# A MIMO Cognitive Radio Antenna System

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***Abstract*—This paper presents an antenna system dedicated for cognitive radio applications. The proposed antenna system consists of two sets of radiating structures. The first set is a two port frequency reconfigurable antenna and the second set is a two port sensing antenna. A prototype antenna is simulated, built and tested to prove the validity of a MIMO system for cognitive radio applications. A good agreement is found between the simulated and the measured data.**

## I. Introduction

The cognitive radio technology presents a potential solution to solve the problem of spectrum crowdedness and thus improve the spectrum usage efficiency. Such a system should be able to track the channel activity and tune its operation accordingly. This can be manifested by a change in the operating frequency, the transmitted power level and/or the modulation schemes. An important feature is the ability to learn from previous channel usage to predict future outcomes. This feature is the key difference between a cognitive radio system and a software defined radio platform [1], [2].

In this paper, we present an antenna system that is dedicated for a cognitive radio system. The proposed antenna is a four port MIMO design. Two ports are frequency reconfigurable antenna structures dedicated to change their operating frequency based on the channel user's demand. The other two ports are a set of two sensing antennas dedicated to monitor the channel activity and provide a tool to achieve the required learning performance. In section II, the proposed antenna structure is discussed. Section III presents the simulated and the measured data to show the performance of the proposed antenna system in MIMO cognitive radio environment.

## II. Antenna Structure

The corresponding antenna structure is shown in Fig. 1. It consists of two sets of MIMO antennas. The first set is made of a two port frequency reconfigurable antenna structures, while the second set is a two port wideband sensing antennas. The overall antenna system is printed on Rogers Duroid 5880 with a dielectric constant of 2.2, a thickness of 1.6 mm and a dimension of 80 mm x 70 mm.

The two MIMO frequency reconfigurable antennas have an identical physical layout. The first one lies on the top layer of the substrate and the second antenna resides on the bottom layer as shown in Fig 1(a), (b). Both frequency reconfigurable antennas are stripline fed and have a partial ground of dimensions 30 mm x 10 mm. The radiating patch of the two reconfigurable antennas consists of a modified printed monopole of length 20 mm. They are ended by a circular shaped contour to accommodate the two sensing antennas.

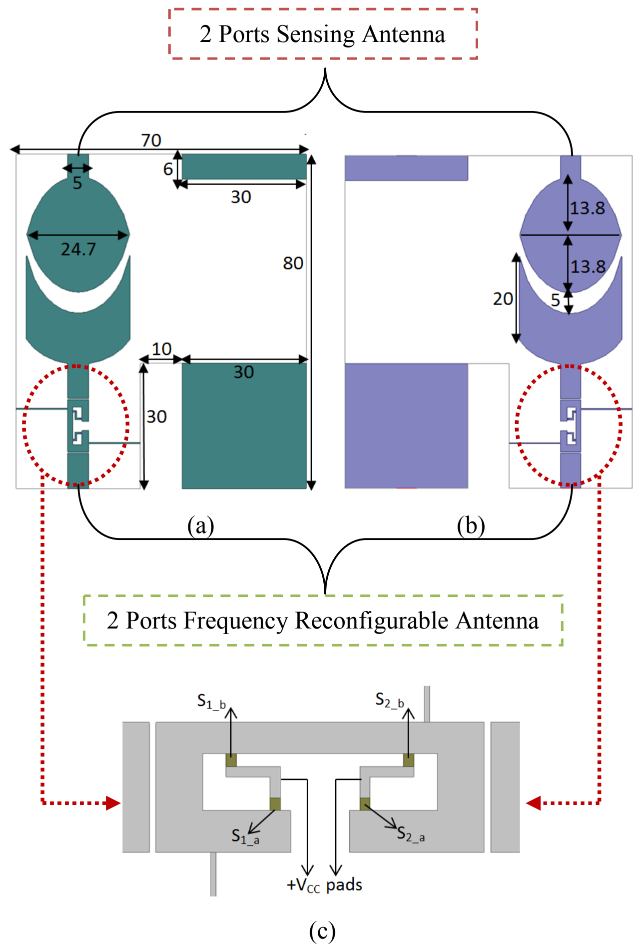


Figure 1. The proposed antenna structure (a) The top layer, (b) the bottom layer, (c) The incorporation of the switches within the T-shaped slot of the band-pass filter

The change in the operating frequency is achieved by incorporating a reconfigurable band-pass filter within the two antennas feeding lines. A zoomed view at the filter structure is shown in Fig. 1(c). It consists of three microstrip lines separated by two gaps that provide the band-pass behavior. In the middle microstrip line, a T-shaped slot is removed. The length of this slot is proportional to the operating frequency of the filter. Thus four switches $\{S_{1\_a}, S_{1\_b}\}$ and $\{S_{2\_a}, S_{2\_b}\}$ are incorporated within this slot as indicated in Fig. 1(c).

The two sensing antennas are also stripline fed and have a partial ground of dimensions 30 mm x 6 mm. One port sensing antenna lies in the top layer and the second port lies in the bottom layer of the substrate. The radiating patch of each sensing antenna consists of two identical half elliptically shaped conducting patches of length 13.8 mm each. These patches are facing each other and are connected together to form a common base of a width of 24.7 mm

## III. RESULTS

The proposed antenna structure is fabricated and tested. To activate the two sets of PIN diodes, two $+V_{CC}$ pads are included within the T-slot as shown in Fig. 1(c). Moreover for each reconfigurable antenna, two sets of biasing lines connect the middle microstrip section of the filter to the antenna ground. These lines are very essential since they provide a DC ground path for the four switches. Fig. 2 shows a comparison between the simulated and the measured reflection coefficient for the reconfigurable antenna. The antenna changes its operating frequency based on the mode of operation of the band-pass filter which is related to the status of the four integrated switches $S_1$: $\{S_{1\_a}, S_{1\_b}\}$ and $S_2$: $\{S_{2\_a}, S_{2\_b}\}$.

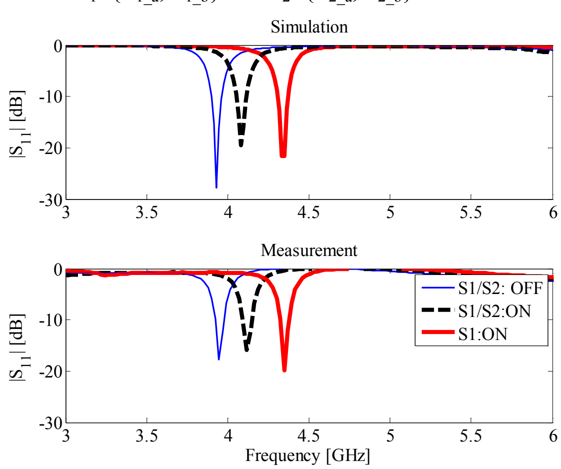


Figure 2. The comparison between the simulated and the measured antenna reflection coefficient for the two port reconfigurable antenna

Fig. 3 shows the comparison between the simulation and the measurement for the sensing antenna reflection coefficient as well as the coupling between the two sensing antennas. This plot corresponds to the case when all switches in the two ports reconfigurable antennas are OFF. The sensing antenna is able to cover the band from 3 GHz till 6 GHz. As for the measured coupling, a maximum value of -15 dB is achieved. This level ensures that the two sensing antennas are well isolated.

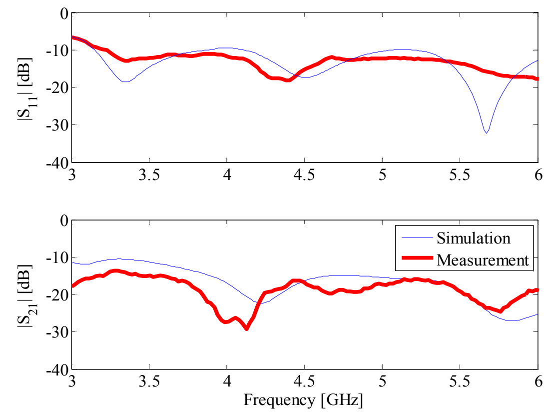


Figure 3. The comparison between the simulation and measurement for (a) the reflection coefficient and (b) the coupling of the two ports reconfigurable antenna

Fig. 4 shows the measured envelope correlation coefficient (ECC) between the two ports of the reconfigurable and the sensing antennas. A low ECC (much lower than 1) is obtained which proves that the proposed MIMO system is a good candidate for a cognitive radio environment

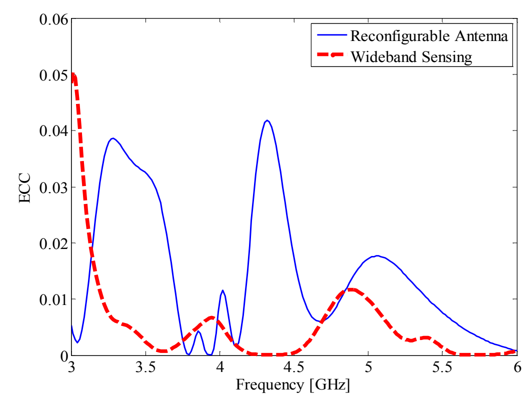


Figure 4. The envelope correlation coefficient for the two ports reconfigurable and wideband sensing antennas

## REFERENCES

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