Design of Inverted U-Shape Rectangular Microstrip Patch Antenna for UWB Application At 2.7 GHz

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***Abstract*-Rectangular Microstrip Inverted U-shape patch antennas havebecome more common in various kinds of UWB applications over the preceding two decades. Due to its potential usage in mobile devices and satellite communication, the inverted U- shape microstrip antenna has grown into a rapidly increasing field of study. This paper proposes a design for rectangular U- shaped microstrip patch antennas operating at 2.7 GHz. It can be utilized by UWB communication systems. The objectives of this study are to analyze, design, and validate a rectangular U-shaped microstrip patch antenna. It is advised to use the HFSS15-based model to measure specific bandwidth and gains for specified dimensions.**

***Index Terms-Inverted* U-shape Rectangular Microstrip patch Antenna, HFSS15.**

1-INTRODUCTION

The development of microstrip antennas accelerated in the latter half of the 1970s. By the beginning of the 1980s, basic microstrip antenna elements and arrays have a solid design and modelling base. Printed antennas have drawn a lot of interest recently because they have advantages over conventional radiating systems, including light weight, reduced size, low cost,conformability, and simplicity of integration with active device [1]. The patch antenna used to be fed at the end, as can be seen in the image below. Because a high input impedance is frequently the result, we wish to modify the feed.[2] Since the current in a half-wave patch is low at the ends and increases in magnitude towards the centre, the input impedance (Z=V/I) would be lower if the patch was fed closer to the centre. One way to accomplish this is by using an inset feed (positioned R from the end), as seen in Figure 1.

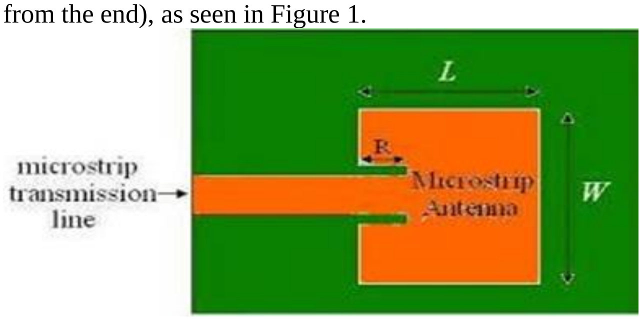

Figure 1: Basic structure of Rectangular Microstrip Antenna.

The u-slot microstrip patch antenna was first introduced in 1995 [3] by Huynh and Lee. Two notable limitations of microstrip patch antennas are their constrained bandwidth and low amplification [4]. It has been demonstrated that the U-slot patch significantly increases the microstrip antenna's bandwidth[5]. The U-slot patch antenna can be built for dual-band, triple- band, and other applications [6] with narrow and broad frequency ratios [7], in addition to wideband applications. The u-slot patch antenna uses programmable frequency [8]. The IEEE standard 802.15.4, which intends to offer the basic lower network layers, attempts to establish a kind of wireless personalarea network (WPAN) that focuses on low-cost, low-speed ubiquitous communication between devices. The primary design makes use of a 250 kbit/s data transfer rate and a 10- meter line-of-sight communication range. An integrated U- shaped rectangular microstrip patch antenna with 2.7GHz resonant frequency-based dimensions is proposed in this research paper. The r value of the dielectric substrate material is 2.2. To meet a particular height, the length and width of the Inverted U-shape patch can be altered in a variety of ways. Theparticular length and width stated in this study are displayed along with antenna properties such as return loss, bandwidth, and gain.

2.THE INVERTED U -SHAPE RECTANGULAR PATCH ANTENA

A ground plane, a substrate material, an inverted u-shape patch, and a microstrip feeding line constitute the proposed antenna. In this part, the most crucial factors that influence how well an antenna performs, like Antenna performance, bandwidth and gain, are discussed. Figure 2 depicts the inverted u-shape antenna's fundamental geometry.

$$\frac{\Delta l}{h} = \frac{0.412\left[\varepsilon_{r_{eff}}+0.3\right]\left[\frac{W}{h}+0.264\right]}{\left[\varepsilon_{r_{eff}}-0.258\right]\left[\frac{W}{h}+0.8\right]}$$

$$L = \frac{1}{2f_r\sqrt{\epsilon_{reff}}\sqrt{\mu_0\epsilon_0}} - 2\Delta L$$

$$\varepsilon_{r_{eff}} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1 + 12\frac{h}{w}\right]^{-1/2}$$

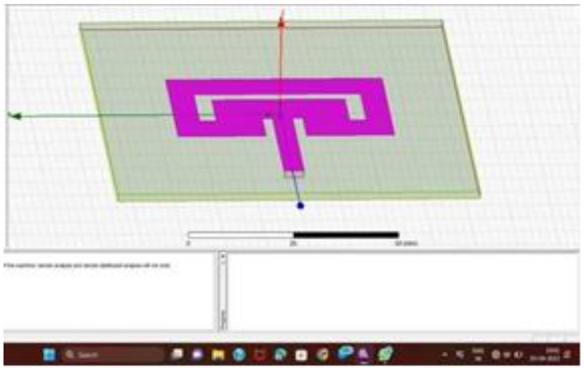

Figure 2: The u-shape microstrip patch antenna.

Table 1 : The table below lists the specifications for the proposed inverted u-shape microstrip patch antenna.

Operatingfrequency	2.75GHz
Substrate	NEW MATERIAL1
Dielectric constant ofsubstrate	2.2
Height ofsubstrate	1.6 in mm
Patch width	43 mm
Patch length	52 in mm

$$w = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}}\sqrt{\frac{2}{\epsilon_r+1}} = \frac{v_0}{2f_r}\sqrt{\frac{2}{\epsilon_r+1}}$$

The standard formula for calculation of width andlength of inset feed microstrip patch antenna at particular operating frequency is given by

Where,

w = Width of rectangular patch

L= Length of rectangular patch

Δ L= Increase in electrical length onetriangular-patch due to fringing effect

f_r = Resonance frequency

μ_0 = Permeability of free space

ϵ_0 = Dielectric constant of free space

ϵ_r = Relative dielectric constant

ϵ_{reff} = Effective value of dielectric constant

3.SIMULATION AND RESULTS DISCUSSION

A 3D electromagnetic (EM) simulation tool called" Ansys HFSS" is used to design and simulate high-frequency electronic devices such antennas, antenna arrays, RF or microwave components, high-speed interconnects, filters, connectors, IC packages, and printed circuit boards. You may compute parameters like return loss, gain, band width,and VSWR, among others, using Ansoft HFSS. Here we will discuss these parameters one by one with appropriate fundamentals.

RETURN LOSS

When the two different load are not compatible, then in this case the entire amount of power cannot be transferred to the load, resulting in a loss. This returned loss is known asthe return loss. SWR goes down as return loss increases.

Return loss is a term which is used for determining how effectively lines or devices are matched. When the returnloss is high, a match is successful. It is preferable to havea high return loss since it reduces the insertion loss.

Figure 3 depicts an inverted U-shape microstrip patch antenna that resonates at 2.7GHz with a maximum returnloss of -30db and an impedance bandwidth of 160MHz ata -10db level.

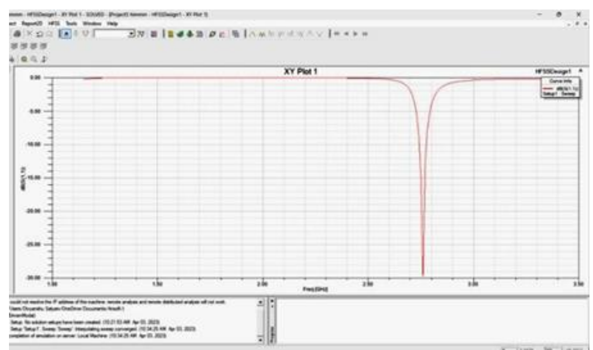

Fig3: Simulated Return loss of Antenna

3.1 GAIN

The term used to characterise the performance of an antenna, or its capacity to focus energy in one direction to provide a clearer image of its radiation performance, is gain.The direction of the maximum radiation is indicated by the unit of measurement, which in this case is dB. The simulated gain of the suggested antenna is shown in Figure

2. have gains up to 7.44dB are possible.

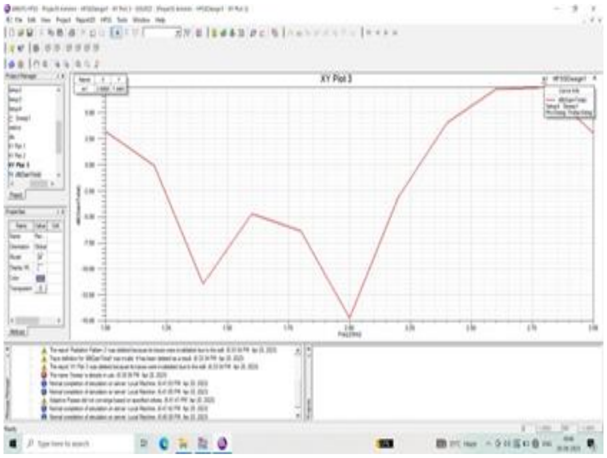

Fig4: Gain Vs Frequency plot

3.2 RADIATION PATTERN

The inset feed microstrip patch antenna radiates or receives power according to its radiation pattern. It depends on the antenna's radial distribution and angular position. Figures 6, 7, and 8 depict the radiation pattern for the suggested inset feed microstrip patch antenna.

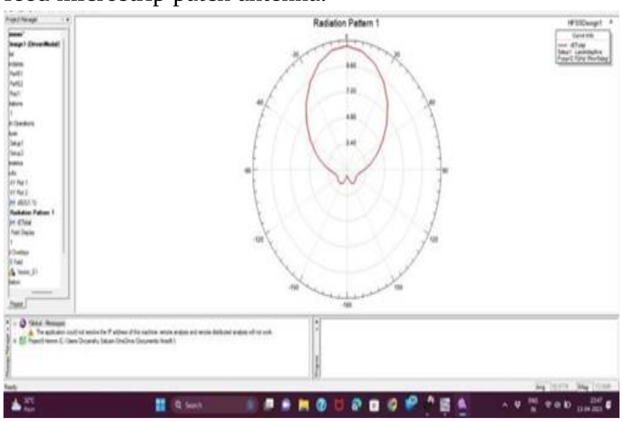

Fig5: Radiation Pattern in E –plane

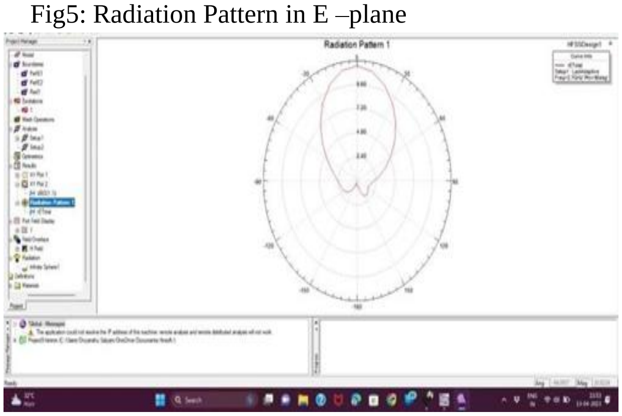

Fig6: Radiation Pattern in H-plane

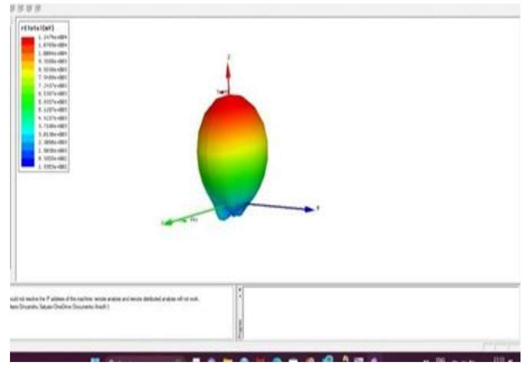
Fig7: 3-D Radiation Pattern

3.3 VOLATAGE STANDING WAVE RATIO

For all significant communication equipment, the VSWR criterion is crucial. It evaluates how well an antenna matchesthe cable impedance at the point where reflection, $|\Gamma| = 0$. It could also be described as the proportion of an antenna system's input voltage to output voltage. This indicates that there is no reflection and that full power is transferred to the antenna. The figure 9 shows the simulation results of the voltage standing wave ratio (VSWR).

By Referring to the Fig9, the value of VSWR at operatingfrequency 2.7 GHZ is 0.2

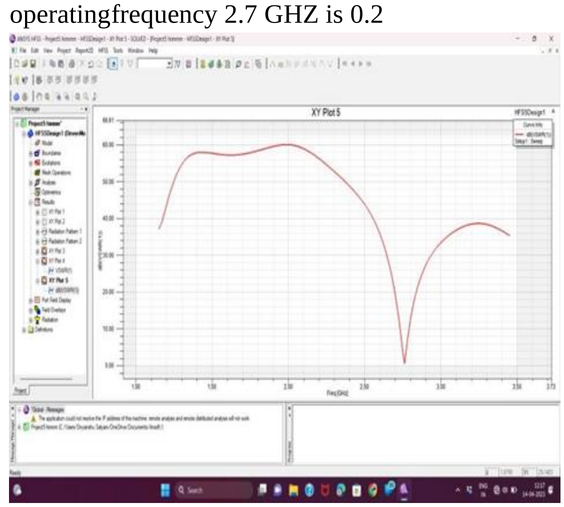

Fig8: Simulated VSWR

4. ELECTRIC FIELD

With the use of a simulation tool like CST or hfss, the E-field produced by the microstrip rectangular Patch Antenna with an inverted U-shape may be estimated. It depends on the patch's length "L" and width "W," as well as its "wavelength " and feeding mechanism. The width of the substrate and the permittivity of the substrate are additional important factors toconsider.

Fig10 shows the electric field variation for inverted U shape microstrip rectangular patch antenna.

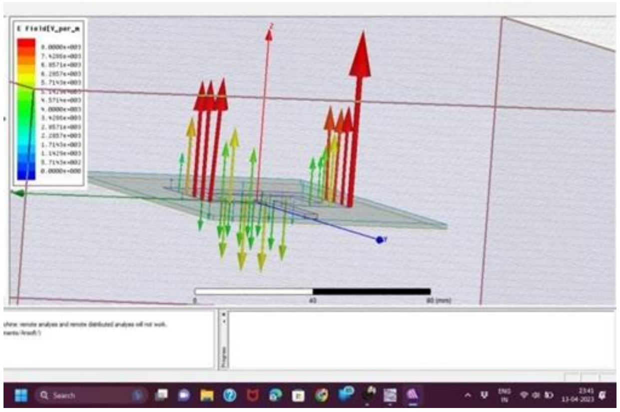

Fig9: E Field Variation

5.MAGNETIC FIELD

In order to see the magnetic field, we click on the patch and then go to plot field. Then we go to “H” and “Vector H”. After this we go to “Vector H” and“All object” and then we click on “done” button.

After this we have found following graph.

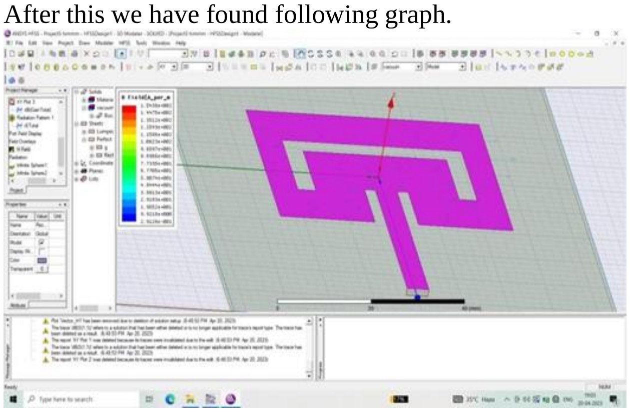

Fig10: H Field Variation

6.CONCLUSION

In this paper we proposed design of inset feed inverted U-slot microstrip rectangular patch antenna for UHW application.

We have observed that when we make variation in frequency from 2.5 GHZ to 2.7 GHZ then the ‘S’ parameter will go beyond -10dB. Here we have designed the antenna at 2.7 GHZ and then simulated, fabricated to validate the work. Here various performance parameter like gain, radiation etc at 2.7 GHZ are discussed. It can be concluded here that the inset feed inverted U-shape microstrip rectangular patch antenna had successfully designed and achieved improved gain and directivity.

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