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DESIGN OF A FREQUENCY TUNABLE PATCH ANTENNA USING HFSS

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ABSTRACT
Indispensable and acute constituents of wireless communication, constitutes the advent of antennas and few cased sometimes their incompetence to adjust with new working circumstances can frontier system performance. Tuning antennas to configure dynamically or manually such that they can adapt to fluctuating system requirements can eradicate those constraints and compromises further functionality. A frequency Tunable E-shaped patch antenna has the operating frequency range from 1.6 GHz to 3.8 GHz. With ideal switch case the simulated results of the design is obtained.

KEYWORDS—patch antenna, reconfigurable antenna, cognitive radio, two E-shape.

INTRODUCTION
Wireless local area networks (WLAN) are widely used worldwide. The IEEE 802.11b and 802.11g standards utilize the 2.4-GHz ISM band. The frequency band is license-free, hence the WLAN equipment will suffer interference from microwave ovens, cordless phone, Bluetooth devices and other appliances that use this same band. The 802.11astandard uses the 5-GHz band which is cleaner to support high-speed WLAN. However, the segment of frequency band used varies from one region of the world to another. Dynamic spectrum management offers many advantages to wireless systems, including diversity and channel capacity improvement through wider bandwidths.
Network architecture is one of the constraints for an antenna which is designed for cognitive radio. The coveted nature of an antenna which is designed for cognitive radio is omni-directional coverage and extremely wide bandwidth design. In recent year's wireless communication have experienced explosive growth, it must support the increasing demand for high rates due to rapidly increasing devices.[1] In this regard, antennas used for those devices have to change based on the parameter changes. So the need for antennas with multiple functions is increased. In order to accomplish current and future demands, antenna parameters such as radiation pattern, operating frequency, polarization are reconfigured.[2] For changing the state various components such as switches, diodes, optical cables and mechanical actuators are used. To access different wireless services such as Bluetooth, Wi-Fi, 3G, GPS and Wi-max over several frequency bands, multi radio wireless systems are presently being developed.[1] Multiband antennas which require complex filtering have to access those devices. Frequency Adjustable antennas with multiband potential can be used to eliminate filtering requirements. To reconfigure frequency of antenna several methods used such as PIN diodes, MEMS based design, stepper motors, optical cables and fluidic micro-pumps.
Software Defined Radio is an adaptive, intelligent network technology that can be configured dynamically. In wireless spectrum available channels are automatically sensed by cognitive radio. It can be evolve as a fully reconfigurable transceiver which dynamically adapts its communication parameters to user and network demands.[9]. For cognitive radio systems patch antennas has been limited due to their narrow bandwidth. Through novel patch topologies, such as the E-shaped patch, their bandwidth can be extended. Frequency reconfigurability is also employed in E-shaped patch.

TUNABLE E-SHAPED PATCH ANTENNA DEGIN STRATEGY
The bandwidth of microstrip antenna may be increased using air substrate [1]. However, dielectric substrate must be used if compact antenna size is required [2]. A few approaches can be applied to improve the microstrip antenna bandwidth. These include increasing the substrate thickness, introducing parasitic element either in coplanar or stack configuration, and modifying the shape of a common radiator patch by incorporating slots. The last approach is particularly attractive because it can provide excellent bandwidth

improvement and maintain a single-layer radiating structure to preserve the antenna's thin profile characteristic.

The successful examples include E-shaped patch antennas [3–7], U-slot patch antennas [8], and V-slot patch antennas [9]Slots in the patch provide access to control switches by bias lines but in this design is use only ideal switch case. Due to slots in the patch, the designed antenna has two resonances. A coveted impedance matching is achieved by altering the slot dimensions which strongly controls the resonance modes of patch. The 2 E-Shaped patch antenna design is shown in the figure below. There is 2 antenna design one is for OFF state switch and the other is for ON state. From the literature study of designed antenna starts from broadband microstrip antenna[4], single layer-single patch U slot[5], double U slot antenna[6]. Then the patch antenna with switchable slots came into picture The E-shaped patch antenna has single feed line and single layer.

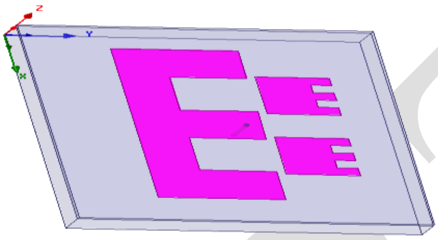

Fig 1: E-Shaped patch antenna when the switch is OFF state

The E-shaped patch antenna is simulated on FR4 substrate and the antenna design has other substrate called foam to increase the bandwidth which is placed between FR4 and ground. The dielectric constant of the substrates used in the design is 4.4 and 1.0 respectively. The size of antenna is 120×100 mm² with 50Ω probe feed.

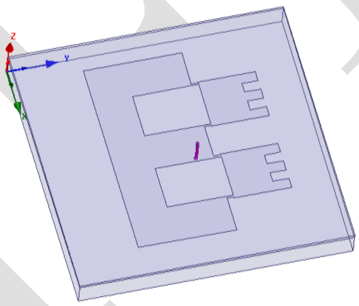

Fig 2: E-Shaped patch antenna when the switch is ON

RESULTS AND DISCUSSION

The 2 E-Shaped patch antenna is designed and simulated using HFSS 13.0 electromagnetic simulator. Four main parameters is obtained as simulated results. The parameters are return loss, voltage standing wave ratio, radiation pattern and radiation efficiency. OFF state of the switch is represented by open circuit and ON state is represented by short circuit. A good antenna must have its return loss is less than -10dB and vswr is in the range from 1 to 2.5.

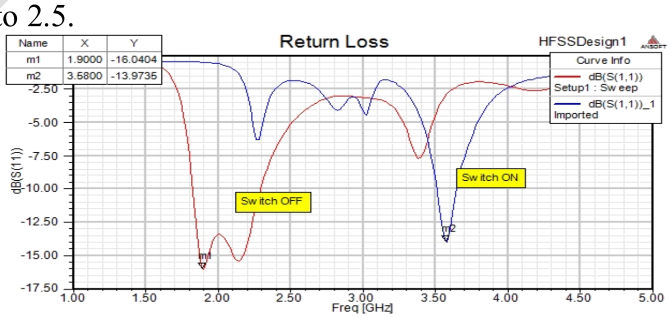

Fig.3. Return loss(S_{11})

In Fig.3.Shows the return loss (S_{11}) is less than -10 dB. For OFF state of the switch -16dB as the return loss at 1.9 GHz and for ON state of the switch -13 dB at 3.58 GHz.

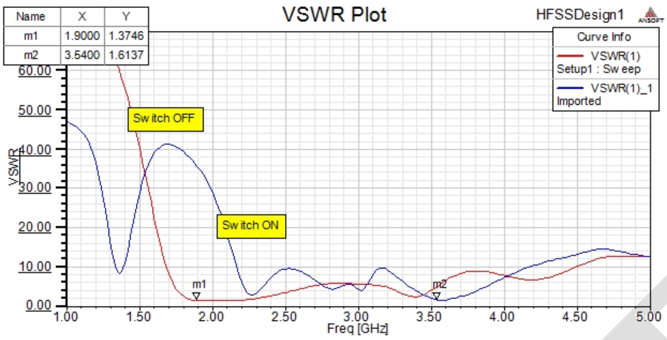

Fig.4.VSWR

Fig.4. Shows the VSWR which states that for the frequencies 1.9 GHz and 3.58 GHz is 1.6 and 1.3 respectively.

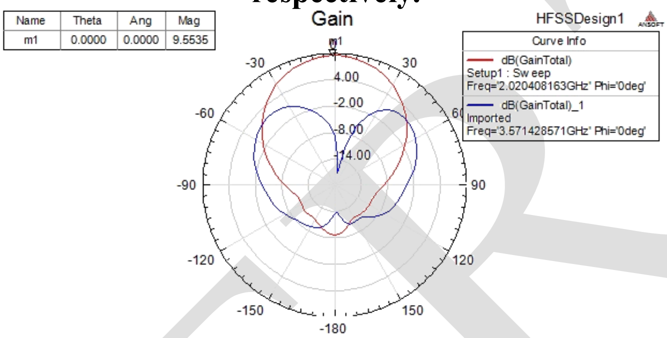

Fig.5.Gain

Fig.5 shows the Gain plot. Total gain is about 9dB obtained at OFF state of the switch and ON state it is about 7dB.

Radiation pattern for OFF and ON state is shown in the figure.6 and figure.7 respectively.

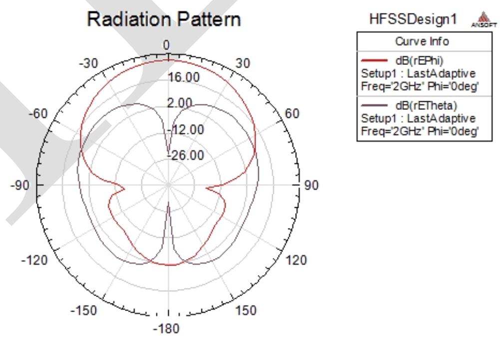

Fig.6 Radiation Pattern when switch is OFF

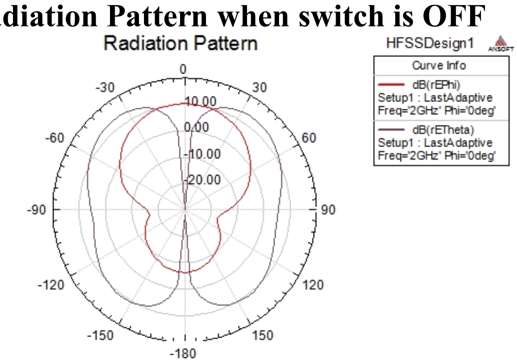

Fig.7.Radiation Pattern when switch is ON

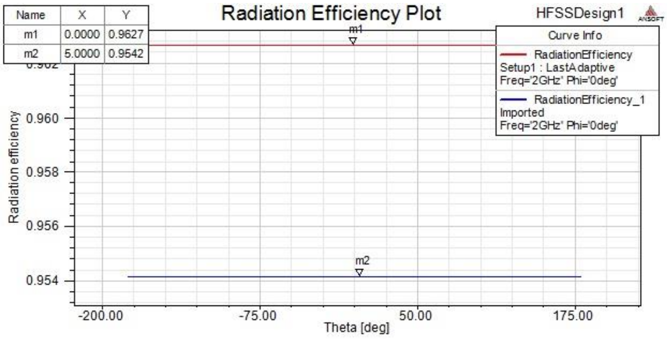

Fig.8.Radiation Efficiency

Finally the radiation efficiency plot is shown in figure.8.For OFF and ON state of the switch, obtained radiation efficiency is 96% and 95% respectively.

CONCLUSION

Unused spectrum in wireless networks can be identified by a new technology called cognitive radio. Adjustable antenna along with a sensing antenna offers a solution for the antenna design challenges in cognitive radio. Proposed E-shaped patch antenna can be used as reconfigurable antenna for cognitive radio.. The parametric study provides a good insight on the effects of various dimensional parameters. It provides guidance on the design and optimization of E-shaped microstrip patch antenna. By locating the feed point at the base rather than the tip of the centre arm, the resonant frequency of the second resonant mode can be tuned without affecting the resonant frequency of the fundamental resonant mode. The bandwidth can be easily tuned by trimming the length of the centre arm

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