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Design of Alarm Fault Monitoring System Based on MSP430

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Abstract
In order to ensure the health status of the alarm in the plant of the nuclear power station so as to be able to in a timely send an alarm notification when in danger, a alarm fault monitoring system based on MSP430 microcontroller is designed for nuclear power and other fields. This paper introduces the hardware circuit and software design of the system,the MSP430F169 detects the voltage on the power line to decides whether start collect the acoustic data of the alarm,the health status of the alarm is obtained according to the level information output by the frequency discriminator. Has been tested that the system can efficiently and accurately obtain the state of health of an alarm, it can be used to automatically monitor the nuclear power and other harsh environments unmanned guard scene to improve safety precautions factor.

Keywords
Alarm; Fault monitoring; MSP430

I. Introduction

In view of the international nuclear power accident and China's energy development plan, China is determined to develop the nuclear power efficiently on the basis of ensuring safety[1]. Safety and reliability are the lifeblood of the existence and development of nuclear power plants. At present, it is still mainly guaranteed through human experience and strict management, but its intelligence and scientific nature are still scarce[2]. For example, a speaker is used in a nuclear power plant to notify a business and a warning is used by an alarm. The use of these audio equipment to improve the safety of the plant defense,however, with the development of modern science and technology, the automatic control system has penetrated into all walks of life. How to adapt to the market demand and improve the safety and reliability is the key to the sustainable development of the nuclear power plants with the existence.

At present, both nuclear power plants at home and abroad haveadopted digital instrumentation and control system to monitor the construction and operation of nuclear power plants[3]. However, a wired alarm system is adoptedin China's Daya Bay nuclear power plant.When the safety accident in the nuclear power station, the alarm sounded by the staff members and proceeded to evacuate. In order to ensure the normality of the working status of the alarm system, it needs to be regularly maintained and tested, that ischecking whether the alarm has failed or not. Disillusionary, due to the wide geographical scope of nuclear power plants, nuclear radiation areas with other special factors such as artificial periodic,manual periodic testing is laborious and unsafe. Conclusions as a result, the paper studies a alarm fault automatic monitoring system based on MSP430 microcontroller that can be used in the "four high" environment of high temperature and high humidity, high noise and high radiation, and can automatically monitor the fault status of the alarm itself, andoutputs the test results.

II. System Component

The existing working mechanism to detect alarms whether a loss or not in the plant is that staff open the brake with the alarm sounding 6 seconds at a regular time in every month, and then according to thesound levelof the alarmto determine the health status.On the other hand,you do not need to add an additional incentive signal to make the alarm soundconsidering the alarm as the active source device. Fig.1showed the system block diagram, MIC is the microphone (Microphone), Microcontroller Unit (MCU) using MSP430F169 microcontroller and Code Compser Studio (CCS) as the development platform. The alarm fault monitoring system is aimed to automatically capture the sounddata of the alarm, and analysis it in time, and finally displayedthe monitoring results.

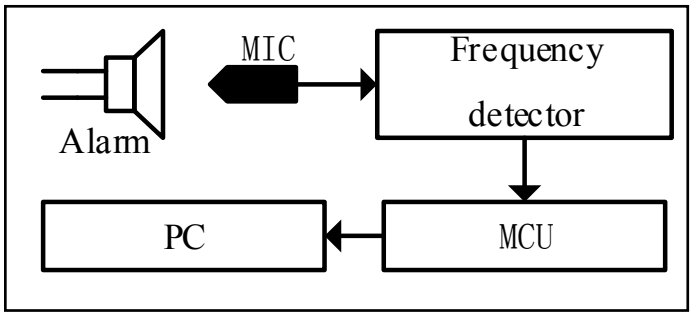

Fig. 1: System diagram

III. MSP430F169

The MSP430F169is microcontroller configurations with two built-in 16-bit timers, a fast 12-bitA/D converter, dual 12-bit D/Aconverter, one or two universal serial synchronous/ asynchronouscommunication interfaces (USART), I2C, DMA, and 48 I/O pins. In addition, it offersextended RAM addressing for memory-intensive applications and large C-stack requirements[4].

There are six 8-bit I/O ports implemented—ports P1 through P6. All individual I/O bits are independently programmable,and any combination of input, output, and interrupt conditions is possible[5]. The edge-selectable interrupt input capability for all the eight bits of ports P1 and P2,andthe read/write access to port-control registers is supported by all instructions.

IV. Hardware Design

A. Discriminator Design

When using the MIC to get the the sound signal of the alarm, amplify it to level 2 and use the LM567 frequency-discriminating chip to identify the frequency. At the same time, using a precision potentiometer to set a fixed frequency, the LM567 compares the amplified microphone sound signal with it, and when the frequency is the same, outputs a switch signal to achieve the audio recognitionwith fixed frequency,it cancorrectly capture the sound data of the alarm[6]. Principle of frequency discriminator

is shown as in Fig. 2.

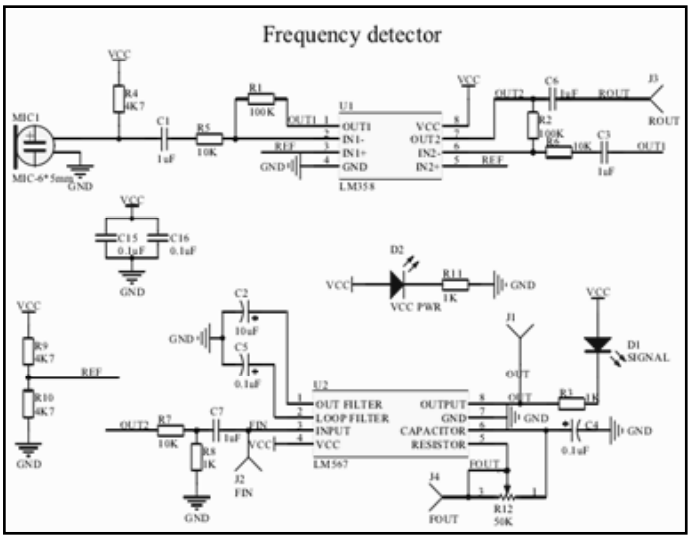

Fig. 2: Frequency discriminator Schematic

The dual amplifier chip LM358 with two high gain, independent and internal frequency compensation is used to realize realize 2 level amplification for alarm sound signal.The precision potentiometers 3362 (FIG R12)with the full range of 50kΩ is used to adjust a fixed frequency, using chip capacitors 0603 (FIG C15 and C16) to decouple and filter for the power supply, it filter out the AC component and ofmake the DC become more smooth in the output signal, while it can be eliminated self-excitedin the amplifier with more stable operation.

B. MCU Design

MCU using MSP430F169 microcontroller, the main design is divided into MSP430F169 minimum system module and peripheral circuit module.

MSP430F169 minimum system with Flash memory, a high frequency 8MHz crystal as the main system CPU operation clock and a standard 32.768kHz crystal as an auxiliary system clock[7]. The reset circuit only needs tothe levelwith more

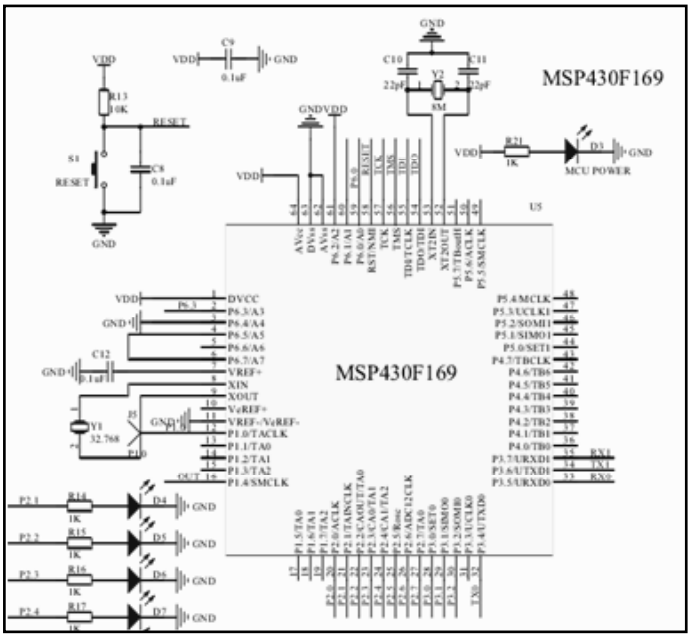

Fig. 3: MCU Schematic

than 2us, and the 3.3V can supply the single-chip microcomputer.

The schematic diagram shown in Figure 3. Peripheral circuits are mainly the use of I / O ports, including the power indicator light and function indicator light.

C. Microcontroller Topology

Connect the OUT pin of the frequency discriminator with P1.4 pin of the MCU, P1.0 pin is connected with the power line, as the GPIO interrupt triggering port.LED1 indicates that the frequency discriminator is getting the signal from the alarm, and the LED2 indicates that the MCU is uploading the detection results to the host's.

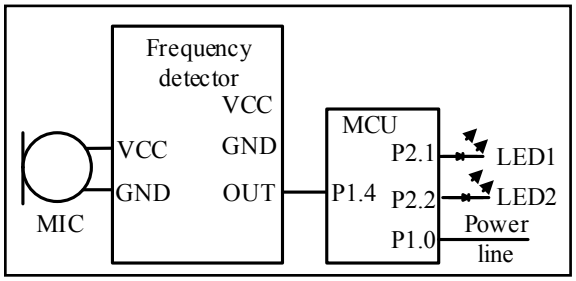

Fig. 4: Microcontroller Topology

V. Software Design

In order to automatically detect the sound data of the alarm and does not interfere with the normal broadcast activities, and can receive the results of the detection alarm in real time, the main idea of the host software design is mainly based on the current working mechanism of the alarm. The main program design flowchart is shown in Figure 5.

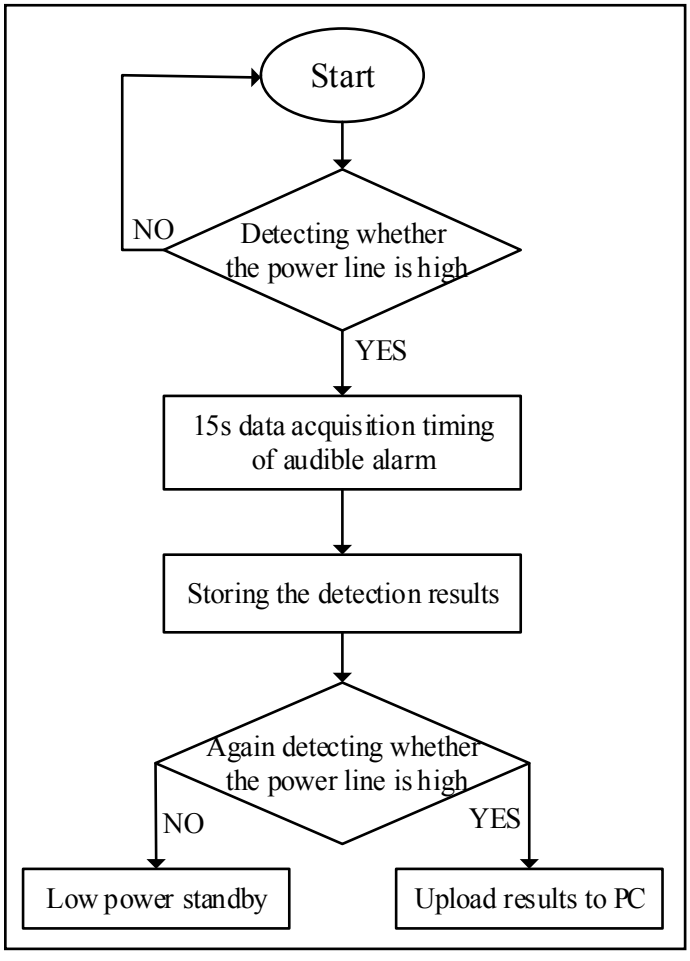

Fig. 5: The main program flow diagram

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The staff pulled the alarm switch, which make the alarm sound for six seconds, then close the alarm.Use an I/O pin to detect the level change on the power line when the switch is on and trigger the program to enter the GPIO interrupt.Use the if statement to determine whether STATE is true, that indicates I/O pinreceived power line level changes when it is true. As the alarm starts sounding, Usingthe timer to produce 15s, which is the time of the MIC on the frequency discriminator to obtain the alarm data. when the alarm is identified, the OUT pin outputs low level, on the contrary, the high level is outputted,and the detection result of the frequency discriminator is stored.Check the voltage of the power line again after the timing expires, then return the detection result of the frequency discriminatorif it is low (non-power supply status). Use power lines as information transmission lines to avoid when they are in power supply, so that data information is not disturbed.

VI. Conclusions

The alarm used in this system is BOSCH-LBC3481 / 12 horn speaker of the Korea Kelaite,which is currently used in the Daya Bay nuclear power station. Its frequency response is 1.5kHz and the noise-to-noise ratio is 105dB. After opening the alarm power, the detection system starts to acquire the alarm's sound data automatically when receiving the voltage change of the power line, and uses a normal and a fault loudspeaker to test the function of the system, the result is shown in Table 1.

Table1 Testing result

	Frequency of alarm (kHz)	Result
Testing result with normal alarm	1.5	R
Testing result with faulty alarm	3	E
	1	E
	0	E

As can be seen from Table 1, the monitoring system can accurately collect the sound data and output the test resultsof the alram sound frequencyfrom 3 to 0,which proves that the system can detect the working state of the alarm automatically and accurately.

VI. Acknowledgement

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