Based of AMR Sensors Device for Multichannel Contactless Measurement of AC Current

Nikola D. Draganov[1], Totka A. Draganova[2]

Abstract–**Measurement and visualization of the AC current is fulfilled on the base of the AMR sensor and microcontroller PIC16F874A offered by Microchip®. Presented device has automatic mode of work. It can be connected to PC by means of the serial interface. Control algorithm enables collection, treatment, preservation and visualization of the information.**

Keywords – **AMR sensors, Contactless current measuring, microcontrollers, digital signal processing.**

I. INTRODUCTION

There are diverse electrical quantities. One of they is an electrical current. A lot of indirect and direct methods for its measurement are known. Very spread is indirect contact less method by a measurement of a magnetic field created by a flowing through a conductor electrical current. Connected in parallel bridge anisotropic magnetoresistors (AMR) are widely applied to contact less measurement of an alternating current in the modern installation. They have high sensitivity, wide frequency band, good linear characteristics and high reliability [6, 8].

The problem connected with collection, measurement, treatment and indication of the information obtained by the sensors is very pressing for engineering practice. Using modern element base is possible to achieve good results in an electrical current measurement.

The purpose of the present working out on a basis of AMR and microcontroller is to create a galvanomagnetic device which fulfills multichannel independent AC current measurement. It can be a base of later investigations and elaborations.

II. PRESENTATION

A device for a four channel independent AC current measurement is made. Its block schematic diagram is depicted in Fig.1. It is composed of measuring unit (MU), microcontroller (CPU), keyboard (KB), digital display (LCD), memory (EEPROM), serial interface (RS232) and power supply (PU). A measuring block is composed of sensor units (SU) which detect a created by a measured current I_{TEST} magnetic field and transform it in a electrical signal again. The SU number is defined by a microcontroller hardware. In a case of an utilized in this elaboration microcontroller PIC16C874A permissible SU number is five [5, 7].

Each sensor block is composed of magnetosensitive block (AMRS) and measuring converter (MC). AMRS is created on the basis of anisotropic magnetoresistance sensor of the type ZMY20M fixed immediately on network measuring conductor. By means of this sensor the created magnetic field is transformed to a voltage proportionally to an electrical current I_{TEST} value [3]. A schematic circuit diagram of galvanomagnetic device for four channel measurement of AC current is shown in Fig. 2.

A magnetoresistance sensor ZMY20M represents four magnetoresistors made on the base of a thin film permaloy connected in bridge circuit together in one case. The output

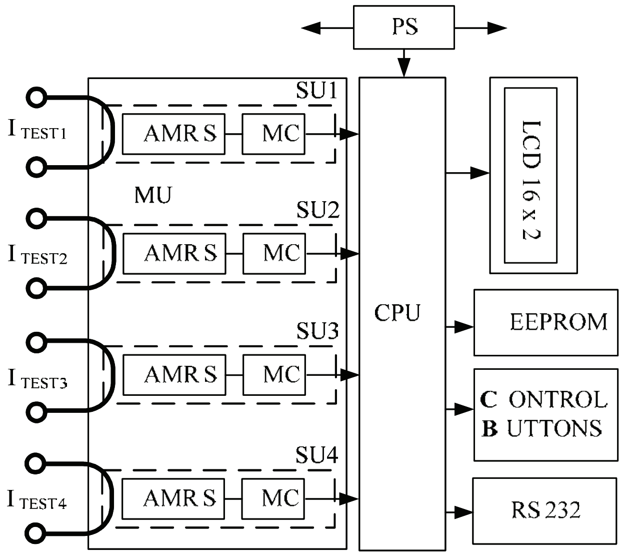

Fig.1. Block schematic diagram.

voltage of this kind sensor is proportionally to an applied external (working) magnetic field in direction B_Y. For the steady sensor operation it is necessary to apply perpendicular another magnetic field B_X created by a fixed in the case constant magnet. A conversion characteristic $U_O=f(B)$ at U_B=const is depicted in Fig. 4 [5, 7]. The sensor unit can transform AC current only in one range (I_{TEST}= 0÷10A). With a view to improve a conversion characteristic stability and toincrease a voltage level on the SU output a measuring converter (MC) is connected.

[1]NikolaD. Draganov is with the Faculty of “Electrical Engineering and Electronics” of Technical University of Gabrovo, Hadgi Dimitar, str.4, 5300Gabrovo, Bulgaria,
E-mail: niko_draganov@mail.bg

[2]Totka A. Draganova is with the Faculty of “Electrical Engineering and Electronics” of Technical University of Gabrovo, Hadgi Dimitar, str.4, 5300 Gabrovo, Bulgaria,
E-mail: totka_koeva@mail.bg

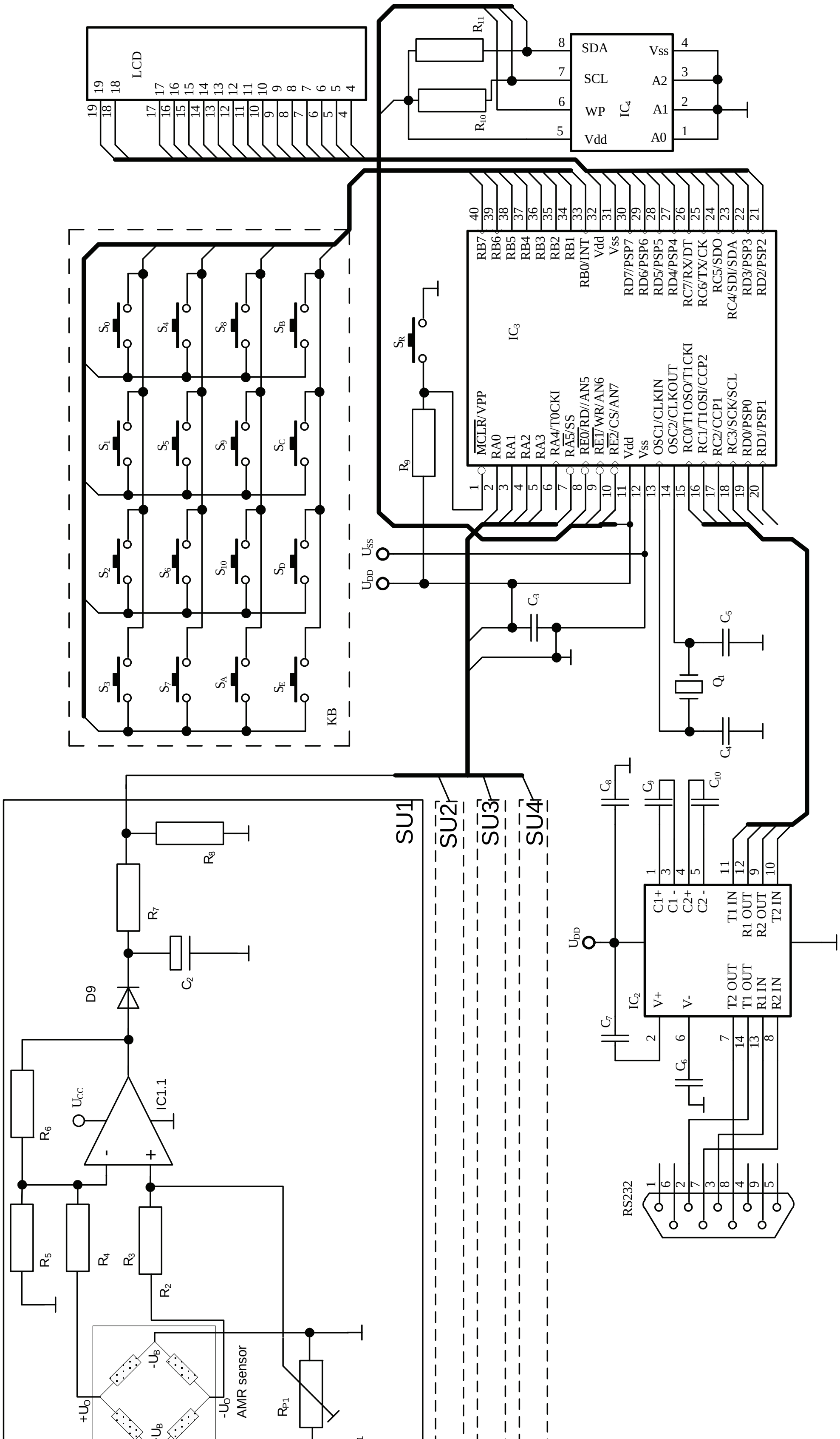

Fig. 2. A schematic circuit diagram

It is realized as classical DC amplifier with gain K=10. So the output information signal maximum value is U_{SUOMAX}= 2,51V at current I_{TEST}=10A (fig. 5).

By means of four independent SUs the galvanomagnetic device enables contact less measurement of four independent current signals. They can be receive as from one so from several signal sources simultaneously without to lose their accuracy by measurement. The received from SU signal is changed from 0 to 2,5V and therefore a reference voltage of the analog-to-digital converter (ADC) is chosen $U_{ref.}$= 5,1V. If a 8 bit discrete is used a minimal measured voltage will be U_{SUOMIN}=0,02V.

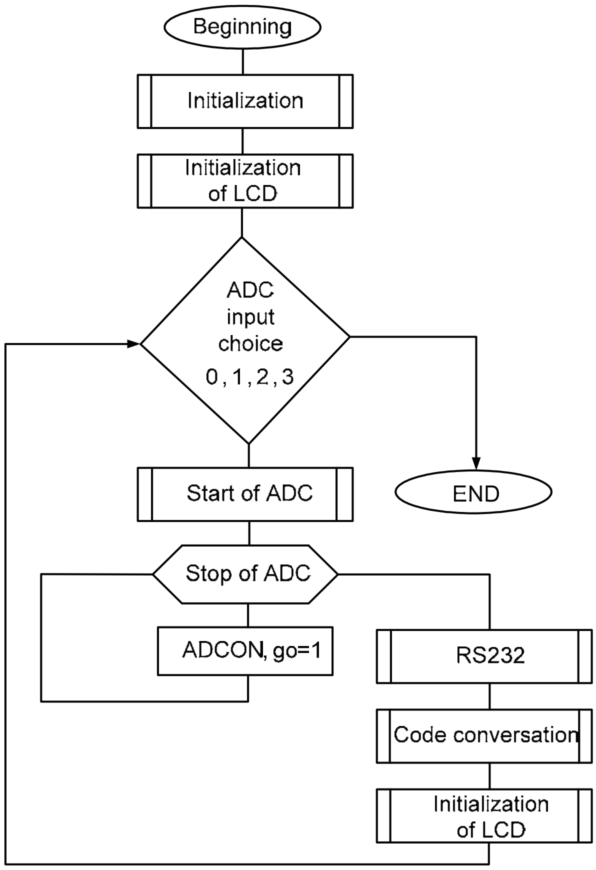

Fig. 3. Main program algorithm

Control organization, processing and monitoring are fulfilled by the main block realized by microcomputer PIC16F874A (Fig. 2).

Accuracy, reliability and measurement parameters are improved thanks to its functional possibilities at a decreased price and dimensions of the device.

The device operates at 20MHz frequency. A microcontroller internal memory (4kb) is enough for normal device processing. An additional 256kb memory of type 24LC256 is intended to buffer a large quantity of information obtained during a measurement of slow changed signals and later their values to send through serial interface RS232 to a personal computer (PC).

The device is equipped with 16 button keyboard which enables to extend its possibilities to assign an automatic or manual channel change and a time of results indication.

By means of intelligent LCD module the measured quantity values are indicated on 16 range display where for each channel the indications take turns in 3 seconds [2].

When power supply is turned on the necessary hardware resources are configured:

- Leads RA0÷RA3 and RA5 are configured as analog inputs through them the sensor unit signal are brought in;
- The keyboard control is fulfilled by port B as their leads (RB0÷ RB7) are configured like inputs;
- Through Port C leads RC0÷RC4 a galvanomagnetic device is connected to PC by RS232. The dispatched values are used for a graphical visualization in different time interval of a measured current change;
- To take out an information from a measurement on LCD display all leads (RD0÷RD7) of Port D are configured like outputs;
- Port E is used to connect a microcontroller to an external memory.

The measurement begins after an initialization fulfillment according to the depicted in Fig.3 algorithms. A measuring input is firstly chosen. Analog-to-digital converter (ADC) treats a input signal in time of 16 seconds. The obtained in binary code signal is sent to PC after that a measured quantity value is transformed in decimal code, respectively in ASCII code and is indicated on LCD screen during 3 seconds.

A measuring cycle of one channel depends on an utilized approach of a filtration. By means of software filter it is achieved an input analog average signal with a view to decrease accident fluctuations influence over a measured electrical current [2-5].

A second channel voltage measurement begins without delay after a finish of a foregoing one. So consecutively the four channels are read. The whole measuring cycle includes the time from a first channel switching on to the last one switching off together with the indication time of 14 seconds.

A measured quantity can be indicated on LCD module as electrical current or magnetic induction unities. By means of a microcontroller tabular transformation is formulated a linear dependence between a magnetic field and a obtained by a sensor output voltage.

III. CONCLUSION

A galvanomagnetic device forfour channel independent measurement and visualization of alternating electrical current on the base of magnetoresistance AMR sensor of type ZMY20M and microcontroller PIC16F874A produced byMicrochip® (Fig. 6) has been created.

A block schematic diagram and schematic circuit diagram have been elaborated. A main program algorithm has been submitted.

A measurement accuracy has been increased by means of software filter which eliminates accidental input quantity peak alterations [2].

The device enables to measure slow alterable in time electrical signals.

The external memory enables to keep large information.

It has been established measuring device errors because of:

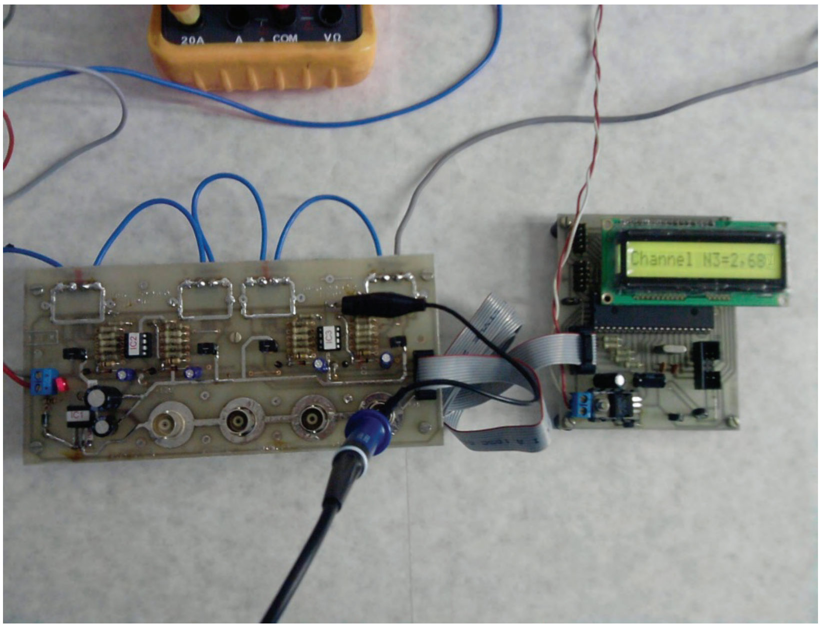

Fig.6. Model of device for four channel contact less AC current measurement.

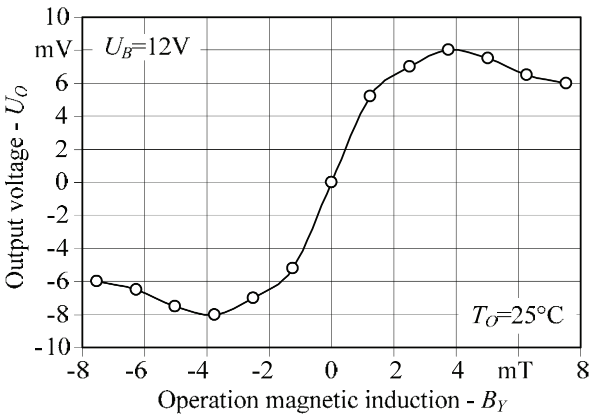

Fig.4. A conversion characteristic U_O=$f(B)$ at U_B=const of magnetoresistance sensor ZMY20M [8].

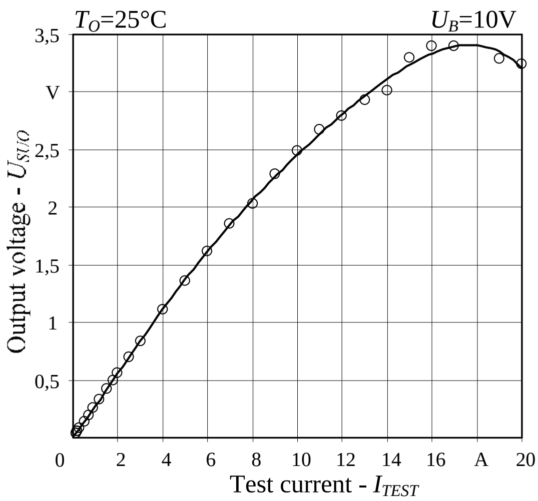

Fig.5.A conversion characteristic U_{SUO}=f(I_{TEST}),U_B=const and U_{CC}=const of sensors units.

- an analog-to-digital transformation which is 0,5% at maximum input ADC voltage U_{INMAX} = U_{SUO} = 2,5V and a discretization step 0,02V;

- analog block in result of temperature sensitivity of a magnetoresistance unit;

It has been made an error reduction by means of embedded in microcontroller program software filter and a sensor unit temperature compensation which decreases an error caused by surroundings temperature change.

Software provided operations have been controlled by 16 button keyboard. An interface has been realized by RS232 for a communication with PC.

The created galvanomagnetic device for contact less AC current measurement is widely applied as in research work so and in industrial installations for technological processes monitoring and control.

REFERENCES

[1] Aleksandrov, A., I. Simeonov. Galvanomagnetic device for measuring of electric current. Journal of the Technical University of Gabrovo, Vol. 15/2000, Gabrovo, 2000.

[2] Goranov, G., A. Iliev. Using of controller with common function in system for control of power. UNITECH`01 conference, Vol. 1, Gabrovo, 2001.

[3] Draganov, N., G. Goranov, A. Aleksandrov. Galvanomagnetic device for contact less measuring of DC current. UNITECH-08 conference, Vol. 1, Gabrovo, 21-22 Nov. 2008, p.142-146.

[4] Draganov, N., G. Goranov, A. Aleksandrov, P. Penchev. Galvanomagnetic device for measuring of magnetic field. Journal of the TechnicalUniversity of Gabrovo, Vol. 37/2009, p.70 - 73.

[5] Smrikarov, A., C. Vasilev. Microcontrollers. Ruse. Avangadr Print House, 2000.

[6] Roumenin, C. S. Solid state magnetic sensors, Amsterdam, Elsevier, 1994.

[7] Data sheet of PIC16F874A. www.microchip.com , April 2010.

[8] Data sheet of ZMY20M. www.zetex.com , April 2010.