



IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES

MAY 1979

VOLUME MTT-27

NUMBER 5

A PUBLICATION OF THE IEEE MICROWAVE THEORY AND TECHNIQUES SOCIETY

SPECIAL ISSUE ON SOLID-STATE MICROWAVE/MILLIMETER-WAVE POWER GENERATION, AMPLIFICATION, AND CONTROL

FOREWORD B. Berson and H. J. Kuno 365

PAPERS

GaAs Field Effect Transistors

- GaAs Power MESFET's. Design, Fabrication, and Performance (*Invited Paper*) J. V. DiLorenzo and W. R. Wisseman 367
- A Unified Approach to the Design of Wide-Band Microwave Solid-State Oscillators G. R. Basawapatna and R. B. Stancliff 379
- Transmission-Type Injection Locking of GaAs Schottky-Barrier FET Oscillators Y. Tajima and K. Mishima 386
- Common-Drain Flip-Chip GaAs FET Oscillators R. L. Camisa and F. N. Sechi 391
- 11-GHz GaAs Power MESFET Load-Pull Measurements Utilizing a New Method of Determining Tuner Y Parameters H. Abe and Y. Aono 394
- Third-Order Intermodulation Distortion and Gain Compression in GaAs FET's R. S. Tucker 400
- 23-GHz Band GaAs MESFET Reflection-Type Amplifier H. Tohyama and H. Mizuno 408
- Performance of a Dual-Gate MESFET as a Frequency Multiplier at Ku-Band P. T. Chen, C.-T. Li, and P. H. Wang 411

Si Bipolar Transistors

- Silicon Bipolar Microwave Power Transistor (*Invited Paper*) R. Allison 415
- Bipolar Microwave Linear Power Transistor Design J. T. C. Chen and C. P. Snapp 423
- Improvement of a Class-C Transistor Power Amplifier by Second-Harmonic Tuning S. R. Mazumder, A. Azizi, and F. E. Gardiol 430

IMPATT and Other Junction Devices

- Progress with CW IMPATT Diode Circuits at Microwave Frequencies (*Invited Paper*) J. W. Gewartowski 434
- High-Frequency Limitations of IMPATT, MITATT, and TUNNETT Mode Devices (*Invited Paper*) M. E. Elta and G. I. Haddad 442
- High Peak Pulse Power Silicon Double-Drift IMPATT Diodes G. Pfund and R. Curby 450
- Nonlinear Noise Theory for Synchronized Oscillators K. Schüemann and K. Behm 452
- Microwave Characterization of Silicon BARRITT Diodes Under Large-Signal Conditions G. K. Montress and M. S. Gupta 458
- Design and Performance of I-Band (8–10-GHz) TRAPATT Diodes and Amplifiers C. H. Oxley, A. M. Howard, and J. J. Purcell 463

Power Combining Techniques

- Microwave Power Combining Techniques (*Invited Paper*) K. J. Russell 472
- Techniques for Increasing the Bandwidth of a TM₀₁₀-Mode Power Combiner R. Aston 479

Millimeter-Wave Devices

- Millimeter-Wave CW IMPATT Diodes and Oscillators (*Invited Paper*) T. A. Midford and R. L. Bernick 483
- Millimeter-Wave Pulsed IMPATT Sources (*Invited Paper*) T. T. Fong and H. J. Kuno 492
- High Effective Subharmonic Injection Locking of a Millimeter-Wave IMPATT Oscillator R. Hayashi and Y. Asano 500
- Millimeter-Wave Pretuned Modules G. Cachier, J. Espagnol, and J. Stevance 505
- A Dual-Diode 73-GHz Gunn Oscillator A. K. Talwar 510
- A Tunable High-Power V-Band Gunn Oscillator C. Sun, E. Benko, and J. W. Tully 512
- Distributed Bragg Reflector Gunn Oscillators for Dielectric Millimeter-Wave Integrated Circuits T. Itoh and F.-J. Hsu 514
- Frequency Triplers and Quadruplers with GaAs Schottky-Barrier Diodes at 450 and 600 GHz T. Takada and M. Ohmori 519

Control Devices

- Microwave Semiconductor Control Devices (*Invited Paper*) R. V. Garver 523
- A Wide-Band Mechanically Stable Quasi-Optical Detector for 100–300 GHz R. Kawasaki and K. Yamamoto 530
- An Avalanche Optoelectronic Microwave Switch R. A. Kiehl 533
- Electrically Controllable Liquid Artificial Dielectric Media H. T. Buscher 540

CONTRIBUTORS 546



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

D. PARKER, *President*

S. F. ADAM, *Vice President*

P. T. GREILING, *Secretary Treasurer*

J. L. ALLEN
J. C. AUKLAND
B. BERSON
K. J. BUTTON

J. E. DEGENFORD, JR.
R. B. HICKS
J. B. HORTON
F. H. HOWE
R. H. KNERR

E. L. KOMAREK
H. J. KUNO
H. G. OLTMAN, JR.
G. P. RODRIGUEZ
C. T. RUCKER

F. J. ROSENBAUM
H. SOBOLEW
R. A. SPARKS
B. E. SPIELMAN
L. R. WHICKER*

* *Ex officio (past presidents)*

Honorary Life Members

A. C. BECK
S. B. COHN

D. D. KING
W. W. MUMFORD

A. A. OLINER
T. S. SAAD

K. TOMIYASU
C. A. LIECHTI

S-MTT Chapter Chairmen

Albuquerque: J. YU
Atlanta: C. E. RYAN, JR.
Baltimore: M. J. GAWRONSKI
Benelux (interim): E. J. MAANDERS
Boston: M. S. GUPTA
Central Illinois: G. E. STILLMAN
Chicago: D. R. SCHMIDT, JR.
Columbus: WALTER D. BURNSIDE
Dallas: J. R. GRIFFIN
Delhi: D. P. SETHI
Denver: C. T. JOHNS
Florida West Coast: P. E. CRANE
Houston: S. A. LONG

Huntsville: M. D. FAHEY
Israel: Y. HIPSH
Kitchener-Waterloo: Y. L. CHOW
NY/Long Island: N. WORONTZOFF
Los Angeles Council: J. KUNO
Milwaukee: C. J. KOTLARZ
Montreal: R. CARDINAL
NJ Coast: A. J. KERECHAN
North Jersey: H. GOLDMAN
Orange County: J. C. AUCKLAND
Orlando: D. N. BOWYER
Ottawa: R. P. DOULVILLE
Philadelphia: W. T. WHISTLER

Phoenix: R. S. STRAWN
Portland: R. CHEW
Princeton: C. N. SECHI
St. Louis: A. D. SEIFER
San Diego: H. FOWLER
San Fernando Valley: H. POMERANZ
Santa Clara V./O.-EB/SF: F. IVANEK
Schenectady: J. A. BRADSHAW
Seattle: T. L. BLAKNEY
S. E. Michigan: P. PERSELL
Syracuse: J. L. LUZWICK
Tokyo, Japan: K. SUETAKE
Washington, DC: J. SHIVE

IEEE TRANSACTIONS® ON MICROWAVE THEORY AND TECHNIQUES

Editor

J. L. ALLEN, JR.
(Applications)

H. G. OLTMAN, JR.
(Business Editor)

J. E. DEGENFORD
(Computer Program Descriptions)

B. PERLMAN
(Special Issues)

M. CAULTON
(Abstracts Editor—Asia)

T. OKOSHI
(Institutional Listing)

Address all manuscripts to the Editor, J. L. Allen, Electrical and Electronic Systems, University of South Florida, Tampa, FL 33620. 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

JEROME J. SURAN, *President*
LEO YOUNG, *Executive Vice President*
DONALD S. BRERETON, *Secretary-Treasurer*
PAUL F. CARROLL, *Vice President, Regional Activities*

C. LESTER HOGAN, *Vice President, Technical Activities*
BENJAMIN J. LEON, *Vice President, Educational Activities*
ROBERT W. LUCKY, *Vice President, Publication Activities*
BRUNO O. WEINSCHEL, *Vice President, Professional Activities*

LAWRENCE K. ANDERSON, *Division IV Director*

Headquarters Staff

ERIC HERZ, *Executive Director and General Manager*
RICHARD M. EMBERSON, *Executive Consultant*

THOMAS W. BARTLETT, *Controller*
DONALD CHRISTIANSEN, *Editor of Spectrum*
ELWOOD K. GANNETT, *Staff Director, Publishing Services*

JOHN M. KINN, JR., *Staff Director, Professional Services*
NEIL D. PUNDIT, *Director, Technical Activities*
CHARLES F. STEWART, JR., *Staff Director, Administration Services*

Publications Department

H. JAMES CARTER, *Director, Publication Production*

Production Managers: STEPHANIE BLUDAU, ANN H. BURGMAYER, CAROLYNE ELENOWITZ, GAIL S. FERENC*
Associate Editors: PRIJONO HARDJOWIROGO, JOSEPH MOYSCATO, PATRICIA H. NOLAN, KALLIE ZAPITI

* *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. (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 © 1979 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.