The Method of Controlling the Frequency of Piezoelectric Oscillators and Filters Using the Direct Control of the Resonator

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Abstract - **This paper presents methods of direct frequency control of generation radio equipment and the signals selection devices by means of direct effect on the piezoelectric element.**

Keywords – **the self-excited oscillator, the filter, the piezoelectric resonator, an interelectrode gap, a graded-index field.**

I INTRODUCTION

Oscillators and frequency filters with adjustable frequency and high frequency stability are necessary for all communication systems, radar, radio navigation, radio communications, radio engineering measurements.

Traditionally, the frequency control in oscillators and filters performed by using varicap, which has a limited range of capacity control and brings noise in the generators output signal. Is topical the exclusion varicap from the frequency control circuit of oscillators and filters, and searching for realizable methods of direct frequency control of frequency defining element - crystal.

II MAIN PART

We consider methods frequency control quartz resonator by means of direct influence on piezoresonance system - mechanical, thermal, and thermodynamic influences on the crystal, by varying mass loading and acoustic load, influence on piezocrystal electric and magnetic fields, varying the geometrical dimensions of the electrodes. Among the possible methods chosen two technically feasible control methods: for extended control range - change the interelectrode gap between one of the electrodes and the surface of the piezoelectric crystal, for minor frequency and phase changes - control of a graded-index field piezo resonance system.

Fig. 1 shows a diagram of a quartz oscillator based on piezoresonance system with controlled interelectrode gap.

For the basic circuits of transistor self-excited oscillators - frequency generation on foundation [1],[2] is defined by expression:

$$f_{\Gamma\Phi}(\tilde{o}) = \frac{1}{2(2h)}\sqrt{\frac{c_{66}}{r}}\left(1-\frac{4(2h)k_{26}^2 e_0}{p^2(2e_0 h+e_{22}x)}\right) \qquad (1)$$

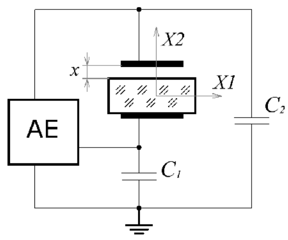

Fig.1 Quartz oscillator based on piezoresonance system

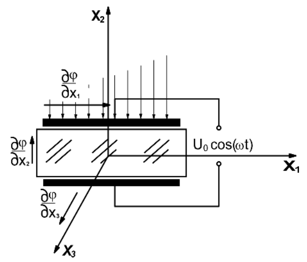

Fig. 2 Piezoelectric plate with the gradient field.

When changing values of the interelectrode gap x between 0 … 100 microns frequency tuning reaches $(5…6)\times10^{-3}$. The disadvantage of this method is limited rate of change of the modulation signal.

Fig. 2 shows controlling graded-index electric field of the piezoresonator. Thus value of resonance frequency can be found from system of equations:

$$\begin{cases} m\frac{\partial^2 U_1}{\partial x_2^2}+m\frac{\partial^2 U_1}{\partial x_3^2}-e_{11}\frac{\partial^2 j}{\partial x_2^2}-e_{14}\frac{\partial^2 j}{\partial x_2 \partial x_3}=r_o\frac{\partial^2 U_1}{\partial t^2}, \\ e_{11}\frac{\partial^2 U_1}{\partial x_2^2}+e_{14}\frac{\partial^2 U_1}{\partial x_2 \partial x_3}+e_{11}\frac{\partial^2 j}{\partial x_2^2}=0. \end{cases} \qquad (2)$$

For a given control method the frequency tuning is possible up to 10^{-7}. The lack of this method - the small range of frequency tuning.

III CONCLUSION

Proposed methods of frequency control radio engineering devices with quartz frequency fixing: for the increased frequency tuning - managing value of the interelectrode gap, for small ranges of regulation frequency - managing the gradient field piezoresonance system.

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