

The 1973 International Microwave Symposium

DAVID F. WAIT AND ROBERT W. BEATTY

INTRODUCTION

THE 1973 IEEE-G-MTT International Microwave Symposium was held on the campus of the University of Colorado, Boulder, Colo., June 4-6, 1973. The Group on Microwave Theory and Techniques has now finished its 21st year, and it is still vigorous, mature, and is entering into a new era of civil applications. In spite of the greatest competition for microwave papers ever experienced, this year's technical program was the largest yet, and for the first time included three simultaneous sessions.

The theme of the 1973 Symposium, "Microwave Applications of the 70's," was addressed most directly in the session on civil microwave systems and in several sessions on biological effects. The first-time features for this year were a session on integrated optics, and a panel on nonlinearities in microwave devices and systems. The millimeter-wave sessions were more extensive than before, and in fact were the most heavily attended of the Symposium.

The Symposium provided a taste of the "University"—an outdoors student dance session could be seen on the way to the evening panel sessions, a small student demonstration (orderly) was directed at Symposium attendees, modern posters (our mothers would not approve of) were on display advertising university events, and fascinating session posters (also the digest cover) were created by one of the university's commercial art students (viz., Ernest A. Komarek, Jr.). Many stayed in the university dormitories and rode a university bus to the sessions. Over 200 of the attendees even made it to the 6:30 A.M. breakfast on top of Flagstaff Mountain—a spot (not time) popular with the many university couples.

STATISTICS

The Symposium was attended by 586 persons from 15 countries: Belgium (1); Canada (17); Denmark (2); England (4); France (5); Germany (2); Holland (1); Hungary (1); India (3); Israel (1); Italy (4); Japan (8); Poland (1); Switzerland (1); and the United States (535).

There were 15 sessions, 3 panels, and 1 workshop held in 3 days. The technical program contained 119 papers: 99 accepted papers; 11 invited papers; 5 postdeadline papers; and 4 workshop papers. The breakdown by topic (some overlap) is as follows.

Millimeter and submillimeter	18
Biological research	17
Active solid-state devices	15
Passive solid-state devices	9
Acoustic devices	8
Civil microwave systems	8
Filters	8
Measurements	8
Computer-aided practices	7
Integrated optics	7
Microwave integrated circuits	7
Waveguide analytical techniques	7

The Symposium was supported by 15 manufacturers who exhibited at the Symposium, by 42 institutions which contributed financial support to defray the expense of the *Symposium Digest*, and by 50 or so institutions which provided time for our committee members and session organizers.

TECHNICAL PROGRAM

A successful effort was made to broaden the scope of the technical program at the 1973 Symposium to emphasize applications and developing areas. The tradeoff was a decreased paper rejection rate and an increase in the number of parallel sessions. A good balance between the obvious advantages and disadvantages seemed to be obtained as evidenced by the increased total attendance and the fairly uniform distribution of session and panel attendance.

The technical program was particularly strong in the areas of millimeter-wave techniques and in microwave biological effects research. The advances reported in millimeter-wave low-noise receiving systems and in the applications of integrated circuit techniques to millimeter waves were particularly exciting. The situation in which the United States and other countries had to formulate standards for microwave radiation hazards with insufficient solid research results is being rectified. The research reported at the Symposium indicated increasing activity in this field at a number of facilities working on various aspects of the problem, including non-thermal effects.

The session on integrated optics was well attended and served the purpose of educating microwave engineers in the possibilities of applying microwave theories and techniques to extremely high frequencies. Some pessimistic comments were heard concerning the extent to which integrated circuit techniques can be applied at optical frequencies. However, there is activity in the field and a bidirectional (optical-microwave) learning process should prove beneficial.

The session on civil microwave systems featured timely papers on communications and on energy gathering and transmission. There are several attractive aspects to the exploitation of solar energy including the fact that it is inexhaustible.

A topic long overdue for discussion at a microwave symposium was discussed by the panel on nonlinearities in microwave devices and systems. It was brought out that agreement and standards are needed for definitions of terms and parameters used to characterize nonlinear behavior. In addition, measurement techniques need improvement. Some of the comments of these and other panelists are published in the *Digest*, and a paper on the topic appears in this issue of the TRANSACTIONS.

Active and passive solid-state devices are being rapidly developed for higher powers, higher frequencies, and broader applications. The Symposium sessions covered improvements in circulators, phase shifters, solid-state amplifiers, and oscillators.

The field of microwave acoustics, which has been virtually limited to delay lines, is expanding into other applications

employing acoustic surface waves. This includes pulse compression and filtering. Activity in microwave filter and multiplexer research continues along traditional lines and tends towards smaller size and the use of active networks.

A special panel on microwave noise measurements and system effects was mainly tutorial and helped increase understanding of the complex and important concepts and problems encountered in this area.

All of the theoretical problems in the microwave area have by no means been solved, even in conventional waveguides. A session dealt with parallel-plate, general cylindrical, and microstrip waveguide problems as well as cavity excitation, waveguide bends, and minimum phase behavior of random media.

Developments in microwave integrated circuits were extensive enough to justify a session on systems components such as phase shifters, mixers, oscillators, and amplifiers.

Advances in microwave measurements include a report of a computer-operated test set to measure mode conversion in components for millimeter-wave systems operating from 40 to 110 GHz.

A basic noise standard for millimeter waves was reported. Other measurement techniques were described for properties of microstrip dielectric materials, cavities, and UHF power transistors. Swept frequency network analyzers and testers of simple design were also reported.

Since late news papers were not listed in the program and could not be reported in the *Digest*, they are listed here by title and author as follows.

- 1) "An Adjustable Quasi-Optical Filter," A. A. M. Saleh (Bell Labs., Holmdel, N. J.).
- 2) "Recent Development in the 110-170 GHz IMPATT Oscillators," R. S. Ying, D. H. Lee, D. L. English, and H. J. Kuno (Hughes Res. Labs., Torrance, Calif.).
- 3) "Traveling Wave Maser Receivers for 20-24 GHz Using Ruby and Iron Doped Rutile," K. S. Yngvesson and A. G. Cardiasmenos (Univ. Massachusetts, Amherst, Mass.; E. L. Kollberg, Chalmers Univ. Technol., Gothenburg, Sweden).
- 4) "GaAs Traveling-Wave Transistor," R. H. Dean, R. E. DeBrecht, A. B. Dreeben, J. J. Hughes, R. J. Matarese, and L. S. Napoli (RCA Labs., Princeton, N. J.).
- 5) "The Development of a 20 dB Multi-Octave Directional Coupler for MIC Applications," B. E. Spielman (Naval Res. Lab., Washington, D. C.).

Substitute: "Designs for Magneto-Optic Isolators and Circulators in Planar Dielectric Waveguide Form," J. Warner (Royal Radar Establishment, Malvern, Worcs., U. K.) replaced "Progress of Integrated Optics in England," J. Midwinter (Post Office Res. Station, Suffolk, England).

Additional Notes: Bob Wenzel of Wavecom, Inc., Northridge, Calif., chaired Session 9 on Microwave Filters, substituting for S. B. Cohn, who could not attend. Professor S. Rosenthal, PIB Graduate Center, Farmingdale, Long Island, served as moderator for the workshop on Biological Effects of Microwave Radiation. Don Parker chaired the session originally scheduled for George Haddad.

SYMPOSIUM BANQUET

Two hundred and fifty one persons attended the banquet where David F. Wait, the Symposium Chairman, served as the Master of Ceremonies. Al Clavin received his Past President's Award from the 1973 President, John Horton. The

Microwave Prize was presented jointly to Harrison E. Rowe and Dale T. Young of Bell Laboratories in recognition of their papers "Transmission Distortion in Multimode Random Waveguides" and "Optimum Coupling for Random Guides with Frequency Dependent Coupling." To Ted S. Saad, Sage Laboratories, a plaque was presented in recognition of his services as 1972 National Lecturer. The dramatic highlight of the evening was the announcement that three new Honorary Life Members had been elected. This special honor was bestowed upon D. D. King, North American Phillips; T. S. Saad, Sage Laboratories; and Kiyo Tomiyasu, General Electric Company. The banquet speaker, Ray Stanish, gave a delightful and humorous talk on "Einstein, Relativity and all that Jazz."

LADIES' PROGRAM

For the ladies, Mrs. Kay Hudson, Chairman, and her committee hosted a tour and luncheon to Heritage Square, a progressive brunch and Denver Art Museum tour, and a memorable morning breakfast on Flagstaff Mountain.

DIGEST

The 343-page *Digest*, ably edited by S. Maley, may be obtained by sending \$20.00 (\$15.00 for IEEE members) for IEEE Catalog No. 73 CHO 736-9 MTT *G-MTT Symposium Digest* to IEEE, 345 East 47th Street, New York, N. Y., 10017.

EXHIBITS

For the second time, the Symposium featured an exhibition of microwave products, held in a hall adjacent to the technical sessions. Coffee breaks held in the exhibition area provided an opportunity not only to converse with friends and associates, but to see some of the results of microwave research.

A WORD OF THANKS

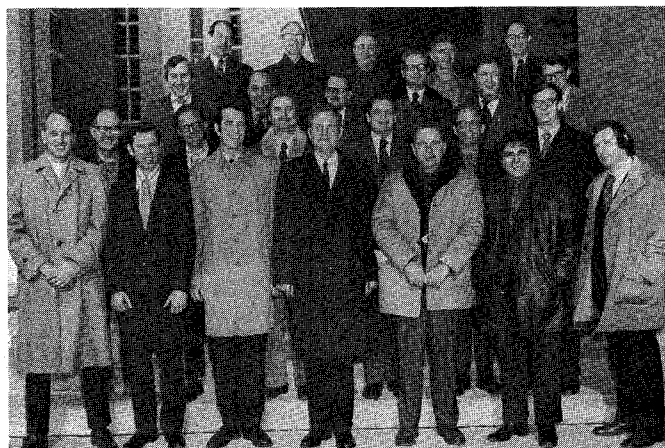
We express our appreciation to all of the organizations supporting the Symposium, especially to the Department of Commerce Laboratories (NBS, ITS, and NOAA) in Boulder, and to the University of Colorado. But as always, the secret of success is dedicated people—many who toil without our notice. For this faceless army we are grateful. To the following and their supporting organizations, we give special thanks.



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U. S. Army Electronics Command
Fort Monmouth, N. J.

S. Maley
Univ. Colorado
Boulder, Colo.

W. Mills¹
Environmental Protection Agency
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N. Nahman¹
Nat. Bureau of Standards
Boulder, Colo.

S. Okwit
LNR Communications, Inc.
Farmingdale, N. Y.

T. Otoshi
Jet Propulsion Lab.
Pasadena, Calif.

D. Parker
Stanford Res. Inst.
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T. Reeder
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F. Rosenbaum
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A. Rumfelt
Nat. Bureau of Standards
Boulder, Colo.

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