

ANTENNAS AND PROPAGATION

Modeling, Simulation & Measurements

Edited by

MD. RAFIQUUL ISLAM B.Sc., M.Sc., Ph.D., MIEEE
International Islamic University Malaysia

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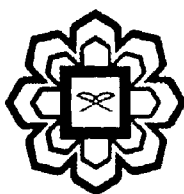
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

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Table of Content

Preface

Part I	Microstrip Antenna Design	Page
Chapter 1	Ultra Wideband Antennas <i>Muhammad Feroze Akbar J. Khan, Shaker MM. Al-Karaki, Md. Rafiqul Islam</i>	1
Chapter 2	Patch Antenna Parameters For Ultra Wideband Design <i>Muhammad Feroze Akbar J. Khan, Shaker MM. Al-Karaki, Md. Rafiqul Islam</i>	6
Chapter 3	Design Procedure for Microstrip Patch Antenna <i>Shaker MM. Al-Karaki, Muhammad Feroze Akbar J. Khan, Md. Rafiqul Islam</i>	13
Chapter 4	Design of Symmetrical Fed Patch UWB Antenna Using Partial Ground and Stairs <i>Md. Rafiqul Islam, AHM Zahirul Alam, Muhammad Feroze Akbar J. Khan and Shaker MM. Al-Karaki</i>	22
Chapter 5	Design of Symmetrical Fed Patch UWB Antenna Using Slotted Partial Ground And Stairs <i>Md. Rafiqul Islam, AHM Zahirul Alam, Muhammad Feroze Akbar J. Khan and Shaker MM. Al-Karaki</i>	33
Chapter 6	Design of Symmetrical Fed Patch UWB Antenna With Tuning Stub And Symmetrical Slotted Ground <i>Md. Rafiqul Islam, AHM Zahirul Alam, Muhammad Feroze Akbar J. Khan and Shaker MM. Al-Karaki</i>	40
Chapter 7	Design of Unsymmetrical Fed Patch UWB Antenna With Unsymmetrical Slotted Ground <i>Md. Rafiqul Islam, AHM Zahirul Alam, Shaker MM. Al-Karaki and Muhammad Feroze Akbar J. Khan</i>	49
Chapter 8	Ultra Wideband Antenna With Band Notch Using Asymmetrical Feedline <i>AHM Zahirul Alam and Md. Rafiqul Islam</i>	56
Chapter 9	Multi-Band Reconfigurable Antenna Using RF MEMS Switch <i>AHM Zahirul Alam and Md. Rafiqul Islam</i>	63
Chapter 10	Multi-Band Planar Patch Antenna <i>AHM Zahirul Alam and Md. Rafiqul Islam</i>	69
Chapter 11	Tuning Fork Type Planar Antenna <i>AHM Zahirul Alam and Md. Rafiqul Islam</i>	76
Chapter 12	Leaky-Wave Array Antenna <i>Mimi Aminah Wan Nordin, Hany E. Abd El-Raouf, AHM Zahirul Alam, Md. Rafiqul Islam</i>	83

Chapter 13	Overview of Smart Antenna System <i>Ibrahim A. Haji, Md. Rafiqul Islam, A.H. M. Zahirul Alam, Othman O. Khalifa Khaizuran Abdullah,</i>	
Chapter 14	Direction of Arrival Algorithms For Array Antenna Design <i>Ibrahim A. Haji, Md. Rafiqul Islam, A.H. M Zahirul Alam, Othman O. Khalifa, Khaizuran Abdullah</i>	97
Chapter 15	Analysis of Beamforming Algorithms <i>Ibrahim A. Haji, Md. Rafiqul Islam, A.H. M Zahirul Alam, Othman O. Khalifa and Khaizuran Abdullah</i>	108
Chapter 16	Design of Linear Array Antenna For Smart Antenna Application <i>Md. Rafiqul Islam, A.H. M Zahirul Alam, Othman O. Khalifa, Khaizuran Abdullah, Ibrahim A. Haji</i>	121

Part II Propagation Measurements and Modeling

Chapter 17	Propagation Path Loss Modeling For Wireless Applications <i>Ali Khadim, Jalel Chebil and Md Rafiqul Islam</i>	137
Chapter 18	Comparison between Measured and Predicted Path Loss For Mobile Communication in Malaysia <i>Jalel Chebil, Md Rafiqul Islam and Ali Khadim</i>	152
Chapter 19	Proposed Path Loss Models For Suburban Area in Kuala Lumpur <i>Jalel Chebil, Md Rafiqul Islam and Ali Khadim</i>	157
Chapter 20	Rain Rate Distribution For Microwave Link Design in Malaysia <i>Jalel Chebil and Tharek Abd. Rahman</i>	164
Chapter 21	Rain Rate Conversion Factor in Malaysia <i>Jalel Chebil and Tharek Abd. Rahman</i>	171
Chapter 22	A Matlab Program for Prediction of Rain Rate and Rain Attenuation Distributions in Malaysia <i>Jalel Chebil and Tharek Abd. Rahman</i>	180
Chapter 23	Time-Delay Neural Network For Rainfall Forecasting <i>Kyaw Kyaw Htike, Othman O. Khalifa and Md. Rafiqul Islam</i>	186
Chapter 24	Development of One-Minute Rain Rate Contour Maps For Radiowave Propagation in Malaysia <i>Jalel Chebil and Tharek Abd. Rahman</i>	193
Chapter 25	Rain Attenuation Measurements in Malaysia <i>Jalel Chebil and Tharek Abd. Rahman</i>	201
Chapter 26	Propagation Study on Rain Attenuation at 18 GHz in Malaysia <i>Jalel Chebil and Tharek Abd. Rahman</i>	206
Chapter 27	Investigation Of Rain Attenuation At 38 GHz	214

	<i>Ahmad Fadzil Ismail and Khairayu Badron</i>	220
Chapter 28	Rain Attenuation Prediction Models For Earth-Space Link <i>Ahmad Fadzil Ismail and Khairayu Badron</i>	
Chapter 29	Development of A Modified Rain Attenuation Prediction Model <i>Ahmad Fadzil Ismail and Khairayu Badron</i>	226
Chapter 30	Antenna Losses Due To Rainfall And Its Effect On The Rain Attenuation Measurements <i>Jalel Chebil and Tharek Abd. Rahman</i>	233
Chapter 31	Modeling Of Wet Antenna Losses For Frequencies 15-38 GHz <i>Md. Rafiqul Islam, Jalel Chebil and Tharek Abdul Rahman</i>	239
Chapter 32	Path Length Reduction Factor For Rain Attenuation Prediction In Malaysia <i>Md. Rafiqul Islam, Jalel Chebil, Ahmad Fadzil Ismail and Tharek Abdul Rahman</i>	248
Chapter 33	Frequency Scaling Methods For Rain Attenuation Prediction <i>Md. Rafiqul Islam, Jalel Chebil, Ahmad Fadzil Ismail and Tharek Abdul Rahman</i>	256
Chapter 34	Proposed Frequency Scaling Method Based On Measured Rain Attenuation Data <i>Md. Rafiqul Islam, Jalel Chebil and Tharek Abdul Rahman</i>	269
Chapter 35	Analyses Of Rain Fade Characteristics For A 38 GHz Link In The Tropics <i>Ahmad Fadzil Ismail and Khairayu Badron</i>	278
Chapter 36	Worst-Month Statistics Modeling Based on Measured Data <i>Md. Rafiqul Islam, Jalel Chebil and Tharek Abdul Rahman</i>	285
Chapter 37	Worst-Month Rain Fade Statistics at 38 GHz <i>Ahmad Fadzil Ismail and Khairayu Badron</i>	298
Chapter 38	Rain Fade Slope Prediction Model Based On Satellite Data Measured In Malaysia <i>Md. Rafiqul Islam, Khalid Al-Khateeb, Sheroz Khan and Hassan Dao</i>	303
Chapter 39	Effects Of Rain On Free Space Optical Propagation <i>Suriza A.Z., Md. Rafiqul Islam, Wajdi Al-Khateeb and A.W. Naji</i>	310
Chapter 40	Investigation Of Solar Environment Effects On Space Assets & Satellite Signals <i>Othman O. Khalifa, Md. Rafiqul Islam, Jalel Chebil, Saad Bashir and Sivamohan A/L V.Shunmugam</i>	318

Chapter 40

Investigation of Solar Environment Effects on Space Assets & Satellite Signals

Othman O. Khalifa¹, Md Rafiqul Islam¹, Jalel Chebil¹, Saad Bashir¹
and Sivamohan A/L V. Shunmugam¹

40.1 Introduction

The sun-earth environment is the region of space extending from the surface of the sun out to, and including, the earth's ionosphere and magnetic field. It is a harsh environment dominated by electromagnetic radiation and electrically charged particles from the sun. It is subject to dramatic and violent change as events on the sun, such as solar flares, blast streams of radiation and energetic particles towards the earth. The goal of this study is to highlight the effects caused by the solar radiation. Despite being far away from everyday experience, the sun-earth environment has a surprisingly wide range of effects on many aspects of everyday life. Changes to conditions in the sun-earth environment are often called "space weather" and this can cause significant damage to technological systems, particularly to communications. Space weather results from changes in the speed or density of the solar wind, the continuous flow of charged particles from the sun past the earth and into interplanetary space. This flow distorts the earth's magnetic field, compressing it in the direction of the sun and stretching it out in the anti-sun direction. Fluctuations in the flow of solar wind cause variations in the strength and direction of the magnetic field measured near the surface of the earth. Abrupt changes in this dynamic medium are called geomagnetic disturbances [1].

At the same time the earth's ionosphere can be severely disturbed by flows of charged particles in the region. This is important because the ionosphere acts as a "mirror", reflecting High Frequency (HF) signals and allowing cheap and convenient communication over long distances. HF is significant for many people including defense, emergency services, broadcasters, and marine and aviation operators. Many other phenomena are associated with space weather. Some of the more notable include heating of the outer layers of the earth's atmosphere altering the orbits of satellites and contributing to their early return to earth. Surge currents induced in power lines sometimes lead to the failure of power grids and currents in long pipelines cause increased corrosion and solar interference to satellites [1].

Most of people are familiar with the effect of weather on their lives. Often this is relatively minor - determining what to wear and where to go; but on occasions, it is dramatic and costly as major events inflict severe damage and even loss of life. Space weather is another important kind of weather that normally people do not know. Space weather serves great importance to many modern technologies. Like ordinary weather,

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