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Design & Implementation of a Multiband Antenna for Wireless Communication.

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***ABSTRACT*- Microstrip antennas are the most widely used antennas in many communication fields. They are used for their light weight, low cost, low profile, simple structure and omni-directinal radiation patterns. This paper presents the design and implementation of a multiband antenna for wireless communication. A proposed antenna is designed which will operate in 3 different frequencies. i.e. WLAN 2.4GHz, GSM-930MHz, GSM-1.84GHz using U slot with inset feeding technique. In this project, various measurements in terms of gain, bandwidth, return loss and radiation pattern are analyzed and a comparative study is done.**

***KEYWORDS*- Multiband, Microstrip antenna, U- Slot, HFSS Software.**

I. INTRODUCTION

The rapid evolution of information technology and wireless communications has enabled the development of applications that one was not able to dream of a few decades ago. Personal communication has become an integral part of our daily lives. An antenna should radiate efficiently in an intended manner to free space, while other components should be more or less isolated from their surroundings. Meanwhile, the reduction in device size has caused an increasingly higher space constraint in the implementation environments for antenna. Microstrip antennas have attracted a lot of attention due to rapid growth in wireless communication area.

Several patch designs with single feed, dual frequency operation or more frequencies have been proposed recently. Microstrip antennas suffer from low impedance bandwidth characteristics. So different techniques can be used to overcome these problems like Probe Compensation (L-shaped probe, capacitive “top hat” on probe), Stacked Patches, Slots, Corner Truncated.

The different multiband techniques studied for converting Single band to multiple band are U, E and H patch over the substrate. The E-shaped patch antenna provides highest bandwidth followed by U-shaped patch antenna and H shaped patch antenna. E slot is used when the frequencies chosen are from different bands. But in this project, the frequencies for the proposed antenna are close together. E slot is formed by using 2 U-slots; hence it can lead to overlapping of the U slots which can cause wrong radiation patterns. U slots can also be designed to perform a number of other functions including wideband, dual-and triple-band operations with small and large frequency ratios, as well as for circular-polarization applications. Even with reduction in the size of rectangular patch that resulting in asymmetric U-slot patch antenna fed with thicker probe, broadening the operating bandwidth is possible.

A stacked antenna also helps in increasing the bandwidth and also covers two bands but the size of the antenna also increases and this is the biggest disadvantage of a stacked antenna. The number of substrates are increased thus leading to the increasing number of patches.

II. METHODOLOGY

The rectangular Microstrip antenna is the simplest configuration of the Microstrip patch. Due to the simplicity of the structure, extensive researches have been done and numerous methods have been made to analyze the characteristics of rectangular microstrip antennas. The most popular model for the analysis of microstrip patch antenna is the transmission line model. The transmission line model is the simplest and it gives good physical insight. In this design simple feeding technique is used and it does not require more than one patch.

The technique used for broadening the patch antenna bandwidth is by incorporating a U slot on its surface. It has recently been found that U slot can be used not only to broaden the bandwidth supported, but also to provide more bands by additional U slots and loading the patch with U slots can broaden not only the fundamental mode frequency band, but also the higher order mode frequency band. The U- slotted Patch Antenna can be provided with an inset feed, which has its dimensions optimized to provide impedance matching such that it can suppress the harmonic frequencies (other than the multiple operating frequency bands) and thus this design eliminates the need of BPF (Band Pass Filter)

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Parameters	Corner Truncated	Probe Compensation	Slots	Stacked Patch
Dielectric Constant	High	Low or high	Low or high	High
Features	Can be used for circularly polarized antennas	Use of a single probe-compensated feed results in radiation pattern distortion, high cross polarisation and low efficiency due both to higher order modes and surface-wave generation.	The slots help in increasing the gain and the coupling of the antenna which in short improves the efficiency of the antenna	In stacking, the number of substrates and the number of patches are increased Hence size increases
Uses	Used for higher frequencies	Used for higher frequencies	Used for low or high frequencies	Used for low or high frequencies

Table 1: Single band to multiband techniques.

III. ANALYSIS

The analysis of the proposed Rectangular Microstrip Patch Antenna (RMSA) is designed for the resonant frequency of 930Mhz. Then, a U slot is introduced and optimized in order to provide multiband response. Since, edge feeding is used, the impedance matching is provided by varying the feed position.

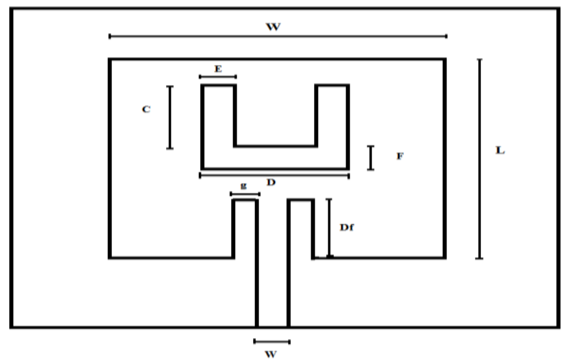

Fig 1 : U slot patch antenna dimensions

- Height of Dielectric substrate = h
- Width of the patch = W
- Length of the patch = L
- Slot thickness = E and F
- Slot Width = D
- Depth of the U-slot = C

Dielectric constant of the substrate (εr) is 4.4 and height of dielectric substrate (h) is 1.67mm.

DIMENSIONS	VALUE	UNIT
substrate W	116.09	mm

substrate L	94.3	mm
feedline L	9.09	mm
feedline W	12.81	mm
patch W	98..09	mm
patch L	76.89	mm

Table 2: Design parameters for microstrip patch antenna

IV. RESULTSAND DISCUSSION

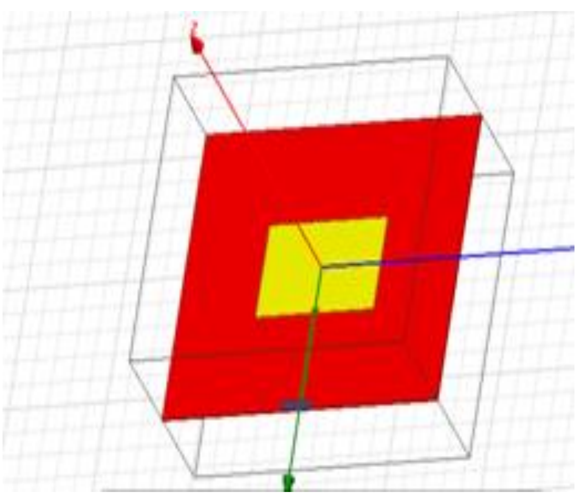

Figure 2: Structure of RMSA designed in HFSS

Fig.2 illustrates the structure of microstrip patch antenna with U slot simulated on HFSS software.

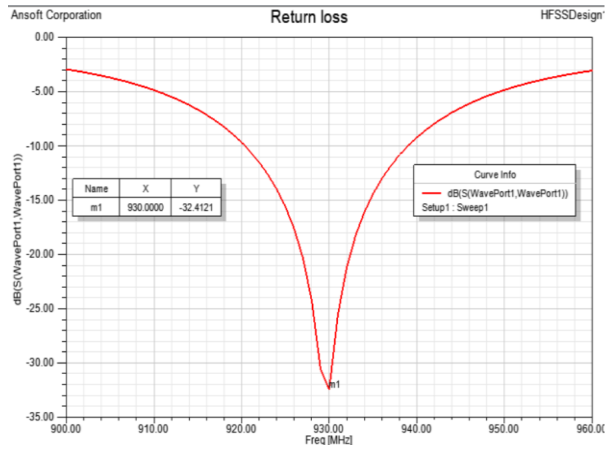

Figure 3: Simulated Return Loss plot at 930 MHz

Fig.3 illustrates the simulated return loss at 930 Mhz in HFSS. The return loss obtained is -32.4 of the simple patch antenna.

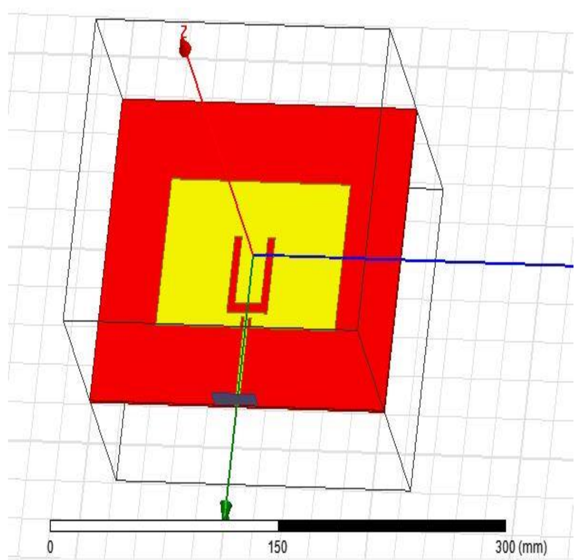

Fig 5: Structure of Microstrip Patch antenna with U-slot simulated on HFSS

Fig.5 illustrates the structure of microstrip patch antenna with U slot simulated on HFSS software.

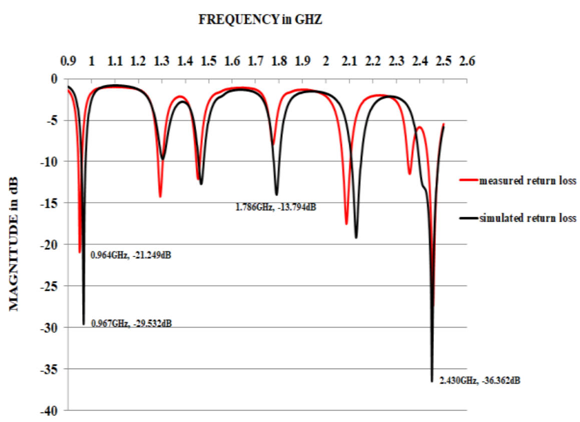

Figure 6: Measured and Simulated Return Loss Result for Proposed Antenna

Fig 6 shows the return loss plot for the simulated and measured results for the proposed antenna. A minor frequency shift has been observed due to the varying value of dielectric constant of the substrate which varies between 3-5

Parameters	Operating Freqencies (GHz)	Return Loss (dB)	VSWR	Bandwidth (MHz)
Simple RMSA	0.930	-32.410	1.049	0.195
Proposed Antenna	0.966 1.789 2.450	-33.204 -13.979 -39.914	1.143 1.31 1.020	0.200 0.204 24.8

Table 3: Comparison Simulated of Results

From table 3, it is observed that the return loss obtained at the resonating frequency using simple RMSA has increased after the insertion of U-slot.

Parameters	Operating Frequencies (GHz)	Return Loss (dB)	VSWR	Bandwidth (MHz)
Simple RMSA	0.906	-29.920	1.114	0.197
Proposed Antenna	0.952 2.097 2.460	-20.420 -17.330 -27.3	1.238 1.310 1.091	0.916 14.706 24.724

		17		

Table 4: Comparison Measured of Results

Table 4 is evident that there is a slight frequency shift in both the resonating bands which was observed during measurements of various parameters. This shift could be attributed to mismatching between the connector and the antenna feeder, fabrication errors, interference and noise. The frequency shift is observed also due to the varying of dielectric constant of the material FR-4 which ranges from 3-5 in India.

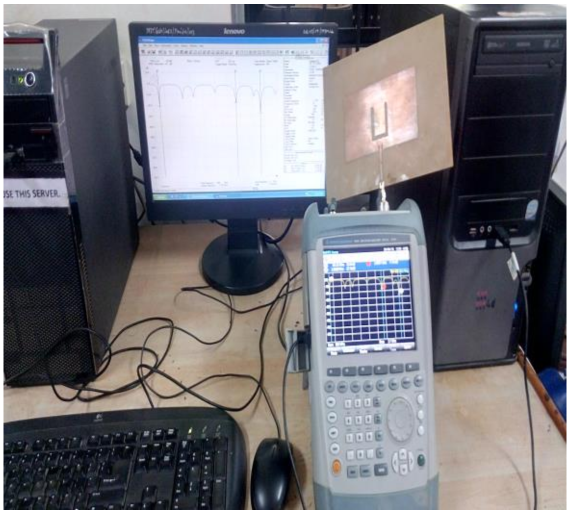

Figure 10: Experimental Setup of antenna testing using Vector Network Analyzer (VNA)

The above figure illustrates the setup of the proposed antenna connected to the vector network analyzer (VNA). Here the antenna is connected to the port 2 of the VNA. Port 2 was calibrated to our desired sweep range, i.e. from 850 MHz to 2.6 GHz. Measured results like return loss plot, VSWR plot and Impedance plot were exported using ‘R and S’ software by connecting the VNA to the computer.

V. CONCLUSION

The proposed work is to design, implement, fabricate and test a Microstrip patch antenna for WLAN and GSM applications. The proposed antenna is designed for the unlicensed frequency bands of 802.1b IEEE standard WLAN applications.

The design and simulation of 930MHz on HFSS software has been done and the results are obtained after optimization of dimensions. Also, the multiband Microstrip patch antenna of 1.84GHz and 2.4Ghz are simulated on HFSS software and a comparative study of simulated and measured results is done.

VII. REFERENCES

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