SASI INSTITUTE OF TECHNOLOGY & ENGINEERING
(Approved by AICTE-New Delhi, Affiliated to JNTUK-Kakinada and SBTET-Hyderabad)
TADEPALLIGUDEM - 534101, West Godavari District, Andhra Pradesh
☎ : 08818-244986,987,989,990 Fax:08818-244628 Web : www.sasi.ac.in., hodece@sasi.ac.in
Department of Electronics & Communication Engineering

## Academic Year 2016-17

## Annexure I

**1. Project Title:** Design of U-slot Microstrip Patch Antenna for WLAN Application

**TABLE OF CONTENTS**

# 1. Abstract & Objective

## 1.1 Abstract

Since the beginning of the human civilization mankind is trying to communicate with the others. Microstrip patch antenna becomes very popular day-by-day because of its ease of analysis and fabrication, low cost, light weight, easy to feed and their attractive radiation characteristics. Earlier systems were narrowband longrange systems but in order to extend the use of available spectrum we are now using microstrip patch antenna. Previously, In order to increase bandwidth and other radiation parameters various antenna designs are made. Although patch antenna has numerous advantages, it has also some drawbacks such as restricted bandwidth, low gain and a potential decrease in radiation pattern.

To overcome this issue, various feeding techniques have proposed .There are many aspects that affect the performance of the antenna like dimensions, selection of the substrate, inserting slot and also the Operating frequency.

This project describes the design of microstrip patch antenna used for WiMAX application with operating frequency 3.75GHz. The antenna is rectangular in shape, in which RF power is fed directly to the centre radiating patch with the help of feeding techniques. Various parameters such as Return Loss, Radiation Pattern, Bandwidth, Gain, VSWR, etc., are determined. The optimized antenna design and results are presented by using ANSOFT HFSS.

## 1.2 Motivation

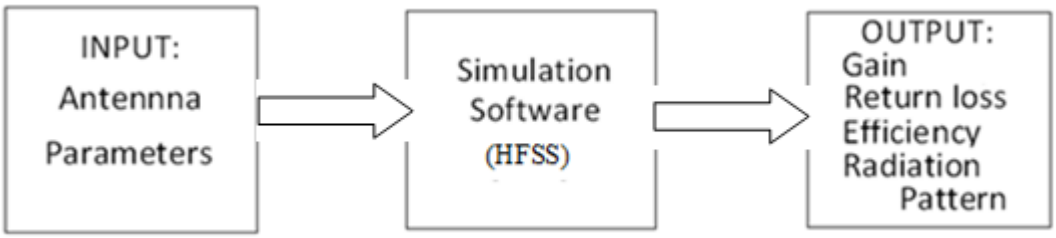
Wireless communications have progressed very rapidly in recent years, and many mobile units are becoming smaller and smaller. It started with hand gestures, then sounds produced by vocal chords and gradually me moved to wired communication and now wireless communication. In wireless communication we mainly exploit the Electromagnetic Spectrum. To meet the miniaturization requirement, the antennas employed in mobile terminals must have their dimensions reduced accordingly. Planar antennas, such as micro strip and printed antennas have the attractive features of low profile, small size, and conformability to mounting hosts. For this reason, compact, broadband and wideband design technique for planar antennas have been attracted much attention from antenna researchers. Wireless communication includes many applications like Wimax, Bluetooth, GPS, WI-FI, 3G and 4G Technologies etc.

### 1.3 Objective

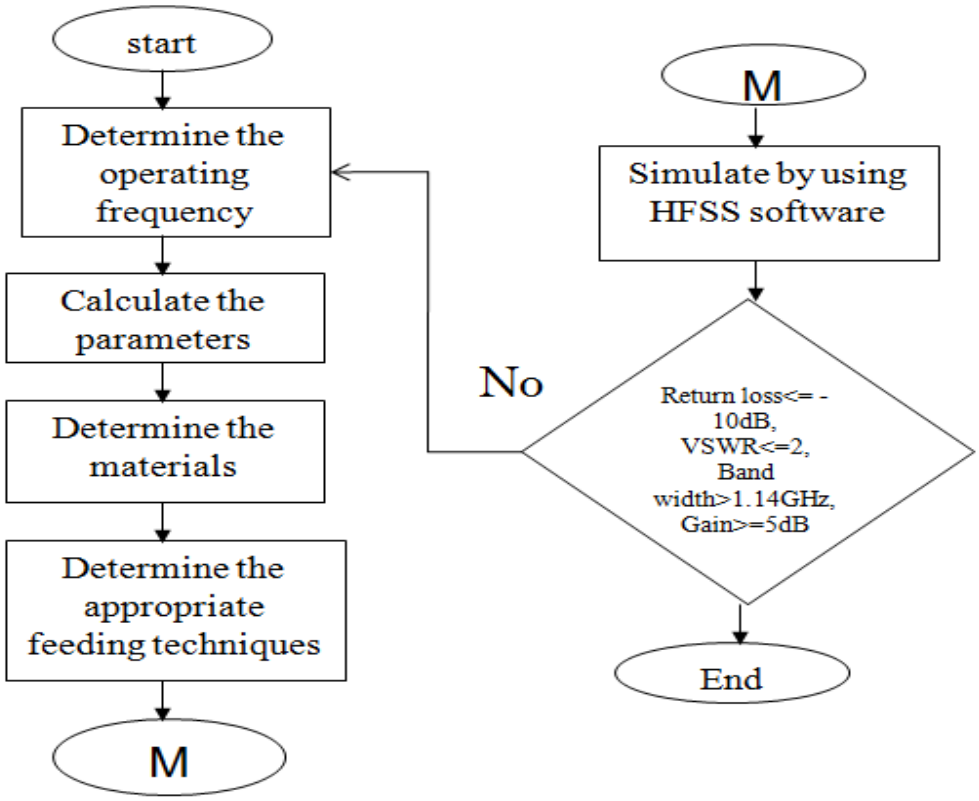
The objective of this project is to design and simulate micro strip patch antenna using High frequency structural simulator (HFSS) and to increase the antenna parameters such as Gain, Bandwidth, Return loss and Efficiency. To meet these requirements the patch antenna is designed at an operating frequency of 3.75GHz. By inserting slot on rectangular patch improves the antenna gain, return loss and antenna efficiency.

## 2. Block Diagram & Technical Specifications

### 2.1 Block Diagram and Working:




### 2.1.1 Flow chart



### 2.1.2. Description:

The summarizations of basic operation for microstrip patch antenna's parameters are discussed as follows. The antenna substrate dielectric constant is given as εr. The εr is primarily affects the bandwidth and radiation efficiency of the antenna. The lower the permittivity will give a wider impedance bandwidth and reduce the surface wave excitation.

The antenna substrate thickness is given as h. The substrate thickness affects bandwidth and coupling level. A thicker substrate results in wider bandwidth, but less coupling for a given aperture size. L is the microstrip patches length. The length of the patch radiator determines the resonant frequency of the antenna. The microstrip patches width is given as w. The width, w of the patch affects the resonant resistance of the antenna, with a wider patch giving a lower resistance.

### 2.2 Technical specifications:

HFSS is a high performance full wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modelling that takes advantage of the familiar Microsoft Windows graphical user interface. It integrates simulation, visualization, solid modelling, and automation in an easy to learn environment where solutions to your 3D EM problems are quickly and accurate obtained. Ansoft HFSS employs the Finite Element Method (FEM), adaptive meshing, and brilliant graphics to give you unparalleled performance and insight to all of your 3D EM problems. Ansoft HFSS can be used to calculate parameters such as S-Parameters, Resonant Frequency, and Fields. Typical uses include

- Package Modelling – BGA, QFP, Flip-Chip
- PCB Board Modelling – Power/ Ground planes, Mesh Grid Grounds, Backplanes
- Silicon/GaAs-Spiral Inductors, Transformers
- EMC/EMI – Mobile Communications – Patches, Dipoles, Horns, Conformal Cell Phone Antennas, Quadrafilar Helix, Specific Absorption Rate ( SAR), Infinite Arrays, Radar Section (RCS), Frequency Selective Surface (FSS)
- Connectors – Coax, SFP/XFP, Backplane, Transitions
- Waveguide – Filters, Resonators, Transitions, Couplers
- Filters – Cavity Filters, Microstrip, Dielectric
- HFSS is an interactive simulation system whose basic mesh element is a tetrahedron. This

allows you to solve any arbitrary 3D geometry, especially those with complex curves and shapes, in a fraction of the time it would take using other techniques.

- The name HFSS stands for High Frequency Structure Simulator. An soft pioneered the use of the Finite Element Method (FEM) for EM simulation by developing / implementing technologies such as tangential vector finite elements, adaptive meshing, and Adaptive Lancozos- pade Sweep (ALPS). Today, HFSS continues to lead the industry with innovations such as Modes to Nodes and Full wave Spice.
- Ansoft HFSS has evolved over a period of years with input from many users and industries. In industry, Ansoft HFSS is the tool of choice for High productivity research, development, and virtual prototyping.
- This chapter includes results regarding the performance of patch antenna and comparison of parameters with U and without U- Shape slot on patch designed at an operating frequency of 3.75 GHz.

## 3 RESULTS:

The below outputs represents the plots of patch antenna without U- slot and coxial feed.

### 3.1.1 S-parameters (S11) Vs Frequency plot:

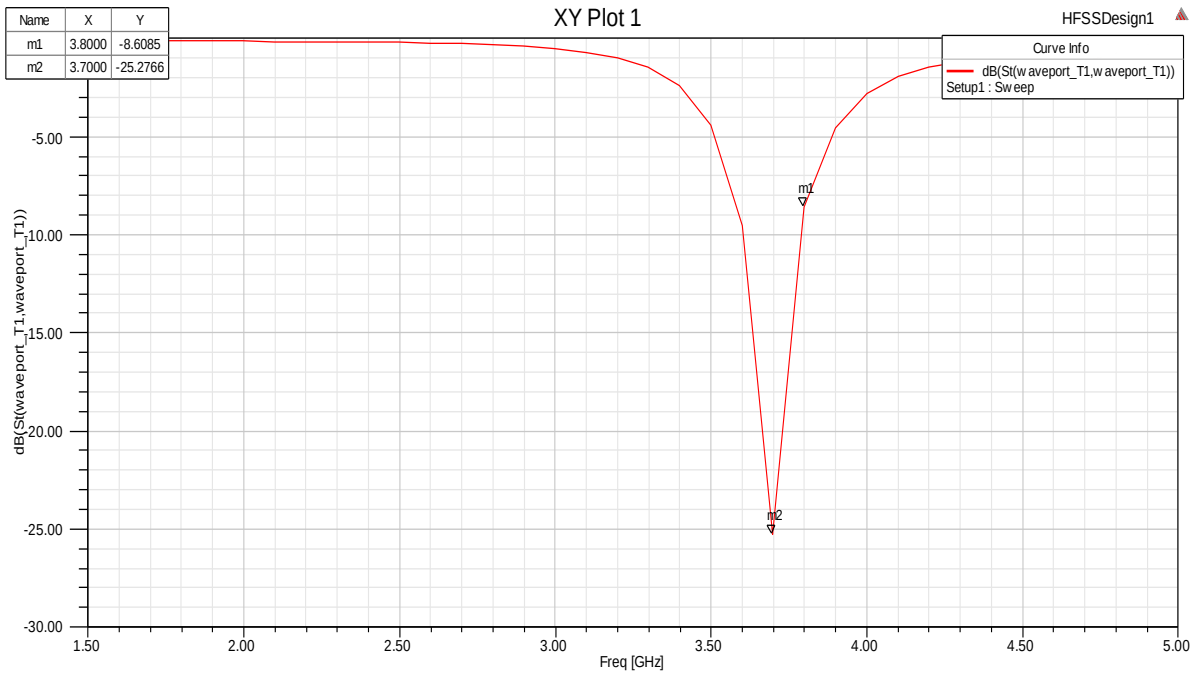



**Figure 3.1 : S-parameters (S11) Vs Frequency plot**

Here the Patch antenna is simulated at operating frequency of 3.75GHz. The S11 value at

-10db is return loss.

**Return loss = -25.2766**

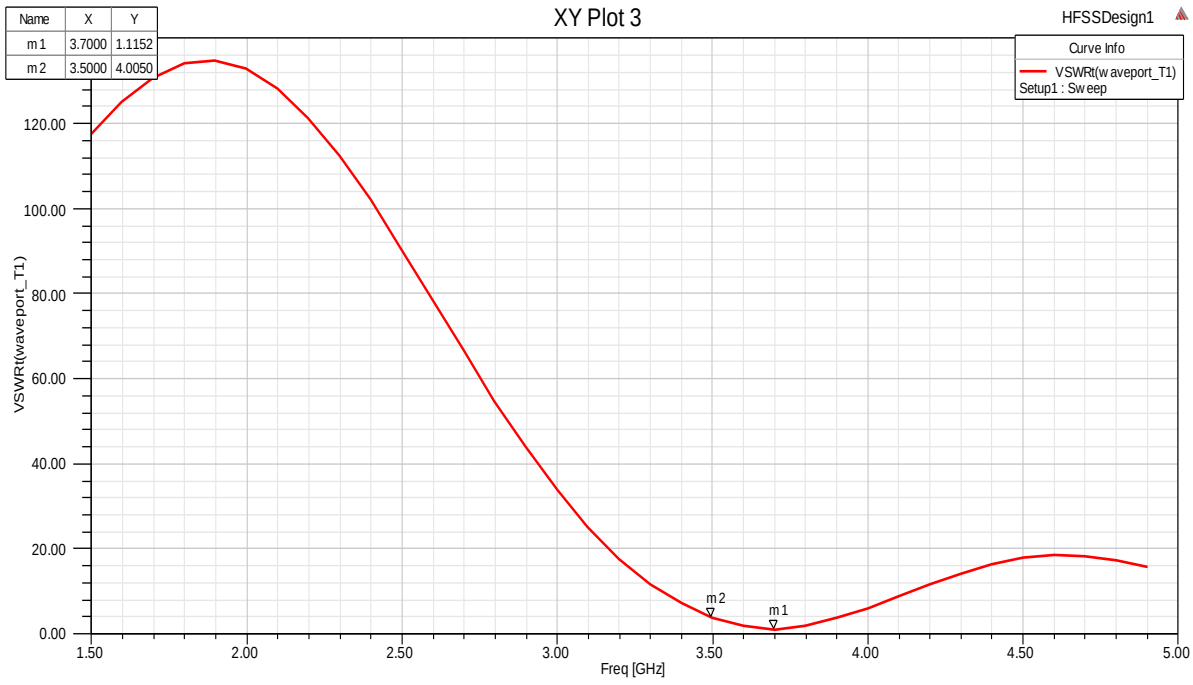
**3.1.2 Bandwidth:**

The difference between upper and lower-cut off frequencies at S11 value -10db from the above graph is taken as bandwidth.

Bandwidth(%) = (3.8 GHz – 3.6 GHz) / 3.75GHz

Impedance Bandwidth **= 5%**

**VSWR Vs Frequency Plot:**



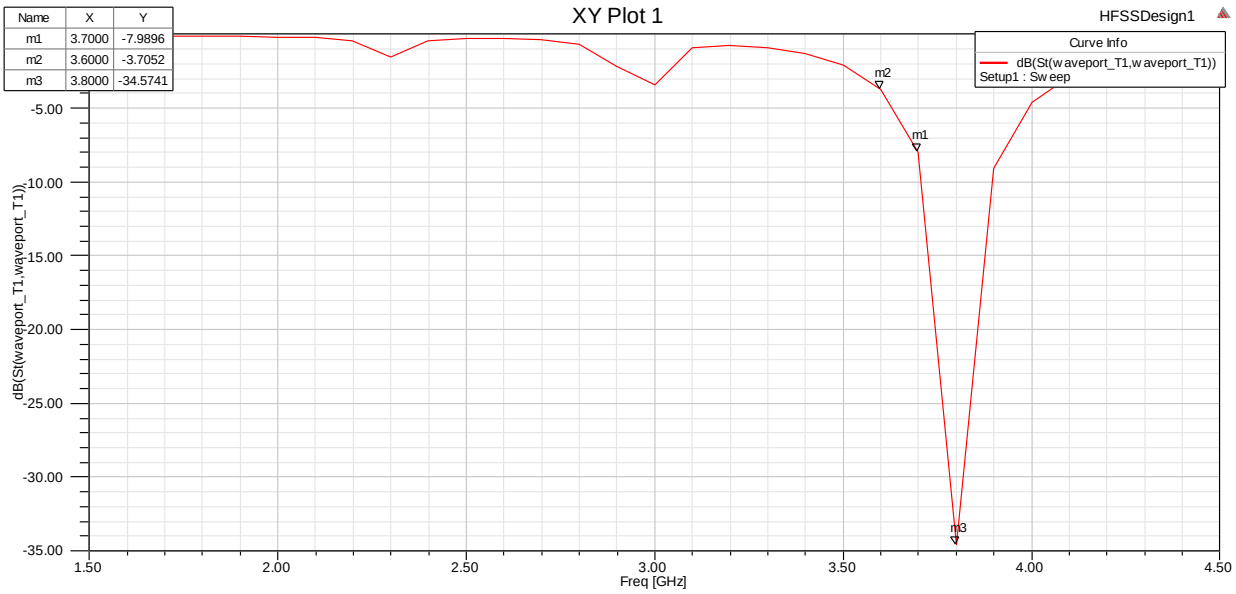

**VSWR Vs Frequency Plot**

VSWR obtained from the above graph is 1.11.

**VSWR = 1.11**

The below outputs represents the plots of patch antenna with U- slot and coxial feed.

**S-parameters (S11) Vs Frequency plot:**




Here the Patch antenna is simulated at operating frequency of 3.75GHz. The S11 value at -10db is return loss.

**Return loss = -34.5741**

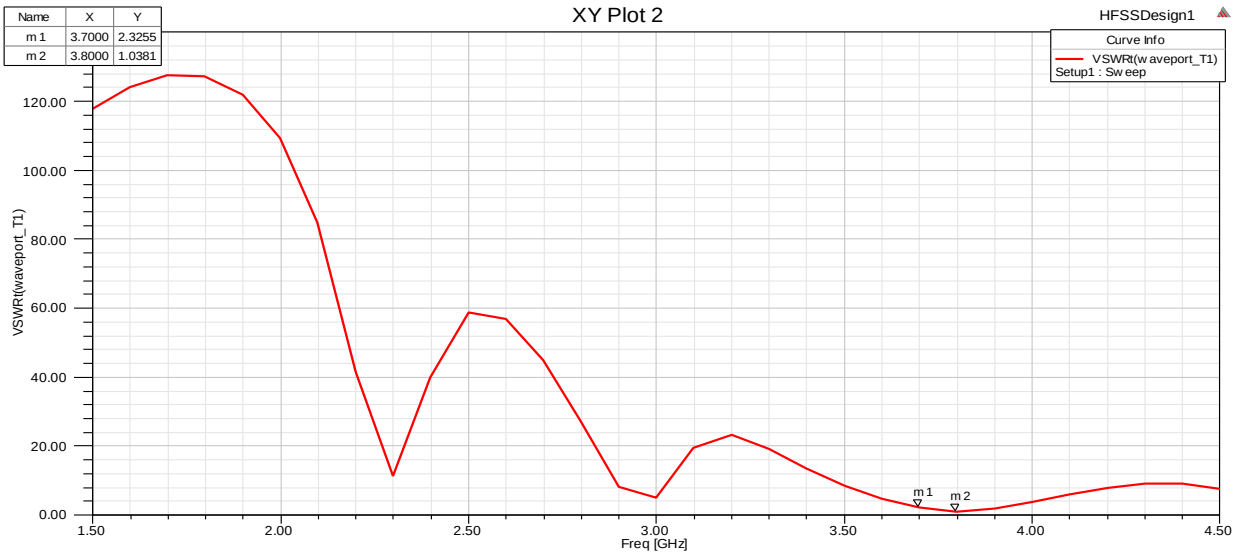
**Bandwidth:**

The difference between upper and lower-cut off frequencies at S11 value -10db from the above graph is taken as bandwidth.

Bandwidth(%) = (3.8 GHz – 3.6 GHz) / 3.75GHz

Impedance Bandwidth **= 5%**

**VSWR Vs Frequency Plot:**




**VSWR Vs Frequency Plot**

VSWR obtained from the above graph is 1.0381.

**VSWR = 1.0381**

**Comparison of Output Parameters at Different Frequencies for 3.75 GHz**

| DIFFERENT TYPES OF ANTENNAS | WITHOUT INSERTING SLOT | WITH U-SLOT | WITH E-SLOT | WITH S-SLOT |
|---|---|---|---|---|
| RETURN LOSS (dB) | -25.276 | -34.57 | -21.379 | -20.625 |
| BAND-WIDTH (MHz) | 100 | 100 | 200 | 250 |
| VSWR | 1.1152 | 1.03 | 1.33 | 1.2 |

# 4. Conclusion

## 4.0. Conclusion

In this project we designed patch antenna operating at 3.75 GHz and compared the results for different slots. We can say that there are many aspects that affect the performance of the antenna such as dimensions, selection of the substrate, feed technique and also the Operating frequency can take their position in effecting the performance. After simulation ,the obtained results are bandwidth 4% and gain as 4.8 db.Therefore, we conclude that the design with U-Shape slot provides more bandwidth and gain compared to other slot results.