Designs for Multi-Port Bifurcated Waveguide Power Dividers at Millimeter-Wave Frequencies

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Power dividers have been extensively used in many microwave circuits and subsystems such as feeding networks for antenna arrays and power amplifiers. For applications requiring high power-handling capability and low insertion loss, conventional *E*- and *H*-plane waveguide T-junctions would be the simplest three-port designs. However, due to their lossless nature and reciprocal property, such junctions cannot be matched simultaneously at all ports. In addition, poor isolation exists between their output ports. These problems place severe limitation on their practical applications. Bifurcated waveguide power dividers were proposed to solve the aforementioned problems. The early bifurcation design features a thin metallic plate inside a rectangular waveguide. The plate is positioned perpendicular to the TE_{10} electric field, which is known as an *E*-plane bifurcation and is able to effectively convert the guide into two reduced-height waveguides. This design offers a solution to determine the power ratio of two output ports by taking the quotient of the two reduced heights of the bifurcated waveguide, but still fails to improve the isolation between the output ports. The introduction of a resistive coupling slot in the thin metallic plate was presented to solve the isolation problem (F. Takeda, O. Ishida, and Y. Isoda, *IEEE MTT-S Digest*, 1982.) The resistive coupling slot consists of a transverse slot and a small resistor. The isolation between two output ports was increased up to at least 30 dB within a 10% frequency range of interest. For millimeter-wave applications, implementation of such resistive coupling slot presents difficulty if the cost and ease of fabrication need to be considered. Therefore, a resistive film was proposed to replace the thin metallic plate with a resistive coupling slot. Current resistive films are made of tantalum nitride (TaN) and must stay on a supportive object. They are usually available in two resistive values, 50 Ω/sq and 200 Ω/sq. The length and width of the resistive film must be adjusted to achieve the desired resistance. In this study, a properly-sized resistive film of 75 Ω sandwiched by two alumina substrates is proposed to serve as a septum for the bifurcated waveguide. Impedance transformation can be implemented at either the input port or the two output ports for three-port power dividers. A corporate configuration is chosen for designs with 2^n output ports ($n > 1$). Design examples for three-port and five-port bifurcated waveguide power dividers at *Ka*-band are presented. The finite element method-based commercial CAD package – HFSS was chosen to conduct the required simulations because of its accuracy for designs involving 3-D structures. The simulation results indicate that the insertion loss is maintained to be less than 3.1 dB for the three-port design and 6.1 dB for the five-port design across the frequency range of interest. The return loss and the isolation are more than 20 dB for both designs. The results are verified with measured data and good agreement is observed.