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CALCULATION OF AMPLITUDE RESPONSE OF AN AMPLIFIER STAGE OPERATING UNDER COLLECTOR CURRENT CUTOFF CONDITIONS

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For investigation of the impact of initial bias of an amplifier stage under collector current cutoff conditions on linearity of its amplitude response, the author proposes to use the accuracy of the polynomial model of the stage transfer function and to study the opportunities for unlimited expansion of the approximation domain of the threshold model. The results of theoretical and experimental investigations are presented.

In accordance with the State Standards [1, 2], the amplitude response of band-pass power amplifiers for TV transmitters has to be linear in the input signal dynamic range no less than 40 dB. In practice this goal can be attained by optimal selection of the base bias of the output transistor in the band-pass power amplifier operating in the AB conditions [3–6]. Within the known nonlinear models of transistors under the collector current cutoff conditions [7–13], it is hardly possible to investigate the impact of the base bias of the transistor on linearity of the amplitude response of the stage with such transistor in it.

However, the inquiry can be performed if we combine the issue of polynomial model accuracy [14–18] with the possibility for unrestricted expansion of the approximation domain of the threshold model [7, 8, 10] while using the cutoff polynomials [19–21]. After expanding the boundaries of instantaneous values of signal source e.m.f. e_g, and instantaneous values of output voltage u_{out}, defined by the polynomial model, we perform approximation of the relation $u_{out} = f(e_g)$ in a new domain of these values with the aid of high-power polynomials with complex coefficients [14–18] such as

$$u_{out} = \sum_{n=1}^{N} (a_n + jb_n) e_g^n. \quad (1)$$

With the coefficients a_n and b_n known, the issue of how the selection of the base bias of a transistor in the cutoff conditions affects the linearity of the amplitude response of an amplifier stage, presents no difficulty [14, 19] and can be resolved with the use of trigonometric functions of a multiple argument.

Figure 1 shows the results of experimental and theoretic investigations of the relation between the shape of amplitude response of a band-pass amplifier stage (Fig. 2) and the transistor base bias value at input drive frequency 180 MHz, where E_g is the amplitude of the signal source e.m.f., and U_{out} is the amplitude of the first signal mode across the load.

The initial polynomial model in the computer-aided analysis program used is prepared based on provisions given in [17]. The approximation of the transfer characteristic within new bounds of the e_g and u_{out} instantaneous values is carried out by the least-square method applied to the 20th order polynomial of type (1). The choice of approximation nodes in this case is performed with account of recommendations presented in [19].

The amplifier stage under consideration has the following linear characteristics: small-signal transfer factor from the generator to the load, i.e., $K_u = U_{out}/E_g$ = 19 dB; operation frequency band — 160 to 190 MHz; AFR nonuniformity —

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