



AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electronics Engineering and Electrical Communications

**DESIGN AND IMPLEMENT OF  
MULTIFUNCTION MULTIPLE-INPUT-  
MULTIPLE-OUTPUT PASSIVE CIRCUITS**

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS OF THE DEGREE OF**

Master of Science In Electrical Engineering

(Electronics Engineering and Electrical Communications )

By

**Amany Mostafa Ahmed Abd El Rahman**

Bachelor of Science In Electrical Engineering

(Electronics Engineering and Electrical Communications )

Thebes Higher Institute for Engineering, 2009

Supervised By

**Prof. Dr. Abdelhalim Zekry**

Professor, Department of Electronics and Communication Engineering,

Faculty of engineering Ain Shams University, Cairo, Egypt

**Prof. Dr. Adel Ezzat El-Hennawy**

Electronics and Communications Engineering Department,

Faculty of Engineering, Ain Shams University

**Dr. Reda Salama Ghoname**

Faculty of Engineering Girls' Campus King Abdul-Aziz University,

Jeddah, Saudi Arabia (1)

Electronics Research Institute, Cairo, Egypt (2)

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## Examiners' Committee

**Name and Affiliation**

**Signature**

Prof.

.....

Choose an item., University

Prof.

.....

Choose an item., University

Dr.

.....

Choose an item., University

Date: 22 January 2017

# Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

**Amany Mostafa Ahmed Abd El Rahman**

Signature

.....

Date: 22 January 2017

# Researcher Data

Name : Amany Mostafa Ahmed Abd El Rahman  
Date of birth : 20/08/1988  
Place of birth : Egypt  
Last academic degree : Bachelor of Science  
Field of specialization : Electrical Engineering  
University issued the degree : Thebes Higher Institute for Engineering  
Date of issued degree : May 2009  
Current job : Instructor

## Thesis Summary

Nowadays, wireless communication systems are increasingly developed to support demands of people. Many current communication systems are coming with several operating bands. Therefore, the multifunction microwave circuits design are Rapid developments in modern communication systems have imposed requirements such as small size and multifunction operation for RF / microwave components.

The thesis is divided into five chapters, as listed below:

- **Chapter One:** This chapter is an introduction to the thesis that clarifies the multifunction circuits, multifunction techniques and describes the types of multifunction circuits beside explanation of the RF Front-end of 4G mobile systems and the organization of this thesis.
- **Chapter Two:** This chapter explains the microstrip antenna, we proposed a design of a microstrip antenna but this design did not achieve the resonance frequency of the fourth generation of mobile communication system then we applied three techniques (the stub length, separation and via technique) to achieve our target. Finally, we introduced the design of the antenna that resonates at 5.2 GHz (4G) by using ready-made software package Zeland then we fabricated and measured this design. A comparison between the simulated results and measured results is introduced.
- **Chapter Three:** This chapter explains the compact microstrip diplexer with Bandpass filter. We applied the same three techniques of the antenna on the microstrip diplexer to achieve the best design with resonance frequency 5.2 GHz (4G) by using software package Zeland IE3D.

Also, we explained the microstrip bandpass filter-antenna (Filtenna). We applied the three techniques (stub length technique, separation technique and via technique) on the structure of the microstrip filter and designed the compact bandpass filter with resonance frequency 5.2 GHz (4G) by using software package Zeland IE3D then we fabricated and measured this design. A comparison between the simulated results and measured results is introduced.

- **Chapter Four:** we presented a design of multifunction circuit antenna, filter, and diplexer in one board (Anfilplexer) at resonance frequency 5.2GHz (4G) then we fabricated and measured this design. A comparison between the simulated results and measured results is introduced.

We proposed a design of multifunction circuit has a 3G resonance frequency at (2.42GHz), and another design has a 2G resonance frequency at (1.82GHz). Finally, we presented the library for front-end receiver of mobile generation in communication system by using the multifunction circuits.

- **Chapter Five:** This chapter discusses conclusion and future work for this research point.
- **Last Part:** it discusses appendices and references for this thesis.

**Key Words:** Front-end subsystem of mobile, 4G, Microstrip antenna, Microstrip BPF, and Microstrip Diplexer.

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**January 2017**

# Table of Contents

<b>LIST OF FIGURES.....</b>	<b>IV</b>
<b>LIST OF ABBREVIATIONS .....</b>	<b>XI</b>
<b>LIST OF SYMBOLS .....</b>	<b>XII</b>
<b>ABSTRACT.....</b>	<b>13</b>
<b>CHAPTER 1: INTRODUCTION.....</b>	<b>ERROR! BOOKMARK NOT DEFINED.</b>
1.1 INTRODUCTION.....	ERROR! BOOKMARK NOT DEFINED.
1.2 MINIATURIZATION TECHNIQUES FOR MULTIFUNCTIONAL CIRCUITS.....	ERROR! BOOKMARK NOT DEFINED.
1.2.1 Sharing a single resonator.....	Error! Bookmark not defined.
simultaneously [3].....	Error! Bookmark not defined.
1.2.2 Combining multiple components.....	Error! Bookmark not defined.
1.2.3 Applying multilayer technology. ....	Error! Bookmark not defined.
1.2.4 Integrating into substrate. ....	Error! Bookmark not defined.
1.2.5 Removing matching circuits. ....	Error! Bookmark not defined.
1.2.6 Multi tasking the microwave element. ....	Error! Bookmark not defined.
1.3 TYPES OF MULTIFUNCTION CIRCUIT .....	ERROR! BOOKMARK NOT DEFINED.
1.3.1 Antenna filter in multifunction circuit .....	Error! Bookmark not defined.
1.3.2 Antenna Diplexer in Multifunction Circuit.....	Error! Bookmark not defined.
1.3.3 Filter Diplexer in Multifunction Circuit .....	Error! Bookmark not defined.
1.4 RF FRONT END OF 4G MOBILE SYSTEM.....	ERROR! BOOKMARK NOT DEFINED.
1.5 MULTIFUNCTION OF SUBSYSTEM FRONT-END RECEIVER .....	ERROR! BOOKMARK NOT DEFINED.
1.6 THESIS OUTLINE .....	ERROR! BOOKMARK NOT DEFINED.
<b>CHAPTER 2: A PROPOSED MODEL FOR MICROSTRIP ANTENNA</b>	<b>ERROR! BOOKMARK NOT DEFINED.</b>
2.1 Microstrip Antenna .....	Error! Bookmark not defined.
2.2 Compact Microstrip Antenna Design.....	Error! Bookmark not defined.
2.3 Microstrip Compact Antenna Techniques .....	Error! Bookmark not defined.
2.3.1 Stub length analysis of compact microstrip antenna.....	Error! Bookmark not defined.
2.3.2 Different Separation techniques Results .....	Error! Bookmark not defined.
2.3.3 Via Location Study of Compact Antenna.....	Error! Bookmark not defined.
2.3.3.1 Design, Fabrication and Measured For Compact Microstrip Antenna with Via Location.2.....	Er ror! Bookmark not defined.
2.4 A proposed model for Antenna Design at 4G.....	Error! Bookmark not defined.
2.4.1 Antenna Equivalent Circuit .....	Error! Bookmark not defined.
2.4.2 Resonance properties .....	Error! Bookmark not defined.
2.4.3 Antenna fabrication and measurement.....	Error! Bookmark not defined.
2.5 Conclusion.....	Error! Bookmark not defined.



**CHAPTER 3: A PROPOSED MODEL FOR MICROSTRIP DIPLEXER AND BANDPASS FILTERS**

.....**ERROR!**  
**BOOKMARK NOT DEFINED.**

- 3.1 Introduction.....**Error! Bookmark not defined.**
- 3.2 Compact Microstrip Diplexer ..... **Error! Bookmark not defined.**
  - 3.2.1 MICROSTRIP DIPLEXER WITH BAND PASS FILTER ..... **ERROR! BOOKMARK NOT DEFINED.**
  - 3.2.2 COMPACT MICROSTRIP DIPLEXER DESIGN.....**ERROR! BOOKMARK NOT DEFINED.**
  - 3.2.3 COMPACT MICROSTRIP DIPLEXER TECHNIQUE.....**ERROR! BOOKMARK NOT DEFINED.**
    - 3.2.3.1 STUB LENGTH ANALYSIS OF COMPACT MICROSTRIP DIPLEXER ..... **ERROR! BOOKMARK NOT DEFINED.**
    - 3.2.3.2 DIFFERENT SEPARATION RESULT OF COMPACT MICROSTRIP DIPLEXER . **ERROR! BOOKMARK NOT DEFINED.**
    - 3.2.3.3 VIA LOCATION STUDY OF MICROSTRIP DIPLEXER..... **ERROR! BOOKMARK NOT DEFINED.**
  - 3.2.4 A PROPOSE COMPACT MICROSTRIP DIPLEXER DESIGN..... **ERROR! BOOKMARK NOT DEFINED.**
- 3.3 Microstrip Bandpass Filter ..... **Error! Bookmark not defined.**
  - 3.3.1 Microstrip Filter Antenna (Filtenna)..... **Error! Bookmark not defined.**
  - 3.3.2 Compact Microstrip Bandpass Filter Design ..... **Error! Bookmark not defined.**
  - 3.3.3 Compact Microstrip Bandpass Filter Techniques..... **Error! Bookmark not defined.**
    - 3.3.3.1 Stub Length Analysis of Compact Microstrip Filter .....**Error! Bookmark not defined.**
    - 3.3.3.2 Different Separation Result of Bandpass Filter ... **Error! Bookmark not defined.**
    - 3.3.3.3 Via Location Study of Compact Microstrip Filter. **Error! Bookmark not defined.**
  - 3.3.4 A propose of Compact Microstrip Filter Design ..... **Error! Bookmark not defined.**
    - 3.3.4.1 Compact Microstrip Bandpass Filter Equivalent circuit ....**Error! Bookmark not defined.**
    - 3.3.4.2 Bandpass Filter fabrication and measurement . **Error! Bookmark not defined.**
- 3.4 Conclusion.....**Error!**  
**Bookmark not defined.**

**CHAPTER 4: MULTIFUNCTION CIRCUIT (ANFILPLEXER) .....ERROR! BOOKMARK NOT DEFINED.**

- 4.1 Introduction ..... **Error! Bookmark not defined.**
- 4.2 Multifunction circuit (Anfilplexer) Design. .... **Error! Bookmark not defined.**
  - 4.2.1 Antenna Output in Multifunction Circuit (Anfilplexer) ..... **Error! Bookmark not defined.**
  - 4.2.2 Diplexer output in multifunction circuit (Anfilplexer) ..... **Error! Bookmark not defined.**
  - 4.2.3 Bandpass Filter output in multifunction circuit (Anfilplexer) .....**Error! Bookmark not defined.**
- 4.3 Fabrication and measurement of Compact Microstrip Multifunction circuit (Anfilplexer) . **Error!**  
**Bookmark not defined.**
- 4.4 Application of multifunction circuit design ..... **Error! Bookmark not defined.**

4.5	Simple Multifunction Circuit .....	<b>Error! Bookmark not defined.</b>
4.5.1	Antenna Output in Simple Multifunction Circuit .....	<b>Error! Bookmark not defined.</b>
4.5.2	Microstrip Diplexer Output in Simple Multifunction Circuit .....	<b>Error! Bookmark not defined.</b>
4.5.3	Bandpass Filter Output in Simple Multifunction Circuit...	<b>Error! Bookmark not defined.</b>
4.6	Conclusion .....	<b>Error! Bookmark not defined.</b>
<b>CHAPTER 5: CONCLUSIONS AND FUTURE WORK .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
5.1	Conclusion.....	<b>Error! Bookmark not defined.</b>
5.2	Future work.....	<b>Error! Bookmark not defined.</b>
<b>LIST OF REFERENCES .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
<b>APPENDICES .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
<b>APPENDIX A: RESPONSE PROPERTIES .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
<b>APPENDIX B: ADMITTANCE EQUIVALENT CIRCUIT OF DIPLEXER .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
<b>APPENDIX C: MICROWAVE NETWORK ANALYSIS OF BANDPASS FILTER.....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
<b>APPENDIX D: MODEL OF FROND-END MULTIFUNCTION CIRCUIT OF MOBILE GENERATION .....</b>		<b>ERROR! BOOKMARK NOT DEFINED.</b>
D.1	A MODEL OF THIRD GENERATION (3G) MULTICIRCUIT DESIGN.....	<b>Error! Bookmark not defined.</b>
D.2	A MODEL OF SECOND GENERATION (2G) MULTICIRCUIT DESIGN.....	<b>Error! Bookmark not defined.</b>

## List of Figures

FIGURE1.1	FILTENNA: (A) WITH THREE-PORT; (B) WITH MULTIPOINT. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE1.2	HIGH / LOW PASS FILTER DIPLEXER .....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE1.3	FRONT END BLOCK DIAGRAM. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE1.4	MULTIFUNCTION BLOCK DIAGRAM OF SUBSYSTEM FRONT-END RECEIVER	<b>ERROR! BOOKMARK NOT DEFINED.</b>
Figure 2.1	Antenna Geometry.....	<b>Error! Bookmark not defined.</b>
FIGURE 2.2	THE REFLECTION COEFFICIENT SIMULATION.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.3	COMPACT MICROSTRIP STUBS STRUCTURE.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.4	STUB LENGTH LA IN CASE.1.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.5	ANTENNA GEOMETRY WITH STUB LENGTH LB.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.6	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT WITH STUB LENGTH LB.	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.7	GEOMETRY OF ANTENNA WITH STUB LENGTH LC.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.8	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT WITH STUB LENGTH LC.	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.9	GEOMETRY OF ANTENNA WITH STUB LENGTH LD. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.10	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT WITH STUB LENGTH LD.	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.11	GEOMETRY OF ANTENNA WITH STUB LENGTH LE. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.12	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT WITH STUB LENGTH LE.	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.13	GEOMETRY OF ANTENNA SEPARATION (S) MM. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.14	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT FOR (S=0.05MM).	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.15	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT FOR (S=0.1MM).	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.16	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT FOR (S=0.15MM).	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.17	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT FOR (S=0.2MM).	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.18	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT FOR (S=0.25MM).	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.19	THE REFLECTION COEFFICIENT S11 SIMULATION RESULT FOR (S=0.3MM).	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.20	(A) VIA CONNECTING TWO MICROSTRIP TRANSMISSION LINES..	<b>ERROR! BOOKMARK NOT DEFINED.</b>
	(B) VIA EQUIVALENT CIRCUIT.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>

FIGURE 2.21	ANTENNA GEOMETRY WITH 3 VIA POSITION.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.22	SUMMARY OF DIFFERENT VIA POSITION AT STUB LENGTH LA. ...	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.23	ANTENNA GEOMETRY WITH 7 VIA POSITION.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.24	SUMMARY OF DIFFERENT VIA POSITION. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.25	RESONANCE FREQUENCY FOR CHANGING VIA POSITION .....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.26	ANTENNA GEOMETRY WITH VIA LOCATION.2 AT STUB LENGTH LA.	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.27	THE REFLECTION COEFFICIENT SIMULATED RESULT ANTENNA WITH VIA LOCATION.2 AT STUB LENGTH LA. ....	<b>ERROR!</b>
	<b>BOOKMARK NOT DEFINED.</b>	
FIGURE 2.28	FABRICATED COMPACT MICROSTRIP ANTENNA WITH VIA TECHNIQUE.	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.29	THE MEASURED RESULTS FOR REFLECTION COEFFICIENT FOR COMPACT MICROSTRIP ANTENNA WITH VIA TECHNIQUE. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.30	THE MEASURED RESULTS FOR VSWR FOR COMPACT MICROSTRIP ANTENNA WITH VIA.	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.31	THE MEASURED AND SIMULATED RESULTS FOR REFLECTION COEFFICIENT FOR COMPACT MICROSTRIP ANTENNA WITH VIA. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.32	THE ANTENNA CONFIGURATION.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.33	THE SIMULATION RESULTS OF THE REFLECTION COEFFICIENT FOR THE ANTENNA.	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.34	THE SIMULATION RESULTS OF VSWR FOR THE ANTENNA.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.35	(A)THE RADIATION PATTERN FOR THE ANTENNA AT 5.19GHZ, ..	<b>ERROR! BOOKMARK NOT DEFINED.</b>
	(B) ANTENNA GAIN AT 5.19GHZ. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.36	EQUIVALENT CIRCUIT OF ANTENNA DESIGN.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.37	FIGURE 3.42, STUB-LOADED OPEN-LOOP RESONATOR. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.38	FABRICATED COMPACT MICROSTRIP ANTENNA. ....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.39	THE MEASURED RESULTS FOR REFLECTION COEFFICIENT FOR COMPACT MICROSTRIP ANTENNA. ....	<b>ER</b>
	<b>ROR! BOOKMARK NOT DEFINED.</b>	
FIGURE 2.40	THE MEASURED RESULTS FOR VSWR FOR COMPACT MICROSTRIP ANTENNA.	<b>ERROR! BOOKMARK NOT DEFINED.</b>
FIGURE 2.41	THE MEASURED AND SIMULATED RESULTS OF REFLECTION COEFFICIENT FOR COMPACT MICROSTRIP ANTENNA.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>

Figure 3.1 Layout of Channel Filter 1 Comprising Single Spiral Resonators.....**Error! Bookmark not defined.**

FIGURE 3.2 EQUIVALENT CIRCUITS FOR THE PROPOSED DIPLEXER.....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.3 LAYOUT OF THE MICROSTRIP CONTIGUOUS DIPLEXER COMPRISING TWO FILTERS.**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.4 THE PHOTO OF THE FABRICATED DIPLEXER. ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.5 CONFIGURATION OF THE PROPOSED PLANAR DIPLEXER.....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.6 COMPACT MICROSTRIP DIPLEXER DESIGN .....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.7 GEOMETRY OF DIPLEXER WITH STUB LENGTH LA. ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.8  $|S_{11}|$ ,  $|S_{21}|$  AND  $|S_{31}|$  SIMULATION RESULT WITH STUB LENGTH LA.**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.9 GEOMETRY OF DIPLEXER WITH STUB LENGTH LB.....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.10  $|S_{11}|$ ,  $|S_{21}|$  AND  $|S_{31}|$  SIMULATION RESULT WITH STUB LENGTH LB.**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.11 GEOMETRY OF DIPLEXER WITH STUB LENGTH LC.....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.12  $|S_{11}|$ ,  $|S_{21}|$  AND  $|S_{31}|$  SIMULATION RESULT WITH STUB LENGTH LC.**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.13 GEOMETRY OF DIPLEXER WITH STUB LENGTH LD.....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.14  $|S_{11}|$ ,  $|S_{21}|$  AND  $|S_{31}|$  SIMULATION RESULT WITH STUB LENGTH LD.**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.15 GEOMETRY OF DIPLEXER WITH STUB LENGTH LE.....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.16  $|S_{11}|$ ,  $|S_{21}|$  AND  $|S_{31}|$  SIMULATION RESULT WITH STUB LENGTH LE.**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.17 GEOMETRY OF DIPLEXER SEPARATION (S). ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.18  $|S_{11}|$ ,  $|S_{21}|$ , AND  $|S_{31}|$  SIMULATION RESULT FOR (S=0.05MM).**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.19  $|S_{11}|$ ,  $|S_{21}|$ , AND  $|S_{31}|$  SIMULATION RESULT FOR (S=0.1MM).**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.20  $|S_{11}|$ ,  $|S_{21}|$ , AND  $|S_{31}|$  SIMULATION RESULT FOR (S=0.15MM).**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.21  $|S_{11}|$ ,  $|S_{21}|$ , AND  $|S_{31}|$  SIMULATION RESULT FOR (S=0.2MM).**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.22  $|S_{11}|$ ,  $|S_{21}|$ , AND  $|S_{31}|$  SIMULATION RESULT FOR (S=0.25MM).**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.23  $|S_{11}|$ ,  $|S_{21}|$ , AND  $|S_{31}|$  SIMULATION RESULT FOR (S=0.3MM).**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.24 STUB LENGTH (LA) WITH 3 VIA POSITION OF MICROSTRIP DIPLEXER.**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.25  $S_{11}$  OF DIFFERENT POSITION VIA AT STUB LENGTH LA. ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.26  $S_{21}$  OF DIFFERENT POSITION VIA AT STUB LENGTH LA. ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.27  $S_{31}$  OF DIFFERENT POSITION VIA AT STUB LENGTH LA. ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.28 STUB LENGTH (LE) OF THE DIPLEXER GEOMETRY WITH 7 VIA POSITION.**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.29 SUMMARIES OF DIFFERENT POSITION VIA AND S- PARAMETER ( $S_{11}$ ).**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.30 SUMMARY OF DIFFERENT POSITION VIA AND S- PARAMETER ( $S_{21}$ ).**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.31 SUMMARY OF DIFFERENT POSITION VIA AND S- PARAMETER ( $S_{31}$ ).**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.32 RESONANCE FREQUENCY FOR CHANGING VIA POSITION .....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.33 DIPLEXER CONFIGURATIONS. ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.34 THE SIMULATION RESULT OF COMPACT MICROSTRIP DIPLEXER. **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.35 EQUIVALENT CIRCUITS FOR DIPLEXER DESIGN. ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.36 THE GEOMETRY OF SIW ONE-SLOT AND TWO-SLOT FILTENNA. ... **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.37 GEOMETRY OF FILTENNA ARRAY. ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.38 COMPACT MICROSTRIP BANDPASS FILTER DESIGN.....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.39 GEOMETRY OF BANDPASS FILTER WITH STUB LENGTH  $L_A$ . .....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.40  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULT WITH STUB LENGTH  $L_A$ .**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.41 GEOMETRY OF BANDPASS FILTER WITH STUB LENGTH  $L_B$ . .....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.42  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULTS WITH STUB LENGTH  $L_B$ .**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.43 GEOMETRY OF BANDPASS FILTER WITH STUB LENGTH  $L_C$ . .....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.44  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULTS WITH STUB LENGTH  $L_C$ .**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.45 GEOMETRY OF BANDPASS FILTER GEOMETRY WITH STUB LENGTH  $L_D$ .**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.46  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULT WITH STUB LENGTH  $L_D$ .**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.47 GEOMETRY OF BANDPASS FILTER WITH STUB LENGTH  $L_E$ . ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.48  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULT WITH STUB LENGTH  $L_E$ .**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.49 GEOMETRY OF BANDPASS FILTER SEPARATION ( $S$ ) MM.....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.50  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULT FOR ( $S=0.05$ MM)....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.51  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULT FOR ( $S=0.1$ MM). ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.52  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULT FOR ( $S=0.15$ MM)....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.53  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULT FOR ( $S=0.2$ MM).....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.54  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULT FOR ( $S=0.25$ MM). ...**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.55  $|S_{11}|$  AND  $|S_{21}|$  SIMULATION RESULT FOR ( $S=0.3$ MM).....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.56 STUB LENGTH ( $L_A$ ) WITH 3 VIA POSITION OF MICROSTRIP BANDPASS FILTER.**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.57  $S_{11}$  OF DIFFERENT POSITION VIA AT STUB LENGTH  $L_A$ . ....**ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.58 STUB LENGTH (LE) OF BANDPASS FILTER GEOMETRY WITH 7 VIA POSITION. **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.59 (A)  $S_{11}$ , (B)  $S_{21}$ , SUMMARY OF DIFFERENT POSITION VIA OF BANDPASS FILTER. **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.60 RESONANCE FREQUENCY FOR CHANGING VIA POSITION ..... **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.61 BANDPASS FILTER CONFIGURATION..... **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.62  $|S_{11}|$ ,  $|S_{12}|$ ,  $|S_{21}|$ , AND  $|S_{22}|$  OF COMPACT MICROSTRIP FILTER. **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.63 EQUIVALENT CIRCUIT FOR BANDPASS FILTER DESIGN. .... **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.64 THE FABRICATED MICROSTRIP BANDPASS FILTER ..... **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.65 THE MEASURED RESULTS FOR S-PARAMETER FOR COMPACT MICROSTRIP BANDPASS FILTER..... **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 3.66 THE MEASURED AND SIMULATED RESULT FOR MICROSTRIP BANDPASS FILTER (A)  $S_{11}$ , (B)  $S_{21}$ ..... **ERROR! BOOKMARK NOT DEFINED.**

Figure 4.1 Geometry of Anfilplexer Design..... **Error! Bookmark not defined.**

FIGURE 4.2 THE SIMULATED RESULTS FOR REFLECTION COEFFICIENT FOR ANTENNA AT PORT 1 INPUT FEEDING..... **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 4.3 THE SIMULATED RESULTS FOR S-PARAMETER OF DIPLEXER AT PORT (2, 3, 4). **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 4.4 SIMULATED RESULTS FOR S-PARAMETER OF BANDPASS FILTER AT PORT (5, 6). **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 4.5 THE FABRICATED MICROSTRIP ANTENNA, DIPLEXER, AND BANDPASS FILTER (ANFILPLEXER)..... **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 4.6 THE MEASURED AND SIMULATED RESULTS FOR THE REFLECTION COEFFICIENT OF ANTENNA AT PORT 1..... **ERROR! BOOKMARK NOT DEFINED.**

FIGURE 4.7 THE MEASURED AND SIMULATED RESULTS FOR THE REFLECTION COEFFICIENT OF ANTENNA AT PORT 2..... **ERROR! BOOKMARK NOT DEFINED.**