Design of Microstrip Antennas Arrays for Applications in Wireless Communications

OTAVIO LAVOR, HUMBERTO FERNANDES, ALMIR SILVA NETO
Department of Electrical Engineering
Federal University of Rio Grande do Norte
Campus Universitário Lagoa Nova, Natal
BRAZIL
otavioplavor@gmail.com

Abstract: - This paper analyses the influence of microstrip antenna arrays designed for a frequency of 2.5 GHz, aiming at applications in wireless communications, in special, 4G Technology. From a standard antenna with circular patch, elements are introduced to obtain linear and circular array, since arrays are interesting, whenever it want high gains. While the linear arrays are simple and practical, circular arrays can provide better symmetry. All prototypes are built and measured data are compared with the simulated data showing a good agreement.

Key-Words: - Microstrip antenna, linear array, circular array, circular patch, gain, wireless communications.

1 Introduction

Among the various types of antennas, one of the most used types due to its characteristics for application in modern communication systems are microstrip antenna [1]. Among the advantages of microstrip antennas, it can highlight: ease of shaping the flat and non-flat surfaces, simple construction, low cost, versatility in terms of the resonance frequency, polarization, impedance and radiation pattern. These kinds of antennas have some disadvantages, such as low efficiency, low power, low directivity and small bandwidth (of a few percent) [2].

These antennas play nowadays an important role in telecommunications, being available in a wide variety of settings [3].

Wireless communications turned out to be the most promising area for the application of antennas due to the quality of research being done, and to ensure the service.

An antenna with circular patch has been used in UWB system [4].

The arrays are widely used, since in many applications, antennas with high gains are necessary. The main arrays are linear, planar and circular, and the linear array is the simple and practical [2]. Planar arrays are more versatile and may provide more symmetrical in relation to the diagrams linear array. Applications include tracking radar, search radar, remote sensing, communications and many other [2]. The circular array has applications in radar, sonar, spread underground and many others. These arrays have been proposed for wireless communications and in particular to smart antennas [5].

In [6], is studied the influence of a semicircular array and in [7], a circular array is designed to operate at 15 GHz, where it was used rectangular elements.

Continuing a series of studies, this paper presents the results of the influence of a linear array with two elements and a circular array with four elements, where these elements are all circular. The purpose is to compare with a standard antenna designed for 2.5 GHz and build prototypes to compare measured and simulated data.

2 Design of Standard Antenna, Linear and Circular Array

The material used for the substrate is glass fiber (FR4) with relative permittivity (ε_r) of 4.4 and a thickness of 1.56mm. For design of standard antenna was used a circular patch structure with ray a = 16.8 mm fed by a microstrip line of length b = 14.3 mm and width w = 2.32mm. This radius value is obtained by the method of Transverse Transmission Line. The material for ground plane, patch and feed line is copper. The figure below shows the geometry of the patch of the standard antenna.

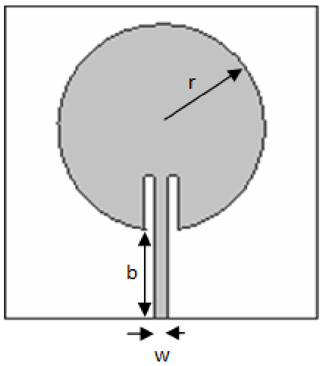

Fig. 1 Geometry of the standard patch

For the linear array are considered two elements, where the spacing between the elements is considered the same length of the fed line. Below can be seen the geometry of a linear array, where the dimensions are described above.

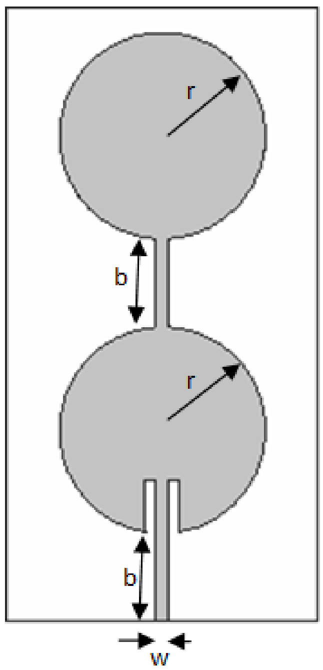

Fig. 2 Geometry of patch of an array with two elements

For the circular array, four elements are considered. Figure 3 shows the geometry of this array, where the dimensions are the values described above. In this array, the distance between two opposite elements is c = 26.28 mm.

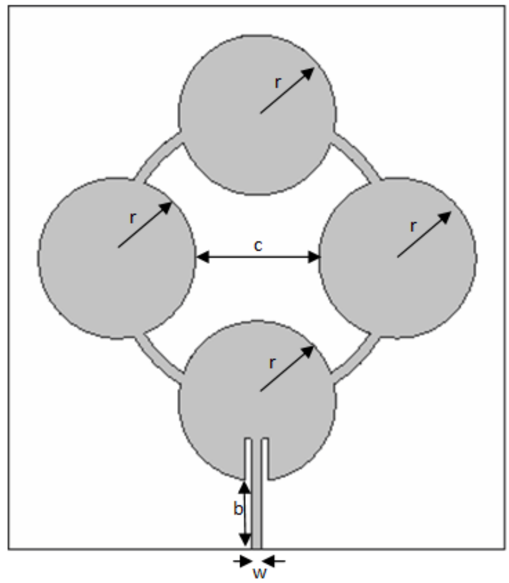

Fig. 3 Geometry of circular array with four elements

3 Results

Simulations are done to compare the return loss of the standard antenna with proposed arrays. The comparisons are made with the standard antenna, linear array with two elements and the circular array with four elements.

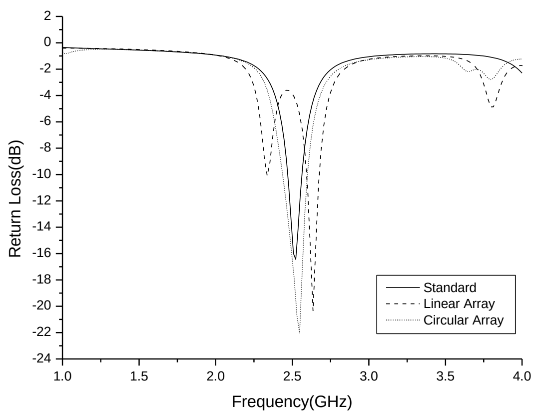

Fig. 4 Return loss versus frequency

Here one sees a shift in frequency when the arrays are considered, in particular linear array. The circular array is one where the curve most closely matches the standard curve. The table 1 below shows the return loss for each resonance frequency.

Table 1 Return loss and resonance frequency.

Type of antenna	Frequency (GHz)	Return loss (dB)
Standard antenna	2.51	-16.69
Linear array	2.33	-10.34
	2.64	-20.34
Circular array	2.54	-22.04

The gain of the standard antenna and arrays was analyzed. Figure 5 shows the total gain as a function of angle.

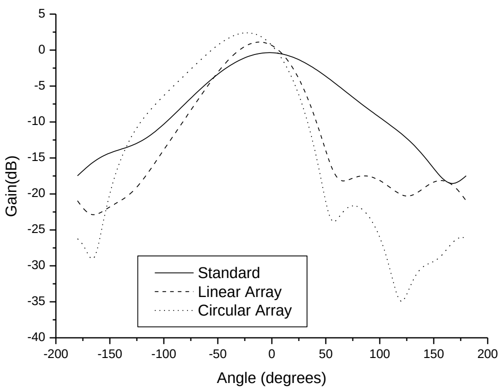

Fig. 5 Total gain of the standard antenna and arrays

While the standard antenna has a gain of -0.35dB, the linear array with two elements has 1.11 dB and circular array has 2.4 dB. The dimensions were increased to achieve the array, but the gain it increased significantly. Therefore, arrays are interesting when you want a better gain to the antenna.

Prototypes were constructed in order to check the simulations. The prototypes were built to the standard antenna, linear array with two elements and circular array. Pictures are seen below.

Fig. 6 Picture of the standard antenna

Fig. 7 Picture of the linear array

Fig. 8 Picture of the circular array

Once constructed, the prototypes were analyzed so that the measured results are compared with the simulated. Comparisons are seen in the graphs of the figures 9 to 11.

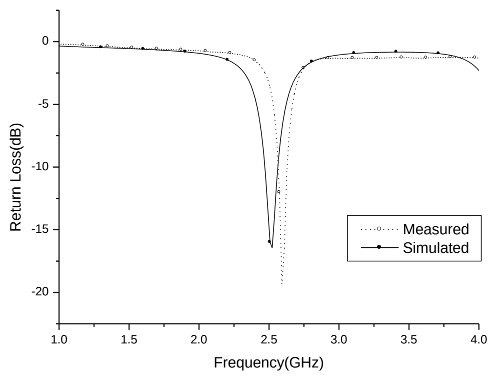

Fig. 9 Return loss of the standard antenna

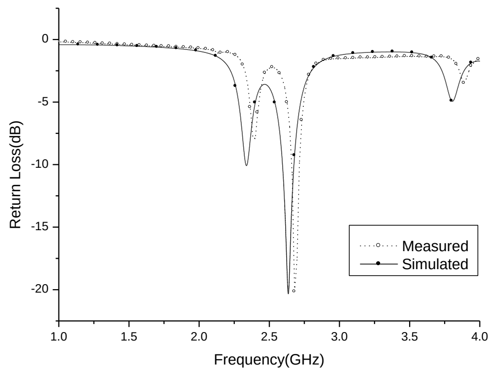

Fig. 10 Return loss of the linear array

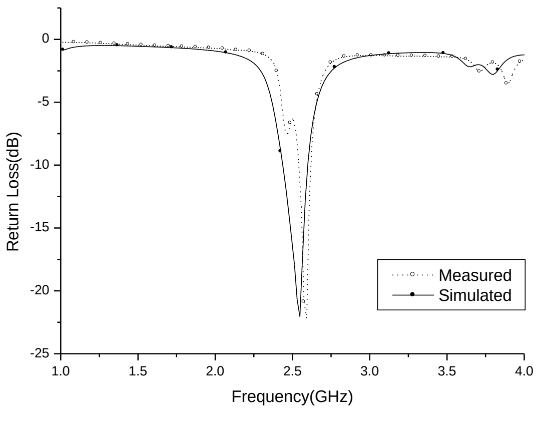

Fig. 11 Return loss of the circular array

In all comparisons there was a shift in the frequency measured, but such displacement is very small and the measured return loss is less than or equal to the simulated, which leads to consider such as very satisfactory results. The differences may be due to inaccuracies of the measures in the manufacturing process.

4 Conclusion

In this work, it was examined the influence of a linear and circular arrays her for applications in wireless communications. The arrays were compared with a standard antenna of circular patch. All prototypes were built and measured data are in accordance with the simulated, making these prototypes good candidates for the 4G technology system.

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