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SYNTHESIS OF ASYMMETRICAL FILTERS WITH REGARD FOR DISSIPATIVE LOSS

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A method is suggested for synthesis of asymmetrical filters with regard for dissipative loss. The generalized approach, free from many limitations inherent in traditional methods of filter synthesis, makes it possible to expand considerably the domain of analytical solutions in respect of synthesis of asymmetrical selective devices.

In a number of problems of design of selective devices, there arises a necessity in matching the electric network to a complex load — to assure minimum reflection of signal from the filter input in a band of operation frequencies and minimum loss of the signal transferred to the load. In the network synthesis we set beforehand the shape of amplitude-frequency response (AFR) and the intrinsic attenuation of the resonant loops d_{0i}, referred to the operation band of frequencies x_b, i.e., $d_{0i}/x_b = D_{0i}$ ($i = 1, 2, 3, ..., n$), where

$$x_b = \left(\omega_{b2} - \omega_{b1}\right) / \sqrt{\omega_{b2} \cdot \omega_{b1}}, \tag{1}$$

while $\sqrt{\omega_{b1} \cdot \omega_{b2}} = \omega_0$ is the central frequency of the pass-band. AFR of a filter with approximation by Chebyshev's polynomial is shown in Fig. 1. Here $L(d)$ is the dissipative loss value, $L(h)$ is nonuniformity of AFR in the pass-band, and $L(c)$ is the filter attenuation in the rejection band.

This problem, as applied to ideal devices, has been resolved in [1], whence we can see that in devices, calculated with no regard to dissipative loss, in the case of complex-valued load $Q = (\omega_2 - \omega_1)CR$, the coefficient of reflection from the device input $|\Gamma| \geq e^{-\pi/Q_n}$. In the event of an ideal matching network, $|\Gamma| = e^{-\pi/Q_n}$. In our work we use $D_n = 1/Q_n$. The attenuation of the last resonant circuit with regard for dissipative loss can be expressed as $D_n = D_{0n} + D_L$ (here D_L denotes attenuation in the loop with a load referred to the working frequency band x_b).

The canonical chain networks used for synthesis of asymmetrical filters are presented in [4] (Fig. 2*a*, *b*). The matrices of realization functions corresponding to these networks are marked as (5) and (6) in the same paper. There $\xi = x/x_b$ is the relative, referred to x_b, frequency variable, where $x = \omega/\omega_0 - \omega_0/\omega$; $D_1 = D_G + D_{01}$; and D_G is attenuation, referred to x_b, which is introduced by the generator into the first loop of the filter. The relation between elements of equivalent circuits of the synthesized filters and the matrix entries is presented in Table 1 of [4].

The function of power transfer into the load of a filter consisting of n loops has the form

$$L(l) = 10\lg\left[4\left(D_1 - D_{01}\right)\left(D_n - D_{0n}\right)\left|\Delta_{1n}\right|^2 / \left|\Delta\right|^2\right] = 10\lg\left|S_{1n}\right|^2. \tag{2}$$

The function of reflection of power into the load of a filter consisting of n loops has the form

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