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SYNTHESIS OF PASSIVE BAND-PASS SYMMETRIC FILTERS WITH REGARD FOR DISSIPATIVE LOSS

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A new method is suggested for synthesis of passive symmetric filters based on prescribed value of dissipative loss and on a level of nonuniformity of amplitude-frequency response in the passband. The synthesis may also be conducted with regard for prescribed attenuation of resonant loops and nonuniformity of the amplitude-frequency response in the passband.

The design of microwave filters and other selective devices is often performed by the method of synthesis of ideal filters with the use of a low-pass filter prototype [1]. However, dissipative loss is not taken into account in such procedures.

In this paper we suggest a method of synthesis of passive symmetric band-pass filters with the use of two alternative sets of the design criteria: (a) a prescribed value of dissipative loss in the filter passband, nonuniformity and shape of the amplitude-frequency response (AFR), and (b) a prescribed value of intrinsic attenuation of resonant loops, nonuniformity of AFR in the passband, and the response shape.

The initial condition for resolving the task of synthesis of passive symmetric filters by a prescribed value of dissipative loss is the defining function [2]. The defining function $L(l)$ (i.e., the function of power transfer into a load) for synthesis of a passive filter represents the superposition of the value of dissipative loss $L(d)$ in the band of operation frequencies and of the frequency-dependent component $L(\omega)$ of the function:

$$L(l) = -L(d) - L(\omega) = 10\lg\left[1/(1+d^2)[1+h^2\cdot|f(\mathrm{j}\,\omega)|^2]\right],$$

where $d = \sqrt{10^{0.1\cdot L(d)} - 1}$ is the dissipative loss parameter; $h = \sqrt{10^{0.1\cdot L(h)} - 1}$ is the AFR nonuniformity parameter; $f(\mathrm{j}\,\omega) = F(\mathrm{j}\,\xi)/F(\mathrm{j}1)$ is the frequency-dependent component of the approximation function; $F(\mathrm{j}\xi)$ is the polynomial of the variable $\xi = x/x_b$; $x = \omega/\omega_0 - \omega_0/\omega$ is the detuning of the frequency ω with respect to the central frequency $\omega_0 = \sqrt{\omega_{b1}\,\omega_{b2}}$, $x_b = (\omega_{b2} - \omega_{b1})/\sqrt{\omega_{b1}\,\omega_{b2}}$ is the relative frequency detuning at the edge of the passband [3], where $|f(\mathrm{j}\,\omega_b)| = 1$ and $L(\omega_b) = L(h)$. In the rejection band $L(l) = L(c)$.

The defining function of a passive symmetric filter, characterizing the module of the function of power transfer into the filter load, is shown in Fig. 1.

Representation of the defining function as the product of the frequency-dependent component by a multiplier invariable in the operating band of frequencies, makes it possible to use the results of numerous works on synthesis of ideal filters and filters with dissipative loss. As can be seen from these works, for approximation of AFR of passive minimum-phase filters one may use the Hurwitz polynomials or their ratios [4]. The transfer functions in this case can be realized by networks in which the "ladder" segments contain a minimum of components (in Fig. 2: *a* — the parallel connection of filter loops; *b* — the series connection of the loops). Moreover, one and the same transfer function can be

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