A Frequency Reconfigurable Monopole Antenna Using for portable devices

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ABSTRACT

With the rapid advancement in wireless communication technologies, the demand for multi-band mobile devices is increasing. For example, the current wireless transceivers have to support various communication protocols such as LTE, WiMAX and WLAN simultaneously. Each of these technologies operates at a different frequency band. Therefore, instead of using several antennas, it is more compact and efficient to use one multi-band antenna that accommodates multiple modes. A reconfigurable antenna is an antenna capable of modifying dynamically its frequency and radiation properties in a controlled and reversible manner in order to provide a dynamical response. By using different reconfiguration of patch we got different result of gain, bandwidth and efficiency. So it is beneficial for compactness. The reconfigurable monopole antenna on proposed by incorporating resonators to monopole antenna. Electronic switches are mounted across these resonators to serve in activating or deactivating their resonance frequency, thus leading to reconfigurability.

Keywords*: LTE, WiMAX and WLAN*

1. Introduction

Because of the speedy advancement in wireless communication technologies, the demand for multi-band mobile devices is increasing. For example, the current wireless transceivers have to support various communication protocols such as WiMAX, LTE and WLAN concurrently. Instead of using a number of antennas, it is more compact and efficient to use one multi-band antenna that accommodates multiple modes Frequency-reconfigurable antennas are probable candidates for mentioned applications.
These components allow the advent of antennas that can be reconfigured during operation [1]. Reconfigurability is basically obtained when the surface current on the blistering element is changed by the mean of switching elements. Several approaches have been followed in regards of designing multi-band antennas. Current multi-band antennas used for wireless applications and monopole-slotted antennas [2]. However, there are some challenges concerning the fabrication of antenna as they have a three dimensional 3D structure which is not suitable for modern compact wireless devices.
Historically, antennas have been premeditated with constant characteristics that stay unchanged after the fabrication. However, this idea started to change with the introduction of switching elements such as microelectromechanical system (MEMS) components, Varactors , PIN diodes. In this project for switching purpose used qpnd-4154 PIN diode, it work at 9V supply using biasing circuite.

2. Literature Survey

The reconfigurable antennas have the advantage of organism able to produce good radiation patterns with better bandwidth, compared to patch antennas. In addition antennas with required reconfigurability can be fashioned by using a combination of strip conductors and slots arranged along the sides of a microstrip feed and probe feed. The basic element of the spiral slot is presented at rest, and the issues evolved from the probe feeding are presented. Based on the concept previously discussed about the microstrip and probe fed rectangular slot, the probe fed spiral slot and the loaded spiral slots are introduced. In the second section, the effort done by other researchers on multi-band and reconfigurable gap antennas is noted. Finally some information about varactor diodes and pin diodes which implement the switches for the reconfigurable antenna is provided.

In designing a small antenna there is always a compromise between size, band-width, and efficiency. Reconfigurable antenna architecture makes very efficient use of limited area by taking advantage of combined multiple functions in one single antenna. This result in sing cant reduction in the area occupied by the multiple antenna elements with enhanced functionality and performances. The exhaustive literature survey starting from 1983-2017 in brief is obtainable in this project.

"A Multi-band-Reconfigurable Antenna Using Split-Ring Resonators" by Ferhad Kasem etc.c[1] work that a design of a compact multi-band antenna with reconfigurability is presented. The design is based on incorporating two split-ring resonators to an F-shaped monopole antenna. Electronic switches are mounted across these resonators to serve in activating or deactivating their resonance frequency, thus leading to reconfigurability. So we understand the meaning of this project frequency-reconfigurable Split Ring Resonator (SRR)-based antenna with quad-band operation was presented. The quad-band operation was obtained by incorporating two single-ring SRRs with an originally dual-band Fshaped microstrip antenna. Each SRR, operated like a radiator, provided its own resonant frequency depending on its electrical length. An RF switch was installed on each SRR in order to control its resonance frequency, thus leading to an antenna with reconfigurability feature.

UMTS2100, and WLAN2400 [24]. Ashok Kumar, Mahendra Mohan Sharma has proposed A quad-band reconfigurable monopole antenna for multiradio wireless systems is presented and designed on Rogers 5880 substrate. The quad-band antenna comprised of circular patch, parasitic double T-stub, two inverted L-stubs. Single diode is employed between stubs to make antenna reconfigurable and obtained four resonance at 2.3/3.89/4.96/5.70 GHz. Impedance bandwidth of antenna are 350/410/110/650 MHz for LTE 2300 and 2.4 GHz WLAN, C-band, 4.9 GHz WLAN, 5.5 GHz WiMAX and 5.8 GHz WLAN bands.

S.W.Lee and Y.Sung has proposed In this communication, a compact frequency reconfigurable antenna for LTE/WWAN mobile handset applications is proposed. The proposed antenna mainly consists of radiating elements and two PIN diodes. In addition, the antenna has a simple structure with a compact size of 36.5 × 10 mm2. This antenna operates in six modes, and each mode is given a different resonant pathway by adjusting the bias states of two PIN diodes. When PIN diodes #1 and #2 are in the on and off states, respectively, the proposed antenna can cover the LTE700 (698–787 MHz) band by operating in mode 1. Moreover, the wide bandwidth in a higher band formed by combining modes 2 and 3 can cover the LTE2300 (2305–2400 MHz) and LTE2500 (2500–2690 MHz) bands. When PIN diodes #1 and #2 are in the off and[41]

on states, respectively, a resonant frequency in the lower band is formed by integrating modes 4 and 5. This can cover the GSM850 (824–894 MHz) and GSM900 (880–960 MHz) bands. [41]When the two PIN diodes are in the on state, the proposed antenna can cover the GSM1800 (1710–1880 MHz), GSM1900 (1850–1990 MHz), up to 2015-2016 and UMTS (1920–2170 MHz) bands in operating mode 6[25]. Ashis Kumar Behera1, Mayank Agarwal, Gaurav Pandey, Manoj K. Meshram are proposed A frequency reconfigurable antenna for LTE/WWAN applications is presented in this paper. The proposed antenna operates over triple bands (729 − 984, 1470 − 2200, and 2300 −2760 MHz) with respect to −6 dB reflection coefficient. The proposed antenna has a compact size of 45 x 17 x 4 mm3. By independently adjusting the ON/OFF states of the two PIN diodes located on the radiating element, the proposed structure can be operated in the PIFA and loop modes. The antenna acts like a planar inverted−F antenna (PIFA). There are several research on reconfigurable antenna but we are seeing few witch based on our project.

3. Proposed Antenna Design System:

System Model-The virtual cloud storage called DepSky Model. It address the issue like data integrity, availability in multi cloud.

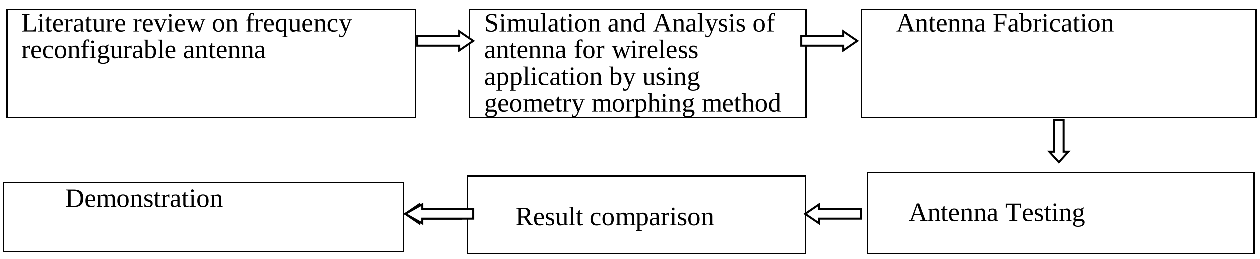


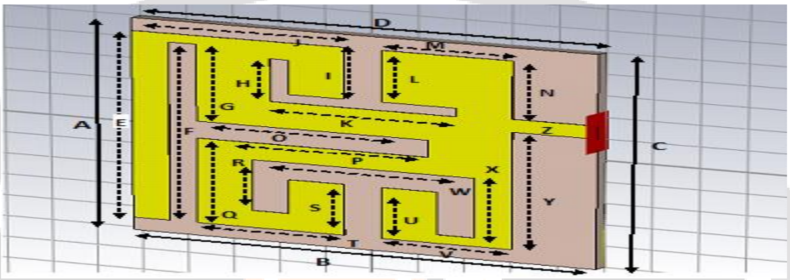
Fig 3.1. Flow for antenna design

A. Simulation Software used for antenna design:

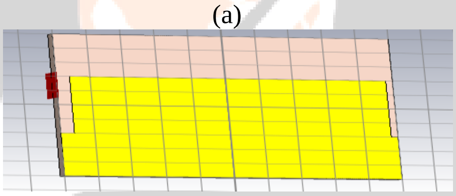
A simple microstrip patch antenna consists of metallic patch and ground between which is a dielectric medium called the substrate. Microstrip patch antennas are used for communication purposes especially in military and civil applications. In this paper a simple microstrip patch antenna is designed in CST Microwave Studio at a resonant frequency of 2.4 GHz. The gain of the designed antenna is 8.27 dB and VSWR of 1.18. Microsrtip antennas are used for number of wireless applications such as WLAN [1][2], Wi-Fi[3], Bluetooth [4] and many other applications. A simple microstrip patch antenna consists of a conducting patch and ground plane between them is a dielectric medium called the substrate having a particular value of dielectric constant. The dimensions of a patch are smaller as compared to the substrate and ground. Dimensions of a microstrip patch antenna depend on the resonant frequency and value of the dielectric constant.

CST microwave studio (CST MWS) is a specialist tool for the 3D EM simulation of high frequency components. CST MWS' has made unparalleled performance making it first choice in technology leading R&D departments. CST MWS enables the fast and accurate analysis of high frequency (HF) devices such as antennas, filters, couplers, planar and multi-layer structures and SI and EMC effects.

B. Simulation patch of antenna geometry with DGS:



(a)



(b)

Fig3.2:The geometry of proposed monopole antenna

Table3.1: name of strip and dimension

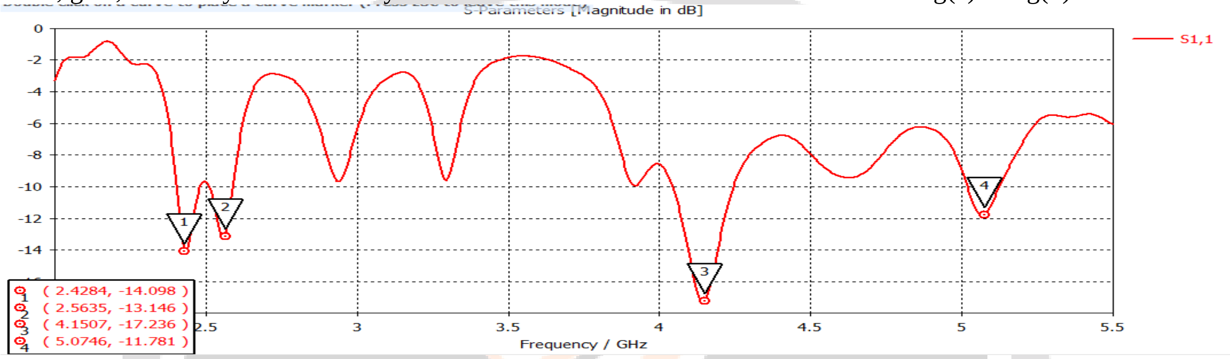
Strip name	Dimension in mm
A	50
B	50
C	50
D	50
E	44
F	42
G	21
H	10
I	19
J	10
K	10
L	12
M	39
N	9.5
O	32
P	26
Q	24.8
R	12
S	12
T	18.8
U	12
V	12
W	24
X	22
Y	30.5
Z	3
S1	2

The geometrical configuration of proposed antenna-I is as shown in fig.10.4.1 The proposed tri-band monopole antenna with DGS structure is designed for LTE 2.5 GHz, Wi-Max 3.2 GHz and WLAN 5 GHz etc. The proposed antenna is more feasible for embedding into mobile phone. The overall size of antenna is (L*W) 34.5*36mm2 The truncated ground structure is used into the geometry to improve the gain and bandwidth. In this geometry of antenna

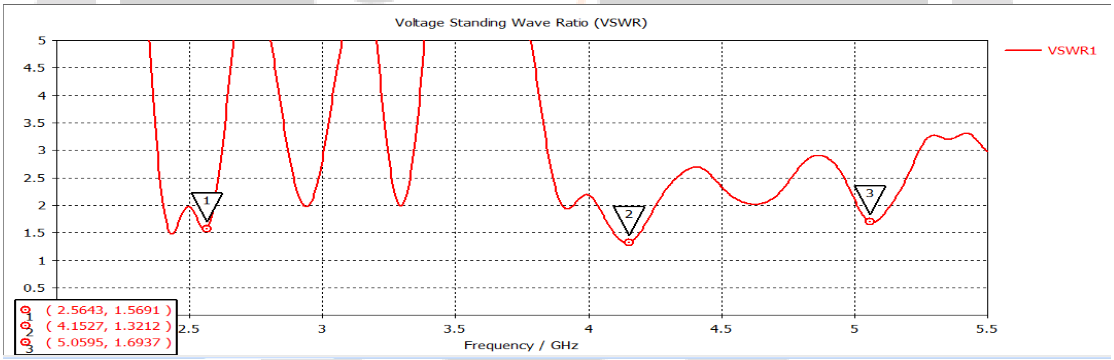
the inverted U shaped elements strip is added to get the WLAN 5GHz band. The strip F shaped in the geometry is the longest element helps to resonate at 3.2 GHz frequency which is Wi-MAX band. The empty rectangle shaped p used to remove 4GHz unwanted band from the results antenna. The strip square geometry used to get 2.5 GHz LTE band. The size of ground 39*40mm². with truncations 31*37mm² with DGS structure. The widths of driven monopoles are 1 and 2mm. The DGS structure based monopole antenna is commonly excited by either probe feeding or micro strip line feeding. In this geometry the monopole antenna is excited by micro strip line feeding. The feeding point F is at the bottom right corner of the geometry. The proposed small size monopole antenna is simulated on CST electromagnetic software. It is commercially available software package based on a Maxwell's equations.
In this project using qpnd-4154 PIN diode as switch for reconfigure the antenna.

C. Simulation result of antenna:
By using Simulation software CST electromagnetic got the result of efficiency, VSWR, 2D,3D radiation pattern etc those graph and result is below

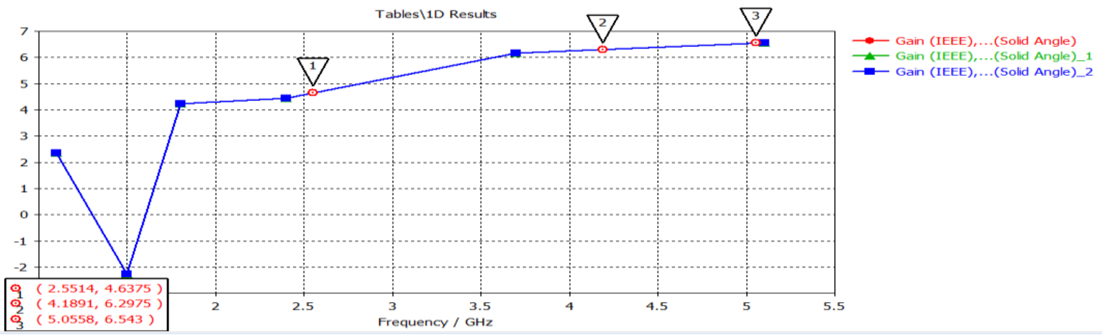
1.When switch is on:
The various parameters of antenna for both condition for switch is on and off such as VSWR, return loss, radiation pattern, gain, efficiency and directivity of antenna etc. are simulated on CST software. Fig(a) to fig(o)



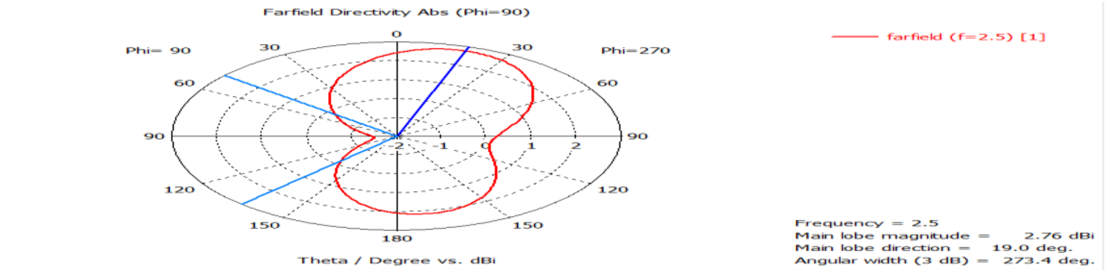
Fig(a) Return loss of proposed antenna switch is on



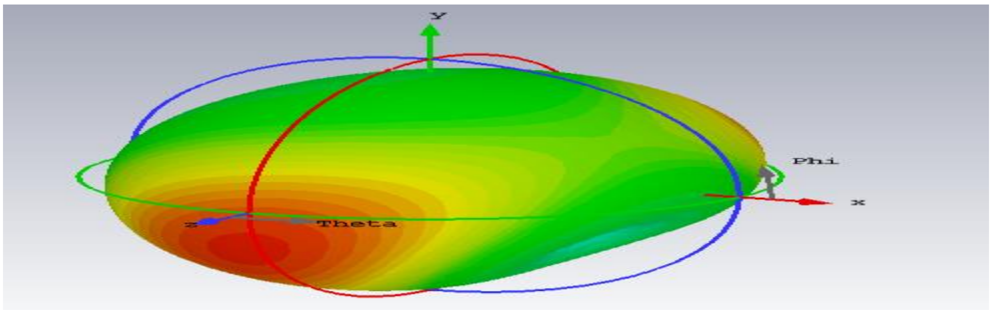
Fig(b) The VSWR of proposed antenna



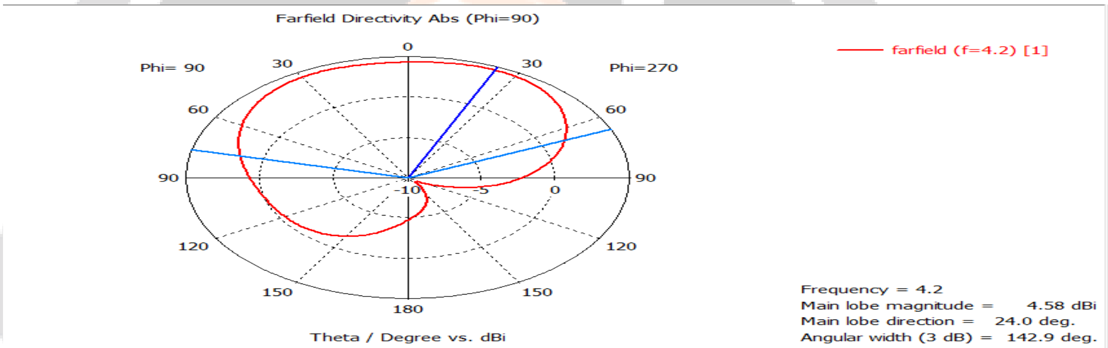
Fig(c) The gain of proposed antenna



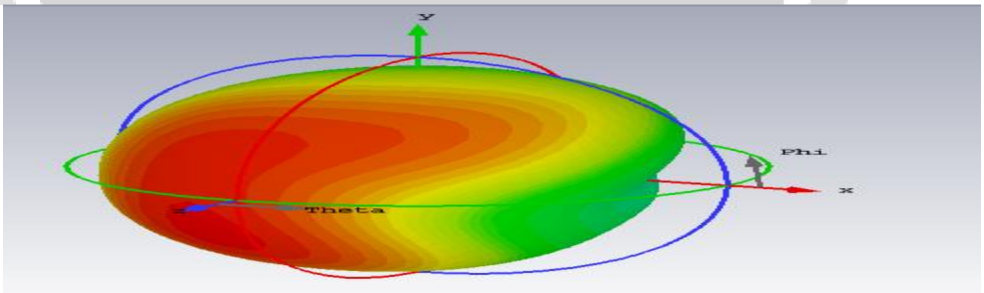
Fig(d) 2D Radiation pattern for 2.5GHz



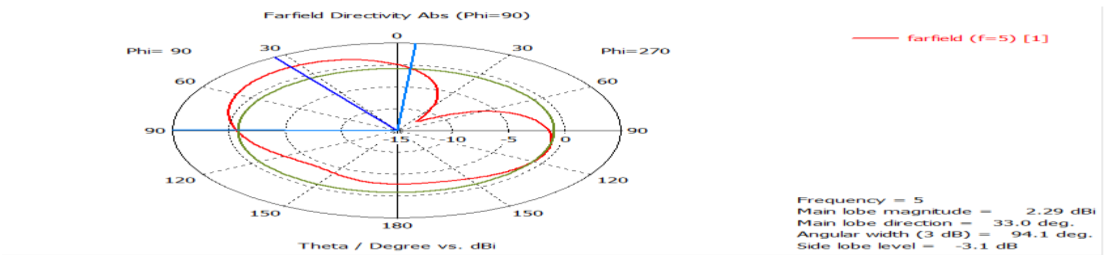
Fig(e) 3D Radiation pattern for 2.5GHz



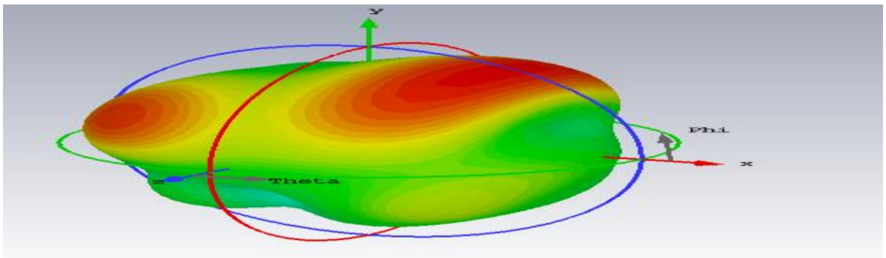
Fig(f) 2D Radiation pattern for 4.2GHz



Fig(g) 3D Radiation pattern for 4.2GHz



Fig(h) 2D Radiation pattern for 5GHz



Fig(i) 3D Radiation pattern for 5GHz

2.When switch is off:

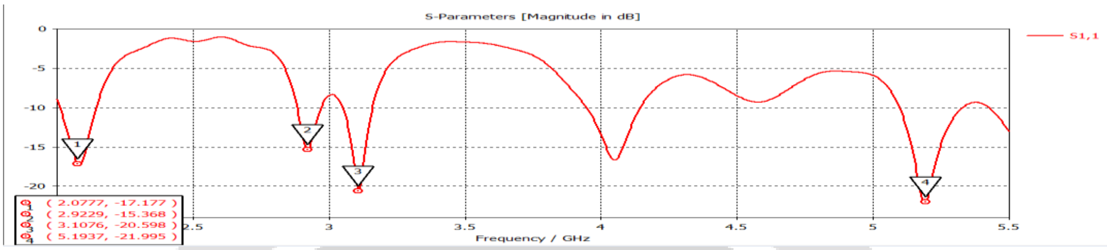
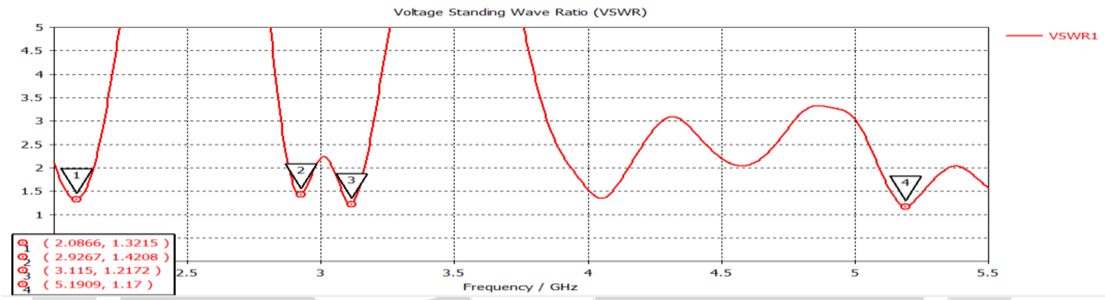
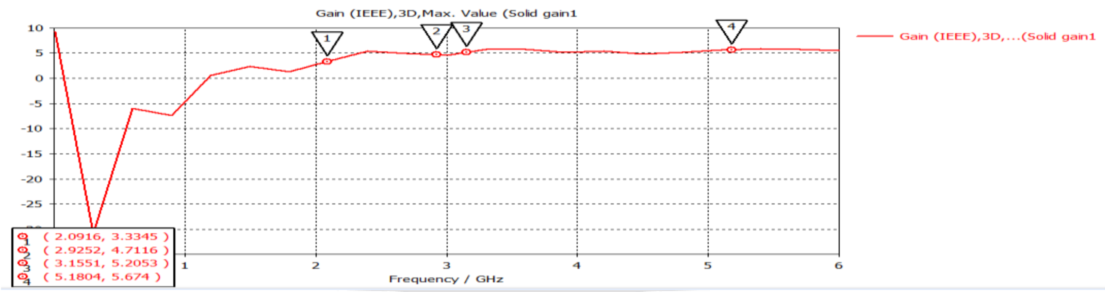


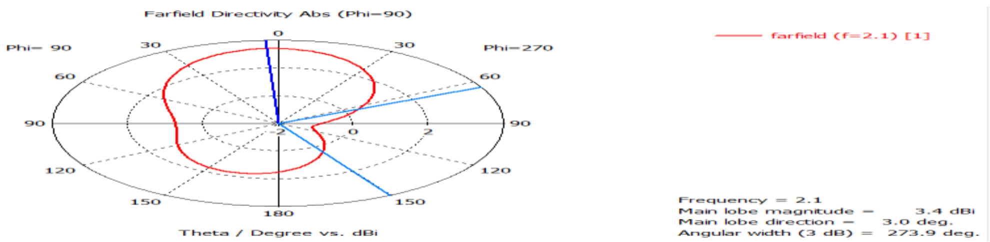
Fig (j) Return loss of proposed antenna switch is off



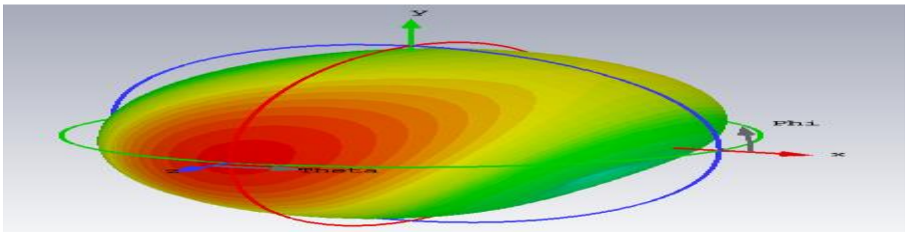
Fig(k) The VSWR of proposed antenna



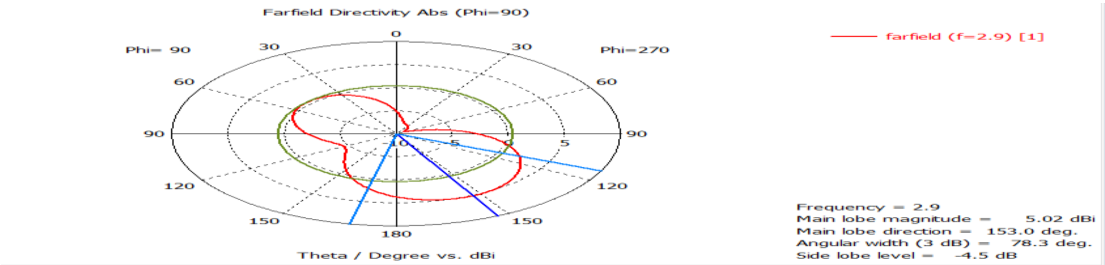
Fig(l): The gain of proposed antenna



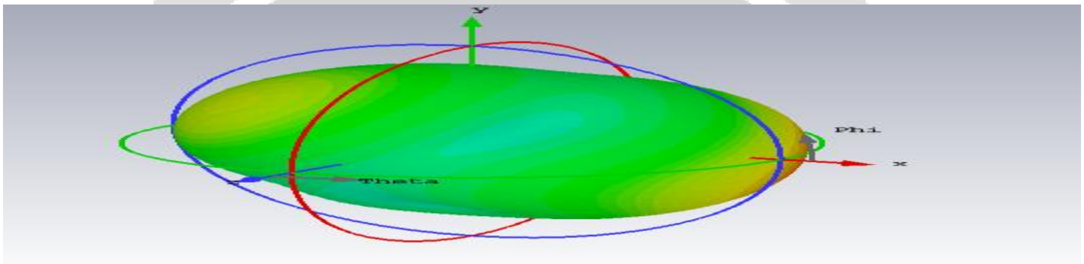
Fig(m) 2D Radiation pattern for 2.1GHz



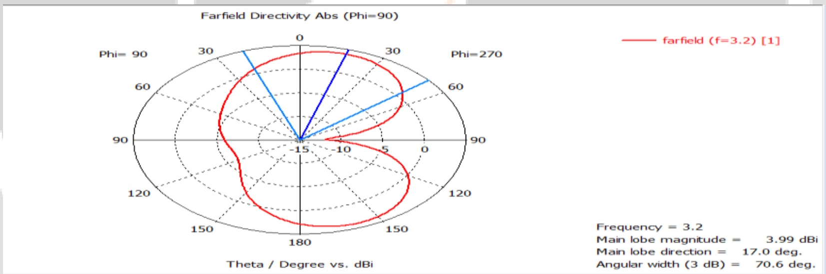
Fig(n) 3D Radiation pattern for 2.1GHz



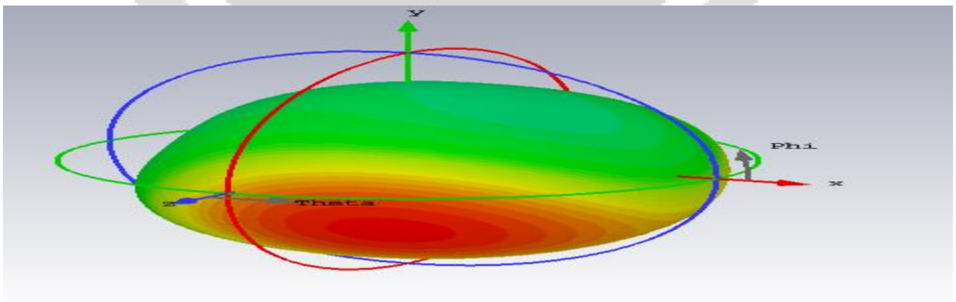
Fig(o) 2D Radiation pattern for 2.9GHz



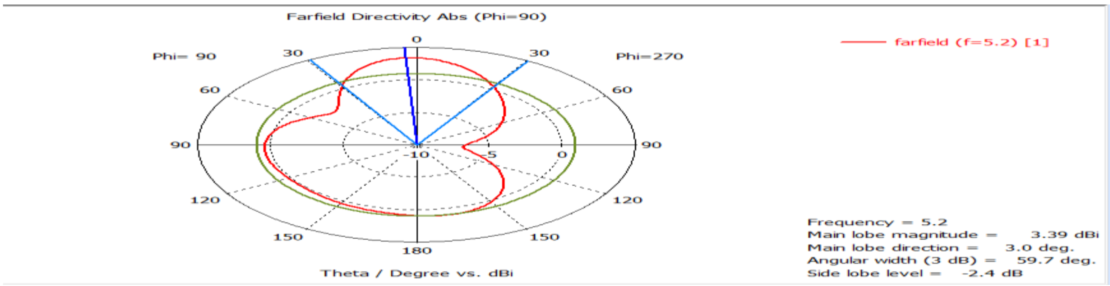
Fig(p) 3D Radiation pattern for 2.9GHz



Fig(r) 2D Radiation pattern for 3.2GHz



Fig(s) 3D Radiation pattern for 3.2GHz



Fig(t) 2D Radiation pattern for 5.2GHz

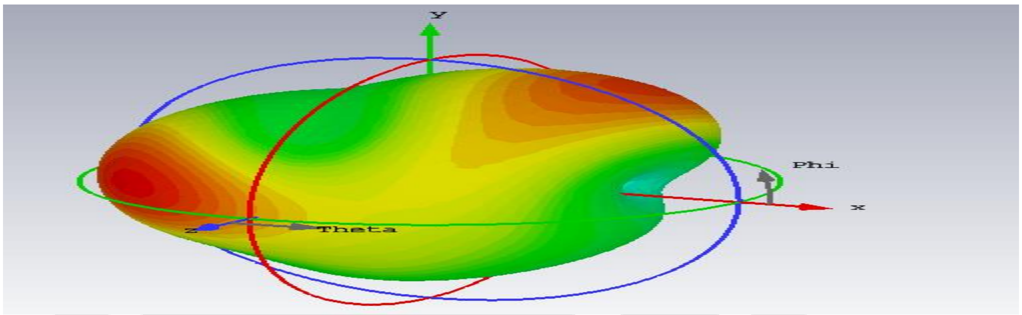
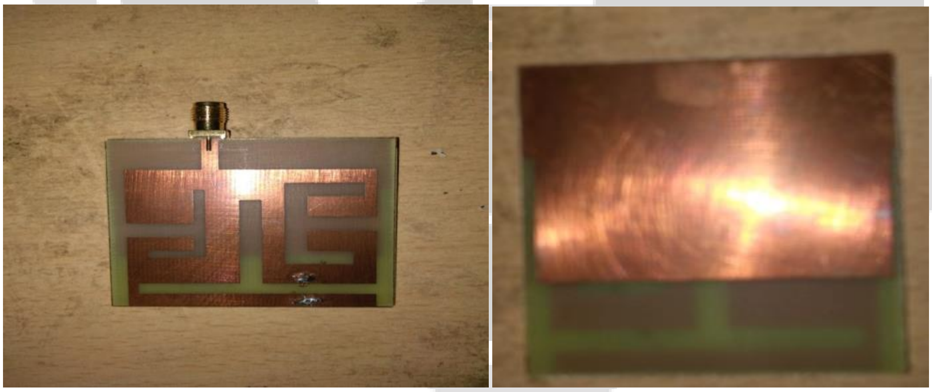


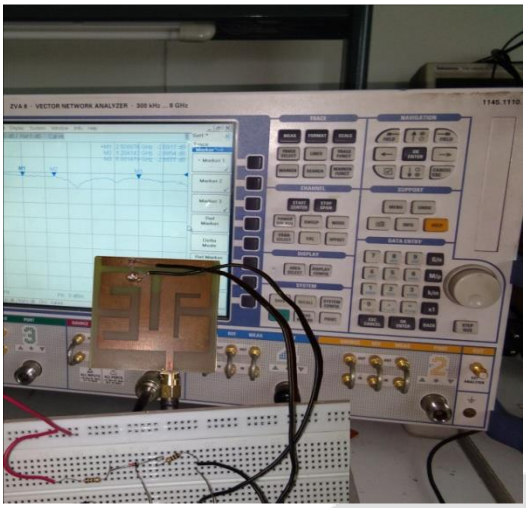
Fig (u)3D Radiation pattern for 5.2GHz

D. Hardware result and discussion:

The photographs of fabricated antenna in fig is printed on a cheap FR4 substrate with a thickness of 1.6 mm, relative permittivity εr = 4.4, and loss tangent, tan δ = 0.02. A 50Ω coaxial cable is connected to antenna through SMA connector. The following fig. (a) shows the top view of antenna design-I and fig.(b) shows the system ground of antenna design.



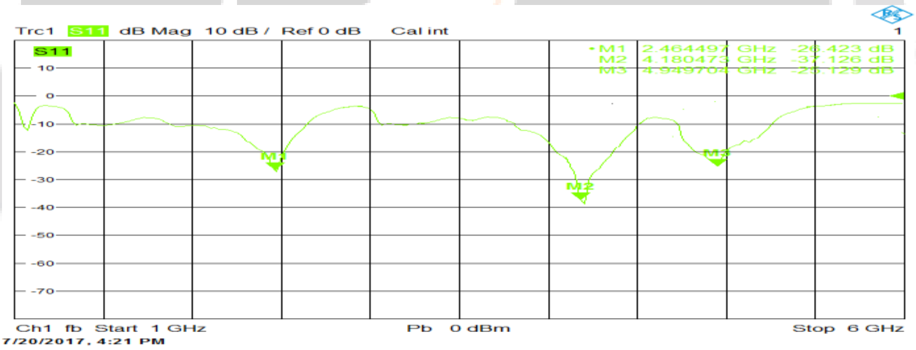
(a) (b)



(c)

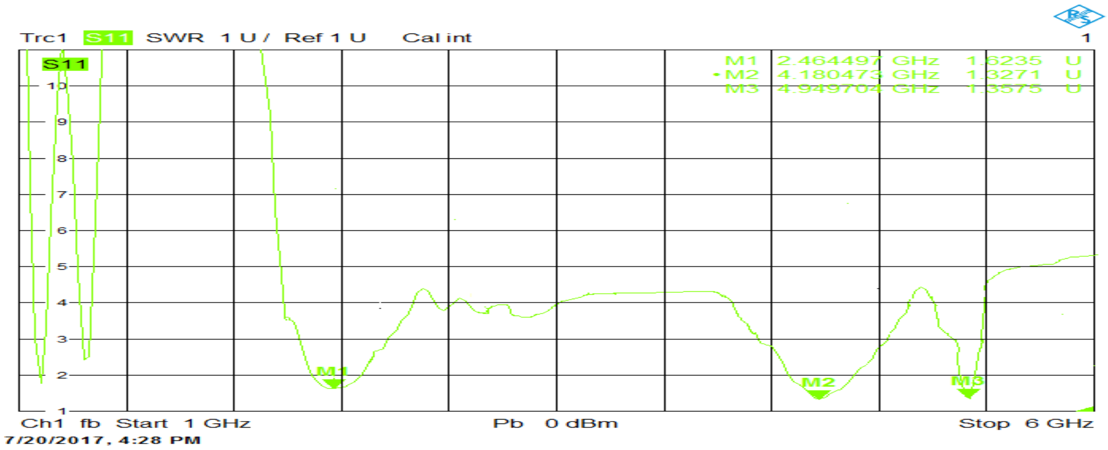
The above fig. demonstrates the design of monopole patch antenna with parasitic elements. A microstrip line feeding is provided at port 1 to excite the antenna. The proposed antenna estimate is 34.5×36×1.6 mm³. The antenna is excited by microstrip line feeding provided to 2 mm width horizontal main strip. The antenna is composed of L and inverted L shaped radiating elements. The main five strips shown in fig. 7.12 plays crucial role in getting the desired bands of LTE 2500 MHz, Wi-MAX 3.2GHz and WLAN 5GHz etc. The main vertical and horizontal long strip having 2mm width and 1mm width of vertical strip 5 are responsible for getting the LTE2.5GHz band then, after introducing strip 4 in the design the 3.2 GHz Wi-MAX &5GHz WLAN band shown below -10dB but, the efficiency and gain are very low for the desired bands hence, strip 2 is added in the design to increase the efficiency of antenna. The problem arrives due to strip 4, 5 & 2 is the new additional 3GHz and 5.9 GHz bands are introduced. To remove these additional bands the strip 3 is connected to the main horizontal radiator. The strip 1 is used to improve the gain of the antenna

D.1 Measured hardware result of antenna when switch is on:



Fig(a): The measured return loss of antenna

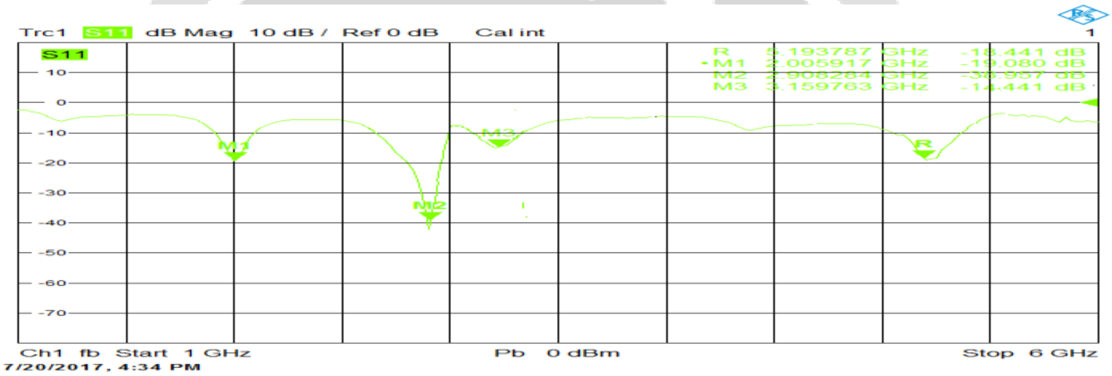
The fig. depict the measured result of return loss for antenna2. The antenna is tested on vector network analyzer for LTE, Wi-MAX and WLAN bands. The marker M1, M2 and M3 are placed on the tips of the wave below -10dB showing the return loss values of -20.24dB for LTE 2.5 GHz, -12.62 dB for Wi-MAX 3.2 GHz and -15.97dB for WLAN 5GHz etc.



Fig(b): Measured VSWR of antenna

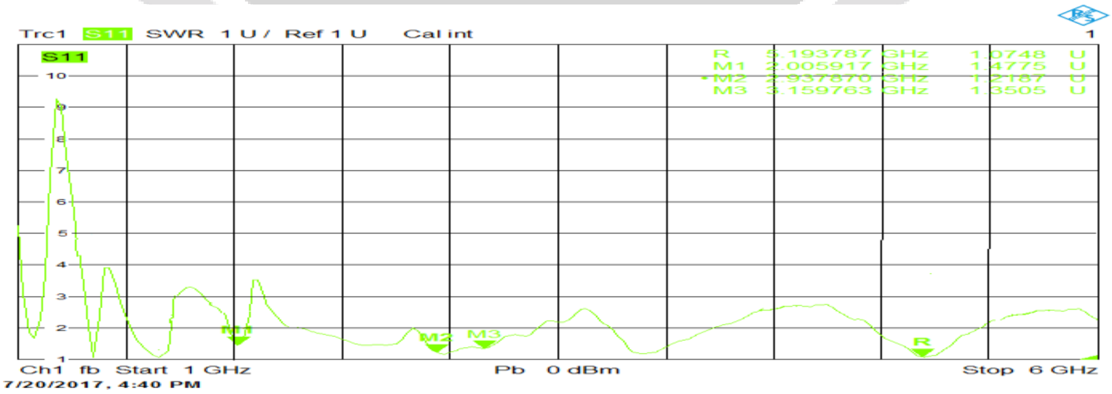
The antenna is tested on vector network analyzer for LTE, Wi-MAX and WLAN bands. The marker M1, M2 and M3 are placed on the tips of the wave between 1-2 showing the VSWR values of 1.33 for LTE 2.5 GHz, 1.54 for Wi-MAX 4.2 GHz and 1.39 for WLAN 5GHz etc.

D.2 Measure Hardware result of antenna when switch is off:



Fig(c): The measured return loss of antenna

The fig. depict the measured result of return loss for antenna. The antenna is tested on vector network analyzer for LTE, Wi-MAX and WLAN bands. The marker M1, M2 and M3, R are placed on the tips of the wave below -10dB showing the return loss values of -19.24dB for LTE 2.0 GHz, -38.62 dB for Wi-MAX 3.2 GHz and -14.97dB , -18.16 for WLAN 5GHz etc.



Fig(d) Measured VSWR of antenna

The antenna is tested on vector network analyzer for LTE, Wi-MAX and WLAN bands. The marker M1, M2 and M3 are placed on the tips of the wave between 1-2 showing the VSWR values of 1.43 for LTE 2.5 GHz, 1.24,1.23 for Wi-MAX 3.1 GHz and 1.39 for WLAN 5GHz etc.

E. Comparison of simulated and tested result of antenna:

Table depicts the comparison of proposed antenna and. The antenna Have good bandwidth, efficiency and gain etc. Antenna is greater size. Hence this antenna cannot use for mobile phones. This antenna can be used in the laptop, portable PC's etc. Where as the antenna have large bandwidth, gain and efficiency because of large dimensions. The Efficiency of antenna is greater and too good. Hence antenna-II is suitable to embed into portable devices.

Switch position	Parameter of antenna	LTE		Wi-MAX		WLAN			
		simulated	measured	simulated	measured	Simulated		Measured	
On	Frequency	2.55GHz	2.46GHz	4.13GHz	4.18GHz	4.9987GHz		4.94GHz	
	Reture loss	-13.157dB	-26.42dB	-17.152dB	-31.126dB	-15.0682Db		-23.97dB	
Off	Frequency	2.07GHz	2.00GHz	2.92GHz	2.908GHz	4.9987GHz	4.94GHz	5.19GHz	5.19GHz
	Reture loss	-17.77dB	-19.08dB	-15.397dB	-38.95dB	-15.0682dB	-23.97dB	-15.057dB	-18.97dB

F. Application & Advantage:

The frequency reconfigurable antennas have good radiation characteristics for various frequency operating bands, Frequency Reconfigurable antenna is low cost and have easy fabrication, The frequency reconfigurable antenna has Compact size, Frequency Reconfigurable antenna is more efficient, Frequency Reconfigurable antenna has Good impedance matching, Single antenna used for multi-band frequency operation.

4.Problem statement:

The aim of this dissertation to design implement frequency reconfigurable monopole antenna for portable devices. The proposed antenna can be used for LTE, WLAN, WiMAX. The antenna is designed and simulated for various antenna parameter like gain, bandwidth, VSWR, efficiency, return loss by using CST software Fabricated antenna tested using network analyzer and testing results are compaire with simulation result.

5.CONCLUSION:

In this dissertation develop and optimize compact single feed tri frequency microstrip antenna that would facilitate frequency diversity without the use of any matching circuits and complicated biasing circuits. RF switches are used for switching or tuning mechanism.

The antennas are designed to operate in the frequency band where a large number of wireless communication applications exist. The important design considerations throughout the study are compactness of the patch and tuning frequency and frequency effortlessly with simplified switching mechanism directly integrated into the radiating patch.

An introduction to the overview of state of the art of microstrip antenna technologies, with a special emphasis to reconfigurable antenna has been discussed in this dissertation.

Dimensional parameters critically determine the resonances. Thus, the slot loaded cross patch antenna is brilliant because it not only provided a flexible tenability of operating frequency but also enhances the compactness of the design. The monopole antenna is designed for LTE, WLAN and Wi-Max ranges. In this dissertation work, small size monopole patch antenna has been implemented. The antennas are designed for frequency range of 2.5GHZ, 3.2GHz and 5 GHZ. The simulation studies, in terms of their return loss and current distribution on the antenna at different resonances, reveal their dependence on the antenna dimensions. The monopole antenna provides an advantage of more compact size of antenna in applications where size of the antenna plays a crucial role.

Antenna is of greater dimension, hence it is suited to use in portable devices like laptop, PCs etc.

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