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Design and Analysis of Dual-Band Microstrip Patch Antenna for Wireless Application& Radar application

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ABSTRACT :- *This work is about dual-band microstrip patch antenna using slot technique. Now, you imagine the world without Antenna there will be no effective wireless communication between two entities. It is the wireless communication, which effectively brings the whole world together. So, Antenna is a very useful & essential device for effective communication. The Bandwidth of microstrip antenna is one of the important features that restrict its wide usages. Here, the aim of is to design Dual band Microstrip Patch Antenna with using two different frequencies on one patch using slot technique and study the effect of antenna dimensions. Microstrip patch antenna using slot achieved an dual frequencies it is 4.1 GHz is used for Wi-Fi and WLAN applications and ISM applications and 7.1 GHz band is suitable forC-band RADAR applications.*

KEY WORDS: *Microstrip Patch Antenna, Broad-band operation, dual-frequency, microstrip feed, coaxial feed, bandwidth, and aperture coupled feed.*

INTRODUCTION

The rapid development of wireless communication systems is bringing about a wave of new wireless devices and systems to meet the demands of multimedia applications. Multifrequency and multi-mode devices such as cellular phones, wireless local area networks (WLANs) and wireless personal area networks (WPANs) place several demands on the Antennas [2].

Primarily, the antennas need to have high gain, small physical size, broad bandwidth, versatility, embedded installation, etc. In particular, as we shall see, the bandwidths for impedance, polarization or axial ratio, radiation patterns and gain are becoming the most important factors that affect the application of antennas in contemporary and future wireless communication systems. The bandwidths vary from 7% to 13% for commercial mobile communication systems, and reach up to 109% for ultra-wideband communications. The antennas used must have the required performance over the relevant operating frequency range [1]. Shown in Figure 1. In Modern wireless communication systems, Worldwide Interoperability for Microwave Access (WiMAX) have been widely applied in mobile devices such as handheld computers and intelligent phones [11].
The bandwidth limitation is usually overcome by various techniques like using air substrate [8], cutting slots in the patch [13-14], using stacked patch antenna [3], increasing the thickness of the substrate [3, 8] etc. Among all these techniques cutting slots in the patch is attractive due to the reason that it maintains the thin profile characteristics of the patch.

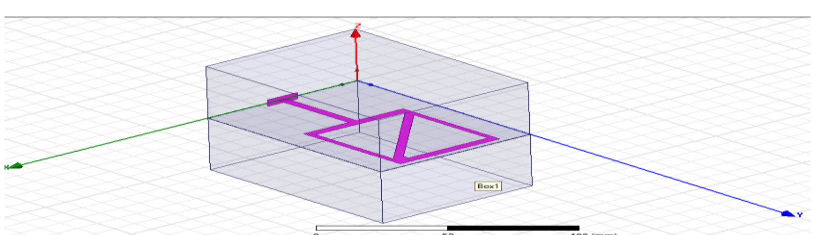

Fig. 1:Proposed slotted Triangle Microstrip Patch antenna

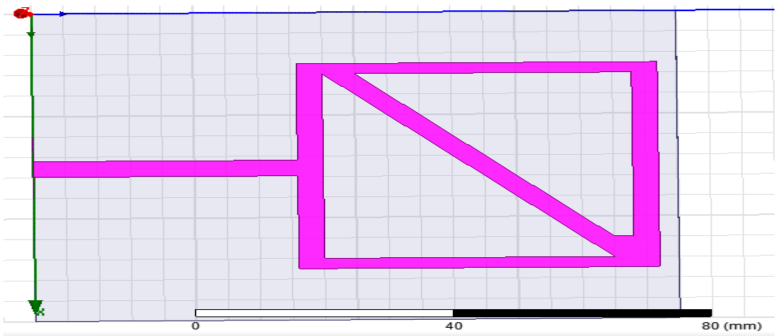

Fig. 2:Front view of design antenna

ANTENNA DESIGN CONSIDERATION

Operation of Microstrip Antenna

In Microstrip antenna, the electromagnetic (EM) wave fringe off the top patch into the substrate, reflecting off the ground plane and radiates out into the air. Radiation occurs mostly due to fringing field between the patch and ground. Fig3. Shows the operation of Microstrip antenna. The radiation efficiency of the patch antenna depends largely on the permittivity (**εr**) of the dielectric. Ideally, a thick dielectric, low **εr**, and low insertion loss is preferred for broadband purposes and increased efficiency [12].

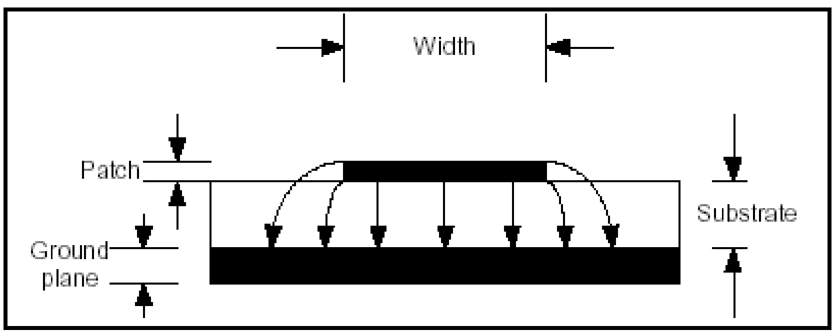

Fig. 3: Operations of a Microstrip Patch

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Feeding Technique

Microstrip patch antennas can be fed by a variety of methods. These methods can be classified into two categories-contacting and non-contacting. In the contacting method, the RF power is fed directly to theradiating patch using a connecting element such as a microstrip line. In thenon-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The four most popular feed techniques used are the microstrip line, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes) [3].

Microstrip Line Feed

In this type of feed technique, a conducting strip is connected directly to the edge of the Microstrip patch. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure. However as the thickness of the dielectric substrate being used, increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation also leads to undesired cross polarized radiation. This method is advantageous due to its simple planar structure [3].

As Shown in fig.1 the proposed patch antenna geometry. The antenna is designed using "Neltec NY9220 (IM) (tm)" substrate having dielectric constant of 2.2. Lp = 56 mm,Wp = 50 mm, Ls = 100 mm, Ws = 75 mm, Lf= 41 mm, Wf = 3.8 mm. The relative dielectric constant and the thickness of the substrate are chosen as εr = 2.2 and h = 0.254, respectively. For designing a rectangular microstrip patch antenna, the length and the width are calculated as below.

The microstrip antenna using transmission model is designed in the following method:

Calculation of the Width: For an efficient antenna, a practical width that leads to good radiation efficiency is given by eqn.

$$W = \frac{C}{2fr}\sqrt{\frac{2}{Er+1}} \qquad (1)$$

Where W is patch width, C is speed of light, fr is the Resonant frequency and Er is the dielectric constant of the substrate.
Calculation of the effective dielectric constant (Ereff): Due to the fringing and the wave propagation in the field line, an effective dielectric constant (Ereff) must be obtained from

$$Ereff = \frac{Er+1}{2} + \frac{Er-1}{2}\sqrt{1+12\frac{h}{w}} \qquad (2)$$

Where, Ereff is the effective dielectric constant and h is the height of the substrate.

The effective length (Leff) for a given resonance

frequency Fr is given as:

$$Leff = \frac{c}{2fr\sqrt{Eeff}} \qquad (3)$$

The length extension Delta L is given as-

$$\Delta L = 0.412h\,\frac{(Eeff+0.3)(\frac{w}{h}+0.3)}{(Eeff-0.258)(\frac{w}{h}+0.8)} \qquad (4)$$

The patch length (L)

$$L = Leff - 2 * \Delta L \qquad (5)$$

Dimensions of Antenna Design

Length of Patch [Lp]	56 mm
Width of Patch[Wp]	50 mm
Length of Substrate[Ls]	100 mm
Width of Substrate[Ws]	75 mm
Length of Feed [Lf]	41 mm
Width of Feed[Wf]	3.8 mm
Feeding method	Microstrip Line feed

Table 1: Dimensions of Proposed Microstrip Antenna

RESULT AND DISCUSSION

Patch antenna has been designed in HFSS software and various important performance metrics are measured toanalyze the performance of the designed TMPA (triangular microstrip patch antenna).

Here, dual-band achieved in this design. In this first band has resonant frequency 4.1 GHz and bandwidth 280 MHz and this frequency are used Wi-Fi and WLAN applications and ISM applications.The resonant frequency second band is 7.1GHz and bandwidth 700 MHz is suitable forsuitable for C-band RADAR applications. The results of proposed microstrip antenna designs such as the return loss, VSWR, radiation pattern and smith chart can be obtained by using the HFSS are shown in Figure.

VSWR: It is used to describe the performance of an antenna when attached to transmission line. It is the measure ofhow well the antenna terminal impedance is matched to thecharacteristic impedance of transmission line.

Ideal value of SWR is unity indicating that there is no standing wave on the line. Here, VSWR vs. Frequency result shown in fig. it is a received at 4.1 GHz, 1.53 and at 7.1 GHz, 1.33.

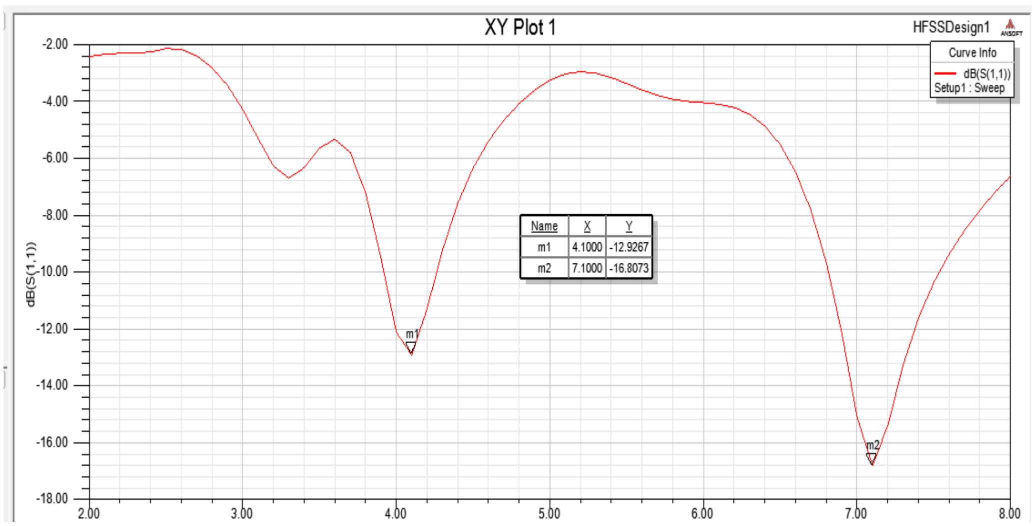

Fig. 4:Simulated Return Loss [S11] at 3.8 and 6.8 GHz

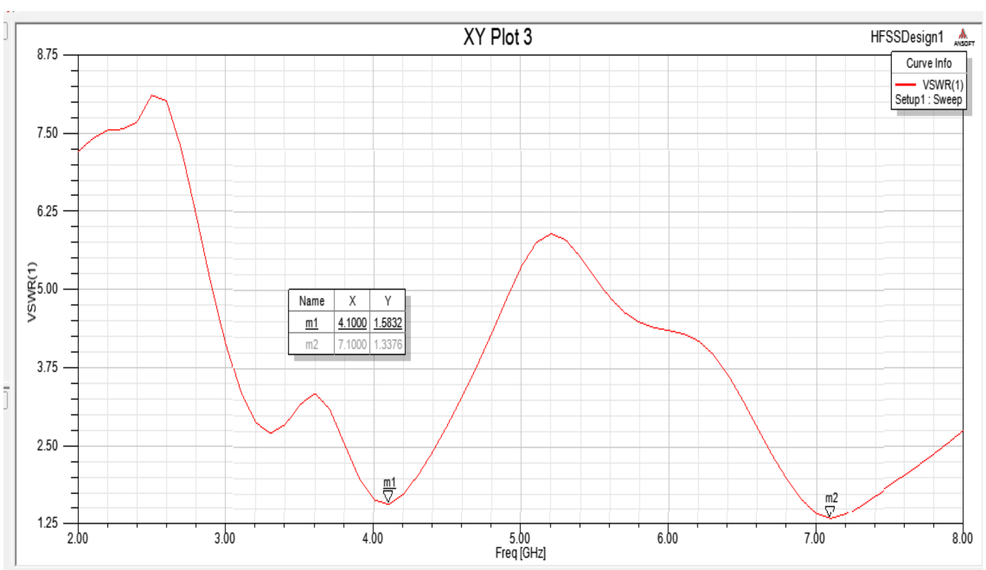

Fig. 5: VSWR for design antenna

Smith chart: The two circles in the smith chart represent the frequencies of the dual band. It can see by in figure.

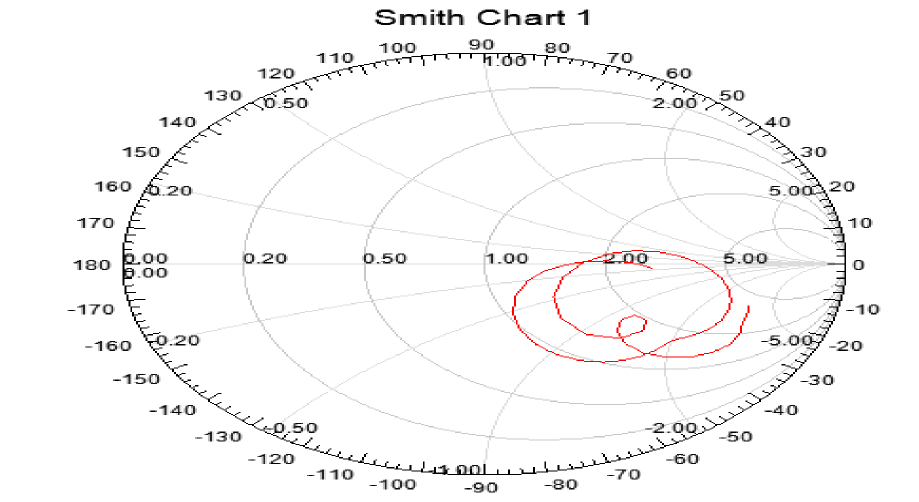

Fig. 6:Smith chart S [1, 1] at 3.82 and 6.82 GHz

Radiation pattern: The radiation pattern is defined as a mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates. In mostcases, the radiation pattern is determined in the far-field region and is represented as function ofthedirectional coordinates. The radiation pattern obtained here is broadside radiation in polar form.

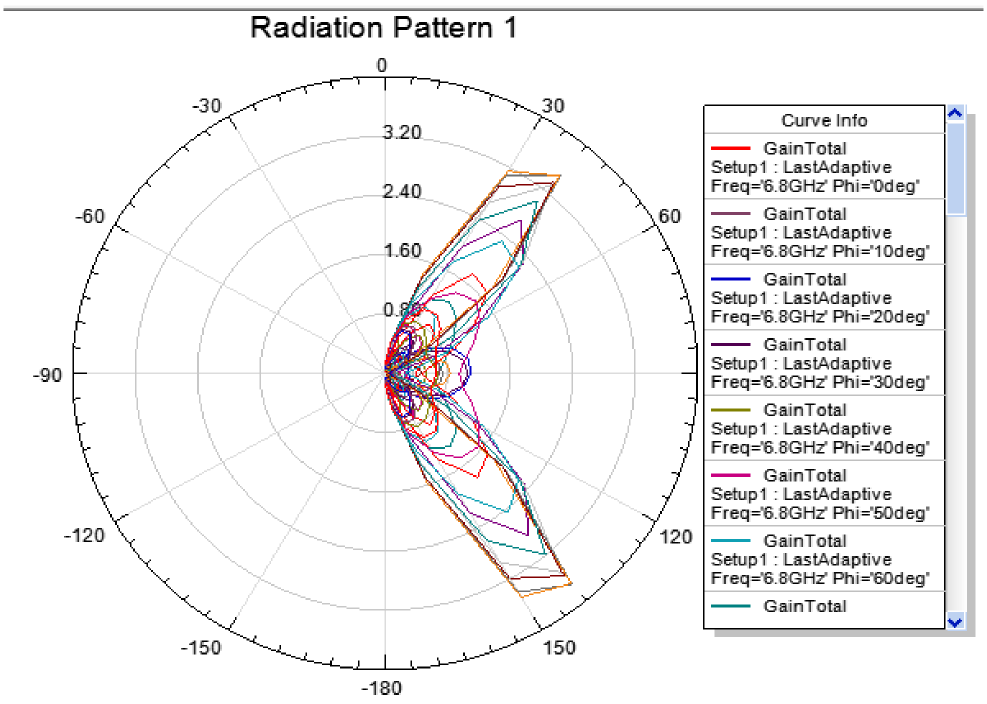

Fig. 7:Radiation Pattern of design Antenna

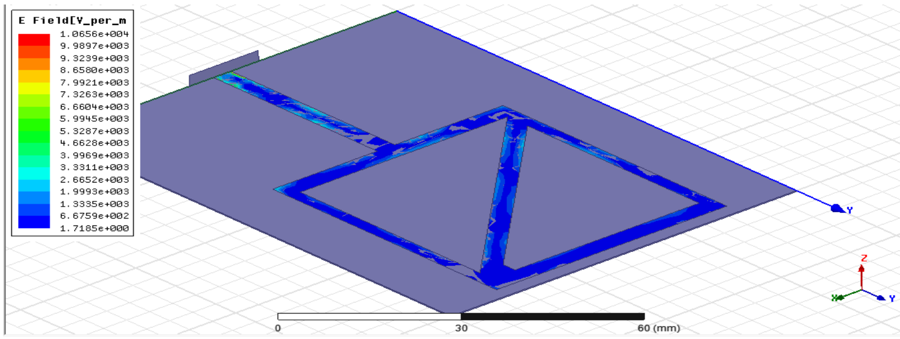

Fig. 8:Electric field distribution pattern

CONCLUSION

In this paper, from the simulation results of HFSS presentedIn section 3 it can be concluded that the optimized patch antennagood bandwidth 280 MHz at 4.1 GHzand 700 MHz at 7.1 GHz bandwidth.The return loss, bandwidth and radiation pattern of dual band triangular-shaped microstrip patch antenna is presented in this paper clearly show that the antenna is a wideband microstrip patch antenna.

This paper has proposed a simple design of patch antenna having a wide range for communication. In the design a slot Isincorporated into the rectangular patch to expand its bandwidth and to reduce the size of antenna .The designed antenna is very simple in look and small in size. Simulation results show that the antenna has VSWR <=1.58 at 4.1GHz and VSWR <= 1.33 at 7.1 GHz.

Future research work should aim at utilizing design and new optimization technique to improve the performance of the triangular patch antenna.

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