Frequency-Compensated Piezoresonance Oscillator System with External MEMS Control

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Abstract – **the paper represents piezoresonance oscillator system with external control based on MEMS – capacitor, which provides frequency compensation of low quality loading influence on high quality quartz resonator due to setting optimal electrical connection between them.**

Key words - **piezoresonance oscillator system, frequency control, MEMS – capacity, measuring transducer**

I. INTRODUCTION

The piezoresonance oscillator systems (POS) are widely used in measuring instruments as high-precision primary measuring transducers (PMT) with frequency output [1]. The high quality quartz resonator (QR) as the component of such POS normally works in low quality load mode and frequency control is performed with varicap. Such type of control has some disadvantages which are increasing level of phase noise, reducing quality-factor, worsening signal harmonic composition due to non-linearity of controlling component, and also actual problem of micro-electronic varicap release on high-integration crystals. Most of these disadvantages can be avoided by using controlled MEMS - capacitors in this type of POS.

II. THE GENERAL FREQUENCY - COMPENSATED POS STRUCTURE

The general structure of frequency compensated POS (FCPOS) (see fig. 1) consists of auto-generator (active part, quartz resonator, loading and MEMS – capacity) that provides continuous oscillations in the system and in the circuit of digital frequency compensation (quartz frequency detector, microcontroller with analog – digital converter). The special structure of high-frequency MEMS – capacity provides its discrete control, which can be conducted as by varying controlling voltage on the separate elementary electrode U_{contr_i} so by changing the total amount of matrix elementary electrodes N_{electr} connected into the electrical circuit. This solution allows obtaining practically any law for capacity control at essentially less noise level compared with electron-adjustable capacity in varicap [2].

By means of digital frequency compensation it's set (maintained) the optimal relation between high-quality quartz resonator and low quality loading by passive part circuit of the auto-generator. It allows compensating influence of loading parameters on generating frequency $f_{out}(U_{out})$.

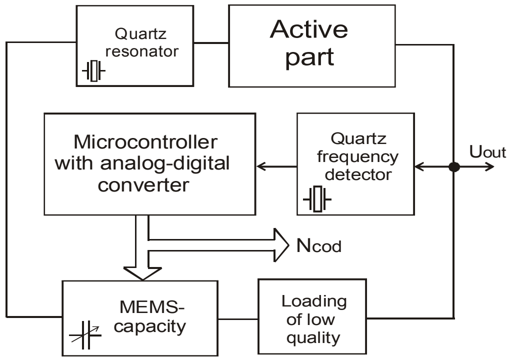

Fig.1 The general FCPOS structure

Using FCPOS as POS, digital control signal N_{cod} is coming up as informative one directly related to changing characteristics of auto-generator passive part circuit effected by one of the measured values. Then choice of FCPOS parameters is made with respect to non-linearity minimum criteria $\vartheta_{N_{cod}}$ of the control discrete characteristic N_{cod} :

$$\vartheta^{opt}_{Ncod} = \min_{X \in D_x} \vartheta_{Ncod}\left(\bar{x}_{load}, C_{MEMS}(\bar{U}_{contr}, N_{electr})\right); \quad (1)$$

$$D_x = \left\{\bar{x}_{load} \in \Re^2 : x_{load\, j_{min}} \le x_{load\, i} \le x_{load\, j_{max}}\right\},$$

where $\bar{x}_{load} = \left(R_{load\,x}, C_{load\,x}\right)^T$ - circuit equivalent parameters of the low quality loading.

III. CONCLUSION

In the paper it has been represented the new class of frequency measuring transducers on the base of POS with external MEMS control, in which the compensation of detrimental effect of low quality loading on high-quality QR has been provided herewith the digital signal of the compensator is the output informative signal of measuring transducers.

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