شبكة المعلومات الجامعية

سامية محمد مصطفى

بسم اللّه الرحمن الرحيم

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التوثيق الالكتروني والميكروفيلم

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سامية محمد مصطفى

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قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

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شبكة المعلومات الجامعية

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بالرسالة صفحات لم ترد بالأصل

ANALYSIS OF MICROSTRIP COUPLERS USING THE MEASURED EQUATION OF INVARIANCE AND THE MOMENT METHOD

By

Eng. Ramy Ahmed Hassan El-Ganainy
Microstrip Department, Electronics Research Institute.

A thesis submitted to the faculty of engineering at Cairo University in partial fulfillment of the requirements for the degree of Master of Science

In

Electronics and Communications Engineering

Faculty of Engineering, Cairo University,
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Under the supervision of

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All Gratitude is Due to ALLAH

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ABSTRACT

Numerical techniques in electromagentics can be classified into two main categories, differential equations techniques and integral equation techniques. Each category has its own advantages and disadvantages. In the microstrip structures the main disadvantage of the differential equation techniques is the need of artificial boundary conditions that should be put at some distance far from the structure which results in a great increase in the computational domain and consequently the required storage memory and computational time. The integral equation techniques on the other hand do not suffer from this problem as the computational domain is on the metallic part of the structure (i.e. the microstrip conductors laying over the dielectric). The main disadvantage of the integral equation technique is that it produces full matrices that require large memory storage and time to solve them as well as the need of Green's function. In 1993, Kenneth Mei and his research team at University of California, Berkley invented a new method, which is a mixture between the differential equation techniques and integral equation technique, namely the Measured Equation of Invariance (MEI).

In this thesis the problem of finding the characteristic impedance of a single microstrip line was studied and solved numerically using the finite difference technique, which belongs to the first category, the differential equations techniques. The same problem was approached using the moment method, which belongs to the second category. After that the same problem was solved using the measured equation of invariance and a comparison between the three methods showing the required memory, time and accuracy was introduced. A study of the sources of error in the measured equation of invariance was carried out and this led us to propose a different scheme for discretizing the computational domain, which results in an increase in the accuracy while decreasing the required computational time to half its value.

The problem of two symmetrical coupled lines was studied using the moment method and the measured equation of invariance. It was shown that the technique of the measured equation of invariance is applicable only if we make use of the even and odd modes property of the structure. If we tried to solve the problem without this property the measured equation of invariance gives incorrect results.

The problem of three coupled lines was approached using the moment method and the measured equation of invariance and again the measured equation of invariance gives incorrect results for the field distribution and the characteristic impedance. An analytical argument that explains reason of this failure of the measured equation of invariance in certain cases was introduced.

The moment method was used to derive design curves for three-line coupler. This coupler has five different mode impedances, three mode numbers and three effective dielectric constants. Then the coupler was modified by slightly increasing the width of he center line to reduce the five mode impedances into three only, which facilitates the design. A curve fitting formula for the ratio of the center line to the outer lines width for equal mode impedance was performed and a simple general equation was obtained, This equation is valid over the geometric range of interest and moreover is valid over a wide range of different materials. A coupler was designed center frequency of 2 GHz, it was fabricated using thin film technology and photolithography technique on Teflon substrates and its performances was measured using HP network analyzer. Good agreement was found between numerical and experimental results.

As an application for the three-line coupler, the six-port reflectometer was studied. It uses three-line coupler to measure the magnitude and phase of unknown complex impedance using power measurements only and without heterodyne techniques. Another coupler suitable for six-port reflectometer application was designed, fabricated, measured and again it gives good experimental results. After calibrating the six-port reflectometer using one matched load and three positions of short circuit, it was used to measure unknown complex impedance. Good agreement was found between results obtained by using six-port reflectometer and that obtained by using vector network analyzer.