The Design and Research of the Operation Status Detector for Marine Engine Room Power Plant Based on Noise

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Abstract. Designed in this paper, based on the noise of ship engine room power plant running status of detector, is mainly used in the operation of the power plant of acoustic shell size to determine when the machine running state, this device is composed of signal disposal and alarm display adjustment part of two parts. Detector that can show the size of the voice, if exceed the set limit alarm value, the detector can sound an alarm, to remind staff equipment fails, it shall timely inspection maintenance, improve the safety of the operation of the ship.

1 Introduction

In the most important part of the detector is the part of signal conditioning, signal conditioning circuit module at present widely used in industrial control, instrumentation, etc of sensor signal detection and processing applications. It is a sensor and A/D converter device such as A follow-up of the interface. It is the sensor output very weak and low level signal is amplified by A variety of noise interference, processing, noise elimination and unified format, making it suitable for A/D converter device such as A subsequence request signal. For different object to be tested and used by many different kinds of sensors, the signal conditioning circuit is put forward different requirements. The follow-up device such as A/D converter combining with technical indicators to design A good performance of signal conditioning circuit has become the key content of system design. With noise sensor as an example, this paper discusses the design method of the corresponding signal conditioning circuit.

2 The basic working principle

Introduction of the principle:
Noise in front of the microphone microphones will environment into a faint millivolt level analog voltage signals, the voltage signal through the front part stage amplifier amplification, enlarged by precision rectifier circuit, the AC voltage signal is converted into DC signal, the signal again after the amplifier section, zoom into 0 to 5V analog voltage signal, and then sending the signal to alarm display part adjustment. Can display the alarm display section size, if more than upper limit alarm value can sound an alarm, to remind staff equipment fails, should be timely check the maintenance, the range and the zero point can be adjusted through the potentiometer.

3 Unit analysis

3.1 Signal conditioning part

This part by stage amplifier, precision rectifier part before and after the amplifier components. Detector receiver
microphones will be in the environment noise into a faint millivolt level analog voltage signals, the voltage signal through the signal conditioning part into 0 to 5V analog voltage signal, and the analog alarm display adjustment to the section.

3.1.1 Before the amplifier application

Stage amplifier part before the electret microphone acquisition of speech signal, convert its signal amplitude is millivolt level of electrical signals, system level before the treatment, as far as possible improve signal-to-noise ratio at the input to the amplifier, guarantee the gain amplifier circuit with precise, stable. Is using the operational amplifier LM386 stage amplifier circuit diagram (see Fig. 3), 2 for inverting input pin, 3 for the same phase input pin, pin 5 for output, pin 6 and 4 respectively the power and ground, pin 1 and 8 set for voltage gain, when used in pin 7 and indirect bypass capacitors in the land. In indirect capacitance of pins 1 and 8 (pin 1 pick capacitance is level) to change the gain.

[3]

Capacitor C3 is pin 7 bypass capacitors, it can have the effect of filter out noise;
Resistance of R3 and resistor R1, bleeder circuit for MIC relatively stable power supply;
Capacitor C5 is the output coupling capacitor, the capacitor is used to partition the dc voltage and coupling of audio communication signals, it constitutes the first-order high-pass filter and load;

3.1.2 Precision rectifier part

To convert AC signal into DC signal must adopt rectifier, the conventional method is to use diode rectifier directly, but due to the diode rectifier threshold voltage (0.3V or 0.7V), small signal rectifying error is big, can't even work.To weak alternating current (AC) is converted into unidirectional pulse of electricity, it is important to adopt precision rectifier, so the circuit must be composed by op-amp and diode to achieve precision rectifier.

In this section we adopt is the operational amplifier LM358 precision rectifier circuit (see Fig. 4), and its internal consists of two independent, high gain, internally frequency compensated dual operational amplifier, two channels to deal with the positive and negative half cycle, regardless of the input is a positive or negative, the output is positive voltage.

![Figure 3. Former stage amplifier circuit diagram](image)

3.1.3 After the amplifier application

After stage amplifier adopts differential amplifier to achieve the required drive ability, its advantage lies in the differential amplifier can get higher common mode rejection ratio, strengthen the anti-interference circuit. [4]

As shown in Fig. 5 the amplifier circuitry, difference amplifier differential amplifier AD620 was adopted to realize. Internal is actually a difference amplifier AD620, the small disturbance voltage current, common mode rejection ratio is high, so deal with weak signal, which is amplified and eliminate noise, excellent performance, it can gain by adjusting the resistance between pins 1 and 8, its gain \( G = 1 + (49.4 \text{ k} \Omega / R_g) \) (Rg in the resistance between pins 1, 8).

AD620 of 6 pins at the back of the part is the conventional RC low-pass filter.R304 and R305 can be considered a current limiting function, can also be considered to be the separation.

OP07 precision op-amp is zero reference source, mainly serving the AD620, provide a reference for AD620 voltage, OP073 pin number at the back of the part for precision voltage regulator, to OP07 provide a stable source of unknown to zero.

Through the above three parts, we can send the electret microphone acquisition of speech signal is converted into 0 to 5V analog voltage signal, and then send it to display debug apparatus.

![Figure 4. Accurate rectifier circuit](image)

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![Figure 5. After stage amplifier circuit diagram](image)

4 Alarm display control part

This part of the signal conditioning module output of 0 to 5V voltage signal is converted to a digital signal, and
through the SCM displayed on the digital tube display, which shows the size of the displayed voice of the environment, that part of the range and alarm value can be set through key artificially, depending on the equipment we can by setting the corresponding value to monitoring equipment, when sound is more than the alarm value set, will sound an alarm, to remind staff, equipment failure, should be lifted. [5]

That part of the physical diagram as shown in Fig. 6 and Fig. 7.

5 Experimental data

In the experiments, the collected Marine auxiliaries a audio noise, the parameters for quantitative figures for 6000Hz, 16 (resolution), or long for 5s (about thirty thousand sampling points), it is the time domain waveform (see Fig. 8 time domain noise figure), obviously can not see the signal from the relevant characteristics or parameters. In view of the signal processing is shown in Fig. 8, get the waveform Fig. 9 after signal processing, including the original signal in black, a red signal after conditioning, obviously, it can be seen from the figure that the cycle of the original signal characteristics are not obvious, but after the signal has the obvious cyclical and smoothness.

In the above the noise of the cases, the noise of the detector set in the range of 0-120dB to get the following results: does not appear within the range set alarm, as shown in figure, the noise detector to 50, numerical display normally, does not appear alarm, when numerical more than set range, for example in number 150, detector alarm, remind engineer equipment that there might be a failure, should be handled in a timely manner.

6 Conclusion

Noise analysis is presented in this paper, on the basis of ship engine room are discussed in detail the design of the utility equipment running status detector circuit, points out the structure and the parts of the circuit components selection, gives the experiment result after testing. Experiment showed that this detector has stable performance, high reliability, strong flexibility and programmable advantages, can set the range of detector and alarm of the upper and lower limits, and abnormal sound when equipment failure, and sound an alarm, to remind staff to repair in time, ensure the safe operation of the equipment, and improve the safety of the operation of the ship.

Mechanical equipment fault diagnosis technology based on the noise signal processing, relative to other diagnostic techniques have signal collection and more convenient, to adapt to a wider frequency range, more suitable for online monitoring, etc, the key lies in how to extract the characteristics of the signal, the more obvious of periodic signal, the signal conditioning unit for the signal to noise amplification, rectifier, filter and post-processing, such as: some components of the signal
attenuation or inhibit, weak signal extraction, etc. This analysis is accomplished through regulating part processing work. In practice, if with other analysis tools, such as Fourier transform, combining can also further speed up the troubleshooting, improve the analysis accuracy. [6]

References