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Ultra-Wide to Narrow Band Agile Reconfigurable Frequency Microstrip Slot Antenna

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Abstract

A simulation of reconfigurable frequency antenna is presented. The antenna is an integration of ultra-wide band antenna with a microstrip slot antenna. It has a capability to operate in ultra-wide band (0.98 - 12.0 GHz) and seven different narrow bands from 2 GHz to 4 GHz. Seventeen switches with eight configuration are used to select between ultra-wide band and the narrow bands. The proposed antenna demonstrates frequency agility which useful for future communication systems such as cognitive radios.

Keywords: reconfigurable frequency antenna; wide band monopole antenna; microstrip slot antenna.

1. Introduction

Agile reconfigurable antennas for future communication systems have attracted researchers around the globe. Antenna's characteristics such as frequency, radiation pattern and polarization are reconfigured to attain the demands for agile radios. A lot of researches focus on frequency reconfiguration as future communication systems such as cognitive radio needs an antenna that can do spectrum sensing and communication. The cognitive radio is categorized to 2 systems. The first system continuously monitor the spectrum of network usage in a process which run in parallel with communication link and the second system use a single channel for both spectrum sensing and communication [1]. The use of omni-directional wideband antenna and directional agile narrow antenna for the first system and agile wideband / scanned narrow band antenna for the second system are widely been explored. The wideband antenna is suggested to be used for spectrum sensing while an agile narrow antenna is used for communication. The agile wideband / scanned narrow band antenna are used for spectrum sensing and communication [2]. Research trend nowadays combine both wide and narrow band antennas to achieve concise, small and less complex front end cognitive radio systems. In reconfigurable frequency antennas development, recently a reconfigurable wide-band to agile narrow frequencies, using a printed log periodic dipole array antenna, was introduced in [3]. A wideband slotted multifunctional reconfigurable frequency antenna for WLAN, WIMAX, UWB and UMTS has been proposed in [4]. In [5], a frequency reconfigurable antenna, consisting of two structures; one is an ultra-wide band (UWB) and other is a frequency reconfigurable triangle shape antenna, is proposed for cognitive radio communication. In this paper, a reconfigurable frequency antenna is demonstrated. The antenna is an integration of ultra-wide band antenna with a microstrip slot antenna. It’s capable to switch between ultra-wide band (0.98 GHz to 12.0 GHz) to seven different narrow bands which are at 2.0 GHz, 2.25 GHz, 2.6 GHz, 2.92 GHz, 3.23 GHz, 3.53 GHz and 3.84 GHz. The frequency bands are selected by controlling seventeen switches. The antenna produces near omni-directional radiation patterns and generates gains around 1 to 4 dBi.

2. Design & Configuration

The simulation is done using Computer Simulation Technology (CST) software. Figure 1 shows the proposed geometry of the reconfigurable frequency antenna. The dimension of the antenna will be included in the full paper. The antenna is designed on Taconic RF-35 with a dielectric permittivity of 3.5, thickness of 1.52 mm and tangential loss of 0.0018. The size of the proposed antenna is 100 mm x 110 mm. It consists of an ultra-wide band wine cup shaped antenna and a reconfigurable slot at the ground plane of the antenna. For proof of concept and simplification purposes, switches are represented as a copper strip in the simulation. The presence of the copper strip represents the switch *on* state while the absence of the copper strip represents the switch *off* state. Also no bias lines were modelled. Two switches, *S1* and *S2* are placed at the transmission line while the others are placed at the slot at the ground plane of the antenna. Figure 2 shows the switches configuration at the slot of the antenna while Table I shows the switch configuration in order to achieve the required frequencies. When *S1* or *S2* is turned *off*, the transmission line acted as a feed for the slot. The seven different narrow bands is produced by changing the length of the slot at the ground plane. When *S1*, *S2* and *St* is turned *on*, ultra-wide band can be achieved. *St* is placed under the transmission line in order to provide proper grounding to the feeding network.

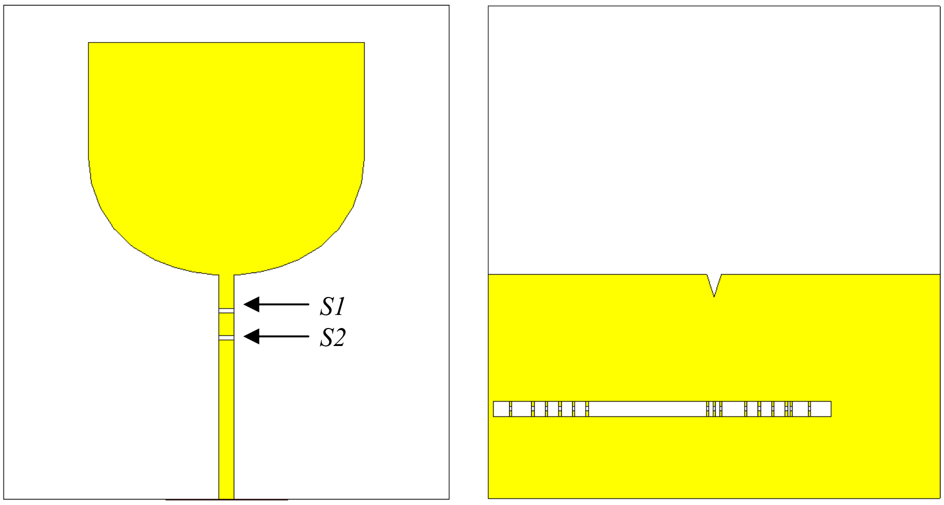


Figure 1: Geometry of the proposed reconfigurable antenna (a) front view and (b) back view

Figure 2: Switches configuration at the slot at the ground plane of the antenna

Table I
Switch configuration for frequency switching

Frequency	**Switch state**
F1, 2.0 GHz	*S2* & *S3* *on*, others *off*
F2, 2.25 GHz	*S2* & *S4* *on*, others *off*
F3, 2.6 GHz	*S2* & *S5* *on*, others *off*
F4, 2.92 GHz	*S6* *on*, others *off*
F5, 3.23 GHz	*S7* *on*, others *off*
F6, 3.53 GHz	*S8* *on*, others *off*
F7, 3.84 GHz	*S9* *on*, others *off*
Ultra-wide band (0.98 GHz to 12 GHz)	*S1, S2* & *St* *on*, others *off*

3. Result & discussion

Figure 3 shows the simulated return loss for narrow band and the ultra-wide band frequencies. From the figure, it is shown that the antenna is capable to reconfigure at seven different frequencies from 2.0 GHz to 3.84 GHz. The return loss at all frequencies are below -10 dB with an average bandwidth percentage of around 12 %. The ultra-wide band frequency of the antenna is operating from 0.98 GHz to 12 GHz with a bandwidth percentage of 321 %. Figure 4 shows the radiation patterns at the narrow band frequencies in E-plane and H-plane. From observation, the radiation patterns is bidirectional in pattern with a gain from 0 dBi to 5 dBi. At the higher narrow band frequencies, the main beam of the radiation pattern is shifted to left side but still sustaining the bidirectional pattern. Figure 5 shows the radiation patterns at the ultra-wide band frequency at 5 different frequencies in E-plane and H-plane. It shows that at all frequencies, the antenna is producing near omni directional radiation patterns. The gain of the antenna in ultra-wide band frequency is from -2 dBi to 3 dBi.

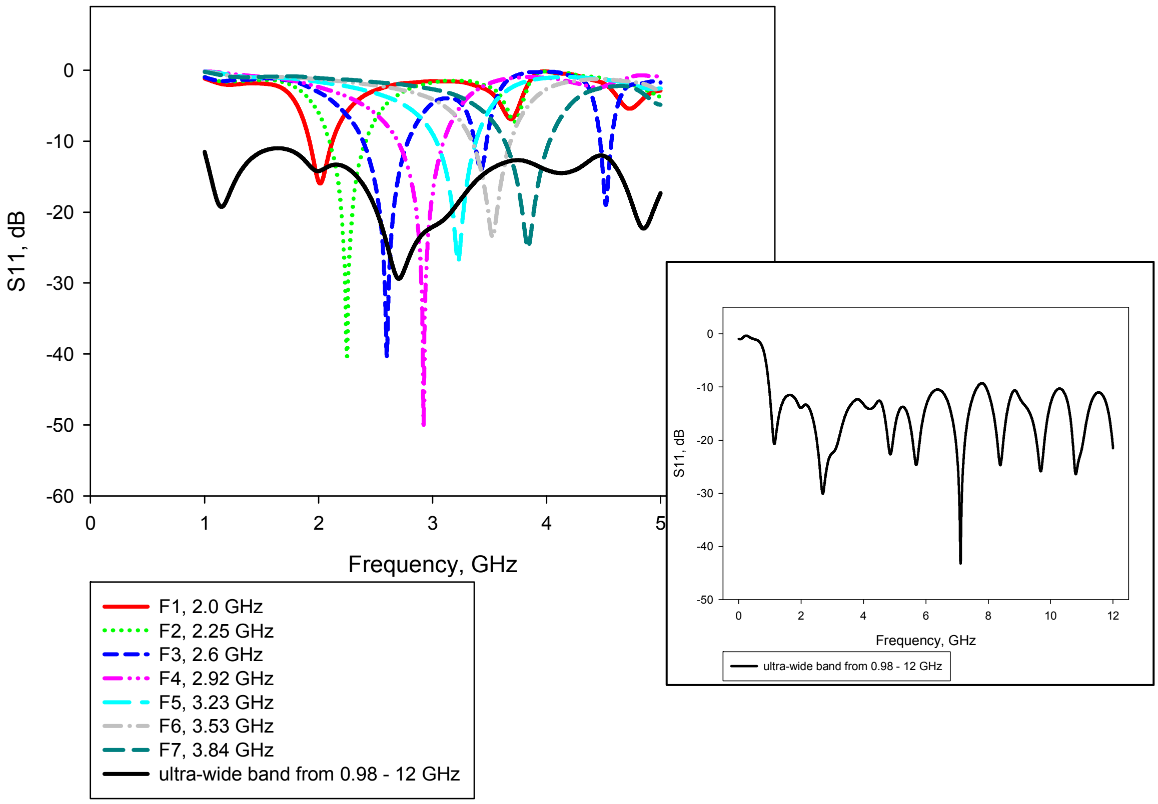


Figure 3: Return loss for narrow band and the ultra-wide band frequencies

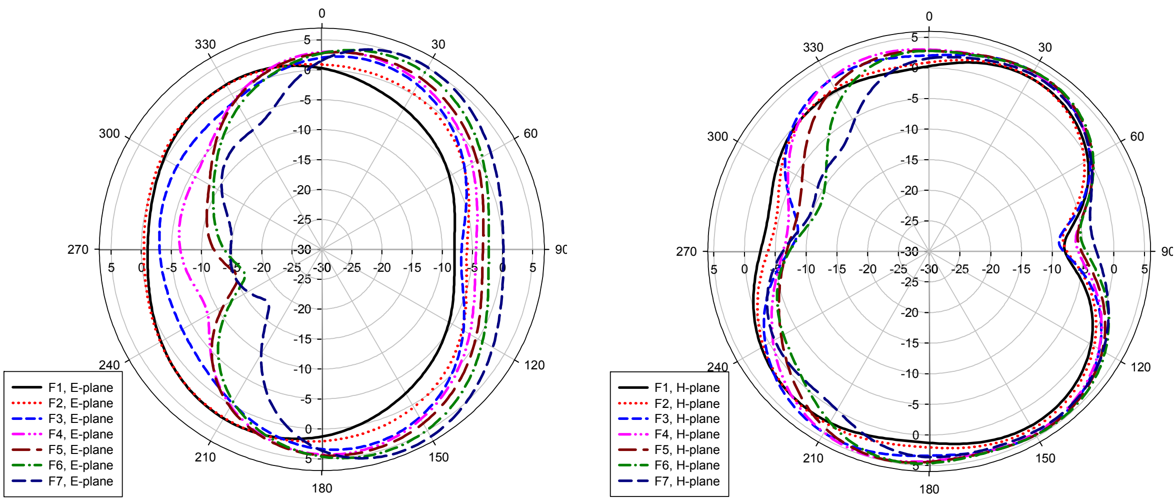
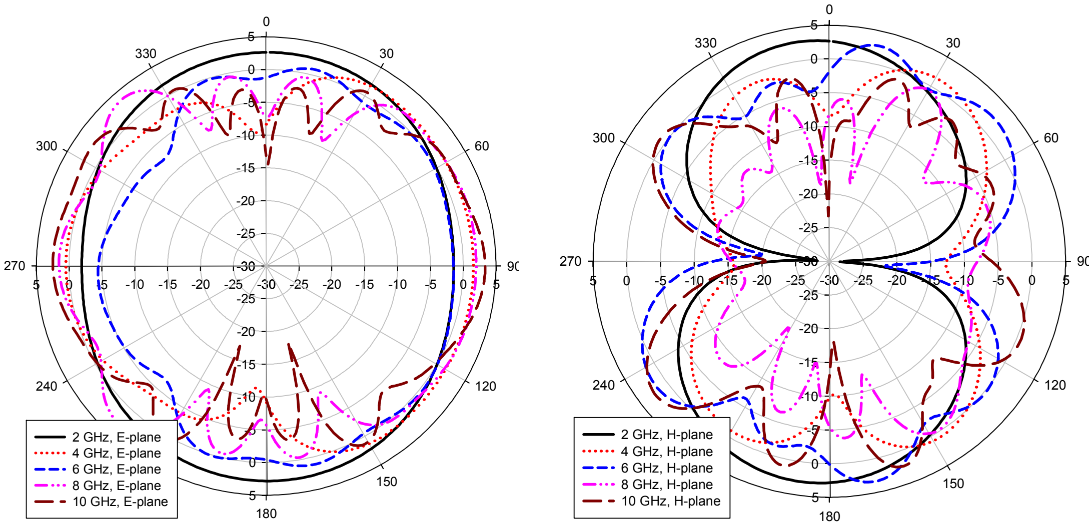


Figure 4: Radiation patterns at the narrow band frequencies in (a) E-plane and (b) H-plane



(a) (b)

Figure 5: Radiation patterns at the ultra-wide band frequencies in (a) E-plane and (b) H-plane

4. Conclusion

A reconfigurable frequency from ulta-wide band to seven different narrow band frequencies antenna has been simulated and presented. The antenna is capable to configure at seven different frequencies which is at 2.0 GHz, 2.25 GHz, 2.6 GHz, 2.92 GHz, 3.23 GHz, 3.53 GHz and 3.84 GHz. The antenna is also capable to configure frequency from narrow band to ultra-wide band frequency. The ultra-wide band frequency is operating form 0.98 GHz to 12 GHz. The frequency configurations are obtained by controlling switches at the slot and the transmission line. The proposed antenna can be used for future systems such as cognitive radio that required frequency reconfiguration.

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