

Intermodulation in Series Balanced Circuits of Field-Effect Transistor Amplifiers

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Abstract—Techniques for the reduction of intermodulation distortions at the expense of compensation in broadband multistage amplifiers with p - n junction field-effect transistors have been investigated. Different series and balanced amplifying structures and their combinations were considered; for each amplifier the conditions of compensating the intermodulation products of the second and third orders were obtained. This formed the basis for establishing and implementing the possibility of compensation of input intermodulation interferences in the amplifier with balanced connection of nonlinear stages. The compensation effect was corroborated by experiment.

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INTRODUCTION

Intermodulation interferences of the second and third orders are a widespread kind of interferences in the input stages of radio receivers. The heightened interest to this subject is related to the fact that these additionally formed products get into the reception band of useful signal and together with the useful signal undergo further processing that finally results in the distortion of received information.

A possibility exists that allows us to reduce nonlinear distortions in stages of a radio receiving equipment using the effect of compensation of intermodulation products. This method can be used both in the case of intermodulation and for the suppression of harmonics of useful signal.

In particular, papers [1, 2] deal with investigations of the optimization of a radio receiver with transistor stages, where the conditions for compensating the nonlinearity products of the second and third orders have been found. The compensation of the third order intermodulation distortions in the low-noise amplifier–mixer circuit was considered in paper [3]. The same effect was achieved as a result of the optimization of series and parallel structures [4].

This paper considers the method of compensation of the second and third order intermodulation components in series and balanced amplifying structures and also the device for suppression of the specified interferences. The results of experimental investigations are also presented.

COMPENSATION IN SERIES STRUCTURES

The compensation is always related to the appearance of at least two products having equal frequencies but opposite phases. The compensation can be complete or partial depending on the accuracy of compliance with amplitude and phase conditions. The generation of counterphase products of nonlinearity involves the need of at least two nonlinear elements or devices with nonlinear elements. As an example, we can take the circuit of amplifier with series connection of stages (Fig. 1).

The following designations are introduced in Fig. 1: AS1 and AS2 are the amplifying stages, A is the attenuator. These stages possess a broad amplification band, and the amplification of high intensity signals may lead to the generation of a variety of higher multiple and combination frequencies.

As follows from paper [1], the selection of inverting amplifying stages with the common source (CS) connection leads to the generation of antiphased products of the second order nonlinearity in case of the single-frequency input, i.e., for such stages the phase condition of compensation is satisfied. The required values of amplitudes of all components at the fundamental and multiple frequencies are set by using the interstage attenuator and the appropriate selection of the operation mode of stages [5].