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Design and Analysis of Frequency Reconfigurable Microstrip Antenna

Sridevi L, Hemalatha B,

PG Scholar, SVCE, Chennai, Tamilnadu, India [1]

Assistant Professor, SVCE, Chennai, Tamilnadu, India [1]

ABSTRACT: A frequency reconfigurable antenna is suitable for modern wireless and portable devices to operate at more than one frequency bands. The incorporation of a U-slot in the patch provides a wider bandwidth than the conventional patch antenna. The frequency reconfigurability is achieved by placing a variable capacitor and an inductor at the antenna input. The multi-band frequency reconfigurable microstrip antenna is operated in the frequency range from 2.44 to 2.56 GHz, 2.64 to 2.92 GHz and 3.1 to 3.24 GHz. This antenna is simulated in Computer Simulation Technology (CST).

KEYWORDS: Reconfigurable antenna, Frequency reconfigurable.

I. INTRODUCTION

In recent years reconfigurable antennas have been receiving much attention due to their several advantages. They reduce fading effects caused by multipath, increase the system capacity by frequency reuse, provide immunity to interfering signals, increase the communication link quality and reduce co-channel interference. They have more functionalities than conventional antennas and can be used in many wireless communication systems. The characteristic of the antenna that can be reconfigurable are frequency, pattern, polarization or combinations of them. One of the techniques proposed to change the resonant frequency of a microstrip antenna. A lumped elements is introduced between the patch and the feeding point, which could lower the effective permittivity of the cavity under the patch. Hence, the resonant frequency of the antenna could be tuned by adjusting this L and C component.

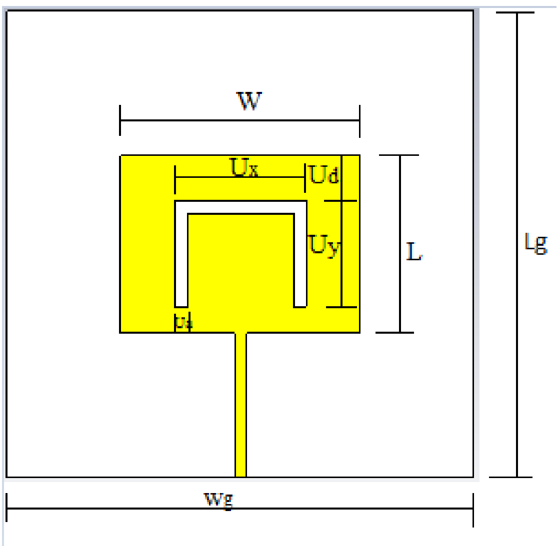

Fig .1 geometry of the proposed U-slot patch antenna

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Reconfigurable antennas have found increasing attention in recent years. Antenna performance reconfiguration is usually achieved by incorporating switches [1], variable capacitors, varactor diodes or MEMS switches in the design of the antenna[3]. These enable the frequency response, radiation patterns, gain or the combination of various antenna parameters to be controlled.

In this letter, a frequency tuneable U-slot microstrip patch antenna is presented. Variable chip capacitor (trimmer) is used to control the frequency of the antenna. The geometry and results of the proposed antenna will be separately presented in the following sections, and a brief discussion about the function of the U-slot will be presented. Finally, a conclusion remark will be drawn.

II. ANTENNA DESIGN

The geometry of the proposed U-slot frequency tunable antenna is shown in Fig.1. The patch has a dimension (W ×L) of 77 mm 57 mm, and is placed 5 mm (H) above the ground plane. The U-slot has a width (U_x) and length (U_y) of 32 mm and 31 mm respectively; a gap width (U_a) of 4 mm, and it is 14.5 mm away from the upper edge of the patch (U_d). The ground plane dimension is (W_g×L_g) 150 mm ×150 mm. The substrate has a dielectric constant of 2.6 and a thickness of 1.524 mm.

The matching frequency of the antenna could be tuned by changing the capacitance value of the variable chip capacitor (trimmer). The model of the trimmer used in this prototype is TZW4, manufactured by MuRata Co.The trimmer has a capacitance range between 0.4 and 1.5 pF.A chip inductor of 1 nH is connected in parallel to the trimmer, this could adjust the capacitance tuning range to the range of the trimmer.

III. SIMULATION RESULTS AND DISCUSSION

An antenna prototype is built to demonstrate the frequency tuning ability of the proposed design. Fig. 2 show the simulated response of s-parameter result of reconfigurable antenna.

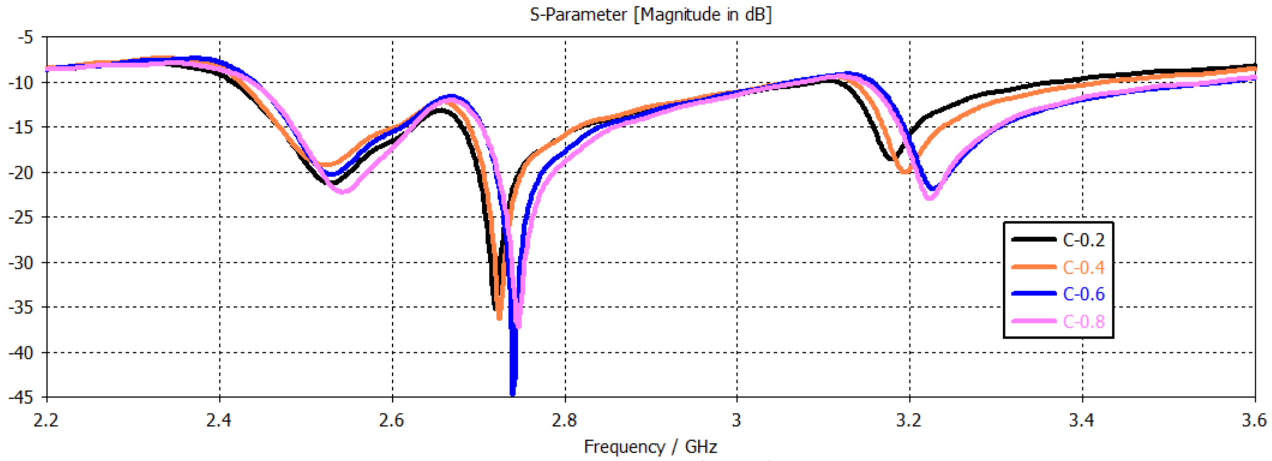

Fig. 2 Simulated response (S-parameter) of reconfigurable antenna.

Fig. 3 Simulated response of S-parameter (S11-return loss) at 2.51 GHz, 2.72 GHz and 3.145 GHz.It is observed that a return loss of -22.95 dB is achieved at 2.51 GHz, -31.56 dB is achieved at 2.72 GHz and -17.949 dB is achieved at 3.145 GHz.

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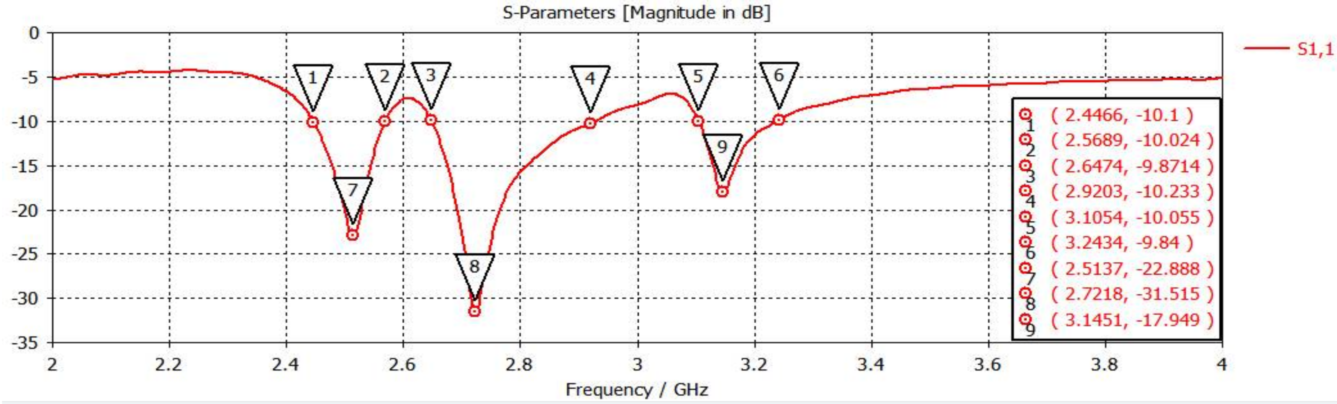

Fig .3 Simulated response (S-parameter) of reconfigurable antenna (C- 0.2).

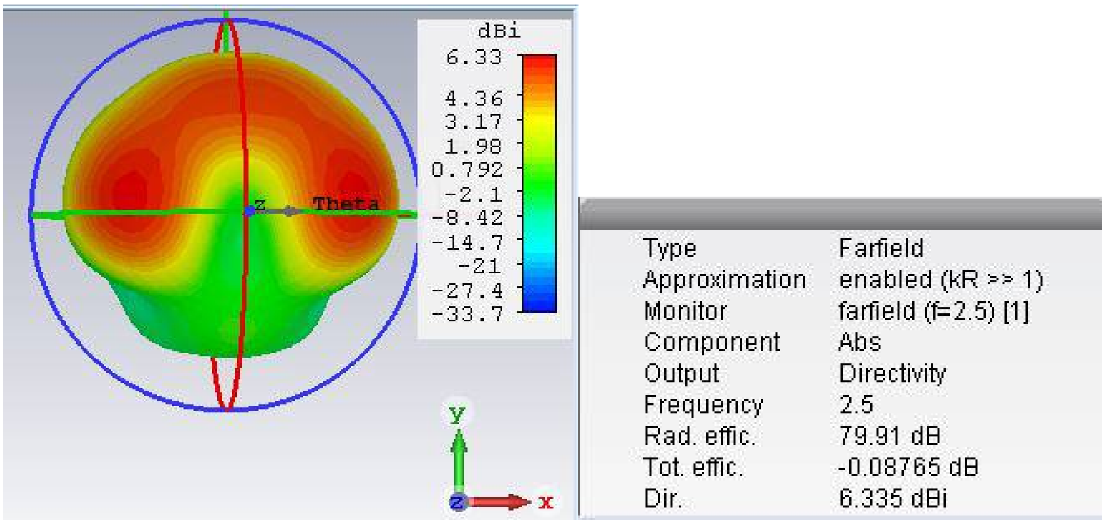

Fig .4 3D radiation pattern for 2.5 frequency.

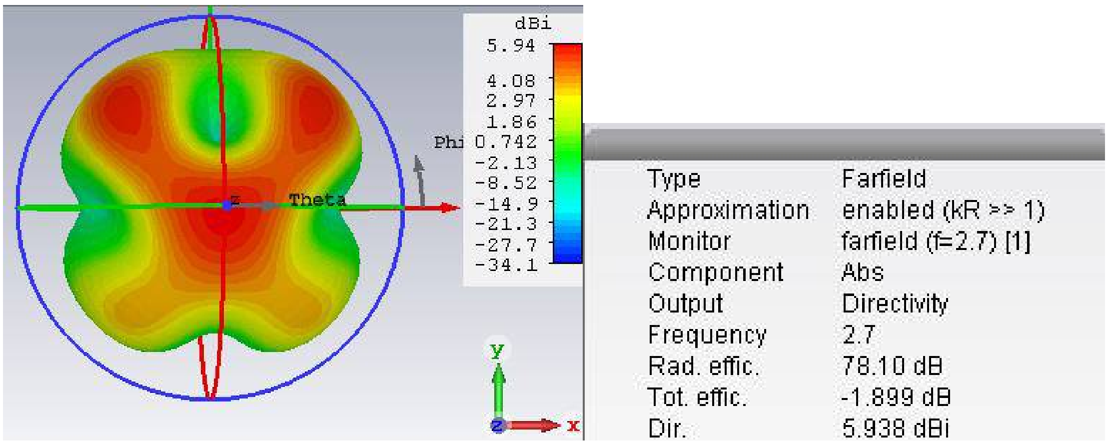

Fig .5 3D radiation pattern for 2.7 frequency

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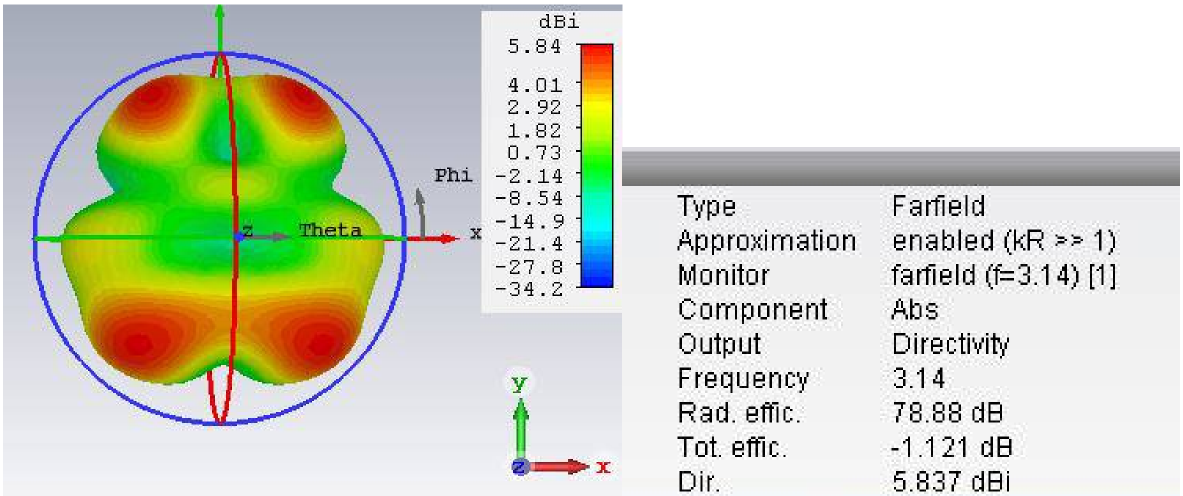

Fig .6 3D radiation pattern for 3.14 frequency

Fig .4 Simulated result of radiation pattern at 2.5 GHz .It is observed that a directivity of 6.335 dBi. Fig.5 simulated result of radiation pattern at 2.7 GHz .It is observed that a directivity of 5.938 dBi. Fig .6 Simulated result of radiation pattern at 3.14 GHz .It is observed that a directivity of 5.837 dBi.

Table 3.2 Parameter Analysis

PARAMETER	FREQUENCY	VALUE
Return Loss (dB)	2.51GHz 2.72GHz 3.14GHz	-22.87 -31.45 -17.95
VSWR	2.51GHz 2.72GHz 3.14GHz	1.1 1.0 1.2
Directivity (dBi)	2.51GHz 2.72GHz 3.14GHz	6.335 5.938 5.837

From the table return loss of -22.9 dB is got at a frequency of 2.51 GHz, -31.56dB is got at a frequency of 2.72 GHz and -17.95 dB is got at a frequency of 3.14 GHz. VSWR of the patch antenna at 2.51 GHz is 1.1, at 2.72GHz is 1 and at 3.14 GHz is 1.2. Directivity of the patch antenna at 2.51 GHz is 6.335 dBi,5.938 dBi at 2.72 GHz and at 3.14 GHz is 5.837 dBi.

IV. CONCLUSION

This project presents a microstrip frequency reconfigurable patch antenna for wireless applications. In this work, a frequency reconfigurable antenna is designed and operating at a frequency range from 2.46 GHz to 2.6 GHz for Wi-Fi standards IEEE 802.11 and bluetooth application. Return loss of -22.9 dB is achieved with a voltage standing wave ratio of 1.15 and directivity of 6.335 dBi, Second resonance operating frequency range from 2.6 GHz to 2.8 GHz for WiMax .Return loss of -31.5 dB is obtained with a voltage standing wave ratio of 1.0 and directivity of 5.938 dBi respectively and The last resonant frequency range from 3.1 to 3.24 GHz for WLAN,Radar imaging technology.Return

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loss of -17.95 dB is obtained with voltage standing wave ratio of 1.2 and directivity of 5.837 dBi. Results indicate that the antenna has its advantage of low cost, compact size and acceptable return loss.

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