

 **IEEE TRANSACTIONS ON  
MICROWAVE THEORY  
AND TECHNIQUES**

DECEMBER 1975

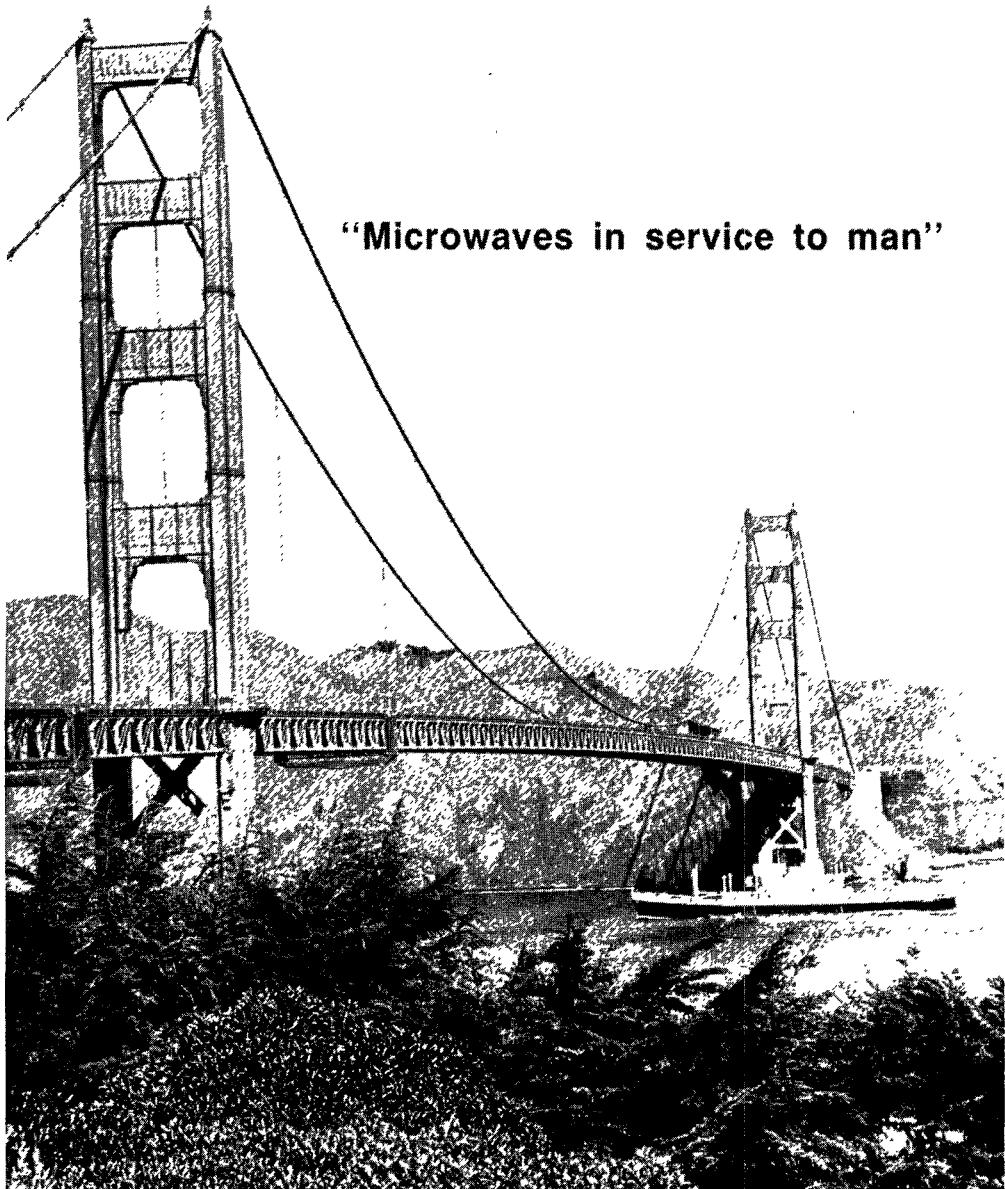
VOLUME MTT-23

NUMBER 12

A PUBLICATION OF THE IEEE MICROWAVE THEORY AND TECHNIQUES SOCIETY



**1975 Symposium Issue**





## 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 \$7.00. Affiliate membership is available upon payment of the annual affiliate fee of \$18.00. For information on joining write to the IEEE at the address below.

### ADMINISTRATIVE COMMITTEE

H. W. COOPER, *President*

S. F. ADAM  
J. L. ALLEN  
D. B. ANDERSON  
R. W. BEATTY  
K. J. BUTTON

G. P. RODRIGUE, *Vice President*

A. CLAVIN\*  
A. W. GUY  
G. I. HADDAD  
J. B. HORTON\*  
R. M. KNOX

J. E. DEGENFORD, *Secretary-Treasurer*

H. G. OLTMAN  
D PARKER  
R. A. RIVERS\*  
F J. ROSENBAUM

H. SOBOL  
R. A. SPARKS  
H. STINEHELPER  
D F. WAIT  
L. R. WHICKER

\* *Ex officio (past chairmen)*

### Honorary Life Members

A. C. BECK  
D. D. KING  
W. W. MUMFORD  
T. S. SAAD  
K. TOMIYASU

### National Lecturer

ROBERT W. BEATTY

### S-MTT Chapter Chairmen

Atlanta	G. H. ROBINSON	India	V. P. KODALI	St. Louis	J. M. ROE
Baltimore	T. L. AP RHYNS	NY/Long Island	A. J. KELLY	San Diego	J. M. DEVAN
Boston	H. E. STINEHELPER, SR.	Los Angeles Council	D. G. KELLING	San Francisco	D. R. CHAMBERS
Boulder-Denver	L. LEWIN	Milwaukee	J. H. BATTOCLETTI	Schenectady	W. A. DAVIS
Buffalo	L. L. GRINIUS	Montreal	G. L. YIP	Seattle	G. L. MITCHELL
Chicago	J. P. PHILLIPS	N. J. Coast	S. MARSHALL	S. E. Michigan	W. G. RADO
Columbus	T. A. SELIGA	North Jersey	E. M. NIEMIEC	Syracuse	A. FARRAR
Connecticut	M. GILDEN	Orange County	J. A. SANGUINET	Tel Aviv	A. I. MADJAR
Dallas	M. L. WALLACE	Orlando	J. R. ASHWELL	Tokyo, Japan	S. SAITO
Florida West Coast	S. C. BLOCH	Ottawa	D. S. JAMES	Washington, D. C.	A. R. SINDORIS
Houston	W. L. WILSON, JR.	Philadelphia	C. E. PROFERA, JR		
Huntsville	J. M. LOOMISI, III	Phoenix	R. J. KENYON		

### IEEE TRANSACTIONS® ON MICROWAVE THEORY AND TECHNIQUES

#### Editor

D. PARKER    H. G. OLTMAN    D. F. WAIT    B. PERLMAN    M. CAULTON    T. OKOSHI    H. E. SCHRANK  
(*Applications*)    (*Business Editor*)    (*Computer Program Descriptions*)    (*Special Issues*)    (*Abstracts Editor—Asia*)    (*Institutional Listings*)

Address all manuscripts to the Editor, D. Parker, Stanford Res. Inst., Building 44, 333 Ravenswood Ave., Menlo Park, Calif. 94025. Submission of three copies of manuscripts, including figures, will expedite the review.

### THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

#### Officers

ARTHUR P. STERN, *President*  
JOSEPH K. DILLARD, *Executive Vice President*  
BURKHARD H. SCHNEIDER, *Secretary-Treasurer*  
FRANK S. BARNES, *Vice President, Publication Activities*

ROBERT F. COTELLESSA, *Vice President, Technical Activities*  
HAROLD S. GOLDBERG, *Vice President, Professional Activities*  
T. F. JONES, JR., *Vice President, Educational Activities*  
ROBERT M. SAUNDERS, *Vice President, Regional Activities*

#### Headquarters Staff

H. A. SCHULKE, JR., *General Manager, Executive Director*

THOMAS W. BARTLETT, *Controller*  
ESMI L. BIDSTRUP, *Special Assistant to the President*  
LEONARD FARRELL, *Director, Professional Services*  
DONALD G. FINK, *Executive Consultant*  
JACK FRAUM, *Director, EDP Services*  
ELWOOD K. GANNETT, *Director, Publishing Services*

JOHN M. KINN, *Director, Educational Services*  
R. J. MENDOLIA, *Director, Administrative Services*  
CHARLES F. STEWART, JR., *Director, Member and Field Services*  
BETTY J. STILLMAN, *Executive Assistant to the Executive Director*  
RICHARD M. EMBERSON, *Director, Technical Services*  
EDWIN D. MACDONALD, *Conference Services*  
SAVA I. SHERR, *Standards*

#### Editorial Department

H. JAMES CARTER, *Manager, Editorial Services*

*Senior Editors:* NANCY B. BUDDE\*, ANN H. BURGMAYER, CAROLYN ELENOWITZ, GAIL S. FERENC  
*Associate Editors:* CLARA FEGER, HELEN S. GOLDMAN, LINDA GRADY, PRIJONO HARDJOWIROGO, CASIMIR PSUJEK, TRUMBULL ROGERS

\* *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, N. Y. 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, N. J. 08854. **Telephones:** Headquarters 212-644 + extension: Information -7900, General Manager -7910, Controller -7748, Educational Services -7860, Publishing Services -7560, Region/Section Services -7750, Technical Services -7890. IEEE Service Center 201-981-0060. Washington Office/Professional Services 202-785-0017. 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. Abstracting is permitted with mention of source. For republication permission write to Director, Publishing Services at IEEE Headquarters. All rights reserved. Copyright © 1975 by The Institute of Electrical and Electronics Engineers, Inc. Printed in U.S.A. Second-class postage paid at New York, N. Y. and at additional mailing offices.