World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:3, No:3, 2009

Simulation and Design of Single Fed Circularly Polarized Triangular Microstrip Antenna with Wide Band Tuning Stub

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***Abstract*—**Recently, several designs of single fed circularly polarized microstrip antennas have been studied. Relatively, a few designs for achieving circular polarization using triangular microstrip antenna are available. Typically existing design of single fed circularly polarized triangular microstrip antennas include the use of equilateral triangular patch with a slit or a horizontal slot on the patch or addition a narrow band stub on the edge or a vertex of triangular patch.

In other word, with using a narrow band tune stub on middle of an edge of triangle causes of facility to compensate the possible fabrication error and substrate materials with easier adjusting the tuner stub length. Even though disadvantages of this method is very long of stub (approximate 1/3 length of triangle edge). In this paper, instead of narrow band stub, a wide band stub has been applied, therefore the length of stub by this method has been decreased around 1/10 edge of triangle in addition changing the aperture angle of stub, provides more facility for designing and producing circular polarization wave.

***Keywords*—**Circular polarization**,** Microstrip antenna, single feed, wide band stub.

I. Introduction

WITH considering to advantage of manufacturing of microstrip antennas with smaller surface, low price and high application on commercial and military has caused a lot of research and study to do on fabricating of several types of microstrip antennas.

One application of microstrip antennas is sending millimeter waves with circular polarization. In the spite of that more study on circular patches and rectangle patches have been obtained. Unfortunately present a little of paper about producing circular polarization wave with triangle patches on the important relevant magazine in the world.

Since triangle patches characteristics are approximately as same as rectangle patches and its size is smaller than rectangle patches therefore. There is tried to study the operation of triangle patch for production the circular polarization wave with wide band stub on the one edge with utilize of one direct feed for creation circular polarization.

First study about this area presented from Suzuki [1], that he could with a little change on the size of two edge of equilateral triangle and nomination the appropriate point for antenna feeding to creation a circular polarization waves.

Next study researches done [2],[3],[4] via Lu and his counterparts. They study production circular polarization, creation a slit on the one triangle edges, or internal surface of patches and also adding narrow band stub and creation perturbation.

II. Single Fed Circular Polarization

A triangle patch with single fed point generally radiates linear polarization. In order to radiating circular polarization, it is necessarily for two orthogonal modes with equal amplitude and 90° out of phase to be induced slightly perturbation on patch at appropriate location feed [5].

As Fig. 1 shows, field of patch can be divided into two orthogonal degenerated modes 1, 2, improve perturbation segment properly detune the frequency response of modes such that at operating frequency f_0, it is the same amplitude but 90° out of phase with respect to mode 1.

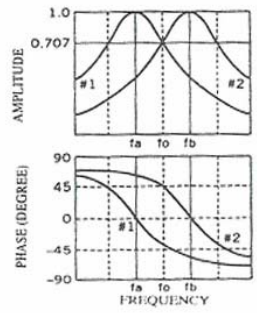

Fig. 1 Amplitude and phase of two orthogonal modes vs. frequency [5]

III. Designed Antenna

Creation circular polarization using wide band stub on button of triangle patch which has been shown in Fig. 2 has been studied in this paper. In this design we use a FR4 laminate with thickness h = 1.6 mm and relative dielectric

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constant ε_r = 4.4. Other parameters of the used triangular patch are illustrated in Table I.

TABLE I
PARAMETERS OF DESIGNED TRIANGULAR PATCH

d (edge of antenna)	48.2 mm
w_i (inner aperture)	1mm
w_o (outer aperture)	6.1mm
l_s (length of stub)	3mm
f_0 (frequency center)	1934 MHz
(x_p, y_p)	(-2.85,9.6) mm

For this purpose, we have used Ansoft HFSS for simulating. Result of simulation is brought in follows.

To concern of S_{11} parameters diagram and Smith chart of designed microstrip antenna which has been presented in Fig. 3 (a) and (b), the resonance frequency of designed triangular patch microstrip antenna is equal 1934 MHz, and band width (BW) is approximately 22 MHz.Circular polarization band width (cp Band width) as Fig. 4 shows , is 6 MHz. Also axial ratio of antenna at frequency 1934 MHz, is 0.25 dB (see Fig. 4). Finally Fig. 5 illustrate LHCP and RHCP diagram in designed antenna.

In [2] the narrow band stub length that has been used for creating perturbation on the patch is 14.7 mm (approximately one third of triangle edge). While in this paper a triangle wide band stub has been used so that the length of stub is approximately one sixteenth of triangle edge (that's clear length of stub has reduced).

Sensitivity of this antenna to tolerance of dimension and feed point is less than proposed microstrip antennas in [1],[2],[3],[4]. Meanwhile angle (θ) of wide band stub is another parameters which help us to tune the antenna for creating cp radiation.

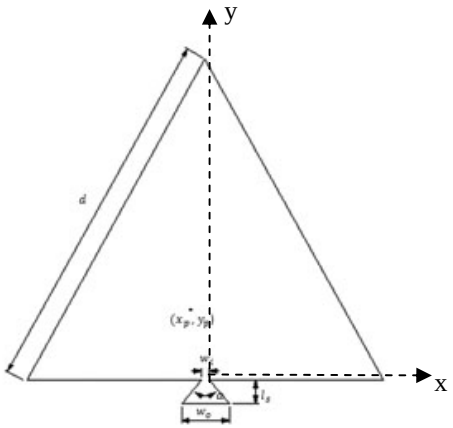
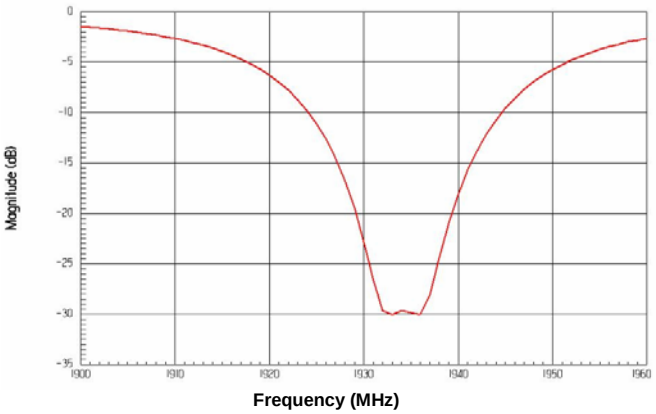
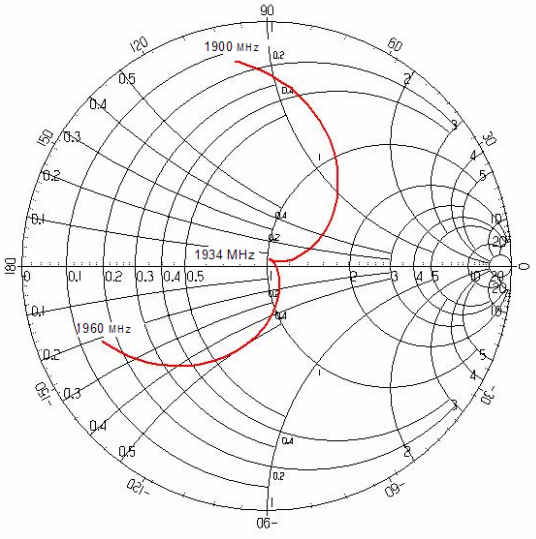


Fig. 2 Geometry of designed triangular microstrip antenna with wide band stub



(a)



(b)

Fig. 3 (a) Magnitude of S11 parameter versus frequency. (b) Smith chart diagram

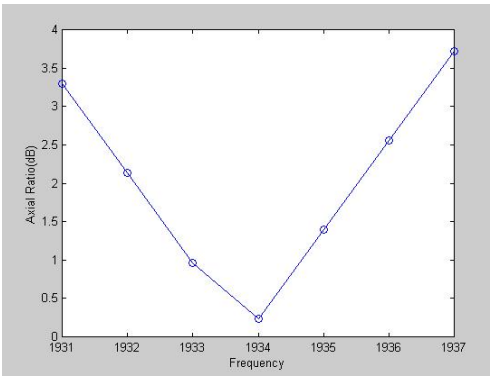


Fig. 4 Axial Ratio of designed Antenna as a function of frequency

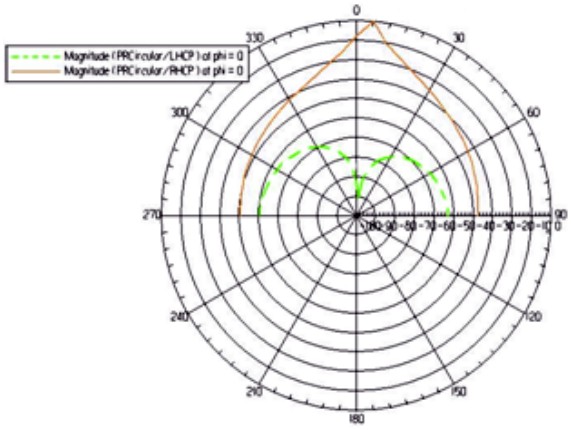


Fig. 5 Normalized polarization ratio versus theta at 1934 MHz

IV. Conclusion

After simulation equilateral triangle microstrip antenna with triangle stub circular polarization radiation correspondent of parameter that is mentioned above, presents an axial ratio of 25dB in central frequency (1934MHz). Also circular polarization band width of 0.31% of band width has been reached in Fig. 4.

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