Variation in Inset Parameters of Microstrip Patch Antenna for Improved Performance

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Abstract
This paper is dedicated to simulate a rectangular patch antenna by using the software HFSS. Microstrip or patch antennas are becoming increasingly useful because they can be printed directly onto a circuit board. Microstrip antennas are becoming very widespread within the mobile phone market. Patch antennas are low cost, have a low profile and are easily fabricated.

Keywords
Wireless local area networks (WLAN), Return Loss (RL), Gain, Radiation pattern.

1. Introduction

Recently, due to growing demand of microwave, and wireless communication systems in various applications resulting in an interest to improve antenna performances. Modern communication systems and instruments such as Wireless local area networks (WLAN), mobile handsets require lightweight, small size and low cost. The efficient microstrip patch antenna technology can fulfill these requirements. WLAN in the 2.4 GHz band (2.4-2.483 GHz) has made rapid progress and several IEEE standards are available namely 802.11a, b, g and j [1]. Here preposed antenna shows that without changing frequency tune the antenna to give better performance and return loss [2]. The purpose of this work to seek chances to improve efficiency of antenna without varying frequency, dimensions of patch L and W and achieve better results through tuning process.

2. Design of Rectangular Microstrip Inset Fed Patch Antenna

Rectangular Microstrip patch has been designed on FR4 epoxy of εr =4.4 and h = 1.5 mm. It is decided to design the rectangular patch for 2.4 GHz. For a dielectric substrate of thickness 'h', relative dielectric constant εr and antenna operating frequency fr [3]. As shown in the design figure 2(a), the patch antenna has length (L) of 3.8 cm and its width(W) of 2.95cm and its resonant frequency of 2.4GHz. The resonant frequency, also called the centre frequency, is selected as the one at which the return loss is minimum. Here we have three designs to understand the tuning results of antenna. As shown in figure 2(b) Antenna A1 as reference antenna design hfss, similarly Antenna A12 through variation in Inset Gap and Antenna B4 tuning through varying Inset Distance

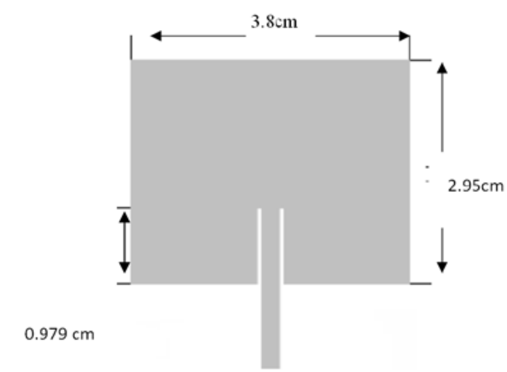
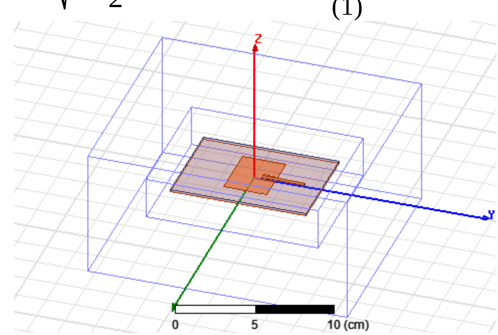


Figure 2 Reference rectangular inset patch antenna

With a specific resonant frequency (f0) and characteristic impedance (Zc), the width (W), length (L) and the Feeding position of rectangular microstrip patch antenna are expressed as follows

$$W = \frac{c}{2 fo\sqrt{\frac{(\varepsilon r+1)}{2}}} \quad (1)$$



$$L = L_{eff} - 2\Delta L \quad (2)$$

Where L_{eff} is effective length and ΔL is extended lengths[1][4]. Other design specification shown in table

Manuscript received September 5, 2015
Manuscript revised September 20, 2015

2.1. Shaded portion shows the changes in the design to achieve impedance matched state for better performance.

3. Result and Discussion

Here we are comparing only return loss, Input impedance and bandwidth of designs. Here Design A1 is a reference antenna as per calculation in which we have design of antenna which provide satisfactory results. Design A1 provide -15.015dB return loss but here we find input impedance is not properly matched. Change in patch length and patch width leads to change in required frequency. Here we are trying to improve input impedance through varying inset distance and inset gap of the Microstrip Inset fed Patch Antenna[5].

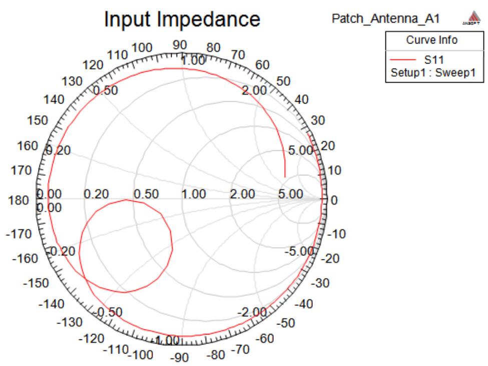


Figure 3.1(a) Result of the input impedance matching of Antenna Design A1

Table 2.1

S.No	Design	Specifiation		
		A1	A12	B4
1	Patch Dimension Along x	3.8 cm	3.8 cm	3.8 cm
2	Patch Dimension Along y	2.95 cm	2.95 cm	2.95 cm
3	Substrate Thickness	1.5mm	1.5mm	1.5mm
4	Substrate Dimension Along x	6.6 cm	6.6 cm	6.6 cm
5	Substrate Dimension Along y	9.09 cm	9.09 cm	9.09 cm
6	Inset Distance	0.979 cm	0.085 cm	0.979 cm
7	Inset Gap	0.143 cm	0.143 cm	0.06 cm
8	Feed Width	0.287 cm	0.287 cm	0.287 cm
9	Feed Length	2.854 cm	2.854 cm	2.854 cm

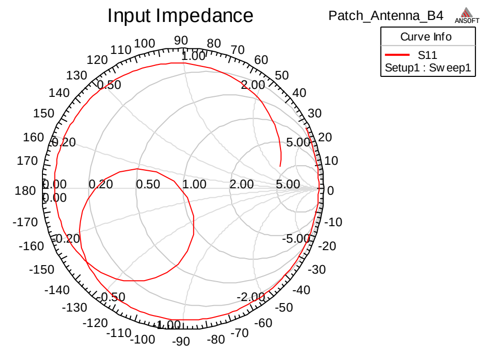


Figure 3.1(b) Result of the input impedance matching of Antenna Design B4

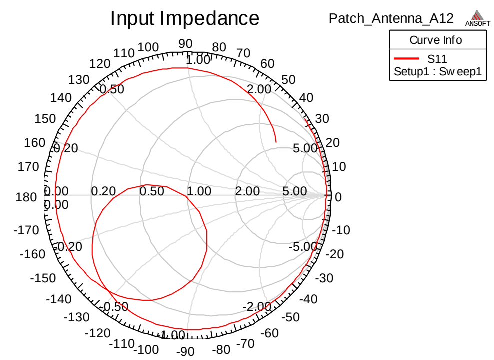


Figure 3.1(c) Result of the input impedance matching of Antenna Design A12

Here we have Figure 3.1(a), 3.1(b) and 3.1(c) shows the simulation result of the input impedance matching of Antenna Design A1, B4 and A12 respectively. Then we start varying the inset distance of the Microstrip Patch antenna to match impedance, we get Design B4 where we achieve input impedance matched state to provide proper input. Figure 3.2 (a) , 3.2(b) and 3.2(c) shows the return loss (RL) of Antenna A1, Antenna B4 and Antenna A12 respectively. Through Design B4 we have -23.43dB return loss at input impedance matched state at frequency 2.4GHz.

In next design we start varying Inset Gap of Antenna till impedance matched state which achieved on Design A12 where return loss is -37.07dB.

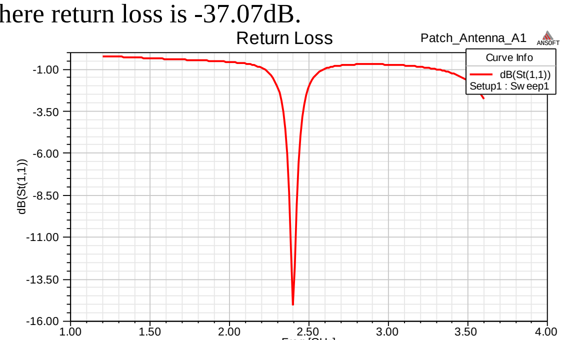


Figure 3.2 (a) Return loss (RL) of Antenna A1

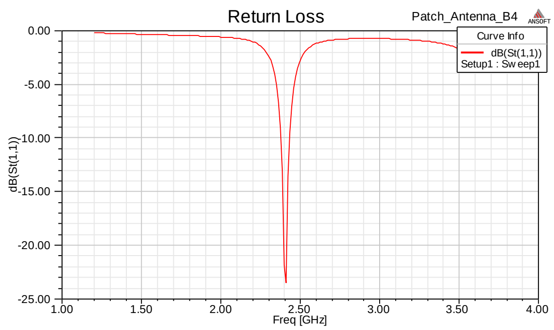


Figure 3.2 (b) Return loss (RL) of Antenna B4

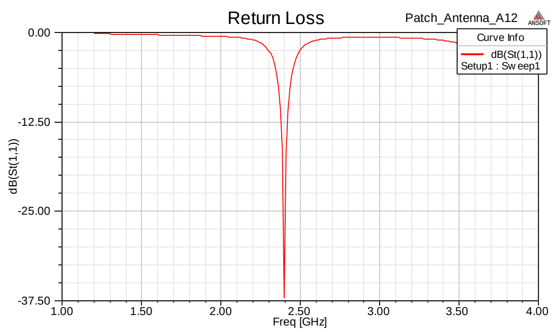


Figure 3.2 (c) Return loss (RL) of Antenna A12

4. Conclusion

A simple technique to improve antenna performance through few changes in design without varying reference frequency of antenna. Here we find in designs that as antenna achieves impedance matched state its results improves. Here we have three design in which Design A1 is reference design in which we have 1.584% bandwidth whereas in Design B4 we get 2.4733% results but in Design A12 we get 2.3021% bandwidth. Design variation provide various results but we achieve better results when we achieve impedance matched state with any variation in design. This paper shows that performance of any antenna can be improved in impedance matched state. A further work focusing on the effect of antenna through change in dielectric constant, design of patch, position and parameters to improve microstrip antenna.

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