ENHANCED C-BAND ANTIPHASE POWER COMBINER/DIVIDER

S. Piltyay, postgraduate student
National Technical Univercitiy of Ukraine
«Kyiv Polytechnic Institute», Kyiv, Ukraine

In some microwave devices, namely, in orthomode transducers and antennas with difference patterns, there is the requirement of antiphase combining / dividing of electromagnetic waves power in wide operation frequency bands with bandwidth ratio 30% and more. The Y-shape junctions (a.k.a. T-shape junctions) of rectangular waveguides are mostly used for these purposes [1 – 4].

The Y-shape junction presented in [1] comprises the three-section step junction and performs the electromagnetic waves transmission between three identical hollow rectangular waveguides. The Y-shape junctions described in [2–4] have the same configuration. The simulated reflection coefficient of antiphase power combiner/divider developed in [1] doesn't exceed −32 dB in operation frequency band 18 − 26 GHz. The Y-shape junction introduced in [2] provides the reflection coefficient lower than −35 dB in operation frequency band 10 − 15 GHz. The reflection coefficient of Y-shape junction developed in [3] doesn't exceed –29 dB in operation frequency band 8 − 12 GHz. The Y-shape junction presented in [4] provides the reflection coefficient lower than −20 dB in operation frequency band 20 − 32 GHz.

The disadvantage of the above-mentioned waveguide antiphase power combiners/dividers at utilization in the orthomode transducers is their considerable transverse sizes compared with the common waveguide sizes. This results in considerable overall dimensions and mass of the orthomode transducer, especially at relatively low operation frequencies. The rigidity of power combiners/dividers based on solid metal waveguides doesn't allow to bend them in arbitrary directions. This is the essential disadvantage at their utilization in coaxial orthomode transducers [5–7], because the access to the inner circular waveguide is significantly limited.

The mentioned disadvantages are avoided in the antiphase power combiner/divider presented in [8]. It consists of two coaxial transmission lines RG-402/U (teflon's diameter equals 3 mm) with 50 Ohms impedance and a rectangular waveguide short-circuited from one side. The probe-to-waveguide transition was roughly optimized in simulation. A grid of models was run for various plausible probe heights, dielectric and conductor widths, and displacements in front of a waveguide back short. The operation frequency band of the antiphase power combiner/divider developed in [8] is 18 − 26 GHz. The measured reflection coefficient of the transition is lower than −14 dB.

In this paper the wideband antiphase power combiner/divider, which provides low reflection in the operation frequency band 3.4 − 5.4 GHz, has been developed. On the whole the design developed is similar to the one presented in [8]. The main modification is the introduction of the pair of metal cylinders to obtain good matching performance.

The parametric minimization of reflection coefficient has been carried out in the operation frequency band 3.4 − 5.4 GHz. The matching resonator length (which is equal to the displacement of the probes axes from a waveguide back short), diameters of coaxial probes and metal cylinders, probes and cylinders heights all were varied during the parametric optimization. The reflection coefficient of optimized configuration has been decreased by 9 dB compared with the one presented in [8] and it is lower than −23 dB. The optimized configuration of additional matching metal cylinders shows that they are very thin and can be considered as discs, because their D/h ratio exceeds 10.

The analysis of matching sensitivity to manufacturing inaccuracies has been performed. It has been defined that for providing reflection coefficient lower than −22 dB the tolerances are equal ±0.05 mm, and for providing reflection coefficient lower than −21 dB — ±0.10 mm.

The wideband antiphase power combiner/divider developed can be used in orthomode transducers and antennas with difference patterns.

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