Toggle Antenna for Next Generation Portable Devices

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Abstract— Advancement in the field of communication and emerging technologies raised the need of multifunctional communication devices. Antenna is the basic building block of any communication system or device so antennas used in communication devices of present generation should be multifunctional which can change their operating frequency or radiation pattern etc. Conventional antennas cannot perform multi-tasking as they cannot adapt different operating frequencies according to environment changes. So multi conventional antennas can be replaced by one smart antenna. Hence reconfigurable antennas can fulfill the need of present communication systems, as they can change their operating frequency according to environment like in cognitive radio where system parameters changes with varying conditions.The aim of this thesis was to design a multiband reconfigurable patch antenna that operates in 700 MHz, 1700 MHz, 1900 MHz, and 2100 MHz bands and equipped with the capability to tune its operating frequencies independently. High Frequency Structure Simulator (HFSS) will be used to design required antenna. Reconfiguriable is automatically tuning to the differnet frequency bands, so I give the name to this design Toggle antenna.

Index Terms— Reconfigurable, Frequency Band, Multiband, Surface Current, RF Switches, Patch,

1 INTRODUCTION

Antennas are vital portion of new communication devices and applications. The antenna is transducer device and able to radiate and receive of electromagnetic waves in preferred and efficient fashion. Antenna is any piece of metal that may radiate and receive electromagnetic radiations in our desired manner.

Antennas require extensive range of solicitations in everyday life of wireless standard of communication trends (WLAN, LTE, GSM and WiMAX), airliner triangulations, Radar structures and added military applications. Therefore, antennas are core of each wireless communication device or application. Ban et al.,(2014)

How Antennas Work?

Antennas, consists of arrangements of metal conductors (basics) that are electrically linked via transmission cables or lines to transmitter or receiver. A wavering current by a transmitter enforced over antenna will generate an magnetic-filed about elements of antenna whereas charge on electrons will create electric field around different parts of antenna.

These continuously changing fields give out waves in space as travelling transverse field of waves from the antenna. During reception of EM waves, the oscillating magnetic and electric fields of arriving radio wave applies power on electrons residing in antenna that causes electrons to travel rear and forth forming oscillating currents within antenna parts.Gray et al., (1998)

The antennas may be aimed to convey and collect waves in entirely horizontal directions or in specific direction). An antenna also contain other elements or shells which may have no electrical link to transceiver, for example parasitic elements, horns or reflectors those help to direct waves in beam shape or any other favorite radiation pattern. (Compton, R. T.,1988)

Reconfigurable Antenna

The reconfigurable type of antenna can change its properties similar to frequency response and polarization in demand to manage fluctuating requirements. The block diagram shown below is reconfigurable antenna with exemplary frequencies. Antenna is part of wireless handheld equipment but antennas are incapable to adjust new modifications which can lemmatize the use and compatibility. In command to overcome these complications, fresh techniques are grown to improve antenna performance that helps to familiarize new operation consequence. The antennas are premeditated for those altering scenario are named Reconfigurable Antennas. Azad et al.,(2014)

MIMO Schemes, reconfigurable antennas presentation is superior as likened to non-reconfigurable antenna type of arrays . Additionally, the operating factors involving cognitive Radio waves Communication are continuously varying as environment change; that situation demands antenna which have tunable and characteristics of reconfigurable. The reconfigurable type of antenna designed to create them the top choice for diverse group of functional frequency bands & every frequency band may also be permitted to be handled by diverse communication devices at same time.

Types of antenna Reconfiguration

1. Frequency Reconfiguration

The frequency reconfigurable type of antennas can regulate animatedly operation frequency. They are predominantly beneficial in conditions where numerous communications systems come together as multiple antennas necessary to be swapped by reconfigurable antenna. This type of reconfiguration is commonly achieved by adapting materially or electrically dimensions of antenna with RF-switches, tunable materials and/or impedance loading. (Yang et al., 2009)

2. Radiation-Pattern Reconfiguration

This type of re-configurability is created on intentional alteration of spherical spreading of radiation styles. The beam steering method is prolonged application and comprises in

directing extreme radiation to make the most of antenna gain in connection with portable devices. The reconfigurable types of antennas are habitually deliberate using mobile rotatable constructions or containing switchable elements of structure.

3. Polarization Reconfiguration

The Polarization reconfigurable types of these antennas are accomplished of swappingbetweenaltered polarizations methods. This ability of switching among horizontal, circular & vertical polarizations may lessen losses because of polarization mismatch in moveable devices. This technique can be delivered by exchanging equilibrium between dissimilar modes of designed antenna configuration.

4. Compound Reconfiguration

This type of reconfiguration has capability of concurrently tuning a number of antenna constraints, for example frequency with the radiation pattern. Most shared use of compound type reconfiguration is mixture of frequency quickness and beam-scanning which to offer better spectral effectiveness.

This re-configurability is attained by joining in identical structure altered single-parameter reconfiguration methods or by redesigning enthusiastically surface. (Rodrig and Jofre, 2012)

Why Reconfigurable Antennas?

Antennas are vital module of each wireless communication structures and being castoff in laptops, imaging devices, tablets, mobiles phones, radar and many further applications. Several devices use 2 or 3 antennas for range reception on insignificant devices to raise enhanced reception but frequently merely one antenna is came into practice for transmission. Additionally, antenna of transferable devices has limitation similar to price, heaviness & power consumption. So that solitary antenna cannot deliver ideal solution in every kind of atmosphere. In this age, operator supposing that single handy device should afford contact to totally wireless networks. So, one reconfigurable antenna is able to deliver numerous advantages in demand to handle restrictions resembling price, load and power feasting. The reconfigurable antennas might be useful in room of multiband & widespread band antenna types. Hence, the number of antennas in handy devices decreased with help to these antennas. Single antenna provide right of entry to quite a lot of wireless standards for communication. (Rodrig and Jofre, 2012)

2. METHODOLOGY

I deeply studied the different antenna in the review of literature, during the study I focused on the different parameters of the different antennas. After the depth analysis of the different antennas with considering their all parameter; I have selected the monopole antenna for my research domain. I used monopole antenna micro striped antenna for the purpose of reconfigurable. In other words Monopole antenna micro striped antenna is selected for achieving the re-configurability. Ease manufacturing, low cast and planner structure are basic and most important elements of monopole antenna that is more beneficial for the monopole antenna for achieving the reconfigurable characteristics. For purpose of making the reconfigurable antennas I did the simulation for the different antenna, after the depth analysis of the different parameters in which the distribution of the surface current is the most important parameters. That why I selected the monopole antenna for my research domain of reconfigurable antenna.

In this chapter I have discussed all the steps of the designing phase of the proposed antenna. The result, summary and discussion of the purposed reconfigurable antenna are also discussed in this chapter. All step by step phases of designing is also discussed in this chapter.

HFSS is precise and operative software in the situation of performance. This is multiuse in calculation of electromagnetic radiations of designed antennas. It shows pictures using GUI box. FEM is special tool work to determine electromagnetic waves of antenna in HFSS. Complete constraints of antenna just like radiation patterns, S parameters, resonant frequencies, different fields & smith charts might be accomplished via this software HFSS. (Kopp, 2009)

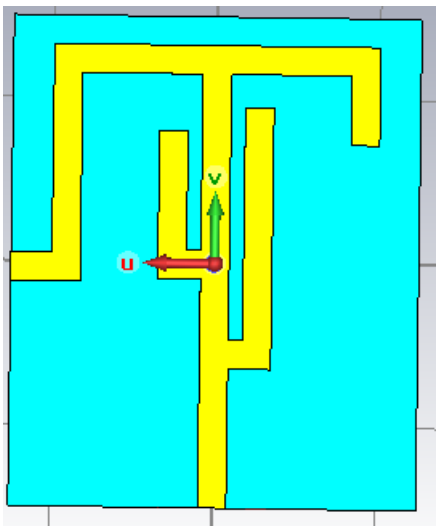
Uses of HFSS

i. For the improvement of Microstrip type antennas similar to patch antenna using for wireless type of the communication of devices and things.
ii. For the scheming of new antenna by addition of particular slot having certain magnitudes.
iii. For the conniving of helical type or loop type antenna having wanted extent and circle.
iv. In manipulative of different type of filters and also many connectors of chosen frequency as well as the impedance.
v. In the proposal of waveguide works, just like many types of couplers, oscillators, isolators or directors.
vi. Parametric revision is castoff to elevate the plan factors of desired antenna for specific characteristics.
vii. Near & far field information of unlike rectangular polar graphs is presented by HFSS.
viii. One chief usage of this software is solution of specifically for normal and high frequency which have complex 3D shapes.

3. RESULTS AND DISCUSSION

Proposed Reconfigurable Antenna

Front View



Pattern of proposed Design

Back View

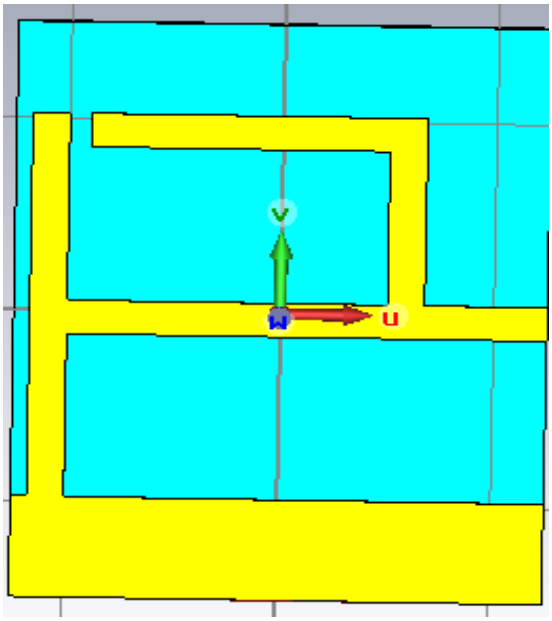


Fig 1 Proposed Design antenna

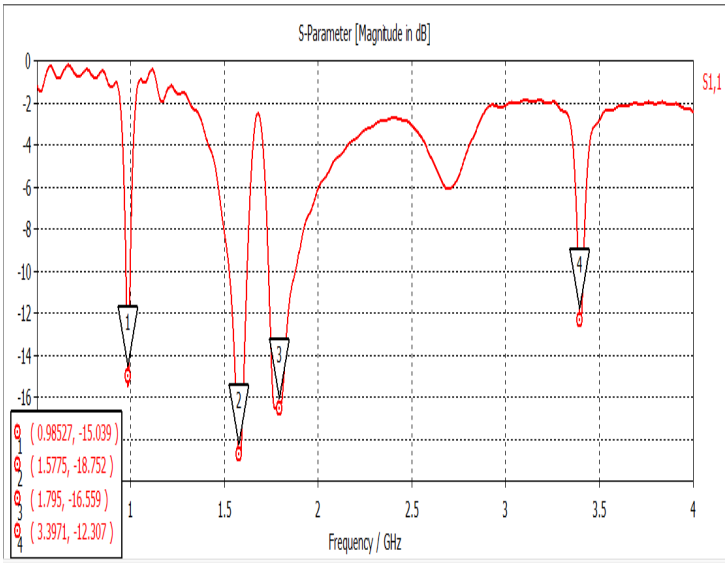
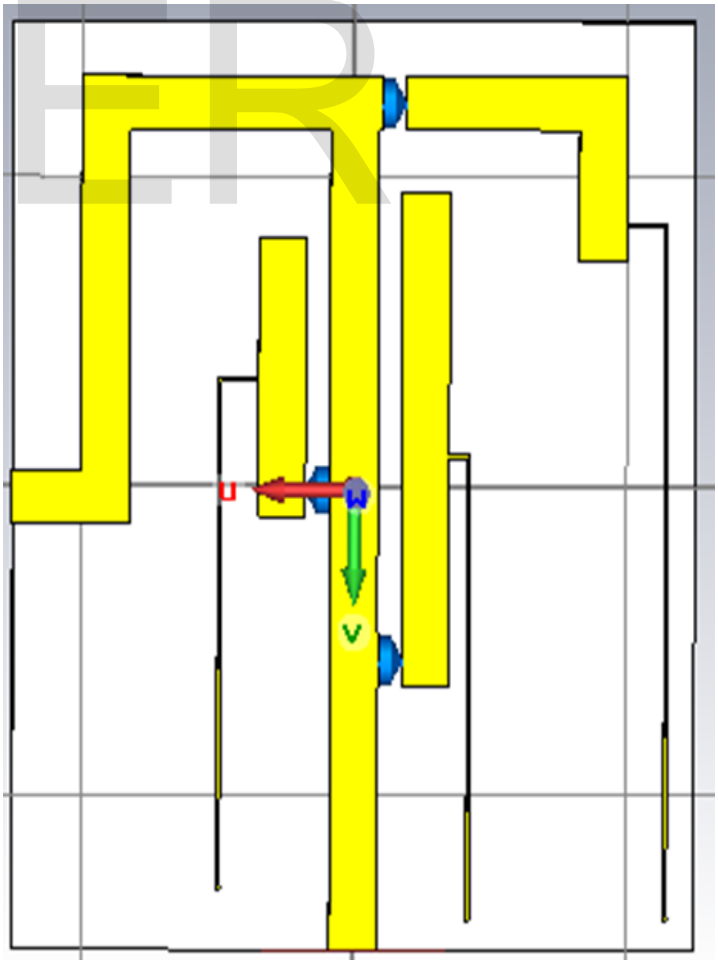


Fig 3 S-Parameter of Design

Fig 1 indicates my design of proposed antenna, it has multi elements that are connected to each other or we can say that they are interconnected to each other. In this design there are three elements in the main structure of the antenna design but also add one other shape on the outer portion (boundary) of the main structure. The shape of this element is resembled to the square.

Design after Adding Switches in Final Design



Current Pattern and result of proposed Reconfigurable Antenna Design

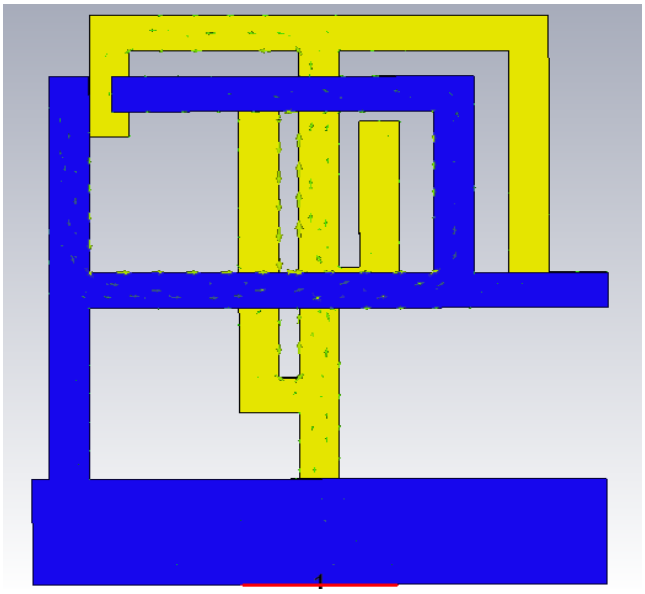


Fig 2 Front (yellow) and back (blue) side Current Distribution

Fig 4 Biasing Lines in reconfigurable antenna

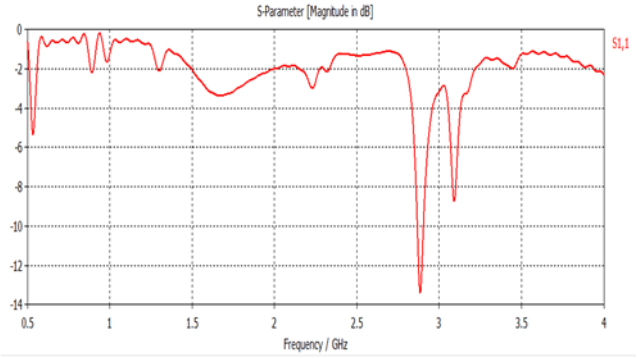


Fig 5 S-Parameter after Adding Switches and biasing lines in Final Design

After adding biasing lines results got disturbed because now biasing lines also radiating.

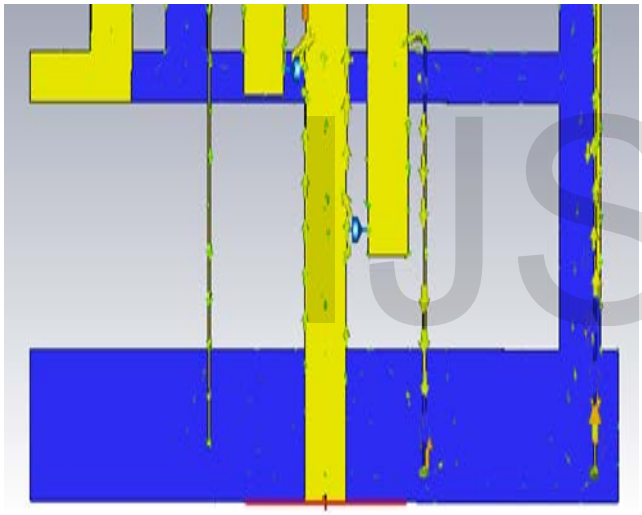


Fig 6 biasing lines radiation Current

Different Switches and their Modes of Operation in Reconfigurable antenna.

Case 1 When All Switches are off

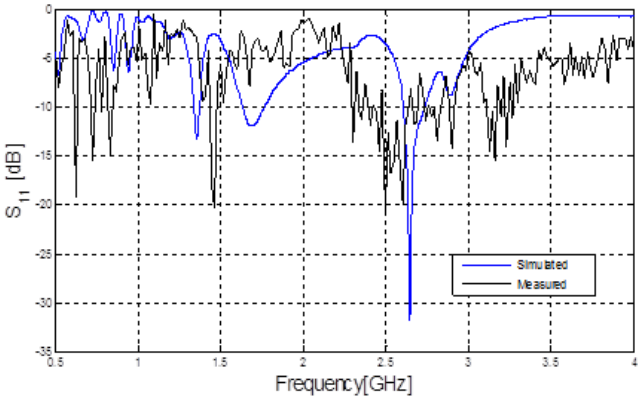


Figure 7 Radiation Pattern of Antenna with all switched off

With all switches are OFF or disconnected, design of antenna is configured at 2500MHz.This band covers some very significant communication band of LTE.

CASE 2 When Switch S1 is ON

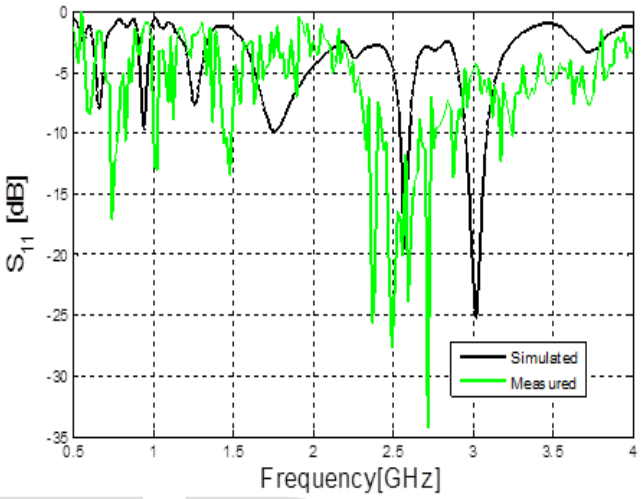


Fig 8 S11- Plot of proposed antenna with switch S1 ON

There are some changes are monitor With Switch S1 is ON, with respect the case one of all the switches off, which is antenna operates on two bands 1700MHz and 2500MHz.

CASE 3 When Switch S3 is OFF.

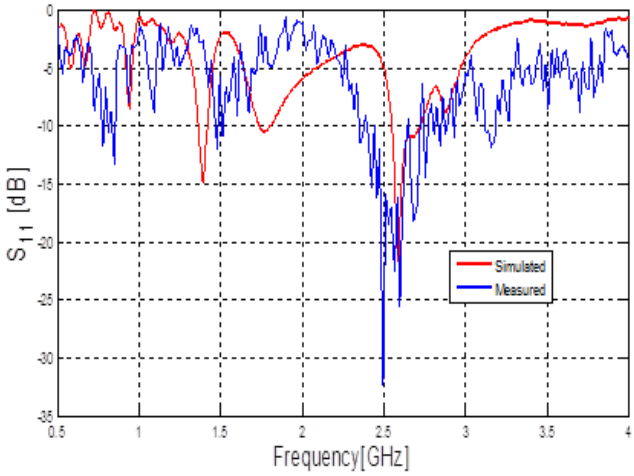


Fig 9 Radiation pattern and S parameter with switch S3 is OFF

When switch 3 is OFF antenna operates on two bands 1700MHz and 2600MHz. It also has the different frequency band. Now we are going to achieve our desired proposed result. With help of ON and OFF Mechanism we achieved the

required band.

CASE 4 When Switch S3 is ON

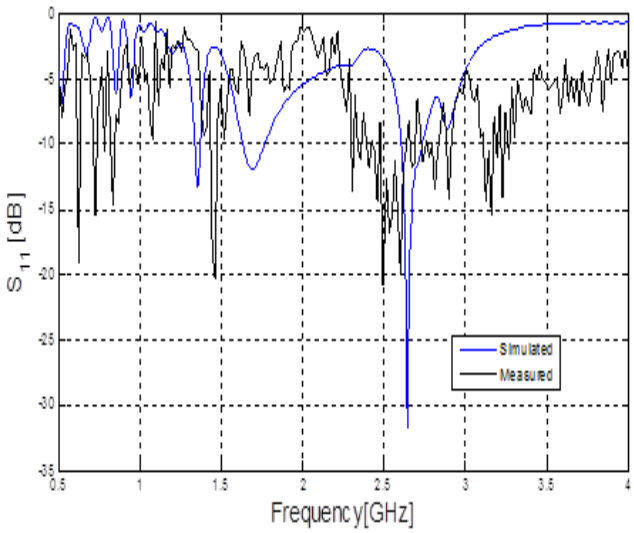


Fig 10 S11- Plot of proposed antenna with S3 is selected ON

With the help of S3 is ON, my design antenna is supporting to the frequency bands of 900MHz and 2.6 GHz. This design, two alternation are 1.5 GHz & 2.3 GHz bands.

CASE 5 With S4 ON

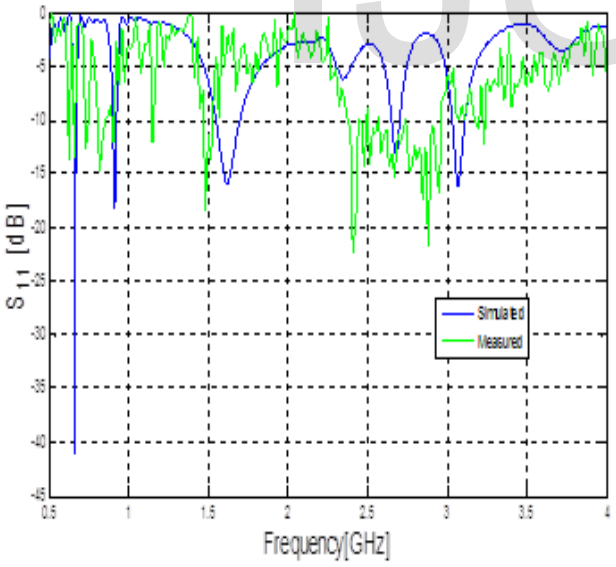


Fig 11 S11- Plot of proposed antenna when switch S2 is ON

When S2 is OFF and S1 and S3 are ON S11 parameters shows proposed model can be operatable at three distinguished frequencies, antenna is covering following bands 900MHz, 1.6 GHz,2.6 GHz.in this case, two significant changes are observed as operation bands increased and Omni directional behavior can be clearly seen through the radiation pattern for 1.6GHz.

CASE NO.6

When Switch S2 & S3 are ON

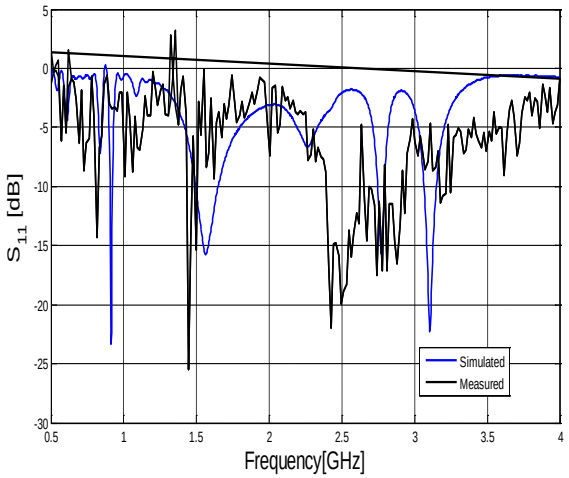


Fig 12 S11- Radiation Pattern and S parameters Of Case 6

With both S2 & S3 are in ON state, working of designed antenna on these frequenvy range 900 MHz, 1.5 GHz. Radiation pattern for antenna configured on case 6 at 1.5 GHz shows omni directional behavior of antenna.

CASE NO.7

When Switch S3, S2, S1 are ON

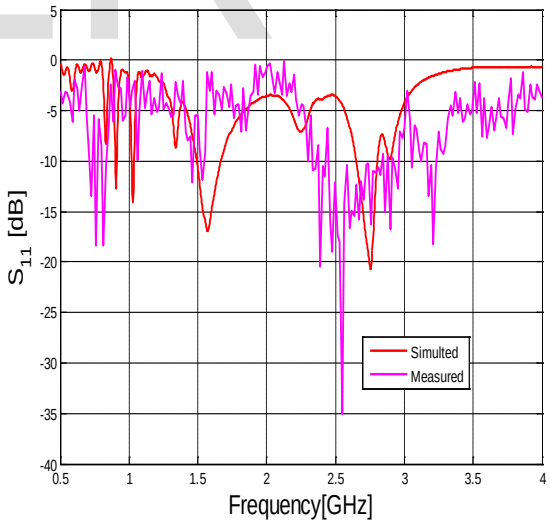


Fig 13 S11- Radiation pattern of proposed antenna Case No. 7

With S3, S2, S1 are kept ON, The design is operating in f range of frequencies 1.5 GHz to 1.7 GHz and 2.6 GHz. Device using configuration in case 7 can be operated in above mentioned bands of LTE.

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Table Summarizing Different Switches and their Modes of Operation in Reconfigurable antenna

	sw3	sw2	sw1	Frequency bands covered		
Case 1	0	0	0			(2.57GHz)2500MHz
Case 2	0	0	1		(1.75GHz)1700MHz	(2.58GHz)2500MHz
Case 3	0	1	1		(1.70GHz)1700MHz	(2.64GHz)2600MHz
Case 4	1	0	0	(.90GHz)900MHz		(2.66GHz)2600MHz
Case 5	1	0	1	(.90GHz)900MHz	(1.61GHz)1600MHz	(2.66GHz)2600MHz
Case 6	1	1	0	(.91GHz)900MHz	(1.56GHz)1500MHz	
Case 7	1	1	1		(1.56GHz)1500MHz	

Table 4.1 Position of Switches and Modes of Operation

4. Conclusion

My research in this thesis successfully designs the reconfigurable antenna that is successfully operate at the different multiple frequencies. It capable to operate the different frequency range of 4G, LTE, Wi-Fi and WLAN applications. It has a simple planner and low profile and low cast. After the depth analysis of S11 parameter and Radiation parameters, It has proved that design proposed reconfigurable antenna is capable to handle or support at different frequencies ranges of 4G, LTE, Wi-Fi and WLAN application. Result of the surface current distribution also

Moreover me design reconfigurable antenna has the benefit of is compact in size and also cover wide or large bandwidth, it also effective in cost and has an advantage with moveable (portable) devices of LTE.

5. Future Work

Antenna is the basic and most important element of the communicable devices of all the generation. It is like a back bone of devices. For enhancement in my thesis further development is that more reduced the size of antenna and efficient use of bandwidth. Most important point is that more reconfigurable at more multiple bands. Modifications also be there that reduced the number of switches

References

Azad, M. Z., & Ali, M. (2004, June). A compact Hilbert planar inverted-F antenna (PIFA) for dual-band mobile phone applications. In Antennas and Propagation Society International Symposium, 2004. IEEE (Vol. 3, pp. 3127-3130). IEEE.

Ban, Y. L., Sun, S. C., Li, P. P., Li, J. L. W., & Kang, K. (2014). Compact eight- band frequency reconfigurable antenna for LTE/WWAN tablet computer.

Compton, R. T. (1988). Adaptive antennas: concepts and performance. Prentice Hall. De Mingo, J., Valdovinos, A., Crespo, A., Navarro, D., & Garcia, P. (2004). An RF electronically controlled impedance tuning network design and its application to an antenna input impedance automatic matching system.IEEE Transactions on Microwave Theory and Techniques, 52(2), 489-497

Gray, D., Lu, J. W., & Thiel, D. V. (1998). Electronically steerable Yagi-Uda microstrip patch antenna array. IEEE Transactions on antennas and propagation, 46(5), 605-608.

Rodrigo, D., & Jofre, L. (2012). Frequency and radiation pattern reconfigurability of a multi- size pixel antenna. IEEE transactions on antennas and propagation, 60(5), 2219-2225.

Kopp, M. (2009). An Introduction to HFSS: Fundamental Principles, Concepts, and Use. Ansoft, Pittsburgh, PA,, 77.

Yang, S., Zhang, C., Pan, H. K., Fathy, A. E., & Nair, V. K. (2009). Frequency- reconfigurable antennas for multiradio wireless platforms. IEEE microwave magazine, 10(1), 66-83.

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