Circularly Polarized Microstrip Patch Array for Wireless Communication Applications

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Abstract

In recent years, great interest was focused on Microstrip antennas for their small volumes, low profiles, good integration, low costs and good performance. With the continuous growth of wireless communication service and the constant miniaturization of communication equipment, there are higher and higher demands for the volume of antennas, integration and working band. This paper presents A circular polarized (CP) Circular Microstrip antenna array with multi- band for wireless communications system application which are suitable for the 2.92GHz, 4.3GHz, 5GHz triple-band operations. These systems may include various combinations of WiMAX (Worldwide Interoperability for Microwave Access) and wireless local-area network (WLAN, 2.8 GHz for wireless video operation). Preliminary numerical results obtained by the HFSS are presented.

1. Introduction

Several methods for obtaining multi-band and/or wideband Antenna characteristics have been developed. In [1], a dual wideband folded Microstrip-patch antenna was introduced for possible wireless local-area network (WLAN) applications in the 3.5-4 GHz frequency range. The proposed antenna operated in a wide frequency band by utilizing a unique coupling mechanism between the radiating elements and the ground plane. In [2], a novel reconfigurable patch antenna with switchable slots (PASS) was proposed to realize various functionalities, such as dual-frequency operation, dual-band circularly polarized (CP) performance, and polarization diversity with only one patch and a single feed .A cavity-model-based simulation tool, along with a genetic optimization algorithm, was presented in [3] for the design of dual-band Microstrip antennas. This used multiple slots in the patch, or multiple shorting strips between the patch and the ground plane. The optimization of the positions of the slots and shorting strips was then performed via a genetic optimization algorithm to achieve acceptable antenna operation over the desired frequency bands. A similar approach was presented in [4], where a single low-profile printed antenna, which provided dual-band operation by having loading from two-step slots embedded close to the radiating edge.In [4], it was also shown that the ratio of the two frequencies can be well controlled by the aspect ratio of the step-loading dimension.

WLAN has made rapid progress and there are several IEEE standards already, namely 802.11a, b, g and n.Which used the bands of 2.4 (GHz) band 2.4 to 2.483 and 5.2 (GHz) band 5.15 to 5.35 (GHz) with the development of WLAN. In this paper we are present a circular polarized (CP) circular Microstrip antenna with triple band for wireless communications system applications which are suitable for the 2.8-GHz, 3.5-GHz and the 5-GHz triple-band operations. So a triple band is going to be generated to be operate on the third frequency band 3.5(GHz) It is well known that the bandwidth of the Microstrip antenna is very narrow. Several techniques such as using thick and air-filled substrate have been employed to improve the bandwidth. Among the feeding techniques, coaxial feed is one of the most popular methods for electrically thick substrate. However, the inherent problem of this method is the inductance of the probe that prevents good matching.

This can be compensated by probe-fed proximity coupled antenna as explained in B.L.Ooi [5]. In this Letter, an alternate design that uses a square probe-fed proximity coupled to a flower-shaped Microstrip patch is proposed. By means of an array of antennas, it is possible to obtain a pattern that is highly directive in one direction. In the case of point- to- point communications highly directive a pattern cannot be obtained by using a single Microstrip patch antenna. However by means of an array of antennas, it is possible to obtain a pattern that is highly directive in one direction.

Multi-polarized operation can be achieved by aperture coupled Microstrip patch antennas, whose many desirable features are well surveyed in the literature such as in A.vallechi [6]. However, the impedance bandwidth is very small, As far as the bandwidth enhancement of radiating structure is issues of primary concern, by using probe-fed proximity coupled element bandwidth up to 12% can be increased. The direct feeding of individual elements in planar multi-polarization antenna arrays is an involved matter and implies

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complex feed networks, crowded with phase-switching circuits and suffering from unwanted mutual coupling between the various sections pertinent to different polarizations, and reduced antenna efficiency. To overcome these difficulties it is convenient to arrange the radiating elements into sub arrays, so as to streamline the array design, decrease losses, and simplify RF control circuitry. Particularly, planar cells with a central patch could be very advantageous since they can provide pencil beam radiation patterns with low side lobes. Indeed, single polarized two-dimensional Microstrip patch sub arrays have been demonstrated in Legacy et al. [7] and Duffy et al. [8], where two similar designs with probe and slot feed, respectively, are described.

The geometry and design approach of the antenna are outlined in next section.

2. Antenna Design And Onfigurations

Figure 1 shows the geometry of the fabricated Antenna array. The antenna comprises a 5 dice flower-shaped Microstrip patch in the first layer, a square-fed patch in the second layer and a ground plane. The exact dimensions for the proposed antenna are also given in figure 1. Since an air-filled dielectric substrate is adopted, the flower shaped patch is separated from the ground plane .The flower-shaped Microstrip patch is proximity-fed via two square probe-feds where the vertical section is made from a 50Ω coaxial connector with an inner diameter of 1.25 mm. The copper square plate on the probe has a length of 5 mm. The probe is feed from centre of square patch. The entire 5 dice flower-shaped patch and the square plate are etched from a 0.1 mm-thick copper sheet. The centre frequency of our proposed antenna is designed at around 5.0 GHz and the height of the substrate is maintained approximately at 0.1λo.

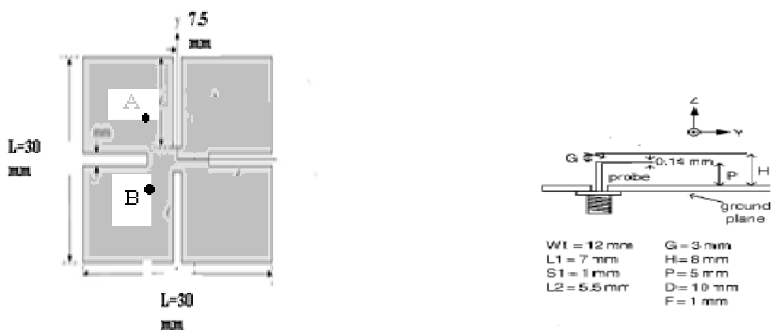

Fig. 1 Geometry of proposed square-fed flower -shaped Microstrip patch antenna

Microstrip T line sections are used to propagate a resonant standing wave to feed the surrounding flower shaped patches. Specifically, these latter elements are connected to the central patch by the pair of their outer corners so as to realize a dual feeding arrangement. A dual corner feed has been adopted for the patches since it provides higher isolation than the standard dual edge feed as shown in Zhong et al. [5]. Each connecting Microstrip line is one wavelength long on the whole to deliver an excitation signal to the external patches with phase equal to that of the central patch. The narrow width of the connecting Microstrip lines, corresponding to 100 Ohm impedance, minimizes the discontinuity effects at bends and at the corners of the central patch. The excitation amplitude for the outlying patches is controlled by the impedance levels of these elements and the central patch. The input impedance of the outlying corner-fed patches can be estimated through the closed form expression derived in Lim et al. [6]. As a result, the loading effect of the outer patches can be included in the design and impedance matching of the central patch by using a full-wave approach in conjunction with basic circuit theory as in Duffy et al. [8]. It is noted that the central patch turns to be smaller than the external ones due to the loading of the Surrounding elements which tend to increase its resonance Frequency.

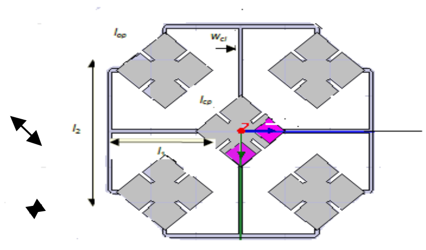

Fig. 2 Bottom view of the dice five antenna showing the square patches, the cross-shaped slot and the two feed lines. The central patch side (*l*cp) is 28.5 mm long, whereas the side length of the outer Patches (*l*op) is 30 mm. The other antenna dimensions are as follows: *l*s = 22.8 mm; ws = 1.2 mm; *l*1 = 38.4 mm; *l* 2 = 66.2 mm; wfl = 3.5 mm;

The above antenna geometry allows obtaining any kind of linear or circular polarization of the radiated field by appropriately driving the two input ports. Particularly quadrature excitation of the feeds results in circularly polarized radiation

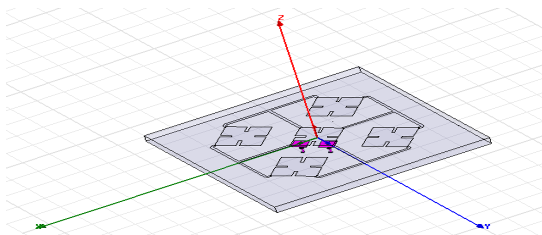

Fig. 3 Perspective view of the antenna in its single layer feed version,

3. RESULT AND DISCUSSION

Various applications can be the subject for this newly designed antenna array, since it is a multi-functional and multi-resonant antenna, according to simulationresults. Each resonant frequency can be the subject of various applications in today's modem wireless communication world. The return loss parameter going under -10 dB; in Figure 4 also indicated the presence of three resonant frequencies. This new wideband operation of the antennas hares the presence of resonances at the wireless CCTV application at 2.8 GHz, and two other completely new applications. In the present work, antennas of operating frequency at 5.0 GHz to 6 GHz 30% bandwidth can also be observed.

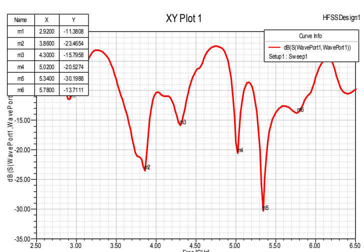

Fig4 .Return loss VS Frequency

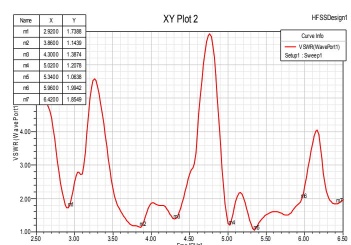

Fig. 5 VSWR Vs Frequency

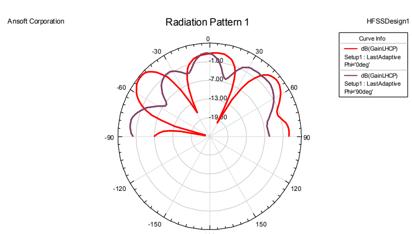

Fig.6 RHCP Radiation pattern

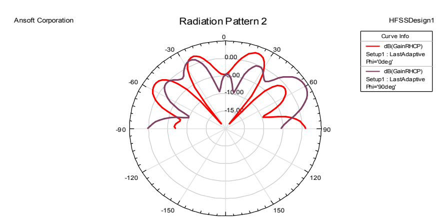

Fig.7 LHCP Radiation Pattern

4. Conclusion

A new multi-band antenna array design has been presented. As shown and discussed, the designed antenna has multiple bands of operation and a wide range of applications. By a simple change of feeding position, the functioning of the antenna varies completely, while maintaining certain constant applications.

5. REFERENCES

1. T. Sittironnarit and M. Ali, "Analysis and Design of a Dual- Band Folded Microstrip, Patch Antenna for Handheld DeviceApplication," *IEEE Southeast Conference Proceedings*, 2002, pp.255-258.

2. F. Yang and Y. Rahmat-Samii, "A Compact Dual Band Circularly Polarized Antenna Design For Mars Rover Mission," *I EEE International Symposium on Antennas and Propagation Digest, 3,* June 22-27, 2003, pp. 858-861.

3. Oziemn, M. Selma, M. 1. Aksun, and L. Alatan, "Design of Dual-Frequency Probe Fed Microstrip Antennas with Genetic Algorithm," *IEEE Transactions on Antennas and Propagation,*AP-51, 8, August 2003, pp. 19 47 -1 95 4 .

4. M.Khairul, H. Ismail, and M. Esa, "Low Profile Printed Antenna With A Pair Of Step Loading For Dual-Frequency Operation," Proceedings of the 2003 Asia Pacific Conference On *Applied Electromagnetics (APACE 2003)*, Shah Alamn, Malaysia,2003.5. H. Y. Kim, Y. A. Lee, C. H. Won.

5. B.L. Ooi and I. Ang "Broadband semicircle-fed flower-shaped Microstrip patch antenna," *Electron. Letter* vol... 41 no. 17, August 2005

6. A.Vallechi "polarization agile microstrip patch planar Array antenna,"Ursi, Emts 2004 Legay, H., and L. Shafai, "A high performance spider sub array of five Microstrips," in *IEEE Antennas and Propagation. Soc. Int. Symposium. Dig.*, 1993, pp. 1394-1397.

7. Duffy, S. M., and D. M. Pozar, "Aperture coupled Microstrip sub arrays," *Electron. Letter*, vol. 30, no. 23, Nov. 1994, pp. 1901-1902.

8. Zhong, S., X. Yang, S. Gao, and J. Cui, "Corner-fed Microstrip antenna element and arrays for dual-polarization operation," *IEEE Trans. Antennas Propagation.*, vol. 50, no. 10, Oct. 2002, pp. 1473-1480

9. Lim, B. W., E. Korolkiewicz, and S. Scott, "Analysis of corner Microstrip fed patch antenna," *Electron. Lett.* vol. 31, no. 9, Apr. 1995, pp. 691-693.

10. Edimo, M., A. Sharaiha, and C. Terret, "Optimised feeding of dual polarised broadband aperture-coupled printed antenna," *Electron. Lett.*, vol. 28, no. 19, Sept. 1992,pp.1785-1787.

11. Yamazaki, M., E. T. Rahardjo, and M. Haneishi, "Construction of a slot-coupled planar antenna for ual polarisation," *Electron. Lett.*, vol. 30, no. 22, Oct. 1994,pp.1814-1815.