Reconfigurable Frequency and Pattern Dual-Mode Dipole/Yagi Antenna

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Abstract

A simulation of reconfigurable frequency and pattern dual-mode Dipole/Yagi antenna is presented. Introduction of switches at the arms of the driver element produces 3 switchable frequencies (1.25 GHz, 1.85 GHz and 2.45 GHz). The radiation pattern can also be configured as omni-directional or directional pattern by switching between Dipole mode and Yagi mode at those 3 frequencies. Dipole and Yagi modes are achieved by placing switches at the reflector and directors elements.

Keywords: Reconfigurable frequency and pattern antenna, yagi-uda antenna, dipole antenna

1. Introduction

Reconfigurable antenna has attracted a lot of interest to many researchers toward improving mobile communication systems. Reconfigurable antenna can be classified to 3 main groups which are reconfigurable frequency [1-2], reconfigurable polarization [3] and reconfigurable pattern [4-5] antennas. The combination those groups produced a new type of reconfigurable antenna such reconfigurable polarization and pattern and reconfigurable frequency and pattern discussed in [6]. This paper discussed on reconfigurable frequency and pattern antenna. The antenna capable to switch between 3 different frequencies (1.25 GHz, 1.85 GHz and 2.45 GHz) and its radiation pattern can be switched between omni-directional and directional pattern. The switchable radiation pattern produced 2 types of modes where omni-directional pattern as Dipole mode and directional pattern as Yagi mode.

2. Design & Configuration

Figure 1 shows the designed reconfigurable frequency and pattern dual-mode Dipole/Yagi antenna. It consists of driver, reflector and directors. The element at the middle is the driver and the elements above it are the directors, whereas the element below it is the reflector. Switches are introduces at every gaps in each element as shown in Figure 2. S1, S2, S3, S4 and S5 represent switches at the elements.

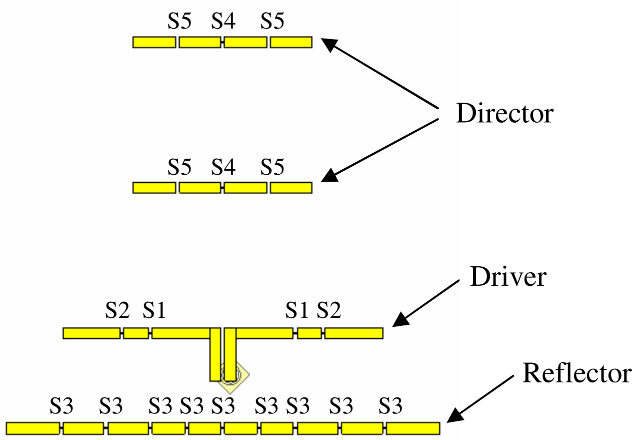


Figure 1: Geometry of reconfigurable frequency and dual-mode Dipole/Yagi antenna

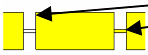


Figure 2: Placement of switches at all elements

The simulation is done using Computer Simulation Technology (CST) software. In this simulation, switches are been represented with copper strip. Length of the driver for 1.35 GHz is 83.8 mm, 51.8 mm for 1.85 GHz and 37 mm for 2.45 GHz. The length of the reflector is 113.8 mm and the 47 mm for the directors. The gap between the driver and reflector is 29 mm and the gap between the driver and director is 38 mm. The antenna is using FR-4 substrate with a dielectric permittivity of 4.5, thickness of 1.6 mm and tangential loss of 0.019. At the driver's element, 4 switches are placed to produce 3 switchable frequencies. Table 1 shows the resonant frequency and the switch configuration. This designed antenna is also capable to switch between Dipole and Yagi mode. Dipole mode produces an omni-directional radiation pattern while Yagi mode produces a directional radiation pattern. Yagi mode can be achieved by switching on switch S3, S4 and S5, whereas the Dipole mode can be achieved by switching off switch S3, S4 and S5. Table 2 shows the switch configuration to achieve the required mode.

Table 1: Switch configuration for frequency switching

Resonant Frequency	Switch Configuration
1.25 GHz	S1 & S2 on
1.85 GHz	S1 on & S2 off
2.45 GHz	S1 & S2 off

Table 2: Switch configuration for pattern switching

Modes	Resonant Frequency	Switch Configuration
Yagi	1.25 GHz	S3, S4 & S5 on
	1.85 GHz	S3, S4 & S5 on
	2.45 GHz	S3 & S4 on, S5 off
Dipole	1.25 GHz	S3, S4 & S5 off
	1.85 GHz	
	2.45 GHz	

3. Results & discussion

Results of the simulated return loss, S_{11} are shown in Figure 3. The antenna in Yagi mode resonates at 1.25 GHz, 1.85 GHz and 2.45 GHz. In Dipole mode, the resonant frequency shifted to a higher frequency which is at 1.3 GHz, 1.88 GHz and 2.5 GHz. This shift is due to the parasitic effect from the reflector and director elements.

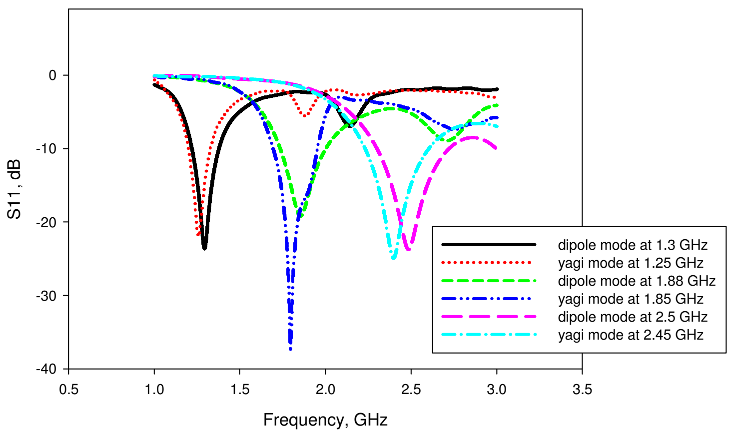
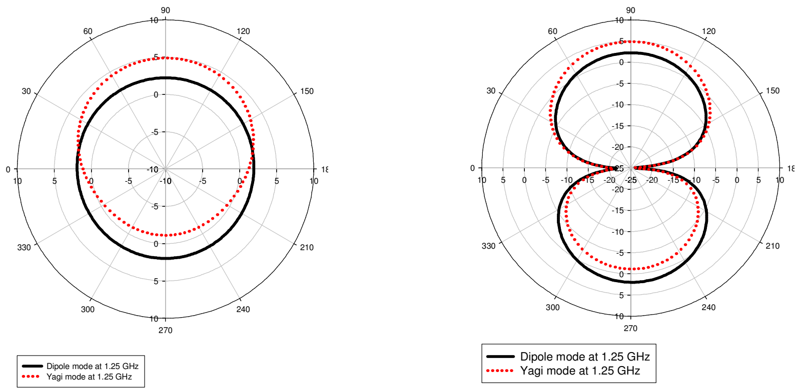


Figure 3: Simulated S_{11} results

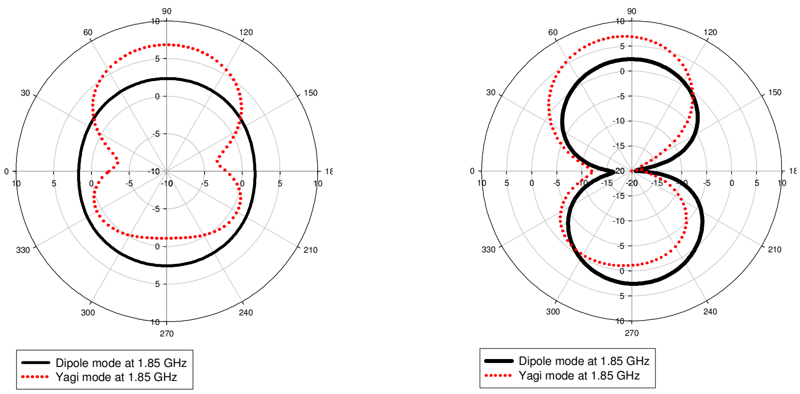
Figure 4 to Figure 6 shows the simulated radiation pattern of the antenna at both Dipole and Yagi modes operate at 3 different frequencies. Figure 4 (a) and (b) shows the radiation pattern in E and H plane at 1.25 GHz in both Dipole and Yagi modes. The gain of the antenna increases up to 2.7 dB in Yagi mode. In both planes, it can be seen that the pattern of Yagi mode is more directional that the Dipole mode. At 1.85 GHz, the gain increases up to 4.4 dB and the radiation pattern of Yagi mode is directional in shape compared to Dipole mode. Figure 5 (a) and (b) shows the radiation pattern at 1.85 GHz in both planes. Figure 6 (a) and (b) shows the radiation pattern in both planes operates at 2.45 GHz. In both planes, the radiation pattern for Yagi mode is more directional in shape compare to Dipole mode and increases the gain up to 3.8 dB.

Refer to Table 2, when the switches at the reflector and directors elements are turned off, the strips are split into many parts and the induced current on it is very weak, the effect toward radiation can be neglected. Therefore, produces an omni-directional radiation pattern (Dipole mode). When the switches at the reflector and directors elements are turned on, the strips work as a normal reflector and directors produce a directional radiation pattern (Yagi mode).



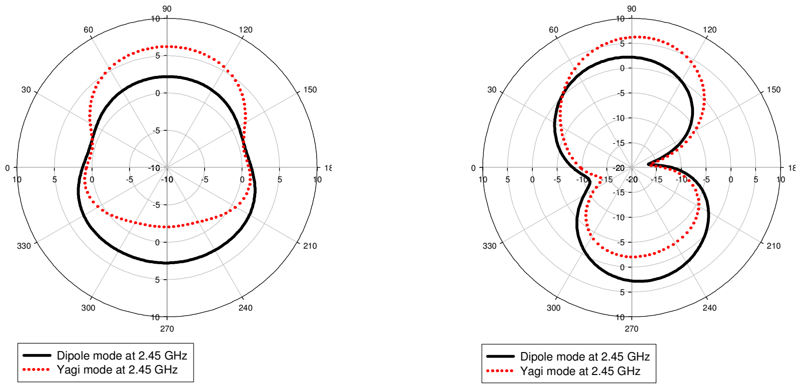
(a) (b)

Figure 4: (a) E-plane radiation pattern at 1.25 GHz and (b) H-plane radiation pattern at 1.25 GHz



(a) (b)

Figure 5: (a) E-plane radiation pattern at 1.85 GHz and (b) H-plane radiation pattern at 1.85 GHz



(a) (b)

Figure 6: (a) E-plane radiation pattern at 2.45 GHz and (b) H-plane radiation pattern at 2.45 GHz

4. Conclusion

A reconfigurable frequency and pattern dual-mode Dipole/Yagi antenna has been designed and simulated. The antenna is capable to configure at 3 different frequencies which are 1.25 GHz, 1.85 GHz and 2.45 GHz. It's also capable to configure between omni-directional (Dipole mode) and directional (Yagi mode) pattern at those 3 frequencies. Yagi mode is achieved by switching on the switches at the reflector and directors elements. Switching off the switches at those elements created the Dipole mode. Higher gain in Yagi mode can be achieved by increasing the number of directors.

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