Ministry of Education and Science of Ukraine

Odessa National Academy of Food Technologies

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2021

Information Technology, Automation and Robotics

Proceedings

Odessa, ONAFT 2021

UDC 004.01/08

Black Sea Science 2021: Proceedings of the International Competition of Student Scientific Works. Information Technology, Automation and Robotics. / Odessa National Academy of Food Technologies; B.Yegorov, M. Mardar, S.Kotlyk (editors-in-chief.) [*et al.*]. – Odessa: ONAFT, 2021. – 526 p.

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Odessa National Academy of Food Technologies, 2021

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HALL ELEMENTS STUDY WITH MICROPROCESSOR SYSTEM

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Abstract. *Silicon semiconductor sensors are widely used in practice. Different species are known, classified according to many parameters. For measuring magnetic field are used Hall elements, magnetoresistors, magnetodiodes, magnetotransistors, magnetothyristors, magnetic sensitive integral circuits and etc. However, the remaining challenge is study of their parameters and exploring their capabilities and fields of application. This article purpose study of Hall sensors - HG302C GaAs and HW300B InSb. An electronic system was developed, based on Atmega 128 microcontroller for study the sensor parameters. Measurements were made and the results are compared and analyzed. The results are presented in tables and graphical form.*

Keywords: *Hall element, microprocessor system, magnetic field, magnetic sensitive elements*

I. INTRODUCTION

In the process of design, it is of great importance understanding and assimilation of how the magnetic sensitive semiconductors work. It leads to further opportunities for synthesis of more complex modules and systems.

Electronics develops in every moment because of new integrated technologies. In many areas of industry, like automation, measuring technics, meteorology, mechanical engineering, chemical and automotive industry and so on, are used electronic magnetic sensors.

Laboratory developments and a number of studies are known in literature, but they require device and hardware resource to measure parameters of Hall sensor [8,4,11]. Most often are needed high sensitive ampmeters, operating in range of mA, and even in μA. This article proposes the development of model for studying the parameters of Hall sensors, without any external measurement equipment. Approach and study of these electronic elements are repeatedly performed since the creation of the Hall sensor [2, 5].

II. LITERATURE ANALYSIS

Microprocessors and digital technology are increasingly used for signal processing from analog output sensors.[6, 7].

A specific feature in the development is using of operational amplifier AD824 with an input voltage shift of 0.1-1mV. This makes the measurements more accurate. This type of operational amplifiers find applications in photodiode preamps, battery powered devices, controls and protection for power supplies, medical equipment, sensor networks and more. [1, 3, 10]

The developed laboratory measuring system is based on Atmel [9] microcontroller, shown in Fig.1 and has the following parameters:

- Setting and measuring the current through Hall sensor – Ih between 0,1 and 12 mA
- Measure Uh voltage
- All the values are displayed

Due to the fact that the required current of the tested sensor can be from 1 to 12mA, is used different range by switching the resistor in the range from – 1k, 10k or 100k Ohms. The measuring system has an output for connection with personal computer. So, the obtained results can be processed by extra developed software.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

A. Setting module

Main block diagram of the schematic of the measurement system is shown in fig.2. On figure 3 is shown the method of setting the current through selectable resistor 1-10-100k Ohms. Operational amplifier is powered by 13.5V from external power supply. Respectively, at the output of the operational amplifier the voltage changes of 0 to 12V with shift of 256. This is because of the used digital potentiometers of Microchip - type MCP42010, which are controlled by a serial interface and powered by 5 volts. At the middle terminal of the digital potentiometer, the voltage changes from 0 to 5 with shift of 256. The gain of the operational amplifiers is set with feedbacks. It is calculated by the formula A = 1+ R4 / R3. The values of the resistors are, respectively, R4 = 10K and R3 = 6.8K. The value received for the gain is 2.47, which at a maximum of 5 volts to the non-inverting input of the operational amplifier, will give 12.35 volts maximum output signal.

Fig. 1. View of the measurement module - design and implementation

The digital potentiometers are two in a hull, with a value 10K. The set current of the Hall Sensor is limited by the maximum output current of the amplifier, which is 20mA.

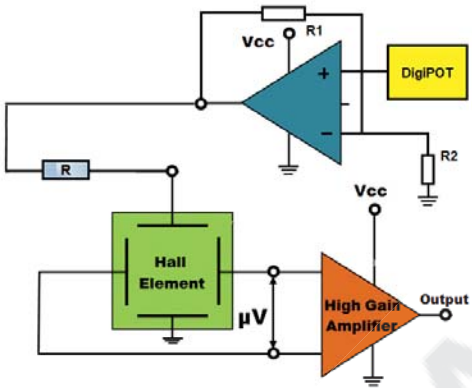

Fig. 2. The block shematic of analog system

Current through the Hall sensor is measured indirectly, i.e. it's measured the voltage drop on the resistor, and the microcontroller calculates the current. Used resistors are pre-measured and their values are set in the software.

B. Measuring module

The measuring module is shown in Figures 4 and 5. Implemented accordingly to measure the current through the sensor. Realized for measuring the current through the sensor, so the resulting voltage is supplied respectively to the inputs of the microcontroller ADC3 for recording the current through the sensor and ADC5 respectively for output voltage from the sensor.

Two differential amplifiers are provided to measure the difference between the two sensor outputs with a range up to 50mV and a measurement shift of 0.1mV - Figure 5. Depending on the polarity of the received voltage, one or the other amplifier operates. This is the way the direction of the magnetic field is recognized. The gain is 100, which at 50 mV potential output difference, will give 5 volts at the ADC input.

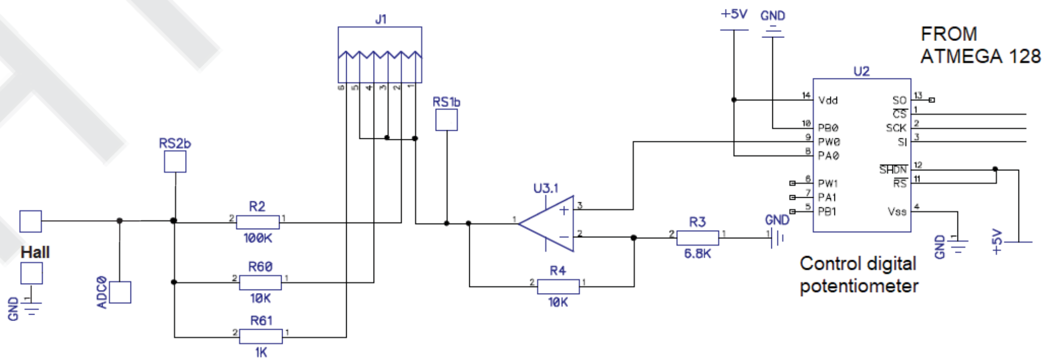

Fig. 3 Setting Ih.

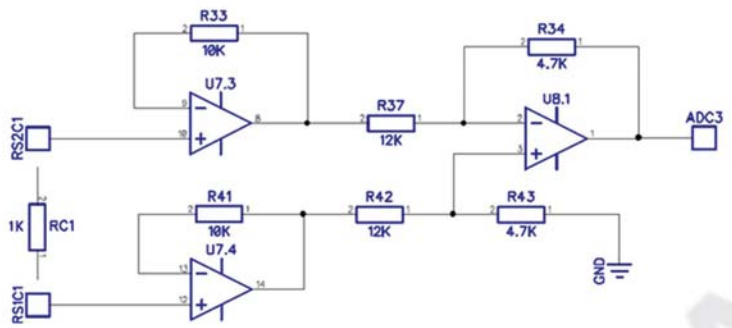

Fig. 4. Measuring Ih.

Working with the laboratory stand is performed by a rotary encoder and a button for recording the setpoints. Exemplary dimensions are shown in Figure 5.

The developed program for the microcontroller performs the following algorithm:

1. Initialization of all ports (inputs, outputs)
2. ADC initialization
3. LCD display initialization
4. Record in digital potentiometers fixed values.

C. Programming cycle

1. Checking encoder status. When the state changes, a value is assigned to an internal variable. Depending on the direction of rotating, the variable decreases or increases. If the encoder button is pressed, a second variable is changed.
2. Depending on the state of the internal variables is running a cycle, which execute operations, related with calculations and displaying parameters on the screen.

There are 2 main screens. The program starts with choosing a resistor to measure the current through Hall sensor – screen 0. This is necessary for correct calculations, and the resistor is set in advance manually with a switch. On screen 1 is set the current and accordingly is measured Uh.

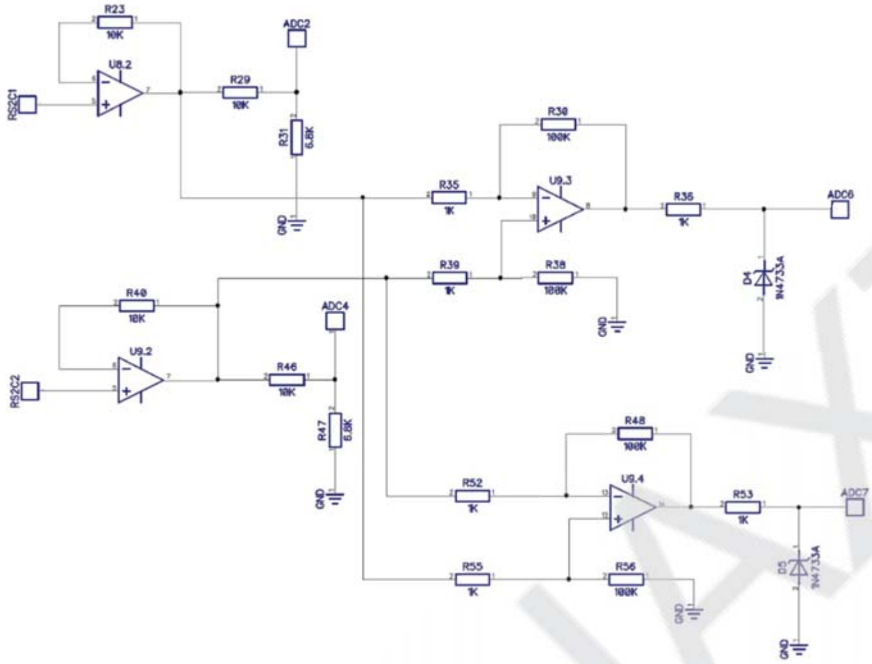

Fig. 5. Measuring Uh

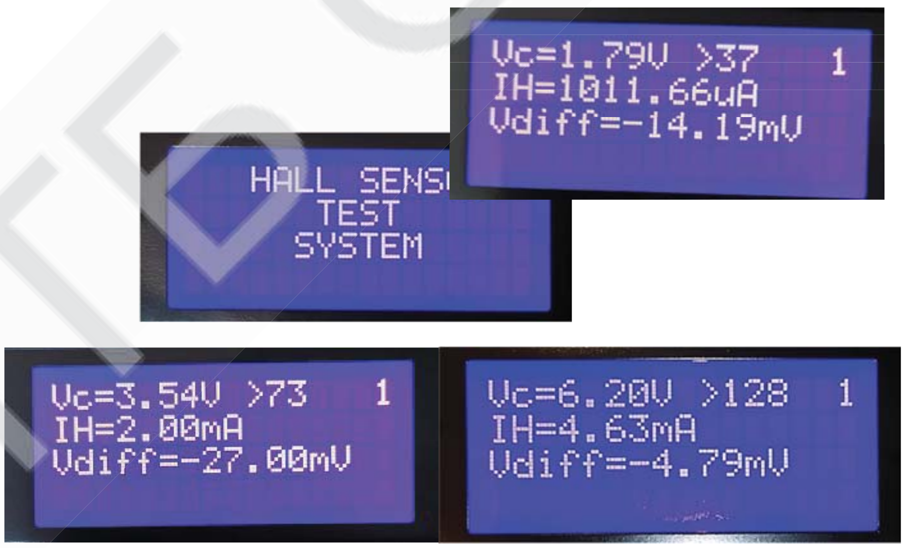

Fig. 6.Options for measuring

IV. RESULTS

The tested sensors are type HG302C GaAs and HW300B InAs. All the results are automatically processed and are presented in a table. For the purpose was used two-pole electromagnet with a maximum current of 4A at 20 volts power supply. (Figure 7).

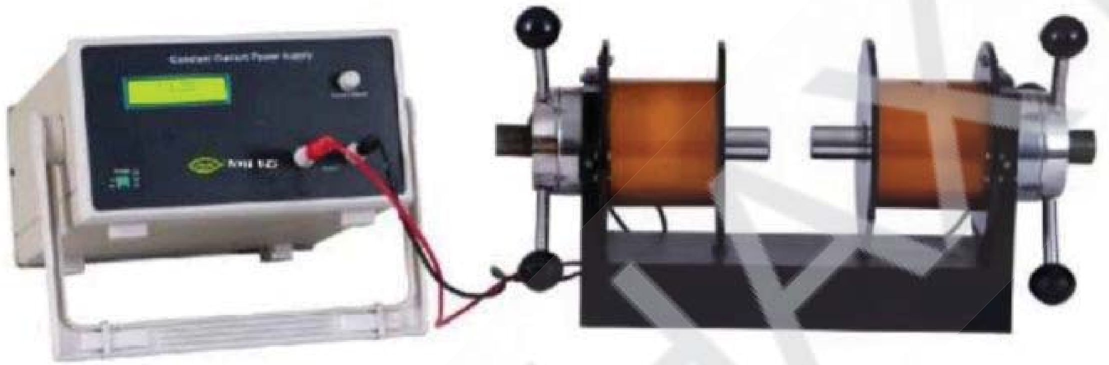

Fig. 7. The electromagnet system

TABLE I. Sensor output voltage, at different magnetic induction

A. Sensor HG 302A

Ih, mA	B, mT	10	20	30	40	50	60	70	80	90
1	Uh, mV	-3.9	-5.5	-6.9	-8.4	-9.8	-11.5	12.7	-14.2	-15.6
2	Uh, mV	-4.3	-7.3	-10.2	-13	-16	-18.8	-21.5	-24.4	-27
4	Uh, mV	-7.6	-13.2	-19.1	-24.7	-29.7	-33.6	-36.5	-38.5	-40

B. Sensor HW 300B

Ih, mA	B, mT	10	20	30	40	50	60	70	80	90
1	Uh, mV	19	34.7	40.8	43.6	45.2	46.1	46.8	47.3	47.5
2	Uh, mV	33.3	43.3	46.1	49.8	52.2	55.5	58	62.4	65.3
4	Uh, mV	43.5	47.4	51.2	55.3	59.1	63.8	67.4	71.9	75.6

At operating current 0.1mA, the offset U_0 = 0.12mV and at a value above 0.5mA, U_0 = -2.6mV.

V. CONCLUSIONS

A specialized module has been developed for study of magnetosensitive elements, which dramatically reduces operating time and helps in the proper analysis of the Hall sensor. Next step in developing is connecting the module to a computer and working on software for further automatic processing and analyzing of the results. The tested sensor is HG302C GaAs and HW300B InAs. The obtained results confirm the possibility of using the sensor in low intensity magnetic fields. Sensor sensitivity increases with increasing operating current. At current value $I_h = 2mA$ and greater, for $B = 50mT$, the output voltage is between 50 and 70 mV.

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The collection includes student works of the participants of the competition, which were not included in the number of prize-winners. The texts of the competitive works are published in the form in which they were submitted by the authors. The authors of the articles are responsible for the content and form of submission of the material.

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Odessa 2021