

The Radar Revolution

Looking Toward Future Applications





Microwave Magazine and MTT Society Officers

Editor

Alfy Riddle, Kumu Networks, microwave.editor@ieee.org

Assistant Editor

Sharri Shaw, NIST, microedt@nist.gov

Associate Editors

Robert H. Caverly, Villanova University, Pennsylvania, United States robert.caverly@villanova.edu Nuño Borges Carvalho, University of Aveiro,

Portugal, nbcarvalho@ua.pt

Ana Collado, CTTC, Barcelona, Spain, ana.collado@cttc.cat

Simone Bastioli, RS Microwave, New Jersey, United States sbastioli@rsmicro.com

Ali Darwish, American University in Cairo, Egypt, ali@darwish.org

Luca Roselli, *University of Perugia, Italy,* urlofi@tin.it; luca.roselli@unipg.it

Anding Zhu, University College, Dublin, Ireland, anding.zhu@ucd.ie

Christian Fager, University of Chalmers, Sweden, christian.fager@chalmers.se

Mohammad S. Hashmi, Indraprastha Institute of Information Technology, Delhi, India, mshashmi@iiitd.ac.in

Almudena Suarez, University of Cantabria, Spain, almudena.suarez@unican.es

Columns and Departments

MicroBusiness

Fred Schindler, RF Micro Devices, m.schindler@ieee.org

Health Matters

James C. Lin, *University of Illinois-Chicago*, lin@uic.edu

Microwave Surfing

Rajeev Bansal, University of Connecticut, rajeev@engr.uconn.edu

Book Reviews

James Chu, Southern Polytechnic State University, Georgia, jchu@spsu.edu

Education Corner

Ramesh Gupta, Lightsquared, Washington, D.C., ramesh.gupta@ieee.org

Membership News

Bela Szendrenyi, Advantest, bela.szendrenyi@advantest.com

New Products

Ken Mays, KMays Technical Services, microwave.newproducts@ieee.org

In Memoriam Contributions

John T. Barr IV, j.barr@ieee.org

Ombuds Officer

Ed Niehenke, Niehenke Consulting, e.niehenke@ieee.org

IEEE Periodicals Magazines Department

Mark Gallaher, Managing Editor
Janet Dudar, Senior Art Director
Gail A. Schnitzer, Associate Art Director
Theresa L. Smith, Production Coordinator
Felicia Spagnoli, Advertising Production Manager
Peter M. Tuohy, Production Director
Dawn M. Melley, Editorial Director
Fran Zappulla, Staff Director, Publishing Operations

Advertising Sales

Mark David, Sr. Manager Advertising & Business Development +1 732 465 6473, fax +1 732 981 1855

Digital Object Identifier 10.1109/MMM.2016.2551478



IEEE prohibits discrimination, harassment, and bullying. For more information, visit http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html.



Volume 17 • Number 7 • July 2016 • ISSN 1527-3342

features

26 Doing More with Doppler

Frequency-Only Radars and Other Frequency-Based Systems with Applications Yılmaz Kalkan

53 An Elegant Solution

An Alternative Ultra-Wideband Transceiver Based on Stepped-Frequency Continuous-Wave Operation and Compressive Sensing Haofei Wang, Vinh Dang, Linyun Ren, Quanhua Liu, Lixiang Ren, Erke Mao, Ozlem Kilic, and Aly E. Fathy

64 Tag, You're It!

Radar Cross Section of Chipless RFID Tags Nemai Chandra Karmakar



IEEE for the Microwave & Wireless Engineer

IEEE Microwave Theory and Techniques SocietyThe Microwave Theory and Techniques Society (MTT-S) is an organization, within the framework of the IEEE, of members with principal professional interests in the field of microwave theory and techniques. All members of the IEEE are eligible for membership in the Society. Information about joining the IEEE or the Society is available on the Web, http://www.ieee.org/membership.

MTT-S AdCom

The Society is managed by an Administrative Committee (AdCom) consisting of 21 elected members of the Society plus additional ex-officio members as provided in the MTT-S Constitution and Bylaws, which is available on the Web, http://www.mtt.org.

Officers

President: President-Elect: Secretary: Treasurer:

Elected Members

Alaa Abunjaileh Silvio Barbin Tom Brazil Ramesh Gupta Rashaunda Henderson Wei Hong Arne Jacob Shiban Koul Iov Laskar Tim Lee Gregory Lyons Mohammad Madihian

Ke Wu Dylan Williams Maurizio Bozzi Alaa Abunjaileh

Sergio Pacheco George Ponchak Sanjay Raman James Rautio Jose E. Rayas-Sanchez Steve Reising Magdalena Salazar-Palma Atsushi Sanada Dominique Schreurs Michael Steer Dylan Williams Ke Wu

Ex Officio Members (with vote)

Immediate Past Presidents:

Tim Lee (2015) Robert Weigel (2014) Madhu Gupta (2013) Nick Kolias (2012)

Honorary Life Members:

Tatsuo Itoh Richard Sparks Peter Staecker

IEEE Trans. Microwave

Theory & Techniques Coeditors:

Jenshan Lin Dominique Schreurs

IEEE Microwave & Wireless Components Letters Editor: IEEÉ Microwave Magazine Editor: IEEE Trans. Terahertz Science &

Technology Editor:

N. Scott Barker Alfy Riddle

Jan Stake

IEEE Microwave Magazine (ISSN 1527-3342) (IEMMFF) is published monthly by the Institute of Electrical and Electronics Engineers, Inc. Headquarters: 3 Park Avenue, 17th Floor, New York, NY 10016-5997 USA. Responsibility for the contents rests upon the authors and not upon the IEEE, the Society, or its members. IEEE Service Center (for orders, subscriptions, address changes): 445 Hoes Lane, Piscataway, NJ 08854. Telephone: +1 732 981 0060, +1 800 678 4333. Individual copies: IEEE members USS20.0 per copy. Subscription rates: Subscriptions for Society members are included with membership dues. Nonmember subscription rates available upon request. Copyright and reprint permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limits of U.S. with credit to the source. Libraries are permitted to photocopy beyond the limits of U.S. Copyright law for the private use of patrons those articles that carry a code at the bottom of the first page, provided the per-copy fee is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923 USA. For other copyring, reprint, or republication permission, write Copyrights and Permissions Department, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854 USA. Copyright © 2016 by the Institute of Electrical and Electronics Engineers, Inc. All rights reserved. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Ride along enclosed. Postmaster: Send address changes to IEEE Microtoxte Magazine, IEEE Operations Center, 445 Hoes Lane, Piscataway, NJ 08854 USA. Canadian GST #125634188
PRINTED IN THE USA

Dividal Object Identifier 10.1109/MMM. 2016.2551479

Digital Object Identifier 10.1109/MMM.2016.2551479

columns & departments

- From the Editor's Desk = Alfy Riddle Radar Management
- President's Column = Ke Wu Challenges and Opportunities for Education in RF/Microwaves
- Health Matters Stefano Pisa, Marta Cavagnaro, and James C. Lin The Influence of Averaging Schemes and Exposure Duration on the Correlation Between Temperature Elevation and RF Power Absorption Metrics in MRI Scans
- MicroBusiness = Fred Schindler Pause!
- Awards Alfy Riddle The Best Paper of 2015-"The Wireless Workhorse"
- Book/Software Reviews James Chu Wideband Amplifiers and Their Applications
- TCC Tidbits

 Mark Kahrs Patents in Microwave Measurement— Nonlinear Transmission Lines
- MTT-S Ombuds Officer Edward C. Niehenke
- Conference Report Wei Hong, Xiao-Wei Zhu, and Zhe Song The 2015 Asia-Pacific Microwave Conference
- Education News = Zlatica Marinković, Ping Jack Soh, and Ramesh Gupta MTT-S Undergraduate/Pregraduate Scholarship Award Recipients for Fall 2015
- 94 MTT World
 - Ajay Kumar Poddar IEEE SIGHT Initiative—Establishing a Ham Radio Station for Blind Amateur Radio Enthusiasts
- Backscatter
- Conference Calendar