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Micro strip Antenna Design for Low Power Cognitive Radio Applications

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Abstract— Wireless Communication Antenna for cognitive radio applications is proposed in this paper by furnishing the design, simulation, and its radiation characteristics. This antenna is simulated under the numerical analysis of IE3D electromagnetic simulator. It shows -12dB return loss, gain of 6 dBi and maximum efficiency of above 60% at 2.40 GHz and 3.40 GHz. This antenna suits in the place of small area and produces radiation in S-band of microwave frequencies.

Keywords: Cognitive Radio, Wideband, Reconfigurable, Narrow band Antennas.

1. INTRODUCTION

Microstrip antennas are low profile planar printed patch antennas. Depending on the design of the antenna, its performance varies in electrical manner. A sheet of conducting material is spread over a grounded dielectric substrate, known as microstrip patch. A low rate glass epoxy FR4 Substrate may be used for processing the patch. Usually thickness is selected as $t \ll \lambda$ and patch dimension is less than $\lambda/2$, λ is operating wavelength.

Cognitive radio (CR) is an upcoming technology in which a transceiver has the cognitive ability to detect spectral holes in the available spectrum and instantly move into unused channels. Cognitive Radio is needed for effective utilization of the bandwidth by identifying the spectral holes or vacant spaces in the wireless spectrum. CR components may be classified into hardware and software categories (Christos, 2016). Impedance synthesizer RF power sensor & Detector, analog to digital converter, antenna control unit are hardware parts in antenna tuning unit (ATU). Wideband frequency sensing, auto configuration, adaptive algorithms, and security issues come under software modules. CR technology uses two types of antennas namely Narrow band and wide band antennas.

To tune dynamically to a particular frequency within the frequency spectrum to perform data transfer, narrow band reconfigurable antenna is required. To monitor continuously the frequency spectrum for activity, wide band sensing antenna is required. The task of spectrum sensing may be accomplished using the wide band antenna and the task of communication may be accomplished using the narrow band antenna.

The logic flow cycle of CR network mechanism includes Sensing the environment for spectral holes and tuning the reconfigurable antenna by adapting the transceiver parameters accordingly to access the vacant spectrum. The design of a microstrip patch for cognitive radio applications, with the simulations carried out and the results obtained by using IE3D tool are presented in this paper.

2. PROBLEM FORMULATION

The problem formulation is identified from the literature survey based on the previous research. It is furnished here. Microstrip antennas array with a reconfigurable methods are discussed by Sayed Missaoui et al (2014) presentations. Youssef Rhazi et al (2013) investigated the circular shaped patch antennas in K-band of microwave frequencies. The radiation beam characteristics of an antenna using Circular Patch were demonstrated by Ali El Alami et al (2013) using Cavity Model for RFID Applications. Noman Murtaza et al (2013) proposed a reconfigurable antenna for cognitive radio applications. Girish Kumar et al (2003) have given elaborately the concepts of narrow band, broad band microstrip antenna. A reconfigurable antenna for Cognitive Radio which can easily adapt to the existing conditions by changing its parameters was developed by Sonia Sharma (2017). The design of microstrip antenna for the cognitive radio is selected as a problem in this research.

3. DESIGN CASE STUDY

Frequency reconfigurable antennas may be preferred over multiband antennas as they improve the performance by enhancing the efficiency of current wireless systems,. Various switches with re-configurability which facilitate the direct incorporation onto antenna structures were studied and examined during the course of research.

Here annular ring of Circular shaped microstrip patch for the S-band of microwave is considered for the research. The edges are etched to form 64 sides of a polygon. After cut, it looks like circular shaped antenna. Substrate having dielectric constant of $\varepsilon r = 4.4$, loss tangent = 0.025 with thickness of t = 1.6 mm is utilised. The location of the feed point (x,y) is such that it is placed to the right side of the centre of the patch. Radius of 28 mm with the ground plane dimension of 40x40 mm2 was preferred for the antenna design. The proposed antenna design is shown in the Figure 1. Proposed antenna is

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designed as two circular parts. A reconfigurable switch is inserted between these two parts. Three dimensional view is shown in Figure 2.

The case study design has been presented to prove that the proposed model is efficient. IE3D software simulator has been used to implement the proposed model.

Table-I Antenna Specifications

Sl. No	Description	Parameter
1	Antenna	Circular shaped annular ring
2	Substrate material	FR4 epoxy
3	Feed	Coaxial probe

This antenna is simulated by an electromagnetic simulator called IE3D. The distribution of current from the feed point of the patch is shown in Figure 2. Uniform current distribution was noticed with nearing 3dB power level. Radiated power of this antenna gives efficiencies of 70% and 60% for 2.40 GHz and 3.40 GHz respectively.

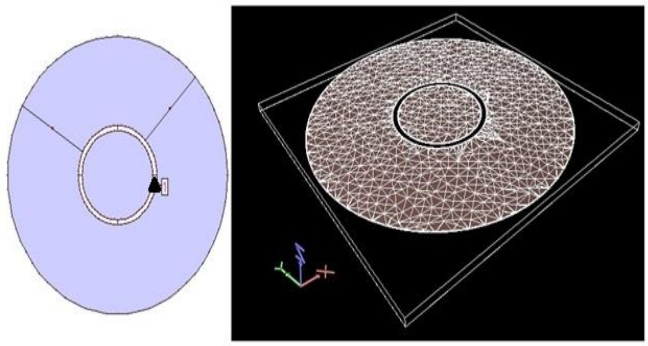

Figure 1. Geometry and Three Dimensional View of the proposed microstrip patch antenna

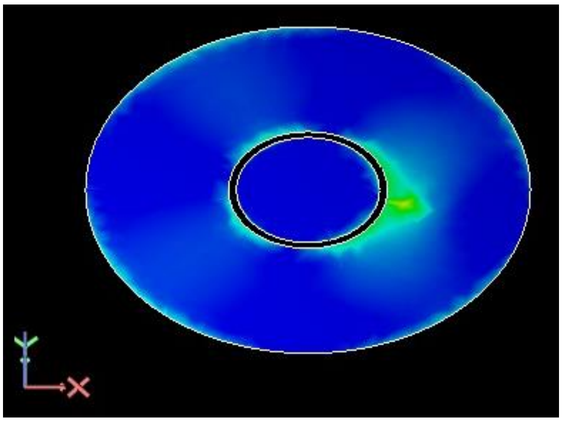

Figure 2. The Current distribution view in the antenna patch

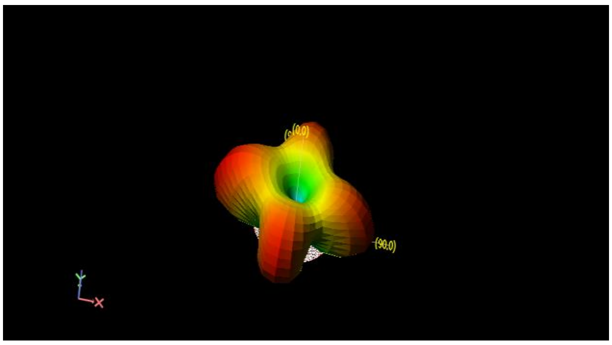

Figure 3. The Three dimensional radiation pattern of antenna patch

The current is spread in all over the patch and at the edges of the patch radiation takes place. When compared to circular patch, in the proposed design, area reduces and the sharp edges give rise to more bandwidth like fractal structure.

4. RESULTS AND DISCUSSION

Simulations were carried out for the proposed patch antenna design and the results were recorded. Scatttering parameter (S-parameter), VSWR, impedance parameters, Gain, Directivity, Antenna Effciency, Radiation Effciency, radiation patterns for elevation and azimuthal angles are presented. The value of the S-parameter obtained shows that the antennas transmitted power is properly distributed.

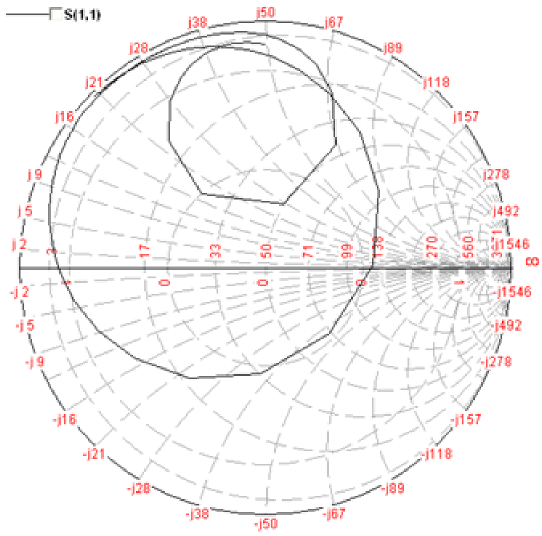

Figure 4. Overview of the Smith Chart.

Proper impedance matching can be noticed from the smith chart.

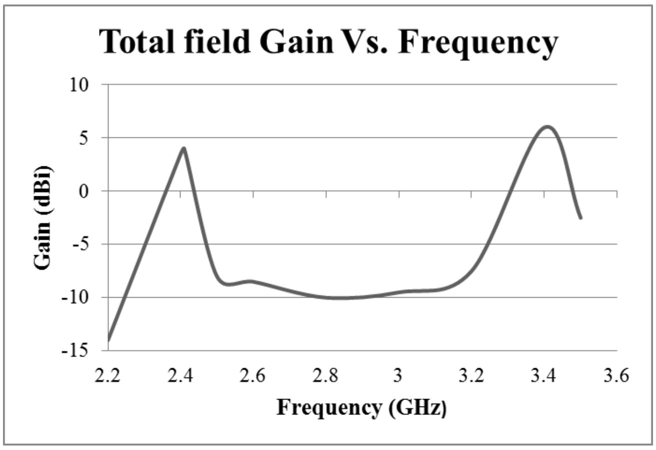

Figure 6. Directivity versus frequency characteristics.

The directivity graph is shown in Figure 6, exhibits the value of the directivity of the antenna takes place well for the frequencies.

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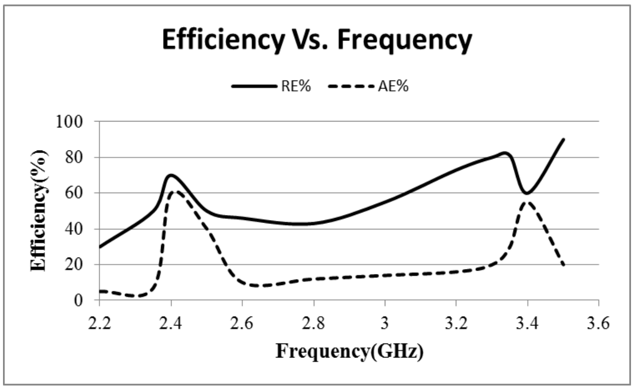

Figure 7. Efficiency versus frequency characteristics

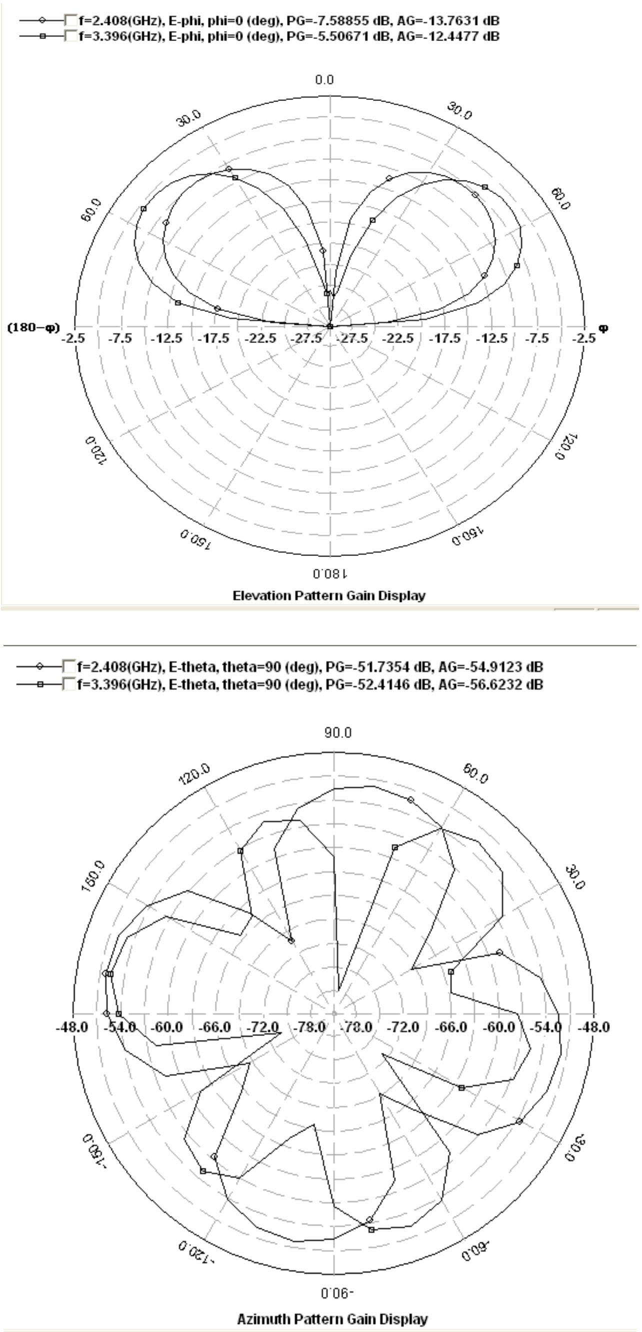

Figure 8. Radiation Pattern of Elevation and Azimuthal direction.

Table 2 Switch functions

Sl. No	Position	Selection frequency
1	ON	3.4 GHz
2	OFF	2.4 GHz
3	Without switch	2.4 GHz and 3.4 GHz

5. CONCLUSION

Microstrip patch antenna for S-band frequencies of cognitive radio applications was proposed. Low power energy was used in this antenna and their results were recorded. The antenna simulation and measured results show that this radiator exhibits reasonable efficiencies in low power.

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