MICROSTRIP ARRAY ANTENNA

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Universiti Malaysia Sarawak
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25/2 199

Tarikh

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Abstrak

Teknik dalam rekaan antena jaluran kecil diketengahkan dengan menekankan beberapa pertimbangan yang perlu diambil kira oleh pereka. Antena jaluran kecil sering digemari kerana strukturnya yang nipis, proses penghasilan yang mudah, kesesuaiannya terhadap MICs (Litar Bersepadu Gelombang Mikro) serta struktur geometrinya yang ringkas. Pengenalan dan ulasan mengenai antena jaluran kecil dibincangkan di dalam Bab 1,2 dan 3. Penekanan terhadap teknik secara teori dan praktikal turut diketengahkan. Pertimbangan yang perlu diambil kira dalam proses mereka antenna jaluran kecil dibincangkan di dalam Bab 5, manakala proses bagaimana antena direka pula dibincangkan di dalam Bab 6. Aplikasi antena ini di dalam sistem komunikasi pula dibincangkan di dalam Bab 7.

Abstract

Microstrip antenna array techniques are reviewed with attention to the basic considerations important to user or the designer. Microstrip arrays are often chosen because of their ruggedness, ease of manufacturing by printed circuit techniques, compatibility with MMICs, and thin, conformal geometry. The introduction and the literature review on microstrip array antenna are discussed in Chapter 1 , 2 and 3. A survey of microstrip antenna elements is presented, with emphasis on theoretical as well as practical design techniques. Chapter 4 emphasis on the practical tools in designing microstrip antenna. The design consideration in microstrip antenna is presented in Chapter 5 while the design process of microstrip antenna covered with a dielectric layer is presented in Chapter 6. The applications of microstrip antenna communication system are discussed in Chapter 7.

CHAPTER 4

PRACTICAL TOOLS FOR MICROSTRIP DESIGN

CHAPTER 5

DESIGN CONSIDERATION IN MICROSTRIP

CHAPTER 6

THE DESIGN PROCESS

CHAPTER 7

APPLICATION OF MICROSTRIP ANTENNA IN COMMUNICATION SYSTEM

LIST OF FIGURES

CHAPTER 1

PROJECT OVERVIEW

The purpose of this paper is to analyze the consideration that should be taken in designing microstrip array antenna. Microstrip antenna is preferable than other since it has a low profile, light in weight, can be made conformal and it is well suited to integration with microwave integrated circuit (MIC). The process of etching is also presented in this paper. with the example of etching gold and chromium.

The design of microstrip array antenna is fundamentally the same as the design of other types of arrays. The first consideration that should be taken into account is the frequency operation. It is important to know the frequency of operation since the value of wavelength need to be calculated. from the basic formula $c = f\lambda$ where c is the speed of light , 3×10^8 m/s.

When the frequency of operation of the antenna is known, then the process of designing the arrays can be initiated. There are some consideration that should be taken in order to get the array pattern. For instance the spacing between each element, the dielectric substrate to be used, the length and width of each element, the matching of the impedance and some other consideration which has been discussed in the later chapters.

There are also some calculations, which are used to specify the characteristic of the arrays including the effective relative dielectric constant of microstrip, the wavelength, characteristic impedance, losses in microstrip lines, etc.

The pattern of the microstrip array that has been designed is also shown with the characteristics of the arrays. While in the last chapter, the applications of microstrip antennas are discussed.

CHAPTER 2

INTRODUCTION

2.1 History

Microstrip antenna dates back about 26 years to work in the U.S.A by Deschamps and in france by Gutton and Bassinot. Shortly thereafter, Lewin investigated radiation from stripline discontinuities. Aditional studies were undertaken in the late 1960's by Kaloi who studied basic rectangular and square configurations.

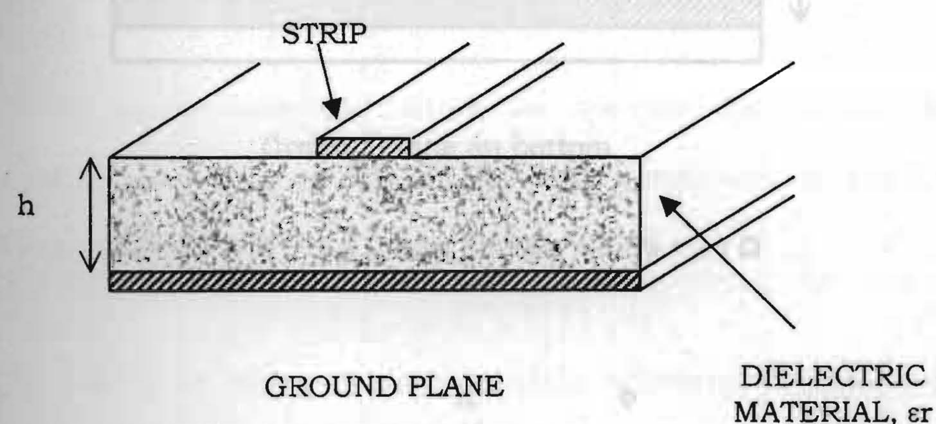
However, other than the original of Deschamps report, work was not reported in the literature until the early 1970's when a conducting strip radiator separated from a ground plane by a dielectric substrate was described by Baron.

In 1975, Garvin et al, Howell, Weinchel, and Janes and Wilson reported work in basic microstrip patch elements. Leo et al, who used the modal-expansion technique to analyse rectangular, circular, semicircular and triangular patch shapes, published the first mathematical analysis of a wide variety of microstrip patch shapes in 1977.

By 1978, the microstrip patch antenna was becoming much more widely known and used in a variety of communication system. In October 1979, the first international meeting devoted to microstrip antenna materials, practical designs, array configurations, and theoretical models was held at New Mexico State University (NMSU)

2.2 What is microstrip transmission line?

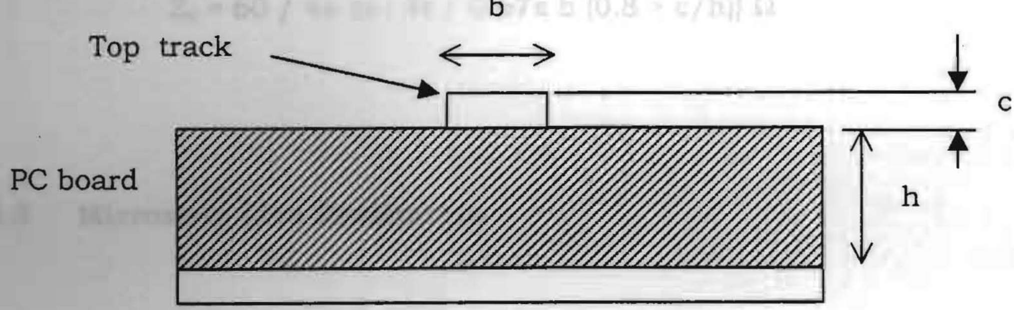
Microstrip transmission line is the kind of "high grade" printed circuit construction, consisting of a track of copper or other conductor on an insulating substrate. There is a "backplane" on the other side of the insulating substrate, formed from similar conductor. Microstrip is therefore a variant of 2-wire transmission line.



The transmission line is only partially filled with dielectric material, with the material being between the strip and an infinite ground plane.

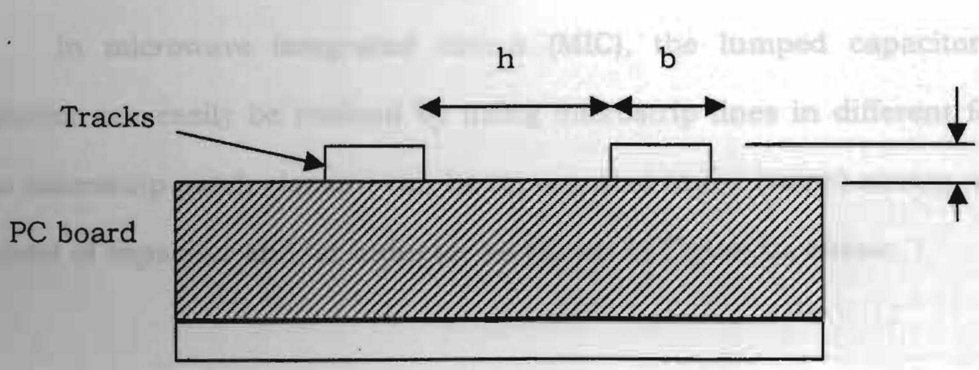
Using microstrip line is like getting the transmission line for free, as part of the board layout. The specific dimensions of the traces are calculated using various formulas, to give the desired characteristic impedance. A wide range of Zo values can be designed by varying the line dimensions. The practical range of microstrip impedance is between 50 and 200 ohms, typically, but the values can be outside this range by careful choice of key dimensions.

Several different microstrip configurations are in common use, and many other configurations are possible.

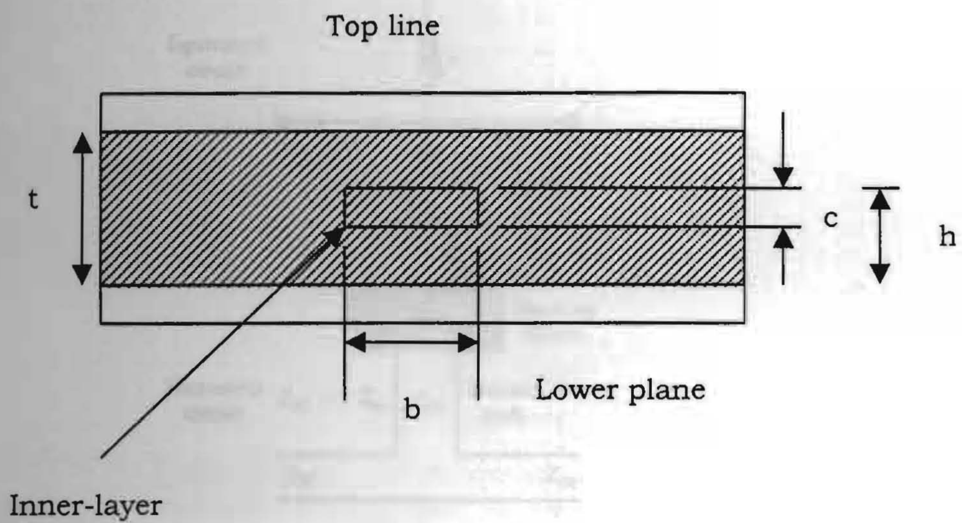


Ground plane on bottom

$$Z_o = 87 / (\epsilon + 1.41)^{½} \ln \{ 5.98h / 0.8b + c \} \Omega$$



$$Zo = 120 / \sqrt{\epsilon} \ln \{ \pi h / (b + c) \} \Omega$$

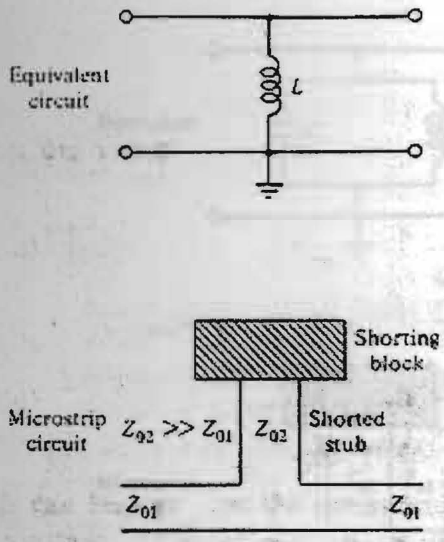


$$Z_0 = 60 / \sqrt{\epsilon} \ln \{ 4t / 0.67\pi b (0.8 + c/h)\} \Omega$$

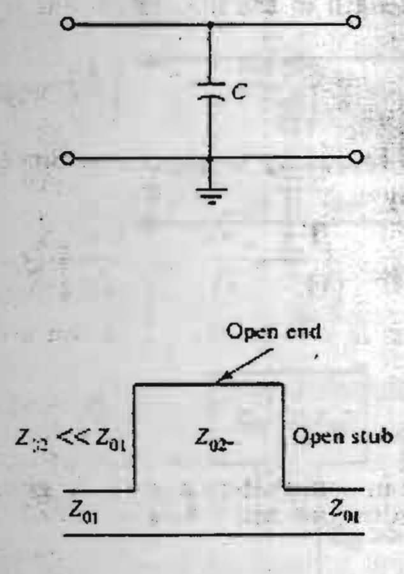
2.2 Microstrip Line Realization

From transmission line theory, an open-circuited termination is equivalent to a capacitor and a short-circuited termination is equal to an inductance when the line is very short.

In microwave integrated circuit (MIC), the lumped capacitor and inductor can easily be realized by using microstrip lines in different forms. The microstrip patch element can be represented in equivalent circuit, which consist of capacitor and/or inductor as shown in Figure 2a below.



Equivalent circuit
L
Shorting block
Microstrip circuit
$Z_{02} >> Z_{01}$
Z_{02}
Shorted stub
Z_{01}
Z_{01}



C
Open end
$Z_{02} << Z_{01}$
Z_{02}
Open stub
Z_{01}
Z_{01}

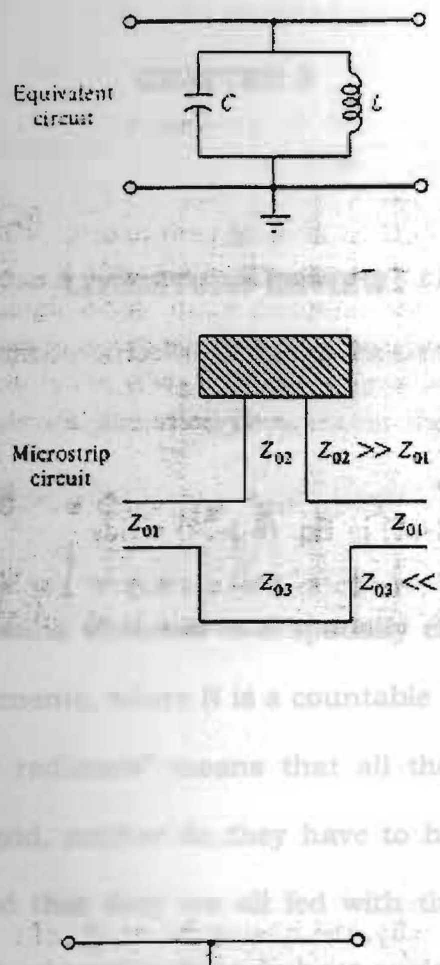


Figure 2a: Realization of microstrip-line circuit.

CHAPTER 3

LITERITURE REVIEW

3.1 Array definition

An array of antenna elements is a spatially extended collection of N similar radiators or elements, where N is a countable number bigger than 1. The term of "similar radiators" means that all the elements have to be spaced on a regular grid, neither do they have to have the same terminal voltages. It is assumed that they are all fed with the same frequency and that one can define a fixed amplitude and phase angle for the drive voltage of each element.

3.2 Element and Array Pattern

The polar radiation pattern of a single element is called the element pattern. It is possible for the array to be built recursively; for instance the element may itself be an array, as would be the case if we had an array of Yagi-Uda antennas.

The array pattern is the polar radiation pattern which would result if the elements were replaced by isotropic radiators, having the same amplitude and phase excitation as the actual elements, and spaced at points on a grid corresponding to the far field phase centres of the elements.

3.3 Pattern Multiplication

If all the polar radiation patterns of the elements is assumed to be identical (within a certain tolerance) and the patterns are aligned in the same direction in azimuth and elevation, then the total array antenna pattern is got by multiplying the array pattern by the element pattern.

3.4 Calculation of array pattern

The radiated field strength at a certain point in space, assumed to be in the far field, is calculated by adding the contributions of each element to the total radiated fields. The field strengths fall off as 1/r where r is the distance from the isotrope to the field point.

3.5 Impedance matching

An imaginary joins between the left half and the right half is made along a very long length of transmission line. The right half presents a real lossless impedance (equal to the characteristic impedance) to waves approaching the junction from the left half. There is no actual discontinuity at the imaginary join, thus there is nothing to give rise to a reflection here.

If the right half transmission line is replaced with a resistor having resistance equal to the real lossless characteristic impedance of the line, there is no way the waves arriving at the junction can tell the difference between the resistor and the long right-half transmission line it has replaced. Thus, there can be no reflection.

All the power delivered by the generator is dissipated in the resistance and there is no reflected wave amplitude or power as well as the backward travelling wave. As far as the generator is concerned, there is no way it can know how long the length of the line is. It cannot tell the difference between a resistive load Z_o and a very long matched line having characteristic impedance Z_o.