PORTABLE ULTRASOUND FLAW DETECTOR

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The task of creating a portable device is solved in this paper. This device uses an ultrasonic method for defect detection and has a convenient and more efficient system for transmitting and processing information in comparison with the previously developed one.

A cable is commonly used when communicating between converter units and data processing. In cases where there is no direct access between them, it is a need for wireless data transmission. Such a method of transmission allows for the automation of the system and frees us from the physical connection of two or more parts of the device. The use of wireless communication for technical diagnostics with known methods of NDT is considered in the paper [1].

You can get acquainted with results of the use of wireless technology in the tasks of NDT for data transmission at short distances in papers [2, 3, 4]. The generated model of the eddy current flaw detector uses Bluetooth [2, 3] and Wi-Fi technology [4]. The application of GSM technology is considered in [5]. It considerably increases the transmission distance of the data obtained.

Mobile devices (smartphones, tablets, etc.) with powerful computing capabilities and touch screens have become widespread in our time. It was set the task of developing a defectoscope using a mobile device as a block of processing the results of control in this work.

Let's consider the structural scheme of the created ultrasonic flaw detector with wireless data transmission (Fig. 1). The converter unit can be divided into two parts: analog (1) and digital (2). An analog incorporates a shock excitation generator, represents as a piezoelectric converter (PCT), which is fed through the key (K) by the reference voltage (RV). The frequency of generator is set by a short pulse supplied from the control unit (CU). The generated impulse propagates in the object of testing (IO). It is reflected and re-enters the PEC after reaching the bottom surface or defect. The resulting echo pulse has a small amplitude, so before digitizing it must be amplify (A). The main task of the digital part (2) is to convert an analog signal to a digital (ADC) and, to transmit it to the information processing unit (DR) through the information transfer unit (DT).

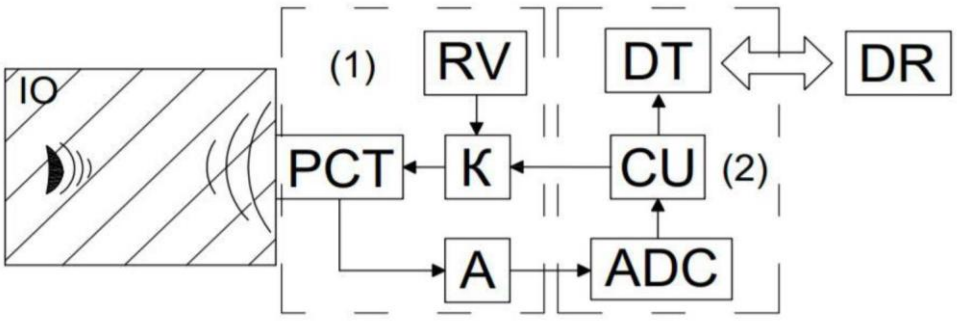

Figure 1. Structural diagram of ultrasonic defectoscope
IO - Investigated object, RV - reference voltage, K - key, PCT – Piezo ceramic transducer, A - amplifier, ADC - analog-digital converter, CU control unit, DT – Data transmitter, DR – Data receiver

A model of a mobile ultrasonic flaw detector was created based on this scheme. It is able to use ultrasonic sensors with different frequency of resonance (1 / 1.25 / 2.5 / 5 MHz)

due to the use of high frequency sampling ADCs. It is possible to install software with a more advanced and optimized code due to work flexibility with microcontrollers.

At the heart of the device is a microcontroller of STM Company, namely chip STM32F4 series with 32-bit ARM Cortex-M4 core. This architecture makes it possible to use several auxiliary modules at once.

The following components were chosen as the circuit of the acoustic oscillator pulse actuator (Figure 2): two complementary pairs of MOSFET transistors TC8220K6-G, Microchip Technology driver circuit chip M1822 and two pairs of two protective diodes MMBD3004BRM-7-F. This circuit can work with a wide range of output voltages (± 100V). The M1822 driver chip gives a chance to operate transistor switches using a wide range of standard voltages (1.8V-5V) for controllers, and diodes are used to protect transistor pairs from high voltage levels acting on the transducer.

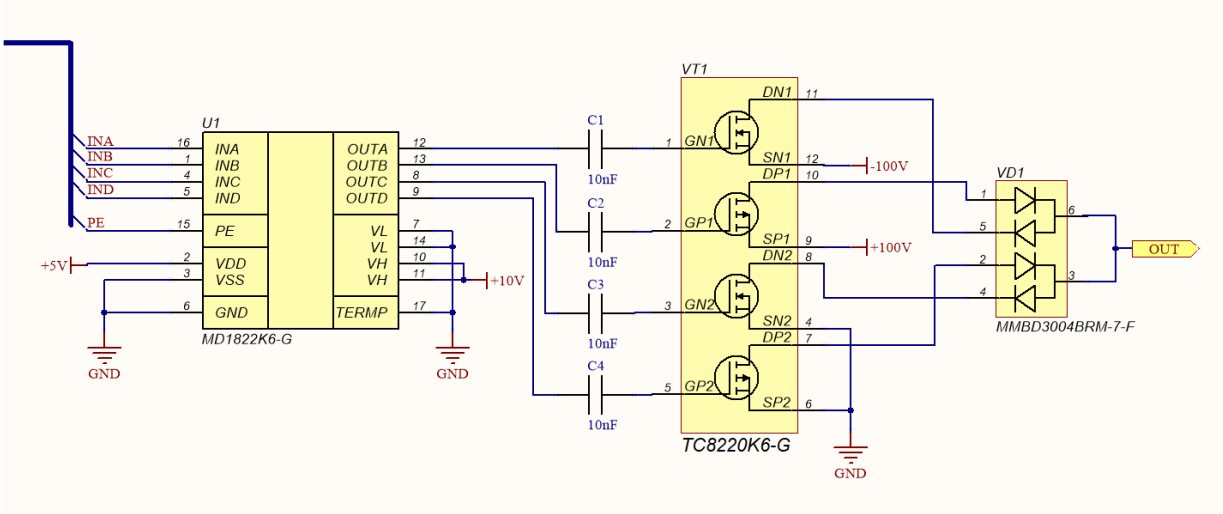

Figure 2. Scheme of pulse exciter of acoustic oscillations with electric damping

We have the opportunity to connect two independent sensors, or connect one sensor and make it an electric damping channel (as shown in Figure 2) due to the presence of two pairs of complementary transistors in the circuit.

During the market research, it was decided to use ADC08060CIMT / NOPB ADCs from Analog Devices. This 8-bit ADC has a sampling rate of 20 - 60 MSPS (Million Signals Per Second), which allows you to work with any sensors, which frequency does not exceed 30 MHz.

It was decided to use Bluetooth wireless technology in the information transfer block. For its implementation, the module BK8000L was used, which is made according to the Bluetooth 3.0 specification. The advantages of such a module include two built-in radio systems: the first provides data transfer speeds of 3 Mbps (standard for Bluetooth 2.0); The second is compatible with the 802.11 standard and provides the ability to transfer data at up to 24 Mbps, and its power consumption is once lower than its competitors and is 32mA.

There is full-speed USB OTG (Universal Serial Bus On-The-Go) as an optional physical data transfer port provided by the capabilities of the microcontroller.

This transmission protocol is compliant with the standards of USB 2.0, as well as OTG 1.0, runs at speeds up to 12 Mbps. This communication channel is more auxiliary than the main one, because it serves as the port for software recording and Li-pol battery charge.

The processing of the received signal can be realized on various devices, the characteristics of which depends on the speed of data processing. At the moment, a mobile application has been developed that allows to visualize the received signal in the form of A-scan, that is a two-dimensional reflection of the amplitude variation at the input of the defectoscope in the passage of time. To construct the image of B, C and other openings, it is necessary to use a flaw detector in conjunction with path sensors.

Conclusions. The portable ultrasonic flaw detector discussed in this article has several advantages over existing devices and for now. The investigation is based on an ultrasonic method for defect detection, which makes the control process not only safe, but also sufficiently precise for unambiguously establishing the state of the research object. Thanks to the analysis of modern electronic elements, energy consumption was minimized, which in turn increased the device's operating time, with the same power source parameters. Taking into account of a power source, it is worth noting that Li-pol batteries are used, which at small sizes can store large volumes of charge. The use of wireless data transfer technology makes it possible to use the device in automated systems to inspect the welds of sheet material, gluing, soldering, etc. for the presence of various defects. The possibility of using the radio waves of information transmission allows the use of more advanced data processing systems at considerable distances from the IO.

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