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U-H SHAPED RECTANGULAR PATCH ANTENNA FOR TUNING RESONANT FREQUENCY IN S- BAND

PARIMITA SAIKIA[1], ANUP KR BORDOLOI[*2], MANIK CHANDRA BORAH[3] and BHAIRAB SARMA[4]

[1,3,4] Computer Science & Electronics, University of Science and Technology, Meghalaya, India.
[*2] Assam Down Town University, Guwahati, India.
Email: [1] parimitasaikia6@gmail.com, [2] bordoloianup@gmail.com, [3]manik.borah1962@gmail.com
[4]sarmabhairab@gmail.com

Abstract:

This paper includes, designing of U-H shaped rectangular patch antenna by geometrical modification of a rectangular patch antenna. Initially a simple rectangular antenna is projected to resonate at frequency 2.89GHz. The antenna is modified in the form of U and H shape to investigate tuning of resonant frequency within the band. The designing of antenna is done by using high frequency simulation software CST Microwave Studio followed by measurement. The overall dimension of the antenna is kept constant while modifying the antenna from simple patch to U and H shaped letters.

Keywords- U-H shaped patch, Tuning, S-band

I. INTRODUCTION

To deploy the patch antenna applicable for various areas in wireless communication covering different bands (L, S and C etc.) different modifications are being carried out on patch antenna. While implementing different modification overall characteristics of the antenna are necessary to decide its characteristic performance. In different applications, where the parameters including weight, cost, size, performance, flexibility in installation, a low profile antennas with different frequencies within the band are required [1]-[4]. At present many other applications like mobile radio and wireless communications having similar specifications microstrip antenna is the most suitable candidate [1, 2, 3, 12]. Microstrip antenna with continuous tuning of resonant frequency within a specified band is required for specific applications for wireless communication. Different designs of MPA such as fractal antenna, H, E Slot [4, 5, 6, 7, 9], compact slot, high gain antennas [8,10,11,13] are investigated by researcher to tune the antenna within the band to make the antenna more applicable for variety of communication area. In the present investigation, a new U and H shaped antenna is designed with tuning arms to meet enhanced performance of the antenna within the band in terms of Return loss (RL) and radiation pattern characteristics.

II. MATERIALS AND METHOD

A simple rectangular patch antenna is designed in S- band and modification of the basic patch is done with feed point fixed for maximum Return loss (RL) value

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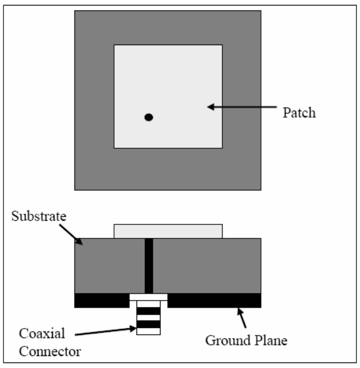
A. Design of basic patch

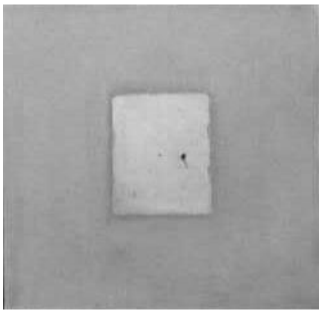
The basic rectangular microstrip patch antenna (RMPA) is designed which resonates at **2.89GHz** with RL value of **-19.50 dB** and matched feed point location is **4mm** (distance between center of patch and one of the radiating edges). The geometry of patch and fabricated patch are shown in **Fig 1**((a) and (b)). Dimension of ground and patch are Lg=80mm,Wg=80mm and Lp =22mm, Wp =24mm respectively. The thickness of both substrate and copper are 1.5mm and 0.025mm respectively. Following table (**TABLE I**) shows the overall dimension of the patch.

TABLE I. Patch antenna dimension

Parameter	Value
width of Patch (Wp)	24mm
length of Patch (Lp)	22mm
Height of the substrate (h)	1.5mm
Dielectric constant (ε_r)	4.9
Feed point location from edge	4mm



(a) Schematic diagram of Basic patch



(b) Fabricated Basic patch antenna

Fig.1: Basic patch Antenna: (a) & (b)

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RL plot for measured and simulated value of basic patch is shown in **Fig 2**. Both simulated and measured value is shown in the figure. Measured value is found at 2.65 GHz with RL value of -17.05 dB. A slight shift of frequency (0.24 GHz) is observed for measured result of the RMPA as compared to simulated value with RL value decreased by 2.14 dB.

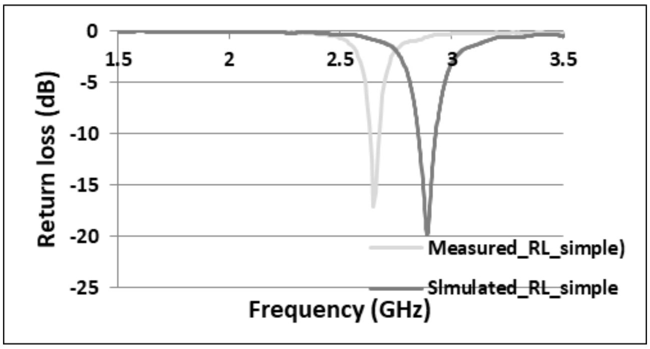


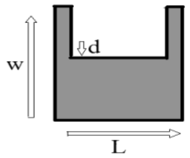
Fig.2: Simulated and Measured Plot for Frequency vs. RL value of basic patch antenna

III. RESULT AND DISCUSSION

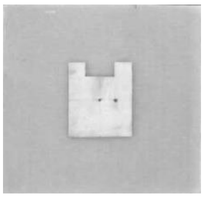
Geometrical modification of basic patch is carried out to change the shape of the antenna as U and H shape alphabetic letters. While doing the modifications original dimension and feed point location are unaltered.

1) U- shaped antenna:

The shape of the basic patch is modified by etching away a portion of conducting section (d=0mm to d=12mm) of the patch with two parallel conducting bars on the radiating edges. **Fig 3(a)** shows the geometry and **Fig 3(b)** is the fabricated sample of the same for d=4mm.



(a) **Geometry of U shaped patch (d=4mm)**



(b) Fabricated U shaped patch antenna (d=4mm)

Fig.3: U shaped patch antenna: (a) & (b)

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Simulated result of the modified patch (U-shape) was followed by measured result using Vector Network Analyzer (Agilent make, PNA Network Analyzer E8362C, 10 MHz-20 GHz).

It is seen that the simulated RL value is improved from -19.19 dB to -27.21dB (d=4mm) compared to basic rectangular patch antenna. A frequency shift of 0.28GHz is observed for this modified U shaped antenna (d=4mm) between simulated and measured result. This shift may be due to fabrication tolerance. Simulated vs. measured RL plot for the U shaped antenna (d=4mm) is shown in the **Fig 4**.

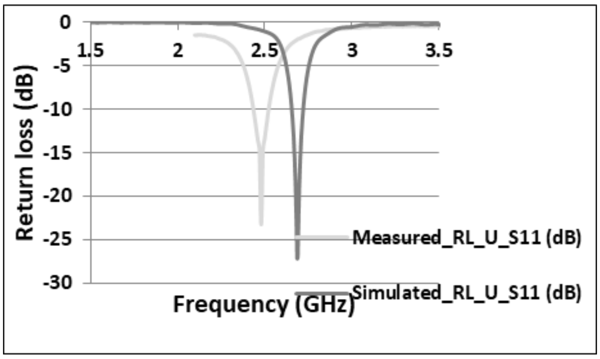

Fig.4. Frequency vs. RL plot of modified U shape patch antenna (d=4mm)

Overall frequency shift of the U shaped patch is 2.09GHz to 2.88 GHz with a frequency shift of 0.79GHz is observed and Simulated plot for d=2mm to 12mm is shown in **Fig 5**.

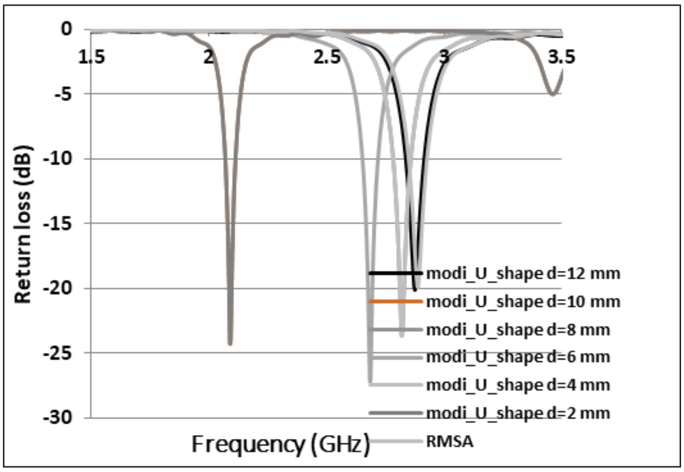

Fig.5: Frequency vs. RL plot of modified U shape patch antenna for d=2mm to 12mm

2) H- shaped antenna:

In this design, d is shifted from bottom side of the patch in a similar way as shifted for the U shaped patch(d shifted from top towards center) leading the shape of the antenna to letter H

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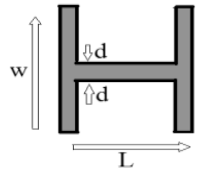
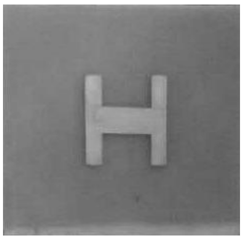
of alphabets. The geometry and fabricated antenna samples are shown in Fig.6 (a)and (b) respectively(d=(+8mm,-8mm)).Dimension of two parallel bar on radiating edges and the bar connecting the two arms are 2mm each.



(a) Geometry of H shaped patch antenna d=(+8mm,-8mm)



(b) Fabricated H shaped patch antenna d=(+8mm,-8mm)

Fig.6: H shape patch antenna: (a) & (b)

It is observed that the simulated return loss value is improved from -19.50 dB to -37.39dB (d=+6mm,-6mm) compared to basic rectangular patch antenna. A frequency shift of 0.70 GHz is observed for this modified H shaped antenna (d=+6mm,-6mm) between simulated and measured result. This shift may be due to fabrication tolerance. Simulated vs. measured RL plot for the U shaped antenna (d=+6mm,-6mm) is shown in the Fig.7.

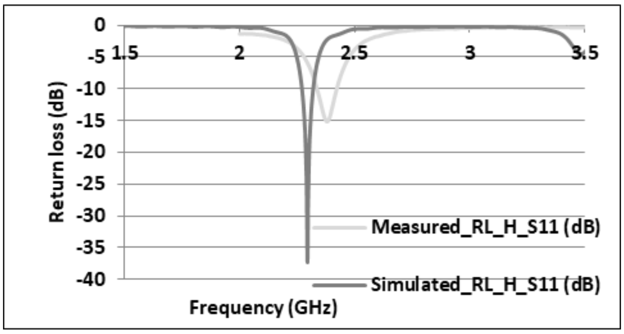


Fig.7: Frequency vs. RL plot of modified H shape patch antenna (d=+6mm,-6mm)

The antenna shown in Fig.6 has been further modified by introducing two tuning arm on both upper and lower side of the central conducting bar having width of 1mm. The two arms are slided towards the centerof the middle conducting bar. Fig.8(a) and Fig.8(b) are the geometry and fabricated sample of H shaped patch with bar respectively.

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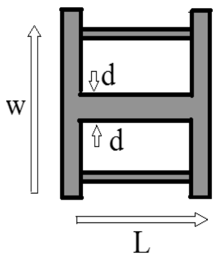
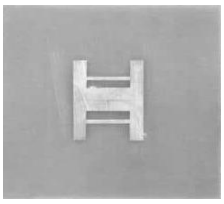


(a) Geometry of H shaped patch antenna with bar



(b) Fabricated H shaped patch antenna with bar

Fig.8: H-shaped antenna with sliding arm: (a) & (b)

Sliding the tuning arm equally from side (+d,-d) for 6 different values with a step value of 2mm results shift in frequency and with significantly lowered value of frequency ranging from 2.08GHz to 2.88GHz. The result indicates tuning of resonant frequency with a range of 0.80GHz. The plot below (Fig. 9) shows the plot of frequency vs. RL value for these 6 different sliding values of the arms.

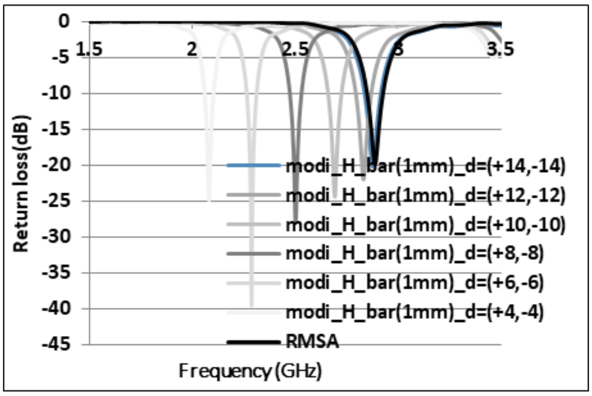


Fig.9.Simulated frequency vs. RL plot of H shape patch antenna with different position of sliding arm

It has been observed that, return loss values are improved compared to original rectangular patch antenna designed at 2.89GHz. The measured results indicate that resonant frequencies for all the modified structures are decreased compared to the RMSA which resonates at 2.65 GHz. From all the investigation carried out a total frequency shift from 2.29GHz to 2.89GHz

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(600MHz) is observed in simulation and 2.65GHz to 2.41GHz (240MHz) is observed in measurement. Plot of Frequency vs. RL between simulated and measured results is shown below in **Fig 10.**

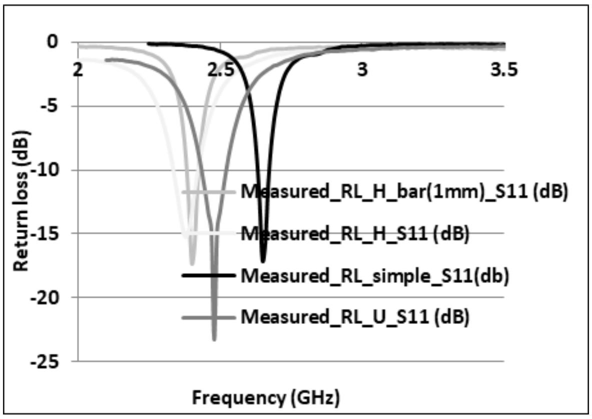


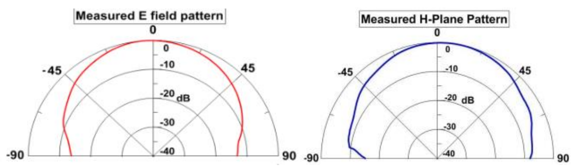
Fig.10: Measured frequency vs. RL plot of H shape patch antenna with different position of sliding arm

Summary of these structures (basic and modified structure) are put in the Table 2.

TABLE II. Simulated vs. Measured result for modified patch antenna

Structures	Simulated		Measured	
	Resonant frequency (GHz)	Return loss(dB)	Resonant frequency (GHz)	Return loss(dB)
RMPA	2.89	-19.74	2.65	-17.05
U- shape	2.60	-27.21	2.48	-23.26
H- shape	2.90	-37.39	2.20	-15.67
H Bar shaped	2.29	-39.46	2.41	-15.26

Radiation pattern measurements are carried out using an automated set up with PC controlled turn table. Radiation pattern for Basic patch, U shaped patch, H shaped patch ad H shape patch with bar are shown below in Figure 11 (a), (b), (c) and (d) respectively.



(a) Basic patch (2.89 GHz)

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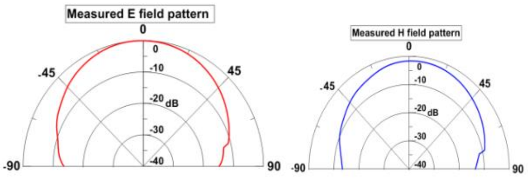
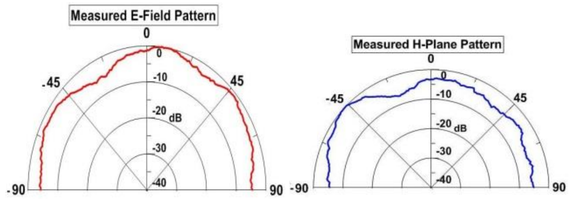
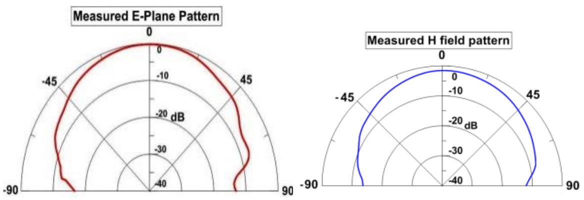


(b) U shaped patch (2.60 GHz)



(c) H shape patch (2.90 GHz)



(d) H shaped patch with bar (2.29 GHz)

Fig. 10: Radiation pattern measurement E field (Y-Z Plane), H field (X-Z Plane)

IV. CONCLUSION

From the present investigation carried out for these modifications of basic patch it can be concluded that the modified antenna produces good matching with tuning of resonant frequency from 2.09GHz to 2.88GHz with a tuning range of 0.79GHz for U shaped patch antenna and a frequency range of 2.08 GHz to 2.88GHz with tuning range of 0.80GHz. This technique of modifying the basic patch with shape change (U and H) and introduction of tuning arm at different positions results shift of resonant frequencies within same band.

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