Designing & Analysis of a Double Slotted Triple-band Microstrip Patch Antenna

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Abstract- *In this paper, a triple band microstrip patch antenna with double 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. Hence, it has been shown that microstrip antenna can be analyzed both theoretically and experimentally through simulations and fed by coaxial feeding techniques. The multiband microstrip patch antenna can have multiple resonant frequency i.e. we can design a single microstrip patch antenna for multiple bands. Also, the feeding point selection i.e. proper matching of feed and patch is very important for having desirable features.*

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

I. INTRODUCTION

Microstrip antennas (MSA) are turning out to be one of the most preferred and promising antennas for the development of wireless communications since its invention in 1969 [1 – 4]. In recent years these antennas are increasingly gaining popularity owing to their versatility in terms of the varieties of geometries, which makes them suitable for different needs and applications. The planar, low profile, inexpensive and light weight construction apart from the adaptability for integration with microwave integrated circuits are the major advantages of the MSAs [1 – 4]. These advantages are also one of the key features due to which many researchers are attracted to design, analyze and investigate the patch antenna characteristics. Recently there has been growing demand of the applications requiring antennas to operate over several frequency bands. In order to avoid the use of different antennas for different frequencies, a single MSA is employed which supports the dual, triple and multi-band operations. However, the multi-band response can never be displayed by the conventional MSAs since the frequency ratio between the two successive modes is generally higher and also they do not give identical radiation pattern characteristics.

The MSAs for dual or multi-band operations are obtained by cutting a slot or by inserting open circuit stubs on the edges of the patch [4 – 9]. From these two techniques, the most preferred one is slot cut technique because it neither increases the patch size nor it affects the radiation pattern of the patch. When the length of the slot incorporated in patch equals half or quarter wave in length, then the slot is supposed to introduce an additional mode near the fundamental patch mode. However it was revealed in the recent study, that the slot modifies the frequency of higher order mode, thereby yielding dual-band or multi-band antenna characteristics [10]. The applications which require transmit and receive frequencies to be closely spaced, effectively use dual or multi-band MSAs with their frequency ratio less than 1.5 [1 – 4]. Also, it's an advantage to utilize MSAs with multi-band dual polarization characteristics, since polarization diversity improves antenna performance in multipath environment [11].

II. PROPOSED WORK

Problem Definition

In the reference paper a dual band double slot loaded microstrip antenna with a diagonal coaxial feeding is proposed. Rectangular patch is used as radiator over which two narrow slots are created. These slot and feed position make antenna both frequency and polarization reconfigurable. The bandwidth of this slotted antenna is 550 MHz and 180 MHz at 4.0 and 4.9 GHz respectively. This bandwidth is sufficient for many applications like satellite and radar communication. The antenna is analyzed and simulated using HFSS. The 10:1 gain bandwidth of the simulated antenna with respect to center frequency is 12.5% at 4.9 GHz and 4.7% at 4 GHz. This antenna having an overall dimension of 60 x 60 x 3.8 mm3 and the dimension of slots created over patch is 18 x 1 mm which is very compact compared to the conventional antenna. The aim of designing of a dual band double 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.

Objectives

The objectives associated with presented work are defined here

- Designing of double slot loaded Microstrip Patch Antenna
- Design of antenna for single band, Dual band, Triple band with only coaxial 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.

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 3.3 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 1.59 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) = 10 GHz.
- Height (h) = 1/16 Inch = 1.59 mm.
- Velocity of light (c) = 3×10^8 ms^{-1}
- Thickness of Patch = 0.5 mm

III. RESULT AND ANALYSIS

Design Of Triple Band Antenna With Double Slot:-

The geometry of proposed antenna which is coaxial probe feed for triple wireless application is depicted in figure. In which the antenna parameter are same as above but there is a change DMPS (Defected microstrip patch Structure) of two parallel rectangular slots and uses normal ground plane. The dimensions of the designed antenna are same as,

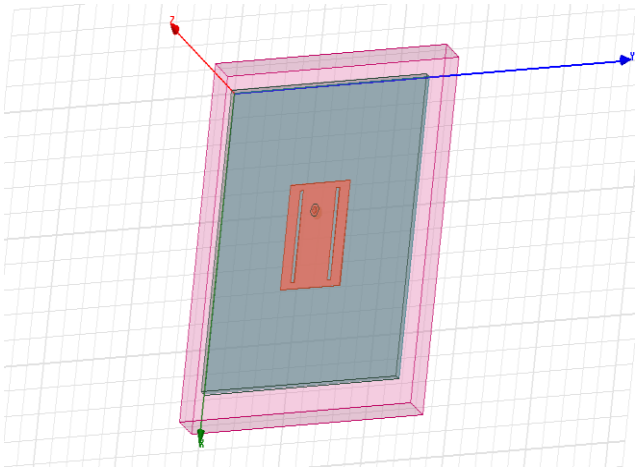

Figure 1:-Design of proposed triple band antenna.

The return loss plot for the designed antenna at -10 dB bandwidth with proximity feed is shown in figure as below.

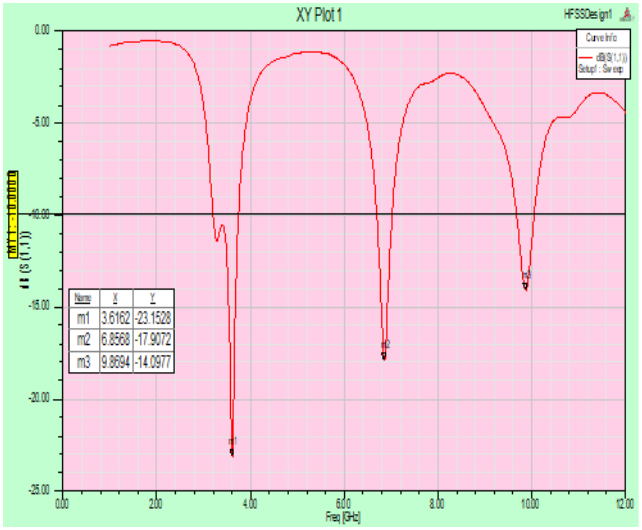

Figure 2:-Simulated return loss

VSWR plot for the proposed antenna.

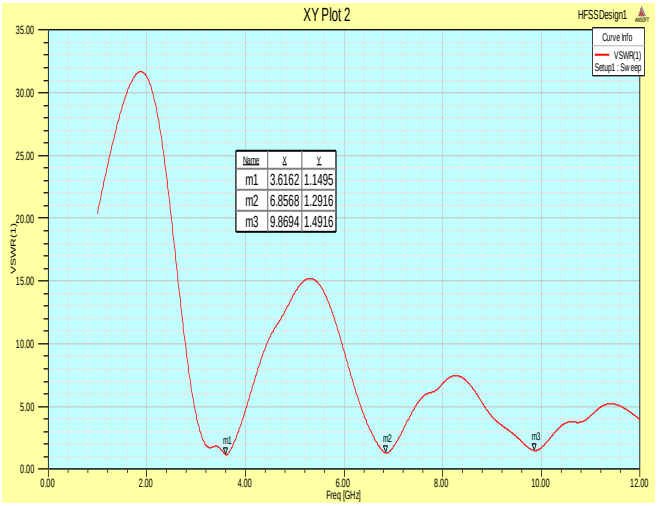

Figure 3:- VSWR plot

The Smith Chart of Proposed Antenna

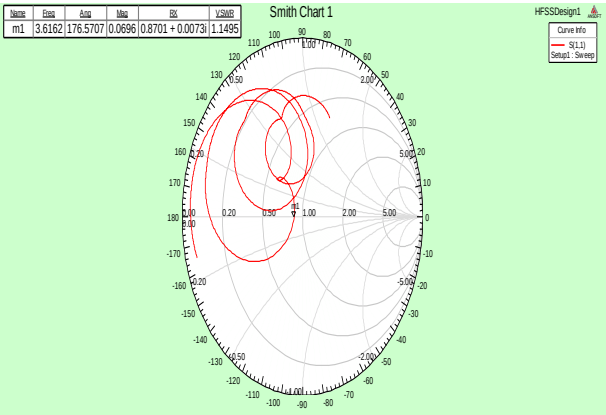

Figure 4:- Smith Chart Plot.

Table 1:- Summarized results of the proposed antenna of triple band.

SR. NO	Frequency (GHz)	RETURN LOSS(dB)	BANDWIDTH (GHz)	VSWR	IMPEDANCE MATCHING
1	3.61	-23.15	3.74-3.20=0.54	1.14	45 ohm
2	6.85	-17.90	7.02-6.69=0.33	1.29	44 ohm
3	9.86	-14.09	10.05-9.67=0.38	1.49	43 ohm

Table 2:- Difference between Summarized results of the proposed antenna and Reference Paper

SR.NO	Size	Frequency (GHz)	RETURN LOSS (dB)	BANDWIDTH (GHz)	VSWR
1. Reference Paper	60 × 60 × 3.18 mm	4.0 4.9	-11.5 -22.5	0.18 0.55	1.6 1.15
2. Proposed Dual Band Result	59 × 59 × 1.59 mm	3.27 5.22	-25.72 -22.14	3.35-3.18=0.17 5.32-5.12=0.20	1.10 1.16
3. Proposed Triple band Antenna	59 × 59 × 1.59 mm	3.61 6.85 9.86	-23.15 -17.90 -14.09	3.75-3.20=0.55 7.02-6.69=0.33 10.05-9.67=0.38	1.14 1.29 1.49

IV. CONCLUSION

The aspects of single band, dual band and triple band microstrip antenna have been studied. In this thesis, a triple band microstrip patch antenna with double 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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