PERFORMANCE STUDY OF PROXIMITY COUPLED STACKED CONFIGURATION FOR WIDEBAND MICROSTRIP ANTENNA

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To my loves

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ABSTRACT

This project started by identifying two main disadvantages of the typical microstrip antenna that are the low gain and narrow bandwidth. These two major drawbacks have limited its application despite of other advantages as compared to the conventional antenna. With the purpose of designing a wideband microstrip antenna, the two already proven bandwidth enhancement techniques; the patch stack configuration and coplanar parasitic patch was studied. Several antenna configurations were proposed and from the simulation result, the antenna bandwidth was improved from the typical 8 ~ 9 % up to 36 % by using these two techniques using a simple coaxial probe feeding without any matching network. Actual fabrication was also carried out and several measurements were conducts to verify its performance. The measurement results, even not fully conform to the simulation result, has proven the effectiveness of the above mentioned bandwidth enhancement techniques.

ABSTRAK

Projek ini bermula dengan mengenal pasti dua kekurangan utama yang terdapat pada antena mikrostrip, iaitu gandaan yang rendah dan jalur lebar operasi yang kecil. Kedua-dua kekurangan yang utama ini telah menghadkan aplikasi antena mikrostrip walaupun terdapat banyak kelebihan-kelebihan lainnya berbanding antena konvensional. Dengan objektif untuk menghasilkan antenna mikrostrip dengan jalur lebar operasi yang luas, kajian terhadap dua teknik yang telah pun teruji mampu untuk meningkatkan jalur lebar operasi, iaitu susunan secara bertingkat dan susunan parasitik di atas satah yang sama telah dijalankan. Beberapa contoh konfigurasi antena telah pun dihasilkan, dan berdasarkan keputusan daripada proses simulasi yang telah dijalankan, jalur lebar operasi mampu ditingkatkan daripada hanya sekitar 8 ~ 9 % kepada lebih 36 % dengan menggunakan dua teknik tersebut. Antena yang dihasilkan menggunakan "coaxial probe feeding" untuk memasukkan signal tanpa menggunakan sebarang litar penyuai. Proses fabrikasi sebenar antena juga telah dijalankan, dan beberapa pengukuran telah dilakukan untuk memastikan keupayaan sebenarnya. Keputusan pengukuran yang telah dijalankan, walaupun tidak sepenuhnya selaras dengan keputusan simulasi, telah membuktikan keberkesanan dua teknik ini untuk meningkatkan jalur lebar operasi.

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LIST OF SYMBOLS

A_s	-	Specific Attenuation in *dB/km*
$A_{0.01}$	-	Predicted attenuation exceeded for 0.01% of an average year
A_P	-	Total path attenuation in *dB/km*
$A_S(t)$	-	Transformed rain attenuation time series for the satellite link
$A_T\ (t)$	-	Measured rain attenuation time series of the terrestrial link
B	-	Brightness temperative in the distance of dr in $Wm^{-2}\ sr^{-1}$
d_0	-	Reduction factor
dr	-	Incremental distance
f	-	Frequency in GHz
f_S	-	Frequency of the satellite link
f_T	-	Frequency of the terrestrial link
H	-	Frequency and attenuation dependent factor
h_R	-	Effective rain height in *km*
h_s	-	Altitude of the station in *km*
Ke	-	Specific attenuation $dBkm^{-1}$
L_G	-	Horizontal projection
L_R	-	Effective path length
L_s	-	Slant-path length under the rain height
L_S	-	the slant path length of the satellite link
L_T	-	the length of the terrestrial link
r	-	Reduction factor
R	-	Rain rate in */h*
$R_{0.001}$	-	Rainfall rate of 0.001 % means that the rainfall rate would be exceeded for 0.001
$R_{0.01}$	-	Point rainfall rate for the location for 0.01% of an average year in *mm/h*

R_e	-	Effective radius of the Earth=(8 500 km
$v_{0.01}$	-	Vertical adjustment factor
γ_R	-	Specific attenuation in *dB/km*
θ	-	Elevation angle in *degrees*
τ	-	Polarization tilt angle relative to the horizontal
Φ	-	Latitude of the earth station in *degrees*

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CHAPTER 1

INTRODUCTION

1.1 Thesis motivation

Despite of its advantages; light weight, low profile, easy fabrication and conformability to mounting post etc as compared to the conventional microwave antennas, narrow bandwidth and low gain are two major disadvantages that limit its application. The compact configuration of microstrip antenna is the main factor to these limitations. The smaller the antenna, either the operation bandwidth or the antenna efficiency (gain) will be decreased. For that, the size reduction together with gain and bandwidth enhancement has become a major consideration in the microstrip antenna design. Many studies have been carried out and several proposed techniques are proven to be able to improve the bandwidth performance and gain of the microstrip antenna.

Several techniques such as stack configuration and co-planar parasitic patch were proposed [1] and able to improve the bandwidth up to 20 %. Using a right parameter configuration, further improvement is expected.

This thesis describes the theory, implementation and discusses the performance of using the bandwidth enhancement techniques; the proximity coupled stack configuration and the coplanar parasitic multi-resonator in the microstrip antenna in order to improve the bandwidth performance.

1.2 Thesis outline

This thesis project starts with the literature study of the microstrip antenna in order to get its basic fundamental and they are all concluded in chapter 2. Here, all the main aspects of the microstrip antenna such as its structure configuration, radiation mechanism, polarization, feeding techniques, method of analysis etc are covered. Several techniques used in the enhancement of the bandwidth are also included in this chapter.

Chapter 3 covers the necessary fundamental aspects for the implementation of the antenna design. This chapter discusses about the configuration of the design including the specification and parameter setting necessary before validation process is carried out.

Validation process including the simulation and fabrication of the proposed antenna is detailed in chapter 4. Here, different variables effects on the performance of the antenna are described.

In chapter 5, based on the result obtained in previous chapter, the overall performance of the proposed designs is concluded. Last but not the least, possible improvement for future work is also outlined.