



IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

JUNE/JULY 1993

VOLUME 41

NUMBER 6/7

IETMAB

(ISSN 0018-9480)

A PUBLICATION OF THE IEEE MICROWAVE THEORY AND TECHNIQUES SOCIETY



SPECIAL SECTION ON MICROWAVE EDUCATION

Editorial	J. C. Wiltse	911
-----------------	--------------	-----

JUNE SPECIAL SECTION PAPERS

Educating Microwave Engineers in the United States (<i>Invited Paper</i>)	R. E. Henning and L. P. Dunleavy	913
Computer-Based Electromagnetic Education (<i>Invited Paper</i>)	M. F. Iskander	920
Microwave Engineering Education in Canada (<i>Invited Paper</i>)	W. J. R. Hoefer	932
The Status of Microwave Education in Italy (<i>Invited Paper</i>)	R. Sorrentino and G. B. Stracca	937
Microwave Education in Belgium (<i>Invited Paper</i>)	A. Vander Vorst	943
Microwave Engineering in Australia (<i>Invited Paper</i>)	N. Fourikis	948

JUNE PAPERS

Design and Analysis of Quasi-Integrated Horn Antennas for Millimeter and Submillimeter-Wave Applications	G. V. Eleftheriades and G. M. Rebeiz	954
TE and TM Modes in Circularly Shielded Slot Waveguides	J. L. Tsalamengas, I. O. Vardiambasis, and J. G. Fikioris	966
A Semi-Automatic 3-Port Network Analyzer	M. Schöön	974
A Linear Dependence of $F_{\min}$ on Frequency for FET's	B. Hughes	979
Stability Analysis and Numerical Simulation of Multidevice Amplifiers	M. Ohtomo	983
Cryogenic Characteristics of Wide-Band Pseudomorphic HEMT MMIC Low-Noise Amplifiers	C. C. Yang, B. L. Nelson, B. R. Allen, W. L. Jones, and J. B. Horton	992
Optically Controlled Oscillators for Millimeter-Wave Phased Array Antennas	D. J. Sturzebecher, X. Zhou, X.-S. Zhang, and A. S. Daryoush	998
Frequency-Dependent FDTD Modeling of Optically Controlled Dielectric Resonators	Y. Shen, K. Nickerson, and J. Litva	1005
Characterization of Picosecond Pulse Crosstalk Between Coupled Microstrip Lines with Arbitrary Conductor Width	Y. Qian and E. Yamashita	1011
The Feature of the Narrow-Pulse Transmission on Conventional Coplanar Waveguides when Power Leakage is Present	M. Tsuji, M. Taniguchi, and H. Shigesawa	1017
Design of Lightweight, Broadband Microwave Absorbers Using Genetic Algorithms	E. Michielssen, J.-M. Sajer, S. Ranjithan, and R. Mittra	1024
Application of High T_c Superconductors as Frequency Selective Surfaces: Experiment and Theory	D. Zhang, Y. Rahmat-Samii, H. R. Feitnerman, S. Prakash, R. F. Bunshah, M. Eddy, and J. L. Nilsson	1032
Multiple Microstrip Lines on a Multilayered Cylindrical Dielectric Substrate on Perfectly Conducting Wedge	H. A. Auda and A. Z. Elsherbeni	1037

(Continued on page 909)

IEEE MICROWAVE THEORY AND TECHNIQUES SOCIETY

The Microwave Theory and Techniques Society is an organization, within the framework of the IEEE, of members with principal professional interest in the field of microwave theory and techniques. All members of the IEEE are eligible for membership in the Society and will receive this TRANSACTIONS upon payment of the annual Society membership fee of \$20.00. Affiliate membership is available upon payment of the annual affiliate fee of \$33.00 plus the Society fee of \$20.00. For information on joining write to the IEEE at the address below. *Member copies of Transactions/Journals are for personal use only.*

ADMINISTRATIVE COMMITTEE

P. W. STAECKER, <i>President</i>	E. J. CRESCENZI, JR., <i>Vice President</i>	M. J. SCHINDLER, <i>Secretary</i>	R. E. BRYAN, <i>Treasurer</i>
R. E. BRYAN	R. H. JANSEN	B. S. PERLMAN	J. W. WASSEL
E. D. COHEN	S. A. MAAS	R. POLLARD	E. YAMASHITA
E. J. CRESCENZI, JR.	M. A. MAURY, JR.	J. E. RAUE	D. G. SWANSON
D. HORNBUCKLE	R. A. MOORE	E. REZAK	G. THOREN

Honorary Life Members

A. C. BECK	T. S. SAAD
S. B. COHN	K. TOMIYASU
A. A. OLINER	L. YOUNG

Distinguished Lecturers

W. CURTICE
P. GOLDSMITH
F. IVANEK
V. RIZZOLI
J. R. WHINERY

Past Presidents

R. KAGIWADA (1992)
F. IVANEK (1991)
T. ITOH (1990)

S-MTT Chapter Chairmen

Albuquerque: M. A. DINALLO
Atlanta: A. J. GASIEWSKI
Baltimore: S. L. ANTHONISEN
Beijing: Y.-R. ZHONG
Benelux: K. VAN T. KLOOSTER
Buffalo: M. R. GILLETTE
Central Iowa: R. J. WEBER
Central & South Italy: P. LAMPARIELLO
Central New England/Boston: R. T. WEBSTER
Chicago: T. G. JURGENS
Cleveland: D. A. FORCE
Columbus: T.-H. LEE
Dallas: G. A. TRUITT
Dayton: G. R. SIMPSON
Denver-Boulder: R. VIDANO
Egypt: O. L. EL-SAYED
Finland: E. T. KEMPPINEN
Florida West Coast: R. HENNING
France: V. F. HANNA
Germany: F. ARNDT
Greece: N. K. UZUNOGLU
Houston: J. T. WILLIAMS
Hungary: I. FRIGYES
Huntsville: H. L. BENNETT
India: S. K. KOUL
Indonesia: S. NANTANAGARA

Israel: E. LEVINE
Ithaca: L. PALMATEER
Kitchner-Waterloo: C. R. SELVAKUMAR
Y. L. CHOW
Los Angeles: H. J. DE LOS SANTOS
Milwaukee: J. RICHIE
Montreal: G. L. YIP
New Hampshire: T. O. PERKINS
New Jersey Coast: T. FITCH
New South Wales: C. D. WILSON
New York/Long Island: F. J. WINTER
North Italy: C. N. NALDI
North Jersey: R. V. SNYDER
Oregon: K. SHENAI
Orlando: D. L. DUNN
Ottawa: D. H. REEKIE
Philadelphia: A. S. DARYOUSH
Phoenix: G. MARACAS
Poland: J. W. MODELSKI
Portland: D. SHENAI
Princeton: A. KATZ
Rio de Janeiro: J. R. BERGMANN
San Diego: A. CLAVIN
San Fernando Valley: A. M. MADNI
Santa Clara Valley/San Francisco: W. OU

Schenectady: R. J. GUTMANN
Seattle: D. T. HARVEY
Seoul: J. S. MYUNG
Singapore: L. M. SENG
South Africa: A. J. BOOYSEN
South Australia: B. D. BATES
South Brazil: D. CONSONI
Southeastern Michigan: E. J. ROTHWELL
Spain: M. P. SIERRA
Springfield: K. M. LAU
St. Louis: R. INDECK
Sweden: P. T. LEWIN
Switzerland: L. PROST
Syracuse: D. W. FERGUSON
Taipei: C. C. TZUANG
Tokyo: T. YONEYAMA
Tucson: H. C. KOHLBACHER
Turkey: A. BUYUKAKSOY
Two Cities: A. GOPINATH
United Kingdom/Ireland: T. H. OXLEY
Utah/Salt Lake City: M. F. ISKANDER
Venezuela: A. N. BIANCHI
Virginia Mountain: I. J. BAHL
Washington/Northern Virginia: G. TAIT
Winnipeg: G. BRIDGES
Yugoslavia: B. JOCANOVIC

IEEE TRANSACTIONS® ON MICROWAVE THEORY AND TECHNIQUES

Editor
D. MASSÉ

R. SORRENTINO
(Tutorial/Review Papers)

Associate Editors _____
J. B. HORTON
(Systems and Applications)

P. W. STAECKER
(Index Issues)

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

Officers

MARTHA SLOAN, *President*
H. TROY NAGLE, *President-Elect*
SOUIGUIL J. M. ANN, *Secretary*
THEODORE W. HISSEY, JR., *Treasurer*
EDWARD A. PARRISH, *Vice President, Educational Activities*

W. KENNETH DAWSON, *Director, Division IV—Electromagnetics and Radiation*

CHARLES K. ALEXANDER, *Vice President, Professional Activities*
HELEN M. WOOD, *Vice President, Publication Activities*
LUIS T. GANDIA, *Vice President, Regional Activities*
WALLACE S. READ, *Vice President, Standards Activities*
DONALD M. BOLLE, *Vice President, Technical Activities*

Headquarters Staff

JOHN H. POWERS, *Executive Director and General Manager*
 PHYLLIS HALL, *Staff Executive, Publications*
 FRANK R. MOORE, *Staff Executive, Volunteer Activities*
 RICHARD D. SCHWARTZ, *Staff Executive, Business Administration*

IRVING ENGELSON, *Staff Director, Corporate Activities*
W. R. HABINGREITHER, *Staff Director, Customer Service Center*
PETER A. LEWIS, *Staff Director, Educational Activities*
MELVIN I. OLKEN, *Staff Director, Regional Activities*

EDWARD ROSENBERG, *Controller*
ANDREW G. SALEM, *Staff Director, Standards Activities*
W. THOMAS SUTTLE, *Staff Director, Professional Activities*
ROBERT T. WANGEMANN, *Staff Director, Technical Activities*

Publications Department

Director, Transactions/Journals: PATRICIA WALKER
Publications Manager: GAIL S. FERENC
Electronic Production Manager: JERI L. UZZO
Managing Editor: VALERIE CAMMARATA
Associate Editor: JOSEPH PAGNOTTA

IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES is published monthly, except for a combined June/July issue, by The Institute of Electrical and Electronics Engineers, Inc. Responsibility for the contents rests upon the authors and not upon the IEEE, the Society/Council, or its members. **IEEE Headquarters:** 345 East 47 Street, New York, NY 10017-2394. **NY Telephone:** 212-705 + extension: Information-7900; General Manager-7910; Public Information-7867; Publishing Services-7560; Spectrum-7556. **Telecopiers:** NY (Headquarters) 212-752-4929, NY (Publications) 212-705-7682. **IEEE Service Center** (for orders, subscriptions, address changes, Educational Activities, Region/Section/Student Services, Standards): 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331. **NJ Telephone:** Information: 908-981-0060; 908-562 + extension: Controller-5365; Technical Activities-3900. **IEEE Washington Office** (for U.S. professional activities): 1828 L Street, NW, Suite 1202, Washington, DC 20036-5104. **Washington Telephone:** 202-785-0017. **Price/Publication Information:** Individual copies: IEEE members \$10.00 (first copy only), nonmembers \$20.00 per copy. (Note: Add \$4.00 postage and handling charge to any order from \$1.00 to \$50.00, including prepaid orders.) Member and nonmember subscription prices available on request. Available in microfiche and microfilm. **Copyright and Reprint Permissions:** Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limits of the U.S. Copyright Law for private use of patrons: 1) those post-1977 articles that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 29 Congress Street, Salem, MA 01970; 2) pre-1978 articles without fee. For all other copying, reprint, or republication permission, write to Copyrights and Permissions Department, IEEE Publishing Services, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331. Copyright © 1993 by The Institute of Electrical and Electronics Engineers, Inc. All rights reserved. Second-class postage paid at New York, NY, and at additional mailing offices. **Postmaster:** Send address changes to IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, IEEE, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331. GST Registration No. 125634188 Printed in U.S.A.



IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

JUNE/JULY 1993

VOLUME 41

NUMBER 6/7

IETMAB

(ISSN 0018-9480)

A PUBLICATION OF THE IEEE MICROWAVE THEORY AND TECHNIQUES SOCIETY



(Continued from front cover)

Transverse Scattering Matrix Formulation for a Class of Waveguide Eigenvalue Problems	
..... Z. Ma, E. Yamashita, and S. Xu	1044
Boundary Element Analysis of a Trapezoidal Transmission Line	B. Toland and T. Itoh
.....	1052
Reduction of Edge Reflections in the TLM Model	I. G. Gosling
.....	1057

JUNE SHORT PAPERS

Simulation of HEMT DC Drain Current and 1 to 50 GHz S-Parameters as a Function of Gate Bias	
..... S. J. Mahon, M. J. Shivers, and D. J. Skellern	1065
Millimeter-Wave Three-Port Finline Circulator Using Distributed Coupling Effect	J. Mazur
.....	1067
The Magnetostatic Waves in Ferrite Film with Losses	S. A. Vyzulin, A. E. Rosenson, and S. A. Shekh
.....	1070

LETTERS

Correction to "A New Implementation of a Multiport Network Analyzer"	
..... A Ferrero, U. Pisani, and K. J. Kerwin	1074

JULY PAPERS

X-Band Thin Film Acoustic Filters on GaAs	R. B. Stokes and J. D. Crawford
.....	1075
Losses in Y-Junction Stripline and Microstrip Ferrite Circulators	R. E. Neidert and P. M. Phillips
.....	1081
Large-Signal HBT Characterization and Modeling at Millimeter Wave Frequencies	
..... D. A. Teeter, J. R. East, and G. I. Haddad	1087
Matched-Line Directional Dividers	T. J. Russell
.....	1094
Reciprocity Relations in Waveguide Junctions	D. F. Williams and R. B. Marks
.....	1105
Computation of Cutoff Wavenumbers for Partially Filled Waveguides of Arbitrary Cross Section Using Surface Integral Formulations and the Method of Moments	S. Shu, P. M. Goggans, and A. A. Kishk
.....	1111
Analysis of Millimeter Waveguides on Anisotropic Substrates Using the Three-Dimensional Transmission-Line Matrix Method	C. Bulutay and S. Prasad
.....	1119
Electromagnetic Model of a Planar Radial-Waveguide Divider/Combiner Incorporating Probes	
..... M. E. Bialkowski and V. P. Waris	1126
"Thermic End-Fire" Interstitial Applicator for Microwave Hyperthermia	
..... G. Cerri, R. De Leo, and V. Mariani Primiani	1135
MSSW and MSVW in a Multilayered Ferrimagnetic Structure with an Arbitrary Orientation Between Two Static Magnetizations	K. Sun
.....	1143
Two-Dimensional Mapping of the Microwave Potential on MMIC's Using Electrooptic Sampling	
..... D. R. Hjelm, M. J. Yadlowsky, and A. R. Mickelson	1149

(Continued on next page)

(Continued from page 909)

Coupled-Mode Analysis of Leaky Waves in Channel Waveguides Consisting of Anisotropic Material.....	<i>M. Geshiro, M. Hotta, and T. Kameshima</i>	1159
Generalized Multiport Reciprocity Analysis of Surface-to-Surface Transitions Between Multiple Printed Transmission Lines.....	<i>N. K. Das</i>	1164
Transients on Lossless Exponential Transmission Lines Using Allen's Method	<i>P. Bouchard, R. R. J. Gagné, and J.-L. Lavoie</i>	1178
The Method of Lines for the Analysis of Rectangular Spiral Inductors	<i>F. J. Schmückle</i>	1183
Triangular-Domain Basis Functions for Full-Wave Analysis of Microstrip Discontinuities	<i>R. Kipp and C. H. Chan</i>	1187
Rigorous, Multimode Equivalent Network Representation of Capacitive Discontinuities.....	<i>M. Guglielmi, and A. Alvarez Melcón</i>	1195
Analysis of Inhomogeneously Filled Cavities Coupled to Waveguides Using the VIE Formulation	<i>A. Jöstingmeier and A. S. Omar</i>	1207
An Efficient Finite Element Solution of Inhomogeneous Anisotropic and Lossy Dielectric Waveguides	<i>Y. Lu and F. Anibel Fernandez</i>	1215

JULY SHORT PAPERS

A Compact Ring-Style 8-Port Comparator Circuit Using Coupled Lines.....	<i>G. P. Riblet</i>	1224
Metallization Effects on GaAs Microstrip Line Attenuation.....	<i>J. Carroll and K. Chang</i>	1227
Modeling of Transverse Propagation Delays in the GaAs/AlGaAs Modulation Doped Heterojunction Field Effect Transistors	<i>A. K. Goel and W. Xu</i>	1230
Calculation of Intercavity Coupling Coefficient for Side Coupled Standing Wave Linear Accelerator.....	<i>R. Roy and O. Shanker</i>	1233
Shape Function Optimization in the Finite Element Analysis of Waveguides.....	<i>H. E. Hernández-Figueroa and G. Pagiatakis</i>	1235

LETTERS

Comments on "Deterministic Approach to Full-Wave Analysis of Discontinuities in MIC's Using the Method of Lines"	<i>X.-H. Jiang and Z. Tang</i>	1239
Reply to Comments on "Deterministic Approach to Full-Wave Analysis of Discontinuities in MIC's Using the Method of Lines"	<i>Z. Chen and B. Gao</i>	1240
Corrections to "A Linear-Operator Formalism for the Analysis of Inhomogeneous Biisotropic Planar Waveguides"	<i>C. R. Paiva and A. M. Barbosa</i>	1240

ANNOUNCEMENTS

Second International Conference on Ultra-Wideband, Short-Pulse Electromagnetics	1241
1994 IEEE MTT-S International Microwave Symposium	1242
Special Issue on Emerging Commercial and Consumer Circuits, Systems and Their Applications	1243
