



IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

OCTOBER 1985

VOLUME MTT-33

NUMBER 10

(ISSN 0018-9480)

A PUBLICATION OF THE IEEE MICROWAVE THEORY AND TECHNIQUES SOCIETY



SPECIAL ISSUE ON NUMERICAL METHODS

FOREWORD	J. W. Mink and F. K. Schwing	845
<i>Characterization of Uniform Waveguides: Propagation Constant and Field Distribution of Modes</i>		
Integrated-Circuit Structures on Anisotropic Substrates (<i>Invited Paper</i>)	N. G. Alexopoulos	847
The Transmission-Line Matrix Method—Theory and Applications (<i>Invited Paper</i>)	W. J. R. Hoefer	882
Review of Numerical Methods for the Analysis of Arbitrarily-Shaped Microwave and Optical Dielectric Waveguides	S. M. Saad	894
Finite-Element Formulation in Terms of the Electric-Field Vector for Electromagnetic Waveguide Problems	M. Koshiba, K. Hayata, and M. Suzuki	900
Integral Formulation for Analysis of Integrated Dielectric Waveguides ...	J. S. Bagby, D. P. Nyquist, and B. C. Drachman	906
A Modified Mode-Matching Technique and Its Application to a Class of Quasi-Planar Transmission Lines	R. Vahldieck and J. Bornemann	916
Propagation of Quasi-Static Modes in Anisotropic Transmission Lines: Application to MIC Lines	R. Marqués and M. Horno	927
Determination of Green's Function Matrix for Multiconductor and Anisotropic Multidielectric Planar Transmission Lines: A Variational Approach	F. Medina and M. Horno	933
Propagation Characteristics of a Microstrip Line Printed on a General Anisotropic Substrate	J. L. Tsalamengas, N. K. Uzunoglu, and N. G. Alexopoulos	941
Propagation in Broadside-Coupled Suspended-Substrate Stripline in E-Plane	H. Mizuno, C. J. Verver, R. J. Douville, and M. G. Stubbs	946
Analysis of Arbitrarily Oriented Microstrip Transmission Lines in Arbitrarily Shaped Dielectric Media over a Finite Ground Plane	J. Venkataraman, S. M. Rao, A. R. Djordjević, T. K. Sarkar, and Y. Naiheng	952
Analysis of Finite Conductivity Cylindrical Conductors Excited by Axially-Independent TM Electromagnetic Field	A. R. Djordjević, T. K. Sarkar, and S. M. Rao	960
Application of Davidenko's Method to the Solution of Dispersion Relations in Lossy Waveguiding Systems	S. H. Talisa	967



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 \$8.00. Affiliate membership is available upon payment of the annual affiliate fee of \$24.00, plus the Society fee of \$8.00. For information on joining write to the IEEE at the address below.

ADMINISTRATIVE COMMITTEE

H. HOWE, JR., <i>President</i>		R. H. KNERR, <i>Vice President</i>		P. W. STAECKER, <i>Secretary-Treasurer</i>	
N. W. COX	H. HOWE, JR.	R. S. KAGIWADA	S. L. MARCH	M. V. SCHNEIDER	
V. G. GELNOVATCH	T. ITOH	R. H. KNERR	D. N. MCQUIDDY, JR.	B. E. SPIELMAN	
P. T. GREILING	F. IVANEK	H. J. KUNO	E. C. NIEHENKE	S. J. TEMPLE	
	G. JERINIC	R. LEVY	J. E. RAUE		

Honorary Life Members

A. C. BECK	W. W. MUMFORD	A. A. OLINER	K. TOMIYASU	K. L. CARR	P. T. GREILING
S. B. COHN		T. S. SAAD	L. YOUNG		S. WEINREB

Distinguished Lecturers

S-MTT Chapter Chairmen

Albuquerque: C. W. JONES	India: B. BHAT	San Diego: M. DICK
Atlanta: J. D. NORGARD	Israel: A. MADJAR	San Fernando Valley: H. POMERANTZ
Baltimore: J. A. FAULKNER, JR.	Kitchener-Waterloo: Y. L. CHOW	Santa Clara Valley/San Francisco: L. A. STARK
Benelux: A. GUISSARD	Los Angeles: D. W. BALL	Schenectady: J. BORREGO
Buffalo: INACTIVE	Middle & South Italy: R. SORRENTINO	Seattle: D. G. DOW
Canaveral: E. P. VALKENBURG	Milwaukee: A. KRAUSKA	South Brevard/Indian River: E. P. VALKENBURG
Central Illinois: G. E. STILLMAN	Montreal: J. L. LEIZEROWICZ	Southeastern Michigan: D. K. REINHARD
Central New England/Boston: S. TEMPLE	New Jersey Coast: N. J. WILSON	St. Louis: D. GRANTER
Chicago: J. BLUBAUGH	New York/Long Island: R. KAMINSKY	Sweden: E. L. KOLLBERG
Columbus: J. D. YOUNG	North Jersey: R. V. SNYDER	Switzerland: F. E. GARDIOL
Connecticut: M. GILDEN	Orange County: J. C. AUKLAND	Syracuse: J. C. RAUTIO
Dallas: J. HINTON	Orlando: F. P. WILCOX	Tokyo: E. YAMASHITA
Denver-Boulder: G. R. OLHOEFT	Ottawa: J. S. WIGHT	Tucson: H. C. KOHLBACHER
Florida West Coast: J. C. CHU	Philadelphia: A. AFRASHTEH	Twin Cities: C. R. SEASHORE
Houston: S. A. LONG	Phoenix: C. E. WEITZEL	Utah/Salt Lake City: M. F. ISKANDER
Huntsville: M. D. FAHEY	Portland: M. H. MONNIER	Washington/Northern Virginia: M. ZISSERSON
	Princeton: A. K. SHARMA	West Germany: R. H. JANSEN

IEEE TRANSACTIONS® ON MICROWAVE THEORY AND TECHNIQUES

Editor

T. ITOH

Associate Editors

J. J. DALY
(*Patent Abstracts*)

F. IVANEK

M. AKAIKE
(*Abstracts Editor—Asia*)

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

Officers

CHARLES A. ELDON, <i>President</i>	CYRIL J. TUNIS, <i>Vice President, Educational Activities</i>
BRUNO O. WEINSCHEL, <i>President-Elect</i>	RLSSEL C. DREW, <i>Vice President, Professional Activities</i>
MERLIN G. SMITH, <i>Executive Vice President</i>	JOSE B. CRUZ, JR., <i>Vice President, Publication Activities</i>
HENRY L. BACHMAN, <i>Treasurer</i>	DENNIS BODSON, <i>Vice President, Regional Activities</i>
WALTER E. PROEBSTER, <i>Secretary</i>	STEPHAN KAHNE, <i>Vice President, Technical Activities</i>

KIYO TOMIYASU, *Director, Division IV, Electromagnetics and Radiation*

Headquarters Staff

ERIC HERZ, *Executive Director and General Manager*
ELWOOD K. GANNETT, *Deputy General Manager*

THOMAS W. BARTLETT, *Controller*
DONALD CHRISTIANSEN, *Editor, IEEE Spectrum*
IRVING ENGELSON, *Staff Director, Technical Activities*
LEO FANNING, *Staff Director, Professional Activities*
SAVA SHERR, *Staff Director, Standards*

DAVID L. STAIGER, *Staff Director, Publishing Services*
CHARLES F. STEWART, JR., *Staff Director, Administration Services*
DONALD L. SUPPERS, *Staff Director, Field Services*
THOMAS C. WHITE, *Staff Director, Public Information*
JOHN F. WILHELM, *Staff Director, Professional Activities*

Publications Department

Production Managers: ANN H. BURGMAYER, GAIL S. FERENC, CAROLYN TAMNEY
Associate Editor: WILLIAM J. HAGEN

IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES is published monthly by The Institute of Electrical and Electronics Engineers, Inc. Headquarters: 345 East 47 Street, New York, NY 10017. 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, Region/Section/Student Services): 445 Hoes Lane, Piscataway, NJ 08854. Telephones: Headquarters 212-705 + extension; Information -7900, General Manager -7910, Controller -7748, Educational Services -7860, Publishing Services -7560, Standards -7960, Technical Services -7890. IEEE Service Center 201-981-0060. Professional Services: Washington Office 202-785-0017. NY Telecopier: 212-752-4929. Telex: 236-411 (International messages only). Individual copies: IEEE members \$9.00 (first copy only), nonmembers \$18.00 per copy. Annual subscription price: IEEE members, dues plus Society fee. Price for nonmembers on request. Available in microfiche and microfilm. Copyright and Reprint Permission: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limits of 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. Instructors are permitted to photocopy isolated articles for noncommercial classroom use without fee. For other copying, reprint or republication permission, write to Director, Publishing Services at IEEE Headquarters. All rights reserved. Copyright © 1985 by The Institute of Electrical and Electronics Engineers, Inc. Printed in U.S.A. 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, 445 Hoes Lane, Piscataway, NJ 08854.