# Multifrequency Core Structure of an Invariant Quartz Oscillatory System

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*Abstract* – **The structure of multifrequency quartz oscillatory system, which is a core of invariant piezoelectric system, where two functions are combined: stabilization of oscillations and current identification of quartz condition**.

*Key words* - **multifrequency quartz oscillatory system, invariant piezoelectric system, identification**

## I. Introduction

High efficiency of a multifrequency mode of oscillations is provided under condition of their high stability. It is possible only at use of filter schemes of multifrequency quartz oscillatory systems (MQOS). Inclusion of the quartz resonator in a feedback chain that provides its oscillation on frequencies of relatives to own consecutive resonances is feature of the given schemes. The multifrequency mode of oscillations is a basis for construction of invariant quartz systems, where two functions are combined: stabilization of oscillations and current identification of its condition [1].

## II. Core Structure of a Multifrequency Quartz Oscillatory System

The core structure includes multifrequency system on the basis of the multifrequency quartz resonator (MQR) and n channels of maintenance of oscillations on the basis of generalized nonlinear element NE$_i$, $i=\overline{1,n}$ and a nonlinear network of feedback (fig. 1). For stabilization of operational mode NE are enveloped by a circuit of autobias with complex equivalent resistance $z_{abi}$ .

Nonlinear networks of a feedback (FB) with a transfer factor $K_{ji}\left(u_{\Sigma}, jw, \tau\right)$, $j=\overline{1,m}$ ; $i=\overline{1,n}$ have multifunction assigning. The basic function – the task of necessary amplitude - phase parities in excitation channels. Besides, FB networks provide essential decrease in a competition of oscillations at the expense of own selective properties and automatic control of amplitude for determination of the maximum power capacity of dispersion on MQR.

In a fig. 1 the following designations are entered also:

$z_{in_{\Sigma}} = R_{in_{\Sigma}} \Big/ \left(1+jw\tau_{in_{\Sigma}}\right)$, $z_{out_{\Sigma}} = R_{out_{\Sigma}} \Big/ \left(1+jw\tau_{out_{\Sigma}}\right)$ – complex equivalent input and output resistance;

$z_{ab_i} = R_{ab_i} \Big/ \left(1+jw\tau_{ab_i}\right)$ – complex resistance of autobias; $\tau_{in\,\Sigma} = R_{in\,\Sigma} C_{in\,\Sigma}$ , $\tau_{out\,\Sigma} = R_{out\,\Sigma} C_{out\,\Sigma}$ , $\tau_{ab_i} = R_{\grave{a}b_i} C_{\grave{a}b_i}$ – constants of time;

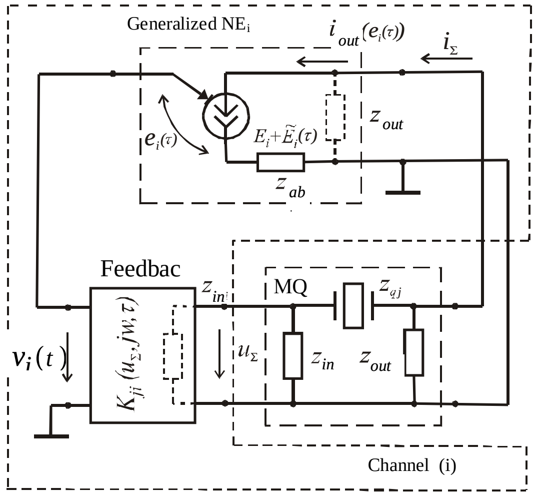


Fig.1. Core structure of MQOS

$R^{-1}_{in_{\Sigma}} = \sum_i R^{-1}_{in_i}$ , $R^{-1}_{out_{\Sigma}} = \sum_i R^{-1}_{out_i}$ and $\tilde{N}_{in_{\Sigma}} = \sum_i \tilde{N}_{in_i}$ , $\tilde{N}_{out_{\Sigma}} = \sum_i \tilde{N}_{out_i}$ – total conductivity and capacity;

$e_i = V_{ji} + E_i + \tilde{E}_i$ – control voltage on an input NE$_i$, where $E_i$ , $\tilde{E}_i$ – constant and variable components of autobias; $u_{\Sigma}\left(\tau\right) = U_0(\tau) + \sum_j U_j(\tau) \cdot \cos[w_j t + \phi_j(\tau)]$ – total voltage on exit MQR; $i_{\Sigma} = \sum_i i_{out_i(e_i)}$ – total current.

Precision MQR is usually used in a mode of small currents. Then its nonlinearity can be neglected:

$$z_{q_j} = \frac{1}{wC_0} \frac{(1-\xi_j^2) + j\delta_j}{\delta_j + j(\xi_j^2 - (1+m_{q_j}))}, \; j=\overline{1,m}, \qquad (1)$$

where $\xi_j = w_j / w_{q_j}$ , $\delta_j = 1/Q_j = wR_{q_j} C_{q_j}$ – relative detuning and attenuation for j - that frequency [1].

## III. Conclusion

Offered the core structure is a basis of mathematical model of multifrequency quartz oscillatory system technically invariant to influence of temperature and vibrating destabilizing factors.

## References

[1] Kolpakov F., Pidchenko S. (2011). *Theory and fundamentals implementation of invariant piezoresonance systems*, National Aerospace University (KhAI), ISBN 978-966-662-222-1, Kharkov, Ukraine, 327 p.

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