

DESIGN OF MICROSTRIP PATCH ANTENNA FOR IEEE 802.16-2004
APPLICATIONS

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For my father and mother
For my wife and daughter
And for my brothers and sister



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ABSTRACT

This thesis presents microstrip patch antenna IEEE 802.16-2004 standards for microwave applications and WiMax. Narrow bandwidth (BW) is the main defect of microstrip patch antenna in wireless communication. The bandwidth can be improved by increasing the substrate thickness, and using air as substrate with low dielectric constant. The antennas were fabricated using FR4 board. Two types of microstrip antenna were used, the first was a single microstrip patch antenna and the second was using an air-gap technique as the dielectric between two antenna boards. The spacer of the air-gap has thickness of 2mm. It was made of wood to separate between the two boards. The transmission line model was used to get the approximate dimension for the design. Different parameters were obtained depending on the simulation and measurement. The Computer Simulations Technology (CST) software was used to simulate the design and the measurement was executed by Vector Network Analyzer (VNA). The two designs were compared to each other and found that some improvements were obtained on the air-gap technique. The bandwidth was improved by 4.51 % with air-gap technique and only 1.02 % with the single patch antenna.



Abstrak

Tesis ini mempersebahka *microstrip patches antenna* untuk standard IEEE 802.16-2004 bagi kegunaan mikrogelombang dan WiMax. *Microstrip patches antenna* menghadapi masalah lebar jalur yang sempit dalam komunikasi wayarles. Lebar jalur tersebut boleh ditambah baik dengan menambah ketebalan *substrate* dan menggunakan udara (pemalar dielektrik, 1) sebagai *substrate*. Kedua-dua antenna ini dibuat menggunakan papan litar tercetak FR4. Dua jenis *microstrip patch antenna* telah digunakan, pertama *microstrip patch antenna* tunggal, dan yang kedua menggunakan teknik sela-udara sebagai dielektrik yang memisahkan antara dua papan. Sela udara mempunyai ketebalan sebanyak 2 mm yang dibuat menggunakan kayu sebagai pemisah antara dua papan. Model *line* penghantaran digunakan untuk mendapatkan dimensi anggaran untuk merekabentuk parameter yang berbeza bergantung pada simulasi dan pengukuran. Perisian Simulasi Komputer Teknologi (CST) digunakan untuk mensimulasi rekabentuk sementara pengukuran dilaksanakan dengan rangkaian Vector Network Analyzer (VNA). Daripada simulasi lebar jalur mencapai peningkatan sebanyak 4,51% dengan teknik sela udara berbanding dengan antenna *patch* tunggal yang hanya mempunyai 1,02% sahaja.



CONTENTS

DESIGN OF MPA FOR IEEE 802.16-2004 APPLICATIONS	ii
ACKNOWLEDGEMENT	v
ABSTRACT	vi
CONTENTS	viii
LIST OF TABLES	xviii
LIST OF FIGURES	xix
LIST OF SYMBOLS AND ACRONYMS	xxii
LIST OF APPENDICES	xxiv
CHAPTER 1 INTRODUCTION	1

1.1	Overview	1
1.2	Antenna	1
1.3	Microstrip antenna advantage and limitation	3
1.4	Problem Statements	4
1.5	Project Objectives	4
1.6	Project Scopes	5
CHAPTER 2 LITERATURE REVIEW		7
2.1	History	7
2.2	Basic Communication System	9
2.3	The Cellular Concept	10
2.4	Different Mobiles Generation	11
2.4.1	First Generation System	11

	x
2.4.2 Second Generation System	12
2.4.2.1 GSM	12
2.4.2.2 Interim Standard (IS-136)	12
2.4.2.3 Personal Digital Cellular (PDC)	13
2.4.2.4 Interim Standard 95 (IS-95)	13
2.4.3 Third generation system	13
2.4.4 Forth generation system and beyond	14
2.5 Wireless local loop (WLL)	15
2.5.1 WiFi (802.11)	15
2.5.1.1 IEEE 802.11b	15
2.5.1.2 IEEE 802.11g	15
2.5.1.3 IEEE 802.11a	16



PT TA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

2.5.1.4	IEEE 802.11n	16
2.6	Bluetooth	16
2.7	IEEE 802.16	17
2.7.1	IEEE 802.16d	18
2.7.2	IEEE 802.16e	18
2.8	Importance of Antenna in Wireless System	19
2.9	Antennas Types	20
2.9.1	Wire Antennas	20
2.9.2	Aperture Antennas	21
2.9.3	Microstrip antenna	22
2.9.4	Array antenna	22
2.9.5	Reflector Antennas	23



PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

2.9.6	Lens Antennas	24
2.10	Antenna characteristics	24
2.10.1	The transmitting antenna	25
2.10.2	Field region of antennas	25
2.10.2.1	Reactive Near Field Region	26
2.10.2.2	Radiating Near Field Region (Fresnel Region)	26
2.10.2.3	Far Field Region	26
2.10.3	Fundamental parameters	27
2.10.3.1	Radiation pattern	27
2.10.3.2	Directivity	28
2.10.3.3	Input impedance	29
2.10.3.4	Voltage Standing Wave Ratio (VSWR)	29



PT TA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

2.10.3.5	Antenna Efficiency	30
2.10.3.6	Antenna Gain	30
2.10.3.7	Polarization	31
2.10.3.8	Q-factor	34
2.10.3.9	Bandwidth (BW)	34
CHAPTER 3 METHODOLOGY		35
3.1	Microstrip Antenna	35
3.2	Project Methodology	36
3.2.1	Design of Microstrip patch Antenna (MPA)	37
3.3	Surface Waves	38
3.4	Feeding Methods	39
3.4.1	Microstrip Line Feed	40

3.4.2	Coaxial Feed	40
3.4.3	Aperture Coupled Feed	41
3.4.4	Proximity coupled Feed	42
3.5	Method of Analysis	43
3.5.1	Transmission Line Model	43
3.6	Patch Antenna Design	45
3.6.1	FR4 Substrate Material	45
3.6.2	CST microwave studio	47
3.6.2.1	Installation Requirements	48
3.6.3	CST Microwave Studio Step Design	48
3.6.3.1	Select Template	49
3.6.3.2	Draw the Substrate Brick	50

3.6.3.3	Model the Coaxial Feed	53
3.6.3.4	Common Solver Settings	54
CHAPTER 4 Designs, Simulation, Fabrication and Measurement Result		57
4.1	Introduction	57
4.2	FR4 Substrate Dimension	58
4.3	Calculations for Patch Antenna Dimension	58
4.3.1	First Case (Single FR4 board) as Substrate Material	59
4.3.2	Second Case (air-gap with two FR4 Boards) as Substrate	60
4.4	Scattering parameters	62
4.5	Simulations Result	63
4.5.1	Simulation Result of Single Patch Antenna without Air-gap	63
4.5.1.1	1D Results	64

4.5.1.2	2D Results	65
4.5.2	Simulation Result of Patch Antenna with Air-gap	66
4.5.2.1	1D Results	67
4.5.2.2	2D Results	68
4.6	Fabrications process	69
4.6.1	UV Exposure	71
4.6.2	Developing	72
4.6.3	Etching	73
4.6.4	Stripping	74
4.6.5	PCB Cutter Machine	75
4.6.6	Drilling the Location of Coax Line	76
4.6.7	Fabricate MPA with Air-gap	77

4.7	Vector Network Analyzer (VNA)	78
4.7.1	Calibration the Vector Network Analyzer (VNA)	78
4.7.2	Connect MPA with Air-gap by VNA for Measurement	79
4.8	Measurement and Result	80
4.8.1	Smith Chart	81
4.8.2	Comparison of Simulated and Measured Results	82
4.9	Conclusion	84
	REFERENCES	85
	APPENDICES	88



PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

LIST OF TABLES

2.1:	Simple timeline in wireless technologies evolution	8
2.2:	Define some of the various 802.16 specifications	17
2.3:	The different 802.16 specification inside different bands	18
2.4:	Comparison of different 802.16 standards	19
4.1:	Measured microstrip patch antenna with air-gap technique	80
4.2:	The smith chart parameter	81
4.3:	Compare the result between the simulation and measurement of the MPA without air-gap and using air-gap	82



LIST OF FIGURES

1.1:	Microstrip patch antenna (MPA)	2
1.2:	Different types of patches	3
2.1:	Block diagram of digital communication system	9
2.2:	Frequency reuse in cellular networks	10
2.3:	Antenna is transition device	20
2.4:	Wire antenna configurations	21
2.5:	Aperture antenna configurations	21
2.6:	Microstrip patch antenna	22
2.7:	Typical array antennas	23
2.8:	Typical reflector antennas	23
2.9:	Typical lens antennas	24
2.10:	Transmit antenna rcl equivalent circuit	25
2.11:	Field region of an antenna	27
2.12:	Radiation Lobes and bandwidths of an antenna pattern	28
2.13:	Transmission line of antenna in transmitting mode	29
2.14:	Linear polarization	32
2.15:	Circular polarization	32
2.16:	Elliptical polarization	33
3.1:	Geometry of microstrip patch antenna(MPA)	36
3.2:	Flow chart for collect the information and writing thesis	36
3.3:	Design methodology	37
3.4:	Microstrip feed line	40
3.5:	Coaxial feed	41
3.6:	Aperture coupled feed	41
3.7:	Proximity coupled feed	41
3.8:	Impact the fringing fields to the effective length	44
3.9:	Single patch antenna with FR4 substrate	46

3.10:	FR4 substrate with air separation	46
3.11:	Spacer between the substrate dual boards	47
3.12:	Supa glue	47
3.13:	Structure of patch antenna with air-gap	49
3.14:	CST microwave studio project	49
3.15:	Antenna template	50
3.16:	Creation brick	50
3.17:	The first substrate creation	51
3.18:	The air-gap with two layers substrate	51
3.19:	Pick face tools	51
3.20:	Extrude Tool	52
3.21:	Dual patch antenna	53
3.22:	Coaxial feed	53
3.23:	Wave guide port excite port using picke face	54
3.24:	Waveguid port	54
3.25:	Frequency range	55
3.26:	Boundary conditions menu	55
3.27:	Patch antenna with boundary conditions	56
3.28:	Farfield monitor	56
4.1:	Dimensions of FR4 PCB used as substrate material	58
4.2:	Design location of the coax line feed.	61
4.3:	Structure of design and dimension for air-gap	62
4.4:	Simulation of single FR4 PCB	63
4.5:	Port signal for single FR4 PCB	64
4.6:	Simulated resonant frequency and S11 using FR4 only	64
4.7:	Simulated bandwidth (BW) of MPA using FR4 only	65
4.8:	Input impedance and coaxial mode	65
4.9:	Simulate MPA with air-gap	66
4.10:	Port signal for MPA using air-gap	67
4.11:	Simulated resonant frequency and S11 with air-gap	67
4.12:	Simulated BW of MPA using air-gap	68
4.13:	Input impedance and coaxial mode for MPA of air-gap	68
4.14:	Flow chart for fabrication process	69
4.15:	Dry film printed	70

4.16:	Fixing dry film on PCB	70
4.17:	UV exposure machine	71
4.18:	The FR4 PCB after exposed to UV light	71
4.19:	Removing the transparent layer	72
4.20:	Developing machine	72
4.22:	Etching process	73
4.23:	Stripping Machine	74
4.24:	The FR4 board after stripping process	74
4.25:	PCB cutter machine	75
4.26:	MPA design	75
4.27:	Drilling	76
4.28:	SMA PCB connector	76
4.29:	SMA connector soldered with FR4 PCB	77
4.30:	Microstrip patch antenna with air-gap	77
4.31:	The vector network analyzer (VNA) device	78
4.32:	Calibration of VNA	79
4.33:	MPA connected with VNA	80
4.34:	S11 measurement	81
4.35:	Smith chart of impedance	82
4.36:	Compare between measurement and simulations with air-gap and without air-gap for MPA	83



LIST OF SYMBOLS AND ACRONYMS

IEEE	-	Institute of Electrical and Electronics Engineers
WIMAX	-	Worldwide Interoperability for Microwave Access
WLAN	-	Wireless LAN
GHz	-	Giga Hertz
KHz	-	Kilo Hertz
FR4	-	Flame Retardant woven glass reinforced epoxy resin
BW	-	Bandwidth
Q-factor	-	Quality factor
CST	-	Computer Simulation Technology
1G	-	first Generation
2G	-	Second Generation
3G	-	Third Generation
4G	-	Fourth Generation
Mbit/s	-	Megabit/Second
A-D	-	Analogue-Digital
FM	-	Frequency Modulation
AMPS	-	Advanced Mobile Phone Service
TACS	-	Total Access Communication System
TDMA	-	Time Division Multiple Access
CDMA	-	Code Division Multiple Access
GSM	-	Global System for Mobil
IS	-	Interim Standard
PDC	-	Personal Digital Cellular
IMT	-	International Mobile Telecommunication
ITU	-	International Telecommunication Union
IP	-	Internet Protocol
TD-SCDMA	-	Time Division Synchronous Code Division Multiple Access

WLL	-	Wireless local loop
WiFi	-	Wireless Fidelity
ISM	-	industrial, scientific and medical band
DSS	-	Direct Sequence Spread
CCK	-	Complimentary Code Keying
PBCC	-	Packet Binary Convolution Coding
OFDM	-	Orthogonal Frequency Division Multiplexing
OFDMA	-	Orthogonal Frequency Division multiple access
MIMO	-	Multiple Input Multiple Output
FDD	-	Frequency Division Duplex
TDD	-	Time Division Duplex
VSWR	-	Voltage Standing Wave Ratio
CW	-	ClockWise
CCW	-	Counter Clock Wise
MPA	-	Microstrip patch Antenna
W	-	Patch Width
ϵ_{eff}	-	Effective Dielectric Constant
ΔL	-	Frings factor
L_{eff}	-	Effective length
VNA	-	Vector Network Analyzer
CST	-	Computer Simulation Technology
TST	-	Thin Sheet Technique
S-parameters	-	Scattering parameters
SMA	-	Sub Miniature type A
TEM	-	Transverse Electromagnetic Mode
AutoCAD	-	Aided Design or Computer Aided Drafting

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	The data from CST software and VNA analysis	89
B	The full description for SMA 503 type connector	95



PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH



CHAPTER 1

INTRODUCTION

1.1 Overview

Radio or wireless communication means to transfer information over long or short distance without using any wires. Peoples exchange information every day using pager, cellular, telephones, laptops, various types of personal digital assistants and other wireless communication product. Telecommunication is assisted transmission of signals over a distance for the purpose of communication. In early time this may involve the use of smoke signals, drums, semaphore (an apparatus for conveying information by means of visual signals, as a light whose position may be changed), flags or heliograph (a device for signalling by means of a movable mirror that reflects beam of light. In modern times, telecommunication typically involves the use of electronic transmitters such as the telephone, television, radio or computer.

1.2 Antenna

Antenna is basic component of any electronic system which depends on free space as a propagation medium. An antenna is a device used for radiating or receiving radio waves. It is a transducer between a guided electromagnetic wave and electromagnetic wave propagating in free space (Smith, 1988). The guiding device or transmission line may take the form of a coaxial line or a hollow pipe (waveguide), and it is used to transport electromagnetic energy from the transmitting source to the antenna or from the

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