The Design and Analysis of Nondestructive Testing System for Oil and Gas Pipeline

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Abstract: In view of the serious problems such as leakage and energy loss during the process of oil and gas transportation, a nondestructive inspection system for oil and gas pipelines is designed. With the use of ultrasonic sensors, digital electronic technology, communication principle of single-chip microcomputer, and development of Windowfrom host computer, the soft hardware of the system has been designed. The bottom of the system using STC89C52RC microcontroller on the ultrasonic signal processing data, through the serial port to send signals to the host computer and the processing and display of the image display finally reflect the pipeline breakage, convenient and intuitive. The debugging results show that the nondestructive test system for oil and gas pipelines designed in this paper works well and can detect the cracks on the pipeline more accurately and without damage to the pipeline.

1. Introduction

The non-destructive testing of pipelines is the Non Destructive Test, abbreviated as NDT. It is also called the non-destructive testing technology of pipelines. When the performance of the detected product itself is not damaged, the detection is carried out using wireless feedback technology such as rays, infrared rays, electromagnetic waves, and ultrasound. Methods, at the same time, combined with special instruments to use materials, parts, equipment to detect defects, chemistry, physics and other different aspects of technology. Oil and natural gas energy is regarded as an important strategic development material by all countries in the world. If it does not find a new energy source that can replace it, its safe transportation in oil and gas pipelines must be guaranteed. And Using lossless inspection technology to quickly determine the online detection of cracks, welding joints and perforation events in pipeline leaks along the line , and accurate positioning, reducing the loss of national property, and winning the shortest time is particularly important.

2. Frame Diagram of Non-Destructive Inspection System for Oil and Gas Pipelines

The main content of the system research is based on the combination of traditional ultrasonic detection, microcomputer processing and control technology. Metal chips and non-metallic materials in semiconductor chips are used for testing, research and development, and a set of digital ultrasonic pulse reflection detection equipment is developed. The research includes the following aspects: (1) High speed data acquisition and processing module based on microcontroller. The data acquisition module can control the selection of power ultrasonic detection modules in high frequency segments, amplification, detection mode selection circuits, etc. It can be processed at a deeper level. The acquisition and detection of signals can be converted into digital signal storage and can be sent to liquid crystal displays and video interfaces. According to the standards, Stored outside the machine according to stored data; or the computer receives the recovery wave signal for further processing. The ultrasonic pulse reflection detector is simulated with other traditional ultrasonic detection equipment. (2) Develop ultrasonic detection module to achieve the best management of the power supply module, with low power consumption and high efficiency;

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Ultrasonic transmission and reception functions, and Super audio echo voltage amplification, filtering, detection and so on. (3) In addition to the functions of data acquisition and ultrasonic detection modules, system software can also control and complete the call defect echo graphics display, store information, and send computers, such as fault alarm prompts.

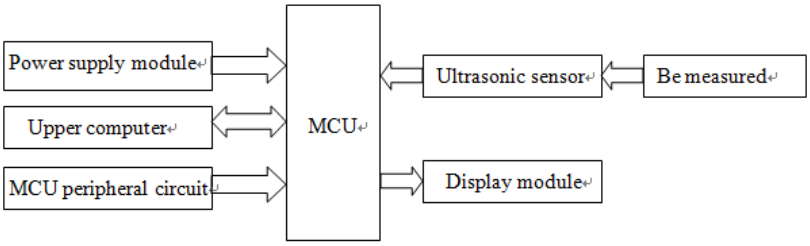

Fig. 1 Frame diagram of non-destructive inspection system

3. Hardware of Non-Destructive Inspection System for Oil and Gas Pipelines

3.1. Hardware Circuit Design of Non-Destructive Inspection System.

In the system hardware detection and testing, the power supply to the single-chip microcomputer using the USB port, the power supply voltage of 5V,500mA,ultrasonic module and single-chip microcomputer power consumption is greater than the power supply power consumption of the computer USB port, so the system design 5V, 700mA power supply. The general circuit diagram of the detection system is shown in Figure 2.

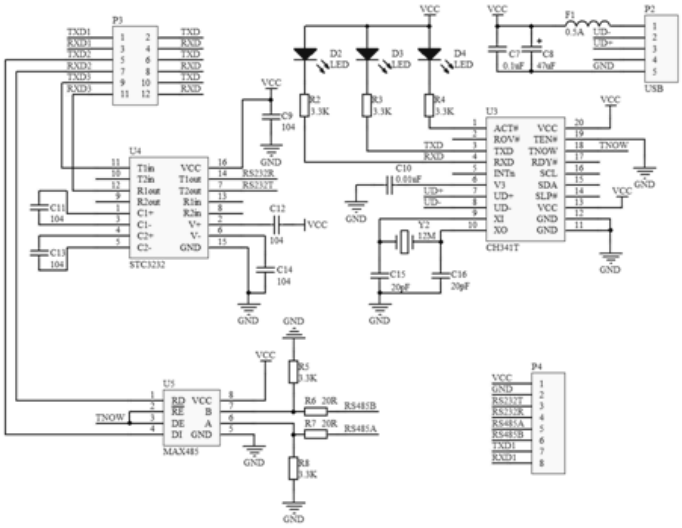

Fig. 2 Diagram of detection circuit

3.2. Design of Single Chip Power Supply Circuit.

The microcontroller in the non-destructive inspection system of oil and gas pipelines requires a 5V DC power supply. The power supply design adopts a commonly used 7805 three-terminal voltage regulator scheme. In this power supply, the Transformer is used to change the pressure first, and the 220 AC power supply is converted into 9V AC power supply. Complete the pressurization work, The alternating current is then converted into direct current through the rectifier bridge, but the dialing is too large, and the capacitance and 7805 are used to stabilize and filter. The schematic diagram of the system power supply is shown in Figure 3.

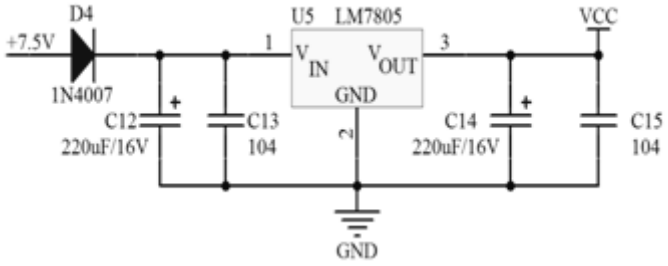

Figure 3 Power circuit diagram

4. USB Connection Circuit Diagram.

The design of USB transfer port schematic is mainly used to implement USB connector to provide USB physical interface, so that USB cable and USB device connection; Secondly, USB provides the power required by the USB serial port, which can be directly powered by it; USB data reception, USB interface and USB serial port master chip communication.

4.1. Non-Destructive Detection System Software Design.

This system software design adopts modular design, which mainly includes editing delay program, editing Main function to achieve logic function, editing information storage control to achieve cache mechanism.

4.2. Process Diagram.

System software programming should start from the circuit design, so that according to the driver protocol communication and injury measurement. According to the circuit designed, the single-chip computer uses P1^3 and P1 ^ 2 to communicate with the ultrasonic injury detection module for ultrasonic specific protocols. This circuit design first inputs a square wave of more than 10 milliseconds from the ultrasonic injury detection module. The ultrasonic module first outputs an ultrasonic signal. The ultrasonic probe responds to the contacted information. The driver circuit first processes the signal. According to the Echo, the single-chip microcomputer receives the feedback data, and finally sends it to the serial port program for transmission.

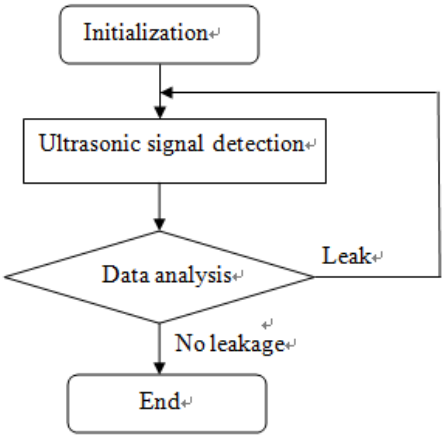

Figure 4 Driver flow chart

On the single-chip program processing of the ultrasonic detection system, the timing counter is first Initialized, the relevant information is configured, and the P1 ^ 1 pin potential is changed through the program, and a square wave of more than 20 milliseconds is given to the ultrasonic detection module. This square wave will drive the ultrasonic detection module to produce an ultrasonic information with a length of more than 40 milliseconds. The MCU stops working at this time, and the program waits for the P1^2 pin to receive the echo circuit of the detection information.

At this time, the timing counter of the single-chip computer begins to count, and the single-chip computer processes the information sent, waiting for a low level of more than 60 milliseconds. This signal shows that the hardware circuit completes the information processing. The single-chip computer saves the received data and uses the time/scar conversion function to calculate the length of the injury. Since then, the main program has called the serial launch program to launch the data. When the process of launching, receiving, and serial launching is completed, enter the next ranging. The main program flowchart is shown as Figure 4.

Before the main program, first define a delay subroutine. In the main program, if you want to use a delay, you can assign a delay subroutine and get a delay directly.

Before the main program, the timer T0 needs to be Initialized, ie: registers such as TH0, TL0, TMOD, TR0, ET0, EA, etc. need to be configured. From the configuration program, it can be seen that the T0 timer is used, and its mode of operation is 0. When the TR0 = 1 is executed, the program begins to count. After the count is completed, the TR0 = 0 is executed. This completes a complete counting process.

4.3. Superior Computer Program Execution Process.

The system Windows From upper computer design considers protocol docking, shows the printing program, port search program. This design adopts the Windows frame design, first initialize the software interface, serial port interface, string receiving slot; Then open the serial port to receive the delegate event, data reception; Finally draw the graphics.

5. Conclusion

The most important feature of the non-destructive inspection system of oil and gas pipeline designed in this paper is that users can operate easily and easily. Moreover, the installation is convenient, intelligent, and the error rate is low, and there is no damage to the product itself. With the enhancement of people's awareness of safety and the rapid development of science and technology, nondestructive testing will certainly have a wider field in the future and will be applied at a deeper level.

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