Study of a Galvanomagnetic Digital-to-Analogue Converter

Anatolii T. Aleksandrov[1], Nikola D. Draganov[2]

Abstract - **The paper studies a galvanomagnetic digital-to-analogue converter, built around specialized ICs LM2917 and MLX1881. A schematic circuit diagram has been developed. The paper presents the conversion characteristics obtained by experiment and determines the optimal range of input variable conversion. It also studies the influence of the adjusting elements (resistor and capacitor) and the supply voltage upon the power consumption and the frequency range.**

Keywords – **galvanomagnetic sensors, magneto-sensitive integrated circuits, control, regulator, digital-to-analogue converter**

I. Introduction

The measurement of electric and non-electric quantities is a major task of modern electronic systems, the solution of which allows their adaptation to the control environment. Therefore it is necessary to develop new devices and to improve the existing ones designed for conversion and processing of the quantities measured with a greater accuracy, sensitivity and variation range. They find application in electronics, automation, electrical appliances, chemistry, medicine, etc., where the measurement and control of environment parameters is of utmost importance for the device operation or for correct analysis [5].

There are various devices available for magnetic field sensing. Most of them are based on a Hall element. The development of microelectronics has enabled the development of integrated circuits with built-in Hall elements, allowing not only detecting, but also processing of the signal [1, 2, 3, 4, 6].

The aim of the work presented in the paper is the synthesis of a galvanomagnetic digital-to-analogue converter, allowing detection of a pulse-varying magnetic field.

II. Presentation

A galvanomagnetic digital-to-analogue converter has been developed, based on specialized integrated circuits MLX1881 and LM2917, whose flow chart is presented in Fig. 1. It consists of a magneto-sensitive integrated circuit (MSIC), frequency-to-voltage converter unit, a supply unit and a tuning unit

[1] Anatolii T. Aleksandrov is with the Technical University, 4 H. Dimitar str. 5300 Gabrovo, Bulgaria, E-mail: alex@tugab.bg

[2] Nikola D. Draganov is with the Technical University, 4 H. Dimitar str. 5300 Gabrovo, Bulgaria, E-mail: nikola_draganov@mail.bg

The magneto-sensitive integrated circuit MLX1881 manufactured by *Melexis* exhibits stable conversion characteristics and high sensitivity. The MSIC output is a digital signal having frequency proportional to the magnetic field frequency.

The frequency-to-voltage converter is of the LM2917 type of *National Semiconductor*, enabling a common indicating instrument to be connected at its output.

The tuning unit consists of elements (capacitors C_1, C_2 and resistor R_4) accomplishing a change in the conversion characteristics and the sensitivity of the frequency-to-voltage converter.

The schematic circuit diagram of the galvanomagnetic digital-to-analogue converter is presented in Fig. 6.

The circuit operation consists in conversion of the magnetic pulses sent to the MSIC into a voltage level proportional to the pulse variation frequency.

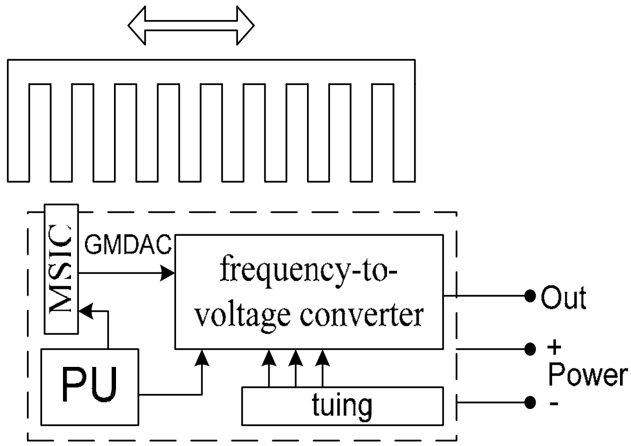

Fig. 1 Flow chart of a galvanomagnetic digital-to-analogue converter

A pulse series is generated when supply voltage is fed to the MSIC output and when there are magnetic pulses of certain frequency there. The frequency of the pulse series is completely identical with the frequency of the magnetic pulses. The signal from the MSIC output is entered at the frequency-to-voltage converter input, built around integrated circuit LM2917, and is converted from pulse into analogue voltage signal. The converter operation mode is regulated by means of tuning capacitors C_1, C_2 and resistor R_4.

With view to choosing an optimal operation mode, experimental tests have been carried out, which show the way the output voltage U_0 changes with the value of resistance R4 and the capacitance of capacitors C_1 and C_2. Fig. 2 shows the dependence of output voltage U_0 on the capacitance of capacitor C_2 $U_0=\varphi(C_2)$ when resistor $R_4 = 100k\Omega$, capacitor $C_1 = 1\mu F$ and supply voltage $U_{DD} = 12V$, while Fig. 3 shows the transfer characteristics $U_0 = \varphi(f)$ depending on the value of resistance R_4.

The analysis of the results obtained shows:

- as the value of capacitor C_2 rises, the range within which the output voltage varies for the same frequency range widens, and therefore the sensitivity of the galvanomagnetic converter increases;
- when the resistance value rises to 250kΩ, a rise in the conversion transconductance and dynamics is observed.

The way in which U_0 varies is due to the attenuator functions of resistor R_4 resistance and capacitor C_1 capacitance in the frequency-to-voltage converter. These functions determine the dynamics of the entire converter. As can be seen in Fig. 4, the optimal value of this resistance is 100kΩ, since it covers the entire frequency range of the converter.

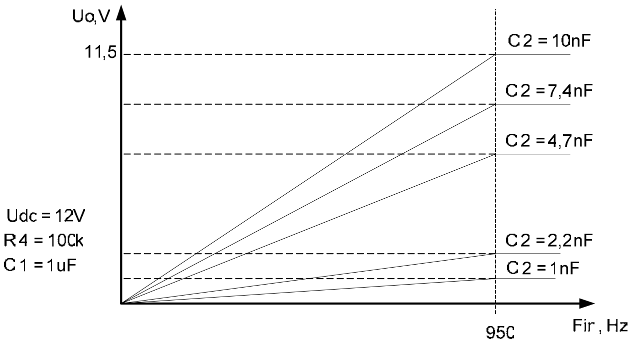

Fig. 2 Influence of the capacitor C_2 value on the change in the transient response

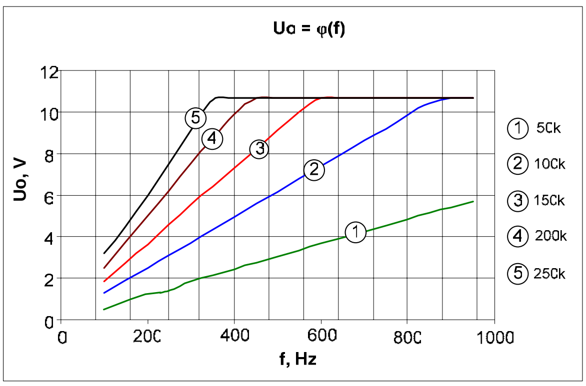

Fig. 3 Family of transfer characteristics showing the influence of R4 on the converter dynamics

The influence of the capacitor C_1 value on the value of the output voltage U_0 is analogous. When its value is raised, a rise in the circuit dynamics is observed. The maximum value of capacitor C_1 is 1μF.

The values of the tuning elements C_1, C_2 and R_4 are determined entirely subject to the converter range obtained by experiment, presented graphically in Fig. 4.

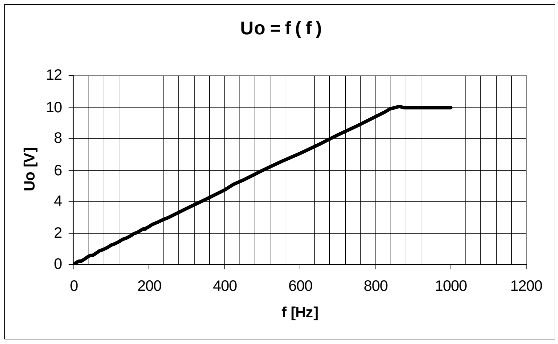

Fig. 4 Transfer characteristic of the converter determining the frequency range

III. CONCLUSION

1. A galvanomagnetic converter has been developed based on a magneto-sensitive integrated circuit MLX1881 manufactured by *Melexis* and an integrated frequency-to-voltage converter LM2917 manufactured by *National Semiconductor*. A flow chart and a schematic circuit diagram have been developed and experimental transient responses are shown, giving idea about the conversion range of the input variable.

2. A good sensitivity and stability of the transfer characteristic (Fig. 4) is achieved by means of the tuning elements, as well as capability of adequate response in case of abrupt changes in the input value.

3. By using an integrated frequency-to-voltage converter, a relatively low power consumption of the device can be achieved (Fig. 5).

4. The proposed device can be applied in speed monitoring and control systems of rotating or linear-displacement mechanisms, namely in devices for monitoring and automatic regulation of electric motor rotation frequency, for various applications in the automobile industry, etc.

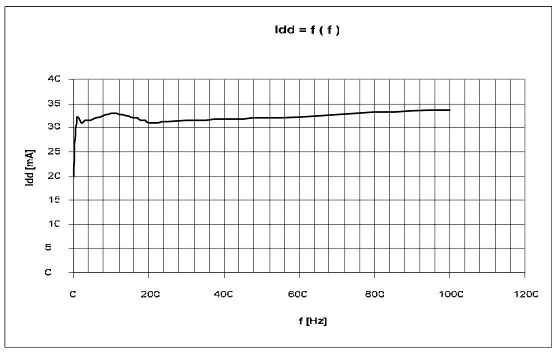

Fig. 5 Power consumption of the device with different values of the input variable

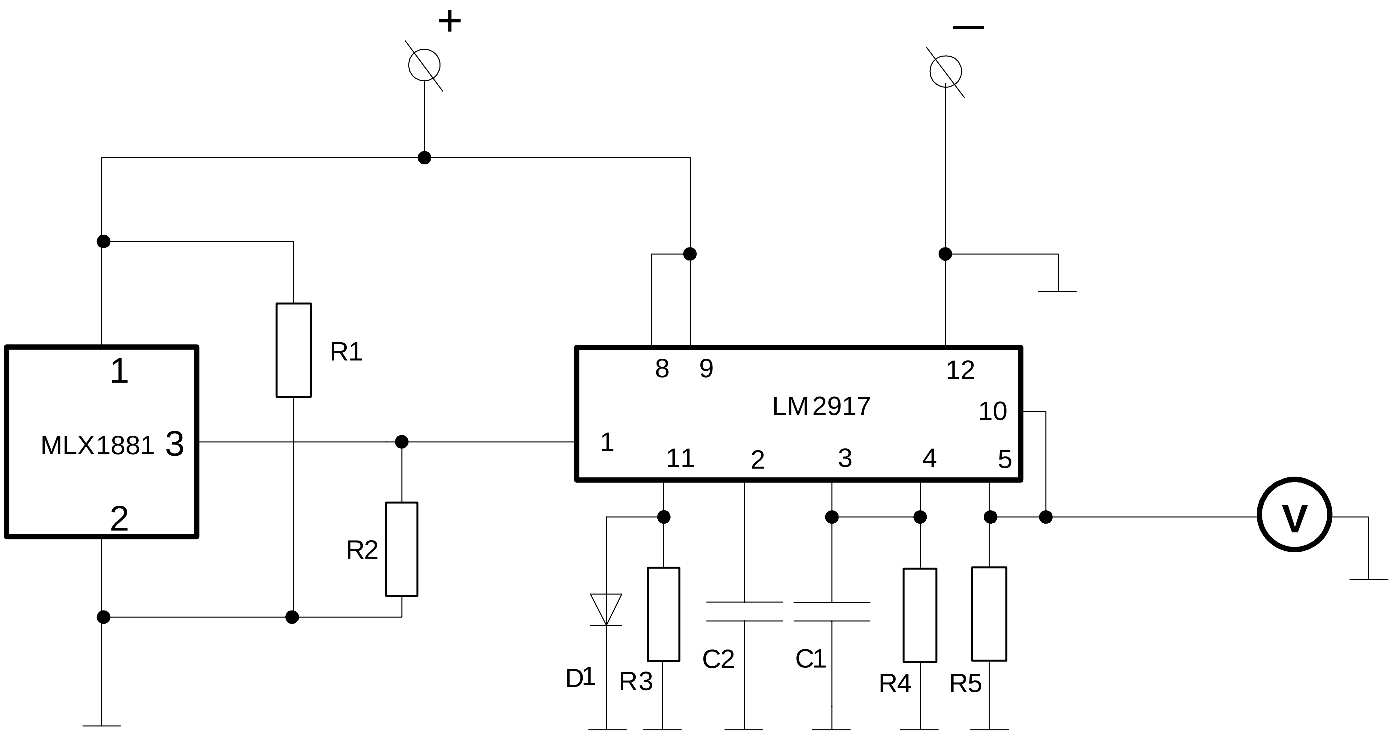

Fig. 6 Schematic circuit diagram of a galvanomagnetic digital-to-analogue converter

IV. REFERENCES

[1] Alexandrov A. T., I. S. Simeonov, "Galvanomagnetic Device for Electric Current Measurement", Journal of the Technical University of Gabrovo, vol. XXIV/00 (in Bulgarian).

[2] [2] Nikolov D., "Application of Sensors for Magnetic Field in Measurement of Linear and Angular Displacement", Avtomatika i Informatika Journal, issue 4, 1998 (in Bulgarian)

[3] Rumenin Ch., "Multisensors for Magnetic Field and Temperature in Contactless Wattmeters", Avtomatika i Informatika Journal, issue 5, 1998 (in Bulgarian).

[4] Takov T., "Semiconductor Sensors", Tehnika, Sofia, 1986 (in Bulgarian).

[5] Göpel W., J. Hesse, J. N. Zemel, SENSORS, A Comprehensive Survey Vol.1, "Fundamentals and General Aspects", VCH, Weinheim, 1989.

[6] Göpel W., J. Hesse, J. N. Zemel, SENSORS, A Comprehensive Survey Vol.5, "Magnetic Sensors", VCH, Weinheim, 1989.