Simulation of System Phase-Locked-Loop Frequency Control

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Abstract – **In this paper purposed method of determining the reaction to the PLL input actions, which allows us to investigate the filter properties of the system as the mathematical modeling of the reference and output signals, and when using the real signals from their analog to digital conversion.**

Keywords - **phase-locked-loop frequency control, transfer function, discrete Fourier transform, frequency fluctuation.**

I. INTRODUCTION

Signal radio systems for various applications, including systems for time synchronization and frequency, wide use of a phase-locked loop (PLL). At the same tasks assigned to the PLL is active tracking reference signal filtering with simultaneous multiplication (division) of the frequency

II. INTRODUCTION FOR AUTHORS

Consider the PLL, the mathematical model describe in Fig.1, and input action in the form [1]

$$X(t) = (w_{ref} - w_{vco} / n) + n(t) - \Delta w_{vco}(t) / n\,,$$

where $(w_{ref} - w_{vco} / n)$ - is entry frequency instability of voltage control oscillator about reference signal frequency; $n(t)$ - frequency fluctuation of reference signal; $\Delta w_{vco}(t)$ - frequency fluctuation of voltage control, n - coefficient of frequency dividing in feedback circuit.

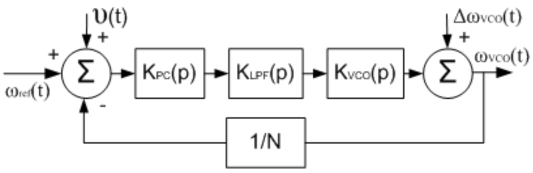

Fig. 1 The simulator of system

Developed the following method of determining the reaction of the PLL to the input action $X(t)$.

Analytically or as result of analog-digital conversion are determined by sampling the input signal amplitude $U(t)$ and as a result of the discrete Fourier transform (DFT) are the real and imaginary parts of the spectral components of the signal. Real and imaginary parts of the spectral components of the reconstructed signal are determined by multiplying them by the transfer characteristic of the band pass filter $K_F(jw)$. The reverse DFT arrays are formed of the real $a(i)$ and imaginary $b(i)$ values of the amplitude of the signal corresponding to the current value of the phase of which are from the expression: [2]

$$j(i) = arctg\left[b(i)/a(i)\right].$$

Comparing these values with the values of the phase fluctuations of the undistorted in i means $j_{ref} = f_s i\Delta t / f_T$, where $\Delta t = \tau_i / N$; $i=0,1,2\ldots N$, obtain the instantaneous phase deviation of the input signal from the desired values $dj(i) = j(i) - j_i(i)$.

After DFT, we get real and imagine spectral components of phase fluctuations:

$$g_{dj}(j) = \mathrm{Re}\left\{G_{dj}(j)\right\} = \sum_{i=0}^{N-1} dj(i)\cos\frac{2p\,ji}{N},$$

$$q_{dj}(j) = Jm\left\{G_{dj}(j)\right\} = \sum_{i=0}^{N}\left[-dj(i)\sin\frac{2p\,ji}{N}\right].$$

Multiplying the corresponding values of the spectral components of the phase deviation in the frequency analysis, we obtain the values of the spectral components of frequency deviations.

$$g_f(j) = g_{dj}(j)F_j\,, q_f(j) = q_{dj}(j)F_j.$$

The fluctuation components in signal spectrum are:

$$g_f^{/}(j) = \mathrm{Re}\left\{G_{d\,f}^{/}(j)\right\} = g_f(j)\,\mathrm{Re}\left\{W(j)\right\} - q_f(j)Jm\left\{W(j)\right\},$$

$$q_f^{/}(m) = Jm\left\{G_{d\,f}^{/}(j)\right\} = g_f(j)Jm\left\{W(j)\right\} + q_f(j)\,\mathrm{Re}\left\{W(j)\right\},$$

where $W(jw)$ - is transfer function of phase-locked-loop frequency control system.

As a result ODPF, that is, the transition into the time domain, we obtain the corresponding instantaneous values of the fluctuation frequency of the output signal due to the instability of the input signal frequency

$$n^{/}(i) = \frac{1}{N}\sum_{j=0}^{N-1} G_{d\,f}^{/}(j)e^{j2p\,ji/N}.$$

If input signals are additive, the result will be sum of obtained partial solutions.

III. CONSULTION

The developed method allows to determine the amplitude and spectral distribution of the fluctuation components in the spectrum of the output signal is controlled oscillator, which is crucial for the performance evaluation of time-frequency synchronization.

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