NONLINEARITY CHARACTERISTICS OF SELECTIVE AMPLIFIERS BASED ON NEGATIVE-FEEDBACK TRANSISTORS

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Izvestlya VUZ. Radioelektronika,
Vol. 33, No. 7, pp. 89-92, 1990

UDC 621.396.62

Among the definitive amplifier parameters characterizing the efficiency of amplifier application under conditions of a complex electromagnetic environment (EME) are the nonlinearity parameters of the active devices. In order to reduce the latter, extensive use is made of resistive negative feedback (NFB) (see [1]). The minimum values of the nonlinearity parameters which can be achieved in engineering practice when implementing NFB are of interest.

The second-order nonlinearity parameter p_2 is defined as the ratio between the first derivative S′ of the transconductance and the transconductance S of the active device.

The third-order nonlinearity parameter p_3 is defined as the ratio between the second derivative S″ of the transconductance and the transconductance S.

Resistive NFB introduced in accordance with Fig. 1 changes the parameters of the active device. Let us find these parameters on the assumption that the static characteristic of an inertialess active device is known:

$$i = f(u). \tag{1}$$

The static parameters of an active device without NFB are defined as $S = di/du$; $S' = d^2i/du^2$; $S'' = d^3i/du^3$. The values of the nonlinearity parameters in the presence of NFB are $S_1 = di/du_1$; $S'_1 = d^2i/du_1^2$, $S''_1 = d^3i/du^3$ and may be obtained by differentiating Eq. (1) with respect to u_1 with allowance for the fact that

$$u = u_1 - iR \tag{2}$$

$$i = f(u_1 - iR). \tag{3}$$

Equation (3) is an implicit function of u_1, but Eqs. (1), (2) allow the nonlinearity parameters of this function to be determined using the well-known relationships $di/du_1 = (di/du)(du/du_1)$; i.e.,

$$S_1 = S\,(du/du_1). \tag{4}$$

Differentiating Eq. (2) with respect to u_1, we obtain $du/du_1 = 1 - (di/du)\ (du/du_1)\,R$ or $du/du_1 = 1 - SR(du/du_1)$; thus,

$$du/du_1 = 1/(1 + SR), \tag{5}$$

and then Eq. (4) will be come

$$S_1 = S/(1 + SR). \tag{6}$$

By analogy, we find

$$S_1' = (dS_1/du)\,(du/du_1) = S'/(1 + SR)^3. \tag{7}$$

Equations (7), (6) define the second-order nonlinearity parameter in the form $p_{21} = S'/S(1+SR)^2$, where p_{21} is the

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23 October 1989