Analysis of Triple Band I-Slotted Microstrip Patch Antenna For Wireless Application

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Abstract- *In this paper, a triple band microstrip patch antenna with I slot subtracted from patch forming a simple and efficient technique of design has been introduced for increasing wireless bands and improving impedance matching, also, giving the same performance at the desired resonant frequency. In this the Dual band and triple band microstrip patch antenna is proposed for the various wireless applications. A novel compact triple band microstrip antenna was designed. This antenna bands is designed for different wireless bands. Hence, it has been shown that microstrip antenna can be analyzed both theoretically and experimentally through simulations and fed by microstrip line feeding techniques. So the proposed antenna give the better result in terms of more band (3 as compare to reference antenna has 2), better S-Parameters, better VSWR and impedance matching.*

Keywords- I-Slot, Triple band, HFSS, DGS, Patch, Ground, Dielectric Substrate, Return Loss, S-Parameter, VSWR, Smith Chart.

I. INTRODUCTION

Microstrip patch antenna has attractive features such as low profile, low cost, light weight, easy integration with integrated circuits and ease of fabrication. There are varieties of techniques to enhance the bandwidth of patch antenna such as using of a foam or a thick substrate material, cutting rectangular and circular slots or notches like U slot, M-shaped, H-shaped, Z- shaped, E-shaped patch antenna, initiating the parasitic elements either in stack configuration or coplanar and changing the shape of the radiating patch by setting up the slots. In [7-10], a wide-slot antenna with a microstrip line is proposed to enhance the bandwidth using a fork-like tuning stub.

Microstrip antennas have some good features written above. Due to these advantages, Microstrip antennas are well suited for Wireless application systems. Microstrip antennas (MSA) have some disadvantages also like narrow bandwidth, low gain etc. Broad banding is the main problem, for solving this problem there are many broad-banding techniques available.

Now a day's the use of the microstrip antenna for many applications like wireless local area network (WLAN), WiMAX and cellular mobile communication system is used extensively because of their inherent ability of low cost and small size along with very high gain [1].The microstrip antenna is incorporated with printed strip line feed networks and active devices. But it is well known that the bandwidth of Microstrip antennas is very small (typically 1-2%) which reduces its extensive use in most of the applications[2]. Today's researchers who work in this domain have the main focus to improve its bandwidth by retaining mentioned features. A number of different techniques has been implemented by using different parasitic elements and low permittivity layers. Other techniques using for bandwidth enhancement are dual band antenna [3][4].The need for dual band antennas in wireless communication systems is to use two bands of frequencies, i.e. Wi-Fi, and WiMax simultaneously because it works like two different antennas, which miniaturize the size, cost, and complexity to design antenna. Dual band antenna also has advantages over the ultra wideband antenna (UWA) by rejecting intervention from the surrounding signals of the spectrum [5]. For now, the slot antenna, that becomes more popular for very low cost and small size antennas.

II. PROPOSED WORK

A. Problem Definition

In the reference paper A dual band Microstrip patch antenna is designed, fabricated and tested. The proposed antenna consists of an I-slot in a rectangular patch over a partial ground which operates at higher order TM02 mode. The presented design is suitable for 3G and WLAN applications as it produces dual beams at 1.9GHz and 5.7GHz respectively. Return loss, VSWR and radiation pattern are obtained and analyzed using HFSS. Antenna is tested and measured results are also analyzed. The aim of designing of a dual band I- slot loaded microstrip antenna with a diagonal

coaxial feeding is to evaluate the all parameters of antenna as like return loss, VSWR, radiation pattern, smith chart, gain and etc.

B. Objectives

The objectives associated with presented work are defined here

- Designing of I shaped slot loaded Microstrip Patch Antenna
- Design of antenna for single band, Dual band, Triple band with only Microstrip line feeding technique is presented implicated antenna
- Design Parameters of Antenna like Bandwidth, Return loss, Smith Chart, Radiation Pattern, VSWR, Impedance Matching and resonant Frequency will be optimized.

C. Simulation Parameters

The parameters used for the design of a rectangular Microstrip Patch Antenna are:

- Frequency of operation (*fr*): The resonant frequency for proposed antenna for wireless systems is 4 GHz.
- Dielectric constant of the substrate (*Ɛr*): The dielectric material selected for proposed design is FR4_epoxy which has a dielectric constant of 4.4.
- Dielectric substrate Height (*h*): Height of the dielectric substrate is selected as 1.6 mm as the microstrip patch antenna to be used in cellular phones, it is essential that the antenna is not bulky.

Design of Rectangular Patch Microstrip Antenna for using HFSS structure Simulator Given some other specifications were,

- Dielectric constant (ε_r) = 4.4
- Frequency (f_r) = 4 GHz.
- Height (h) = 1/16 Inch = 1.6 mm.
- Velocity of light (c) = 3×10^8 ms^{-1}
- Thickness of Patch = 0.5 mm

III. RESULT AND ANALYSIS

A. Design of Proposed Triple Band Antenna:

In this design we introduce some rectangular slot in patch to made I-Shape slot as according to reference paper and design a triple band antenna.

In this technique, microstrip patch antenna is designed using microstrip line and four same dimension slot in patch detailed as shown below:

In this proposed design (I-Shape) the width of I slot is increased as compare to reference antenna and using microstrip line feed.

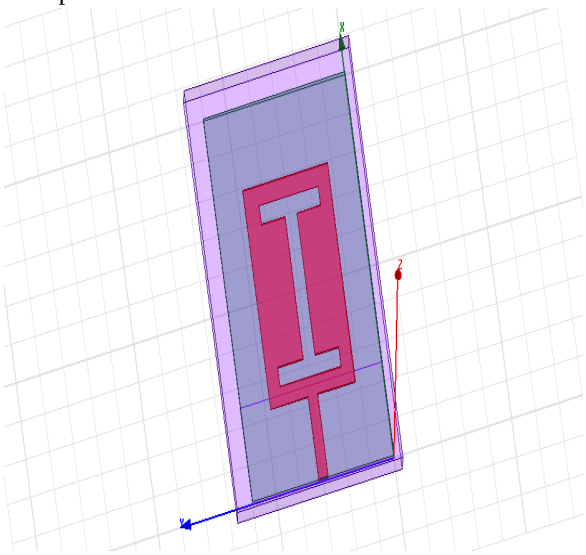

Figure 1 Designing of proposed antenna

a) Observation from -10dB return loss

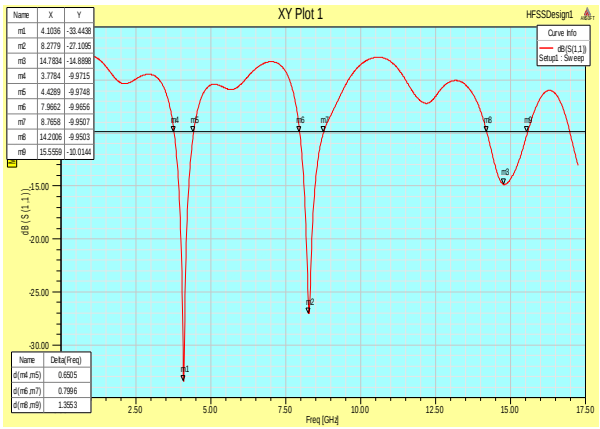

Figure 2 Return loss graph of Proposed antenna

The Proposed antenna is resonating at Five frequencies means provide five band as described below:

1. Resonant frequency = 4.10 GHz at -33.44 dB(S-parameter)
2. Resonant frequency = 8.27 GHz at -27.10 dB(S-parameter)
3. Resonant frequency = 14.78 GHz at -14.88 dB(S-parameter)

b) Observation from VSWR

The proposed antenna give the value of VSWR less than 2 at each resonating frequency which is practically very good.

1. VSWR at Resonant frequency 4.10 GHz is 1.04
2. VSWR at Resonant frequency 8.27 GHz is 1.09
3. VSWR at Resonant frequency 14.78 GHz is 1.43

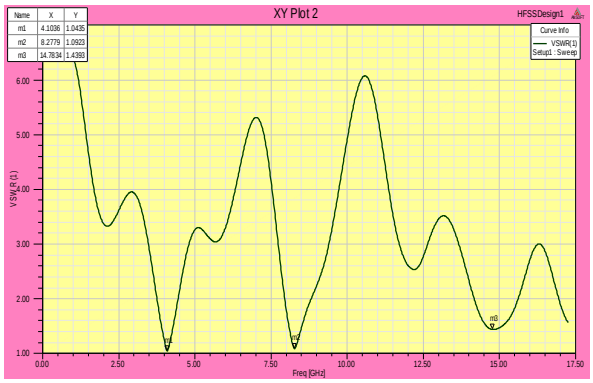

Figure 3 VSWR graph of Proposed Antenna

c) Smith Chart

The smith chart curve of Proposed Antenna is shown in Figure.

Impedance Matching at initial resonant frequency (3.78GHz) = 1.0339 ×50= 51.69 ohm

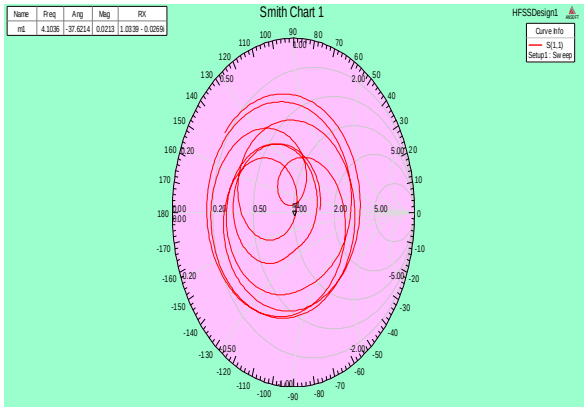

Figure 4 Smith chart curve of Proposed antenna

B. Conclusion with difference between Reference Antenna and Proposed Multiband Antenna:

So the proposed antenna give the better result in terms of more band (3 as compare to reference antenna has 2), better S-Parameters, better VSWR and impedance matching.

Table 1 Difference Table between Reference and Proposed antenna

Antenna	Difference in Design	Resonant Frequency	VSWR
Reference Antenna (Single band)	Simple plane design using dimension as reference antenna	4 GHz	1.20
Reference Dual band Antenna	Using I-slot in patch	1.9 GHz 5.7 GHz	1.64 1.26
Proposed Triple Band Antenna	Using wider I-slot in patch and microstrip line feed is used.	4.10 GHz 8.27 GHz 14.78 GHz	1.04 1.09 1.43

IV. CONCLUSION

The aspects of single band, dual band and triple band microstrip antenna have been studied. In this paper, a triple band microstrip patch antenna with I shaped slot subtracted from patch forming a simple and efficient technique of design has been introduced for the betterment of bandwidth and impedance matching, also, giving the same performance at the desired resonant frequency. In this the Dual band and triple band microstrip patch antenna is proposed for the various wireless applications. A novel compact triple band microstrip antenna was designed. This antenna bands is designed for different wireless bands.

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