

Design of Dual-Frequency TEM-Mode Coupled-Line Directional Couplers

Valeriy Oborzhytskyy, Oleg Samsonyuk

Abstract - In the report a three variants of coupled-line directional coupler, which can provide simultaneous work at two arbitrary frequencies are considered.

Keywords – Dual-band components, coupled-line couplers, parallel coupled line, even and odd modes.

I. INTRODUCTION

The development of modern communication system with dual-band or multiband operation is in close connection with dual-frequency microwave devices design. Their use allows to get the attractive solution towards the reduction of system size and cost. As a directional coupler is one of base circuit components, which are used in the various devices such as amplifiers, mixers, phase shifters and others, so in recent years much attention is given to design of new schemes for the couplers, operating at two arbitrary frequencies. Thus the variants of branch-line directional couplers are considered in most cases, while the attention to the dual-frequency structures on the base of coupled-line segments is enough small. In the last of the known publications on this theme [1] the circuit of a new dual-band 90° coupler using three quarter-wave coupled-line sections is proposed. Only 3-dB coupler with transdirectional signal distribution is considered at that.

In the report the variants of dual-frequency transdirectional or contradirectional couplers, which can provide the arbitrary coupling level are offered.

II. DIRECTIONAL COUPLER CIRCUITS

At development of dual-frequency branch-line couplers in most cases the method of equivalent replacement of single transmission line section by dual-frequency transforming circuit is used. For coupled-line directional couplers such approach using is not succeeding. Therefore for providing of dual-frequency transformation it is required to complete a structure by new elements. The simplest in this case is to use the additional coupled lines sections. With the purpose of structure symmetry saving, the designing process of which is considerably simpler, it is necessary to add minimum two sections in the circuit. In Fig. 1 three variants of dual-frequency directional coupler circuit, which were got as a result of such addition are shown. In every structure lateral sections differ from central by the values of even and odd modes characteristic impedances. The expressions for computation of the circuit electrical parameters (characteristic impedances Z_e , Z_o , Z_{e1} , Z_{o1}) are written down

Valeriy Oborzhytskyy, Oleg Samsonyuk -
Lviv Polytechnic National University, S. Bandery St., 12, Lviv,
79046, UKRAINE.
E-mail:oborz@polynet.lviv.ua

by using of input impedances method [2]. The mode of dual-frequency operation of coupler, when on both working frequencies f_1 and f_2 there will be the identical values of coupling at the input matching and decoupling input against isolated output, it is possible to provide by electrical lengths of sections choosing at the first working frequency equal to values:

$$q_1 = \frac{p}{1+k_f}; \quad q = \begin{pmatrix} q_1 \\ 2 \cdot q_1 \end{pmatrix} \quad (1)$$

where $k_f=f_2/f_1$. In this case at the transition to second working frequency if $\theta=2\theta_1$ there is the change of signs of input reactances of double even and odd excitation partial two-poles, and at $\theta=\theta_1$ – mutual exchange by their values. As a result in this and other case the given operation parameters of coupler are kept.

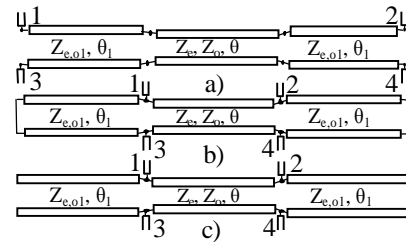


Fig.1. Variants of directional coupler circuit.

The analysis of the adduced variants of circuits shows the following. The first (Fig. 1, a) and third (Fig. 1, c) circuits can be used only for the contradirectional (on outputs 2 and 3) input signal distribution and better fit for realization of low level of coupling at different values of k_f . The similar [1] second circuit (Fig. 1, b) works only with transdirectional (on outputs 3 and 4) signal distribution at high level of coupling and at $k_f < 3$. All circuits provide high level of isolation only in TEM-mode regime.

III. CONCLUSION

The offered variants of directional couplers can be used in the structures of microwave devices with dual-frequency operation. Thus their realization is possible on a base of coupled transmission lines the modes of even and odd excitation of which have the identical or near values of phase velocities.

REFERENCES

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