Frequency Reconfigurable Antenna : WLAN, Aeronautical Radio, WiMAX Applications

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Abstract- A compact flexible coplanar waveguide-fed frequency reconfigurable antenna is presented. The proposed antenna uses Rogers RT 5880 as a substrate with a volume of $30\times28\times0.508$ mm^3. To make the antenna reconfigurable, two lumped switches are integrated in the design. The proposed antenna is simulated on CST Studio suit 2017, which exhibits VSWR < 2 and positive acceptable gain in the desired band. The proposed antenna is applicable around the frequencies 4.3GHz, 5.2GHz, 5.5GHz, and 7.5GHz

Keywords-reconfigurable antenna; lumped switches; coplanar waveguide;

I. Introduction

Due to customer demand for more number of services in a single device, the antenna which is operated at multiple frequencies has gained lot of importance in the wireless technology industry. These multiband antenna propagate electromagnetic waves at all supported frequencies along with desired frequency which has severe effect on human being.

The reconfigurable antenna clears the above problems, which are reconfigured at the desired frequency or frequency band. This reconfiguration process can be done by introducing lumped elements or switches within the radiator [1]. This antenna reduces the frequency interference between two adjacent operating frequencies and also provides better tuning ability between those adjacent frequency bands with a stable gain.

There is no. of switches which are used for frequency reconfiguration like varactor diodes [2], pin diodes [3], FET switches [4]. Usage of large no. of pin diodes increases the insertion loss and circuit complexity [5]. The frequency reconfigurable antennas uses pin diodes which are explained in [6, 7, 8] for Bluetooth, WLAN, WiMAX applications. Using pin diodes, the designs suffer from larger complexity, larger design dimensions, limited impedance bandwidth etc. Present days, flexible antennas have gained much priority due to their robustness, less weight, better dimensions [9]. In this paper, a compact flexible frequency reconfigurable antenna is proposed with coplanar waveguide feeding technique where antenna element and patch are mounted same side of the substrate. By applying lumped switches at required locations in the design, frequency reconfigurable is possible for different applications.

2. Antenna Design

A. DESIGN STRUCTURE

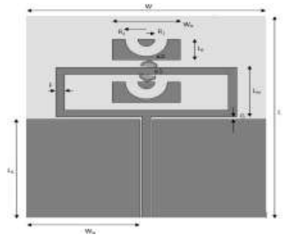

Figure 1. Proposed antenna design

B. DESIGN PARAMETERS

Table 1. Optimized Design Parameters

Design Parameter	**Value (mm)**	**Description**
W	28.4	Substrate width
L	30	Substrate length
H	0.508	Substrate thickness
W_G	13.45	Ground width
L_G	14.642	Ground length
H_G	0.0356	Ground thickness
W_M	20	Main radiator width
L_M	7.3	Main radiator length
F	1	Feed width
G	0.358	Gap between ground and main radiator
W_R	8	Inner radiator width
L_R	3	Inner radiator length
R_2	2.5	Outer circle radius
R_1	1	Inner circle radius

C. Design Description

The proposed antenna uses Rogers RT/Duroid 5880 as a substrate whose dielectric constant is 2.2 and loss tangent is 0.0009 with the thickness of 0.508mm. The area of the substrate is 30×28.4 mm^2. The antenna is feed by a 50Ω Microstrip line. The coplanar waveguide has a width of 1mm is connected to main radiator, the inner and outer radiator are connected to the main radiator through the switches S1 and S2. Initially, the antenna is designed for a single frequency band. To acquire more number of resonant frequencies, a rectangle is inserted inside and outside of the main radiator. To obtain a desired band, a half circle shaped slots are inserted in the inner radiator and outer radiator and the return loss depends on the width of the half circle shaped slot. Depending on the state of the switch, there are four combinations for two no. of switches which are [S1-ON, S2-ON], [S1-OFF, S2-ON], [S1-ON, S2-OFF], [S1-OFF, S2-OFF].

3. Results and Analysis

The proposed antenna design is shown in figure-1which is simulated using CST Microwave Studio. If the switch is ON means there is an electrical connection between main radiator and sub radiator (outer radiator or inner radiator). If the switch is OFF means there is no electrical connection. Because of limitations, we use conductors instead of diodes. In these four switch combinations main radiator must conduct. If any switch is open then the current circulates in the main radiator and sub radiator. When both the switches are open, the current circulates only in the main radiator

A. WHEN S1 AND S2 ARE OPEN

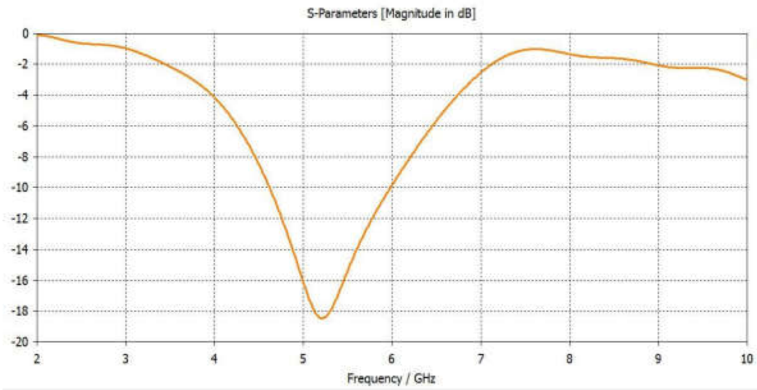

Figure 2. S parameter graph when S1 and S2 are open

Initially, we had designed antenna for single frequency band at 5.8GHz. After the insertion of inner and outer radiator, there is a shift in frequency from 5.8 GHz to 5.2 GHz with a wide bandwidth of 1.4 GHz (4.6-6 GHz). Here 5.2 GHz is a frequency for WLAN applications shown in figure 2

B. WHEN SWITCH S2 IS OPEN

When the switch S2 is open i.e. switch S1 is at ON position then the antenna resonates at a frequency of 4.6 GHz with a bandwidth of 600MHz (4.3-4.9 GHz) that covers 4.3 GHz of Aeronautical Radio Navigation and 4.5 GHz of AMT Fixed Services shown in figure 3.

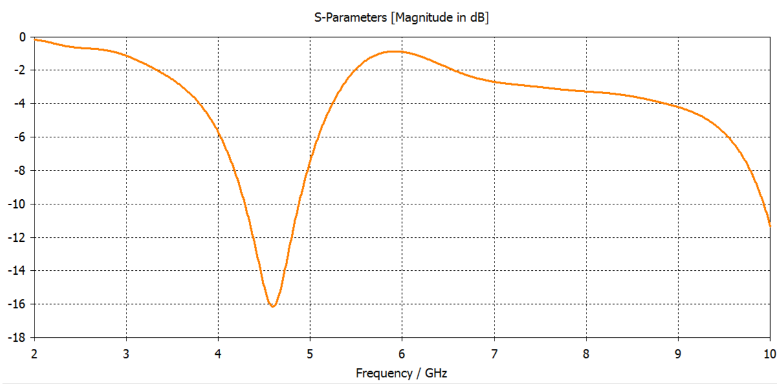

Figure 3. S parameter graph when S2 is open

C. WHEN SWITCH S1 IS OPEN

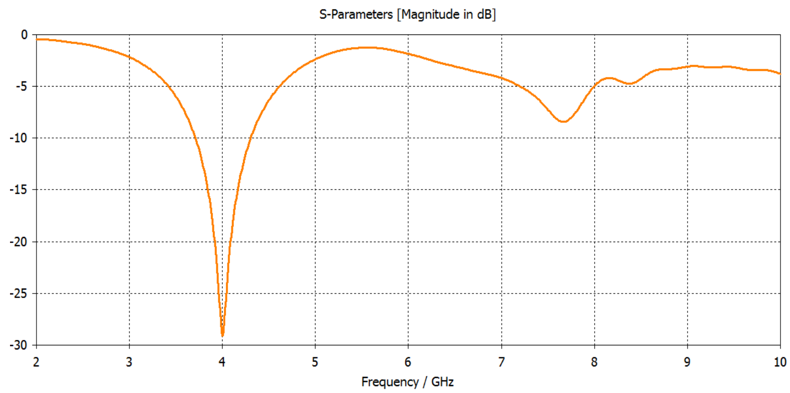

Figure 4. S parameter graph when S1 is open

When the switch S1 is open i.e. switch S2 is at ON position then the antenna resonates at a frequency of 4 GHz with a impedance bandwidth of 600 MHz (3.7-4.3 MHz) that covers the frequency range of WiMAX and it contains the frequency range of C-band Interference Elimination Filter shown in figure 4.

D. WHEN BOTH S1 AND S2 ARE CLOSED

When both the switches S1 and S2 are at ON position then the antenna resonates at a lower frequency of 3.9 GHz with a impedance bandwidth of 630 MHz (3.6-4.1 MHz) and due to strong current intensity, another frequency band exists from 6.4 GHz to 6.6 GHz with a bandwidth of 200 MHz figure 5.

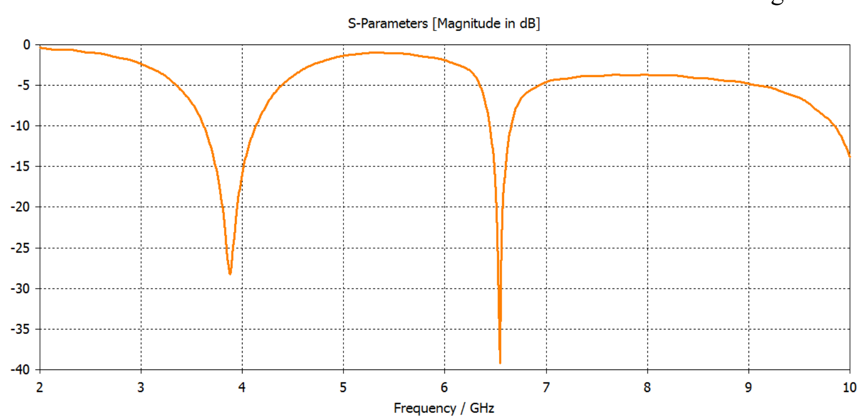

Figure 5. S parameter graph when S1 and S2 are closed

4. Conclusion

A flexible frequency reconfigurable antenna for WLAN, Aeronautical Radio Navigation, WiMAX, and AMT Fixed Services is proposed. The proposed antenna design parameters are optimized. By employing the switches effectively, the electrical length of the antenna is effectively changed. This antenna also has a good radiation pattern and has flexibility, reconfigurability and operates effectively at all the respected frequency bands.

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