave to provide a perfect and stable power supply for the electronic devices to be tested, so as to improve the reliability and ductility of the electronic device detection system. This module is realized by welding appropriate resistance and capacitance between the sine wave output module and the electronic device to be tested.

The output voltage acquisition module of electronic devices is used to realize the real-time acquisition of the output voltage of electronic devices to be measured. This module uses the ADC of STM32H743IIT6 to collect data. In order to reduce the error of data acquisition, the ADC uses 12 bit high-precision mode, and uses DMA to quickly transfer the collected data to sine wave output control and data analysis processing module.

The sine wave output control and data analysis and processing module is used to control the sine wave output according to the frequency and amplitude parameters input by the parameter input module, and analyze the collected output voltage values of electronic devices according to the threshold parameters, so as to automatically judge whether the working state of electronic devices is normal and obtain the detection results. This module directly controls the DAC and timer to control the frequency and amplitude of the output sine wave, analyzes and processes the collected output voltage value according to the conversion relationship between the collected data and the actual voltage value, and obtains the detection results.

The detection result display module is used to display the detection results obtained by the sine wave output control and data analysis and processing module. In order to make the detection results show clearly, this module uses the combination of speaker and LED light which is convenient for human observation. That is: when the detection result is abnormal, the loudspeaker will give an alarm and the red LED will be on at the same time. When the test result is normal, the loudspeaker will not sound and the green LED will be on at the same time.

When the electronic device detection system detects the performance of electronic devices, it completes the detection of electronic devices according to the work flow chart shown in figure 2.

![Work flow chart of electronic device detection system](image-url)

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**Fig 2 Work flow chart of electronic device detection system**
3. Results & Discussion

In order to verify that the electronic device detection system has the function of output frequency and amplitude controllable sine wave, when detecting electronic devices, it can be observed directly through the oscilloscope. When the input amplitude parameter of the parameter input module remains unchanged at 3.2V, and the frequency parameter changes to 300, 500, 800 and 1000Hz respectively, the output sine wave waveform are shown in figure 3-6.

![Fig 3 Sine wave with frequency of 300Hz](image)

![Fig 4 Sine wave with frequency of 500Hz](image)

![Fig 5 Sine wave with frequency of 800Hz](image)

![Fig 6 Sine wave with frequency of 1000Hz](image)

It can be seen from the above oscilloscope picture that the output sine wave waveform is good, the frequency and amplitude match with the input parameters, and the error is small. The output sine wave frequency controllable function is well realized, which can meet the detection requirements.

When the input frequency parameter of the parameter input module remains unchanged at 500Hz and the amplitude parameter changes to 2V, 2.5V, 3V and 3.3V in turn, the output sine wave waveform are shown in figure 7-10.

![Fig 7 Sine wave with amplitude of 2V](image)

![Fig 8 Sine wave with amplitude of 2.5V](image)
It can be seen from the above oscilloscope picture that the output sine wave waveform is good, the frequency and amplitude match with the input parameters, and the error is small. The output sine wave amplitude controllable function is well realized, which can meet the detection requirements.

In the experiment, when the voltage output value of the electronic device in the serial port debugging assistant is within its threshold, the speaker does not sound, and the green LED light is on. When the voltage output value of the electronic device exceeds the threshold value, the loudspeaker sound an alarm and the red LED is on. It shows that the electronic device detection system has good real-time display performance.

4. Conclusions

Based on STM32H7 platform, this paper has designed and implemented an electronic device detection system, which provides an efficient, convenient and high accuracy solution for electronic device detection. The output sine wave of the detection system is good, the frequency and amplitude are...
controllable, and the operation is simple, which can meet the power supply requirements of most electronic devices. The output voltage value of electronic devices has high acquisition accuracy, which can monitor and judge the working state of electronic devices in real time. The combination of sound and light of the test result display module makes the display of detection results is simple and clear, which realizes the detection of electronic devices well. The research of this paper provides a practical experience for the research and development of electronic device automatic detection system which can output more voltage range and more voltage waveform in the future, and is of great significance to engineering practice.

References

[1] Michoux Nicolas F et al. (2021) Repeatability and reproducibility of ADC measurements: a prospective multicenter whole-body-MRI study. European radiology, 31: 4514-4527.

[2] Boutekkouk Fateh. (2021) Application of a Fuzzy MCDM Method to Select the Best Operating System for an Efficient Security-Aware Design of Embedded Systems. International Journal of Applied Evolutionary Computation, 12: 1-20.

[3] Alonso Sara et al. (2021) Evaluating Latency in Multiprocessing Embedded Systems for the Smart Grid. Energies, 14: 3322-3322.

[4] Edoardo Ragusa et al. (2021) Random-based networks with dropout for embedded systems. Neural Computing and Applications, 33: 6511-6526.

[5] Calixto Rodriguez M. et al. (2021) Design and Development of Software for the SILAR Control Process Using a Low-Cost Embedded System. Processes, 9: 967-967.