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DESIGN OF NEW COMBINED ANTENNA FOR DUAL POLARIZATION USING CROSSED DIPOLE AT 2.23 GHZ AND 5 GHZ

Zeyneb Berkat and Noureddine Boukli Hacene
Faculty of Technology, Telecommunication Laboratory, University Abou Bekr Belkaid Tlemcen, Algeria
E-Mail: zinebtelecom@hotmail.fr

ABSTRACT

This paper discusses the design of new compact dual polarized antenna for wireless communication systems, dual band for 2.23 GHz and 5.14 GHz, the polarization diversity becomes one of the most important techniques than can be used, the main reason for this shift is that the method does not require any extra bandwidth or physical separations between the antennas, the final design Consists of a rectangular patch with notches combined by a crossed dipole in the same Ground and substrate, by optimized of this new structure, the two polarizations in the required band are obtained. The stable peak gain, omnidirectional radiation patterns are also achieved due to its good performance, through simulation by CST Microwave.

Keywords: combined antenna, S band, circular polarization, diversity of polarization, axial ratio.

1. INTRODUCTION

Recently, wireless communications represent one of the highest growing markets, especially on the development of mobile communications and wireless local area networks (WLANs), where high capacity transmission systems are required. These concern new wideband RF wireless components such as antennas, filters and so on. Especially for antenna issue, planar broadband antennas using coplanar waveguide CPW feed lines have been proposed as an alternative for micro strip feed lines [1].

An antenna is a transducer that converts radio frequency electric current to electromagnetic waves that are then radiated into space. The electric field or "E" plane determines the polarization or orientation of the radio wave. In general, most antennas radiate either linear or circular polarization. A linear polarized antenna radiates wholly in one plane containing the direction of propagation. In a circular polarized antenna, the plane of polarization rotates in a circle making one complete revolution during one period of the wave. If the rotation is clockwise looking in the direction of propagation, the sense is called right-hand-circular (RHC). [2] If the rotation is counter clockwise, the sense is called left-hand-circular (LHC).

An antenna is said to be vertically polarized (linear) when its electric field is perpendicular to the Earth's surface. An example of a vertical antenna is a broadcast tower for AM radio or the "whip" antenna on an automobile. Horizontally polarized (linear) antennas have their electric field parallel to the Earth's surface. Television transmissions in the USA use horizontal polarization. A circular polarized wave radiates energy in both the horizontal and vertical planes and all planes in between. The difference, if any, between the maximum and the minimum peaks as the antenna is rotated through all angles, is called the axial ratio or ellipticity and is usually specified in decibels (dB) [3]. If the axial ratio is near 0 dB, the antenna is said to be circular polarized. If the axial ratio is greater than 1-2 dB, the polarization is often referred to as elliptical.

As well know, the micro strip monopole antenna can only radiate the linearly polarized (LP) wave with wide band bandwidth until to now, few studies of the circularly polarized monopole antenna have been investigated.

The presented antenna is also able to operate in linear polarization mode for S band the same radiating elements are implemented for a linear or circular polarization antenna, this new design has been manufactured and measured, with good broad band results in both linear and circular polarization operation mode [4].

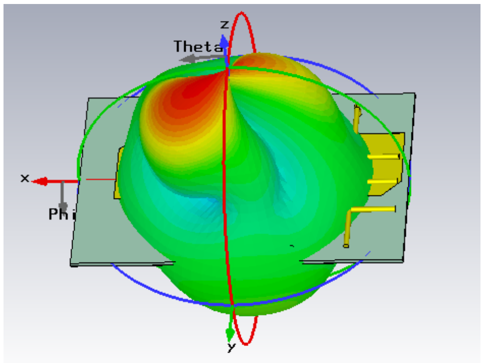

Figure-1. Geometry of antenna combined.

Our goal is to design a small size combined antenna with diversity of polarization. The antenna structure shows in Figure-1 has several advantage, first a patch antenna at the lower side of the fused FR-4 substrate

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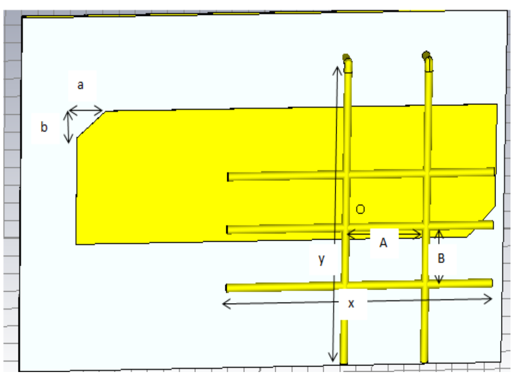
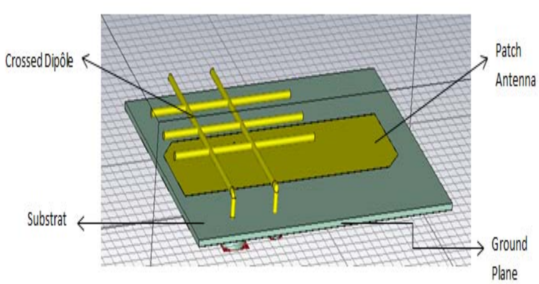
with a dielectric constant equal a 4.4, the idea of combined antenna is used to enhance the diversity of polarization, and to increase the antenna bandwidth towards low frequencies, and using the patch antenna with notches produce a circularly polarization combined with dipole using in X bands is obtained, hence, the elements is miniaturized and its height is optimized, with dual polarization in the same band. The distance between elements should be as small as possible to prevent grating lobes in high frequencies but, the small distance between elements, increase the coupling between the elements in horizontal and vertical directions [6].

2. ANTENNA STRUCTURE

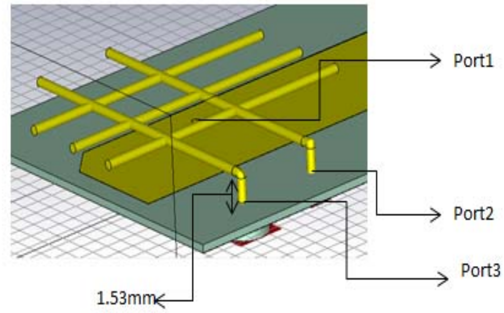
For initial design, micro strip fed rectangular patch with notches antenna is applied to achieved left hand or right hand circular polarization. When the AR should be less 3dB within the targeted beam with to guarantee the radiation is circular polarization conversely [7], for AR>3dB, the microwave polarization will be linear, Patch geometry is chosen since it can easily be arranged and fabricated to CP radiation, the patch is connected to a coaxial feed the two elements radiation are truncated for either diversity of polarization [8, 9, 10].



(a)



(b)



(c)

Figure-2. Geometry layout of antenna array (a), (b), (c).

The micro strip having the dimensions of 52*15 mm^2 are printed on the same layer of FR-4 substrate, the antenna is excited through by coaxial feed, Both the FR-4 substrate are with the thickness of 1.6 mm and relative permittivity 4.4.

Table-1. Geometry parameters.

Parameters	**Size** (mm)		
a	4		
b	4		
x	33		
y	33		
A	10		
B	10		
Coaxial feed	R=0.5	L=4	
Substrate (FR-4)	Length=60	Weight=45	Height=1.6
Ground (copper)	Length1=60	Weight=45	Height1=0.035

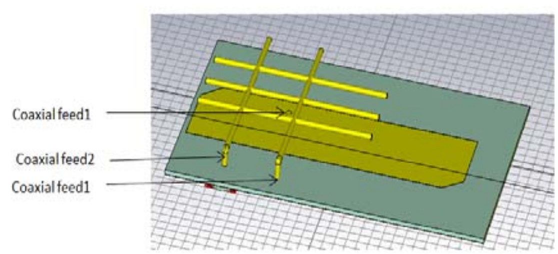


Figure-3. Coaxial feeds of antenna combined.

Figure-3 present that each element is fed by a coaxial cable, the elements are excited simultaneously with identical signal to obtain the return loss to each port.

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3. RESULTATS AND DISCUSSIONS

The final dimensions of the patch antenna are optimized to make both resonant frequency and the frequency with minimum axial ratio at 5.14 GHz.

Table-2. Main specification of the design.

Parameters	Specification	
	F1	F2
Frequency centers	2.23GHz	5.14GHz
S11	-14.78	-22.61
Axial ratio (dB)	6>3dB	1.4<3dB
Polarization	Linear polarization	Circular polarization

Reflection coefficients

The simulated reflection coefficients (S11 in dB) and axial ratio of optimized antenna are plotted in Figure-4.

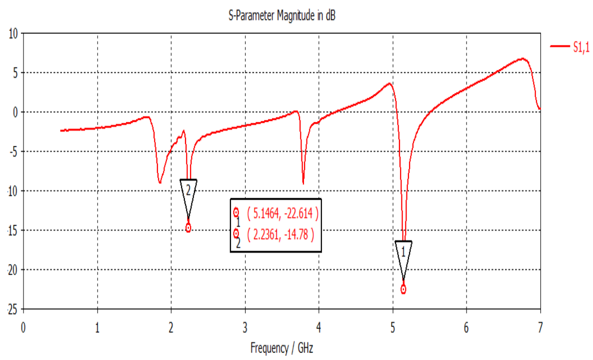


Figure-4. Simulated reflection coefficients (S11 in dB) of the combined antenna.

Axial ratio

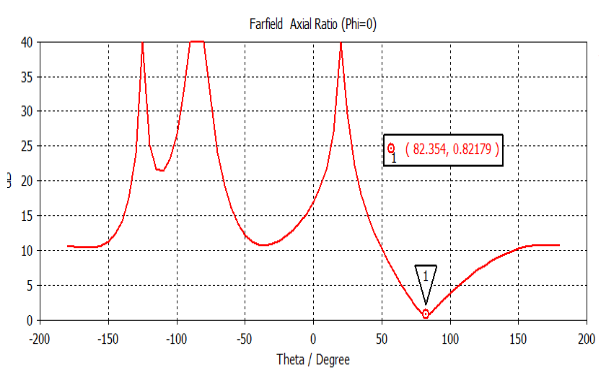


Figure-5. Axial ratio vs. angle theta.

The axial ratio evolution of combined antenna in two polarizations is obtained where 83.35 °angle coverage is achieved for 3dB axial ratio criteria.

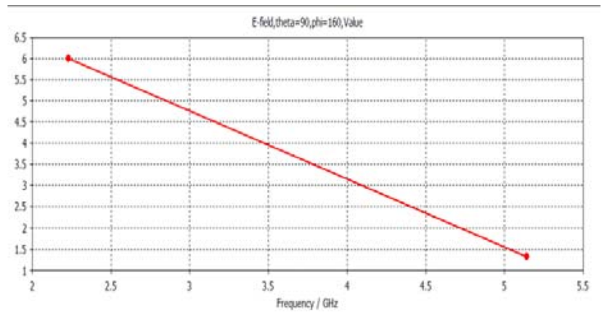
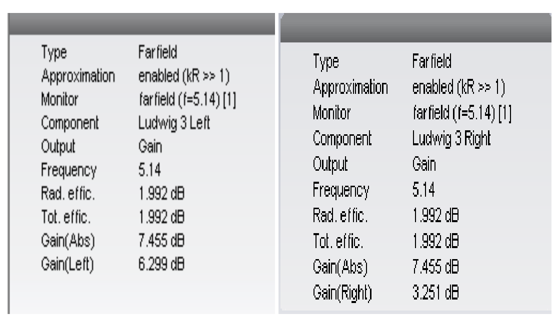


Figure-6. Axial ratio vs. band of frequencies.

Axial ratio is less than 3dB from 5.14GHz with a bandwidth of 20%, and AR is more than 6dB from 2.23 GHz, with this results we can see that our goal are obtained with this simulation, the antenna designed have two polarization, the linear polarization at 2.2GHz and circular polarization at 5.14GHz Then Figure-7. We would like to determine the sense of circular polarization for antenna in 5.14 GHz with comparing, of maximum gain in each frequency. The maximum gain is achieved in the left hand so in 5.14GHz we have LHCP.



(a) (b)

Figure-7. The Comparison with gain at 5.14GHz Of Lhcp (b) and Rhcp (a).

Gain

The gain response shown in Figure-8 and Figure-9 depicts a stable gain response for both the pass bands (5.14 GHz and 2.23 GHz).

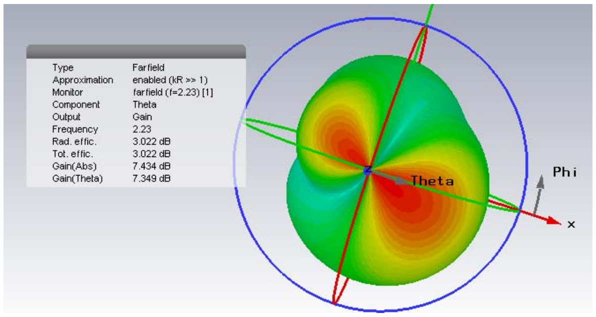


Figure-8. Gain at 2.23 GHz.

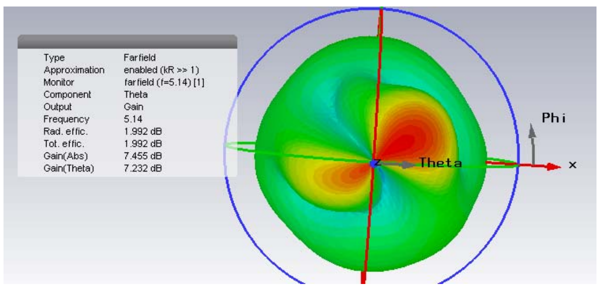
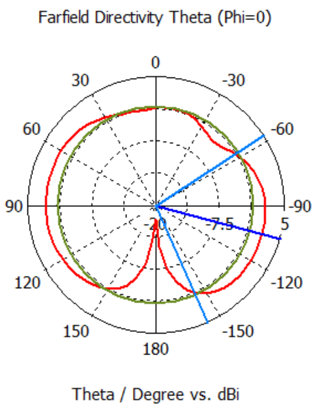


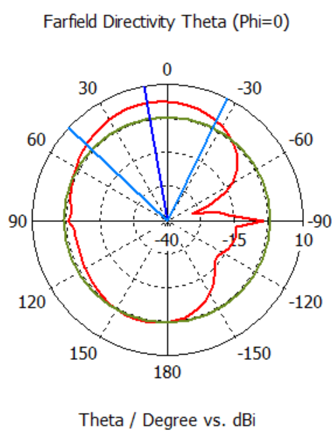
Figure-9. Gain at 5.1 GHz.

Directivity

Usually, the radiation pattern of a single radiating element is relatively wide with low directivity [10, 11]. In many applications, antennas with directive characteristics are needed, and this can be done by enlarging their electric dimensions. Another way to achieve this is to use an antenna array.



F=5.14GHz



F=2.23 GHz

Figure-10. Measured omnidirectional radiation pattern.

Table-3. Effect of patch size.

at F=5.14GHz				
Size(mm)	**15*52**	**15*42**	**15*35**	**15*30**
S11(dB)	-22	-23.6	-24.5	-28.9
Gain(dB)	7	10	12	21.4
AR(dB)	1.4	2	1.05	3.6
Polarization	LHCP	LHCP	LHCP	Linear polarized

From Table-3, the results showed that the variation in the size of patch antenna does effect on all parameters, as shown the Gain and return loss start to increase, while for the AR is unstable when the size is decreased, for example at 15*30 mm^2 we have linear polarization because AR>3db.

4. CONCLUSIONS

This paper presents a new model of combined antenna in the same structure has been investigated and the relation between the two elements radiating produce a dual polarization (LP and CP), extensive simulations using CST Microwave Studio were done. A gain increase up to 7 dB in two bands achieved. With these characteristics, the new proposed antenna can be used in Wimax or in S band applications.

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