ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
*Vol. 2, Issue 6, June 2013*

# Bandwidth Enhancement of a Microstrip Line-Fed Rotated Slot Antenna with a Parasitic Center Patch

**Shilpa Verma[1], Shalini Shah[2], Paurush Bhulania[3]**

PG student, Department of Electronics & Communication, Amity School of Engg & Technology, Noida, India[1]

Assistant Professor, Department of Electronics & Communication, Amity University, Noida, India[2,3]

**Abstract**: With day to day advancement wireless and communication industry, a single device needs to operate at multi frequency and enormous high bandwidth. Microstrip antenna is only to fit in this. A small rotated square slot antenna with a parasitic patch for bandwidth enhancement is proposed and investigated. A simple 50- microstrip line is used to excite the slot. A rotated square slot resonator with center parasitic patch is considered as reference geometry. The rotated square slot antenna exhibits two resonances .By embedding a parasitic patch into the center of the rotated square slot, the lower resonant frequency is decreased and the higher resonant frequency is increased. Thus, broadband characteristic of the wide-slot antenna is achieved. The measured results demonstrate that this structure exhibits a wide impedance bandwidth, which is over 85% for dB ranging from 2.19 to 5.95 GHz. Also, a stable and Omni directional radiation pattern is observed within the operating bandwidth. In this design, a smaller ground plane is considered compared to the reference antenna (rotated square slot antenna with the parasitic center patch). The proposed antenna has a strong application in UWB and WiMax devices. The IEEE 802.16 working group has been established a new operating band name as Worldwide Interoperability for Microwave access (WiMax). WiMax has three allocated frequency bands. The low band (2.5-2.69 GHz), the middle band (3.2-3.8 GHz) and the upper band (5.2-5.8 GHz).

**Index Terms:** Bandwidth Enhancement, parasitic patch, CPW feed, UWB, WiMax antenna, slot antenna.

## I. INTRODUCTION

Numerous multiband and wideband antennas have been developed [1]–[2] in response to the recent demand for wireless communication systems. Ultra wideband (UWB) systems are attracting more and more attentions in a wide range of applications, including ground penetrating radars, high data rate short range wireless local area networks and communication systems for military purposes etc., due to their fine spatial resolution, extraction of target feature characteristics, and low probability of interception and non-interfering signal waveform . The UWB channel model is developed by the IEEE 802.15.3a . A February 14, 2002 FCC Report and Order authorized the unlicensed use of UWB in the frequency range from 3.1 to 10.6 GHz. As an important component of the UWB system, the UWB antenna with simple structure, wide impedance bandwidth (BW), linear phase delay, stable radiation patterns, and constant gain in desired directions is required for the smallest degradation of the radiated pulses.

This paper uses the structure proposed in [5] as a reference antenna. In this paper, we present a compact microstrip line-fed printed small square rotated slot antenna with a parasitic center patch for bandwidth enhancement, and radiation characteristics of such a design are also investigated. A detailed simulation is conducted to understand its behavior and optimize for broadband operation. From the simulated results, the obtained impedance bandwidth (determined from 10-dB reflection coefficient) of the proposed antenna can operate from 2.225 to 5.355 GHz covering the 2.4/5.2/5.8-GHzWLAN bands and 2.5/3.5/5.5-GHz WiMAX bands.

In this case, the total area (including ground plane) of the proposed antenna total area is 37x 33.5 mm2
mm . It has a size reduction of about 11%, as compared to the designed antenna in [5].

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
*Vol. 2, Issue 6, June 2013*

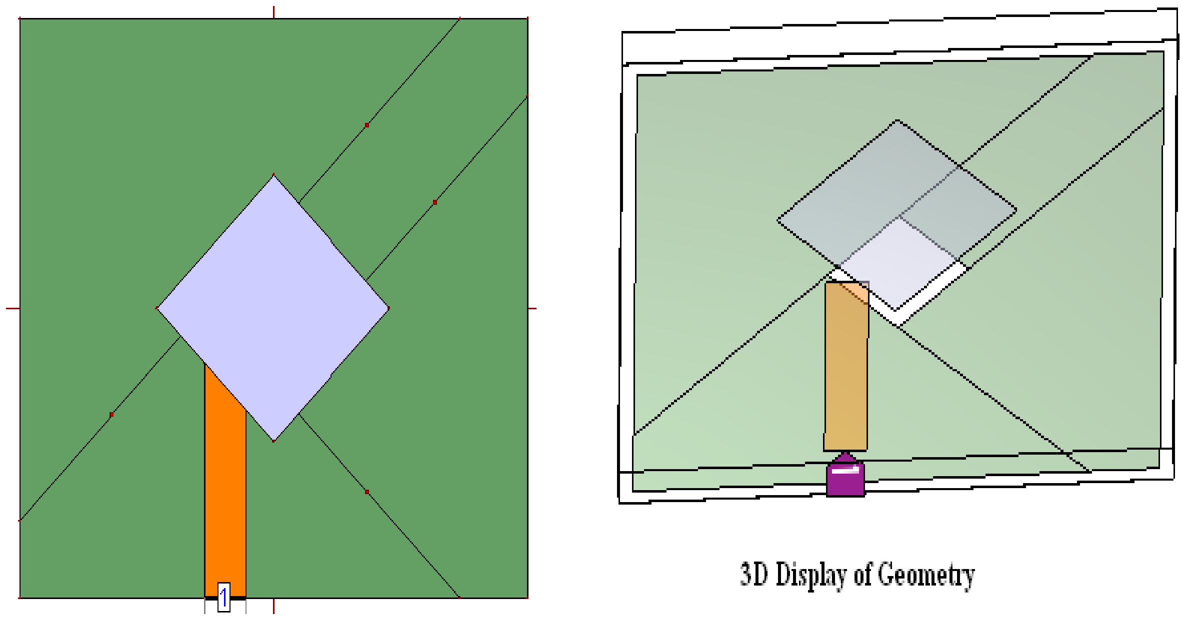


Fig.1. Geometry and dimensions of line-fed printed square antenna with a rotated slot

## II. ANTENNA CONFIGURATION

Fig. 1 shows the geometry and dimensions of the proposed microstrip-line-fed wide-slot antenna. The printed wide slot is chosen to be a square in order to excite two modes with close resonant frequencies. For exciting the operating frequencies at around 4.5 GHz, this printed square slot rotated with an angle has dimensions of 7 x 7 $mm^2$ and is printed on an FR4 substrate of thickness 1.6 mm and $\epsilon_r = 4.4$.

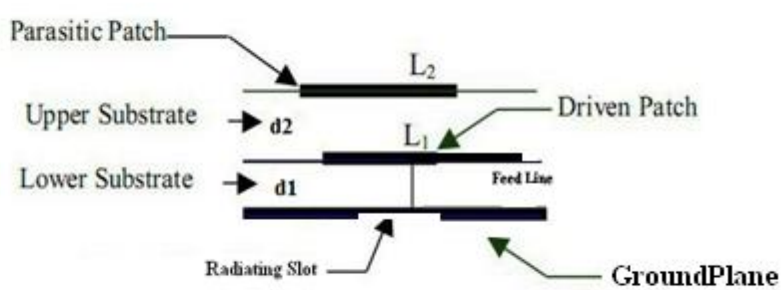


Fig.2. Layered Architecture of Proposed geometry

The ground plane is also chosen to be square with a dimensions 37 x 33.5 mm2. In this geometry to enhance the bandwidth we use a parasitic patch and its height is optimized to 2.9 mm.This square slot is fed by a 50- microstrip line with a simple tuning stub having a straight length of L mm, which is printed on the opposite side of the microwave substrate. For design simplicity, the width of the tuning stub is chosen to be the same as that of the 50 ohm microstrip line. Simulated results show that square slot antennas with various rotated angles need different tuning-stub length (L in Fig. 1) to be matched. The correct values can be optimized by observing the reflection coefficient of the antenna.

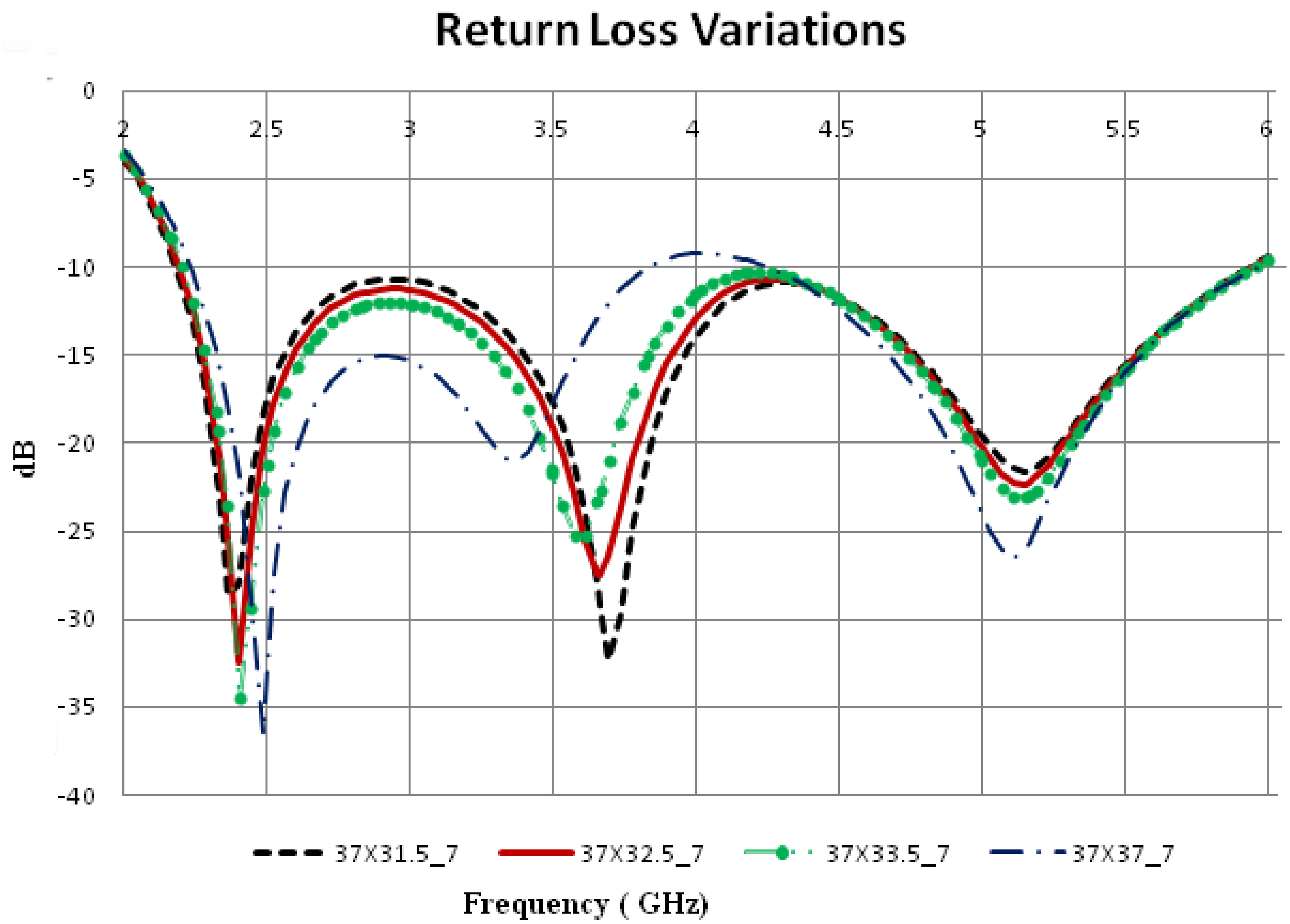


Fig.3. Return Loss of Proposed Geometry with β=45° and L=15

## III. PARAMETER STUDY

### *A. Impedance Characteristics of the Proposed Antenna*

The proposed microstrip-line-fed square slot has been constructed and studied on IE3D, an electromagnetic simulation tool by Zealand.. By varying the parameters of β and L in Fig. 1, the measured return loss results of several design examples are shown in Fig. 3. This paper uses the structure proposed in [5]-[6] as a reference antenna.

It is observed that the reflection coefficient of antenna has a promising result at ground plane dimensions of 37x33.5mm$^2$. It is further improved if ground dimensions are reduced in width till 31.5. It is also investigated that with increase in the rotated square slot dimensions the -10 dB bandwidth is improved but it has good results for 7mm slot.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
*Vol. 2, Issue 6, June 2013*

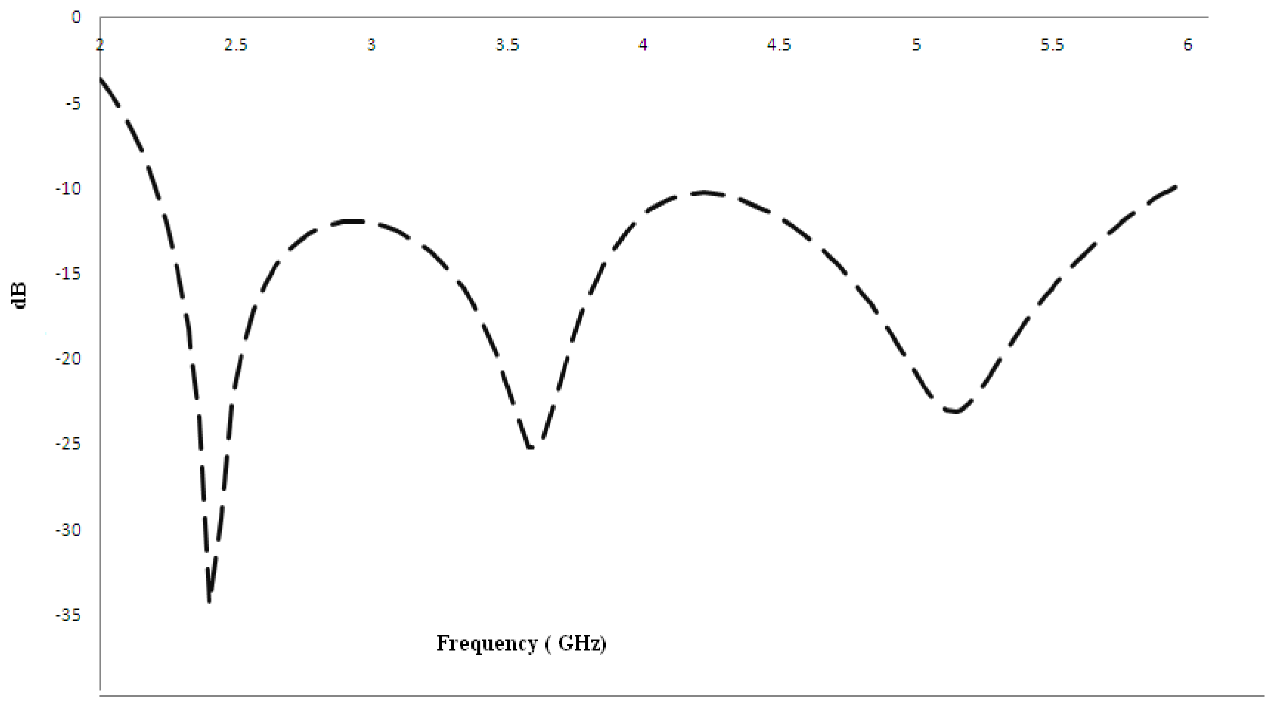


Fig.4. Reflection coefficient of the proposed antenna

### *B. Radiation Characteristics of the Proposed Antenna*

The proposed antenna with various parameters of β and L shows the same radiation characteristics, and thus only those of the proposed antenna with β =45 and L =15 mm are plotted by E- and H-planes here. Fig.4. show typical measured radiation patterns of this antenna at the operating frequencies 2500, 3250, 4500, 5800 MHz respectively. Note that a printed antenna without a reflecting plate is a bi-directional radiator, so the radiation patterns on both sides of this antenna are similar. From these results, it can be seen that the operating frequencies across the impedance bandwidth of this antenna within 2190–5950 MHz have same polarization planes and similar broadside radiation patterns. From the obtained results, it can be seen that the proposed antenna with β = 45 and L =15 mm has an large impedance bandwidth.

### *C. Gain Characteristics of the Proposed Antenna*

A wide-band antenna can usually provide larger operating impedance bandwidth than other types. For example, the proposed printed wide-slot antenna with β=45 and L =15 mm in Fig. 1 has an impedance bandwidth as large as 2760 MHz. In this paper several geometries are investigated which results are shown in figure 5. From simulated result it is concluded that the ground dimension 37x33.5 mm2 have the highest values at respective frequencies.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
*Vol. 2, Issue 6, June 2013*

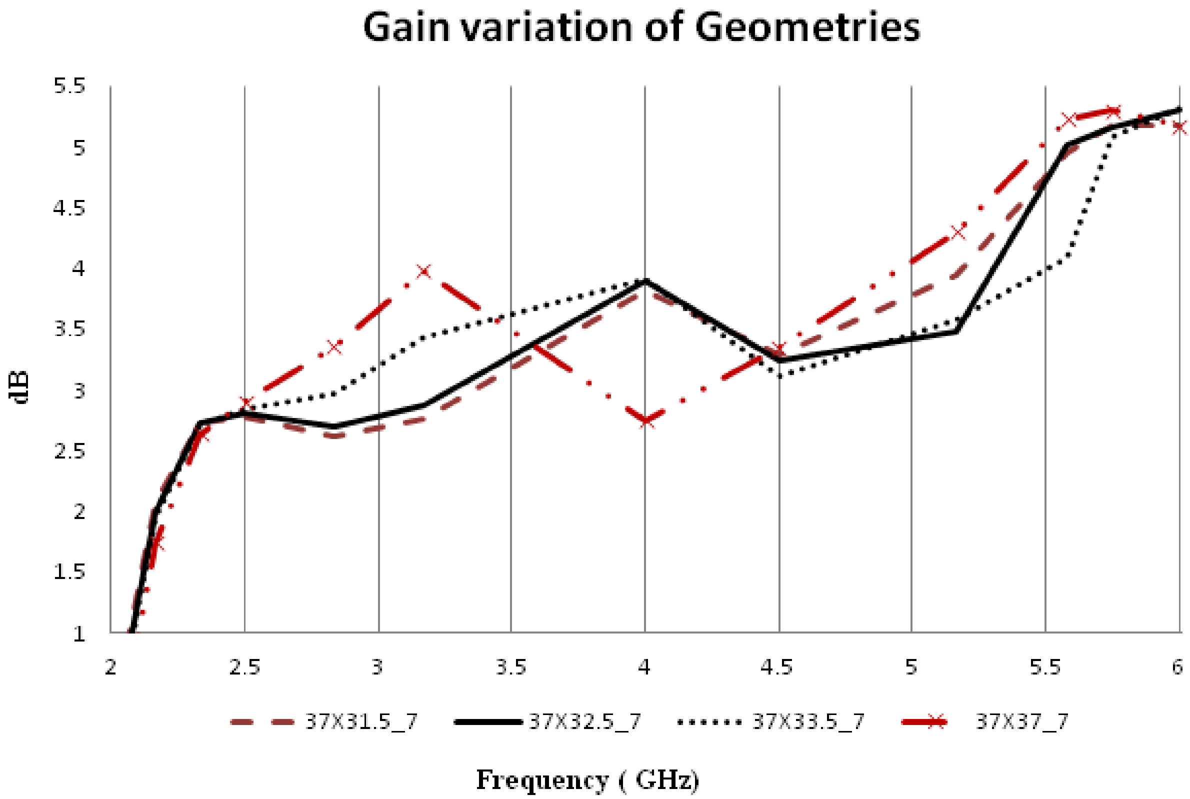


Fig.5. Gain Variation at different frequencies

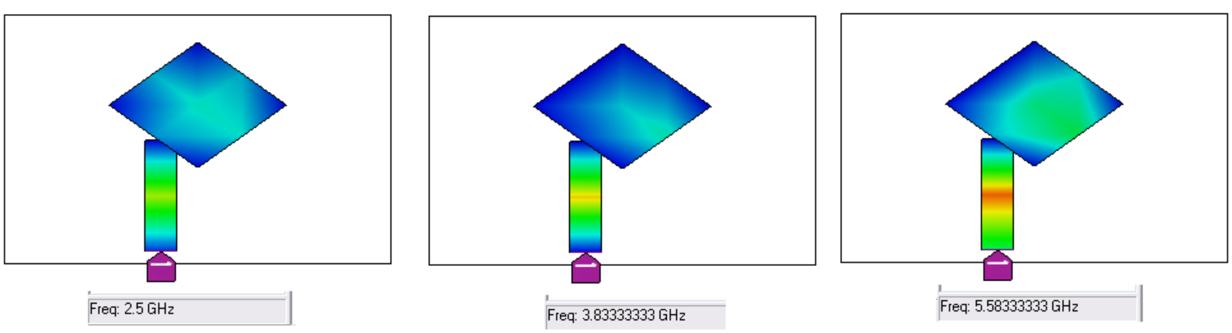


Fig.6. Current distribution over Patch

When we decreases the size of ground the gain is also starts decreasing. For the `frequency range 2.19 to 5.95 GHz the it is also noted that the VSWR is lies between 1 to 2.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
*Vol. 2, Issue 6, June 2013*

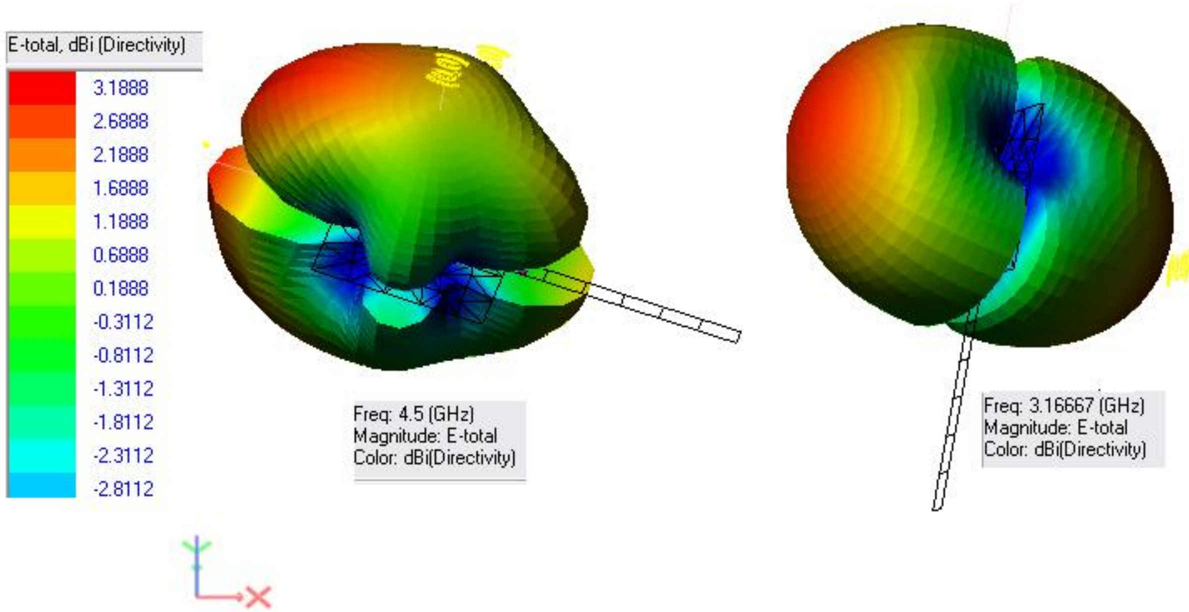


Fig.6. 3D Pattern View of Radiating Patch

## IV. CONCLUSION

A square small size rotated slot antenna, fed by a 50- microstrip line with a rotated square wide parasitic patch for bandwidth enhancement has been investigated. Multiple design examples have also been implemented to get the optimized geometry. Analyzed results show that the impedance bandwidth of a proposed antenna can be improved by rotating a suitable angle of the square slot and shifting the feed line from its central position. For the optimized antenna parameters β =450 and L =15mm in this study, the impedance bandwidth determined by 10 dB return loss can reach nearly 2.19 GHz for the proposed antenna with designed operating frequencies around 4.5 GHz, at optimized ground of 37x33.5 mm2.. The proposed antenna has a size reduction of 11% to its reference goemetry.Within this wide impedance bandwidth gain is greater than 2 dBi. The proposed antenna has a strong application in UWB and WiMax devices.

## REFERENCES

[1]. C.A. Ballanis, "*Antenna Theory* : *A Review*", 2nd Edition Willy publication
[2]. FCC News release, "*New public safety applications and broadband internet access among uses envisioned by FCC authorization of ultra wideband technology"*. FCC 02-48, Feb. 14,2002.
[3]. K.L.Wong, "*Compact and Broadband Microstrip Antennas*" New York: Wiley, 2002.
[4]. M.Kahrizi, T.K.Sarkar,andZ.A.Maricevic, "*Analysis of a wide radiating slot in the ground plane of a microstrip line*," IEEE Trans. Antennas Propag., vol. 41, no. 1, pp. 29–37, Jan. 1993.
[5]. S.-W.Qu,J.-LLi,J.-X.Chen,andQ.Xue, *"Ultra wideband strip-loaded circular slot antenna with improved radiation patterns,"* IEEE Trans. Antennas Propag.,vol.55,no.11,pp. 3348–3353, Nov.2007.
[6]. Y.Sung, " *Bandwidth enhancement of a microstrip Line-fed Printed Wide-slot Antenna with a centre parasitic patch*", IEEE Transactions On Antennas And Propagation, Vol. 60, No. 4, April 2012
[7]. J. Y. Sze and K. L. Wong, *"Bandwidth enhancement of a microstrip line-fed printed wide-slot antenna,"* IEEE Trans. Antennas Propag.,vol. 49, no. 7, pp. 1020–1024, Jul. 2001.
[8]. T.Dissanayakeand, K.P.Esselle," *UWB performance of compact L-shaped wide slot antennas,"* IEEE Trans. Antennas Propag., vol. 56,no. 4, pp. 1183–1187, Apr. 2008.
[9]. Jen-Yea Jan and Jia-Wei Su, "*Bandwidth enhancement of a Printed Wide slot Antenna with Rotated Slot*". IEEE Transactions On Antennas And Propagation, Vol. 60, No. 4, 2005.
[10]. Kamya Yekeh Yazdandoost, Kiyoshi *Hamaguchi "Very Small UWB Antenna For Wban Applications*", IEEE 2011