International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 3 Issue 1, January-2014, pp: (330-334), Impact Factor: 1.252, Available online at: www.erpublications.com

Design and Performance evaluation of Microstrip Antenna at 5.4GHz

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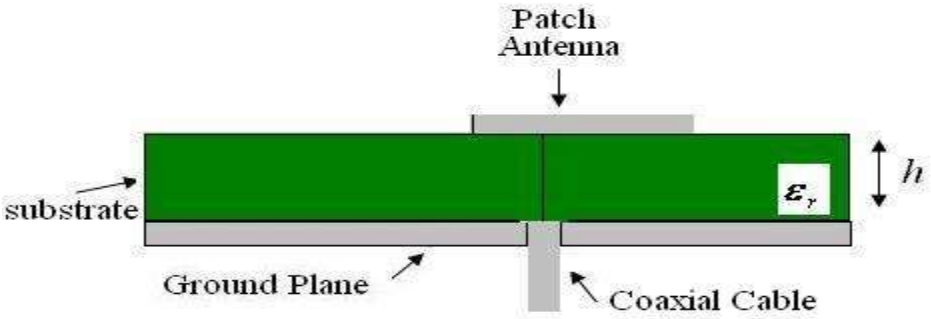
Abstract: The microstrip antenna at 5.8GHz has been designed, which has dedicated to short range communication (DSRC) band. This frequency band includes road transport and traffic telematics (RTTT) applications. The proposed antenna has been designed both in Microwave office and Hfss. The dielectric substrates FR4 and Nelco 4350-RF13 have been used. The proposed antenna has composed of two diagonals slots.

1. Introduction

Microstrip patch antenna has been used in many wireless application systems due to its compact, small and low cost designs. The proposed antenna has composed of two diagonal slots make X shape in the patch. In order to achieve circular polarization the diagonal slots have been made which can be used in radio application. Such type of antenna can also be consider for reducing multipath fading and thus increase the spectral efficiency of RF system. Further the use of such antenna as receiver and transmitter having circular polarization can maximize the isolation between the two antennas (3).

2. Design

The patch antenna operating at 5.8GHz with single feed is shown in the figure.1, the antenna has circular polarized. Ansoft Hfss and microwave Microsoft office software have been used to design the antenna.



The length of the antenna has been determined, having frequency of 5.8GHz and dielectric of 4.3 as.

$$L \approx 0.49\,\lambda_d = 0.49\,\frac{\lambda_0}{\sqrt{\varepsilon_r}}. \qquad (1)$$

L= 12.4 mm

The antenna is a circular patch of radius 5.8mm, relative permittivity of 4.3 and thickness of 3.2mm printed on FR4 substrate. The length of two diagonals slots are 9mm and width of 0.5mm.Antenna has been fed by a probe with a radius of 1.3mm. The feed location has been adjusted in order to have good impedance matching.

3. Simulated Results

3.1 Return Loss

The simulated return loss of the proposed antenna from Microwave office is shown in figure 2. The return loss of -11db has been obtained at 5.8GHz.

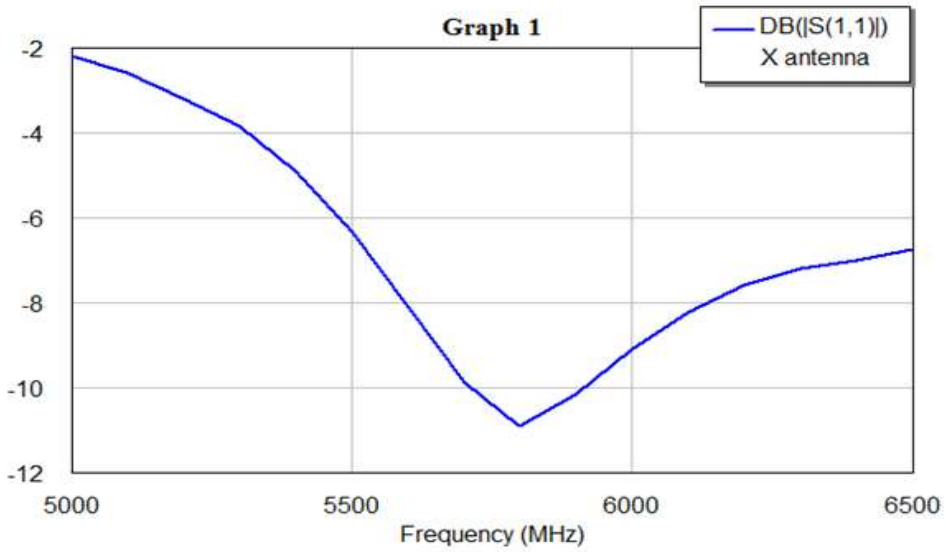


Figure 2: Return Loss of X Antenna in Microwave Office

To compare the Microwave office result with HFSS showed batter result, the return loss from HFSS at 5.8GHz has -14db has been obtained shown in figure 3.

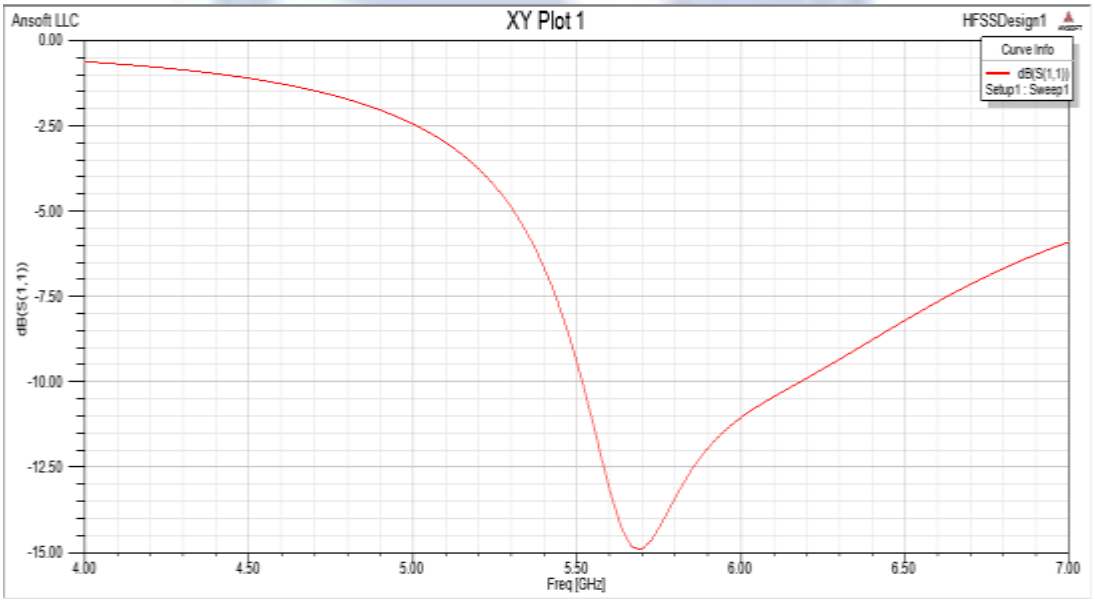


Figure 3: Return loss of X antenna using HFSS.

3.2 Radiation Pattern

The microstrip patch antenna radiates normal to its patch surface. The radiation pattern for φ=0° and φ=90° from MWO has been presented in the figure 4.

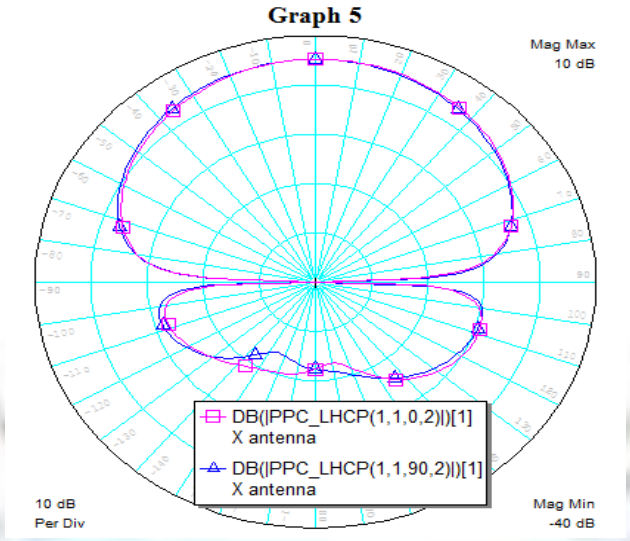


Figure 4: Radiation pattern for φ=0° and φ=90° in Microwave office.

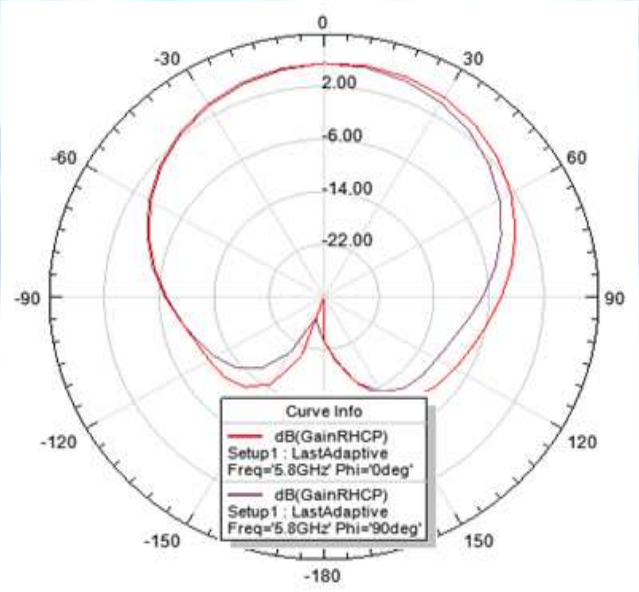


Figure 5: Radiation Pattern for φ=0° and φ=90° in HFSS

The simulators shows similar results only deviate in back lobe as they are presented in db so the variation is not so important.

The gain curve from microwave office shows a peek gain of 5.5db. The peek gain at θ=+35° for this application is important to consider. At θ=+35° a gain of 4.6db and at θ=--35° gain of 3db has been obtained. A separation between co and cross polarization shows good circular polarization.

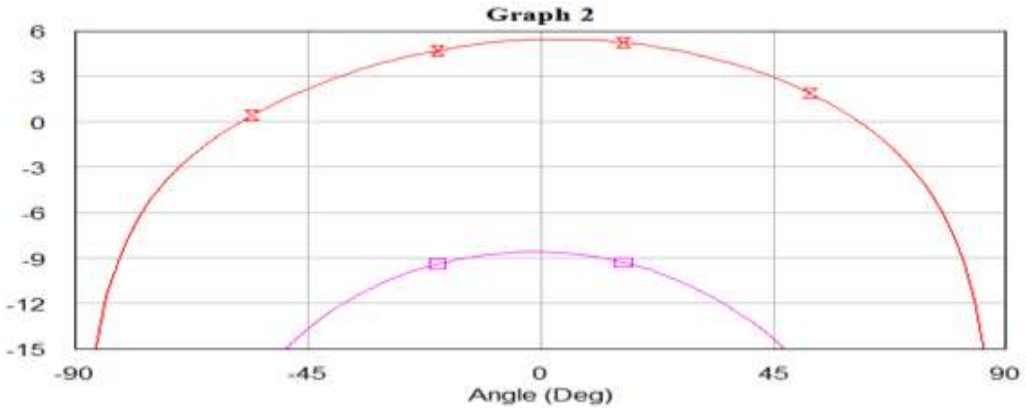


Figure 6: RHCP (Pink) and LHCP (red) in Microwave office

The simulated gain from Ansoft HFSS shows a peek gain of 5.6db at $\theta=10^{o}$. At $\theta=+35^{o}$ a gain of 4.5db and at $\theta=---35^{o}$ gain of 3db has been achieved. The separation between co and cross polarization has well matched with that of Microwave office. Both simulated gain in Microwave office and HFSS shows that the peek gain is tilted toward positive θ.

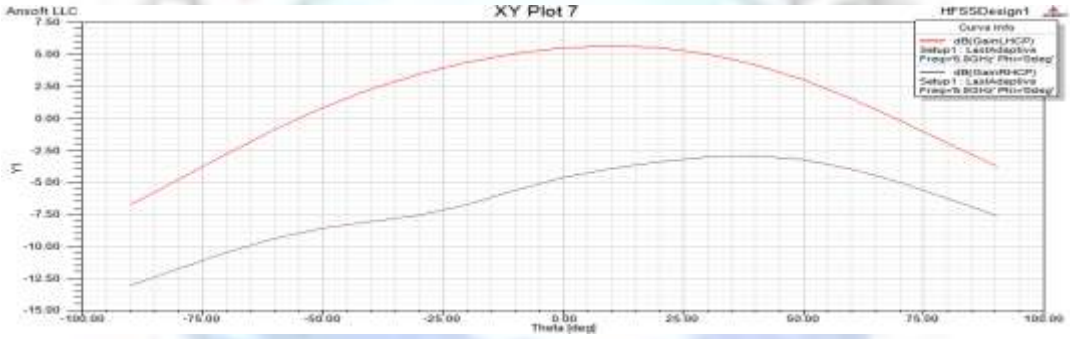


Figure 7: Gain RHCP (red) and LHCP (gray) in HFSS.

4. Measured Gains

A peak gain of 5.9db has been obtained in the measured result which is better than the simulated gain at +35 a gain of 4.5db and at -35 a gain of 4db.While considering the size of the antenna this is quite impressive.

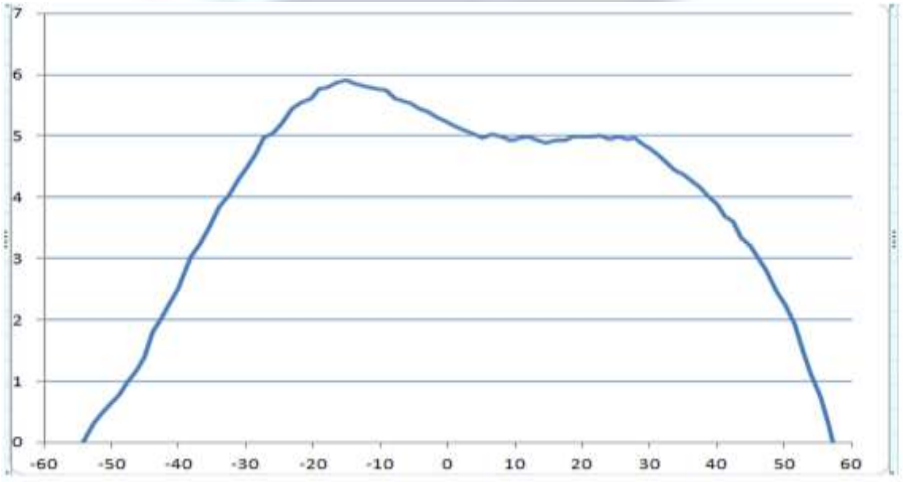


Figure 8.1: Measured gain in Azimuth

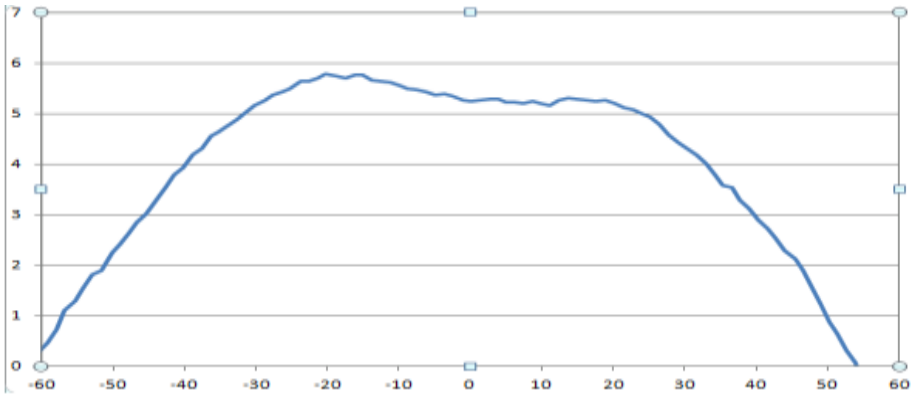


Figure 8.2: Measured Gain in Elevation

5. Cross Polarization

The cross polarization for azimuth and elevation shows that major region of the curves have below -10db which indicate excellent circular polarization.

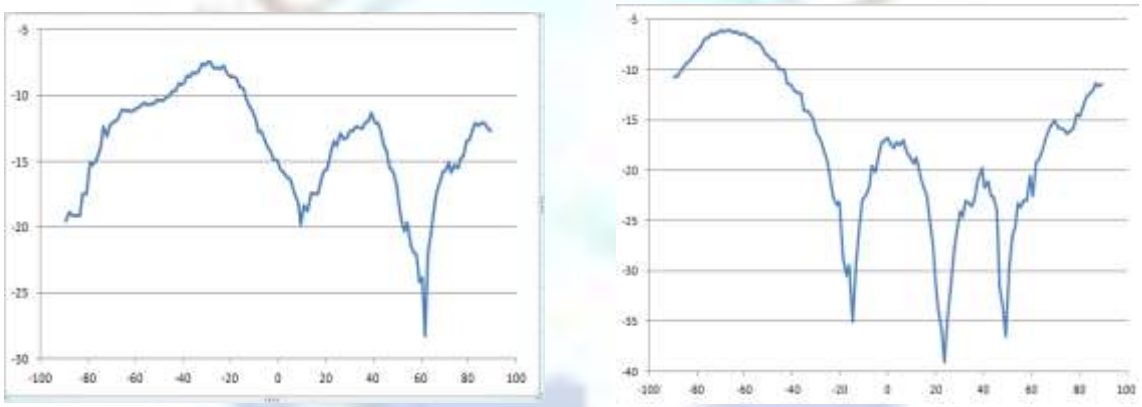


Figure 9: Cross polarization for azimuth and elevation.

6. Conclusions

The proposed antenna shows good results. It has a good return loss and show nice gain and also having excellent circular polarization. The beam width is very wide which is helpful to achieve good gain within 35°.The only disadvantage of this antenna is that, the substrate thickness of 3.2mm has been used which makes it a little more expensive. However it is fabricated with a standard FR4 substrate which is significantly cheaper than substrates made for microwave application.

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