Rectangular Ring Microstrip Patch Antenna for Wimax Applications

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Abstract -- Radio antenna which is also known as patch or printed antenna is one of the best antenna structures, because of its low cost, compact design and low profile. In this paper, we are going to present a new approach in order to improve the radiation effectiveness and the performance of the antennas. It is mainly applicable at microwave frequencies, where wavelengths are very short so that the patches are small. It is extensively used in portable wireless devices. We designed different shapes of micro strip patch antennas by using CST (Computer Simulation Technology).The summary and results of the design are shown and discussed in paper.

Key Words: Microstrip Patch Antenna, Planar, Broadband, Ultra wide Band.

I. INTRODUCTION

Antenna is which is simply a transducer used for converting radio frequency (RF) fields into alternating current (AC) and vice-versa. The two basic types of antenna are transmitting antenna and receiving antenna. In other words, antenna acts as a medium between guiding device and free space. Antennas are essential devices in all types of communication and radar systems. Without an antenna there is no communication. Recently, wireless communication systems have known a great development because the Federal Communications Commission (FCC) in 2002 has certified the use of ultra wide-band (UWB) devices that operate in the 3.1-10.6 GHz frequency range. Many developments have been taken place in the UWB communication systems have generated scope in the field of research activity which is purely dedicated to antenna bandwidth. The transmitting antenna is a device which takes input i.e., electromagnetic energy from the transmitting line or waveguide and then transmits into free space. In receiving mode, antenna takes those electromagnetic waves and converts them back into signals. Various kinds of planar broadband antennas have been studied and reported for UWB applications. The microwave communication and radar systems do not exist without one type of antenna or the other. The size of the antenna mainly depends on the frequency of operation. If the frequency is low, the size of the antenna becomes large and vice-versa. Many of them have large radiation patch connected with the micro strip-fed line.

In the world of communication systems wireless technology is one of the major areas for researchers. Without an antenna, communication is not possible. The study of communication is incomplete without the proper understanding of antenna design. A printed Ultra Wideband (UWB) antenna has been designed and analyzed in detail. The experimental results that are obtained should be checked theoretically. Hence the proposed antenna will be used for wireless applications.

There are several techniques for designing of different shaped slots on the micro strip. Antenna patches and also designed using parasitic elements of various geometries or by fractal geometry of an antenna. Simple and commonly used approach is to incorporate slots or parasitic strips into the antennas. In this paper, a simple and compact micro strip inset-feed planar UWB antenna characteristic at 3.1 GHz and 5.5 GHz is proposed. The antennas that we designed show some properties for WiMAX (3.3-3.7GHz) and WLAN (5-6 GHz). The appropriate efficiency and stable radiation

patterns are obtained. Moreover, the simulated results have a good agreement with our requirements.

In this paper, we designed a rectangular patch composed of a circular shaped patch or a rectangular shaped patch which is fed with a proper impedance feeder. Due to its small size and simple structure it is made very easy for manufacturing. The main advantage is it can be used for a wide range of applications. We design this sort of antenna by using CST microwave studio software.

II. ANTENNA CONFIGURATION

Antennas play a vital role in any of the wireless communication system. In the design of any antenna system, the most important design parameters are usually the number of elements, excitation, half power beam width, and directivity and side lobe level. In a design procedure some of these parameters are specified and the others are then determined.

The parameters that are specified and those that are determined vary among designs.

Substrate type - FR4 Substrate thickness (h) =1.6 mm, (0.003λ0 ≤ h ≤ 0.05 λ0), Dielectric constant (2.2≤Ɛr ≤12), Where λ0 is free- space wavelength, Patch thickness t << λ0,

In order to design a micro strip patch antenna the following parameters are required.

Length of the patch is λ0 /3 < L < λ0 /2, As, L / h >> 1

and

The electric field lines mostly focuses in the substrate.

A. Rectangular Patch Antenna Formulae

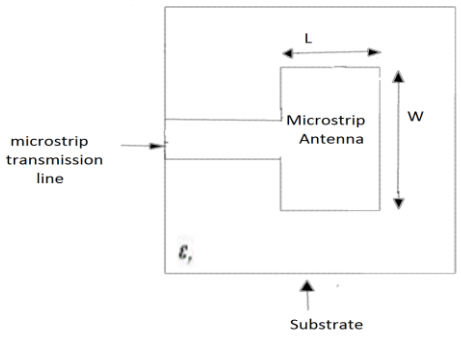

Fig -1: Rectangular patch antenna

$$Width = W = \frac{c}{2f_r\sqrt{\frac{\varepsilon_R+1}{2}}}$$

$$\varepsilon_{eff} = \frac{\varepsilon_R+1}{2} + \frac{\varepsilon_R-1}{2}\left[\frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}}\right]$$

$$Length = L = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}} - 0.824h\frac{\left(\varepsilon_{eff}+0.3\right)\left(\frac{W}{h}+0.264\right)}{\left(\varepsilon_{eff}-0.258\right)\left(\frac{W}{h}+0.8\right)}$$

2.2 Design Procedure for Circular Patch

Radius of the circular Patch is

$$a = \frac{F}{\left\{1+\frac{2h}{\pi\varepsilon F}\left[\ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\right\}^{1/2}} = 5.77mm$$

$$F = \frac{8.791}{f_r\sqrt{\varepsilon_r}}$$

Where = 0.6189

f_r in GHz , h in cm

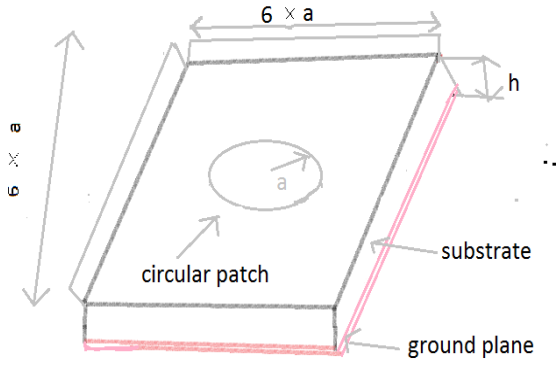

Fig -2: Circular patch

III. GUIDELINES

The following flow chart Fig -3 shows the design flow of micro strip patch antenna at 3.1 GHz. We can follow this design procedure for any type of frequency for which the antenna works.

IV. SOFTWARE USED

The software we used is Computer Simulation Technology (CST).In brief, CST is nothing but a software package which simulates and solves the electromagnetic problems from low frequency to microwave as well as optical. CST offers error free, precise, efficient estimated solutions for electromagnetic design and detailed evaluation. CST studio suite is widely used in various fields .many new designs are evolved within the use of CST software. It is extensively used in top leading industries, researchers, engineers, defense, and designers. CST is not only used in industries but also in the field of medicine like health care. CST is extremely used for both general purpose and specialized solvers for electromagnetic and multi physics problems in one user friendly interface. Many new features and improvements have been done to calculate Maxwell's equations for better results and related problems have been solved. We, not only design micro strip patch antenna but also various antenna prototypes have been simulated using microwave studio suite.

V. ANTENNA DESIGNS

In antenna design the important material is substrate which decides the bandwidth of an antenna. It causes miniaturization as well as broad banding the antenna. The antenna which we used is a rectangular patch microstrip patch antenna. The substrate we used here is FR-4(lossy).FR abbreviates as flame retardant. Due to its properties it is widely used in printed circuit boards.FR-4 material is a lossy substrate which is very cheap and easily available. The substrate comprises of length =30 mm and width= 20 mm. The relative permittivity of 4.4 and thickness of 1.6 mm. The proposed antenna is resonating at a particular frequency with a bandwidth of operation below -10dB.

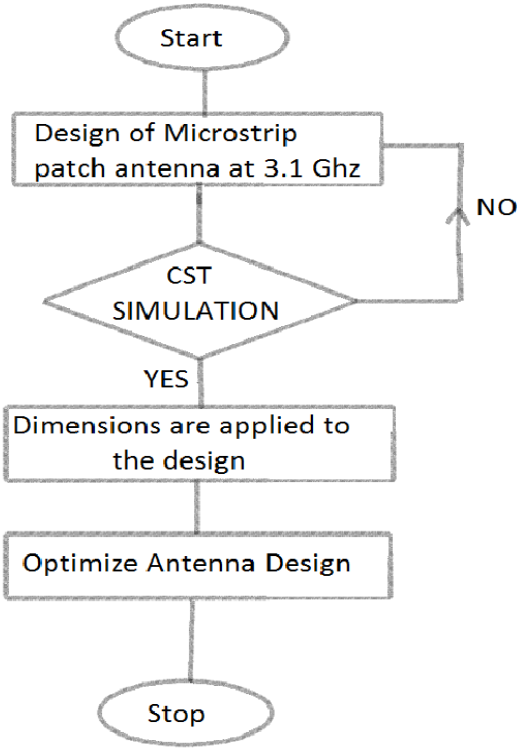

Fig -3: Flow Chart of Microstrip Patch Antenna

ANTENNA PROTOTYPES:

S.NO	PARAMETER	LENGTH(in mm)
1	Ls	30
2	Ws	20
3	Lg	10
4	Wg	20
5	Wp	2.9
6	Lp	12

The above table corresponds to length and width of the proposed antenna types.

Where Ls=length of the substrate
Ws=width of the substrate
Lg=length of the ground
Wg=width of the ground
Lp=length of the patch
Wp=width of the patch

VI. RESULTS

6.1 SIMULATED RESULTS

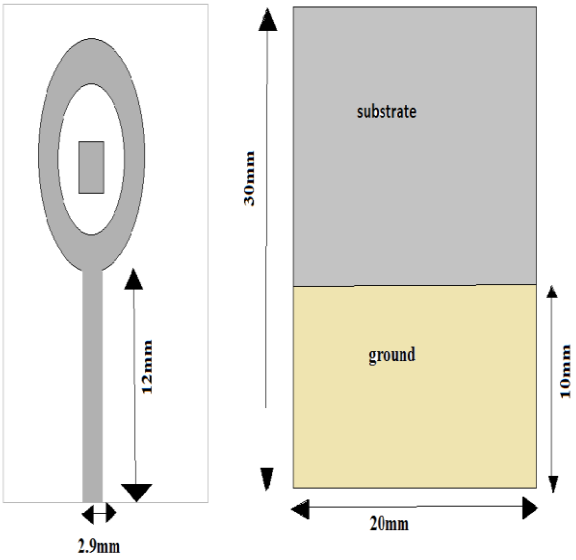

Fig -4: Antenna Prototype 1

Radius of inner circle=5mm
Radius of outer circle=8mm

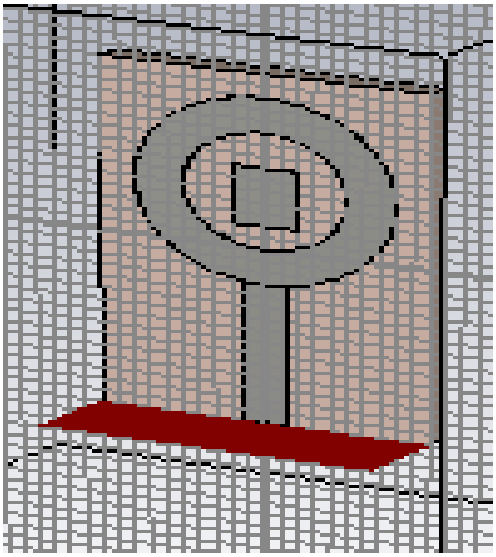

Fig -5: Proposed antenna shape 1

The simulated results of the proposed antenna ideally working at 3.36 GHz.

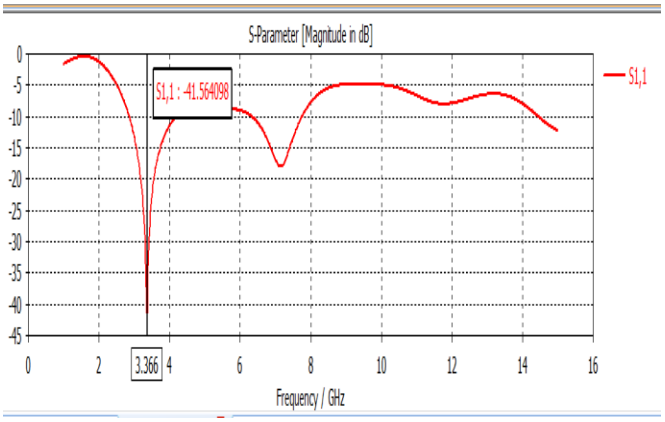

Fig -6: S-parameter of the proposed antenna 1

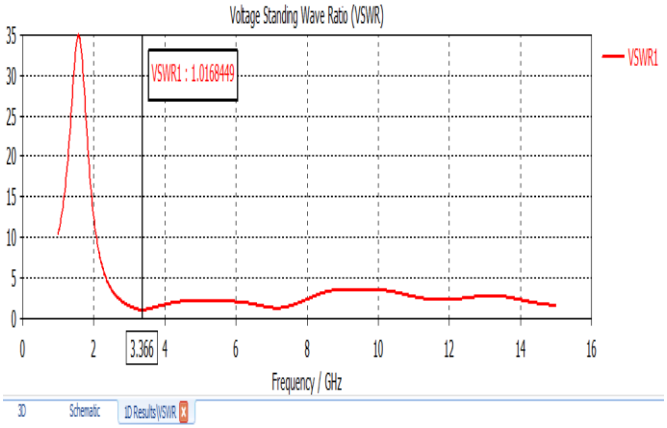

Fig -7: VSWR of the proposed antenna 1

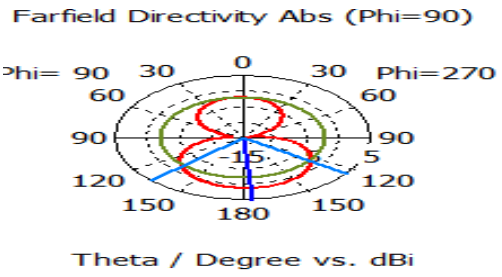

Fig -8: Far field radiation pattern

Return loss of the antenna 1(S11) =-41.56dB
VoltageWaveStandingRatio(VSWR) of antenna1=1.0

It is designed and optimized using CST Microwave studio finally, the proposed antenna is operating at a frequency which comes under the range of ultrawide

band. Simulation results show the acceptance radiation and are almost unidirectional over the entire bandwidth with a significant gain.

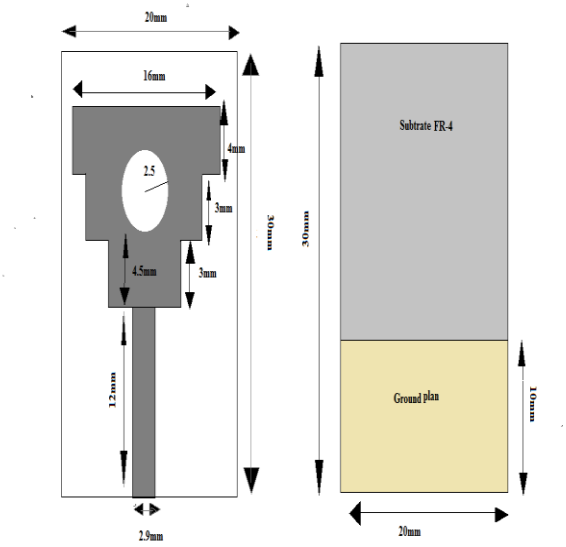

Fig -9: Antenna protype 2

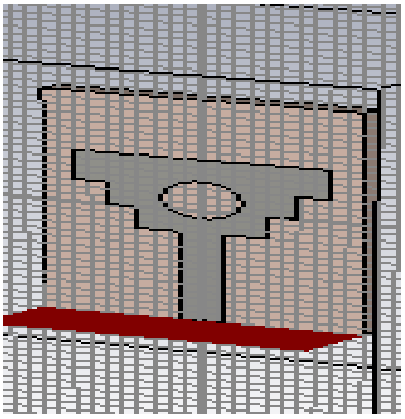

Fig -10: Proposed antenna shape 2

Radius of circle ==2.5mm

6.2 SIMULATED RESULTS

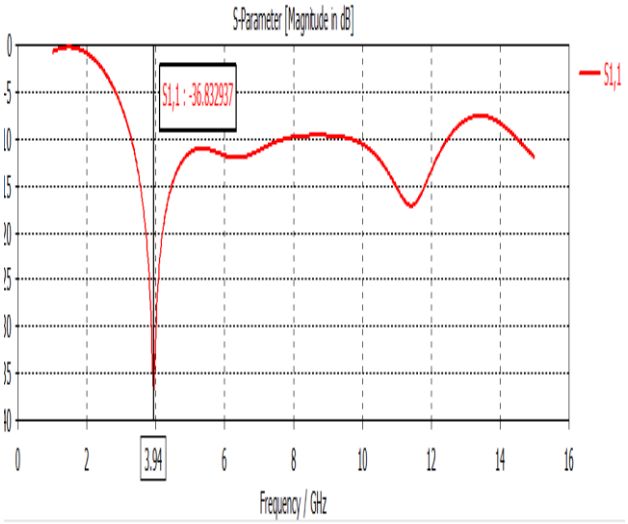

Fig -11: S parameter of proposed antenna 2

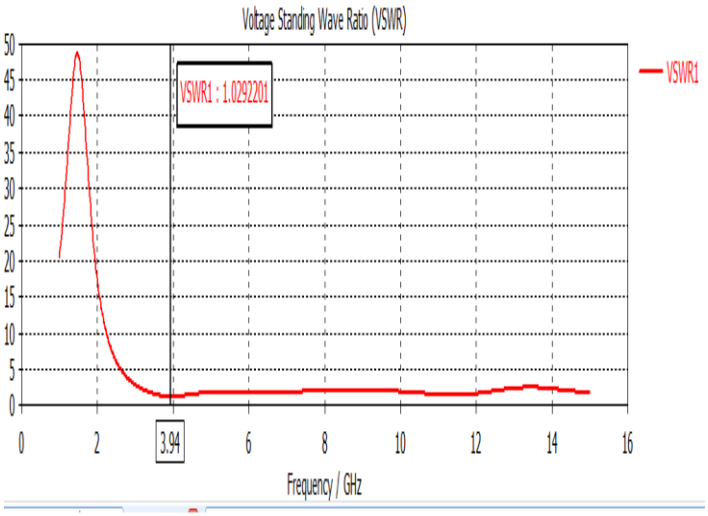

Fig -11: VSWR of the proposed antenna 2

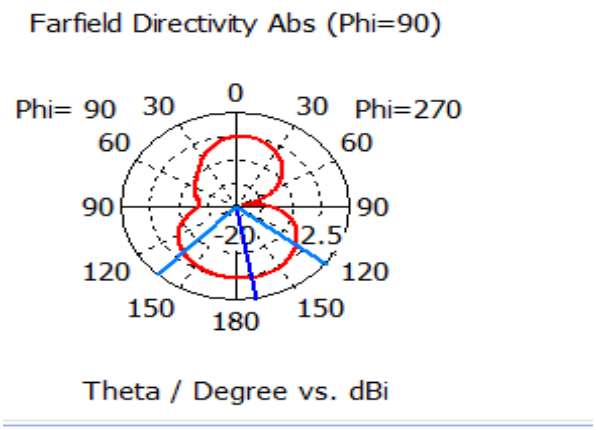

Fig -12: Far Field Radiation Pattern

Return loss of the antenna 1(S11) =-36.83dB
VoltageWaveStandingRatio(VSWR) of antenna2=1.0

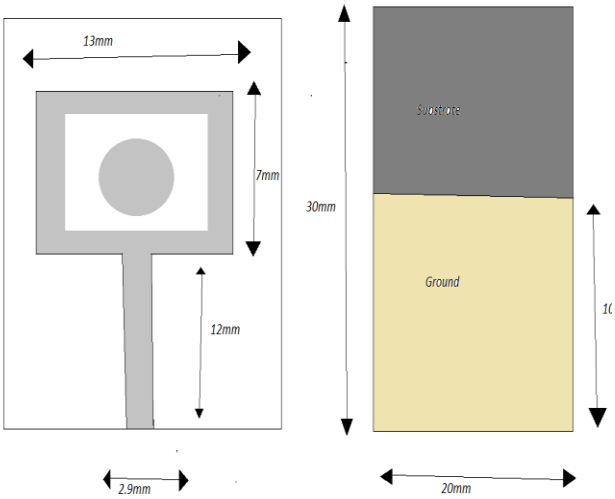

Fig -13: Antenna prototype 3

Radius of circle=2.5mm

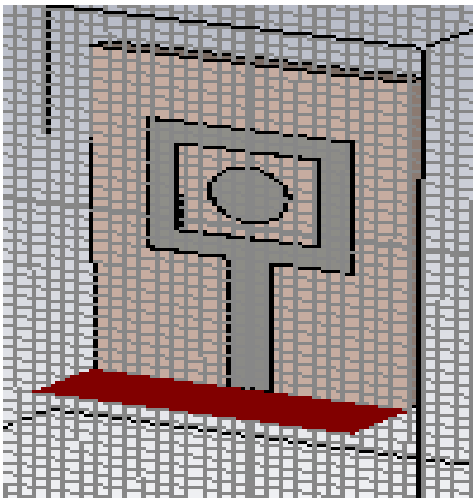

Fig -14: Proposed antenna 3

6.3 SIMULATED RESULTS

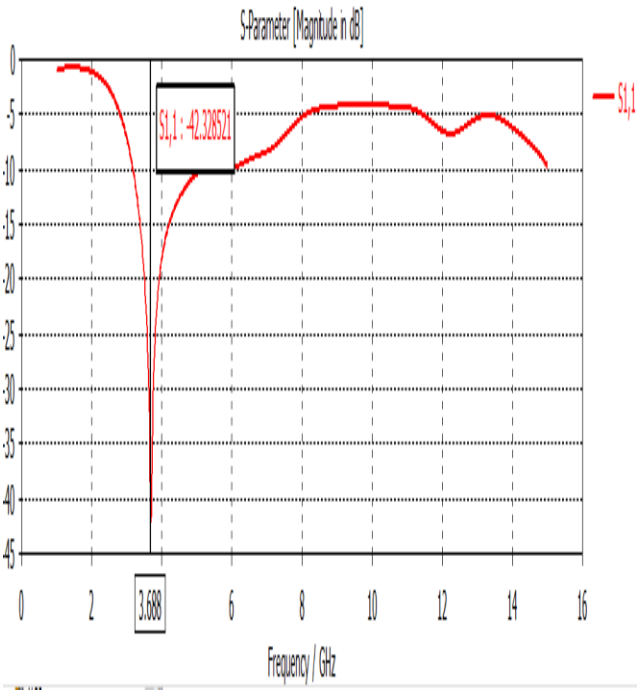

Fig -15: S-Parameters of proposed antenna 3

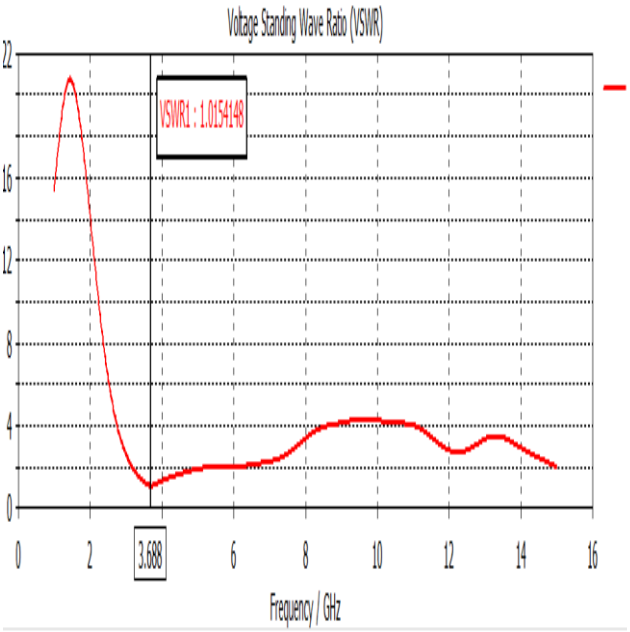

Fig -16: VSWR of proposed antenna 3

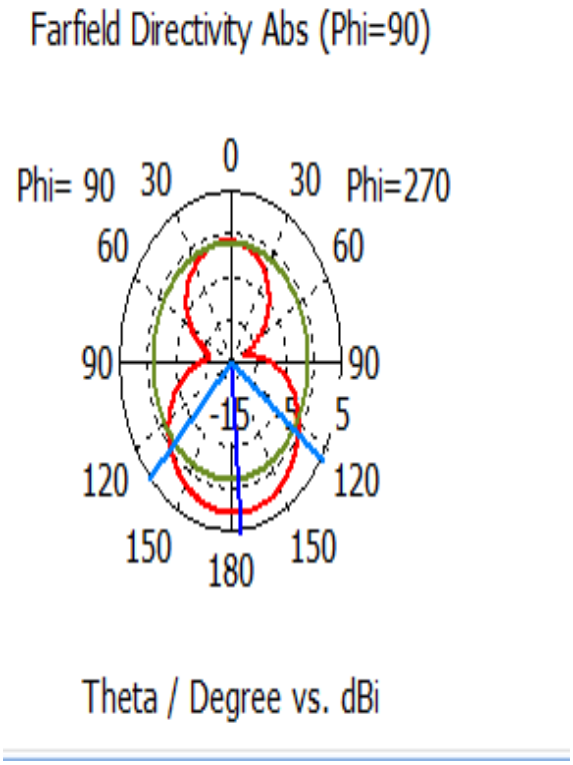

Fig -17: Far Field Radiation Pattern

Return loss of the antenna 1(S11) =-42.32dB
VoltageWaveStandingRatio(VSWR) of antenna3=1.0

VII. CONCLUSIONS

The proposed antenna types work near 4GHz which comes under WIMAX applications. WIMAX is nothing but Worldwide Interoperability for Microwave Access. We can use for mobile broad band connectivity across various cities and countries. We designed all the above antennas by using CST (Computer Simulation Technology) software.

The patch antenna has been proposed and explained in detail. By carefully adjusting the widths and lengths of the slots. The centre frequencies and bandwidths are controllable. This feature is suitable for an antenna. Therefore, the suggested antenna is ideally tuned for a particular frequency and is used for a wide range of applications. The antennas proposed are most commonly used for modern wireless communication systems.

FUTURE SCOPE

These types of antennas can be used in wide range. Applications are many. We designed antennas which operate at around 4 GHz. These antennas can be used for long distance communications as in Satellites, Radar systems.

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