SYNTHESIS OF MULTISTEP MULTICHANNEL DIRECTIONAL COUPLERS

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Multistep N-channel directional couplers based on multiconductor coupled lines have undoubted advantages compared with N-channel power dividers based on cascade-connected directional couplers having two coupled transmission lines. However, their application is prevented by the lack of any design procedure. The principles of the design of single-step multichannel directional couplers are described in [1], and the principles for designing two-step couplers are described in [2], while multistep directional couplers with identical side channels are described in [3]. In this paper the results obtained in [1-3] are extended to the case of directional couplers based on multiconductor coupled lines with an arbitrary number of steps and an arbitrary power distribution in the output channels.

We will represent the N-channel directional coupler in the form of a cascade connection of K sections of multiconductor coupled lines with arbitrary couplings in the system with respect to the input line with poles 1 and N + 1 (Fig. 1a). We will assume that there only T-modes in this system, and that there are no dissipative losses in the transmission lines. We will carry out the analysis for the case when an input line or screen is placed between the lines of the side channels (in this case the mutual capacitive coupling between lines 2, 3, ... N is negligibly small) [1]. These assumptions enable us to obtain expressions for the elements of the wave transmission matrix [T] and scattering matrix [S] in analytical form. In general, they are fairly complicated. It follows from these expressions that the necessary conditions for ideal matching at the input and ideal directivity of a multistep multichannel directional coupler is satisfaction of the following equations: $S_{11} = 0$ and $S_{N+i,1}=0$ $(i=2, 3, \ldots, N)$ for the individual steps. Investigations enabled us to establish that the synthesis of multichannel multistage directional couplers based on coupled transmission lines with Chebyshev or maximally flat transfer-attenuation characteristics can be reduced to the synthesis of an equivalent directional coupler based on two coupled transmission lines using the tables given in [4]. Then, the working attenuation and the operating frequency band of the equivalent directional coupler remain the same as in the initial directional coupler based on multiconductor coupled lines, and its transfer attenuation $C_{e\Sigma}$ is given by

$$C_{e\Sigma} = \left(\sum_{j=2}^{N} C_{j\Sigma}^{-1}\right)^{-1},$$

where $C_{j\Sigma}$ is the value of the transfer attenuation of the j-th channel C_{1j} at the center

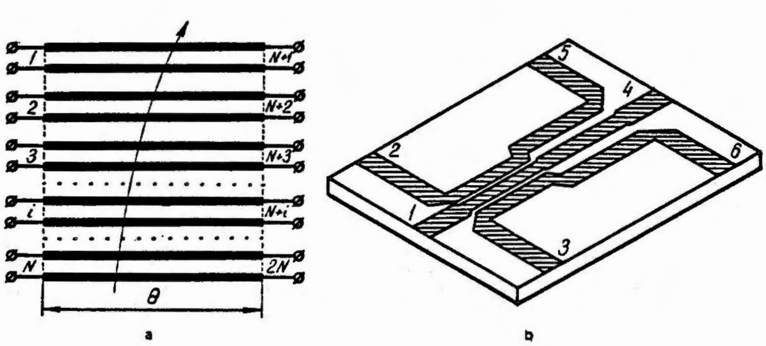

Fig. 1

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