Efficient Design of Micro Strip Patch Antenna for the Ultra Wideband (UWB) Applications

Ram Soni, Ramji Gupta, Devkant Sen

***Abstract**: In this research paper a design of Microstip patch antenna for the ultra-wide band (UWB) applications is presented. Ultra wide band antennas has very wide band of operation which accommodates many communication frequencies as set by the federal commission of communication. The UWB antennas is based on the micro strip patch antenna concept and the design of the antenna is based on the stack antenna or multi-layer antenna. Stacking is used in designing for increasing the bandwidth of the antenna so stacking concept is good for the designing of the UWB antenna. The feeding used to feed the antenna is micro strip line feed. Micro strip line feeding technique is one of very popular feeding technique to feed the antenna because its fabrication is very simple. The proposed design is simulated in the CADFEKO software which is very useful for the design and analysis of a wide range of electromagnetic problem. It has many applications to simulate 3D electromagnetic circuit included antenna design, micro strip antenna and circuits. The simulation results shows the antenna bandwidth of 13.9 GHz from 2.6 to 16.5 GHz. So we can clearly say that the antenna is ultra-wide band in nature.*

Keywords: Ultra wide band (UWB), micro strip patch antenna, voltage standing wave ratio (VSWR)

I. INTRODUCTION

The premise of the different technique for wireless communication is ultra-wide band (UWB). Heinrich Hertz in 1886, thought of the primary spark gap transmitter and confirmed Maxwell's condition. The first model for communicating two post office was invented in 1896, in London [1]. They were a mile apart. Further advancement will take place in transmitter, a new framework for UWB was presented by U.S. military. The utilization of this transmitter is from heartbeat transmissions to cover imaging, stealth and radar communication [2].

As indicated by the Shannon-Hartley hypothesis, channel capacity related to bandwidth is the primary advantage of the UWB communication system. UWB frameworks work at exceedingly low levels of energy transmission. Likewise, The UWB can handle extra capacity of many Mbps as a result of it is vast bandwidth. Because of low energy density, UWB framework can offer a great degree sheltered and dependable communication framework and it makes incidental discovery rather troublesome.

There is various UWB correspondence applications are available, among which Low Data Rate (LDR) applications are exceptionally straightforward transmitters that restrict the unreasonable utilization of energy, in this manner empowering the battery to last longer. By and large, in UWB the pulse has extremely narrow range, typically a couple of nanoseconds, so it creates an ultra-wideband frequency spectrum [3]. This is utilized fundamentally in low information rate systems, for example, those utilized in armed forces networks, and these are difficult to distinguish and are likewise uncommonly up to the marks at obstructing protection. Additionally UWB is utilized in to the application areas where High Data Rate (HDR) is required, for example, True random number generator, [11-13], access of web and mixed media services, area specific services, home administration systems and gadgets [4], Super regenerative receiver [14] .

II. MICROSTRIP PATCH ANTENNA

Microstrip patch antenna has arrived in mid twentieth century after the innovation of printed circuit technology and it is shown in Fig 1 while the side view of this antenna is given in Fig 2. Many researchers have done work in year 1950 to 1955 at the same time Deschamps present idea of radiator in microstrip [5-7]. Gutton and Baissinot registered a patent in 1955 in France [8]. To use of microstrip antenna beneficial for least loss tangent with emanate proficiently. Around then the main focus has come for stripline microwave planer structure and it has transverse electromagnetic wave (TEM) [8]. Microstrip radiator has come in knowledge due to its low loss tangent and better thermal and mechanical properties. These were currently named as microstrip antenna. The main reason of the real advantages of microstrip antenna is that they are extremely comfortable to planar and nonplanar surfaces can be effortlessly mounted on that and some application was done by scientist for example, flying machine, rocket, satellite correspondence led the cause of inspiration to the researchers for exploration of microstrip antennas. Narrow bandwidth was additionally an extreme issue for microstrip antenna. After the IEEE invention an extra ordinary growth has come for this antenna all issue in present in IEEE Transaction on Antenna and propagation [8].

The substrate is sandwiched between radiating patch and ground plane.

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Two thin metallic layers (t << W) of copper and gold are use as metallic layer. Generally most transmitting patch has square, rectangular, dipole, triangular, elliptical, and circular. Dielectric constants $2.2 \leq \varepsilon_r \geq 12$ is accessible for substrate [9-10]. Thickness of substrates assumes an essential part in antenna attributes by and large are in the range $.03 \leq L \geq 0.05$ cm utilized as ground plane.

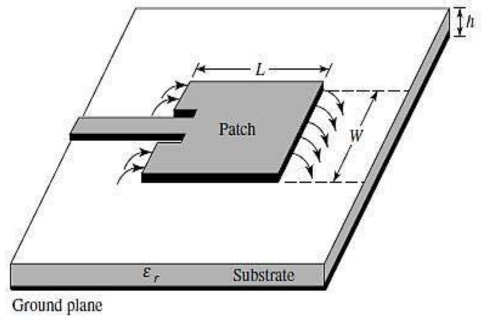


Fig: 1 Microstrip patch

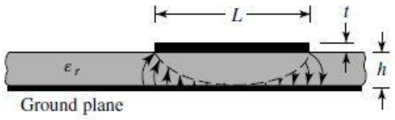


Fig: 2 Side view of Microstrip Patch Antenna

III. METHODOLOGY OF UWB MICROSTRIP PATCH ANTENNA

In this manuscript, the design methodology of Ultra Wide Band antenna (UWB) with CADFEKO software is presented. For the given dielectric substrate and length a patch antenna effective dielectric constant ε_{reff} and width w is calculated by formula in eq. 1 and eq. 2 respectively

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + 12\frac{h}{w}\right)^{-1/2} \quad (1)$$

$$w = \frac{c}{2 f_r}\left(\frac{\varepsilon_r + 1}{2}\right)^{-1/2} \quad (2)$$

and solution frequency is

$$f_r = \frac{c_0}{2L\sqrt{\varepsilon_{reff}}} \quad (3)$$

Where L is the length of patch and ε_{reff} is the effective relative dielectric constant of the substrate. In Table 1 the effective dielectric constant two different substrate materials is given. c_0 is the speed of light in free space.

Table 1 Effective dielectric constant of substrate

Parameter	Symbol	value
Dielectric constant of FR4-epoxy	εreff_1	4.2
Dielectric constant of Rogers RT duroid 5880	εreff_2	2.1

A. Frame work of proposed microstrip patch Antenna

The Fig 3 gives the flow chart of the proposed design for microstrip patch antenna first study the literature of the antenna patch. Select a patch dimension and carried out the simulation using the CADFEKO software and check it results.

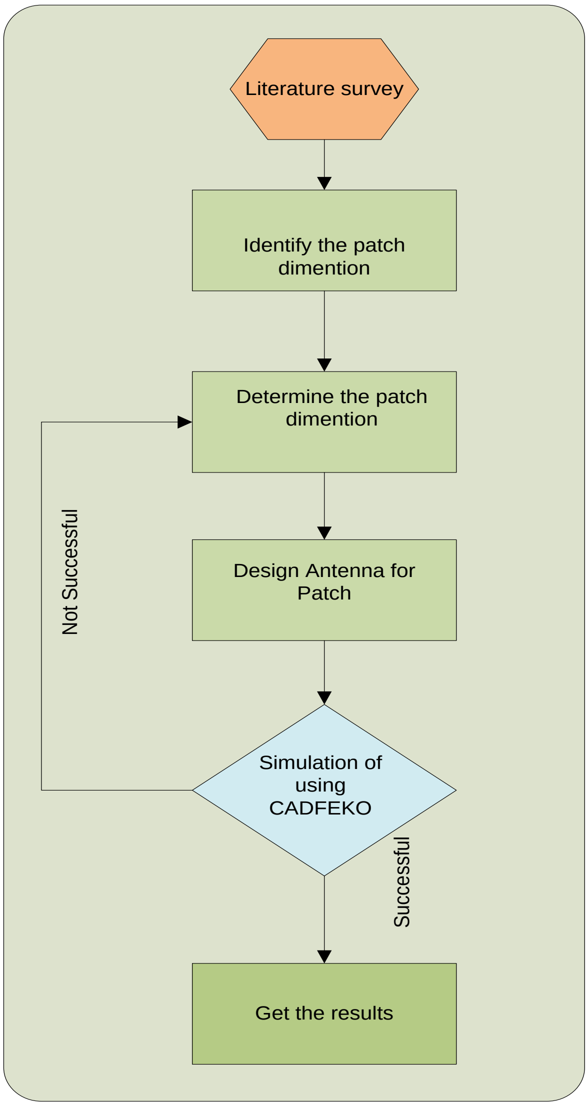


Fig. 3 Flowchart of proposed methodology of microstrip patch Antenna.

There is use of the proposed antenna in the all FCC standard band i.e. 3.1-10.6 GHz. Further enhanced bandwidth of antenna can be use in X and Ku band of antenna. The X and Ku band antenna is very helpful in communication ranges, X band is use for Radar, Satellite communication and wireless computer networks. Whereas Ku band has the application in the satellite communication in the Europe, also for direct broadcast satellite services.

B. Simulation Results of Proposed Design

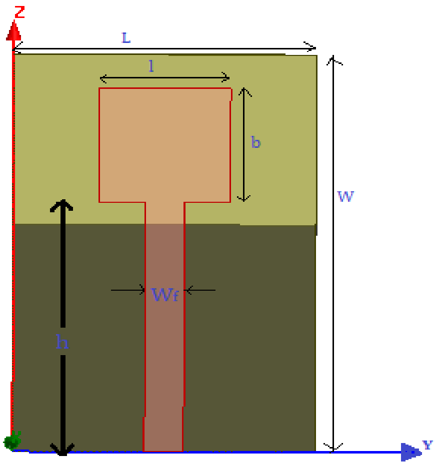
The microstrip patch antenna using the FR4-epoxy substrate is shown in Fig 4.1.

In the proposed design, microstrip feed patch is designed with the rectangular shape patch with FR4 epoxy substrate and then feeding it with 50 ohm feed line having multi resonant frequency obtained. The 50 ohm feed line is use to make return loss minimum so it produces efficient high gain of antenna. Further improvement of its S_{11} parameter by introducing slot on the ground is designed.

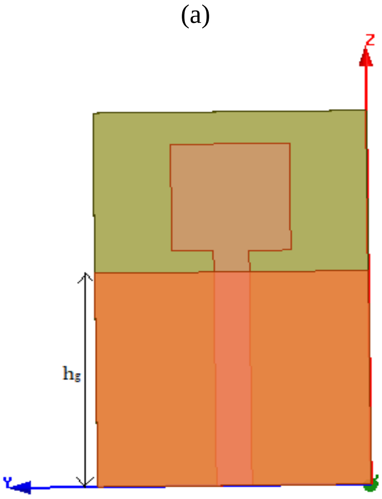
According to IEEE standard the acceptable range for S_{11} parameter for a perfect design of antenna is less than -10 dB. Here simulation of S_{11} parameter has been done at the resonance frequency of 7.8 GHz. The different parameter of the patch and substrate is given in Table 2. In all design for all dielectric substrate material thickness is taken 1.6 mm.

Table 2 Parameter of substrate and patch

Parameter	Value (in mm)
L	23
W	35
l	10
b	10
h	22
W_f	3
h_g	20



(a)



(b)

Fig. 4 (a) Microstrip Patch and (b) Ground

Where W and L is the length and width of dielectric substrate as shown in Fig 4 respectively. The ground dimension is h_g and W which is same as dielectric substrate. W_f and h is the feed dimension which is combined with patch. Source is used at the bottom side of feed line.

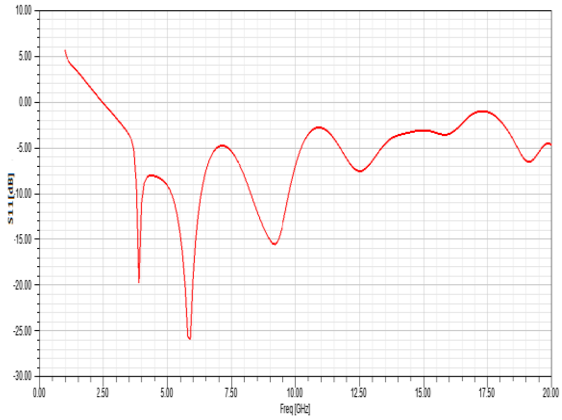


Fig 5 S_{11} parameter of microstrip patch

The result of S_{11} parameter is shown in Fig 5. Here more than one frequency has come in the acceptable range of -10 dB. The frequency in GHz is shown on the x axis whereas reflection coefficient parameter in y axis in dB. Further, the parametric analysis of the patch is done below.

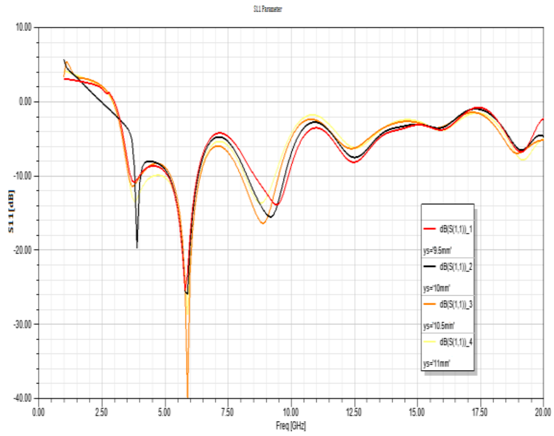


Fig 6 Parametric y dimension variation of microstrip patch

Here parametric analysis is shown for reflection parameter and found that the y dimension of the patch at 10.5 mm gives the sharp patches. The patch y dimension ys are shown in Fig.6. The value of ys has varied from 9.5 to 11 mm.

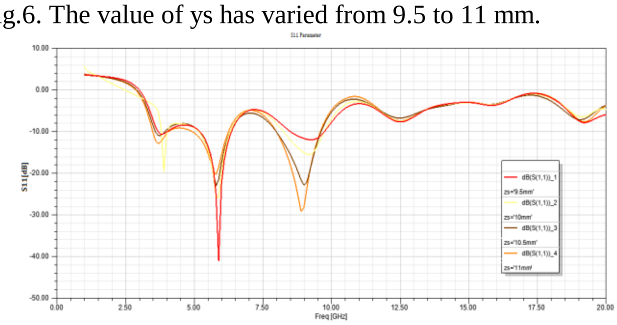


Fig 7 Parametric z dimension variation of microstrip patch

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Here parametric analysis is shown and found that the z dimension of the parametric solution gives the sharp frequency at 9 mm. The patch z dimension zs are shown in Fig.7 The value of zs also has varied from 9.5 to 11 mm.

IV. CONCLUSION

The microstip patch antenna for the application of UWB are proposed in this manuscript. The design of the antenna is based on the stack antenna or multi-layer antenna. The proposed antennas has wide band of operation and they are satisfying all the design standards of microstrip patch antenna design. We got the antenna bandwidth of 13.9 GHz from 2.6 to 16.5 GHz. So we can clearly say that the antenna is ultra-wide band in nature.

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