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MICROELECTRONIC CONVERTER OF GAS CONSUMPTION BASED ON TWO BIPOLAR TRANSISTORS WITH ACTIVE INDUCTIVE ELEMENT

The scheme of microelectronic converter of gas consumption, based on two bipolar transistors with active element is suggested. The given scheme realizes self-excited oscillator where gas consumption conversion is realized into output frequency signal. Analytical expressions of conversion function and sensitivity equation are obtained.

Key words: *frequency converter, generation frequency, sensitivity.*

Introduction

Modern level of development of information-measuring engineering is characterized by the variety of methods of gas consumption determination, where output signal is voltage or current, that leads to low noise immunity and measurement accuracy.

Microelectronic converters with frequency output signal combine both simplicity and universality, that are inherent to analogue devices and also accuracy and noise immunity that are characteristic for the converters with code output. They possess high sensitivity to measured parameters, small mass and dimensions, information constructive and technological compatibility with microelectronic facilities of information processing, that provides their advantages over the existing flowmeters [1].

Thus, the aims of the paper are: obtaining of theoretical dependences of active and reactive component of output impedance on charges; theoretical and experimental dependence of generation frequency and sensitivity on gas consumption.

Calculation of the parameters of microelectronic converter of gas consumption

Using of frequency signal as information parameter of primary converter is characterized by high noise immunity, simplicity and accuracy of the conversion into digital code, as well as convenience of switchings in multichannel measuring systems. Microelectronic converter of gas consumption, realized on the base of self-excited device with active inductance of oscillatory circuit, implemented on transistor structure with negative resistance. Electric circuit of microelectronic converter of gas consumption is shown in Fig.1.

The device consists of [2] two bipolar transistors VT1 and VT2 that form the tank capacitance and bipolar transistor VT3 with RC-circuit, that creates inductive impedance of oscillatory circuit. Sensitive elements are transistors VT1, VT2, VT3, that enables to improve the sensitivity of the converter.

Active and reactive components of input impedance, that are needed for determination of conversion function, are defined on the basis of equivalent circuit (Fig. 2), constructed on the base of electric circuit (Fig. 1).

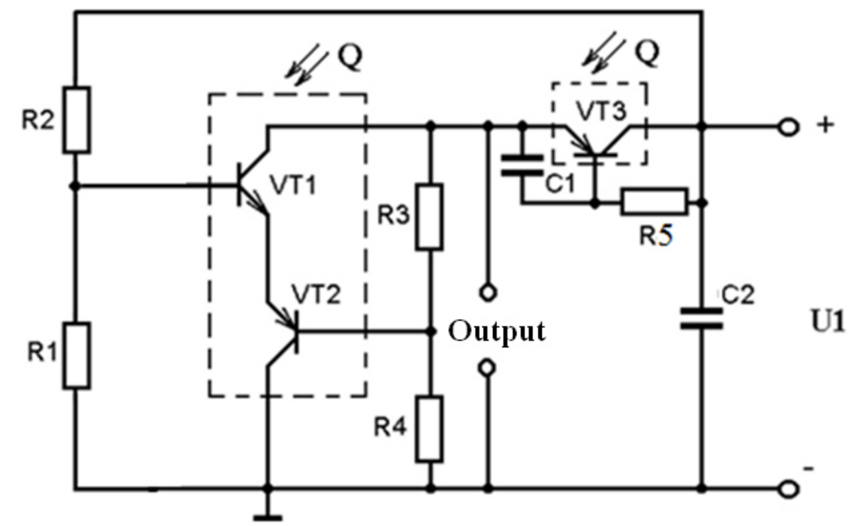

Fig. 1. Electric circuit of microelectronic converter of gas consumption with active inductive element

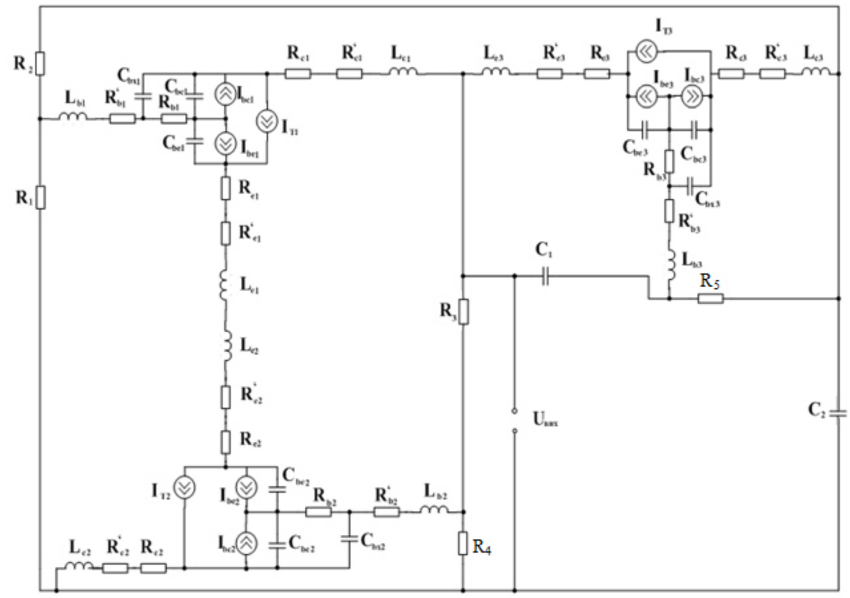

Fig. 2. Equivalent circuit of the converter on the basis of two bipolar transistors with active inductive element

Parameters of equivalent circuit elements and their values are taken from the literature [3].

Fig. 3 shows theoretical dependence of active component on the expenses at various values of control voltage. Increase of control voltage from 2.1 to 2.3 V leads to the increase of active resistance, at value U_1=2,2 V it has almost linear dependence.

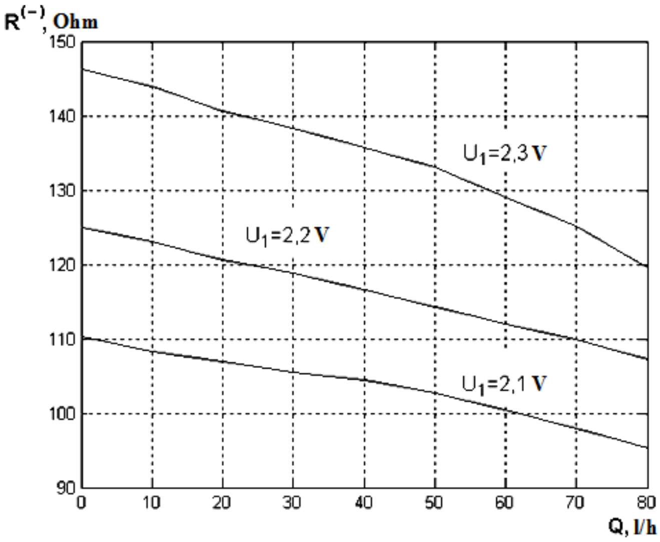

Fig. 3. Theoretical dependence of active component of output impedance on expenses

Fig. 4 shows theoretical dependence of reactive component of the impedance on the expenses. It is seen from the graph that with the increase of U_1 from 2.1 V to 2.3 V reactive component increases and at increase of expenses it decreases, whereas at U_1=2.2 V it has linear character.

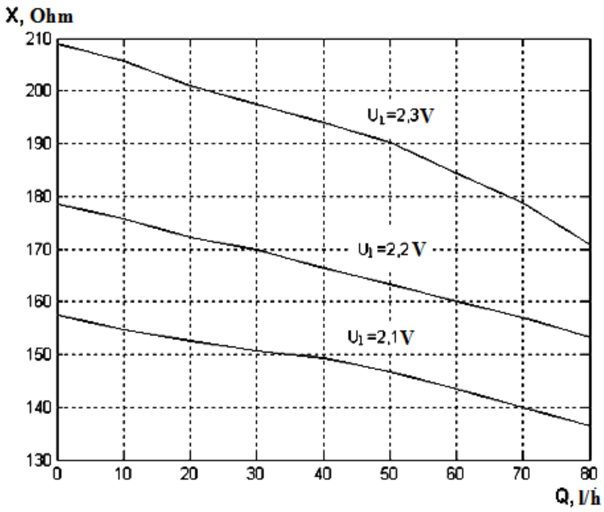

Fig. 4. Theoretical dependence of reactive component of output impedance on expenses

Fig. 5 shows the dependence of equivalent capacitance on expenses at different control voltage. It is seen from the graphs, that the equivalent capacitance decreases with the increase of control voltage.

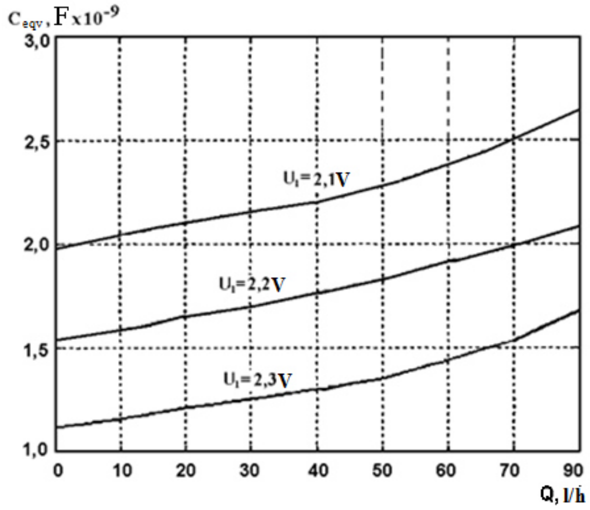

Fig. 5. Theoretical dependence of equivalent capacitance on expenses

Fig. 6 shows theoretical and experimental dependences of generation frequency on gas consumption. As it is seen from the graph, linear dependence for transfer function may be obtained, if control voltage is U_1=2.2 V.

Dependence of generation frequency on gas consumption, i.e., transfer function, is defined by the expression:

$$F_0 = \frac{1}{2\pi R^{(-)}(Q)C_{eqv}(Q)}\sqrt{\frac{R^{(-)2}(Q)C_{eqv}(Q)}{L} - 1}, \qquad (1)$$

where $R^{(-)}$ -active component of output impedance; C_{eqv} - equivalent capacitance of oscillatory circuit of the generator, that is determined on the base of reactive component X of output signal; *L* – value of active inductance.

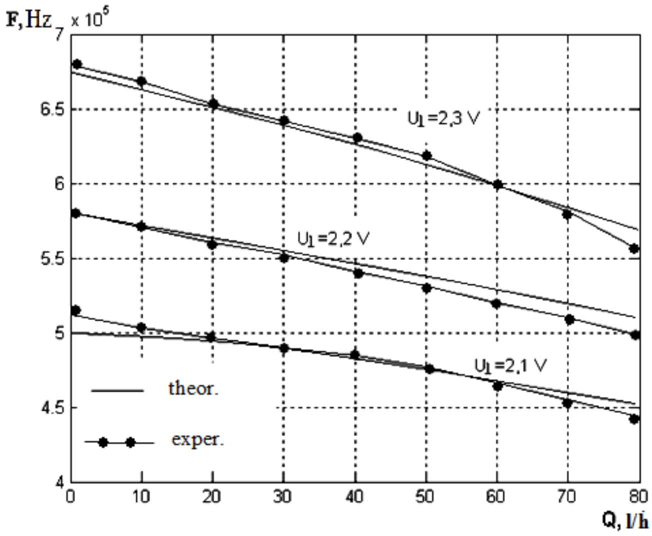

Fig. 6. Theoretical and experimental dependences of generation frequency on gas consumption

Sensitivity of the converter is defined on the base of the expression (1) and is described by the equation:

$$S_Q^{F_0} = \frac{\partial F_0}{\partial Q} = -\frac{1}{2\pi R^{(-)}(Q)C_{eqv}(Q)}[\sqrt{\frac{R^{(-)2}(Q)C_{eqv}(Q)}{L}-1}\,\frac{\partial R^{(-)}(Q)}{\partial Q} + \frac{1}{C}\sqrt{\frac{R^{(-)2}(Q)C_{eqv}(Q)}{L}-1}\,\frac{\partial C_{eqv}(Q)}{\partial Q} -$$
$$-\left(2L\sqrt{\frac{R^{(-)2}(Q)C_{eqv}(Q)}{L}-1}\right)^{-2}\left(2R^{(-)}(Q)C_{eqv}(Q)\frac{\partial R^{(-)}(Q)}{\partial Q} + R^{(-)2}(Q)\frac{\partial C_{eqv}(Q)}{\partial Q}\right)]. \qquad (2)$$

Graph of sensitivity dependence is shown Fig. 7.

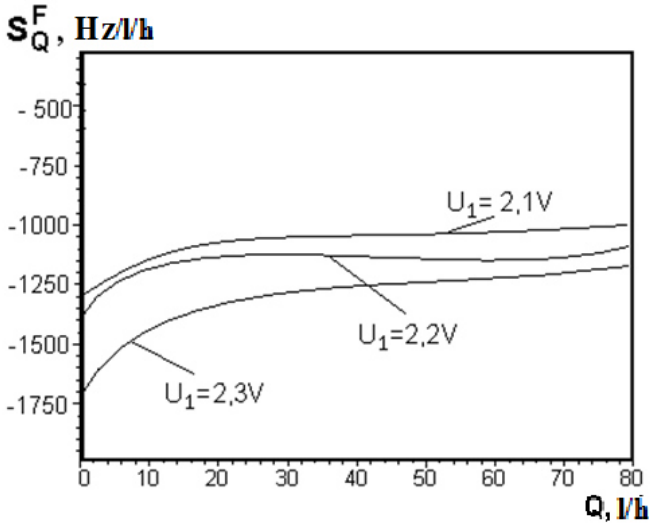

Fig. 7. Dependence of sensitivity on gas consumption

In accordance with the graph, the highest sensitivity of the device is within the range from 0.1 to 25 l/h and is1000-1750 Hz/(l/h).

Conclusions

Scheme of microelectronic converter of gas consumption on the base of two bipolar transistors with active inductive element is suggested. It realizes autogenerator device, where consumption of gas is converter into output frequency signal. Analytical expressions of transfer function and sensitivity equation are obtained. Sensitivity of the device changes in the range from 1000 Hz/(l/h) to 1750 Hz/(l/h).

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