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General design equations, small-sized impedance transformers, and their application to small-sized three-port 3-dB power dividers

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In this paper, design equations for three-port power dividers have been derived. These design equations are available for both arbitrary power divisions and arbitrary termination impedances, and many sets of design equations are possible. Therefore, the design equations may be called general design equations and an arbitrary design impedance A is introduced to describe them. On the basis of the derived general design equations, a coplanar three-port power divider with a power split ratio (3 dB) terminated by 50, 60, and 70 /spl Omega/ is designed with A=33.33 /spl Omega/, so that a commercially available resistor 100 /spl Omega/ can be used for the isolation resistance. Additionally, to reduce the size of transmission-line impedance transformers, two types of small-sized impedance transformers are designed, named a constant VSWR-type transmission-line impedance transformer (CVT) and a constant conductance-type transmission-line impedance transformer (CCT) and compared with conventional reduced-sized impedance transformers. These impedance transformers are designed in the low-Q region on the Smith chart. Therefore, they show wide-band properties. To make sure that the derived design equations of CVTs and CCTs are reasonable, four 1;6:1 impedance transformers, CVT 20/spl deg/, CVT 30/spl deg/, CCT 15/spl deg/, and CCT 20/spl deg/ have been fabricated in microstrip technology and measured. The measured results show the expected tendency. Based on the CVTs and CCTs, small-sized three-port 3-dB power dividers are constructed and named a constant VSWR-type three-port 3-dB power divider (CVT3PD) and a constant conductance-type three-port 3-dB power divider (CCT3PD). For the CVT3PD and CCT3PD, perfect isolation conditions are derived, and it is shown that the perfect isolation circuit (I.C) must be composed of resistance combined with capacitance or inductance in the case that the length of transmission lines is not /spl lambda//4. These I.Cs are quite different from conventional ones composed of only resistance. Finally, on the basis of the derived perfect isolation impedance, CVT3PD and CCT3PD are designed and simulated, giving the possibility that a CCT3PD can be

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realized with the electrical length 15.30/spl deg/ of the transmission lines.

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