



IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

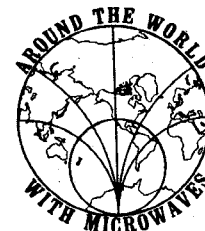
DECEMBER 1981

VOLUME MTT-29

NUMBER 12

(ISSN 0018-9480)

A PUBLICATION OF THE IEEE MICROWAVE THEORY AND TECHNIQUES SOCIETY



1981 Symposium Issue



Bonaventure Hotel, Los Angeles, California



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 \$20.00. For information on joining write to the IEEE at the address below.

ADMINISTRATIVE COMMITTEE

F. J. ROSENBAUM, *President*

R. A. SPARKS, *Vice President*

J. M. ROE, *Secretary-Treasurer*

S. F. ADAM*

J. L. ALLEN

J. C. AUKLAND

G. R. BASAWAPATNA

* *Ex officio (past presidents)*

B. E. BERSON

J. E. DEGENFORD, JR.

V. G. GELNOVATCH

P. T. GREILING

R. B. HICKS

F. H. HOWE, JR.

R. H. KNERR

H. J. KUNO

S. L. MARCH

E. C. NIEHENKE

H. G. OLTMAN, JR.

D. PARKER*

C. T. RUCKER

H. SOBOL*

B. E. SPIELMAN

Honorary Life Members

A. C. BECK

S. B. COHN

D. D. KING

W. W. MUMFORD

A. A. OLINER

T. S. SAAD

K. TOMIYASU

National Lecturer

F. IVANEK

S-MTT Chapter Chairmen

Albuquerque: K. KUNZ

Atlanta: G. SMITH

Baltimore: S. N. STITZER

Benelux: A. GUISSARD

Boston: A. G. CARDIASMENOS

Boulder/Denver: C. T. JOHNK

Buffalo: INACTIVE

Canaveral: J. W. COFER

Central Illinois: G. E. STILLMAN

Chicago: B. LEVIN

Columbus: P. H. PATHAK

Connecticut: M. GILDEN

Dallas: B. SCOTT

Florida West Coast: M. MOCZYNSKI

Houston: W. L. WILSON, JR.

Huntsville: M. D. FAHEY

India: R. P. WADHWA

Kitchener-Waterloo: Y. L. CHOW

Los Angeles: G. LINDGRIN

Milwaukee: C. J. KOTLARZ

Montreal: R. BELANGER

New Jersey Coast: B. GLANCE

New York/Long Island: J. HAUSNER

North Jersey: R. SNYDER

Orange County: J. C. AUKLAND

Orlando: C. F. SCHUNEMANN

Ottawa: J. S. WIGHT

Philadelphia: M. AFIFI

Phoenix: A. C. BROWN, JR.

Portland: INACTIVE

Princeton: M. KUMAR

San Diego: G. L. VANCE

San Francisco/Santa Clara: C.-C. HSIEH

Schenectady: R. A. DEHN

Seattle: D. K. REYNOLDS

Southeastern Michigan: P. I. PRESSEL

St. Louis: J. BOGDANOR

Syracuse: C. R. ROBERTS

Tel Aviv: A. MADJAR

Tokyo: Y. KONISHI

Tucson: E. P. PIERCE

Washington, DC: A. W. FRIEND, JR.

IEEE TRANSACTIONS® ON MICROWAVE THEORY AND TECHNIQUES

Editor

R. H. KNERR

N. R. DIETRICH
(*Patent Abstracts*)

H. G. OLTMAN, JR.
(*Applications*)

Associate Editors

B. PERLMAN
(*Computer Program
Descriptions*)

E. YAMASHITA
(*Abstracts Editor—
Asia*)

Address all manuscripts to the Editor, R. H. Knerr, Bell Laboratories, 555 Union Boulevard, Allentown, PA 18103. Submission of three copies of manuscripts, including figures, will expedite the review *Publication Policy*. All papers will be reviewed for their technical merit, and decisions to publish will be made independently of an author's ability or willingness to pay charges. Voluntary page charges of \$70 per printed page will be requested for papers of five pages or less. Page charges of \$100 per page are mandatory for each page in excess of five printed pages. Also, the MTT-S Administrative Committee has established a quota for the number of pages printed in each issue of this TRANSACTIONS whose costs are not defrayed by payment of page charges. Papers not covered by page charges may be delayed until space in an issue is available. The Editor can waive the quota requirement for exceptional papers or because of other extenuating circumstances.

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

Officers

RICHARD W. DAMON, *President*

ROBERT W. LUCKY, *Executive Vice President*

CHARLES A. ELTON, *Treasurer*

DICK C. J. POORTVLIET, *Secretary*

E. W. ERNST, *Vice President, Educational Activities*

RICHARD J. GOWEN, *Vice President, Professional Activities*

THEODORE H. BONN, *Vice President, Publication Activities*

LARRY K. WILSON, *Vice President, Regional Activities*

ROBERT E. LARSON, *Vice President, Technical Activities*

ALLAN C. SCHELL, *Division IV Director*

Headquarters Staff

ERIC HERZ, *Executive Director and General Manager*

THOMAS W. BARTLETT, *Controller*

DONALD CHRISTIANSEN, *Editor of Spectrum*

IRVING ENGELSON, *Staff Director, Technical Activities*

LEO FANNING, *Staff Director, Professional Activities*

ELWOOD K. GANNETT, *Staff Director, Publishing Services*

ERIC HERZ, *Acting Staff Director, Field Services*

SAVA SHERR, *Staff Director, Standards*

EMILY L. SIRJANE, *Staff Director, Corporate Services*

CHARLES F. STEWART, JR., *Staff Director, Administration Services*

JOHN F. WILHELM, *Staff Director, Professional Activities*

Publications Department

H. JAMES CARTER, *Associate Staff Director*

Production Managers: ANN H. BURGMAYER, CAROLYN ELENOWITZ, GAIL S. FERENC*, ISABEL NAREA

Associate Editors: MARY E. GRANGEIA, THOMAS R. GRECO, ELAINE A. MAROTTA,

JEFFREY S. MARTIN, BARBARA A. SOMOGYI

* *Responsible for this Transactions*

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): 445 Hoes Lane, Piscataway, NJ 08854. **Telephones:** Headquarters 212-644 + extension: Information -7900, General Manager -7910, Controller -7748, Educational Services -7860, Publishing Services -7560, Region/Section Services -7750, Standards -7960, Technical Services -7890. IEEE Service Center 201-981-0060. Washington Office/Professional Services 202-785-0017. **NY Telecopier:** 212-752-4929. **Telex:** 236-411 (International messages only). Individual copies: IEEE members \$5.00 (first copy only), nonmembers \$10.00 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, 21 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 © 1981 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.