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Разработка интегрируемого с персональным компьютером универсального RLC-сенсора

Development of a universal RLC-sensor integrated with a personal computer

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Аннотация

В статье рассмотрена возможность компьютеризации электрохимических методов анализа, в частности кондуктометрических. Предлагается схема создания универсального датчика измерения сопротивления, ёмкости и индуктивности. Также рассмотрен алгоритм работы программы MultiMeter 0,03, которая служит для интеграции данного сенсора с персональным компьютером. Показаны предварительные результаты измерений, рассчитаны погрешности измерений. Выведены формулы для расчёта прогноза погрешности.

Ключевые слова: датчик, компьютеризация, Multi Meter 0.03, сопротивление, ёмкость, индуктивность

Keywords: sensor, computerization, Multi Meter 0.03, resistance, capacitance, inductance

Modern school pays much attention to the work on improving the content of theoretical knowledge in chemistry on the basis of alternative training plans, which cannot be said about knowledge associated with the organization and setting up of a chemical experiment, especially performed by students themselves [1, p. 27]. In connection with the informatization of education, there has been an increased interest in the problem of the use of computer technologies in subject teaching, including in the teaching of chemistry. In the light of the increasing role of information and communication technologies, one can consider the possibility of partial automation and computerization of methods for studying properties. In particular, the equipment integrated with the PC can be used in the study of electrical conductivity and some other properties of solutions [2, p. 94]. All this can be possible with the use of electrochemical methods of analysis. An analytical signal can be any functionally connected with the concentration of the analyzed solution and measurable electrical (current, voltage) or electrochemical (electrical conductivity of solution, polarization of electrodes) parameter [3, p. 11]. Electrochemical methods of analysis allow to determine the concentration of substances in a wide range (from 1 to $1 \cdot 10^{-9}$ mol/l), can be easily automated [4, p. 7].

A tool for electrochemical analysis methods is an electrochemical cell, which is a vessel with an electrolyte solution in which at least two electrodes are immersed. In the course of the study, a universal RLC sensor was made from an easily accessible material:

- Copper wires, insulated
- Two mini-jacks (3.5 mm)
- Resistors of different denominations
- Crocodile type terminals.

All the wires are connected according to the diagram shown in Figure 1 and connected to the plugs of the line-in and headphone connector. Two plugs mini-jack were used (3,5 mm).

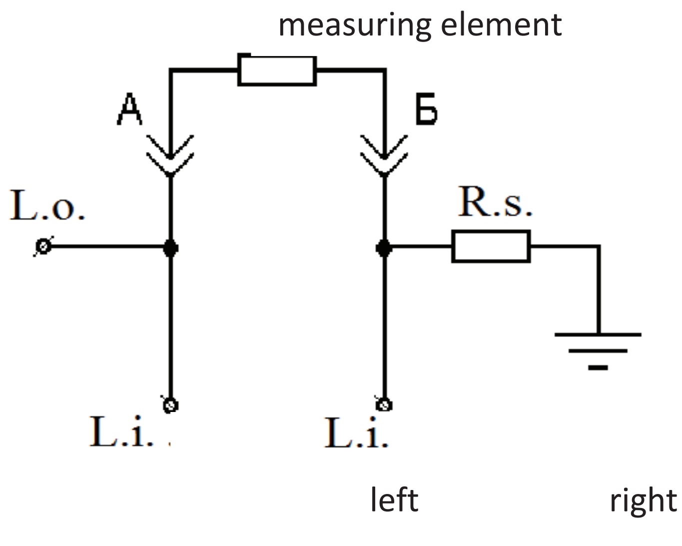

Figure 1. Wiring diagram of the sensor components, where L.o. linear output, R.s – series resistor, L.i. left – line input left channel, L.i. right – line input right channel

For the analysis and processing of measurement results obtained with a sensor, the corresponding software was used.

1) the program was selected according to the following criteria:
2) reliability and reproducibility of indications;
3) the simplicity of the interface;
4) absence of special requirements for PC;
5) low requirements for computer RAM.

The operation of this program is carried out according to the following principle: Also, R serial is used, coming from the "crocodile" connected to Line In Right, and connecting to the PC case or to the ground from Line In.

The program generates and sends to the sound card a signal of a certain amplitude. The generated AC signal from the Line Out output is applied to the Line In line input. On one circuit the signal goes directly from Line Out to Line In Left – this is the reference signal. On the second circuit, the signal comes from the same Line Out output, through the measured element, and goes to Line In Right, where the received signal is compared to the reference one. The results of the comparison are sent by the sound card to the program and displayed on the screen.

The program Multi Meter 0.03 consists of one file, does not require installation, the interface is simple and understandable (Figure 2). In the "work mode" area, calibration modes are set. In the R-serial window, enter the value of the resistor built into the circuit,

The frequency window is used to enter the frequencies of the sound card (from 50 to 1000 Hz).

The lower windows display values (Resistance, Capacitance and Inductance).

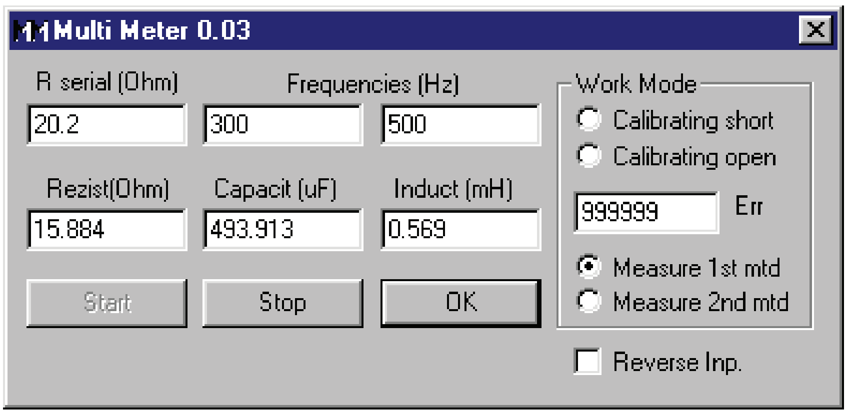

Figure 2. Window of the program Multi Meter 0.03

Calibration to short circuit.

1. The circuit is short-circuited, without R.s. ("Crocodiles" are connected to each other, as shown in Figure 3).

2. Calibration is started by pressing the "Start" button.

3. It is necessary to wait for some time until the minimum value is set in the error window.

4. Press the "Stop" button.

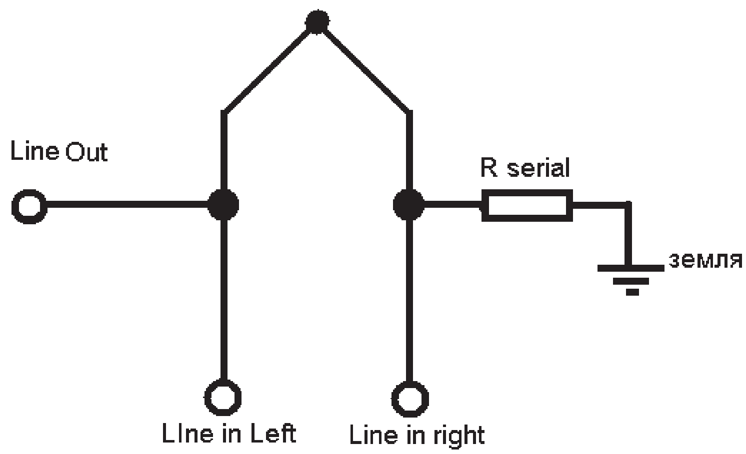

Figure 3. Short circuit diagram

Calibration for opening.

1. The chain opens ("crocodiles" are disconnected, as shown in Figure 4).

2. Calibration is started by pressing the "Start" button.

3. It is necessary to wait for some time until the minimum value is set in the error window.

4. Press the "Stop" button.

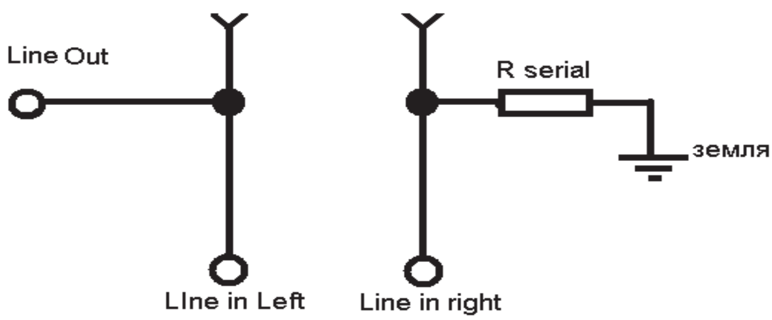

Figure 4. Circuit Open Circuit

After the end of the sensor assembly, calibration was performed, comparing the sensor readings for different Rs.s. (Tables 1 and 2).

Table 1

Calculation of the error of indications at R.s. = 51,8 Ohm.

Marking of the resistor, Ohms	Program readings, Ohm	Difference of readings, Ohm	Accuracy,%
0,8	1,3	0,5	62,5
1,3	0,8	0,5	38,462
1,4	0,85	0,55	39,286
2,5	1,95	0,55	22
3	2,5	0,5	16,667
6,45	5,9	0,55	8,5271
10,2	9,7	0,5	4,902
13,3	12,5	0,8	6,015
23,3	22,7	0,6	2,5751
24,2	23,8	0,4	1,6529
49,3	48,3	1	2,0284
50	49,8	0,2	0,4
52,3	51,2	1,1	2,1033
67	66,8	0,2	0,2985
97,8	96,6	1,2	1,227
98,4	97,08	1,32	1,3415
100,5	99,3	1,2	1,194
100,8	99,5	1,3	1,2897
102	101,6	0,4	0,3922

Table 2

Calculation of the error of indications at R.s. = 98,5 Ohm.

Marking of the resistor, Ohms	Program readings, Ohm	Difference of readings, Ohm	Accuracy,%
1	**2**	**3**	**4**
0,8	0,3	0,5	62,5
1,3	0,5	0,8	61,538
1,4	0,6	0,8	57,143
2,5	1,7	0,8	32
3	2,7	0,3	10
6,45	5,7	0,75	11,628
10,2	9,6	0,6	5,8824
13,3	12,2	1,1	8,2707
23,3	22,75	0,55	2,3605
24,2	23,7	0,5	2,0661
49,3	48,4	0,9	1,8256
50	50,05	0,05	0,1

Окончание табл. 2

1	2	3	4
52,3	51,3	1	1,912
67	66,3	0,7	1,0448
97,8	97,2	0,6	0,6135
98,4	97,8	0,6	0,6098
100,5	99,8	0,7	0,6965
100,8	100,3	0,5	0,496
102	100,6	1,4	1,3725

According to the data of the table, curves for the dependence of the error on the resistor value are constructed (Figures 5 and 6).

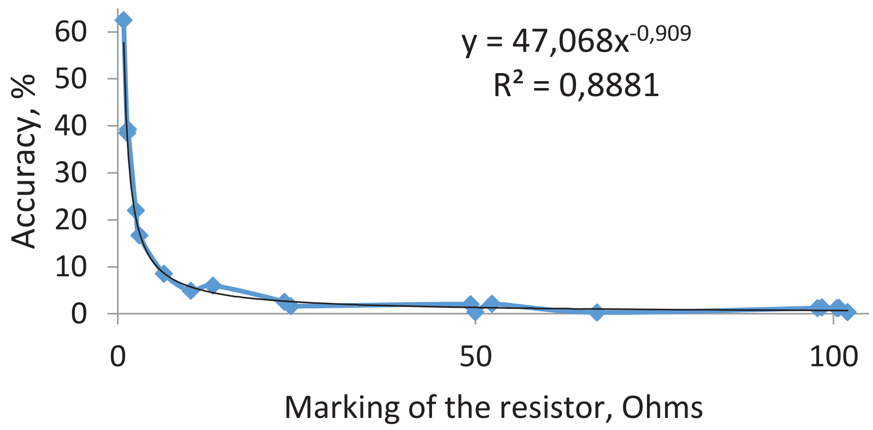

Figure 5. Dependence of the accuracy on the resistor value at R.s.=51,8 Ohm

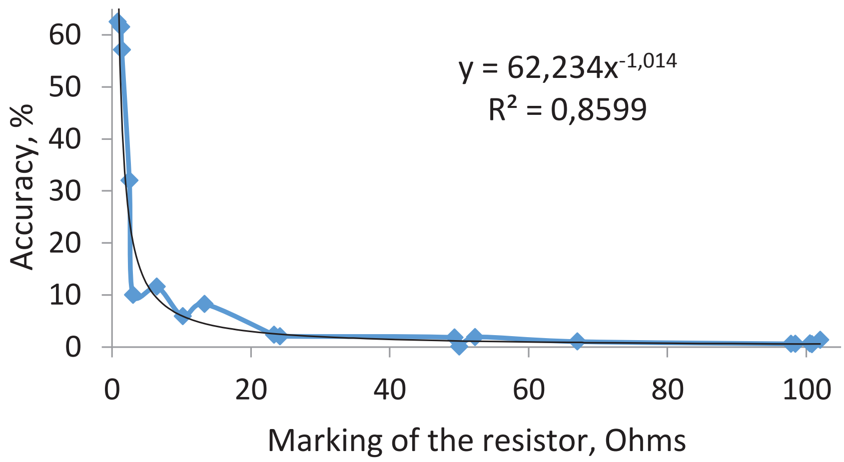

Figure 6. Dependence of the accuracy on the resistor value at R.s.=98,5 Ohm

On the basis of tabular data it was deduced that the closer the desired index to the value of R.s., the lower the error. Also, for values above 100 Ω at Rs.s. = 51.8, the error increased in the arithmetic progression, since with the 400 ohm resistor measured, the reading was 375 ohms (1/16 ohm per step), and at a measured 300 ohms the readout was 281 ohms (1/16 ohms per step).

These results indicate a regular change in the error, which allows us to predict the measurement error.

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Преподавание биологии на английском языке в школах Казахстана

Teaching biology in English in Kazakhstani schools

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Annotation

This article deals with some examples of CLIL-based exercises used at the lesson of biology in Kazakhstani schools. This is an attempt to demonstrate the connection of biology or any other science with the English language.

***Keywords*:** CLIL, biology, photosynthesis, multilingualism.

Teaching science (as it is basically considered in European researches that includes chemistry, geography, biology, etc.) has the aim of formation of basic knowledge in scientific domains so that the child could have an opportunity to choose specific direction of his future profession.

This article dwells upon some general aspects of teaching biology in modern Kazakhstani schools in English. Proliferation of English penetrating into