MICROSTRIP ANTENNA FOR RADIO

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Universiti Malaysia Sarawak
2000

Borang Penyerahan Tesis
Universiti Malaysia Sarawak

R13a

BORANG PENYERAHAN TESIS

Judul: Microstrip Antenna For Radio

SESI PENGAJIAN: 1997/2000

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This project report attahed hereto, entitled "Microstrip Antenna For Radio". Prepared and submitted by Suziwati Bt. Fadzli as a parial fulfillment of teh requirement for the degree of Barchelor of Engineering with honours (Electronic and Telecommunication) is hereby read and approved by:

	8/4/2000
Mr. Al Khalid Othman	**Date**
Supervisor	

MICROSTRIP ANTENNA FOR RADIO

SUZIWATI BT. FADZLI

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Fakulti Kejuruteraan, Universiti Malaysia Sarawak
Sebagai Memenuhi Sebahagian Daripada Syarat
Penganugerahan Sarjana Muda Kejuruteraan
Dengan Kepujian (Kejuruteraan Elektronik dan telekomunikasi)
Mac 2000

ACKNOWLEDGEMENT

Bismillahirrahmanirrahim. Firstly, I would like to express my gratitude to Mr. Al Khalid Othman for his advice and guidance and for supervising this project. Mr. Thelaha Masri, who helpfully suggested many improvements and ideas, deserves a special note of thanks for making many useful suggestions for revision.

My thanks are also due to my family for their support and encouragement.

Last, but not least, I owe especially important debts of gratitude to all that had helped me directly and indirectly during the preparation of this project.

I am indeed fortunate to have all of them with me over this year, and I wish to thank them sincerely for their many-many efforts on my behalf.

ABSTRACT

The "Microstrip Antenna For Radio" aims to live up to its title, as a useful companion and reference for all who wish to extend their familiarity with microstrip antenna. I have naturally concentrated on planar antenna, which is one type of microstrip antenna, to replace the old dipole radio antenna. The brief introduction to microstrip antenna is discussed in chapter one while literature review is discussed in chapter two. The problem why the planar antenna and FM frequency are chosen here are also discussed in this thesis. The experiment set up and results and discussion are discussed in chapter three and chapter four. The last chapter discusses about the conclusion and further work. In doing my thesis, the most problem I faced was the difficulty to find the suitable references as this project is new. As a result, this thesis report may contain some mistakes and confusion, I am very apologize for that.

ABSTRAK

Thesis bertajuk *Microstrip Antenna For Radio* bermatlamat untuk dijadikan sebagai teman dan rujukan kepada mereka yang berhasrat untuk memperluaskan atau melanjutkan pengetahuan mereka ke atas *microstrip antenna*. Tesis ini lebih menekankan *planar antenna*, di mana ia merupakan salah satu jenis *microstrip antenna*, untuk menggantikan *dipole radio antenna* yang lama. Pengenalan kepada *microstrip antenna* secara ringkasnya dibincangkan dalam bab satu sementara ulasan kajian dibincangkan dalam bab dua. Persoalan mengapa *planar antenna* dan *FM frequency* dipilih di sini juga turut dibincangkan dalam tesis ini. Eksperimen serta keputusan dan perbincangan dibincangkan dalam bab tiga dan bab empat. Bab akhir membincangkan kesimpulan dan tugas selanjutnya. Dalam menajalankan tesis ini, masalah yang utama adalah kesulitan dalam mencari rujukan yang sesuai dan tepat memandangkan projek ini masih baru lagi. Hasilnya, mungkin terdapat kesalahan dan kekeliruan dalam laporan tesis ini, oleh itu, harap maklum.

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INTRODUCTION

1.1 BASIC ANTENNA THEORY

The IEEE Standard Definitions of terms for Antennas (IEEE Std 145 1983) defines the antenna or aerial as;

"A means of radiating or receiving radio waves."

In other words, the antenna is the transitional structure between free-space and a guiding device. The guiding device or transmission line may take the form of a coaxial line or a hollow pipe (waveguide), and it is used to transport electromagnetic energy from the transmitting source to the antenna, or from the antenna to the receiver.

Antennas serve either or both of the two functions: the generation and the collection of electromagnetic energy. In a transmitting system, a radio frequency (RF) signal is developed, amplified, modulated, and applied to the antenna. The RF currents flowing through the antenna produce electromagnetic waves that radiate into the atmosphere. In a receiving system, electromagnetic waves "cutting" through the antenna induce alternating currents for use by the receiver.

To have adequate signal strength at the receiver, either the power transmitted or the efficiency of the transmitting and the receiving antennas must be high because of the high losses in wave travel between the transmitter and receiver.

Any receiving antenna transfers energy from the atmosphere to its terminals with the same efficiency with which it transfers energy from the transmitter into the atmosphere. This property of interchangeability for transmitting and receiving operations is known as antenna reciprocity. Antenna reciprocity occurs because antenna characteristics are essentially the same regardless of whether an antenna is sending or receiving electromagnetic energy.

Because of reciprocity, antennas are generally treated from the viewpoint of the transmitting antenna, with the understanding that the same principles apply equally well when the antenna is used for receiving electromagnetic energy.

Antennas produce or collect electromagnetic energy and should do so in an efficient manner. Consequently, antennas are composed of conductors arranged so as to permit efficient operation. Efficient operation also requires that the receiving antenna be of the same polarisation as the transmitting antenna. Polarisation is the direction of the electric field and is, therefore, the same as the antenna's physical configuration. Thus, a vertical antenna will transmit a vertically polarised wave. The received signal is theoretically zero if a vertical electric field cuts through a horizontal receiving antenna.

The received signal strength of an antenna is usually described in terms of the electric field strength. If a received signal induces a 10 μV signal in an antenna 2 meter long, the field strength is 10 μV / 2 m, or 5 μV / m [7].

1.2 HISTORY OF MICROSTRIP ANTENNA

Microstrip antenna concept dates back about 26 years to work in the U.S.A. by Deschamps and in France by Gutton and Baissinot. Shortly thereafter, Lewin investigated radiation from stripline discontinuities. Kaloi, who studied basic rectangular and square configurations, undertook additional studies in the late 1960's. However, other than the original 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 Byron.

Garvin et al, Howell, Weinschel, and Janes and Wilson reported additional work on basic microstrip patch elements in 1975. The early work by Munson on the development of microstrips antennas for use as low profile flush-mounted antennas on rockets and missiles showed that this was a practical concept for use in many antenna system problems, and thereby gave birth to a new antenna industry.

The first mathematical analysis of a wide variety of microstrip patch shapes was published in 1977 by Lo *et al.* By 1978, the microstrip patch antenna was becoming much more widely known and used in a variety of communication systems. In 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), Las

Cruces, under cosponsorship of the U.S. Army Research Office and NMSU's Physical Science Laboratory [2].

1.3 WHAT IS MICROSTRIP ANTENNA

The word *antenna* is best referred to interface between the transmission line and free space. When a microwave radiating or receiving element is formed on top of an MMIC dielectric substrate with a complete ground plate, it is a *microstrip antenna* or a patch antenna depending on the shape of the pattern of the active element on the substrate. If a large part of the ground plate corresponding to the active element on the substrate is absent or the ground plate is completely missing, then it is a planar antenna.

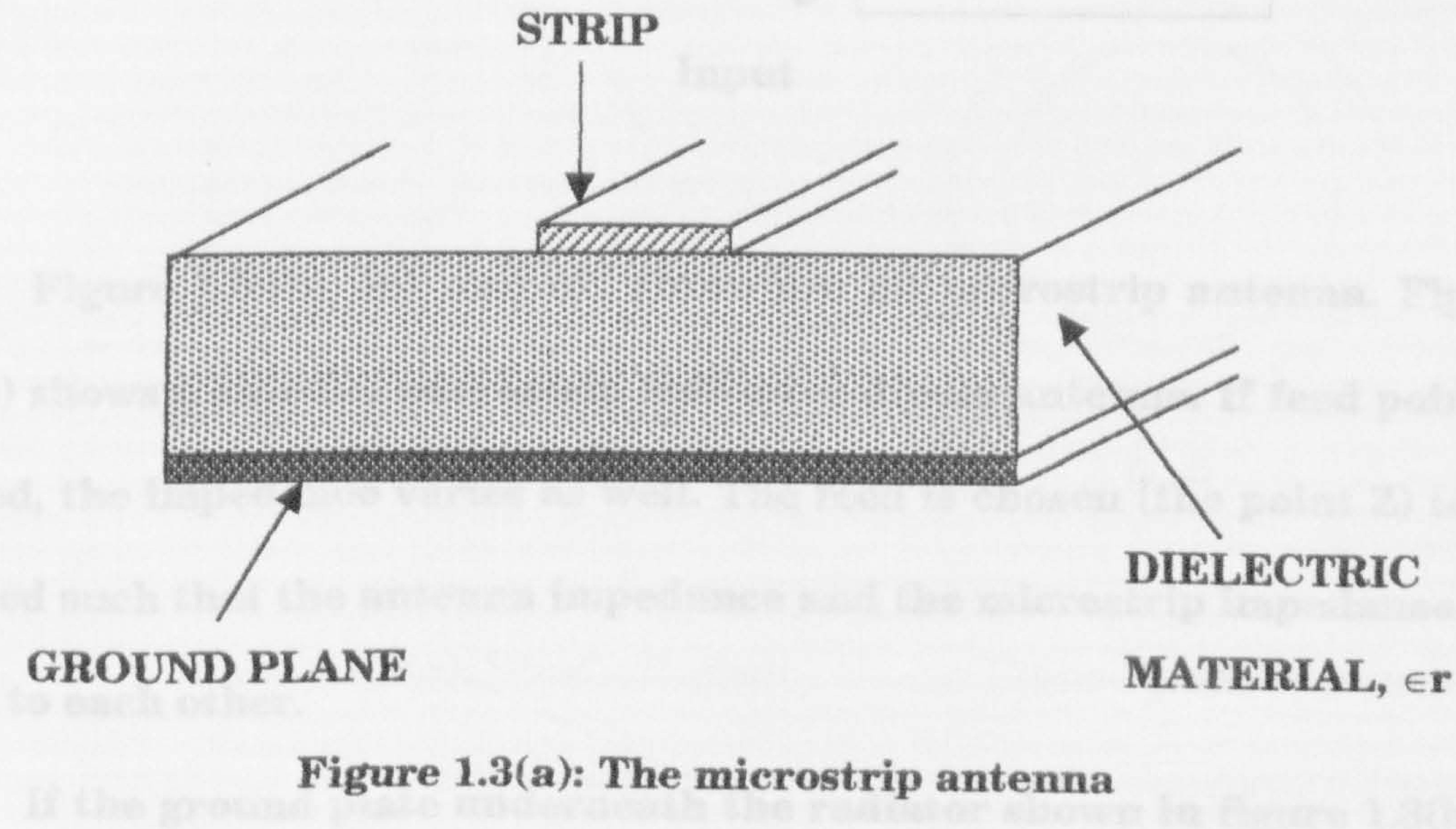

Figure 1.3(a): The microstrip antenna

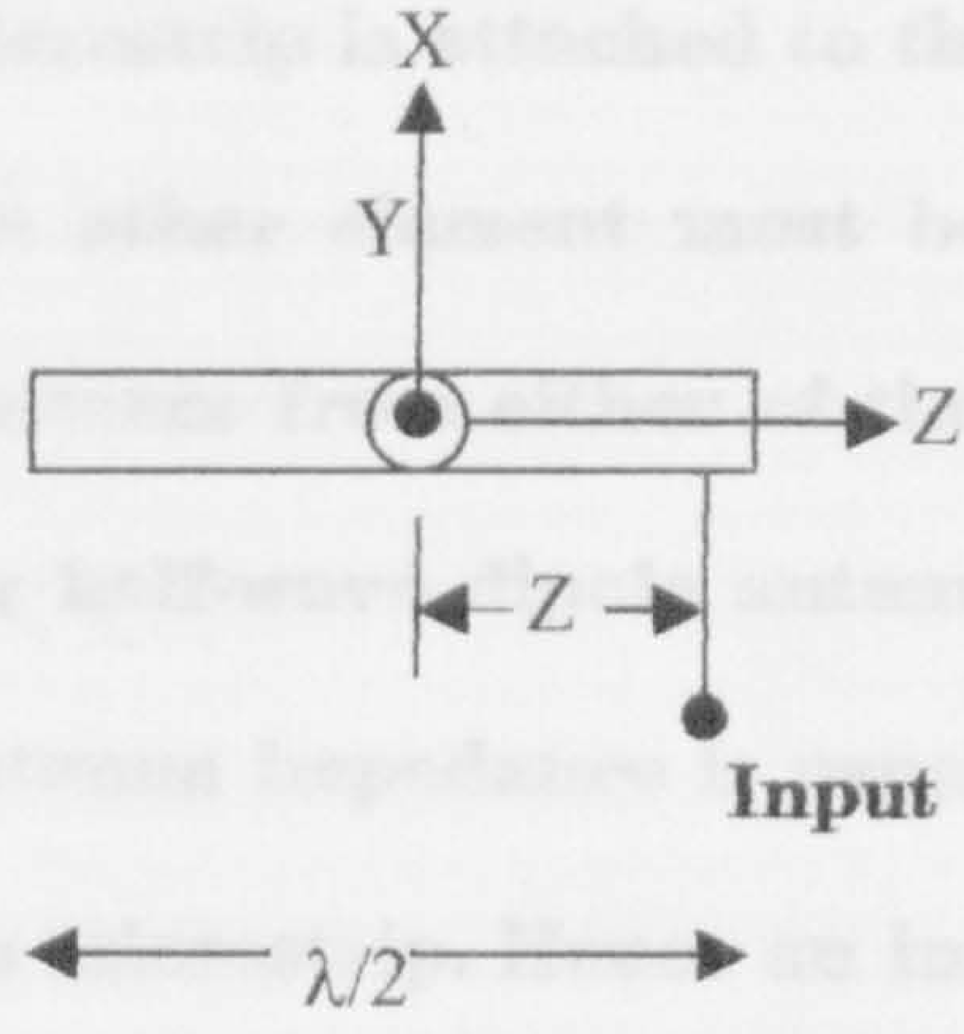

Figure 1.3(b): Side-fed antenna

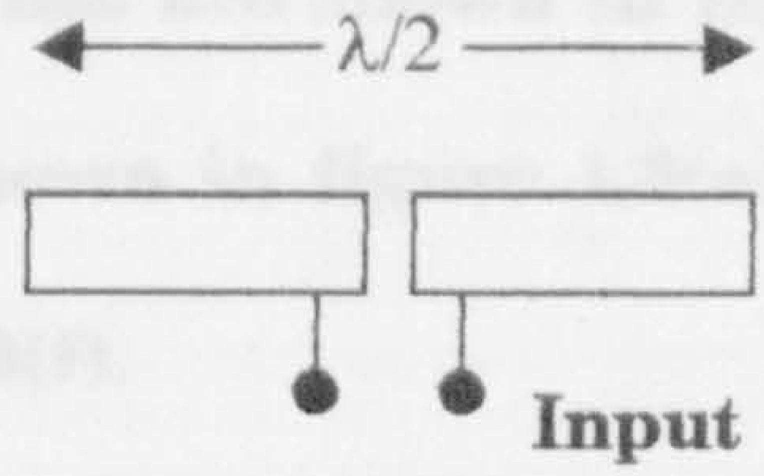

Figure 1.3(c): Planar antenna

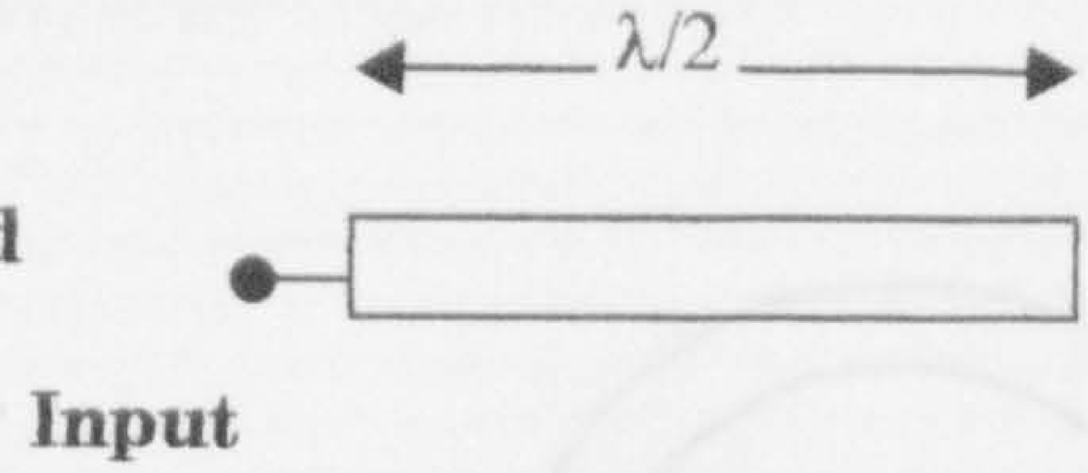

Figure 1.3(d): Feed point at one end

Figure 1.3:(b), (c), and (d) above are all microstrip antenna. Figure 1.3(b) shows a side-fed microstrip half-wave dipole antenna. If feed point is moved, the impedance varies as well. The feed is chosen (the point Z) to be located such that the antenna impedance and the microstrip impedance are close to each other.

If the ground plate underneath the radiator shown in figure 1.3(b) is removed, the antenna becomes a planar antenna (figure 1.3(c)). The feed is different in this antenna. The microstrip planar antenna can be fed through a balanced parallel stripline or a conventional single microstrip

line. When the conventional microstrip is attached to the feed point of one element, the feed point of the other element must be grounded to the ground plate. The radiation patterns from either of these antennas is the same as that from the familiar half-wave dipole antenna. When fed from one end (figure 1.3(d)), the antenna impedance is usually higher that the characteristic impedance of the microstrip. Hence an impedance matching transformer is needed [5].

Typical microstrip loop antennas are shown in figure 1.3:(e) and (f). A single-ended microstrip loop is shown in figure 1.3(e), while a balanced microstrip loop is shown in figure 1.3(f).

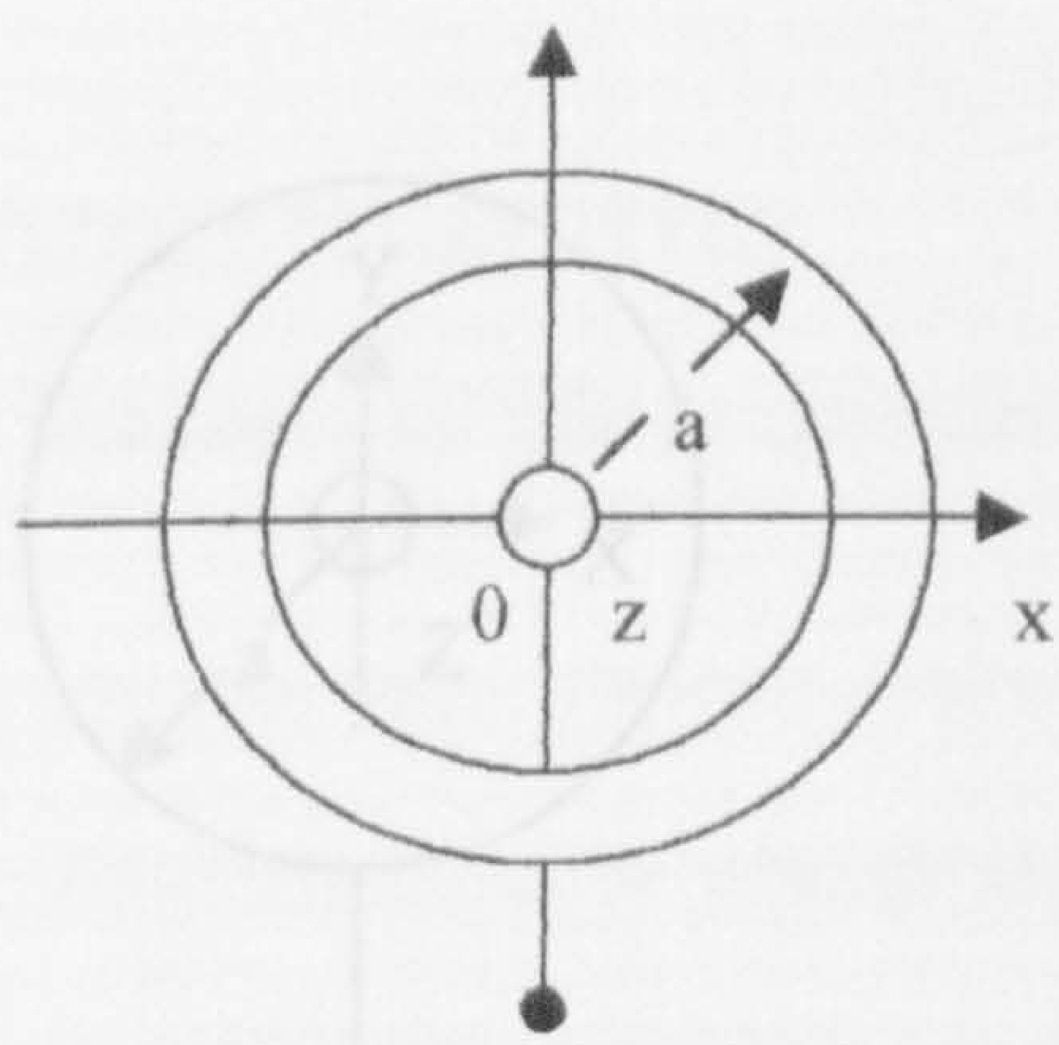

Figure 1.3(e): Single-Ended Microstrip Loop

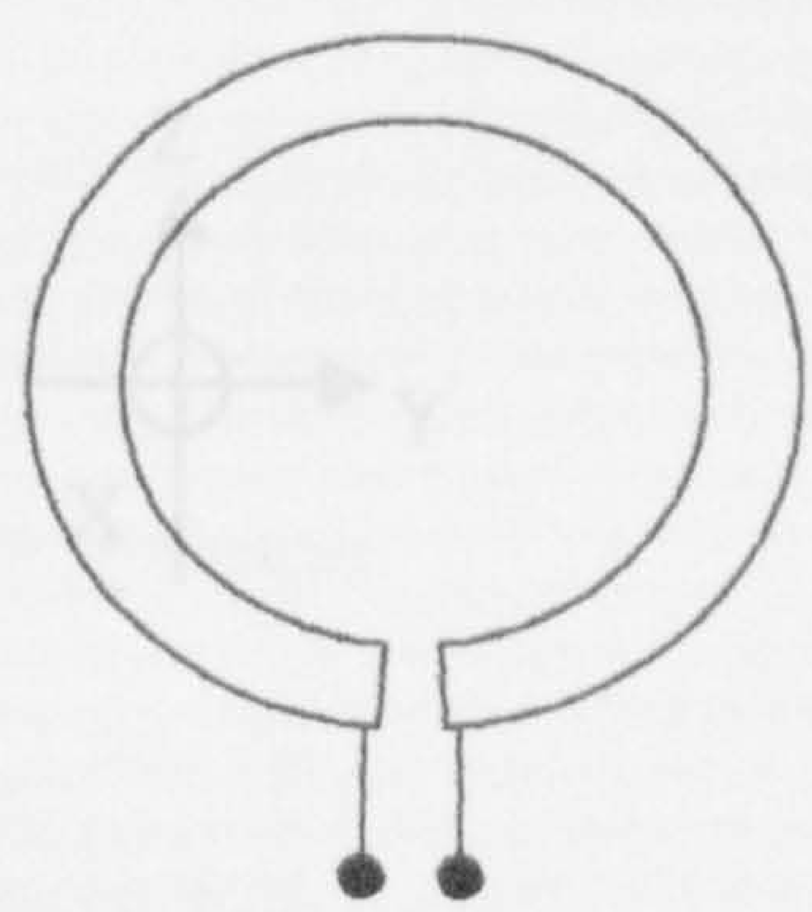

Figure 1.3(f): Balanced Microstrip Loop

A conducting square or circular patch formed on a dielectric substrate, as shown in figure 1.3:(g) and (h), can be used as an antenna. If the ground plate is present, the radiation pattern is in both the Z and Y directions. When the ground plate is not present, the antennas are planar antennas. More specifically, planar antennas are considered end-fed $\lambda/2$ dipole antennas. Here, there is very little radiation in the Z direction.

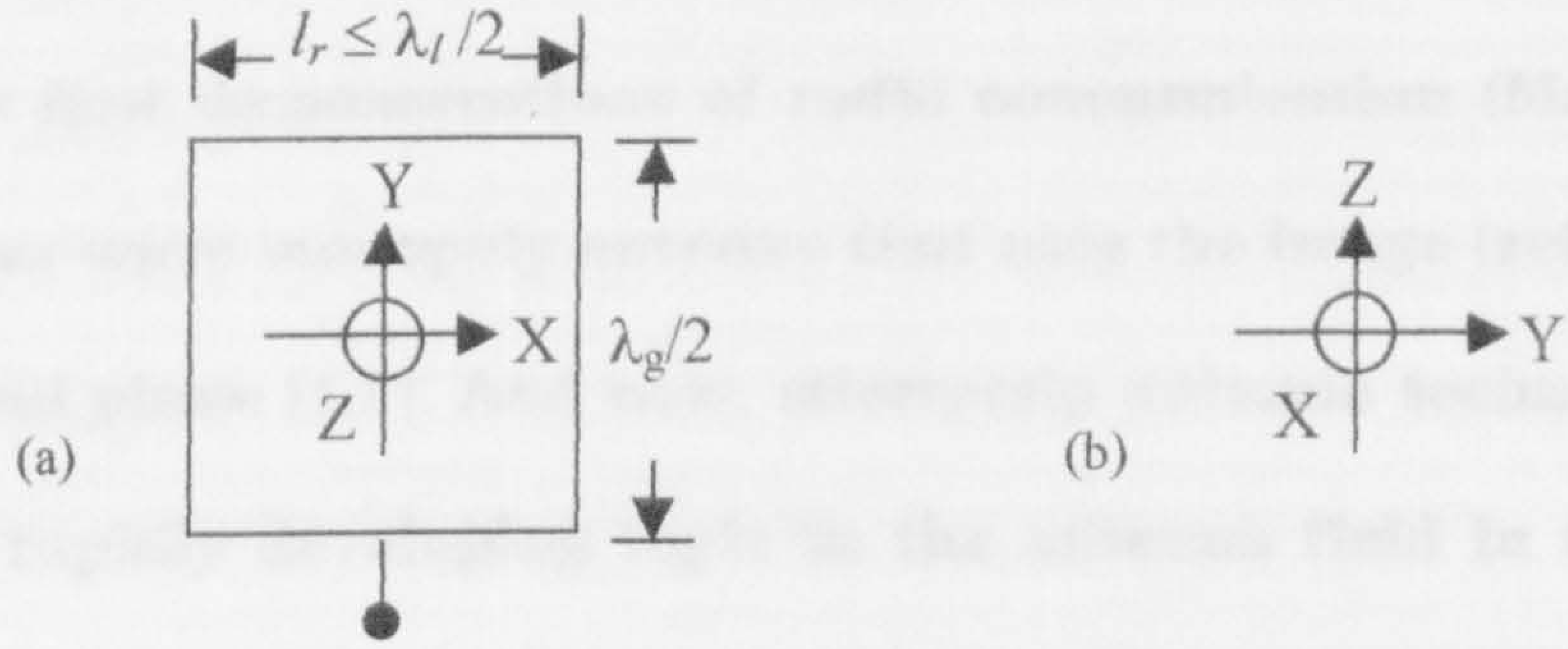

Figure 1.3(g1): (a) Square Patch, Ground Plate Present and (b) Coordinate For A Planar Square Patch Antenna

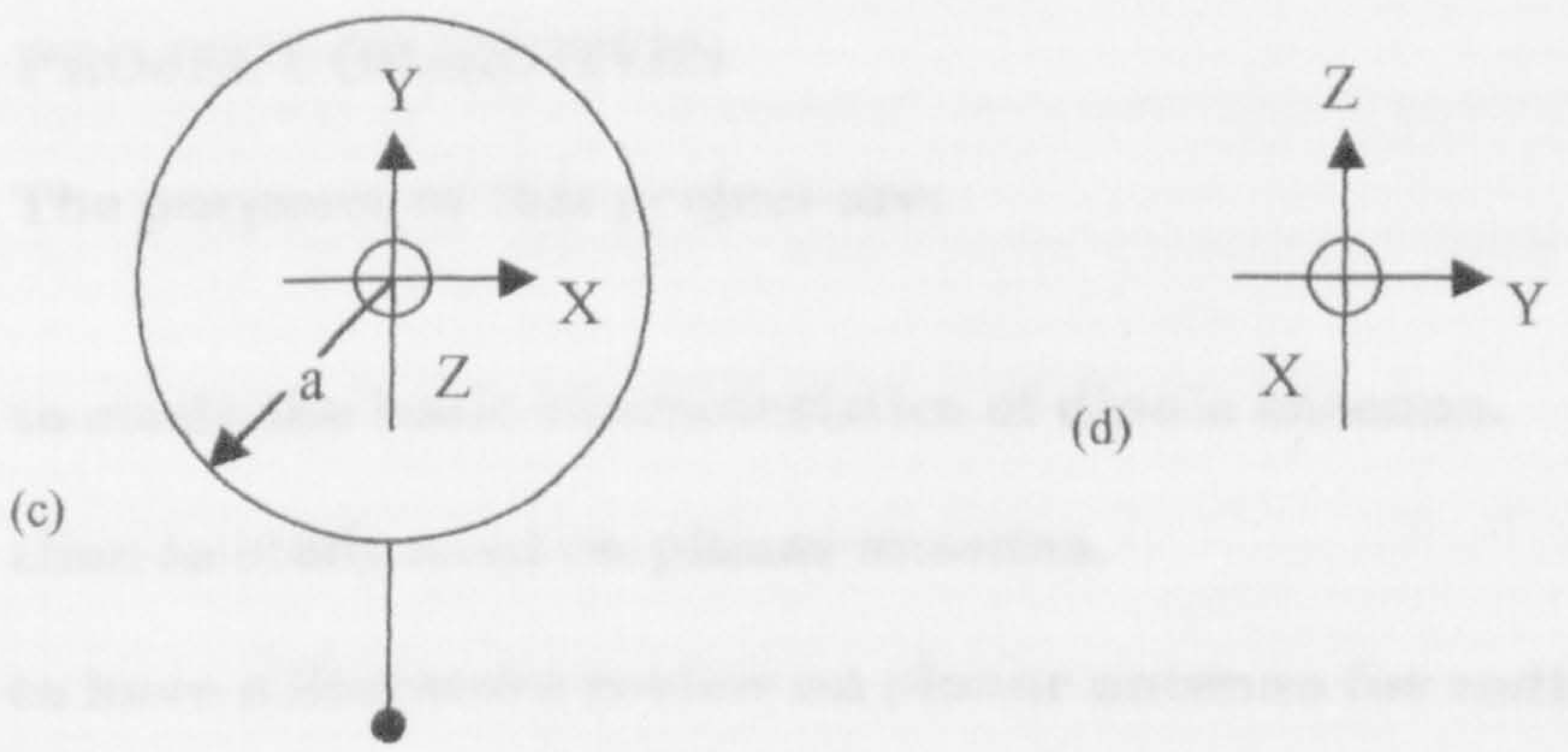

Figure 1.3(h): (c) Circular Patch, Ground Plate Present and (d) Coordinate For A Planar Circular Patch Antenna [5].

The term stripline and microstrip are often encountered in the literature, in connection with both transmission lines and antennas. A stripline or triplate device is a sandwich of three parallel conducting layers separated by two thin dielectric substrates, the center conductor of which is analogous to the center conductor of a coaxial transmission line. If the center conductor couples to a resonant slot cut orthogonal in the upper conductor, the device is said to be a stripline radiator [2].

There is still research and experiment to be carried out in the field of antenna design and behavior, although nearly a century has passed since Marconi's first demonstrations of radio communication (Marconi antenna is a quarter-wave monopoly antenna that uses the image (reflective) effects of a ground plane [1,5]. And now, microstrip antenna technology has been the most rapidly developing topic in the antenna field in the last fifteen years, receiving the creative attentions of academic, industrial, and government engineers and researches throughout the world [2].

1.4 PROJECT OBJECTIVES

The purposes of this project are:

i. to study the basic characteristics of dipole antenna.

ii. then to study most on planar antenna.

iii. to have a literature review on planar antenna for radio.

iv. to implement the planar antennas.

v. to build and test the planar antennas to replace the old dipole radio antenna

1.5 PROJECT OVERVIEW

There are many types of radio antennas now. Some of them, which are very common antennas, are dipole, monopole, and arrays.

TYPE	ABA 20	ABE 01
CHANNEL	FM	FM
RECEIVING RANGE (MHz)	87 - 108	87 - 108
LENGTH (mm)	1485	1070
WEIGHT (kg)	0.85 - 1	1 – 2.1

Table 1.5: The ABA 20 and ABE 01 antenna for radio

The table above has shown some of the type of antennas for radio. Most of them are quite heavy compared to planar antenna.

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, λ, need to be calculated from basic formulae: $c = f \times \lambda$, where c is the speed of light, 3×10^8 m/s [3].

For FM channel, the receiving range is 87 to 108 MHz. So, when the frequency is 110 MHz, wavelength, λ, is equal to:

$$\lambda = 3 \times 10^{8} / 110 \times 10^{6}$$

$$= 2.73 \text{ m.}$$

There is a reason why planar antenna has been chosen here. Below is a MATHCAD simulation program for microstrip antenna by Thelaha Masri in determining the length and width of a rectangular microstrip antenna operating in range of frequency from 80 MHz to 200 MHz. It can be shown that the rectangular microstrip antenna is bigger than planar antenna. For frequency 80 MHz, the rectangular microstrip antenna will have

1.186 m x 1.1417 m wide.