ANALYSIS AND SYNTHESIS OF A POLYHARMONIC SIGNAL IN NONLINEAR MICROWAVE AMPLIFIERS

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The successful solution of numerous problems in electromagnetic compatibility of radioengineering systems, as well as satellite and tropospheric radio communications, depends to a considerable degree on progress in the field of analysis and synthesis of a multifrequency signal in nonlinear microwave amplifiers (see [1]).

The traditionally developed radioelectronics methods of description turned out to be ineffective and did not ensure the required accuracy of computation. This made it necessary to develop radioengineering methods which permit, without penetrating into the internal physical processes, operation solely with the output characteristics of the microwave amplifiers by treating them as certain nonlinear radioengineering devices. One such method is based on representing a nonlinear microwave amplifier by means of a mathematical model in the form of a typical radioengineering component (TREC).

The present work has demonstrated the possibility of using TREC as a means to solve a number of problems in the analysis and synthesis of polyharmonic signals using as an example the investigation of the amplification of a monochromatic signal against the background of several regular waves having arbitrary amplitudes and frequencies. Arbitrarily, the harmonic waves arriving at the input of the amplifier at all frequencies except the fundamental frequency may be treated as regular interferences.

In order to be specific, the characteristic of the instantaneous values of an inertialess nonlinear element (INE) is stipulated in the form of the exponential series

$$y(t) = \sum_{s=0}^{\infty} \alpha_s \exp(\beta_s x(t)), \tag{1}$$

where α_s, β_s are real numbers.

If the input signal is a sum of harmonic waves $x(t) = \sum_{n=1}^{\infty} X_n \cos(\omega_n t + \theta_n) = \sum_{n=1}^{\infty} X_n \cos\Phi_n$, among which the signal having the amplitude X_1, the frequency ω_1 and the phase θ_1 may be treated as the useful signal, while the remaining signals are considered to be harmonic interferences, it follows that at the output of the INE the value of the amplitude of each of the spectral components of the waves may be determined according to the formula

$$Y_m = 2\sum_{s=0}^{\infty} \alpha_s I_{m_1}(\beta_s X_1)\, I_{m_2}(\beta_s X_2) \ldots I_{m_k}(\beta_s X_k) \ldots, \tag{2}$$

where I_{m_k} are modified Bessel functions; m is the order of the combination frequency $\omega_m = m_1\omega_1 + \ldots + m_k\omega_k + \ldots$ $(-\infty < m_i < +\infty)$.

From Eq. (2) it is not difficult to derive the expression for the amplitude response

$$Y_1(X_1) = 2\sum_{s=0}^{\infty} \alpha_s I_1(\beta_s X_1). \tag{3}$$

Having used the expansion of the modified Bessel functions into series in Eq. (2) and having compared the resulting expansions with the expansion (3), we find the value of the amplitude of the useful signal at the output of the INE with an accuracy of up to the fifth power for the condition that the (n - 1)-th harmonic interference appears at the

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