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ANALYSIS OF INTERFERENCE-TYPE MEASURER OF DIRECTIONAL COUPLER DIRECTIVITY

G. A. Luk'yanchuk

Sevastopol National Technical University, Ukraine

A new method is suggested for construction of a measurer of directivity factor in directional couplers. The method is based on analysis of interference of the forward and backward wave in the secondary channel made as a closed ring. An equation relating the coupler directivity to the standing-wave ratio in the secondary channel is derived. An example of determination of couper's directivity is included. The advantages of the proposed method are outlined.

Directional couplers (DC) have found wide application in microwave equipment [1]. However, in the design and investigation of DC by known methods we sometimes cannot determine the directivity factor without instrumental high-power generators and highly sensitive indicators. The method described below makes it possible to determine, with sufficient accuracy, the coupler directivity from the measured VSWR magnitude in the resonant ring.

Reduction of the mass and overall dimensions of DC and, at the same time, improvement of their directivity in a broad range of frequencies is an important scientific and technical problem. Its resolution may be associated with implementation of DC supplied with wide-band coupling elements made as two narrow inclined slots in the waveguide wide wall [2]. The optimal choice of physical parameters of the slots (their length, width, angle of inclination, distance between centers, shift of the slot centers with respect to the waveguide narrow walls etc.) permitted to obtain an almost frequency-independent phase shift between the tapped signals. The slots in the coupler considered in [3] may serve a good example. The maximal deviation of the phase shift from 90° is 1.6° at the edge frequencies of the band equal to 37% of the central frequency. Directional couplers with such coupling elements provide high directivity, whose minimal value exceeds 20 dB at the ends of the range. The transmission attenuation of the two-slot directional couplers exceeds 30 dB. Thus, the overall attenuation of amplitude of the wave tapped into the secondary channel of the DC in the backward direction is 50 to 60 dB. Determination of directivity by the traditional technique, related to measurement of attenuation of such magnitude, presents considerable difficulties. Another problem is that in practice we use low-power microwave measuring generators and indicators (instrumental amplifiers of moderate sensitivity).

In the suggested interference-type measurer we compare amplitudes of waves propagating in the secondary channel of DC in two opposite directions. In this case the ratio between powers of these waves depends only on the directivity value and is invariant to the transmission attenuation of the coupler. In addition, the closed secondary channel of DC represents a resonant ring. The amplitudes of waves, running in opposite directions, exceed many times the amplitudes propagating in an open-circuited channel. The measurements are performed at resonant frequencies of a travelling-wave resonator (TWR). These properties of the measurer facilitate considerably determination of the coupler directivity.

The block diagram of the measurer, realizing the above method, is presented in Fig. 1, with the following notation: DC — directional coupler; ML — matched load; WSR — waveguide semiring; DP — diode probe; MML — movable measuring line; Ind — indicator; and L is the length of the axial line in the waveguide ring.

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