Broad- and Narrow-band Frequency Reconfigurable Antenna for Cognitive Radio Application

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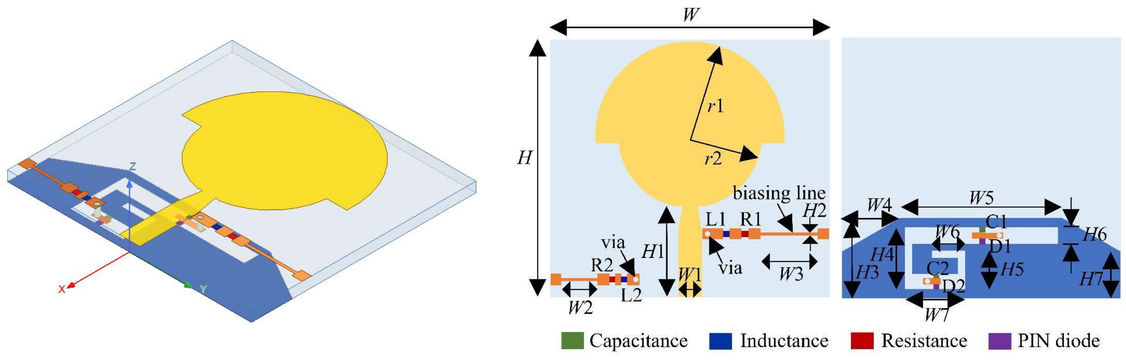
Introduction

In order to solve the problem of spectrum resource shortage, cognitive radio technology as an alternative approach has been proposed, cognitive radio technology requires ultra-wideband (UWB) sensing capabilities to search the idle spectrum, and narrowband communication capabilities to permit unauthorized users to use the free spectrum. Frequency reconfigurable antenna can realize spectrum switching between broadband and narrowband. Based on the above background, the frequency reconfigurable antenna is effectively used in cognitive radio systems.

Antenna design

- Substrate material: Rogers RT/duroid 5880 with a permittivity of 2.2, a loss tangent of 0.0009.
- Dimension: 19×17.5 ×0.787 mm^3.
- How to achieve narrow bands: By etching spiral slit on the ground plane.
- How to achieve frequency reconfigurable: By controlling the on/off of two PIN diodes loaded in the slit.



(a) Stereoscopic structure (b) Top view (c) Bcak view

Fig.1. Configuration of the proposed antenna.

Working principle

- UWB: The antenna structure can be designed to increase the adjacent resonance points within the broadband and to achieve UWB bandwidth characteristics.
- Narrow bands: The current on the back of the substrate is mainly concentrated in the middle of the ground plane. Therefore, a slit is etched in this area. By feeding with the microstrip line, it can be resonant in the narrow bands and radiate electromagnetic wave outside.
- Frequency reconfigurable: By controlling the resonant length of the radiation slit to achieve UWB and narrow bands. When the PIN diode work, it needs a biasing circuit.

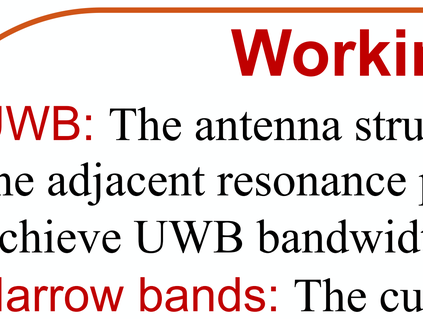


Fig. 2. The surface current distribution of the UWB antenna.

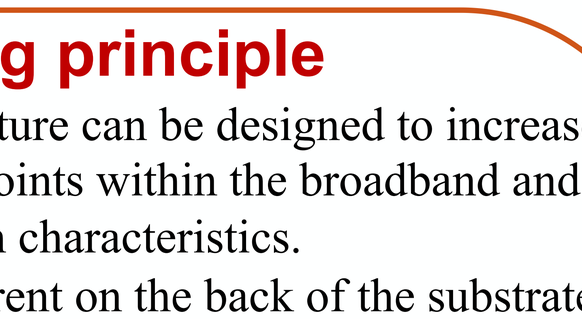


Fig. 3. DC bias circuit.

Simulation results and analysis

By controlling the on/off of D1 and D2, the antenna can operate in three states.

- State1: Antenna operates in UWB.
- State2: Antenna operates in single band with a central frequency of 3.7GHz.
- State3: Antenna operates in dual band with the central frequency of 3.6GHz and 6.7GHz.

Tab. I. Three operation modes of the antenna

Working State	States of PIN diode		Simulation bandwidth
	D1	D2	
State 1	ON	ON	3.82-12GHz
State 2	OFF	ON	3.02-4.40 GHz
State 3	OFF	OFF	3.05-4.16 GHz and 6.23-7.20 GHz

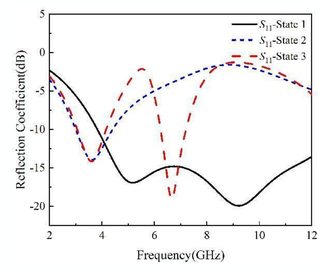


Fig. 4. Reflection coefficient of three states.

At 3.6GHz the current is mainly distributed around the rectangular slit on the top of the spiral slit, while at 6.7GHz the current is mainly distributed around the entire spiral slit. It can be verified the working principle of narrow bands.

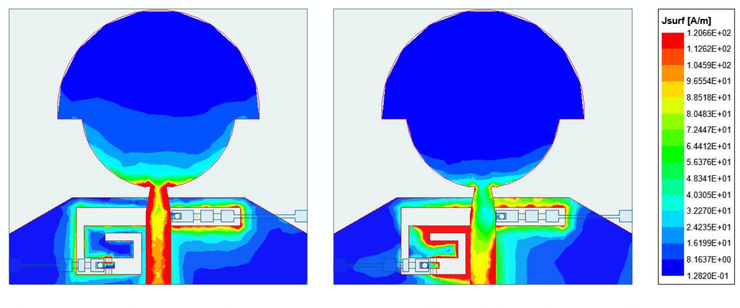


Fig. 5. The surface current distribution of state 3.

At 3.6GHz and 6.7GHz, the xoz-plane pattern shows directional radiation characteristics and the yoz-plane pattern shows omnidirectional radiation characteristics, which shows that the designed antenna has good radiation characteristics.

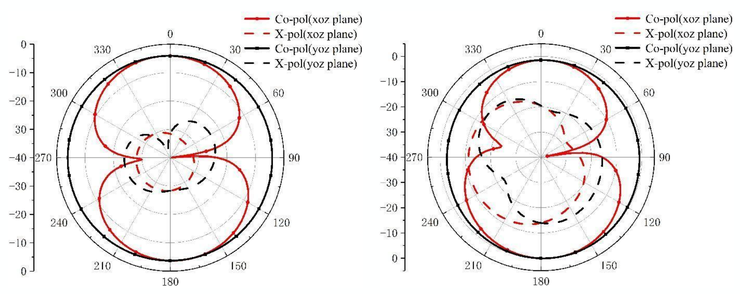


Fig. 6. Simulated radiation pattern.

Conclusion

The spiral slit in the ground plane allows the antenna to operate in dual band. To change the current distribution on the antenna surface through the on/off of the PIN diode, the antenna can realize the switching between different frequencies. This enables the antenna to select the operating band according to the desired application environment, which can be applied in cognitive radio systems.

Acknowledgment

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