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STUDY OF RETURN LOSS OF AN ARRAY OF STACKED MICROSTRIP RING ANTENNAS

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Return loss is the difference, in dB, between forward and reflected power measured at any given point in an RF system and, like SWR, does not vary with the power level at which it is measured. To meet high performance requirements microstrip antenna are used. In this paper an array of 4x4 and 2x2 microstrip antenna elements is designed using CST (Computer Simulation Technology) Microwave studio and TXL Software and Return Loss is obtained. Return loss of 4x4 structure is compared with the 2x2 Structure. By comparing these structures it has been observed that 4x4 structure has better return loss of –24.27 dB as compared to –11.23 dB of 2x2 antenna structure. Thus, it can be concluded that stacking the model and using more number of antenna patches in the form of array could increase the bandwidth.

Keywords: Array, Microstrip Ring Antenna, Return Loss

1. Introduction

The rapid growth of wireless and mobile communication systems has increased the demand for wider bandwidth and smaller devices. Antennas following this trend have to be compact and integrated while satisfying desired impedance behavior and radiation characteristics. In communication, wideband is a relative term used to describe a wide range of frequencies in a spectrum. Microstrip ring antennas are known to have broader bandwidth than that of rectangular and circular patches. They are widely used due to their advantages like lightweight, inexpensive and ease of integration with active components and radio frequency devices [1,2]. The design of microstrip antenna is strongly related to several characteristics such as gain, radiation pattern, complexity, side lobe level and bandwidth [3,5]. Microstrip ring antennas have been extensively used but stacked microstrip ring antennas deserve special attention because surface waves can be eliminated while maintaining large bandwidth. Also stacking reduces the side lobe level of antennas considerably and can be used for wide band antenna design. Etching the transmission lines and antenna array on the same layer enables to reduce the manufacturing cost. Unfortunately, this may increase the size of antenna and could degrade antenna performance [4]. The main objective of this paper is to compare the return loss of 4x4 array with the 2x2 array of microstrip antenna structure. To overcome many problems of antenna multiple layer printed antennas were studied. Stacking of model can be used to extend to thick heights. In this context, an analysis of 4x4 array of antenna elements is compared to 2x2 array of elements and return loss is studied. Both antenna structures are analyzed numerically using computer simulation technology (CST) microwave studio).

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2. Theory

In the most basic form, a microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate, which has a ground plane on the other side. The patch is generally made of conducting material such as copper or gold and can take any possible shape. Microstrip antennas are used not only as single elements but are very popular in arrays. Arrays are very versatile and are used to synthesize a required pattern that cannot be achieved with a single element. Microstrip ring antennas have a number of useful features like the number of resonant modes can be controlled by controlling the ratio of outer to inner radii. When operated with TM_{12} mode input impedance can be achieved with high accuracy but at the cost of larger size. In many applications it is necessary to design antennas with very directive characteristics. This can only be accomplished by increasing the electrical size of antenna. Enlarging the dimensions of single elements often leads to more directive characteristics. Another way to enlarge dimensions of antenna without increasing the size of individual elements is to form an assembly of radiating elements in an electrical and geometrical configuration. This new antenna, formed by multi elements, is referred to as an Array. In most cases elements of an array are identical. The total field of the array is determined by the vector addition of the fields radiated by the individual elements. Arrays are very versatile and are used to synthesize a required pattern that cannot be achieved with a single element.

3. Antenna Structure

An array of 4x4 and 2x2 elements is made by stacking. Layers of dielectric material are stacked one over another with $\mu = 1$ & $\in = 2.2$ thus creating the base of the antenna. Then the radiating patches are formed on this stacked base. An array of 4x4 & 2x2 elements is created. In both the cases, the thickness and length of transmission line is selected with TXL software.

3.1. 4x4 Array of Antenna Structure

The antenna layout is represented in fig (a). The length (L) and thickness (T) of transmission line depends on the impedance of transmission line. For 50Ω T = 4.94Ωm, L = 10.836Ωm. For 100Ω T = 1.43mm, L=11.30mm. For 200Ω T = 0.17mm, L = 11.53mm. This length can be taken in multiples of 2, 3, 4 and so on. The outer and inner radius of the radiating patch is 9.7mm and 2.5mm. Fig (b) shows the Return Loss of 4x4 structure in dB which is –24.27.

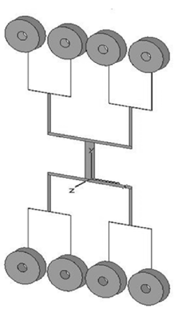

Fig (a)

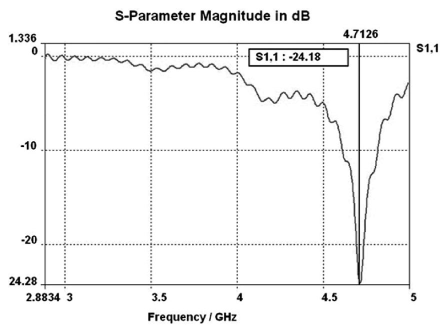

Fig (b)

3.2. 2x2 Array of Antenna Structure

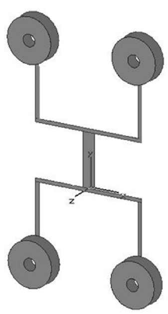

Fig (c)

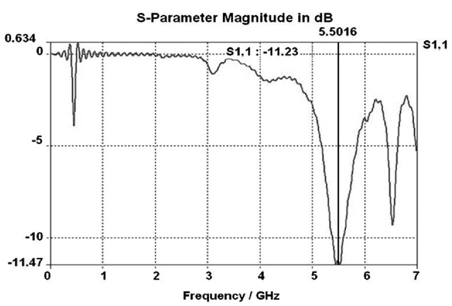

Fig (d)

The layout of array is given in fig (c). The length (L) and thickness (T) of transmission line depends on the impedance of transmission line. For 50Ω T = 4.94mm, L = 10.836mm. For 100Ω T = 1.43mm, L = 11.30mm. For 200Ω T = 0.17mm, L = 11.53mm. This length can be taken in multiples of 2, 3, 4 and so on. The outer and inner radius of the radiating patch is 9.7mm and 2.5mm. Fig (d) shows the Return Loss of 2x2 structure in dB which is –11.23.

4. COMPARISON BETWEEN BOTH THE STRUCTURES

A comparison is made between the return loss of both antenna structures i.e. 4x4 array and 2x2 array. From the results of comparison of return loss of both the structures we see that both the structures have good impedance matching of –24.27dB and –11.23dB respectively. The results are obtained for a frequency up to 5 GHZ. The comparative results are shown in TABLE I.

Table I

Specifications	Structure 1 (4×4)	Structure 2 (2×2)
Return loss (dB)	–24.27	–11.23
Radii of radiating patch	9.7(outer) & 2.5 (inner)	9.7(outer) & 2.5 (inner)

5. Conclusions

The 4x4 stacked array structure is studied in this paper with the aim to compare its return loss with 2x2 stacked array structure. The unique property is that it is a stacked model which reduces the side lobe level. From the comparison it is obviously shown that 4x4 array gives better return loss as compared to 2x2 array structure instead all their dimensions are same. Thus, it can be concluded that by using more number of antenna elements in the form of array better performance can be achieved.

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