Dual-Band Devices Based on Coupled Striplines for Different Power Distribution in the Frequency Bands

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Abstract—The approach to the development of dual-band power distribution devices with different power division ratios in different frequency bands, based on the method of a dual-frequency equivalent replacement, is considered in the article. For its implementation, an equivalent four-terminal network based on a section of coupled microstrip transmission lines is proposed in addition to the T- and Π-type circuits. Relations for calculating the electrical parameters of the circuit elements of these four-pole devices are obtained. The relations allow replacing the transmission line section with different values of the wave impedance in different frequency bands. The electrical length of such a section can vary and be different from π/2. Examples of modeling of non-equilateral power distribution devices with unequal branches such as two-channel balanced dividers and a ring divider (ring coupler) with power division coefficients of 2.0 and 1.0 in frequency bands with center frequencies of 2.0 and 3.6 GHz are given. Experimental measurement of characteristics of the designed models of the two devices showed good agreement between the experiment and the simulation results.

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The rapid development of modern wireless communication systems with several operating frequency bands, according to accepted standards, encourages the design of input channels using multi-band devices, which allows simplifying the structure of systems, to reduce size and cost. First of all, attention is paid to the development of dual-band microwave passive devices that provide specified values of operating parameters at different central frequencies (in general non-multiple) of the two operating bands. One of the problems that needs to be addressed in this field is the development of a method for the design of integrated dual-band balanced devices with defined distribution of microwave power in the frequency bands, which are important components of radio engineering systems and communication systems.

The problem of dual-band unequal branches (UB) power division has been considered in many studies [1–4], but the proposed methods are applicable for calculating two-channel dividers with the same division ratios in both frequency bands. Different power division in the operating bands was considered only for several options of stub directional couplers [5–7] and a ring bridge [5].

In most cases, for the implementation of dual-band power dividers, single-line sections are used, loaded with open or shorted stubs, which often leads to a narrowing of the operating bands of the device. In order to make more wideband device, as well as to reduce its size, a number of studies [4, 8, 9] consider dual-band UB two-channel dividers on the basis of sections of coupled microstrip lines. However, the proposed methods of calculation concern only the division ratios equal in both bands. It does not take into account the difference in phase velocities between the even and odd modes of the associated microstrip lines, which has a significant effect on the characteristics of the device.

In addition, authors in study [9] consider a structure on the basis of coupled lines loaded only with a short-circuited stub, and without sections of single transmission lines, which complicates the construction of the divider. In [8], the sections of the transmission lines are used, however their larger length, equal to the length of the coupled lines, increases the dimensions of the device and degrades its characteristics.

Therefore, the development of analytical methods for calculating dual-band devices based on sections of coupled lines without the mentioned limitations and with different power division ratios is the purpose of this article.
REFERENCES


