International Journal of Engineering Research ISSN:2319-6890)(online),2347-5013(print)
Volume No.3, Issue No.3, pp : 141-145 01 March 2014

Analysis of Effect of Conductor Line on Folded Type Meander-Line Antenna

Susmita Ghosh
Department of Electrical and Electronic Engineering, American International University-Bangladesh(AIUB), Banani, Dhaka-1213,Banglsdesh
Susmitaghosh14@aiub.edu

Abstract— In this paper folded type meander line antennas have been proposed. Performance of three different meander line antennas have been investigated, first one without conductor line and the other two with conductor line. First antenna is a triple band resonator while second antenna with conductor line becomes tetra band resonator and the last design is a dual band resonator but with higher return loss, -35 dB at 1.86 GHz. CST_STUDIO_2012 is being used for simulation. Far-field response, efficiency, gain, directivity and reflection coefficients have been chosen as factors for performance analysis and it has been successfully illustrated here that insertion of conductor line makes the antenna a better resonator and also improves the return loss. The proposed antennas in this paper work are able to operate in the LTE700, LTE/GSM1800, PCS/ UMTS/ WLAN/ LTE2400, L band (1-2 GHz) and S band (2-4 GHz).

Keywords— Conductor line, folded type meander line antenna, return loss and tetra band resonance.

I. Introduction

In recent years, the wireless communication business has expanded greatly. Some of the most recognized communication fields are WLAN system, GSM/EDGE, UMTS/HSPA & 4G LTE networks [1-3]. LTE is the last step toward the 4th generation (4G) of radio technologies designed to increase the capacity and speed of mobile telephone networks. LTE provides ultra-broadband speeds for mega multimedia applications by using a high performance antenna [1]. Meander line antennas provide a very important role in the designs of these systems [4-8]. Meander line antenna is electrically small, low profile antenna and has small structure [5]. Since wireless communication system is becoming more and more flexible day by day compared to wired system so equipment working in these systems requires low profile and multi band resonance [9]. The purpose of this paper work is to design a meander-line antenna which will be of smaller size, which will be able to operate in multiband and which will be applicable in 2G, 3G as well as 4G technologies. For achieving all these goals a folded type meander line antenna is being used whose performance characteristics are improved by inserting conductor line [10].

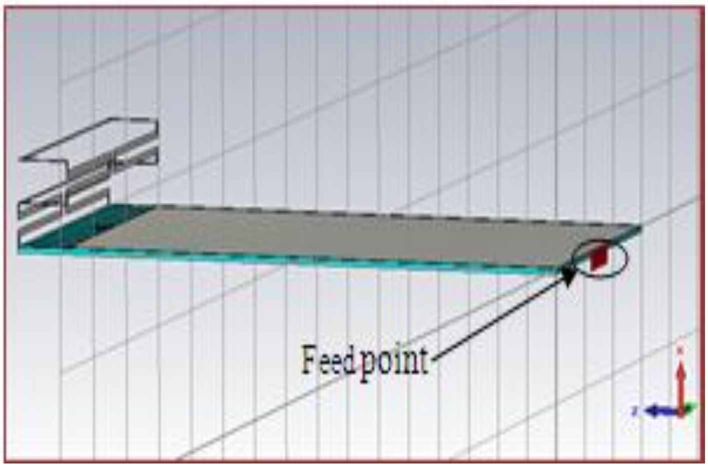
II. Antenna Design

For this paper to demonstrate the effect of conductor line three proposed antennas are designed and analysed. All antenna designs have been done with 'CST Microwave Studio' for the 3D layout. All the proposed antennas are mounted on a substrate of 60 mm width and 110 mm length and 0.8 mm thickness, with the relative permittivity of 4.4. As the ground plane, perfect electric conductor (PEC) is being used which is 60 mm wide and 100 mm long with a fixed thickness of 0.1 mm. All designs have dual folded loop strips and a capacitively coupled feeding line [11]. The loop pattern is meandered and folded to increase the electrical length but at the same time reduce the size it occupies. To excite at least one resonant mode by coupling, a strip line is arranged directly above the coupling element on the back plane in all designs and also to support the meandered loop another strip line is inserted at the beginning of the first fold.

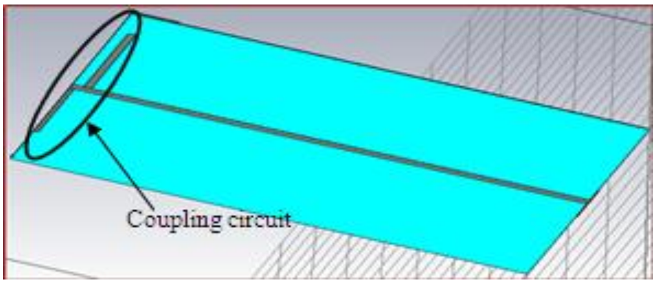
A. Design of Antenna_1

The design of Antenna_1 is the proposed antenna design. The total length of the folded and meandered loop strip is 425 mm, which is mounted within 10 mm, on the substrate, touching the finishing end of ground plane. The height of each fold is 6.5 mm i.e. total height of the antenna is (6.5mm+6.5mm+0.8mm) =13.8mm. The feed size has been chosen to ensure good impedance matching and resonance. Feed position is very important and is being chosen carefully to obtain good antenna performance.

It has been investigated that with single folding, only dual band resonance is achieved but after increasing the fold number the antenna becomes a triple band resonator. Figure 1(A, B) represents the orientation and back plane including capacitive coupling of Antenna_1.



(A)



(B)

Figure 1: (A) Orientation of Antenna_1 including feed point, (B) Back plane of Antenna_1 including coupling circuit

B. Design of Antenna_2

Antenna_2 is a folded type meander line antenna. By inserting a conductor line in Antenna_1 between the second strip line and at the edge of the meandered loop, Antenna_2 is designed. Due to insertion of the conductor line this design becomes a tetra band resonator as well as return loss is improved to -26 dB at 2.5 GHz where Antenna_1 has maximum -16 dB at 1.8 GHz. The antenna orientation of Antenna_2 is shown in Figure 2.

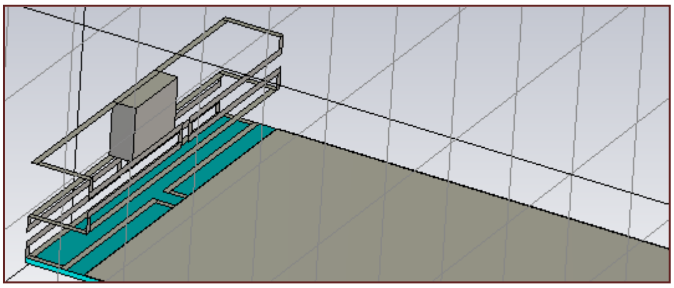


Figure 2: Orientation of Antenna_2

C. Design of Antenna_3

In this design, the antenna orientation is similar as Antenna_2, just the optimum value of conductor line is being found so that one resonating frequency, exact at 700 MHz is obtained. But the trade-off is that two frequency bands are being sacrificed for that. But at the same time in this design, for the optimized dimension of the conductor line the value of return loss has been improved. One of the resonating frequencies, 1.8604 GHz has found with return loss of around -35 dB. The antenna orientation of this design is being shown in Figure 3.

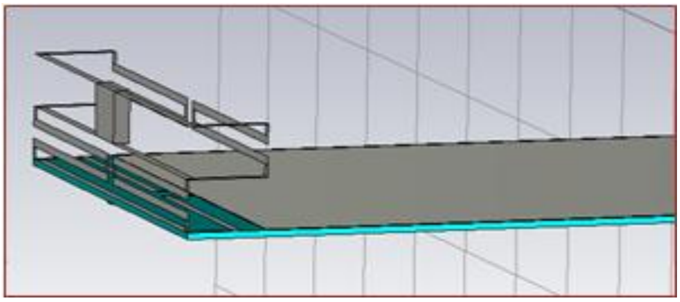


Figure 3: Orientation of Antenna_3

III. Results

Performance analysis of proposed antennas has been done with the help of simulation results. Following are the demonstration of Antenna_1, Antenna_2 and Antenna_3 with the illustration of different graphs, plots and tables.

A. Simulation Results of Antenna_1

After running simulation on Antenna_1 with CST Microwave Studio, it is found from the reflection coefficient of Antenna_1 that this antenna has three resonant frequencies i.e. antenna_1 is a triple band resonator. The three frequencies with maximum resonances are: 0.65362 GHz, 1.887 GHz and 2.4736 GHz. Figure 4 shows the reflection coefficient of Antenna_1 obtained after simulation.

Table I depicts the results of S-parameters magnitudes, radiation efficiency, gain, directivity and main lobe magnitude after running simulation on Antenna_1. Figure 5-7 represents the Far-field of three resonating frequencies with maximum resonance of Antenna_1.

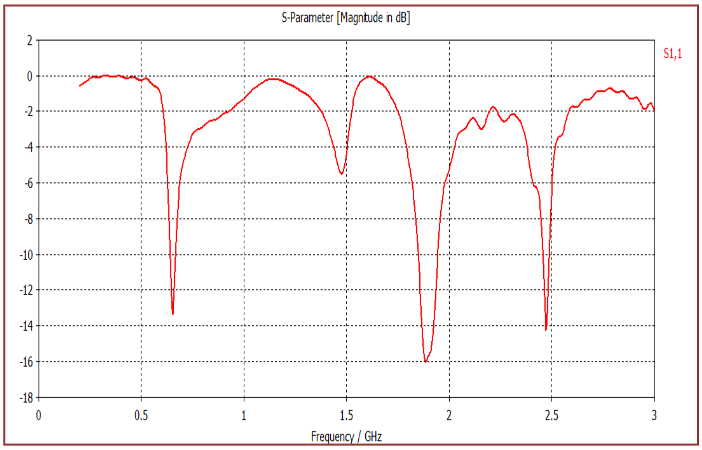


Figure 4: Reflection coefficient of Antenna_1 expressed in dB

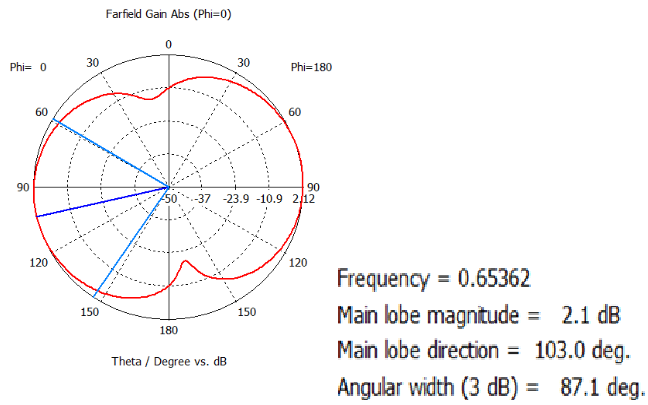


Figure 5: Far-field Response of Antenna_1 at 0 .65362 GHz in polar plotting

International Journal of Engineering Research
Volume No.3, Issue No.3, pp : 141-145
ISSN:2319-6890)(online),2347-5013(print)
01 March 2014

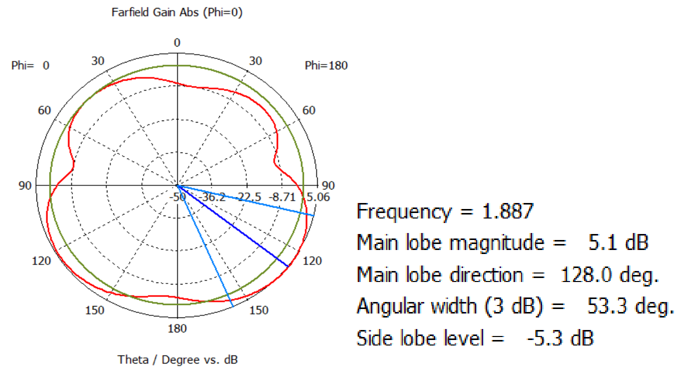


Figure 6: Far-field Response of Antenna_1 at 1.887 GHz in polar plotting.

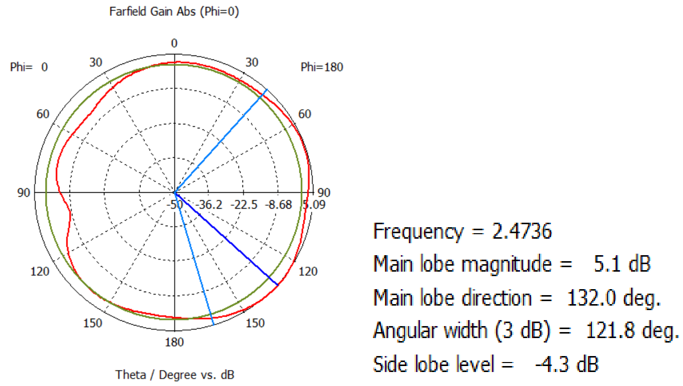


Figure 7: Far-field Response of Antenna_1 at 2.4736 GHz in polar plotting

According to Figure 5-7, the main lobe direction as well as angular width of three different resonant frequencies of Antenna_1 is not overlapping with each other i.e. Antenna_1 can be operated at three different frequency bands successfully which indicates that Antenna_1 is a triple band antenna.

Frequency (GHz)	Return Loss (dB)	Radiation Efficiency (%)	Gain (dB)	Directivity (dBi)	Main lobe magnitude [Phi=0°] (dB)
0.65362	-13.389	99.6	2.115	1.929	2.1
1.887	-16.031	99	5.272	5.038	5.1
2.4736	-14.263	93.45	5.191	3.404	5.1

Table I
Summarized Simulation Results of Antenna_1

The values of antenna parameters obtained after simulation is enlisted in Table I. Return loss and radiation efficiency of all three resonances are almost same whereas gain, directivity and main lobe magnitude of last two resonant frequencies are better than the first one. According to IEEE standard radar band(IEEE Std. 521) first two resonant frequencies fall in L band, also 1.887 GHz can be used for LTE/GSM1800 communication systems and the last one, 2.4736 GHz falls in S band, can also be used for PCS/UMTS/WLAN/LTE2400 and unlicensed band communications. Thus the application of this antenna can be in the field of Global Positioning System, Digital Audio Radio Satellite, Mobile Satellite Service Ancillary, Terrestrial Components, Direct-to-Home satellite television, PCS/UMTS/WLAN/LTE2400 and unlicensed band communication systems.

B. Simulation Results of Antenna_2

After running simulation on Antenna_2 with CST Microwave Studio, it is found from the reflection coefficient of Antenna_2 that this antenna has four resonant frequencies i.e. antenna_2 is a tetra band resonator. The four frequencies with maximum resonances are: 0.65919 GHz, 1.8157 GHz, 1.9388 GHz and 2.5351 GHz. Figure 8 represents the reflection coefficient of Antenna_2 obtained after simulation.

Table II depicts the results of S-parameters magnitudes, radiation efficiency, gain, directivity and main lobe magnitude after running simulation on Antenna_2. Figure 9-12 represents the Far-field of four resonating frequencies with maximum resonance of Antenna_2.

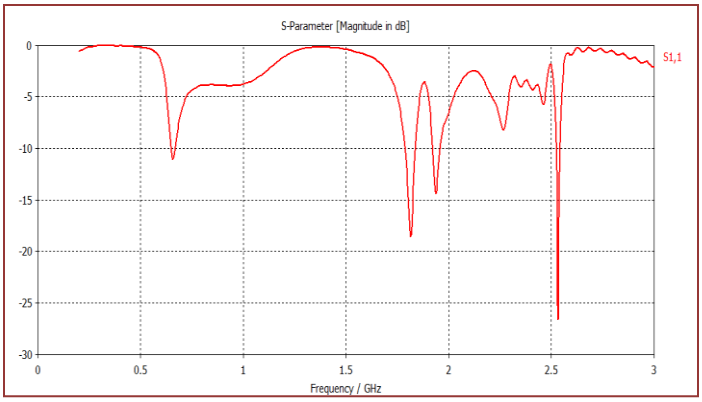


Figure 8: Reflection coefficient of Antenna_2 expressed in dB

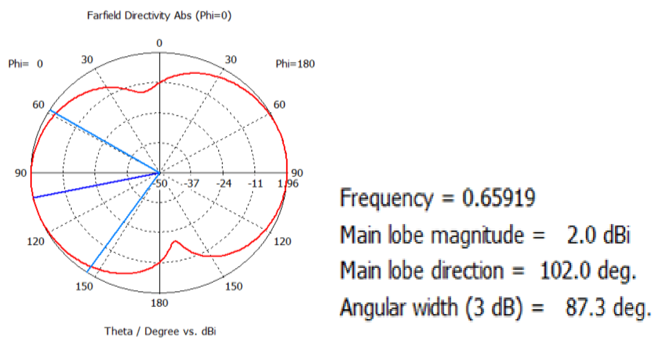


Figure 9: Far-field Response of Antenna_2 at 0.65919 GHz in polar plotting

International Journal of Engineering Research
Volume No.3, Issue No.3, pp : 141-145

ISSN:2319-6890)(online),2347-5013(print)
01 March 2014

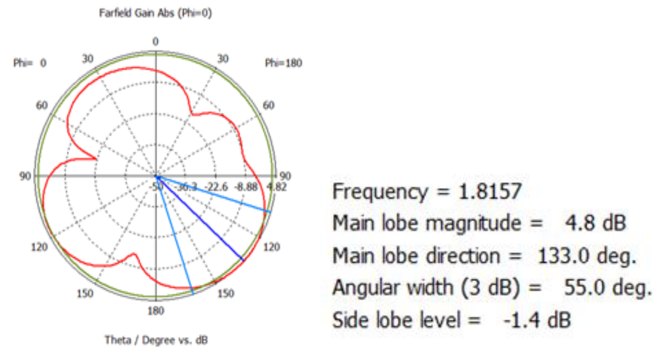


Figure 10: Far-field Response of Antenna_2 at 1.8157 GHz in polar plotting

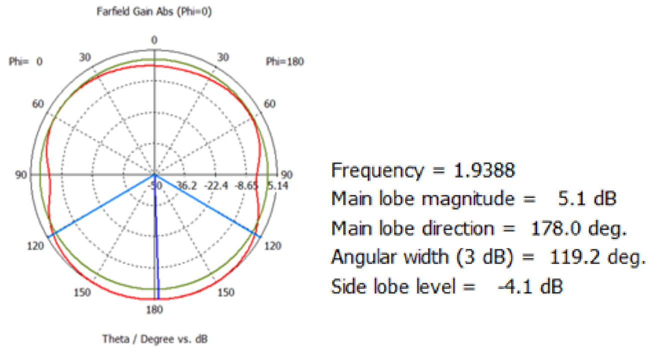


Figure 11: Far-field Response of Antenna_2 at 1.9388 GHz in polar plotting

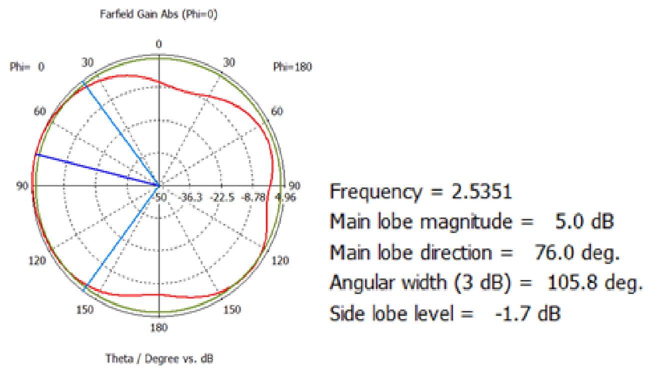


Figure 12: Far-field Response of Antenna_2 at 2.5351 GHz in polar plotting

According to Figure 9-12, the main lobe direction as well as angular width of four different resonant frequencies of Antenna_2 is not overlapping with each other i.e. Antenna_2 can be operated at four different frequency bands successfully which indicates that Antenna_2 is a tetra band antenna.

Table II
Summarized Simulation Results of Antenna_2

Frequency (GHz)	Return Loss (dB)	Radiation Efficiency (%)	Gain (dB)	Directivity (dBi)	Main lobe magnitude [Phi=0°] (dB)
0.65919	-11.096	97.85	2.205	1.948	2.0
1.8157	-18.542	99	4.895	4.791	4.8
1.9388	-14.399	97	5.401	5.370	5.1
2.5351	-26.619	85.91	4.960	5.610	5.0

The values of antenna parameters obtained after simulation is enlisted in Table II. Return loss of 2.5351 GHz is better than other three resonant frequencies whereas radiation efficiency of first three resonant frequencies is better than 2.5351 GHz. Gain, directivity and main lobe magnitude of 1.8157 GHz, 1.9388 GHz and 2.5351 GHz is almost same and better than 0.65919 GHz resonance. First three resonant frequencies of Antenna_2 fall in L band (according to IEEE Std. 521) and can be used in the field of Global Positioning System, Digital Audio Radio Satellite, Mobile Satellite Service Ancillary, Terrestrial Components, Direct-to-Home satellite television, and LTE/GSM1800 communication systems. The last resonant frequency can be used in PCS/UMTS/WLAN/LTE2400 and unlicensed band communication systems.

C. Simulation Results of Antenna_3

After running simulation on Antenna_3 with CST Microwave Studio, it is found from the reflection coefficient of Antenna_3 that this antenna has two resonant frequencies i.e. antenna_3 is a dual band resonator. The two frequencies with maximum resonances are: 0.70142 GHz and 1.8604 GHz. Figure 13 represents the reflection coefficient of Antenna_3 obtained after simulation.

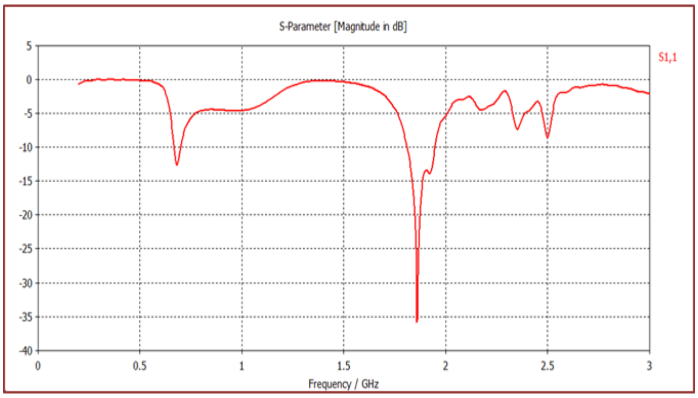


Figure 13: Reflection coefficient of Antenna_3 expressed in dB

Table III depicts the results of S-parameters magnitudes, radiation efficiency, gain, directivity and main lobe magnitude after running simulation on Antenna_3. Figure 14-15 represents the Far-field of two resonating frequencies with maximum resonance of Antenna_3.

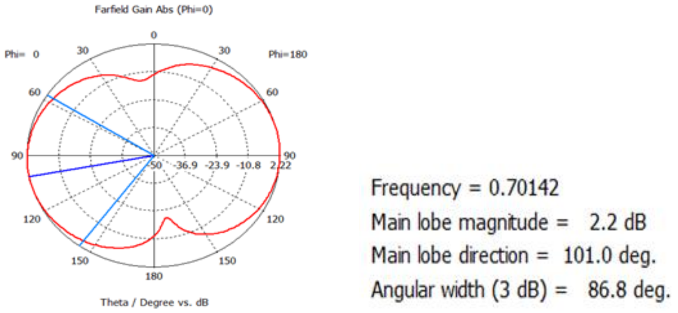


Figure 14: Far-field Response of Antenna_3 at 0.70142 GHz in polar plotting

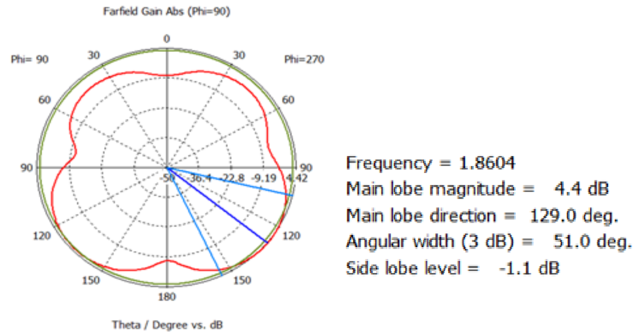


Figure 15: Far-field Response of Antenna_3 at 1.8604 GHz in polar plotting

Table III : Summarized Simulation Results of Antenna_3

Frequency (GHz)	Return Loss (dB)	Radiation Efficiency (%)	Gain (dB)	Directivity (dBi)	Main lobe magnitude [Phi=0°] (dB)
0.70142	-10	94.16	2.217	2.021	2.2
1.8604	-35.802	99	5.247	5.073	4.4

The values of antenna parameters obtained after simulation is enlisted in Table III. It can be stated that all antenna parameters including return loss, radiation efficiency, gain, directivity and main lobe magnitude are better in case of resonating frequency 1.8604 GHz, even 1.8604 GHz has least amount of return loss, -35 dB among all resonating frequencies of three proposed antenna designs. Both resonating frequencies fall in L band (according to IEEE Std. 521). 0.70142 GHz can be used in LTE700 and 1.8604 GHz can be used in GSM/LTE1800 communication systems.

IV. Conclusion

Considering all the results it can be concluded that the folded meander line antenna with conductor line will provide better performance. The first proposed antenna, Antenna_1 is a triple band resonator with maximum -16 dB return loss but due to insertion of conductor line in Antenna_1, it becomes a tetra band resonator, Antenna_2 as well as the return loss improves up to -26 dB. Antenna_2 is able to operate in the LTE/GSM1800, PCS/UMTS/WLAN/LTE2400, L band and S band. But with the optimized dimension of the conductor line Antenna_2 becomes a dual band resonator, Antenna_3. Antenna_3 has only two resonating frequencies but one frequency has around -35 dB return loss, which represents good characteristics of antenna. Also one resonating frequency of Antenna_3 is 0.07142 GHz, which makes the antenna to operate in the LTE700, along with GSM/LTE1800 communication system. So the insertion of conductor line enhances the performance of meander line antenna.

Acknowledgement

The author would like to thank Mr. Shuvashish Dey for his good comments related to this paper and also for his help in the antenna simulation using CST Microwave Studio.

References

i. *Sesia S., I. Toufik, and M. Baker, "LTE -The UMTS Long Term Evolution: From Theory to Practice", Wiley, Chichester, UK, 2009.*

ii. *Lin C.-C., S.-W. Kuo, and H.-R. Chuang, "A 2.4-GHz printed meander-line antenna for USB WLAN with notebook-PC housing" IEEE Microwave and Wireless Components, Vol. 15, No. 9, September 2005.*

iii. *Galehdar A., D. V. Thiel, S. G. O'Keefe, and S. P. Kingsley, "Efficiency variations in electrically small, meander line RFID antennas" IEEE Antennas and Propagation Society International Symposium, 2007.*

iv. *Braatenll B. D., M. Reich, and J. Glower, "A compact meander-line UHF RFID tag antenna loaded with elements found in right/left handed coplanar waveguide structures" IEEE Antenna and Wireless Propagation Letters, Vol. 8, 2009.*

v. *Ide K., S. Ijiguchi, and T. Fukusako, "Gain enhancement of low profile, electrically small capacitive feed antennas using stacked meander lines" International Journal of Antennas and Propagation, Volume 2010, Hindawi Publishing Corporation, 2010.*

vi. *Bentaher K., F. Choubani, T.-H. Vuong, and J. David, "Design of non -uniform meander line antennas for passive RFID tags in the UHF band" PIERS Proceedings, 400-403, Marrakesh, Morocco, March 20-23, 2011.*

vii. *Marrocco G. "Gain-optimized self-resonant meander line antennas for RFID applications" IEEE Antennas and Wireless Propagation Letters, Vol. 2, 2003.*

viii. *Ma M. J. and K. Deng, "The study and implementation of meander line antenna for an integrated transceiver design" Master Thesis in Electronics/Telecommunications, February 2010.*

ix. *Khaleghi A., "Dual band meander line antenna for wireless LAN communication" IEEE Trans. Antennas Propagat., Vol. 55, 1004-1009, March 2007.*

x. *D. Misman, L.A. Salamat, M. F. Abdul Kadir, M. R. Che Rose, M. S. R. Mohd Shah, M. Z. A. Abd. Aziz and M. N. Husain, "The Effect of Conductor Line to Meander Line Antenna Design".*

xi. *Li W. Y. and K. L. Wong, "Seven-band surface-mount loop antenna with a capacitively coupled feed for mobile phone application," Microwave and Optical Technology Letters, Vol. 51, No. 1, 81-88, Jan. 2009.*