Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

Design of Reconfigurable Antenna for Wireless Applications

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***Abstract*— There are many applications in the field of wireless communication like Bluetooth, GSM, GPS, WLAN and LTE etc. It can be noticed that different antennas must be used for different applications as they use different frequencies to work efficiently. This paper deals with the design of a new concept called a reconfigurable antenna. A rectangular patch with a microstrip feed is used as the antenna. The frequency reconfiguration is possible due to the presence of square slots on each of edges of the patch. The antenna can operate at frequency ranges from 1.8 to 9GHz.**

***Index Terms*— Frequency Reconfiguration, Microstrip Feed, Rectangular Patch, Slots**

I. INTRODUCTION

Antennas are one of the most important devices for communication in the 21st century. The latest communication techniques are mostly wireless in nature and antennas are indeed an integral part of it. Microstrip antennas are one of the latest advancements in the field of antenna theory. It has many advantages like ease in fabrication, easily integrated in arrays, compact, lightweight, and low profile structure. Hence they are used in cellular phones, pagers, mobile and aerospace applications. But microstrip antennas can also suffer from low power handling capacities, low gain and tolerance problem.

Wireless communications occurs at the frequency range of a few MHz to 30GHz. GSM and GPS systems utilize frequencies of 1.6 and 1.8 GHz. LTE utilizes a band of frequencies from 400MHz to 4GHz. Most modern WLANs are based on IEEE 802.11 standards, which uses a frequency of 2.45GHz unlicensed frequency as its center frequency and is marketed under the Wi-Fi brand name. Hence, each applications have different frequencies.

In this paper a rectangular patch is selected for the microstrip antenna. The micro-strip patch antenna is fed using microstrip feeding technique. Microstrip feed is one of the contacting feed techniques. In this particular configuration, the patch antenna is on the substrate and the micro-strip feed line is given to the patch. This feeding technique uses lumped port. For impedance matching, 50Ω feed line is used. In this paper, the proposed antenna is frequency reconfigured by different connection of slots introduced at each corners of the patch.

II. ANTENNA DESIGN

The proposed antenna is realized on an FR4 substrate which is fire resistant and has a dielectric constant, ε_r =4.4 and a thickness (h) of 1.6mm. The dimensions of the patch are calculated by the following equations.

Width,

$$W = \frac{1}{2fr\sqrt{\varepsilon o \mu o}}\sqrt{\frac{2}{\varepsilon r+1}} = \frac{vo}{2fr}\sqrt{\frac{2}{\varepsilon r+1}}$$

where, c= free space velocity of light
ε_r= Dielectric constant of substrate

Effective dielectric constant,

$$\varepsilon eff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2} \cdot \frac{1}{\sqrt{1+\frac{12h}{W}}}$$

Actual length of the patch,

$$L = Leff - 2\Delta L$$

where,

$$Leff = \frac{c}{2fr\sqrt{\varepsilon eff}}$$

Length Extension is given by

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon eff+.3)(\frac{W}{h}+0.264)}{(\varepsilon eff-0.258)(\frac{W}{h}+0.8)}$$

The dimensions of substrate is given by the following equations.

$$Wg = 6h + W$$
$$Lg = 6h + L$$

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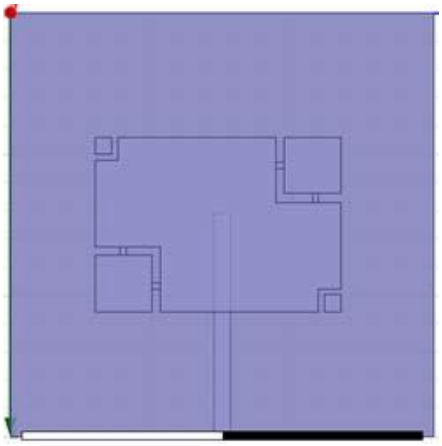
Square slots are introduced at each diagonal corners of the rectangular patch such that the diagonals of the modified rectangular patch will have different slot dimensions. The separated slot at each corner of the patch can be connected to the patch by using open and short circuit path so that it can be operated at different frequency [3]. Transmission lines are used to connect the slot to the patch for simulation purposes. The introduction of the slots at the corners disturbs the current flow in the structure, thereby the current follows a longer path. The frequency shift occurs as the current follows
different paths for different variations in slot dimensions. The geometry of the reconfigurable antennas is shown in Fig. 1.



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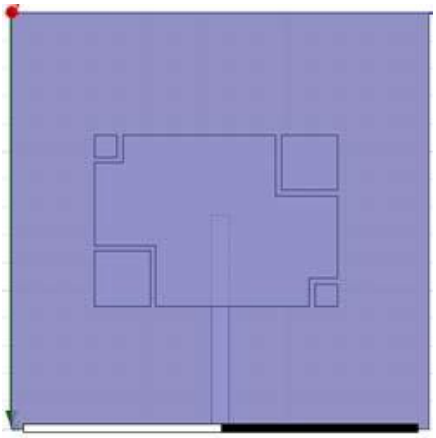

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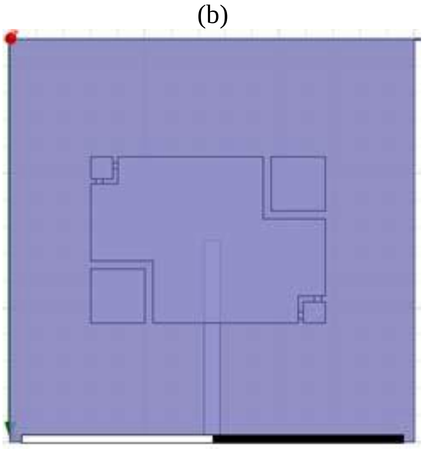

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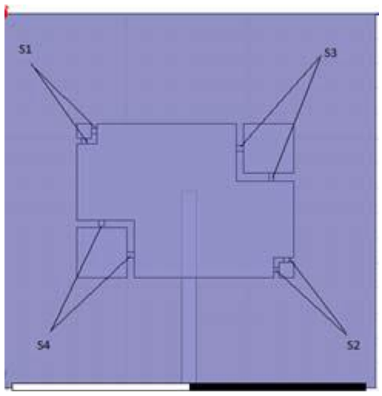
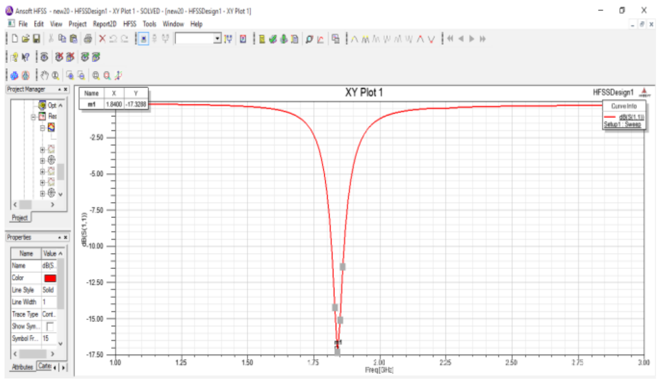


(d)

Fig. 1. Geometry of the proposed reconfigurable antenna for frequency (a) 1.880GHz (b) 1.840GHz (c) 1.850GHz (d) 1.890GHz

III. SIMULATION RESULTS

The prosed antenna is based on passive reconfiguration where the frequency varies as the current across the slot varies. When all there is no connection between all the four slots, the antenna resonates at a frequency of 1.850GHz. If the two smaller slots are connected, the frequency is 1.840GHz. If the two larger slots are connected, the frequency is 1.880GHz. When all the four slots are connected, the frequency is 1.890GHz. Hence, for different connections different frequencies are obtained.



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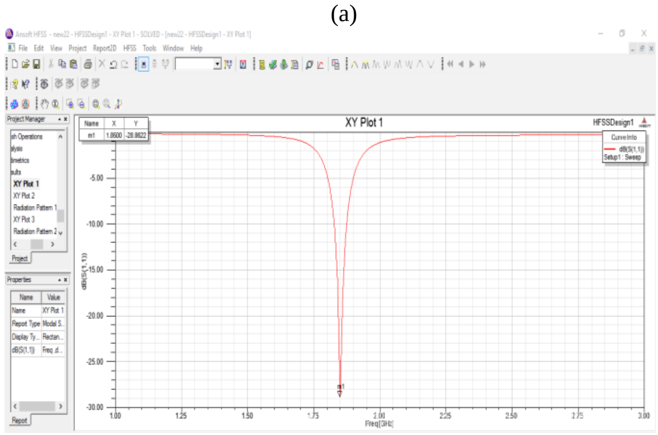

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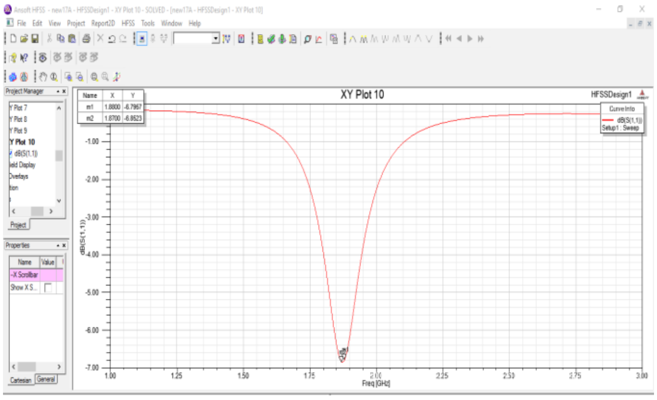

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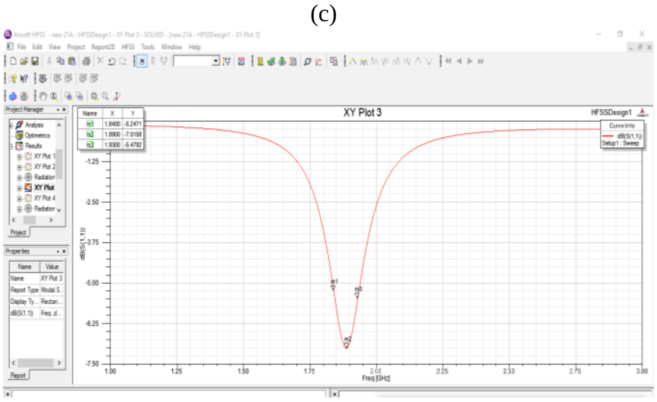
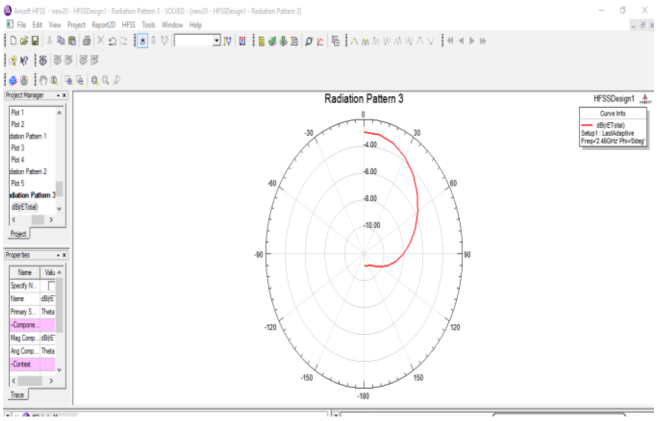


(d)

Fig. 2. Return loss characteristics for frequency (a) 1.840GHz (b) 1.850GHz (c) 1.880GHz (d) 1.890GHz

By the return loss graph we can observe the different frequencies for different antenna slot configurations.



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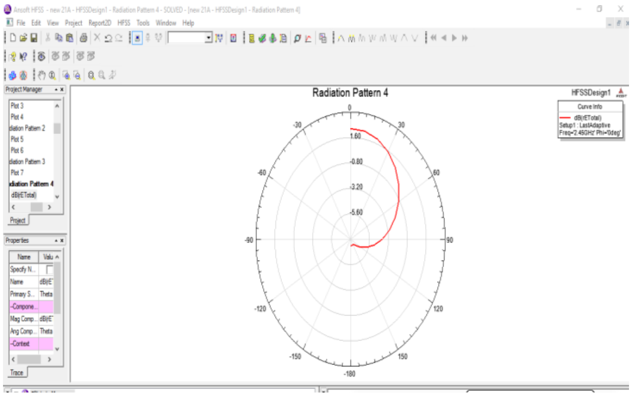

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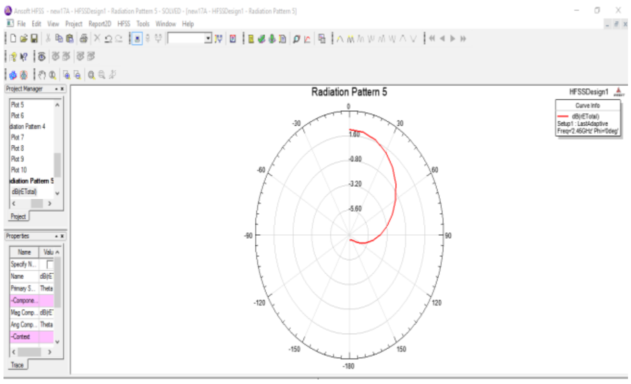

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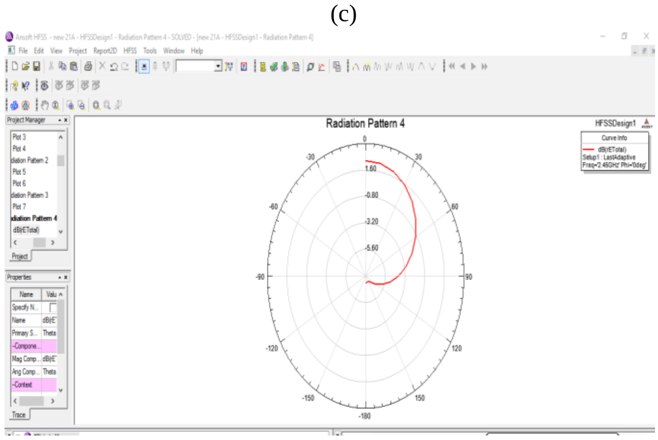

(d)

Fig. 3. 2D radiation frequency of the reconfigurable antenna at (a) 1.840GHz (b) 1.850GHz (c) 1.880GHz (d) 1.890GHz

IV. CONCLUSION

The proposed reconfigurable antenna resonates at the frequencies of 1.840GHz, 1.850GHz, 1.880GHz, and 1.890GHz. Return loss of less than -20dB is obtained for all the reconfigurations. The proposed antenna exhibits directivity above 5dB for all the configurations and hence can be used for real time applications like in the cases of GSM and GPS. The active reconfiguration of frequency can be obtained using PIN or varactor diodes.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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