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A 2x2 Array Antenna for WLAN and WiMAX Applications

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Abstract: A 2x2 array antenna for WLAN and WiMAX applications is proposed. The antenna is conformed with rectangular patch elements and it´s resonant frequencies are 2.4 GHz and 3.6 GHz, with base band signal bandwidths of 100 MHz and 120 MHz, respectively. The 2x2 array antenna is oriented to operate in the WLAN 2.4 GHz and WiMAX 3.6 GHz. The overall size is 12.5 x 12.5 cm^2, with rectangular patches printed on FR4 Epoxy substrate with relative permittivity of 4.3, height of 1.6mm and tangential loss of 0.02. The ground plane is printed at the bottom of the substrate. La gain reached by the antenna is equal to 6.7 dB at 2.5 GHz and 0.13 dB at 3.7 Ghz.

Key words: Wireless Local Area Network · WiMAX · Patch Array Antenna · 2x2 array antenna

INTRODUCTION

Antenna arrays have multiple advantages and important properties, such as high gain, light weight, small dimensions compared to other antenna arrays and can achieve multiband resonance enabling the user terminal to operate simultaneously in various communication technologies. At present, there are interesting proposals for microstrip array antennas for short- and long-range wireless communication systems, such as WiFi and WiMax networks, respectively. The proposal presented [1] is one of them, which consists of a 2x2 array antenna with rectangular microstrips with slots, just for simultaneous operation in WiMAX and WLAN technologies, with resonance in the frequencies 2.41 GHz and 3.61 GHz, gains of 3.65 dB and 1.01 dB, respectively. The design of a microstriparray antenna with rectangular slots for 5G and C band applicationsis presented in [2].The estimated gain is 5.37 dBi. An array antenna for GSM, WiMAX and WLAN technologies is presented in [3], with resonances in the frequencies 1.8 GHz, 3.6 GHz and 5.5 GHz, with gains of 6.45 dBi, 7.67 dBi and 7.55 dBi,respectively.

In this 2x2 array antenna each patch element is spaced half wave length for the 2.4 Ghz frequency, in the direction of the “x” and “y” axes. The geometry of the patch antenna element was designed using mathematical microstrip equations presented in literature [4-5]. Each array element is a triband patch antenna, which performance parameters are presented.

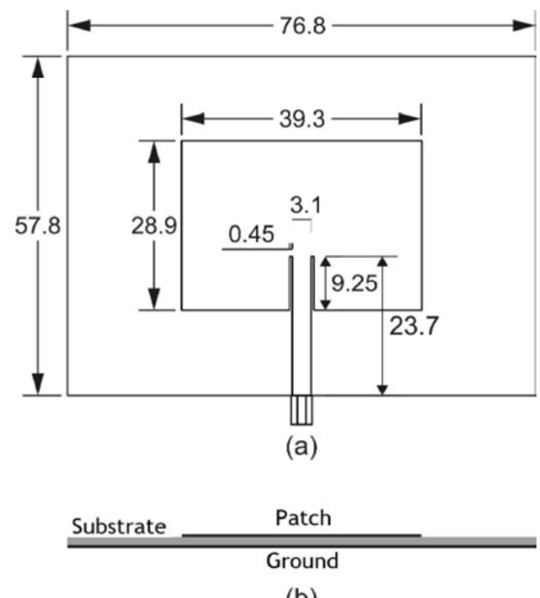

Fig. 1: Geometry of the patch antenna (a) top view y (b) side view, with dimensions in millimeters.

Rectangular Patch Element: Figure 1 shows the geometry of the rectangular patch element of the array antenna. Mathematical design equations were used in the design

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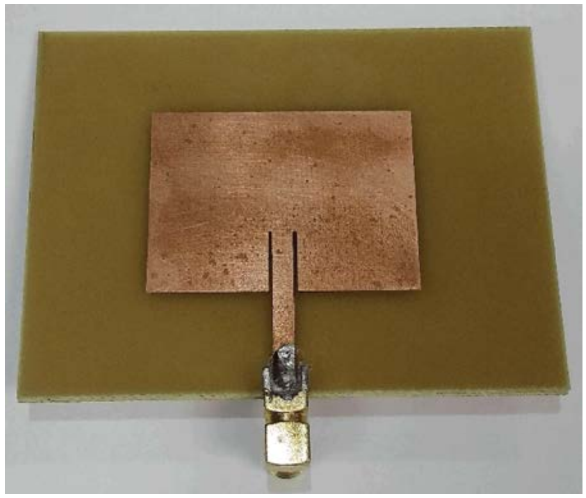

Fig. 2: Triband microstrip antenna

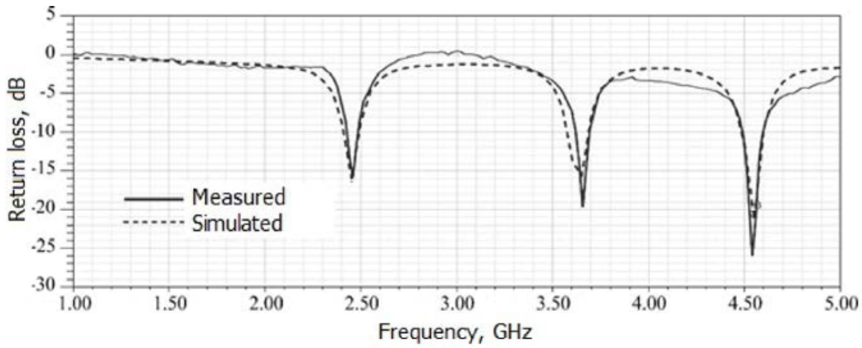

Fig. 3: Return loss of the triband microstrip antenna

of the microstrip antenna. The dimensions are in millimeters. Figure 2 shows the picture of the patch element.

The patch is printed on FR4 dielectric substrate with 1.6 mm of height and 4.4 of relative permittivity. The miscrostrip antenna was fabricated and probed using a vector signal analyzer. Figure 3 shows the measured and simulated return loss in decibels.

The measured and simulated return loss results coincide satisfactorily in the three defined resonance frequencies below -10 dB. The first resonance frequency is at 2.45 GHz with an 80 MHz bandwidth defined between 2.40 GHz to 2.48 GHz. The second resonance frequency is 3.65 GHz with an 83 MHz bandwidth defined between 3.584 GHz and 3.667 GHz. The third resonance frequency is 4.52 GHz with an 84 MHz bandwidth defined between 4,480 GHz and 4,564 GHz.

The radiation pattern responses for E and H -plane in polar coordinates (r, θ) and in decibels are presented in Figures 4 and 5, respectively. The polar response in E-plane presents the distribution of electric field strength and that of H-plane presents the distribution of magnetic field strength.

Figure 6 shows the 3D radiation pattern for the three resonant frequencies. The simulated gain is 2.3 dB, 1.2 dB and 4.6 dB for the operation frequency 2.4 GHz, 3.6 GHz and 4.5 Ghz.

Geometry of the Array Antenna: The 2x2 array is shaped with the rectangular patch of Figure 1. The geometry of the 2x2 microstrip array has a surface area equal to 15,625 x 12.5 cm^2, shown in Figure 7.The four patch elements are spaced 62.5 millimeters each other, in the direction of the "x" and "y" axes, which is equal to half a wavelength compared to the 2.4 GHz frequency. The return loss response for the array was calculated using the 3-dimensional electromagnetic simulation program HFSS by ANSYS. The return loss response corresponding to the array is presented in Figure 8. The array has two resonance frequencies, at 2.5 GHz and 3.7 GHz, with bandwidths for baseband signals of 130 MHz and 50 MHz, respectively.

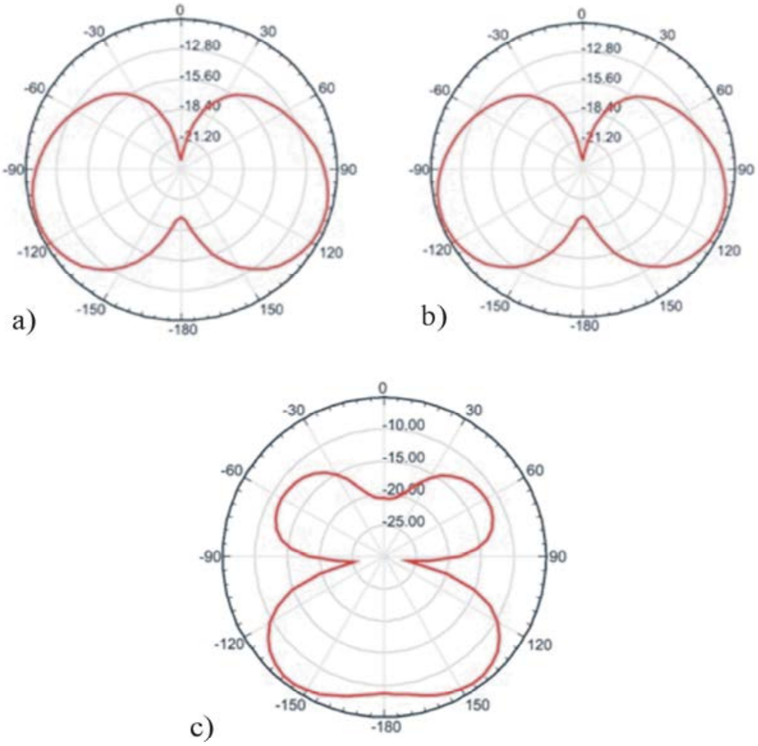

Fig. 4: E planeradiation pattern for the frequency of (a) 2.4 GHz, (b) 3.6 GHz y (c) 4.5 Ghz

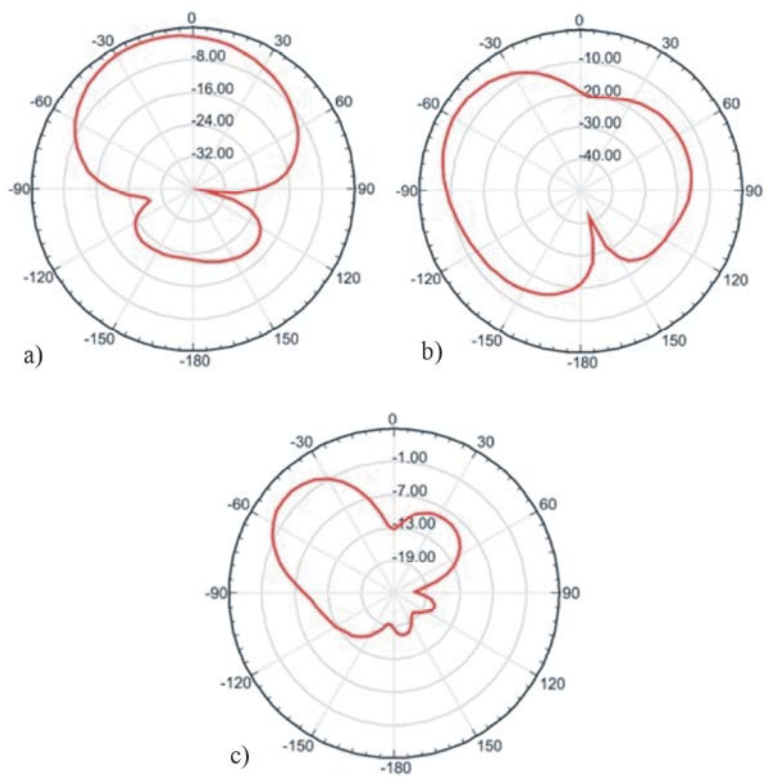

Fig. 5: H plane radiation pattern for the frequency (a) 2.4 GHz, (b) 3.6 GHz y (c) 4.5 Ghz

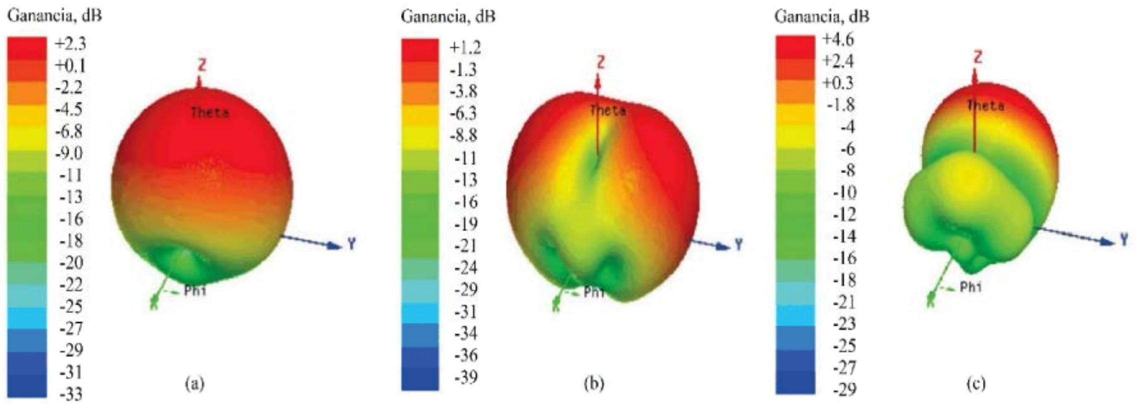

Fig. 6: Patrón de radiación en 3 dimensiones de la antena de microcinta para las frecuencias (a) 2.4 GHz, (b) 3.6 GHz y (c) 4.5 GHz

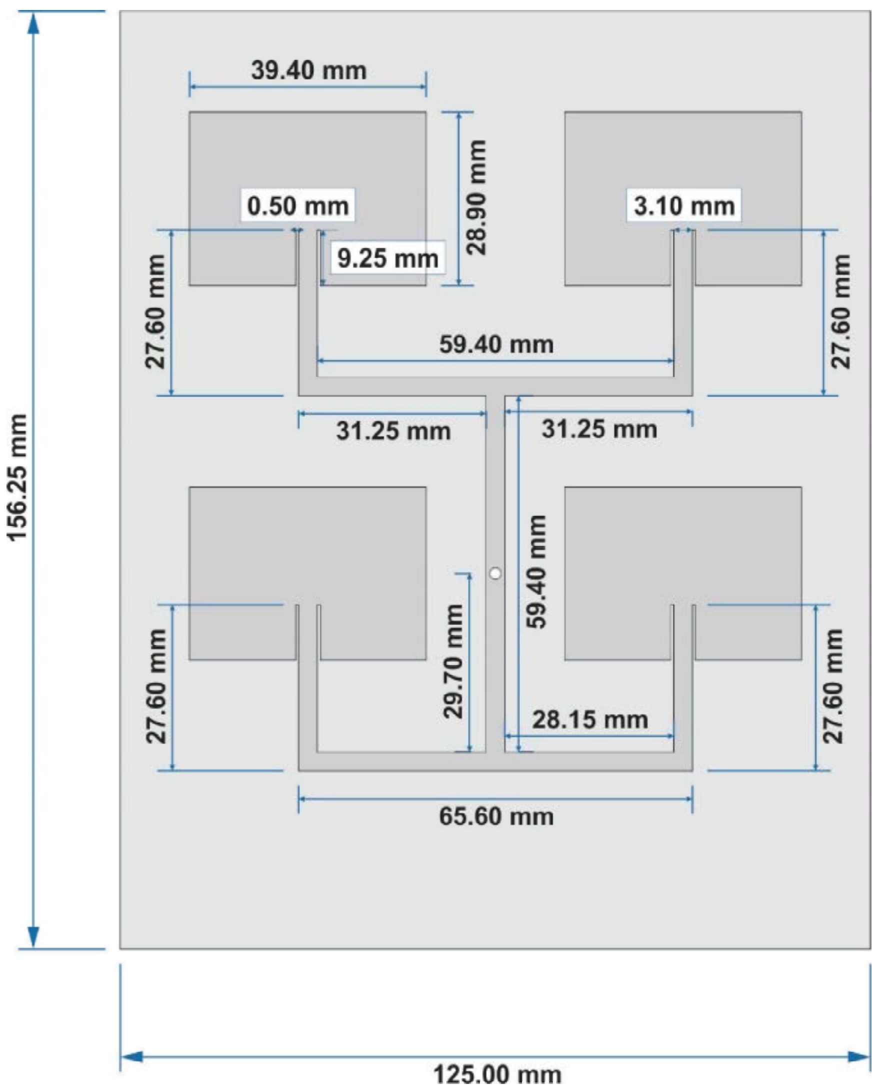

Fig. 7: Arrayantennageometry

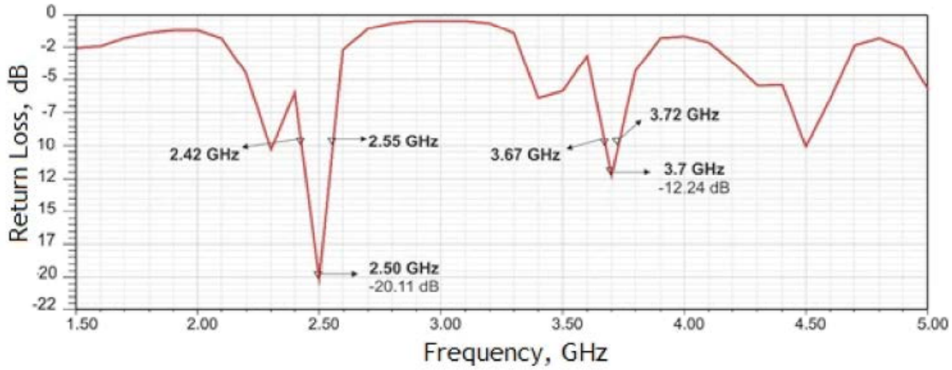

Fig. 8: The simulated return loss of proposed array antenna

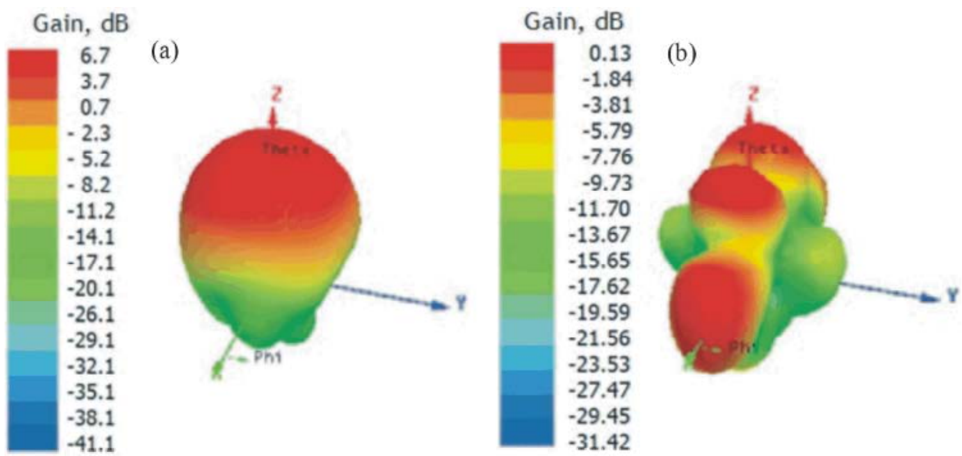

Fig. 9: 3D radiation patterns for the frequencies(a) 2.5 GHz and (b) 3.7 Ghz

The 3D radiation patterns for the operation frequencies of 2.5 GHz and 3.7 GHz is presented in figure 9. The gain reached by the antenna, at the two resonant frequencies are 6.7 dB and 0.13 dB.

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CONCLUSIONS

A dual band 2x2 array antenna isproposed. The patch element was manufactured and experimentally tested. The performance parameters of the rectangular patch are presented. The resonance frequencies of the patch are 2.45 GHz, 3.65 GHz and 4.52 GHz, each one with return loss of -15 dB, -20 dB and -25 dB and bandwidth of 80 MHz, 83 MHz and 84 MHz, respectively. The gain achieved by the microstrip antenna is equal to 1.98 dB at the 2.4 GHz frequency, 1.2 dB at 3.6 GHz and 4.6 dB at 4.5 GHz. Radiation patterns are also presented in the E and H planes. The 2x2 array antenna isconformedwith the patch element and it provides a simultaneous application in WLAN and WiMAX technologies. The return loss response of the 2x2 array has two resonance frequencies, at 2.5 Ghz and 3.7 GHz, with bandwidths of 130 MHz and 50 MHz, respectively. The antenna achieves a gain equal to 6.7 dB at 2.5 GHz and 0.13 dB at 3.7 GHz.

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