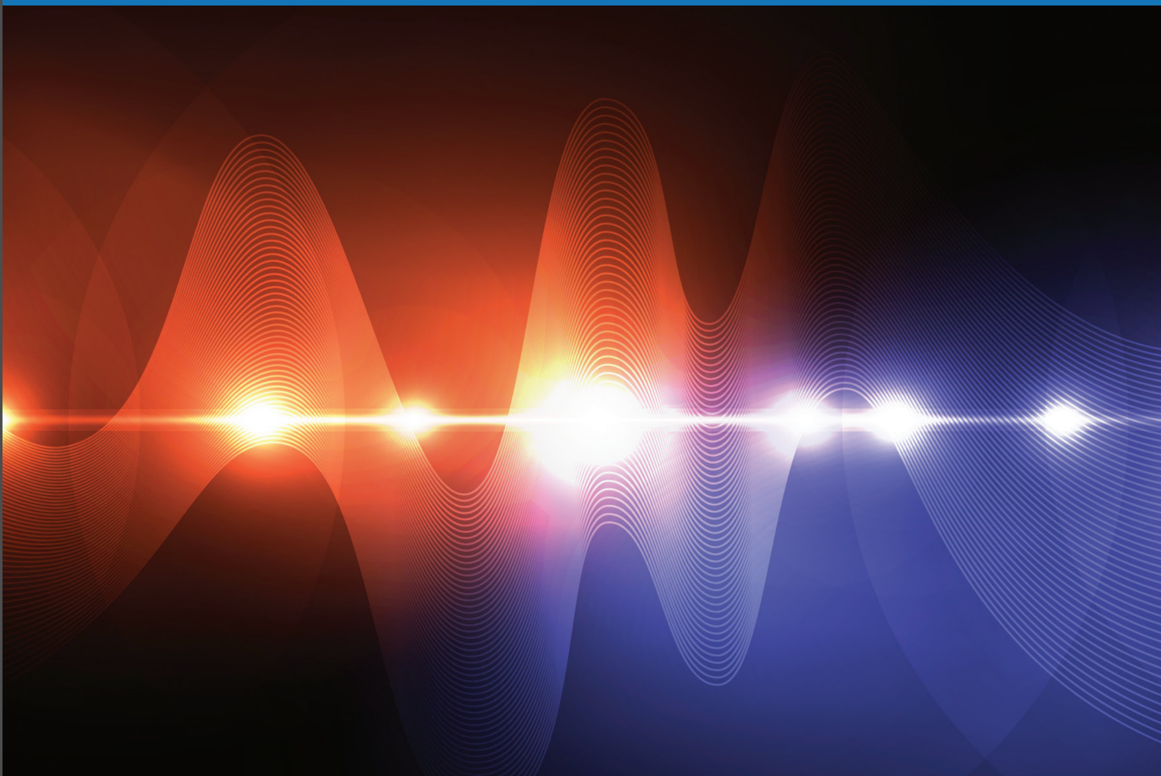
CRC Press
Taylor & Francis Group

Ultra Wideband Antennas

DESIGN, METHODOLOGIES, AND PERFORMANCE



Giselle M. Galvan-Tejada
Marco A. Peyrot-Solis
Hildeberto Jardón-Aguilar

Ultra Wideband Antennas

DESIGN, METHODOLOGIES, AND PERFORMANCE

Ultra Wideband Antennas

DESIGN, METHODOLOGIES, AND PERFORMANCE

Giselle M. Galvan-Tejada
COMMUNICATIONS SECTION
DEPARTMENT OF ELECTRICAL ENGINEERING
CINVESTAV-IPN
MEXICO CITY, MEXICO

Marco A. Peyrot-Solis
INIDETAM
MEXICAN NAVY
VERACRUZ, MEXICO

Hildeberto Jardón-Aguilar
COMMUNICATIONS SECTION
DEPARTMENT OF ELECTRICAL ENGINEERING
CINVESTAV-IPN
MEXICO CITY, MEXICO

CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Version Date: 20150506

International Standard Book Number-13: 978-1-4822-0651-7 (eBook - PDF)

Visit the Taylor & Francis Web site at
http://www.taylorandfrancis.com

and the CRC Press Web site at
http://www.crcpress.com

To my beloved husband, Aldo Gustavo and young children Gustavo Stuart and Minerva Montserrat, for their love, support and encouragement all the time. You are always in my mind and heart.

To my mom for giving me the warm space of her being and my dad for giving me the blood of an engineer.

To all my brothers and sisters who were always supportive during the progress of this book.

Giselle

This book is dedicated to my wife Cynthia, and my son and daughter Marco Antonio Cesar and Cynthia Carolina for their patience and support through the long nights when this work was completed.

Marco Antonio

Contents

List of Figures

List of Tables

Preface

Over the past decades ultra wideband antennas have attracted the attention of the scientific community due to their wide variety of applications such as body area networks, radar, imaging, spectrum monitoring, electronic warfare, and wireless sensor networks, among others. As a result, a vast quantity of work presenting diverse designs has been reported around the world. In spite of this, some other possibilities have to be explored in the UWB antenna's design in such a way that current challenges may be solved.

Thus, this book was conceived as reference material for the development of UWB antennas. Different aspects are considered in this text, from recent proposals on ultra wideband antennas reported in diverse forums, theory specific for these radiators, up to guidelines for the design of omnidirectional and directional UWB antennas.

According to current tendencies, two types of antennas are identified based on their structures, planarized and planar, to distinguish between those flat radiators embedded and non-embedded on the ground plane. An important concept used here is the solid-planar equivalence, which allows that flat structures can be implemented instead of volumetric antennas. This principle is vital for the developments of UWB antennas on portable equipment and for the recent body area networks, where small low profile radiators are intended to integrate to wearable devices.

Time domain signal analysis for UWB antennas, from which the distortion phenomenon can be modeled through group delay and phase linearity, is addressed as well. It is one of the main differences with traditional narrowband or wideband antennas where transient response has not been considered. Thus, in particular, some important quantities associated with the impulse response of UWB antennas are reviewed.

Design methodologies for omnidirectional and directional antennas are described, and the dependence on their operation as a function of distinct factors (ground plane, beveling on radiator, height/wide proportion, reflector, etc.) is examined in depth. In all cases, three objectives are considered: Impedance matching, phase linearity, and variations of the shape of the radiation pattern. Performance comparisons among different reported UWB designs are discussed.

Some current tendencies and unresolved problems in the field of UWB antennas are also noted. The book ends with a brief exposition of numerical techniques for electromagnetics, including the generalities of the classical Finite Differences Method, Finite Element Method, and Method of Moments.

Certain antenna models are taken to illustrate particular conceptual aspects of these methods.

Outline

In summary, the main points addressed in this book are

- An outline of recent developments on UWB antennas
- Developed theory for UWB antennas in frequency and time domains
- Design methodologies for omnidirectional and directional UWB antennas
- Performance comparisons of different UWB antennas
- A vision of tendencies and unresolved problems to date
- An exposition of numerical methods for electromagnetics oriented to antennas

Regarding simulations, it is worth mentioning that CST Microwave Studio was the platform used through this book.

For product information, please contact:
CST-Computer Simulation Technology AG
Bad Nauheimer Strasse 19
64289 Darmstadt, Germany
Tel: +49 6151 7303 0
Fax: +49 6151 7303 100
Email: info@cst.com
Web: www.cst.com

Plots presented in distinct sections of chapters were generated using MATLAB®.

For product information, please contact:
The MathWorks, Inc.
3 Apple Hill Drive
Natick, MA 01760-2098 USA
Tel: 508-647-7000
Fax: 508-647-7001
E-mail: info@mathworks.com
Web: www.mathworks.com

Acknowledgments

The authors are deeply grateful to MSc Ruben Flores-Leal for his support in simulating many antenna structures, and Mrs. Eva Ojeda-Sanchez for her help in drawing a vast quantity of figures through the whole manuscript. Seeing our ideas transformed into electronic images was possible thanks to the amazing tasks of both appreciated persons, who were always in total support of this book. This work was also enabled by the SEMAR-CONACYT project 2003-C02-11873, MEXICO.

Finally, we would like to express the honor we feel on writing this book in the year of the 150th anniversary of the publication of the dissertation of James Clerk Maxwell, *A Dynamical Theory of the Electromagnetic Field*, who has been an academic guide and inspiration for our work with antennas.

Giselle M. Galvan-Tejada
Marco A. Peyrot-Solis
Hildeberto Jardón-Aguilar
Mexico

About the Authors

Giselle M. Galvan-Tejada was born in Mexico City, Mexico. She earned a B.Sc. degree in communications and electronics engineering from the National Polytechnic Institute, Mexico, in 1994, an M.Sc. degree in electrical engineering from the Center for Research and Advanced Studies of IPN, Mexico, in 1996, and a PhD degree in electronics and telecommunications engineering from the University of Bradford, U.K., in 2000. Currently, she is working in the Communications Section of the Department of Electrical Engineering of the Center for Research and Advanced Studies of IPN, Mexico, as a lecturer and full-time researcher. She is member of the IEEE and National Researcher of the National Council of Researchers of Mexico. Her research interests include radio communication systems, wireless sensor networks, radio propagation, antenna array technology, ultra wideband antennas, WiMAX, space division multiple access, and techniques to make efficient use of the spectrum.

Marco Antonio Peyrot-Solis was born in Veracruz, Mexico. He earned a BS degree in naval sciences engineering from the Mexican Naval Academy, an MSc degree in electrical engineering from the United States Naval Postgraduate School and a PhD in communications from the Centre for Research and Advanced Studies of the National Polytechnic Institute in Mexico City in 1989, 2003 and 2009, respectively. Currently, he is working for the Mexican Navy, and his research interests are UWB antennas and electromagnetic compatibility.

Hildeberto Jardón-Aguilar was born in Tenancingo, Mexico. He earned a BS degree in electrical engineering from ESIME-IPN, and a PhD degree in radio systems from the Moscow Technical University of Telecommunications and Informatics. He has been working as a full professor at the Center for Research and Advanced Studies of IPN since 1985. His research interests include analysis of nonlinearities in RF and microwave circuits, electromagnetic compatibility, antennas and photonic systems. He is the author of five books and more than 100 technical papers published in journals and symposiums.