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Design of Microstrip Patch Antenna for Cognitive Radio Environment

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Abstract: A reconfigurable antenna built on E-shaped structure with an ability to control bandwidth is discussed in this proposed work. To configure antenna automatic or manual tuning is done so that they can accustom to the varying system requirements thus can avoid those limitation and offers extra functionality. A frequency reconfigurable E-shaped patch antenna can be utilized for improving the bandwidth.The bandwidth can cover the frequency range from 1.85 GHz-2.33 GHz. The enactments of the offered antenna, in terms of reflection losses and radiation patterns, with divergent DC bias voltages is analyzed using a varactor diode. A broad research was taken over to analyze the nature of the antenna at different frequency.

Keywords: Antenna design, Bandwidth control.

I. Introduction

The immense extension of wireless communication technologies in recent decades, the usage of multiband antennas is snowballing to meet diverse applications in wireless. Therefore the theme of reconfigurable antennas is ahead great responsiveness. These antenna are investigated comprehensively and realized enhancements to more or less range through the different schemes implemented [15]. There have been interests in the field of reconfigurable antennas where the multiband capacities can be further heightened to assimilate various wireless standards [1]. Forthcoming cognitive communication systems will also need antennas proficient of functioning over widespread bandwidth [2]. Recent wireless communication systems trusting on multiband reconfigurable antennas are quite more generally held for their dexterity to deal with multiple standards using a solitary compact antenna and thus decrease the measurements of wireless device and provide more area to consolidate with other electronic devices [6]. Dynamic spectrum management offers numerous recognition to wireless integral, inclusive of diversity and channel capability enhancement by using larger bandwidths. The main restraint for an antenna which is framed for cognitive radio is network planning. Smart antennas are relevent for development of wireless innovation [20-25]. The characteristics of the antennas are to retort spontaneously by altering the operating frequency and the radiation pattern, to meet huge number of wireless administrations that work over wide frequency bands. Almost we cannot contribute a single antenna for every service. These antennas are substituted by solitary reconfigurable antenna which gratifies almost every service by just varying the frequency of operation [16]. Only Just, a polarization reconfigurable antenna that can deal various polarizations at the similar operating frequency has got considerable attention as it has the latent to progress wireless communication systems. In Such cases even the switchable polarization antenna might be utilized to alleviate signal fading in multipath propagation surroundings and deliver double transmission channels for frequency reuse [17-18].

Frequency reconfigurable antennas are categorized into two, specifically coarse tuning and continuous tuning. Among them using varactors continuous tuning can be realized and thus the antennas are maintained for very smooth transitions in the operating frequency bands [7]. However coarse tuning can be attained by using PIN diode switches and the frequency of operation is swapped within diverse services, liable on the interchanging states [8]. Cognitive radio is an adaptive, intelligent network system that is designed automatically. In wireless spectrum free channels are axiomatically sensed by this cognitive radio. The transceiver is fully reconfigurable which automatically adjust its parameters for communication demands of user and as well as network. The design of cognitive radio is unidirectional coverage and almighty wide design bandwidth. For cognitive radio systems patch antennas are not being used because of their bandwidth is extremely narrow. By using E-shaped patch antenna which is the novel topologies in which bandwidth can be improved considerably. Moreover reconfigurable frequency can also be integrated in the E-shaped patch. Components such as, diodes, optical cables, switches and mechanical actuators are used for altering its states. To access various wireless services such as Bluetooth, Wi-Fi, 3G, GPS and WiMAX in various frequency bands, multiradio wireless systems are nowadays introduced [1]. Complex filtering is needed for Multiband antennas to have the accessibility of those devices. However, frequency adjustable antennas with the capability of multiband potential are used to avoid the filtering. Various techniques are used such as PIN diodes, MEMS based design, stepper motors, optical cables and fluidic micro-pumps which indeed the cause to frequency reconfiguration [26].

In this proposed work, we have deliberated E-shaped radiators, a CPW and varactor diodes connecting the E-Shapes. By introducing bias voltage between the varactor diodes, antenna bandwidth can be managed to be wide or narrow. The wireless communication involved in rapid development within this decades, however it should also attain the augmenting need for high rates developing systems [1]. In this category, antennas used for these devices must change its characteristic function related to the change in parameter. So multiple functions antennas are needed in more number. In order to achieve present and future requirements, antenna parameters such as operating frequency, radiation pattern, polarization are being designed as reconfigurable [2].

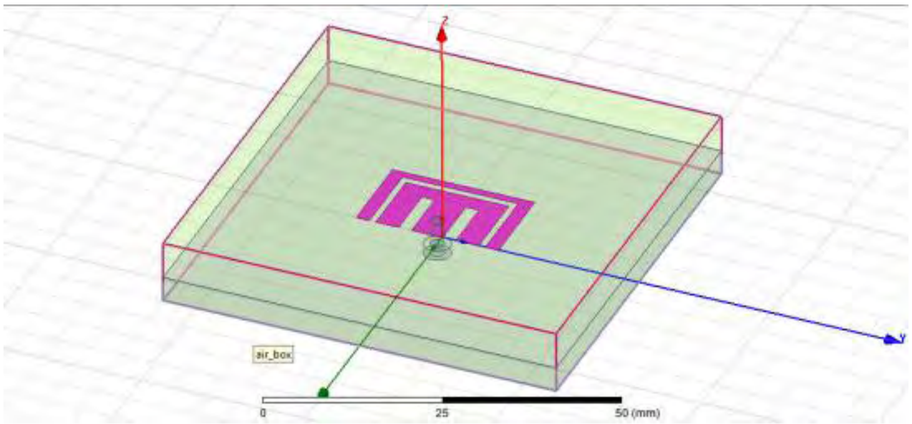

Fig. 1: E-Shaped patch antenna

II. Design Methodology

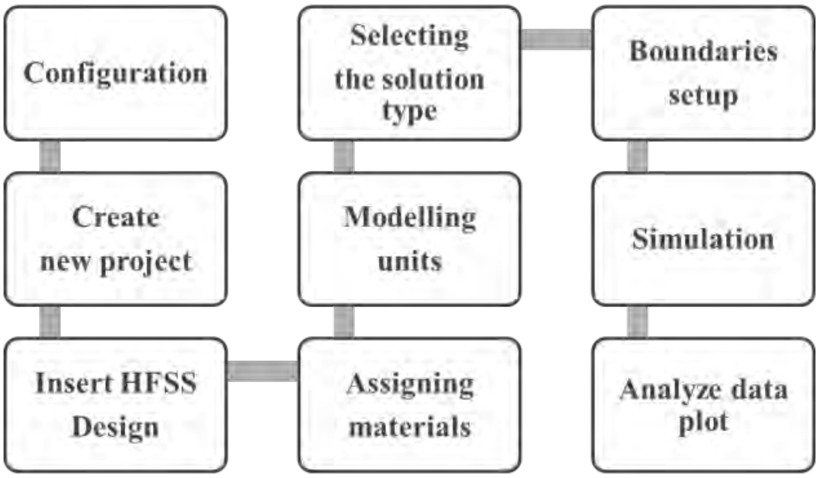

Fig. 2: Simulation methodology

HFSS is a versatile enactment full-wave electromagnetic (EM) field emulator for random 3D volumetric passive device forming that takes benefit of the familiar Microsoft Windows graphical user interface. By using the HFSS simulator software varactor position in the design is improved which gain the widespread controlled region. The antenna was fabricated using an FR-4 substrate Procedure for designing patch antenna is explained in Fig. 2.

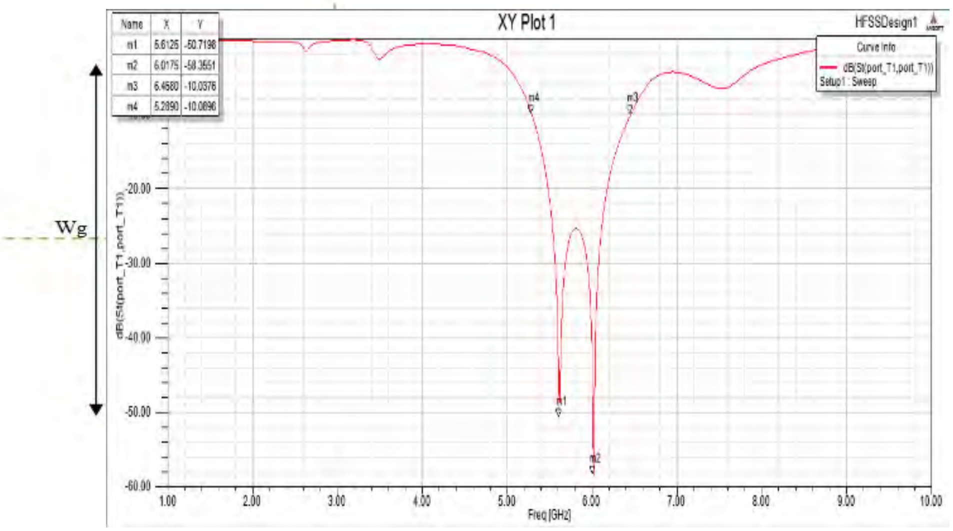

Fig. 3: Design process [19, 27]

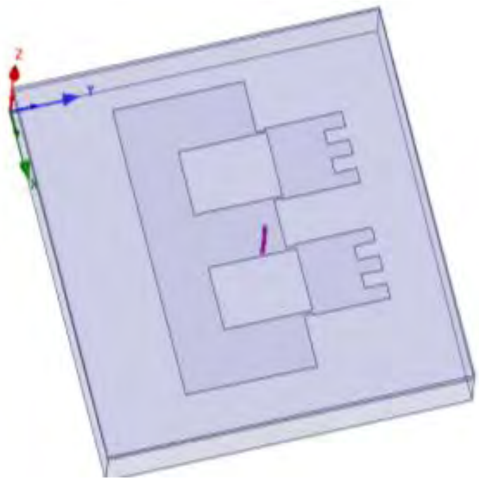

Fig. 4: Patch antenna for switch off

Driven mode and eigen mode are the two solution types generally used and we have preferred driven mode. Choose the object to which you want to allocate a material and then Click Modeler>Assign Material. Choose proper ground and then substrate. Transparency is set above 0.7. After creating substrate and patched observe the radiation pattern. In the models, the varactor diodes were sculpted using Resistance, Inductance and Capacitance(RLC) boundary sheet as soon as varactor diodes capacitance change from 1 pF to 12 pF. The characteristic of Fig. 5 are used for the varactor diode in the simulation tests. To show our scheme model, controlling DC bias voltage varying from 1V to 12V and a varactor diode with a capacitance value between 1 pF and 10 pF are designed. The varactor diode dimension is approximately 1mm2. The E-shaped patch antenna is simulated on FR4 substrate and in this antenna scheme another substrate introduced between FR4 and ground which is called foam to have an improvement in bandwidth.

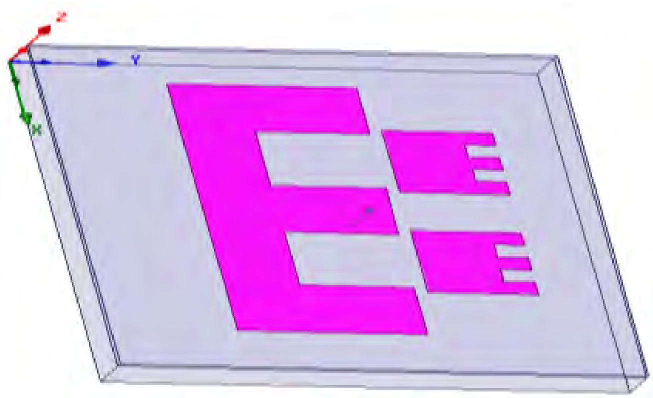

Fig. 5: E-Shaped patch antenna when the switch is ON

III. Simulated Results

The E-Shaped patch antenna is designed and computer-generated using HFSS electromagnetic simulator. Two main parameters are obtained as simulated results.

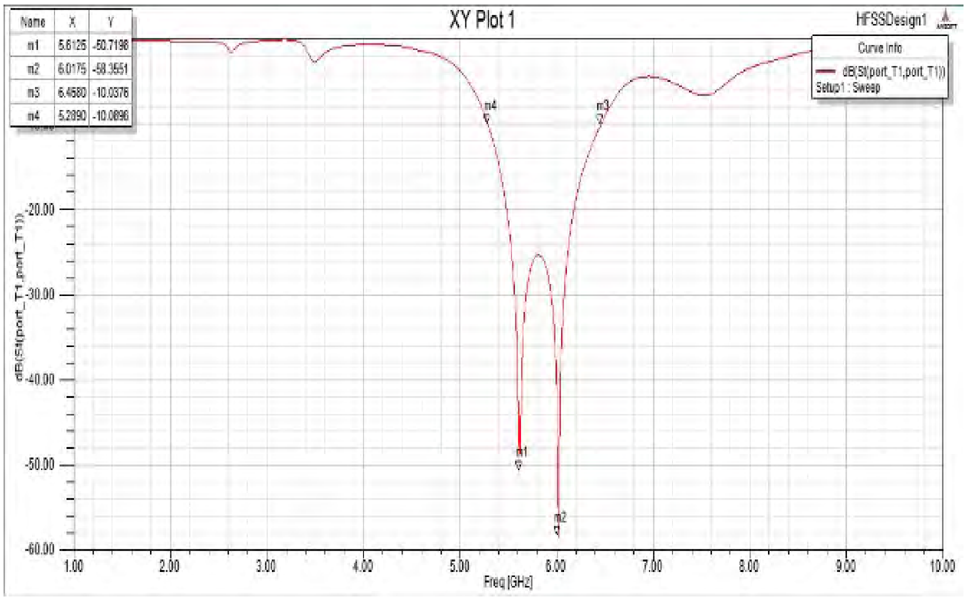

Fig. 6: Return loss

The parameters are return loss, voltage standing wave ratio. OFF state of the switch is represented by open circuit and ON state is represented by short circuit.

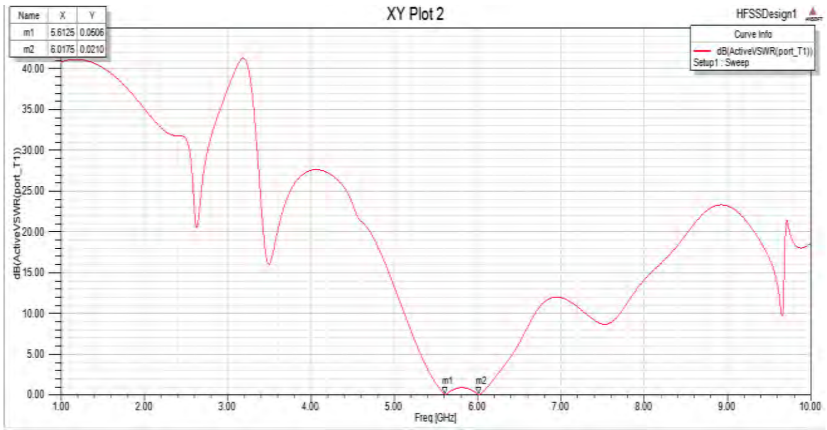

Fig. 7: VSWR

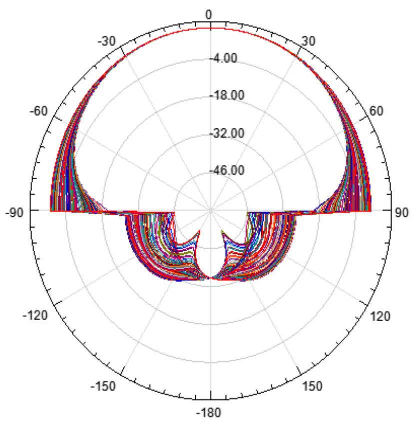

Fig. 8: Radiation pattern

III. Conclusion

Results show that, when all the varactors are fixed at 2 pF, the bandwidth of the antenna is 2.4% (for reflection coefficient S11 < -10 dB). The bandwidth of the antenna can be further increased when increasing the varactor diodes respectively. The main advantages of the proposed antenna include low profile, lightweight and easy to make simple structure for upcoming minor wireless communication devices and cognitive radio applications.

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