Ain Shams University
Faculty of Engineering
Cairo - Egypt

Compact Microstrip Power Dividers

A Thesis
Submitted in partial fulfillment of the requirement for the degree of **Master of Science in Electrical Engineering**

Submitted by

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STATEMENT

This thesis is submitted to Ain Shams University in partial fulfillment of the degree of Master of Science in Electrical Engineering.

The work included in this thesis was carried out by the author in the Department of Electronics and Communications Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any other university or institute.

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Abstract

Power dividers may be classified into many categories such as directional couplers, hybrid junctions, multi-stage multi-way power dividers, sector power dividers, Wilkinson power dividers, etc. This thesis is mainly concerned with the branch-line coupler which is one type of hybrid junctions. These components are used for wide range of applications such as power division, power combining, signal mixing and as a feeding network in various antenna systems.

The conventional branch-line coupler (BLC) consists of four quarter-wavelength transmission lines of loop structure. It has the property that when all ports are matched, the power entering from one port will be divided into other two ports and the fourth port is isolated. However, the conventional branch-line coupler has many disadvantages such as occupying huge area when it is fabricated on a thin substrate, or under the MIC or MMIC technology. It also suffers narrow bandwidth and the existence of higher order modes. One of the problems that are related to the BLC is that when loose coupling is required for example -10 dB coupling, the width of the microstrip line will be very small which complicates the fabrication process and reduces the power handling capability. Many techniques are used to reduce the size of the hybrid junction and to get rid of other limitation such as using artificial transmission lines, using space-filling fractal curves, using quasi-lumped element approach, using vertically installed planar couplers, using folded line, using meandering and multi-meandering, using defected ground structures and photonic bandgap structures. In this thesis, the methods of low and high impedance open stubs and the method of defected ground structures are adopted to miniaturize the branch-line coupler, suppress the higher order modes and increase the power handling capability as compared to the conventional coupler.

Miniaturized BLCs are designed, simulated and fabricated using FR4 substrate with dielectric constant 4.6, dielectric substrate height 1.6 mm and loss tangent of 0.02. These BLCs operate at 2.4 GHz. First low and high impedance open stubs are used to miniaturize the conventional BLC using the T, π and combinational models. The proposed design is reduced by more than 69% compared to the conventional design. The second step was to use DGS underneath the BLC. The proposed design is capable to achieve any dividing ratio without reducing the width of the line, which means that the power handling capability is not reduced. In addition, suppression of higher order modes is achieved and more than 18% reduction in size as compared to the conventional shape is obtained. As a final step, the two techniques are combined together and a third BLC is proposed. Good agreement is found between experimental and simulated results using the software package Zeland IE3D.

Key words: Power divider, branch-line coupler, high-impedance open stub, defected ground structure, miniaturization, suppression, and power handling capability.

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