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Frequency Reconfigurable for Ultra Wideband Planar Antenna Based Cognitive Radio Design

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Abstract *– Cognitive radio is one of the most promising techniques to efficiently utilize the radio frequency (RF) spectrum. As the Digital Video Broadcasting – Handheld (DVB-H) band is targeted (470-862 MHz), the size of the antenna becomes challenging.Metamaterial idea is utilized as a miniaturization technique. Two antennas are composed, created and estimated. The first accomplished multiband activity by stacking it with a metamaterial unit cell. These groups are controlled by sketching out the scattering connection of the unit cell. The arrangement of a three-port transmitting structure, joining wide and slim band antenna for scholarly radio applications, is presented. It contains a UWB reception apparatus for range perceiving and two narrowband antenna for remote communication incorporated on a similar substrate.*
Keywords*: Reconfigurable antennas, Cognitive radio, UWB*

I. Introduction

As per the prerequisite for higher information rates is expanding because of the change from voice-just correspondences to multimedia type applications. The current static frequency allocation has led to a shortage in the radio frequency (RF) spectrum, and hence, the need of dynamic spectrum access (DSA) became a must. Cognitive radio (CR) is considered a champion among the most encouraging and imaginative DSA strategies because of its two novel properties: psychological ability and reconfigurability. A antenna is described by the IEEE Standard Definitions [1] as "a strategies for radiating or tolerating radio waves". It changes the electric vitality to electromagnetic vitality and the different way. Starting late, with the movement of novel correspondence frameworks, recurrence reconfigurable antenna have gotten a colossal measure of thought, by changing their properties to accomplish selectivity in recurrence, polarization, data transmission and gain (Pazin and Leviatan, 2013). Reconfigurable reception apparatus is a antenna fit for changing adequately its recurrence and radiation properties in a controlled and reversible way (Bernhard, 2007). With a definitive target to give a dynamical reaction, reconfigurable antennas join an inner segment, (for instance, RF switches, varactors, mechanical actuators or tunable materials) that engage the deliberate redistribution of the RF streams over the antenna surface and make reversible modifications over its properties. Reconfigurable antennas differentiate from brilliant antennas in light of the fact that the reconfiguration framework lies inside the antenna rather than in an outside beam forming system. The reconfiguration furthest reaches of reconfigurable radio wire is utilized to overhaul the antenna execution in a changing condition or to fulfill changing working prerequisites. Reconfigurable antenna apply distinctive systems and strategies to achieve the required change in something like one of its operation parameters. The most basic procedure depends on utilizing switches, for example, PIN diodes, Gallium Arsenide Field Effect Transistors (GaAsFETs) or Micro-Electro Mechanical System (MEMS) switches. Distinctive procedures join the usage of optical switches or mechanical structure alteration to achieve the fundamental change in the antenna outline and these are promising systems to defeat the huge biasing issues of the electronic switches.

The prerequisite for higher data rates is expanding a result of the change from voice-only correspondences to sight and sound compose applications. The present static recurrence portion has prompted a deficiency in the radio recurrence (RF) range, and consequently, the need of dynamic range get to (DSA) turned into an absolute necessity. Intellectual radio (CR) is viewed as a standout amongst the most encouraging and creative DSA strategies because of its two exceptional properties: psychological capacity and reconfigurability (as will be appeared in beneath area). Bunches of research has been done on CR. As it has not been standardized yet, different research groups target different frequency bands.

II. Antenna

An antenna can be characterized as a generally metallic gadget which radiates and receives electromagnetic waves (EM waves), more specifically,(Kraus and Marhefka, 2003). Another clarification says that an antenna is the change between a guided EM wave and a free-space EM wave (Balanis, 2005) and the other way around. This procedure is clarified by a general correspondence between a transmitting antenna and a receiving.As shown below, for both antennas, the transmission line has the form of a coaxial line or a waveguide. The latter, when a transmitting antenna is considered, is connected to a transmitter that generates radio-frequency (RF) energy that is guided through the uniform part of the line as a plane.

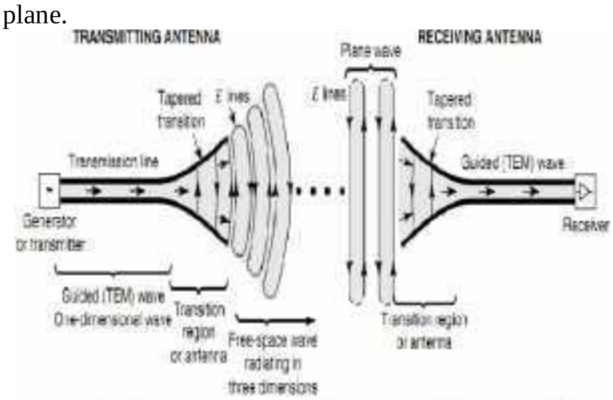

Fig. 2: The antenna as a transition structure, for a transmitting antenna and for a receiving antenna

Transverse Electromagnetic (TEM) wave with little loss, changed into a signal that is increased, modulated and applied to the antenna; generally, when an receiving antenna is considered, the transmission line is associated with a receiver which gathers the alternating currents that came about because of the change procedure of the got radio waves by the antenna.

Antenna characteristics concerning to radiation are basically the same regardless of its type. Hence, if a period changing current or a speeding up (or deceleration) of charge happens, the radiation will be made in a specific length of current component. This can be described by

$$l.\frac{dI}{dt} = l.qi.\frac{dv}{dt}\left(A.\frac{m}{s}\right) \quad (1)$$

Where:

l - Length of the current element in meters (m);

di/dt Time-changing current in ampere per second (A/s).

qi Charge per unit length (coulombs/m).

Note that q = I. t = 1.602×10-19 Q.

Furthermore, the radiation is always perpendicular to the acceleration and its power is proportional to the square of both parts of the equation (1). It is important to refer that the spacing between the two wires of the transition line is just a small part of a wavelength; therefore, the more the transition curve of the antenna opens out the more the order of a wavelength or more is reached; consequently, the more the wave tends to be radiated and launched into the free-space (Kraus and Marhefka, 2003).

Looking at the antenna structure as a whole, the transition region of the antenna is like a radiation resistance (Rr) to the transmission line point of view, which represents the radiation that the antenna emits, analyzing it as a circuit. Figure 3 shows the complete circuit of an antenna; where the source is an ideal generator with a tension V_g (or V_s) and with an impedance Z_g (or Z_s); the transmission line is a line with characteristic impedance Z_c (or Z_o), and the antenna itself is represented by a load impedance ZA [*ZA= (RL+ Rr) + jXA*] connected to the transmission line. The load resistance RL is utilized to represent the conduction and dielectric losses related with the antenna structure while Rr, alluded to as the radiation obstruction, is utilized radiation by the antenna

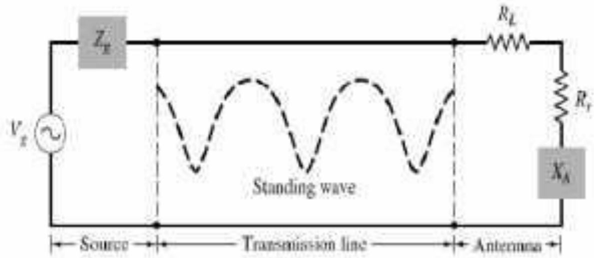

Fig.3: Circuit representing antenna as whole structure

The reactance XA is utilized to represent the nonexistent part of the impedance related with radiation by the antenna. Therefore, if ideal conditions are applied, the radiation resistance Rr, which is used to represent radiation by the antenna, will get all the energy that is generated by the transmitter.

III. Dynamic spectrum access and cognitive radio

The expanding interest for remote availability and current swarming of authorized and unlicensed spectra require another correspondence worldview to misuse the current range in better ways.The present methodology for spectrum allocation depends on relegating a particular band to a specific administration. The FCC Spectrum Policy Task Force [12] announced tremendous worldly and geographic varieties in the use of assigned spectrum with usage extending from 15 to 85% in the bands below 3 GHz. In the frequency range over 3 GHz the bands are much more ineffectively used. In other words, a large portion of the assigned spectrum is utilized sporadically, prompting an under use of a lot of range. This wastefulness emerges from the rigidity of the administrative and authorizing process, which commonly relegates the entire rights to a frequency band to a primary user. This methodology makes it to a great degree hard to reuse these bands once they are allocated, regardless of whether these users ineffectively use this important asset.An answer for this wastefulness, which has been exceptionally fruitful in the ISM (2.4 GHz), the U-NII (5– 6 GHz), and microwave (57– 64 GHz) bands, is to make spectra accessible on an unlicensed premise. Notwithstanding, with the end goal to acquire spectra for unlicensed activity, new sharing ideas have been acquainted with permit use by secondary users under the necessity that they restrain their interference to previous primary users.

Cognitive radio

Cognitive radio (CR) innovation is key empowering innovation which gives the ability to impart the wireless channel to the authorized users in an astute way. CRs are anticipated to have the capacity to give the high bandwidth to mobile users through heterogeneous wireless structures and dynamic spectrum access techniques.

In order to share the spectrum with licensed users without interfering with them, and meetthe diverse quality of service requirements of applications, each CR user in a CR networkmust [2]:

• Determine the portion of spectrum that is available, which is known as Spectrum sensing.

• Select the best available channel, which is called Spectrum decision.

• Coordinate access to this channel with other users, which are known as Spectrum sharing.

• Vacate the channel when a licensed user is detected, which is referred as Spectrummobility.

To fulfill these functions of spectrum sensing, spectrum decision, spectrum sharing andspectrum mobility, a CR has to be cognitive, reconfigurable and self-organized. An exampleof the cognitive capability is the CR's ability to sense the spectrum and detect spectrumholes (also called white spaces), which are those frequency bands not used by the licensedusers. The reconfigurable capability can be summarized by the ability to dynamically.

IV. Spectrum Sensing and Allocation

With the end goal to distinguish the spectrum holes in OSA model, CR frameworks need to scan the spectrum and recognize the empty or inert parts of the spectrum which is known as spectrum sensing. Based on the information CR knows about its own internal state and surrounding environment, it then determines the optimum frequency band and subsequently starts the communication. This procedure is referred to as communication. Two main approaches for spectrum sensing and communication are as follow:

A. The continuous spectrum sensing is carried out in a process in parallel to the communication link as shown in Fig. 4.

B. A single channel is utilized for both spectrum sensing and communication as appeared in Fig. 5.

A two antenna system is proposed for methodology (A) [8]. One antenna is wideband and Omni-directional, encouraging a recipient fit for both coarse and fine spectrum sensing over a broad bandwidth. The second antenna is directional and feeds a frequency deft front end that can be tuned to the selected band. A single wideband antenna sustaining both spectrum sensing module and the frequency agile front can likewise be an answer for methodology (A) [9].

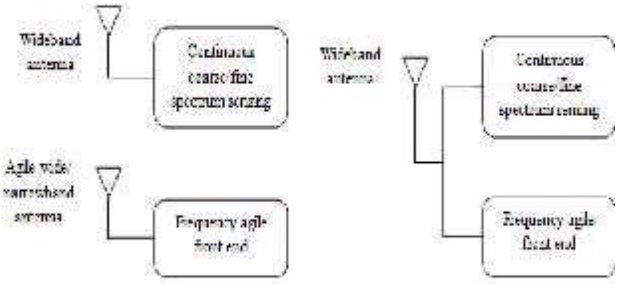

Fig. 4 Cognitive radio architecture with parallel sensing and communications

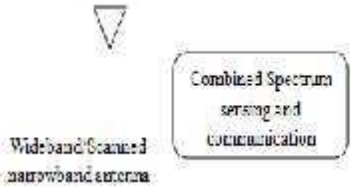

Fig. 5 Cognitive radio architecture with combined sensing and communications

In methodology (B), spectrum sensing and radio reconfiguration are performed when the communication link quality falls beneath characterized edges. In [10], two thresholds are used. Link quality falling underneath the first threshold triggers spectrum sensing, with the goal that a superior system framework design can be recognized that will meet the connection quality necessities. At the point when the quality debases underneath a second lower limit, the system is reconfigured.

Considering the system requirements discussed above a potential antenna solution for CR might be an antenna with multiple functionalities. The potential system may incorporate an antenna with wideband frequency response and Omni-directional radiation design for spectrum sensing together with reconfigurable narrowband usefulness. Narrowband usefulness can be accomplished by advantageous sifting in the RF stage; in any case, this may add to the complexity of the RF front end circuitry. Filtering and reconfiguration can be included into the antenna in order to reduce the complexity of the filtering circuits in RF stage.

V. Advantages and Disadvantages of reconfigurable antenna

The advantages are as follows:

- Have a multiband antenna in a single terminal for different applications.
- Simple to incorporate with exchanging gadgets and control circuit.
- Small in size.

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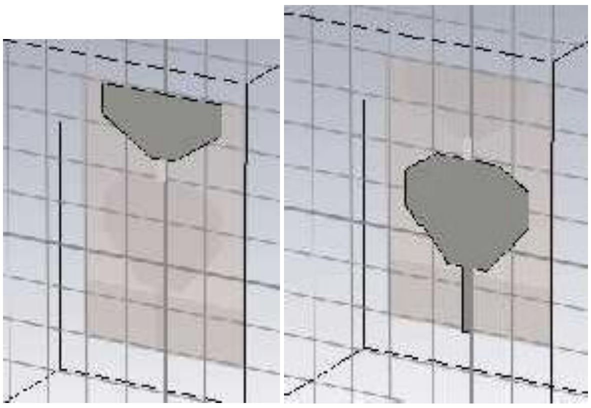
However, the design of reconfigurable antenna are commonly determined by the parity of tradeoffs. Contrasted and settled tuned antenna, because of its short creating time, there are still a few hindrances holding up to be explained:

- The innovation of reconfigurable depends generally on RF switch innovation, or, in other words enough yet.
- Expanded complexity and cost to the cell phone. Lessened Efficiency Reduced Efficiency.

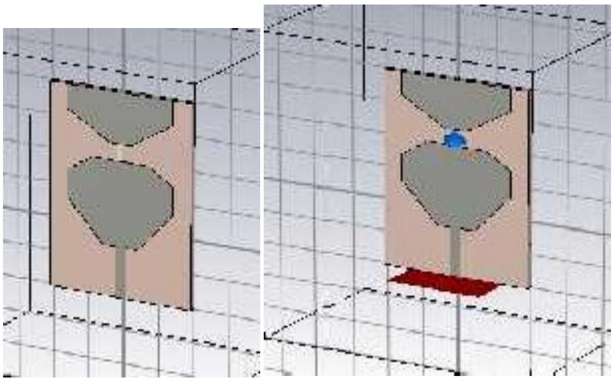
VI. Results

In this segment, discuss about the proposed three-port antenna system made out of a UWB and two NB antennas integrated on a similar substrate. As examined before, each antenna has an independent excitation port as shown in Figure 6(a).

In this way, to accomplish great isolation characteristics between each antenna, the substrate dimensions, the active patch, and the ground plane structures are precisely changed. Specifically, a UWB antenna connected with the primary port is utilized for spectrum sensing, while the staying two NB antennas connected with the other two ports of the antenna system are utilized for wirelesscommunications.The UWB and the two NB antennas are imprinted on top surface of FR4 dielectric substrate so that electromagnetic isolation among them is very high. By and large, for UWB antennas incomplete grounds are exceedingly favored, while for narrow band antennas full grounds are generally utilized. Here likewise the base layer appeared in Figure 6(b) is going about as partial ground for the UWB antenna and as a full ground for the two narrow band antennas. In the proposed design, we consolidated different spaces on the top and bottom layers to upgrade return loss performance. Top and bottom perspectives of the proposed three-port antenna system are appeared in Figure 6. Execution of the Radiating System in the First Operative Condition.



(a) Solid (b) Path



(c) Without Switch (d) With Switch

Figure 6: Another Antenna design

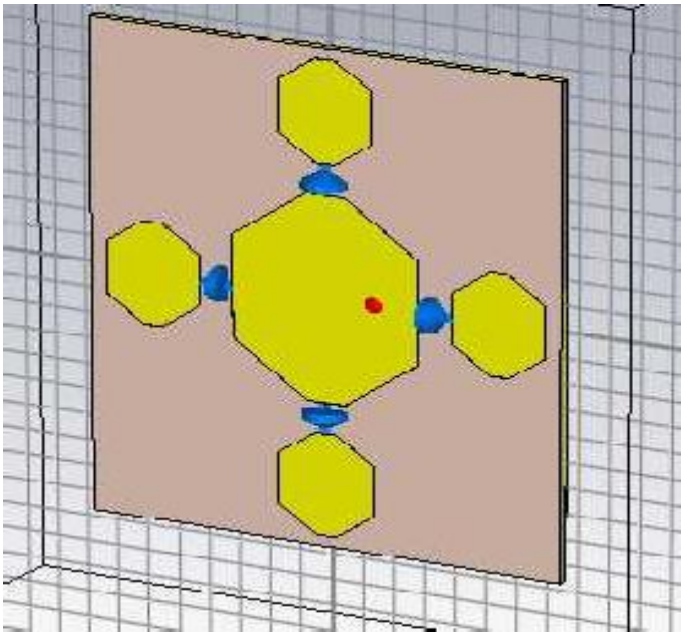


Figure: 6.2 Proposed Reconfigurable USB with Four switch

The performances of the radiating system in the first operative condition, specifically, with Ports 1 and 2 energized and with Port 3 shut on coordinated load, are inferred by the investigation of the frequency behavior of the scattering parameters, of the gains, and of the radiation patterns of the three-port system shaping the antenna system. Specifically, by investigating the frequency behavior of the scattering parameter ??11, delineated in Figure 7, it results that the UWB antenna covers the frequency band running somewhere in the range of 2.76GHz and 13.96GHz, with an expanding gain which shifts between about0.54 dBi and 5.58 dBi (see Figure 8) and with E- and H-radiation patterns described by the curves reported inFigure 9.

Different is the radiative behavior of the first NB antennawhich resonates at 6.5GHz and 9GHz (see Figure 10) withreturn loss values of 28.3 dB at 6.5GHz and 20.5 dB at 9GHz,respectively. As it shows up from Figure 10 the antenna displays a dual band behavior covering the frequency bands between additionally breaking down frequency behavior of the scattering parameter ??12 this is portray in figure 10.

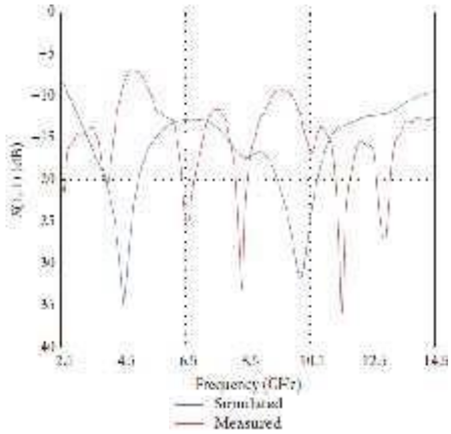


Figure 7: Comparison of simulated and measured reflection Coefficients of the UWB antenna.

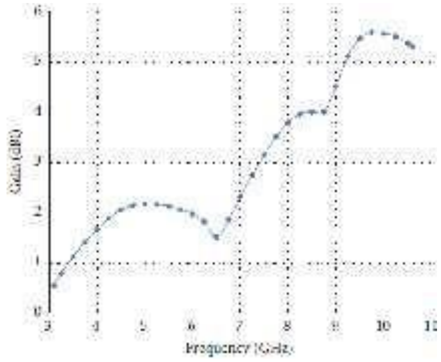


Figure 8: Peak gains versus frequencies plot of the UWB antenna.

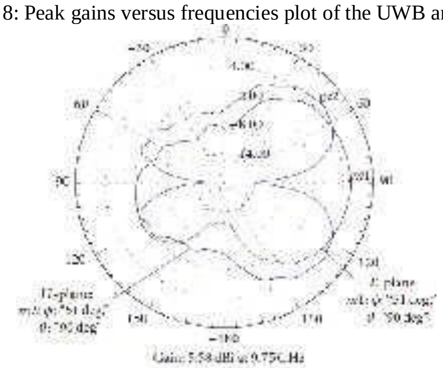


Figure 9: 2D radiation pattern of the UWB antenna at 9.75GHz.

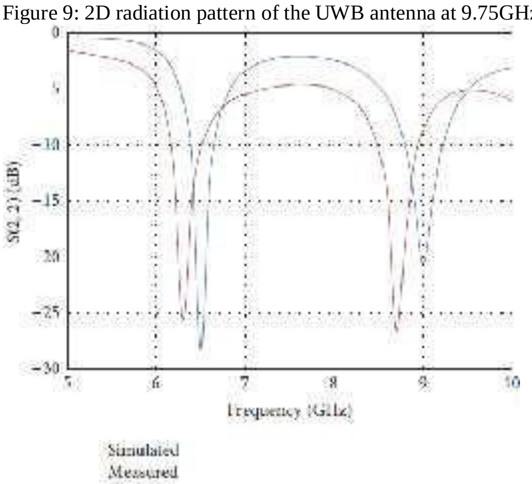


Figure 10: Comparison of simulated and measured reflection Coefficients of the first NB antenna.

	Base		Proposed	
The Switch Slate (S1,S2, S3 & S4)	Frequency Range	Relative Bandwidth%	Frequency Range	Relative Bandwidth%
Off OffOff Off	5 to 7 Ghz.	33.8%	2 to 6 Ghz	31.3%
Off OffOff ON	4.3 to 6 Ghz & 7 to 9 Ghz	33.4% & 25.2%	2 to 6 Ghz & 7 to 9 Ghz	30.1% & 26%
	4 to 5.1 Ghz & 7 to 9 Ghz	26% & 25.2%	2 to 9 Ghz	24%

VII. Conclusion

In this paper, an antenna system composed of three antennasintegrated in the same substrate, employed for the realizationof cognitive radios, has been presented. It is employed withtwo narrow band antennas to overcome the drawbacks of thereconfigurable antennas during their practical implementation.In this way, after a concise exchange concerning the attributes of cognitive radios, reasons for the UWB antenna and of the two narrow band antenna shaping the proposed antenna system have been depicted. At that point, the investigation and plan of each antenna have been represented in detail. Full-wave commercial software dependent on the FEM technique has been utilized for a precise expectation of the proposed antennas performances.The antenna measurements carried out on anantenna prototype have shown a good agreement with theexperimental measurements. Because of compact structureand better performance, proposed system can be a goodcandidate for emerging cognitive radio technology.

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