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► **To cite this version:**

Mhamad-Hassanein Rabah, Divitha Seetharamdoo, Rafik Addaci, Marion Berbineau. Future Communication Systems: Cognitive radios from Antenna Point of View. 20th LAAS International Science Conference, Mar 2014, France. 2p. hal-00991711

**HAL Id: hal-00991711**

**<https://hal.science/hal-00991711>**

Submitted on 30 Jul 2014

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# Future Communication Systems: Cognitive radios from Antenna Point of View

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**Abstract:** A review for the antenna requirements of future communication systems is provided. An antenna solution for such system is proposed. It consists of a combination of a miniaturized extremely wideband antenna and two planar inverted F antenna for WIFI application. Presented results make from this compact antenna system a very good candidate for cognitive radio applications.

**Index Terms**— Cognitive radios, antenna miniaturization, antenna cohabitation, and future wireless systems.

## I. INTRODUCTION

With the diversity of wireless systems, flexibility to operate within different standards is required. Cognitive radio (CR) consist the future system that can propose this flexibility. The federal communications commission, FCC [1] has defined cognitive radio as a radio, which can change its transmitter parameters, based on an interaction with the environment in which it operates. At the hardware level, the implication for future antenna design is the varying degree of reconfiguration and band tuning. CR can have different possible architectures, combined or parallel spectrum sensing and communications. The key difference is at the dynamic spectrum access (DSA) level. Two approaches are considered for DSA model: spectrum interweave (figure 1. (a)) and spectrum underlay (figure 1. (b)).

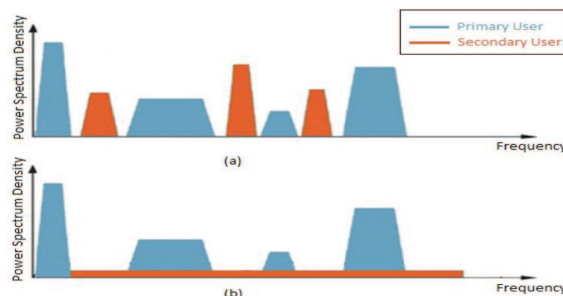


Figure 1: DSA approaches for CR systems: (a) Spectrum Interweave, and (b) Spectrum Underlay

Whatever, in both architectures two types of antennas are needed [2]. One antenna is extremely wideband and omni-directional, feeding a receiver capable of both coarse and fine spectrum sensing over a broad bandwidth. The second antenna is directional and feeds or is fed by a frequency agile front end that can be tuned to the selected band. The significant antenna challenges for CR can be summarized into three parts: miniaturization, omnidirectional and stable power pattern. The cohabitation between antennas enclosed within the same space prove to be a challenge. In this paper, a novel compact antenna system is presented enclosing an extremely wideband antenna (EWB) for spectrum sensing operations and a second one for communication in WIFI band (2.4-2.5 GHz), for interleaved CR's.

## II. ANTENNA SYSTEM DESIGN

### A. Separated Antennas design

The antenna system is divided into two parts: First a miniaturized wideband antenna for spectrum sensing, then two narrow band antennas that operates near to 2.4 GHz for WIFI application. The EWB antenna is a printed elliptical slotted monopole antenna on an 1.55 mm thick FR4 substrate ( $\epsilon_r=4.2$ ,

$\tan(\delta)=0.0023$ ) with a triangular ground plane, fed by semi-ring triple feed followed by a tapered CPW line (figure 2. (a)). The triangular shape of the ground plane is to reduce the coupling with the radiating element, when the triple feed has the purpose of increasing the bandwidth [3]. The elected narrow band antenna is a modified planar inverted F antenna (PIFA). The antenna configuration and dimensions are shown in figure 2. (b).

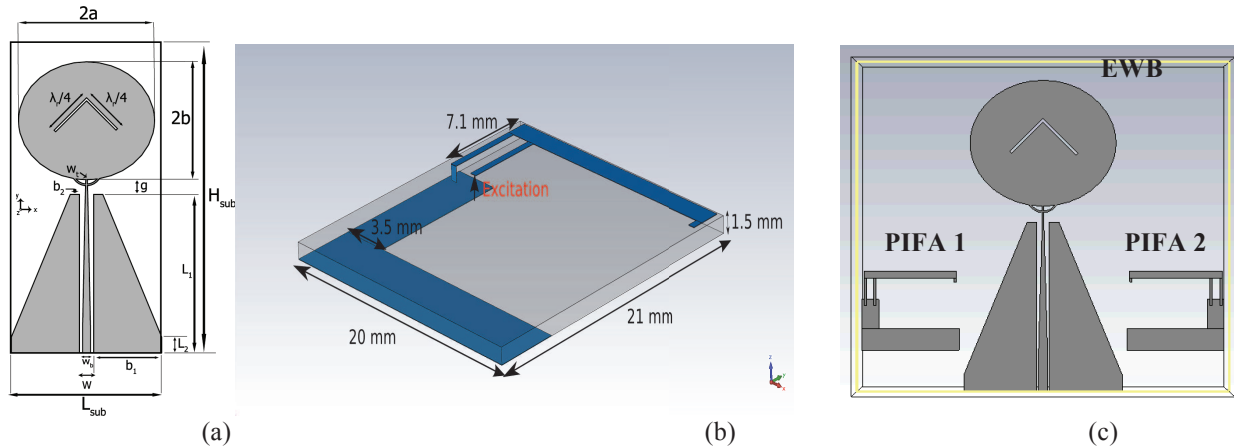


Figure 2: Configuration of the proposed antennas, (a) Extremely wide band antenna ( $H_{sub}=68$  mm,  $L_{sub}=33$  mm), (b) narrow band antenna, and (c) The antenna system with overall dimensions of  $100 \times 67$  mm.

### B. Combination of both Antennas

Cohabitation between both antennas is a challenge. Many configurations has been investigated to maximize the isolation between antennas and to keep power pattern stable and omnidirectional. Since the EWB antenna uses one side of the substrate. Thus, by sharing this side of the substrate with the ground plane of the two PIFA's and using the other side for their radiating elements, less space is needed and more isolation is achieved (more than 15 dB). This configuration guarantees a stable omnidirectional radiation pattern (figure 3 (left)). Figure 3 (middle) shows the reflexion coefficient of the EWB antenna, the frequencies covered for a  $S_{11} \leq -10$  dB extends from 0.85 GHz to 12 GHz. The resonance frequencies of the PIFA's are slightly shifted due to the presence of the EWB antenna.

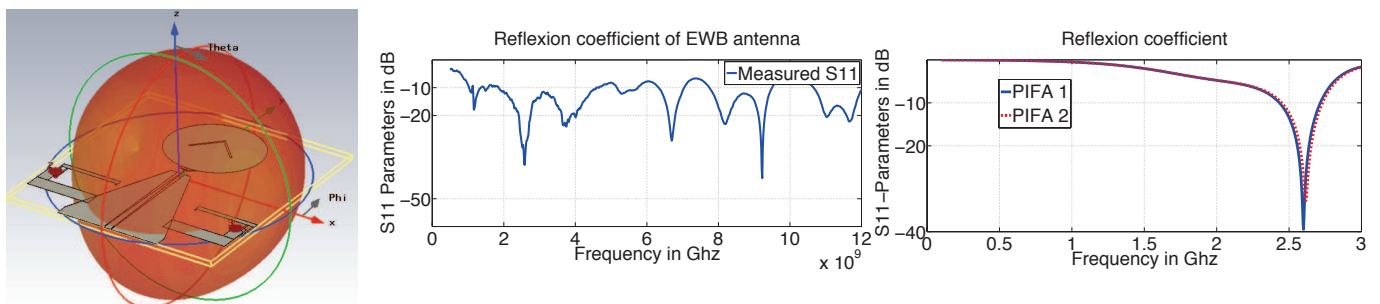


Figure 3: “Antenna system” radiation pattern at 2.4 GHz (left), Measured Reflexion coefficient of the EWB antenna (middle), and the computed reflexion coefficient of the two PIFA's (right).

Finally, these performances make from this antenna design a very good candidate for CR applications.

### REFERENCES

- [1]“Federal Communications Commission, ‘Spectrum Policy Task Force,’ Rep. ET Docket Nov. 2002”.
- [2] Y.-C. Liang, K.-C. Chen, G. Y. Li, and P. Mahonen, “Cognitive Radio Networking and Communications: An Overview,” *IEEE Trans. Veh. Technol.*, vol. 60, no. 7, pp. 3386–3407, Sep. 2011.
- [3] M. H. Rabah, D. Seetharamdoo, R. Addaci, M. Berbineau, and J.-P. Ghys, “A Miniaturized EWB Antenna for Spectrum Sensing Applications,” in *2013 IEEE Antennas and Propagation Society International Symposium (APSURSI)*, 2013, pp. 1750–1751.