ISSN 0735-2727, Radioelectronics and Communications Systems, 2009, Vol. 52, No. 3, pp. 150–153. © Allerton Press, Inc., 2009.
Original Russian Text © V.F. Tunik, 2009, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2009, Vol. 52, No. 3, pp. 56–61.

# Calculation of Self-Tuning Process of Frequency Filters in Mathcad System

**V. F. Tunik**

*Dnipropetrovs'k National University of Railway Transport (DIIT), Dnipropetrovs'k, Ukraine*

Received in final form December 17, 2007

**Abstract**—On a basis of theory of automated following the frequency of input signal systems in dynamic mode we have obtained analytical expression for transient frequency of general frequency filters tuning. As a result we have proved a possibility of MathCAD application for filter self-tuning process. Taking into account known features of non-stationery process active spectrum, we have obtained another possibility of mentioned calculations. We propose an algorithm for these calculations for general filters. We note that known problem of mathematical analysis of general following filters is solved.

**DOI:** 10.3103/S0735272709030066

## PROBLEM STATEMENT

Now it is known [1] mathematical tool for description of processes in automatically controlled following the frequency of input signal second order filters (FF). But these filters follow the frequency of input signal only up to signal capture initial time point and after self-tuning process end. In paper [2] it is mentioned that mathematical tools for strong analysis of FF self-tuning process is already insufficiently developed. Thus, it is necessary to carry out researches [1, 2] of mentioned process, using FF mathematical model. Although these researches results have proven exactly some theoretical statements, they cannot be regarded as sufficient even for second order filters due to great amount of idealization, using in mathematical model.

Thus, mathematical analysis of self-tuning process of FF and, hence, AFF system [3] is still an essential problem. This problem is difficult for the second and higher order filters. But it can be solved with help of MathCAD system. So, the problem is stated as a problem of analytic expression of transient process for filters adjustment frequency. Then substituting this expression into differential equation coefficients, corresponding to given transient function of specific FF, we can use for this equation solution a computing unit Given-Odesolve. Obtained solution function can be used for further analysis, for example, for spectral analysis. Application of this analytical expression as variable parameters, appearing in FF transient function, allows to build with MathCAD different three-dimensional charts of its dynamic frequency characteristics.

## A PROCESS OF FREQUENCY MODIFICATION OF FF STATIC SYSTEM

To solve stated problem we suppose FF signal input is fed only with harmonic voltage source $u_1(t)$ with frequency $\omega_1$. This influence can be considered analogously to [3] as this frequency jump from zero up to $\omega_1$ at general filter input, which is a part of FF. Therefore, investigation results in [3] can be used without proof. It is only necessary to substitute letter values $\Delta f_s$, $\Delta f_g$, and $\Delta f$, which are used in [3], on used here $\Delta\omega_{ini}$, $\omega_{cnt}(t)$, and $\Delta\omega(t)$, correspondingly.

Here $\Delta\omega_{ini} = \omega_1 - \omega_{ini}$ is initial frequency mistuning of FF according to frequency $\omega_1$, $\omega_{cnt}(t)$ is transient controlled frequency of FF self-tuning on frequency $\omega_1$, and $\Delta\omega(t)$ is current frequency mistuning according to frequency $\omega_1$.

Frequency $\omega_{ini}$ is low-pass filter (LPF) cut-off frequency or high-pass filter (HPF) cut-off frequency or central frequency of band-pass filter (BPF).

All mentioned above substituting frequencies are related with each other by following equation:

$$\Delta\omega(t) = \Delta\omega_{ini} - \omega_{cnt}(t). \tag{1}$$