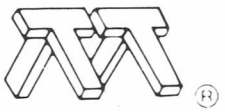
IEEE SOCIETY ON
MICROWAVE THEORY
AND TECHNIQUES



NEWSLETTER

Number 124
Spring 1989

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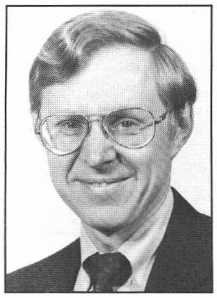


by Peter Staecker

Long Beach Preview

It is time for the yearly MTT blowout, the 1989 IEEE MTT-S International Microwave Symposium. How many of the 298 papers do you plan to attend? How many bags full of catalogs, plastic rulers, rubber magnetic refrigerator icons, on-site laminated business card luggage tags, and other exhibition memorabilia will you carry home? Should we offer a prize to the person who can survive the entire week on box lunches? Are you ready for *three* hardcover volumes of the MTT Symposium Digest? Is it possible to read all the breathless editorials (including this one) and technical pre-symposium copy to plot your course through Microwave Week? Can we really tolerate an Awards Banquet with *no head table*? Do people really pay 50 bucks to wait in line at Universal Studios, or is that Chuck Swift's secret plan to make the transportation budget? Just kidding. In fact, there is quite a bit of exciting new technical stuff in this year's show. Do not miss it. Kudos to Chuck Swift and his Committee for organizing an outstanding event. In the pages of this issue, you will find

- the musings of Chairman Swift
- notes on the Seymour Cohn special session
- a tour of the special exhibits
- technical notes on MTT and monolithic meetings
- related ARFTG activities
- your own copy of the Microwave Week schedule

Use them to your advantage.

Membership Services

Although the Symposium is one of the most visible of MTT's services to the membership, it is by no means the only one. Members and Chapter Officers alike will find in the following the means of carrying the technical content of our annual show back to the local level. Vehicles such as the Distinguished Microwave Lecturer, the Speakers' Bureau, and videotape lectures on Emerging Technologies are available to every MTT member. Ideas for additional topics and events at the local level can be found in Zvi Galani's compilation of Special Chapter Meetings.

Technical contributions to this issue include Ray Pengelly's sequel to his overview on MMICs begun last issue. This two-part series provides an excellent comprehensive review of the state-of-the-art in monolithic integrated circuits. The latest in machine computation news is given by Ed Miller in his regular article. Your contributions, suggestions and comments are welcome. See you in Long Beach!

MTT-S NEWSLETTER COPY DEADLINE INFORMATION

Issue	Copy Deadline*
Spring	February 28
Summer/Fall	July 2
Winter	December 1

* For special technical articles, submit 8 weeks earlier.

Letter to the Editor

MTT, IEEE, and YOU. . .

I used to think of microwaves in terms of radar, guided waves, and rather artistic plumbing. Maxwell was supreme in a highly specialized field.

But, oh my, how the world has changed. Microminiaturization of devices and integrated circuits have increasingly moved all functions imaginable into the microwave range, extended to include the infrared spectrum. Beyond transmission and radar, we have added logic, computing, switching, power - just about everything in only 20 years. And today with very little plumbing, unless you count glass fibers.

This technological evolution, at superpace, has brought a flood of new applications which are revolutionizing the way we do business and lead our leisure lives. Perhaps 80% of today's communications and computers form the infrastructure of just about every business whether it be manufacturing, airlines, banking, insurance, investment houses or opera houses,. . . etc. These 'operations systems,' under the control of few humans, optimize design, inventories, scheduling, record keeping, billing, production machines,. . .just about everything a business does. Properly used, these applications of our technology promise to enhance business productivity at an ever increasing pace. And, they are necessary to keep us competitive in price, as well as time to market. They are the key to the nation's prosperity.

The IEEE must foster proficiency in the surge of current technology and encourage the emergence of new techniques. Publications, conferences, and workshops keep us at the cutting edge. As new fields open up, IEEE must respond quickly. With the influx of innovative contributions from Asia and Europe, IEEE must become increasingly transnational.

Although MTT-S has performed superbly by helping members to understand the art and practice of microwaves, the Society has not encouraged adequate coverage of the uncharted spectral range extending from submillimeter waves to the far infrared. Some more specific concerns to be addressed by AdCom are as follows:

1. The International Microwave Symposium is overloaded with other symposia, conferences and workshops running concurrently. An overabundance of riches offered to attendees in a short time leads to frustration. Two annual conferences should be considered.
2. The Symposium program has consistently arrived too late for potential participants to plan and budget their attendance at the conference. This problem could be alleviated by mailing a preliminary program six months in advance as done for other important conferences. Doing this may require hiring a staff person at IEEE headquarters.
3. AdCom needs infusion of new talent to provide wider horizons to Society members.

MTT-S has been and must continue to be a leader among the 35 IEEE Societies in services to members, quality of publications, and in innovative educational programs. This newsletter is tribute to your, to our success. And human society is much the better for it, every year.

Eric E. Sumner
Vice President, Operations Planning
AT&T Bell Laboratories

Editor's Note: Mr. Sumner is a candidate for IEEE President-Elect, 1990. He is an IEEE Fellow and member of the MTT Society.

AdCom Highlights

by Tatsuo Itoh
Vice-President, MTT AdCom

The winter AdCom meeting was held in Long Beach on the evening of January 10, 1989 immediately after the Technical Program Committee meeting (for selection of symposium papers) and continued on January 11. The meeting was presided over by V.G. Gelnovatch, the new MTT-S president.

In accordance with the procedure recently established, the standing Budget Committee met prior to the AdCom meeting to discuss and recommend to the AdCom all the expense requests from the other standing committees. Based on the evaluation and recommendation of each item by the Budget Committee, the AdCom resolutions were made. The following two items are considered to be worthy of being included here. The Membership Committee's request for $3200 was approved for mailing a welcome letter and a copy of the AdCom directory to new MTT members. This action clearly conveys a strong indication from the AdCom that the well being of the membership takes a very high priority. Also approved was a cash advance of $5000 for the Microwave and Millimeter-Wave Monolithic Integrated Circuit Symposium at Long Beach in June. This action guarantees preparation for a successful Monolithic Symposium. This annual symposium was initated several years ago as an exciting new area of MTT-S.

In regard to financial matters, the Finance Committee Chairman, R. Moore, has initiated the 1990 budget process. He has been streamlining the budgeting process so that the funds can be better managed and be more effectively used for service to the membership. He has indicated that he would like input from Chairmen of Standing Committees by mid February, so that all the input can be considered at the Budget committee meeting in March.

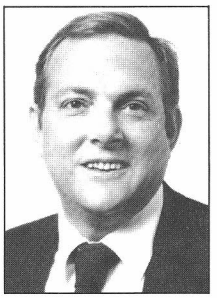
The page budget for the IEEE Transactions on Microwave Theory and Techniques is 2150. This will be increased to 2300 pages in 1990. Of the 2150 page budget, only 300 pages will be allocated to the Symposium issue on December 1989. This is in consideration of an attempt to control the ever increasing transaction page budget, much of which is caused by the Symposium issue. The Publications committee also reported on three MTT sponsored IEEE Reprint Books. 'Instrumentation and Techniques for Radio Astronomy' by Paul F. Goldsmith was issued in the Fall of 1988. 'Numerical Methods for Passive Microwave and Millimeter-Wave Structures' by Roberto Sorrentino is in the production stage. Finally, the two volume book, 'HEMTs: Fundamentals, Properties and Technology' and 'HEMTs: Devices, circuits and Applications' by Heinrich Daembkes is ready to go into production. As a new attempt, six video tape tutorials 'MTT Society Series' are being made available in January.

The Long Range Planning Committee was instructed by President Gelnovatch to formulate a strategic plan called MTT 2000. The Committee will engage in an extensive brain storming session to look into the future activities of the MTT in terms of technical activities, operations, membership services, etc. One of the most critical issues is how to address the emerging technology and to cope with technological changes to maintain the viability and health of the Society. This topic is important from the membership services point of view as well.

The Membership Services Committee has also initiated a Strategic Plan: Toward 2000 in response to the Long Range Committee's MTT 2000 plan. In addition, the committee reported a membership growth of 10.5% in 1988 and a record activity of Distinguished Lecturers. As a part of the Membership Services Committee, the International Liaison Activities will be enhanced.

Outgoing Award Committee Chairman C.T. Rucker reported that a design and a citation for the N. Walter Cox Award have been prepared and are ready for presentation with the assistance of Mrs. Cox and her daughters who will be attending the Symposium.

Call for Nominations



by Edward C. Niehenke
Chairman, MTT AdCom
Nominations Committee

The MTT-S holds elections at the annual Fall meeting to elect members to serve on the Administrative Committee (AdCom). The Bylaws state the Nominations Subcommittee will select a slate of at least two members of the Society for each vacancy in the elected membership, which will occur on the Administrative Committee the following January 1. The Nominations Subcommittee shall be guided in their selections by principals of efficiency, geographical, and organizational distribution. Administrative Committee members who have served three consecutive terms by the following January 1 shall not be considered eligible for nomination by the Nomination Subcommittee.

The Bylaws provide three means by which one may be nominated for the Administrative Committee. They are as follows:

1. Nominations by the Nominations Subcommittee
2. Nomination by petition signed by 25 MTT-S members and submitted to the nominations chairman prior to September 1, 1988
3. Informal Chapter nominations

Informal nominations by Chapter do not guarantee nomination. The Chapter Chairman should convey the informal nominations to the Nominations Chairman by Spetember 1, 1989. Both nominees and potential nominees must be contacted prior to the fall annual meeting to ascertain that they will accept the nomination.

This year the nomination subcommittee consists of 8 Society members, half of whom are not current AdCom members as specified by the Bylaws. They are:

Robert H. Brunton III	Seattle, WA	(206) 392-4990
Rudolph Henning	Tampa, FL	(813) 974-4782
Ferdo Ivanek	Palo Alto, CA	(415) 329-8716
Matthew Jacobs	Long Island, NY	(516) 226-8900
D. Gary Lerude	Dallas, TX	(214) 995-5678
Mario A. Maury, Jr.	Cucamonga, CA	(714) 987-4715
Wayne R. Openlander	Chicago, IL	(312) 491-7888
Peter W. Staecker	Burlington, MA	(617) 272-3000, Ext. 1602

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CALL FOR NOMINATIONS (continued from page 3)

The wide geographic distribution of the nomination subcommittee should give a reasonable fair representation to all chapters and members. The geographical and affiliation distribution of the current AdCom membership is given below.

Present AdCom (1989) Total = 18

Eastern U.S.	7	Industry	16
Central U.S.	5	Government	1
Western U.S.	5	University	1
Europe	1		

Holdover Members (1989) AdCom Total = 11

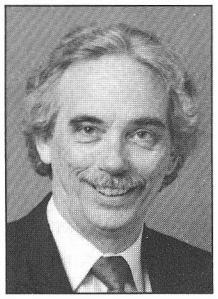
Eastern U.S.	4	Industry	10
Central U.S.	2	Government	0
Western U.S.	4	University	1
Europe	1		

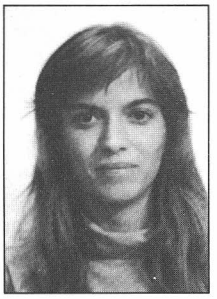
Term Ends (1989) Total = 7

Eastern U.S.	3	Industry	6
Central U.S.	3	Government	1
Western U.S.	1	University	0

The Nominations Subcommittee needs your help in suggesting potential nominees to serve our membership as AdCom members. Please submit your suggestions to a memnber of the membership subcommittee and/or your local Chapter Chairman. The schedule for the nomination subcommittee calls for providing a slate of candidates by September 1, 1989. Please keep in mind the potential nominees must be able to commit themselves to at least three meetings a year held across the U.S. Nominate your prospective AdCom member today.

Membership Services





by Alton L. Estes, Chairperson and April S. Brown, Co-Chairperson

SERVICE TO MEMBERS COMES FIRST

Yes! Our Society's Officers and Committees believe 'Service to Members Comes First.' The Membership Services Committee is working on a strategic plan, 'Toward 2000,' to provide the best service possible to our Society members every year into the next century. In order to develop 'Toward 2000,' we defined our purpose for existence as a committee.

'Toward 2000' Mission

The MTT Society membership services Committee mission is to stimulate Chapter and Membership growth, to coordinate and stimulate technical exchanges and meetings of Chapters and Members, to maintain Society and Chapter records pertaining to membership and meetings, to disseminate IEEE and MTT Society information and publicity to Chapters and Members, and to maintain liaison among the IEEE, Chapters, and the Administrative Committee.

In order to plan for the future we are reviewing the services our Society is currently providing its Members. Included in this Newsletter are articles by the Membership Services team and other MTT-S Committees which document that our Society continues to offer our Members new and improved services which are essential for enhancing the vitality of the IEEE, the MTT-S and their Members.

The following examples of service by our Society demonstrate behavior compatible with our belief that 'Service to Members Comes First.' Our Society co-shared travel support (MTT-S share budgeted for $26,000) for four Distinguished Microwave Lecturers in 1988 with the Lecturers' companies. The four distinguished Microwave Lecturers gave 88 lectures in 1988. The MTT-S Speaker's Bureau was started in 1988 and includes some of the most prestigious technical leaders of IEEE and our Society. The topics chosen include ten of the hottest technical topics discussed when microwave engineers gather to discuss their professional work. In 1989 the Bureau's Speakers will give over 60 lectures with $15,000 of the anticipated speaker's $30,000 travel expenses supported by the MTT-S. Our Society provided $8,500 support to our Chapters to assist putting on technical meetings. Society Chapter Chairmen who needed support to attend the recent International Microwave Symposium were reimbursed up to $1,000 each, with the total support reaching $8,661 in 1988. The cost to provide the 12 issues of IEEE Transactions on MTT to each Society Member is over 3 times the Society dues ($12). These and other services provided by our Society truly reflect that as far as our Society service performance is concerned, 'Service To Members Comes First.'

1988 PROGRESS UPDATE

Record Service by Distinguished Microwave Lecturers

In 1988 and for the first time, the MTT-S had four MTT-S Distinguished Microwave Lecturers actively presenting their lectures. Dave Barton completed his 1987/1988 lecture series presenting 'Technology Trends in Microwave Radar.' Rolf Jansen completed his 1987/1988 lecture series presenting 'CAD of Hybrid and Monolithic Microwave and Millimeter-Wave MICs' to UK/Ireland and King's College London in January, 1989. Arnold Silver and Reinhard Knerr are busy with their 1988/1989 tours presenting 'Microwave and Gigabit Superconductive Electronics' and 'Lightwave Communications.' In 1988 Dave Barton gave 30 talks to Chapters in the United States, Canada, Australia, and New Zealand. Rolf Jansen presented 26 lectures to Chapters in the USA, Canada, Japan, and Europe. Arnold Silver gave 13 talks in the USA and Reinhard Knerr has given 19 lectures to Chapters in the USA and Europe.

New MTT-S Chapters Formed

Five new chapters were formed in 1988 which increased the percent of MTT-S Membership affiliated with Chapters from 76.5 percent in 1987 to an estimated 78 percent in 1988. The following new Chapters were formed in 1988:

France, Ithaca, North Italy, Taiwan, and Winnipeg.

The total number of Chapters in 1988 is 62, and the increase of Chapters in one year was 6.9%. New Chapters which are currently in the process of being formed are:

Central North Carolina, Greece, Korea, Poland, Southern Connecticut/Westchester, and Yugoslavia

Financial support Utilized by Chapters

In 1988 a total of 18 Chapters requested and received $8,500 assistance for organizing technical meetings. In addition, 9 Chairmen were reimbursed $8,661 travel expenses to attend the 1988 IMS in New York City.

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MEMBERSHIP SERVICES (continued from page 4)

Computer Officer Mailing Labels Service Established

Our new computer has been installed and available to generate currently reported Chapter Chairmen or Vice-Chairmen mailing labels. Zvi Galani is prepared to service MTT-S committee or Chapter mailing label requests.

Membership Reaches 11,750

The Membership Development goal of 10 percent membership increase in 1988 was almost attained. MTT-S Membership grew by 9.96 percent over 1987 and missed the 10 percent goal by only 5 Members. MTT-S ended 1988 with 1,064 more Members than in 1987. The MTT-S, Computer and Communications Societies, were the only three Societies of the 36 IEEE Societies who added mre than 1,000 Members in 1988.

1989 PROGRESS

Each committee member determined 1989 goals for their area of responsibility. We selected goals that are challenging but attainable. The next Newsletter will contain a progress report.

1989 GOALS

- 70% Current Chapter Officer Office Tenure
- 70% Current Chapter Meeting Reports
- 100% Utilization of Speaker's Bureau
- Develop Member Service Awareness Program
- Form Five New Chapters
- 85% Member Retention
- 6% Member Growth
- Develop IEEE Senior Membership Program
- Develop Student Membership Program
- 15% Student Member Growth
- Develop Chapter Officer Training Program
- Develop Overseas Conference/Workshop Support Guidelines

PROBLEMS TO BE SOLVED IN 1989

The Problem

Communications to and from our Chapters appears to be our main problem to be solved in 1989. Zvi Galani reported at the January, 1989 AdCom meeting, only 49% of our chapters had reported any meetings in 1988. Also, he reported that over 55% of our Chapters had Officer terms-of-office that were out of date. This was a slight improvement over the November statistics when there was 60% of our Chapters which had Chairmen terms-of-office that were out of date. The slight improvement was due to the Chapter Chairmen's repsonse to a letter and response form that had been sent to all the delinquent Chapters' Chairmen. Obviously, a five point improvement occurred, but that small of an improvement is not good enough. Our Society cannot continue to allow miscommunication with up to 60 percent of our Chapter Chairmen. This same exact problem was reported last year to AdCom. Response is still coming in from Chapter Vice-Chairmen in reponse to a letter and form sent to the delinquent Chapters' Vice-Chairmen in January.

Members Can Be Part of the Solution

The Chapter Members can help solve these two communicaton problems. First, we want the members to know why it is in your best interest for this problem to be solved.

The Chapter Chairman is the focal point for all communication about Chapter services from our Society and Institute to the Chapter and its Members. Our committee's objectives include stimulating growth and activities of MTT-S Chapters, and coordinating all services to Chapters and their Members. We cannot perform the important function to provide valuable service to your Chapter and its Members if we do not know who the current Chapter Chairman is, and what his or her address is. Please help us get this important information.

Here's How You Can Help

Please look in the 1989 MTT-S Committee Directory or in the recent 'Chapter Records' section of the Newsletter for the names, addresses, and current tenures of office for your Chapter's Chairmen and Vice-Chairmen. If the information is not correct, ask the current Chairmen to correct the information by completing the form that Zvi Galani sends to all Chapter Chairmen whose office tenure is out of date. Also, you could start reviewing the meetings reported for your Chapter in the 'Chapter Records' section (published once a year) of the Newsletter. If your Chapter's meetings are not reported ask your chairman to see to it they are reported. Your IEEE Section receives $50 rebates from IEEE for each Chapter meeeting (if reported). The money is given to the Sections by IEEE to use for supporting the Chapters technical meetings since it is the IEEE Sections who supervise Chapters. Meeting reports are supposed to be completed and mailed within ten days of each Chapter meeting. Check with your Chapter Secretary and find out what is being done to report meetings. And if your Chapter Officer asks you to help put on a technical meeting, say 'yes.' This is another way you can help your Chapter, its members, and yourself.

1989 IEEE/MTT-S MEMBERSHIP BOOTH

You Are Invited

Please drop by our IEEE MTT-S Membership Booth that will be open during registration hours at the 1989 International Microwave Theory an Techniques Symposium. Members of MTT-S AdCom and the local IEEE Sections in addition to MTT-S Members will be staffing the booth. Share your perceptons about MTT-S services or discuss whatever you wish with the booth staff. We look forward to hearing from you.

See you in Long Beach.

☐ **Better presentations** *with visual aids:* Rehearse with the aid *before* giving the presentation...be sure each aid supports your talk—don't talk to support the aid...continue talking while changing or handling aids...handle them as little as possible...speak louder to compensate for the audience's divided attention...remove the aid after you are through discussing it...turn equipment off when not in use.

An Executive's Guide to Effective Presentations, Executive Information Network, 11545 W. Bernardo Ct., San Diego, 92127. $33.45.

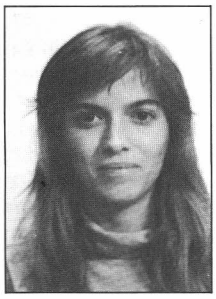
☐ **Before you fire an employee,** protect yourself from a lawsuit by adequately warning him/her about unsatisfactory performance. *Keep it on file:* A copy of at least one dated memo to the employee that details the poor performance over a period of time. *Also needed:* Proof (consisting of a statement signed by the employee) that the two of you discussed the problem, and a follow-up report on the employee's failure to improve after a given time period.

Arline Golden, lecturer on business communication, Sloan School of Management, Massachusetts Institute of Technology, Boston, quoted in *Working Woman*, 342 Madison Ave., New York 10173. Monthly. $18/yr.

☐ **Before going back to school,** *ask yourself:* What will I do differently after this course...are there better ways to get the same information...are promotions in my business based on this knowledge...will my employer pay for the course, and if not, why not? If your answers don't seem hopeful, the classes are not likely to be helpful.

Kennedy's Career Strategist, 1153 Wilmette Ave., Wilmette, IL 60091. Monthly. $59/yr.

MTT-S Speakers' Bureau



by April S. Brown
Co-Chairperson,
Membership Services Committee

The MTT-S Speakers' Bureau was established in 1988 by the MTT-S to provide continuing education to members on a large number of technical topics. The topics were chosen to inform our members about advanced or emerging microwave devices, circuits, circuit analysis, and systems. The members of the Bureau are nationally recognized leaders in their field of interest. They have agreed to give up to six lectures during 1989 to MTT-S Chapters.

Members of the Bureau are continuing a busy schedule. Fred Gardiol gave his lecture on *Microstrip Circuit Analysis* to the German MTT Chapter in Munich and Erwin Schanda gave his on *Remote Microwave Sensing* to the Beijing Chapter. The Ithaca and Syracuse Chapters have received lectures from Michael Wengler on *Submillimeter Heterodyne Detection*, and the Springfield Chapter received Paul Goldsmith's talk on *Quasioptical System Design*. Octavius Pitzalis lectured to an audience of approximately 50 people on *GaAs FET and HEMT Modeling* at a meeting of the Dallas MTT-S chapter. Charles Holmes, Peter Parrish and Octavius Pitzalis gave their joint lecture at Drexel University.

Each of the Chapters has received a form to use to simplify requesting and scheduling lectures by members of the Speakers' Bureau. We have received over 25 requests from different Chapters for lectures. This response is very encouraging and is a good indication that this service will be fully utilized in 1989. Also, the spread of the requests for the different topics is good.

We are currently in the process of organizing the Speakers' Bureau for 1990/91. Please look over the topics currently offered and think about additional topics which would add to the current choices. We are looking for topics which report recent technology advances as well as historical or tutorial talks. Call or write to me indicating your choice for a topic or a speaker which should be considered for the MTT-S Speakers' Bureau. The MTT-S Membership Services Committee plans to spend at least $15,000 for this service in 1990/91.

A table which summarizes the 1989 MTT-S Speakers' Bureau information including the Speakers' addresses and telephone numbers follows.

Your Home

☐ **Home painting aid:** Aluminum foil. It crimps easily around faucets, door knobs, wall phones, etc., before painting...and is easily removable when paint is dry.

Family Handyman, 1999 Shepard Rd., St. Paul, MN 55116. 10 issues. $11.79/yr.

☐ **Clinging vines** that grow on an outside wall exposed to sunlight increase the level of comfort *inside* the house. *Reason:* The overlapping leaves shield the wall from direct sunlight, reducing the wall's surface temperature...and the leaves stand off from the wall, allowing a cool stream of air to carry off heat from the inside. *Warning:* Clinging vines are destructive to wooden walls. Masonry is unharmed.

Nature's Guide to Successful Gardening and Landscaping, by William Flemer III, University of South Carolina Press, Columbia 29208. $24.95.

Lightwave Communications

by Reinhard H. Knerr
AT&T Bell Laboratories
555 Union Boulevard
Allentown, PA 18103
Phone (215) 439-7505

DISTINGUISHED MICROWAVE LECTURER (1988/1989)

Abstract

Lightwave communications technology has now reached a fairly sophisticated level of maturity. Applications range from multi-mode short wavelength LED systems, which can transmit at kilobits per second and are used primarily for short range applications, to long-haul single-mode laser systems, which can transmit at the rate of gigabits per second.

This talk will touch on the full range of lightwave communications applications. A short introduction to basic fiber technology will be given. Applications to optical data links and interfaces for point to point data networks, will be discussed as well as the extension of such technologies to lightwave local area networks (LANs). Different network architectures for lightwave LANs will be discussed, including the fiber distributed data interface (FDDI), and the manufacturing automatic protocol (MAP). Long haul digital systems will be mentioned, with special emphasis on the microwave aspects of gigabit systems, such as stripline and low noise GaAs preamplifier technology.

Coherent lightwave systems will be reviewed with emphasis on the equivalence between such systems and the older microwave technology. We will detail problems which have been addressed in microwave systems and which are now being encountered in coherent lightwave systems and being solved by analogy to the older microwave technology. These include techniques such as isolation, internal and external modulation schemes, low noise amplification and phase lock techniques. Emphasis will be placed on heterodyne rather than homodyne systems.

Because of the wide range of topics covered, the talk will be more in the nature of a review than an in-depth presentation of any given topic. Some theoretical discussion will be included, but hardware will be emphasized. We will conclude with a short look into the future, and a discussion of the fundamental problems that have yet to be solved in order to make certain exploratory systems practical.

BIOGRAPHY

Reinhard H. Knerr is a native of Pirmasens, Germany. He received a PhD and an MS in EE from Lehigh University, Bethlehem, PA and Dipl. Ing. degree from the Ecole Nationale Superieure d'Electrotechnique et d'Hydraulique in Toulouse, France and a BS degree from the Technical University of Aachen, Germany.

He joined AT&T Bell Laboratories as a Member of the Technical Staff in 1968. He was involved in R&D on circulators, IMPATT power amplifiers, low noise and power GaAs FET amplifiers and satellite receivers. He has published extensively in the field and holds six patents.

Knerr has supervised work in lightwave passive components, integrated optics, lightwave local area networks and lightwave data interfaces.

He is a Fellow of the IEEE and was editor of the Transactions on MTT from 1980 to 1982. He served as president of the MTT Society in 1986.

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MTT SPEAKER BUREAU (SB) / VIDEOTAPE LECTURES (VT) : SUMMARY INFORMATION					
Lecturer	**Affiliation**	**Topic**	**VT**	**SB**	**Abstract & Biography Ref (Newsletter)**
Heinrich Daembkes Phone: 49-731-392-4272	AEG Research Center Sedanstrasse 10, D-7900 Ulm West Germany	Microwave and Millimeter-Wave HEMT Devices and Circuits		X	Winter 1988
Pierre Encrenaz Phone: 33-45-347530 FAX: 33-45-342151	Observatoire de Paris 92190 Meudon, France	The Impact of Coherent Detection Techniques on Terrestrial and Planetary Atmospheric Research, and on The Discovery of Interstellar Molecules		X	Spring 1988
Fred Gardiol Phone: 41-21-472670 FAX: 41-21-4746600	Ecole Polytechnique, Dept. D'Electricite El-Ecublens, CH-1015 Lausanne, Switzerland	Microstrip Circuit Analysis: The Integral Approach		X	Winter 1988
Paul Goldsmith Phone: (413) 665-8551 FAX: (413) 665-2536	Millitech Corp. South Deerfield, MA	Quasioptical System Design for Millimeter Wavelengths		X	Summer/Fall 1988
C. Holmes **P. Parrish** **O. Pitzalis** Phone: (818) 991-7530	EEsof Incorporated 5795 Lindero Canyon Road Westlake Village, CA 91362	GaAs FET and HEMT Modeling Circuit and System Simulation — State of the Art and Beyond		X	Spring 1988
Richard E. Howard Phone: (201) 949-5952 FAX: (201) 949-8988	AT&T Bell Laboratories Crawford Corner Road Holmdel, NJ 07793	High TC Superconductivity: Facts and Fancy	X		Winter 1989
Rolf H. Jansen Phone: 49-2101-83095 FAX: 49-2101-842391	Industrial Microwave and RF Techniques, Inc. Neanderstrassse 5 D-4030 Ratingen 1 West Germany	CAD of Hybrid and Monolithic Microwave and Millimeter-Wave MICs	X		Summer/Fall 1988
Reinhard H. Knerr Phone: (215) 297-5432 FAX: (215) 391-2570	AT&T Bell Laboratories Route 222 Breinigsville, PA 18031	Lightwave Communications	X		Summer/Fall 1988
U. Mishra Phone: (919) 737-7354 **A. Brown** Phone: (919) 549-0641	N.C. State Univ. (U.M.) Raleigh, NC 27695 Army Research Office (A.B.) Durham, NC 27709	Gallium Indium Arsenide Heterostructures for Low Noise Ampliciation, High Speed Logic Circuits, and Lightwave Detection	X	X	Summer/Fall 1988
Edward C. Niehenke Phone: (301) 765-4573 FAX: (301) 993-7432	Westinghouse Electric Corp. P.O. Box 746—M.S. 75 Baltimore, MD 21203	Gallium Arsenide—Key to Modern Microwave Technology	X		Winter 1986
Erwin Schanda Phone: 41-31-658910	Institute of Applied Physics University of Bern CH-3012 Bern, Switzerland	Remote Sensing with Microwave and Millimeter Waves		X	Winter 1988
Kurt Weingarten Phone: (415) 962-0755 FAX: (415) 962-1661	Lightwave Electronics 897-5A Independence Ave. Mountain View, CA 94043	Testing of High Speed ICs with Ultrashort Optical Pulses		X	Summer/Fall 1988
Michael Wengler Phone: (716) 275-9402 FAX: (716) 275-0135	Dept. of Electrical Engineering University of Rochester Rochester, NY 14627	Submillimeter Heterodyne Detection with Superconductive Electronics		X	Summer/Fall 1988
Bernard Yurke Phone: (201) 582-4961	AT&T Bell Laboratories 600 Mountain Avenue Murray Hill, NJ 07974	Quantum Noise in Microwave and Millimeter-Wave Electronics		X	Winter 1988

Microwave and Gigabit Superconductivity Electronics

by Arnold H. Silver
TRW Space and Technology Group
One Space Park, MS R1//2170
Redondo Beach, CA 90278
(213) 812-0115

DISTINGUISHED MICROWAVE LECTURER 1988/89

Superconductive electronics is an integrated circuit technology which can provide the highest performance detection and signal processing circuits from dc to the submillimeter-wave region and the fastest digital logic and memory. This performance is achieved by combining the fundamental properties of superconductors, the superconducting Josephson tunneling diode, and the cryogenic environment required for superconductivity.

This lecture will review the fundamental and historical development of superconductive electronics. Its inception traces from the successive discoveries of flux quantization, the Josephson effect and the SQUID (Superconducting Quantum Interference Device) in the early 1960's; its appliation is a direct consequence of the development of a thin film integrated circuit technology for computer applications. From a lead alloy technology in the 1970's, we now have a highly developed niobium circuit technology which is capable of operating at picosecond speeds and into the submillimeter-wave region.

We will discuss the performance and appliation of such components as quantum-noise limited microwave and millimeter-wave amplifiers, mixers, and video detectors, voltage-controlled oscillators, analog correlators and convolvers, and analog-to- digital converters. The recent discovery of superconductivity at temperatures as high as 95 kelvin may be herald the widespread use of superconductive circuits. Prospects for development and application of high temperature superconductive electonics, and its possible impact on semiconductor devices will be explored.

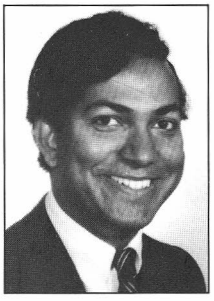
Biography

Arnold H. Silver joined TRW Space and Technology Group in 1981 after serving as Director of the Electronics Research Laboratory at the Aerospace Corporation for 10 years. Prior to that, he was with the Scientific Laboratory of the Ford Motor Company at Dearborn, MI for 12 years. He is a member of the IEEE, a Fellow of the APS, and has been active in the superconductive electronics community including service at Technical Program Chairman of the 1976 Applied Superconductivity Conference and a member of the Organizing Committees of the Workshop on superconductive Electronics and the US - Japan Workshop on Josephson Electronics.

Silver has been active in the development and application of superconductive electronics since his invention of the SQUID at Ford in the early 1960's. At Aerospace, his laboratory pioneered the development of low noise millimeter wave mixers and detectors, including the super conducting-Schottky diode and the quantum theory of superconductive Electronics Research at TRW, his group has pioneered the development of low noise microwave amplifiers and oscillators, analog-to-digital converters, a niobium-based itegrated circuit technology and now the development of a high temperature superconductive technology.

Silver received the BS, MS, and PhD degrees in Physics from Rensselaer Polytechnic Institute. His dissertation was on the application of nuclear magnetic and quadrupole resonance effects in the study of the structure of solids. He continued that research at Ford until his work on superconductive devices. He has authored more than 50 publications and numerous patents.

Membership Development



by Fazal Ali
Chairman,
Membership Development

STUDENT MEMBERSHIP PROGRAM

One of the primary goals this year is to develop a student membership program that will help increase the number of student members affiliated with the MTT Society. The main objectives of this program are to stimulate the growth and technical activities of our Society's student members. How do we accomplish these goals? My suggestions are listed below:

- Letters to professors of the colleges and universities that have significant microwave programs asking them to promote student membership.
- Send 1989/1990 IEEE MTT-S student membership pamphlets to professors teaching microwave courses.
- Local MTT Chapter officers to visit schools in their area and give talks to undergraduate and graduate students regarding their work and MTT Society activities.
- Increase student participation at MTT-S sponsored local workshops and International Microwave Symposium by having registration and travel paid for by local chapter for 'Best Student' in a microwave course, or 'Best Student Project/Paper.'
- Have local chapters, in cooperation with the university professors, promote and sponsor student paper/project contest at least once a year to increase the awareness of undergraduate students to microwave engineering.
- Have a 'Student Night' sponsored by the local MTT chapter in cooperation with the local companies to provide informal exchange of information between students, teachers, local MTT officers and the working engineers.

Please send me information concerning your local chapter activities in this area with comments as to what has or has not succeeded.

MTT-S MEMBERSHIP BOOTH AT THE 1989 MICROWAVE SYMPOSIUM

There will be a membership booth at the 1989 IEEE MTT-S International Microwave symposium in Long Beach, California. The booth, located in the registration area, will be open from Tuesday, June 13, until noon on Thursday, June 15, 1989. Please stop by the booth and visit with the membership service committee members, AdCom members, and chapter chairmen who will be contributing their time to promote *Free MTT-S Membership* and answer any MTT-S related questions.

IEEE Introduces the 'MTT Society Series' of Home Video Tutorials

Emerging Technologies

Co-produced by
Martin V. Schneider, *IEEE/MTT Society*
Richard P. Moos, *AT&T Bell Laboratories*
Rudolf A. Stampfl, *IEEE Educational Activities Department*

Six experts present a state-of-the-art overview in five lecture videotapes

Lightwave Communications

by Reinhard H. Knerr, AT&T Bell Laboratories, Breinigsville, PA*

Lightwave communications technology has reached a fairly sophisticated level. Applications range from multi-mode, low bit rate, short wavelength, LED systems to single mode, long wavelength laser systems which can transmit information at the rate of many gigabits per second. This author discusses the full range of lightwave communications applications including basic fiber technology, applications to optical data networks, direct detection and coherent lightwave systems.

Gallium Indium Arsenide Heterostructures for Low Noise Amplification, High Speed Logic Circuits, and Lightwave Detection

by Umesh K. Mishra, Technical Staff, Advanced Devices, Hughes Research Laboratories, and April S. Brown, Outstanding Technical Achievement Award Winner, Hughes Research Laboratories, CA.

GaInAs has long been recognized for its excellent electronic properties and its wavelength compatibility with low loss optical fibers. The advent of advanced growth technologies such as MBE and MOCVD has led to the development of MODFETs and HBTs. This presentation addresses the status of the materials, device properties, circuits and applications of heterostructures based on InGaAs.

Gallium Arsenide—Key to Modern Microwave Technology

by Edward C. Niehenke, Westinghouse Defense and Eelctronic Center, Baltimore, MD*

Recent advances in microwave technology can be traced to developments in GaAs devices and circuits. GaAs has found its niche for the FET, HEMT, varactor, PIN, IMPATT and Gunn devices. The insertion of GaAs in the modern microwave system—whether communication, radar, electronic warfare, missile guidance or commercial—has improved reliability, efficiency, performance, and speed as well as extended the frequency range. GaAs is compared with other materials, its salient properties which benefit various semiconductor devices is highlighted and the latest device technology for discrete devices and monolithic circuits is reviewed.

High TC Superconductivity: Facts and Fancy

by Richard E. Howard, AT&T Bell Laboratories, Microelectronics Research Department, Holmdel, NJ

With the recent discovery of the high transition temperature superconductors, dramatic and wide-ranging claims have been made for the opening of a new era of technology. Examples that capture the imagination include high speed electronics, levitated trains, power transmission and high-field magnets for everything from controlled nuclear fusion to pollution control. While the new superconductors make the technoology more accessible, the need for cryogenic colling still limits applications. A more serious limitation is in the existing array of materials problems In this presentation, a balanced account of the potential applications for superconductivity and the problems yet to be overcome is given.

CAD of Hybrid and Monolithic Microwave and Millimeter-Wave MICs

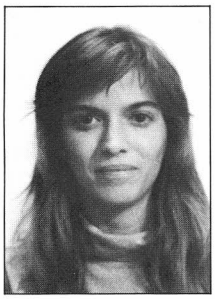
by Rolf H. Jansen, Industrial Microwave and RF Techniques, Inc., Ratingen, West Germanay*

With the availability of transistors having useful gain n the mm-wave range, and the advanced development of GaAs monolithic MICs in the last five years, the demand for accurate and relaible CAD up to the highest frequencies is growing. The economic design of MMICs without CAD is simply impossible. Yet the development of sophisticated computer-aided design tools is far behind the pace of technology. In this presentation, the electrical phenomena which complicate the design of MICs are discussed. Also given is an overview of existing CAD packages and their specific features including linear and nonlinear CAD and the advantages and shortcomings of frequency-domain and time-domain analysis. Various MMIC designs are also demonstrated.

** IEEE/MTT Society Distinguished Microwave Lecturer*

For Order Information Call IEEE Service Center, Piscataway, NJ, Phone (201) 562-5499.

MTT-S Chapter Activities



by April S. Brown
Co-Chairperson,
Membership Services

A number of MTT-S Chapters have reported special meetings and activities which took place at the end of 1988 and beginning of 1989. A couple of these are summarized below.

The Swiss MTT-S Chapter (joint with AP-S) held a one-day Symposium on *Microwaves and Lightwaves* on December 2, 1988 in Solothurn (Ascom Radiocom). The event was organized by Mr. Walter Vollenweider, Vice-Chairman of the Chapter. Key lectures were presented by Dr. R. Knerr, Distinguished Lecturer, and Dr. M. Schneider, Chairman of the Publications Committee of the MTT-S. Eight lectures by Swiss technical experts outlined the state of the art within Switzerland, both in universities and in industry, to provide a basis for comparison with developments within the United States and elsewhere. The Symposium was attended by more than 80 participants. Thanks to Professor Fred Gardiol, member of the MTT-S Speakers' Bureau, for reporting this event.

A low noise FET design worksession was sponsored by the Dallas Chapter in January, 1989, to provide an informal forum to review key technical papers which have been published in recent years. Randy Lehmann, of Texas Instruments in Dallas, served as the program coordinator. A unique feature of this MTT worksession was that each attendee was required to read each of three journal articles related to low noise FET design, characterization, and amplifier design. Approximately twenty people attended the two-hour sessions which were held on two consecutive Monday evenings at the University of Texas in Dallas. The variety of backgrounds of the attendees provided an excellent interchange of technical information on topics covered in the papers as well as other specific issues which individuals had encountered in recent designs. The success of this worksession has provided a foundation for similar sessions in the future on other pertinent topics.

The New York/Long Island Chapter announced a series of **industry nights**. These meetings will consist of a short lecture followed by a hands-on equipment demonstration. The first of these was held in November, 1988 and dealt with the HYPRES PSP 1000/750 Time-Domain Reflectrometry System. According to Matthew Jacobs, Chapter Chairman, approximately 20 people attended with a favorable response. This series of meetings will continue through 1989.

The examples above show that different types of meetings can be used to enhance the quality and the variety of the services offered by the Chapter. An active Chapter will plan a number of different types of meetings and lectures to help keep the local membership informed and interested in microwave technology. The Memberhship Services Committee supports the Chapters through educational and financial means. Up to $500 per year is available for each Chapter to use to cover the cost of Chapter Activities. Members are encouraged to make sure that they are getting the most support possible from their Chapter. Make sure that your Chapter Officers are requesting this support and activities are being planned that you will benefit from. The MTT-S Membership Services Committee mailed a copy of the IEEE videotape, *Planning Successful Chapter Meetings* to each of the MTT-S Chapters in March. The purpose of this tape is to stimulate the Officers and Members to come up with new ideas for meetings and improve the efficiency with which business is taken care of during the meetings.

The Membership Services Committee budget includes a significant amount of money to assist Chapter activities. The total budget for the Chapter Activities funds mentioned above is $10,000. Travel funds to the International Microwave Symposium and the Annual Chapter Chairman's Meeting are available to Chapter Chairmen. A total of $10,000 is available for this service. There are also special services, such as the distribution of the IEEE videotape mentioned above, which can be funded. The cost of that service was $1500. The Membership Services Committee wants to ensure that each Chapter is taking full advantage of these funds and that each member realizes that service to the membership comes first in the Microwave Theory and Techniques Society.

MTT-S Special Meetings, Courses, Symposia, Workshops, Clinics & Social Events (1986/1987/1988)

Reporting Period: 6/24/87—12/27/88

Presented below is a list of special meetings held by MTT-S Chapters. From this list it is evident that since mid-1987 only one third of the Chapters have reported their special meetings. Please help me to keep up to date records of special meetings by sending me the appropriate information. My address and telephone number are listed below.

Zvi Galani
Raytheon Company
Mail Stop CF1-49
Hartwell Road
Bedford, MA 01730
(617) 274-4184

ALBUQUERQUE (MTT/AP/EMC)
1. New Years Eve Party and Election of Chapter Officers, 12/31/87. Attendance: 38.

ATLANTA (MTT/AP)
1. Field Trip to the PAVE PAWS Radar Installation at the Warner Robbins AFB (Joint meeting with AESS), 11/17/87. Attendance: 27.

BALTIMORE (MTT/AP)
1. A one day short course on the theory, design and application of microstrip antennas, 12/5/87. Attendance: 25.

BEIJING (MTT)
1. Symposium, 60 papers presented in 6 sessions. Some of the papers were: Zi-Hong Zhang, Zhejiang University, Hanzhou, China, 'Measurements of Complex Dielectric Constants of Solids Using 300-600 MHz,' Xue-Zhi Chu, East China Teachers' University, Shanghai, China, 'Computer-Aided Measurement of Dielectric Constant,' Zhao-Wein Sun, Peking University, Beijing, China, 'The

continued on page 11

SPECIAL MEETINGS (continued from page 10)

Application of Microwave Techniques to Accurate Distance Measurements,' Tian-Chun, Lanzhou University, Lanzhou, China, 'Chemistry Laboratory Automatic Monitoring System,' Huang Shao-Gin, Hua-Zong Polytecnic Institute, Wuhan, China, 'Programmable Gain Amplifier and its Application to Electrical Measurements of Non-Electrical Quantities,' 7/13,14,15/87. Attendance: 75.

BUFFALO (MTT/AP)
1. Organizational Meeting and Demonstration of the Hewlett-Packard 54112D Sampling Oscilloscope, 11/18/87. Attendance: 13.

CHICAGO (MTT/AP)
1. Chicagoland IEEE AP/MTT-S Symposium and Exhibition. Display and discussion of the latest in microwave components and instrumentation. Papers: Gilmore, Rowan J., Compact Software, Inc., 'Design in the Nonlinear World - The Method of Harmonic Balance,' Daw, Ed, Wiltron Co., 'A 40 GHz VANA Based on the New 'K' Components,' Landry, Will, Adams-Russell Inc., Antenna & Microwave Div., 'Polarization Diversity Provided by a New WRD650 Orthomode Transducer Design,' Sullivan, William, Northern Scientific Labs, 'Ambiguity Errors in a Digital Frequency Discriminator,' 3/15/88. Attendance: 126.

CENTRAL NEW ENGLAND/BOSTON (MTT)
1. A Panel Discussion, 'Microwave Applications of High Temperature Superconductors,' 4/19/88. Attendance: 45.

COLUMBUS (MTT/AP)
1. Two Video Presentations, 'Heinrich Hertz, Theorist and Experimenter, Father of Radio' and 'In Search of a Call From Space,' 5/31/88. Attendance: 32.

DALLAS (MTT)
1. Mini-Seminar. Presentations: Wilton, Don, Univ. of Houston, Houston, TX, 'Numerical Solution of Integral Equations,' Shieh, T. J., Univ. of Texas at Arlington, Arlington, TX, 'Computer-Aided Analysis of GaAs MESFETs at Microwave Frequencies,' Sussman-Fort, Steven, State Univ. of New York, Stony Brook, NY, 'Automatic Synthesis of Broadband Microwave Matching Networks,' Cuthbort, Thomas R., E-Systems, Plano, TX, 'A Tough Optimizer for Microwaves,' 9/25/87. Attendance: 72.

2. Industry Event. Microwave Technology Inc., 'GaAs Amplifier Technology,' Communication Techniques, 'Recent Advances in Phase-Locked Source Technology for High Reliability Military Applications,' Advanced Performance Technology, 'Producing Changeable GaAs Logic Circuits that Support 5 GHz Clock Rates in 6 to 8 Weeks,' General Instrument Corp., 'Recent Developments in Wideband Multi-Correlator Frequency Measurement Receivers,' PC Dynamics, 'Design Considerations on Thick Metal Backed MIC Carriers,' Rogers Corp., 'Planar Resistor Technology for Microwave Circuits,' FEI Microwave, 'Tunnel Diode Detectors: Today's Technology,' 'Design and Test Standardization for Cost Effective Hybrid Integrated Amplifiers,' W. L. Gore, 'State of the Art Automatic Test Equipment Cable Assemblies,' Digital RF Solutions, 'A Digital Frequency Hopping Modulation Engine for Microwave Systems,' M/A-COM Marketing Inc., 'Applications and Usage of GaAs PIN Diodes in Fast Microwave Switches,' 'Application and Usage of GaAs MMIC Technology,' 9/25/87. Attendance: 72.

3. Mini-Workshop on Integration of Digital Control Circuitry on Analog ICs. Speakers: Jim Mason and Karl Varian, Texas Instruments and John Waddil, Rockwell, 10/28/88. Attendance: 48.

ISRAEL (MTT/AP)
1. One-Day Symposium. Presentations: Jansen, Rolf H., Industrial Microwave & RF Techniques Inc., Ratingen, West Germany, 1987/1988 Distinguished Microwave Lecturer, 'CAD of Hybrid and Monolithic Microwave and Millimeter Wave MICs.' Also, 13 papers were presented by Israeli experts in the areas of microwave oscillators (DROs, VCOs), antennas, switched filters and multiplexers, MESFET mixers, receiver front-ends, novel Gunn devices and MMICs, 11/9/87.

2. Symposiom on Antennas. Seven presentations including one on SAR radar, 4/11/88.

3. 11th Symposium, Hotel Laromme, Jerusalem. Many presentations including Dr. R. H. Knerr (AT&T Bell Laboratories) on lightwave communications and Prof. Deutcher (Tel Aviv University) on superconductors and their applications, 11/24-25/88.

NEW YORK/LONG ISLAND (MTT)
1. 1986 Long Island MTT Symposium, 'Microwave Integrated Circuits,' 10 speakers, a panel session and over 40 exhibitors, 4/22/86. Attendance: 350.

2. 1987 Long Island MTT Symposium, 'Computer Aided Engineering, Design, Manufacturing and Test,' 13 speakers and 50 exhibitors, 4/28/87. Attendance: 341.

3. Workshop on Microwave System Design, Crest Hollow Country Club, Woodbury, New York. 2 presentations on Packet Radio communication systems and 2 presentations on Electronic Support Measures systems. 10/12/88. Attendance: 55.

NORTH JERSEY (MTT/AP)
1. Mini Show and Technical Exposition, approximately 50 exhibitors. Speaker: D. K. Barton, ANRO Eng. Consultants, Lexington, MA, 'Technology Trends in Microwave Radar,' 11/5/87. Attendance: 425.

2. Symposium and Mini-Show, ITT-Avionics, Nutley, NJ. Included 40 exhibitor booths and 2 presentations: Arnold H. Silver, 'Microwave and Gigabit Superconductive Electronics,' Christen Rauscher, 'Linear and Non-linear Applications of GaAs FETs,' 10/27/88. Attendance: 374.

PRINCETON (MTT/AP/ED)
1. Guided tour of the Tachonics Corp. GaAs MMIC foundry, 10/29/87. Attendance: 40.

2. Guided tour of the Tachonics Corp. GaAs MMIC foundry, 12/15/87. Attendance: 40.

SAN FERNANDO VALLEY (MTT)
1. IEEE Video Conference, 'High Performance Integrated Circuit Packaging,' 9/22/87. Attendance: 8.

SPAIN (MTT/AP)
1. Course (Technical): Eli Brookner, 'Radar Technology - Present and Future,' 5/25-27/87. Attendance:50.

ST. LOUIS (MTT/AP/ED)
1. Tour of McDonnell Douglas manned flight simulation facilities, 1/19/88.

SWEDEN (MTT/AP)
1. Mini-Symposium on Antenna Pattern Synthesis, A. Chakraborty, ITT, Kharagpur, India, 'General Pattern Synthesis,' B. Westcott, Univ. of Southhampton, United Kingdom, 'Reflector Shaping for General Pattern Synthesis,' A. Derneryd, Ericsson Radio, Sweden, 'Monopulse Pattern Optimization,' P. Balling, TICRA, Denmark, 'Contouring by Single Reflector Shaping,' J. Johansson, Chalmers Univ., Sweden, 'Multiple Beams for Sky Mapping,' 10/1/87. Attendance: 18.

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SPECIAL MEETINGS (continued from page 11)

2. Mini-Symposium on GaAs FET Devices and Modeling, Mikunda B. Das, Penn. State Univ., 'Hetero-Structure Millimeter Wave HEMT's and HBT's: Limitations and Realization of Performance,' Ryszard Vogel, Inst. Mikroelektronik, 'Application of RF Probing in MESFET Modeling,' Urban Wetergren, Inst. Mikroelektronik, Numerical Simulation of GaAs MESFET and GaAs/AlGaAs TEGFET Structures', Herbert Zirath, Radio och Rymd, CTH, Status Report on the Microwave GaAs Device Project at CTH,' Hans-Olof Vickes, Elkretsteknik, CTH, 'Modeling of a Dual-Gate GaAs FET,' 11/24/87. Attendance:87.

SWITZERLAND (MTT/AP)

1. Workshop on Laboratory Problems at High Frequencies, L. G. Bernier, GD-PTT Bern, Switzerland, 'Time Domain Frequency Stability Measurements,' Jorg Forrer, Physikalische Chemie, ETH Zurich, Switzerland, 'Bridged Loop Gapped Resonator: A Lumped Resonant Structure,' U. Bolliger, Autophon AG, Solothurn, 'Probleme in Frontend Eines Direct Conversion Empfangers,' Anja Skrivervik, J. F. Zurcher, LEMA, EPF- Lausanne, Switzerland, 'Automatic Measurement of Complex Permittivity,' 10/21/87. Attendance: 18.

TOKYO (MTT)

1. Reports from 1987 MTT-S International Microwave Symposium, Shigekazu Hori and 5 other members, 9/18/87. Attendance: 15.

2. 1987 European Microwave Conference report, Masami Akaike and 3 other members. A brief report on 1987 International Microwave Symposium in Brazil, Koichi Nio. 12/23/87. Attendance: 32.

3. The rehearsal of 1988 MTT-S Symposium speakers, 5/13/88. Attendance: 14.

4. Reports from the 1988 MTT-S International Microwave Symposium. Shigekazu Hori and 5 other members, 9/30/88. Attendance: 27.

5. Report on 1988 MTT-S International Symposium Workshop, Toshio Nojima, NTT, Yokosuka, Japan. Papers: Itoh, Tatsuo, Univ. of Texas, Arlington, TX, 'Recent Trends in Applications of Planar Transmission Lines in Microwaves and Millimeter Waves.' Inatani, Junji, N.A.O., Nagano, Japan, 'Ultra-Low-Noise Receiver for Radio Astronomy.' 10/31/88. Attendance: 37.

WEST GERMANY (MTT/AP)

1. 4th Workshop of the MTT-S Chapter, 'Solid State Sources at Millimeter and Submillimeter Wavelengths,' 9/29-30/87. Attendance: 70.

2. 5th Workshop of the MTT/AP-S Joint Chapter, 'CAD of Microwave Circuits and Microwave Antennas,' 3/24-25/88. Attendance: 98.

Your Car

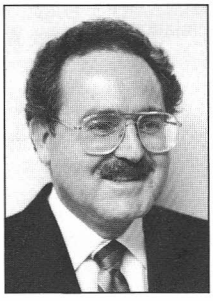
☐ **The faster 65-mph speed limit** resulted in an 18% increase in fatalities on rural roads in states that adopted the new limit. *Comparison:* Only a 4% fatality increase on comparable roads where the speed limit remained at 55 mph.

Study by the Department of Transportation, cited in *Motor Trend,* 8490 Sunset Blvd., Los Angeles 90069. Monthly. $19.94.

☐ **A clogged catalytic converter**—used to decrease air pollution from auto exhausts—will hurt a car's mileage and performance. *Symptom:* A rotten-egg odor. *Solution:* Buy a new converter.

James T. Powell, an automotive-maintenance expert in Boise, ID.

MTT-S Meetings & Symposium Committee Report



by Mario A. Maury, Jr.
Chairman, Meetings & Symposium Committee

1989 MTT-S Symposium

It looks like the 1989 International Microwave Symposium to be held in Long Beach, California under the able leadership of Chuck 'Pistachios' Swift is quickly shaping up and promises to be an outstanding event, as evidenced by the many articles in this issue of the Newsletter. We are all looking forward to 'Microwave Week' in sunny Southern California—'Don't miss the boat, plan to be there.'

Future MTT-S Symposia

The following is a listing of International Microwave Symposium sites with their chairmen. If you are interested in participating please contact the chairman directly, they can always use the help and this is a good way to actively support your Society.

- 1990—Dallas, Texas/May 7-11, 1990
  John W. Wassel, Chairman
  Texas instruments Incorporated
  (214) 995-3216
- 1991—Boston, Massachusetts/June 9-13, 1991
  Peter W. Staecker, Chairman
  M/A-COM, Inc.
  (617) 272-3000, ext. 1602
- 1992—Albuquerque, New Mexico/June 1-5, 1992
  Jerry Hausner, Chairman
  R&D Associates
  (505) 345-8236
- 1993—Atlanta, Georgia/June 14-18, 1993
  Peter Rodrigue, Chairman
  Georgia Institute of Technology, MRC
  (404) 894-2994
- 1994—San Diego, California/May 23-27, 1994
  Don Parker, Chairman
  Hughes/RSG
  (213) 615-2576
- 1995—Orlando, Florida/May 16-18. 1998
  Keith Huddleston
  Martin Marietta
  (305) 356-7201

1996 MTT-S Symposium Site Selection

Site Selection for the 1996 MTT-S Symposium will be held at the June 1989 AdCom meeting in Long Beach, California. Proposals have been received from San Francisco, California and Portland, Oregon.

By the time you read this the Site Negotiations Committee consisting of George Oltman (Chairman), Dave McQuiddy and myself will have completed inspection of both proposed sites and will be

continued on page 13

1990 SYMPOSIUM (continued from page 12)

prepared to submit their final report to AdCom so that a decision can be reached at the June 1989 meeting. Both proposed sites will give a presentation at this meeting.

1997 MTT-S Symposium Site Proposals

Its looking like we are going to the middle of the U.S. in 1997. We have received letters of intent from the following locations as of this writing.

1. Dallas
2. Denver
3. New Orleans

There is still time to submit a letter of intent for 1997, the deadline is June 30, 1989 in order to provide sufficient time to perform site inspections. Final site selection is planned for the January 1990 AdCom meeting.

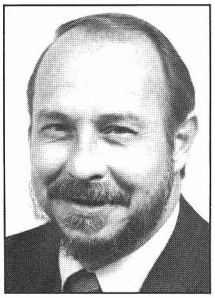
1998 and Beyond MTT-S Symposium Proposals Requested

We are now looking for proposals for the East in 1998. Letters of intent must be received by December 29, 1989 in order to be considered. Also 1999 (West) and 2000 (Middle or East) are coming up.

Chapters wishing to host any of these Symposia are encouraged to submit their proposals to:

Mario A. Maury, Jr., Chairman
MTT-S Meetings & Symposium Committee
Maury Microwave Corporation
8610 Helms Avenue
Cucamonga, CA 91730
Phone: (714) 987-4715, ext. 200

The 1990 Joint IEEE APS/MTT-S International Microwave Symposium



by John Wassel
Chairman, 1990 MTT-S
Symposium Steering Committee

The 1990 Joint IEEE AP-S/URSI/MTT-S International Microwave Symposium (IMS) will be held in Dallas, Texas on 8, 9, and 10 May, 1990. the Antennas and Propagation Society (AP-S) and the National Radio Science Meeting (URSI) will combine their meetings with the Microwave Theory and Techniques Society (MTT-S) International Microwave Symposium (IMS) and the Microwave and Millimeter-wave Monolithic Circuits Symposium (to be held 7 and 8 May, 1990). The Automatic RF Techniques Group (ARFTG) will host their conference on 11 May 1990. Our annual Microwave Week will be especially full in 1990 considering all the conferences, symposia, workshops, panel sessions, Microwave Exhibition, and the subsidiary meetings associated with the IMS.

Since the 1990 IMS will be held about a month earlier than previous Symposia, MTT AdCom has moved the Technical Program Committee meeting to 12 December 1989 rather than holding it is early January. Our call for papers will reflect this also and the abstracts will be due 14 November 1989. The timing for the Advance Program and the IMS Digest is always critical and we appreciate the extra time for getting these out.

The symposium theme is 'Merging Technologies for the 90's' and we plan to emphasize the mutual and overlapping areas of interest of the microwave and antenna practioneers in our technical sessions. With the advent of monolithic microwave integrated circuits (MMICs), numerous opportunities exist to consider a closer integration of the radiating elements with the MMICs such as in electronically steerable antenna arrays or phased array radar systems. Further, integration of control elements such as switches and phase shifters with antenna structures seems to offer some good possibilities for further developments as do microwave logic and optoelectronic ICs for higher level functions.

The last Joint APS/URSI/MTT-S International Microwave Symposium was held in Los Angeles in 1981. Shortly after the Dallas MTT Chapter announced plans to host the IMS in 1990, the Dallas AP-S Chapter began to explore the feasibility of joining forces to hold a Joint IMS. A number of microwave and antenna specialists were consulted before we jointly began arrangements for what is now the 1990 Joint IMS. The Dallas AP-S and MTT-S Steering Committees are presently completing these arrangements.

All of the meeting activities will be in the West Hall of the Dallas Convention Center. AP-S and MTT-S will have separate hotels to serve as their headquarters. MTT-S will be in the Hyatt Regency, site of the 1982 MTT-S IMS, and AP-S will be in the Plaza of the Americas. The Award Banquets for each Society will be on a different night so members of both societies will be able to attend. A single fee structure will be used and all meetings will be open to encourage cross-participation. We're hopeful this will lead to some good interchanges and will allow attendees to see how each society operates their symposia.

The Microwave Exhibition and Historical Exhibit will be open to all attendees. I'm hoping the AP-S members will consider bringing some of the early antenna developments to show along with our collection of historical microwave developments. AP-S, to my knowledge, has not done this before so we may have a rare opportunity to see the best of both the microwave and antenna worlds.

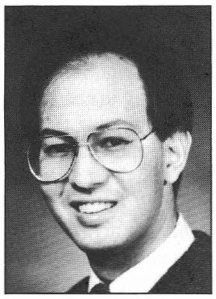
At the end of 1988, AP-S had 8337 members and MTT-S had 11761 members; however, 3588 members belonged to both AP-S and MTT-S. I suspect that many professionals now consider memberships in several different societies to be necessary because of overlapping technologies.

Our Steering Committee is now experiencing the pressures of planning all the events that need to happen for the IMS. Fortunately, we have received good advice and assistance from other IMS Steering committee members, both of previous and future symposia. I'm convinced one of the reasons why MTT-S remains a strong and viable Society year after year is this concern and interest evidenced by our members in all the happenings we have. For as most of you know, the 1990 IMS doesn't depend upon just our Steering committee—it depends upon all of us. Plan to join us in Dallas in 1990.

☐ **Motor oil codes:** The two letters at the top of the American Petroleum Institute (API) engine oil service classification symbol tell you what kind of vehicle the oil is best suited for. *SG* oils are recommended for today's passenger cars, vans and light-duty trucks with gasoline engines. *SF* oils are recommended for the same engines manufactured before 1988. The other codes—*CE, CD-II, CD* and *CC*—mean the oil is for diesel engines.

Consumer's Research Magazine, 800 Maryland Ave. NE, Washington, DC 20002. Monthly. $18/yr.

Meetings of Interest



by Frank Occhiuti

GENERAL INTEREST

ELECTRO '89 / MINI/MICRO NORTHEAST. Apr. 18-20, Jacob K. Javits Convention Center, New York, NY. Contact: Ms. Alexes Razevich, Electronic Convention Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045. (213) 772-2965.

NORTHERN ELECTRIC SHOW & CONVENTION (NORTHCON '89). Oct. 17-19, Portland Memorial Coliseum, Portland, OR. Contact: Ms. Alexes Razevich, Electronic Convention Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045. (213) 772-2965.

WESTERN ELECTRIC SHOW & CONVENTION (WESCON '89). Nov. 14-16, Moscone Center Brooks Hall/Civic Auditorium, San Francisco, CA. Contact: Ms. Alexes Razevich, Electronic Convention Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045. (800) 421-6816.

AEROSPACE MILITARY

AEROSPACE AND DEFENSE '89. April 26-28, Santa Clara Convention Center, Santa Clara, CA. Contact: Chuck Jungi, AEA, 5201 Great American Parkway, Santa Clara, CA 95054. (408) 987-4202.

NATIONAL AEROSPACE & ELECTRONICS CONFERENCE (NAECON '89). May 22-26, Dayton Convention Center, Dayton, Ohio. Contact: Roger Lorelle, Publicity Committee Chairperson, ADBA Associates, P.O. Box 31586, Dayton, OH 45431. (513) 256-4739.

COMMUNICATIONS

INTERNATIONAL CONFERENCE ON COMMUNICATIONS (ICC '89). June 11-14, Sheraton Hotel, Boston, MA. Contact: Ed Elowe, Infocorp International, P.O. Box S, Brunswick, ME 04011. (207) 833-5403.

1989 AFCEA INTERNATIONAL CONFERENCE. June 20-22, Washington, D.C. Convention Center, Washington, D.C. Contact: AFCEA General Program Office, Fairfax, VA . (703) 631-6125.

COMPUTERS

EUROPEAN TEST CONFERENCE. April 11-14, Paris, France. Contact: Roger Cogonen, 36 Avenue Jean Janurs, 95230 Soisy-sous-Montmorency, France. (33+1) 39-89-03-46.

INFOCOM '89. Apr. 24-27, Westin Hotel, Ottawa, Canada. Contact: Celia Desmond, Telecom Canada, 483 Bay St., 5th Floor So., Toronto, Ontario, M5G-2E1 Canada. (416) 581-2318.

1989 11TH INTERNATIONAL CONFERENCE ON SOFTWARE ENGINEERING. May 15-18, David L. Lawrence Convention Center, Pittsburgh, PA. Contact: Larry Druffel, General Chairman, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA 15213-3890. (412) 268-7740.

1989 16TH ANNUAL CONFERENCE AND EXHIBITION ON COMPUTER GRAPHICS AND INTERACTIVE TECHNIQUES. July 30-Aug. 4, Hynes Auditorium, Boston, MA. Contact: Mr. Chris Herot, Javelin Software Corporation, 1 Kendall Sq., Bldg. 200, Cambridge, MA 02139.

ELECTROMAGNETICS & OPTICS

INTERNATIONAL CONFERENCE ON COATINGS AND SENSORS May 9-11, Penn State University, University Park, PA. Contact: Prof. Vijay K. Varadan, Dept. of Eng. Science & Mechanics, 227 Hammond Building, University Park, PA. 16802. (814) 865-2410.

1989 INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY. May 23-25, Radisson Hotel, Denver, CO. Contact: John W. Adams, 1435 Gillaspie Dr., Boulder, CO 80303. (303) 497-3328.

CPEM '90 (CONFERENCE ON PRECISION ELECTROMAGNETIC MEASUREMENTS). June 11-14, Westin Hotel, Ottawa, Canada. Contact: Dr. J. Vanier, Director, Laboratory for Basic Standards, Division of Physics, National Research Council of Canada, Ottawa, Canada K1A OR6. (613) 933-9326.

1989 PROGRESS IN ELECTROMAGNETIC RESEARCH SYMPOSIUM (PIERS). July 25-26, MIT, Cambridge, MA. Contact: Prof. J.A. Kong, MIT, Room 26-305, Cambridge, MA 02139. (617) 253-5625.

INSTRUMENTATION

IEEE INSTRUMENTATION & MEASUREMENT TECHNOLOGY CONFERENCE (IMTC-89). Apr. 25-27, Key Bridge Marriott Hotel, Washington, D.C. Contact: Robert Meyers, Conference Coordinator, 1700 Westwood Blvd., Suite 101, Los Angeles, CA 90024. (213) 475-4571.

MICROWAVES & ANTENNAS

6TH INTERNATIONAL CONFERENCE ON ANTENNAS AND PROPAGATION. Apr. 4-7, Coventry, UK. Contact: ICAP 89 Secretariat, Conference Services, IEE, Savoy Place, London, WC2R OBL, UK.

43RD ANNUAL FREQUENCY CONTROL SYMPOSIUM. May 31-June 2, Denver Marriott City Center Hotel, Denver, CO. Contact: Raymond L. Filler, Publicity Chairman, US Army Laboratory Command, Electronics Technology and Devices Laboratory, Fort Monmouth, NJ 07703-5302.

1989 IEEE MICROWAVE AND MM-WAVE MONOLITHIC CIRCUITS SYMPOSIUM. June 12-13, Sheraton Hotel, Long Beach, CA. Contact: Reynold S. Kagiwada, TRW, 3117 Malcolm Ave., Los Angeles, CA 90034. (213) 535-5515.

1989 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM June 14-16, Hyatt Regency Hotel, Long Beach, CA. Contact: C.W. Swift, C.W. Swift Associates, 15216 Burbank Blvd., Van Nuys, CA. 91411, (818) 873-4778.

33RD AUTOMATIC RF TECHNIQUES GROUP CONFERENCE. June 15-16, Long Beach, CA. Contact: Mark Roos, EIP Microwave Inc., 2731 N. First St., San Jose, CA 95134. (408) 433-5900.

1989 IEEE AP-S INTERNATIONAL SYMPOSIUM & URSI/USNC RADIO SCIENCE MEETING. June 26-30. Red Lion Inn, San Jose, CA. Contact: Ray J. King, General Chairman, Lawrence Livermore National Laboratory, L-156, Livermore, CA 94550. (415) 423-2369.

1989 IEEE AP-S INTERNATIONAL SYMPOSIUM & URSI/USNC RADIO SCIENCE MEETING — AMTA WORKSHOP — Testing Phased Array Antennas and Diagnostics. June 30, Red Lion Inn, San Jose, CA. Contact: Dr. Andrew Repjar, (NIST), Workshop Coordinator, (303) 497-5703 or Livio Poles, (RADC), Technical Coordinator, (617) 377-4214.

continued on page 15

MEETINGS OF INTEREST (continued from page 14)

IGARSS '89 URSI-F 12TH CANADIAN SYMPOSIUM ON REMOTE SENSING July 10-14, Vancouver, Canada. Contact: John S. MacDonald, MacDonald, Dettweiler & Associates, 3751 Shell Road, Richmond, B.C. Canada V6X 2Z9, (604) 278-3411.

1989 SBMO INTERNATIONAL MICROWAVE SYMPOSIUM July 24-27, Sao Paulo, Brazil. Contact: Dr. Edmar Camargo, Publicity Committee Chairman, LME-EPUSP, CP 8174- CEP 01051, Sao Paulo, SP.-Brazil. Tel. No. (011) 8159322, ext. 255.

1989 INTERNATIONAL SYMPOSIUM ON ANTENNAS AND PROPAGATION, JAPAN (ISAP '89, JAPAN). Aug 22-25, Nippon Toshi Center, Tokyo, Japan. Contact: Dr. Takashi Katagi, Chairman of ISAP '89 Publicity Committee, Mitsubishi Electric Corporation, 325 Kamimachiya, Kamakura, 247 Japan. Tel. No. +81-467-44-8862.

19TH EUROPEAN MICROWAVE CONFERENCE. Sept. 4-7, London, England. Contact: N. Nazoa, Secretary, 1989 European Microwave Conference, ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey, KT22 7SA, England

2ND INTERNATIONAL SYMPOSIUM ON RECENT ADVANCES IN MICROWAVE TECHNOLOGY. Sept. 4-8, Beijing, China. Contact: Banmali Rawat, Technical Program Committee Chairman, EE/CS Computer Science Department, University of Nevada, Reno, NV 89557-0030. (702) 784-6927.

GOMAC '89 (GOVERNMENT MICROCIRCUIT APPLICATIONS CONFERENCE). Nov. 7-9, Orlando, FL. Contact: Randolph A. Reitmeyer, GOMAC-89 Technical Program Chairman, USA LABCOM, Electronics Technology & Devices Laboratory, Attn: SLCET-1, Fort Monmouth, NJ 07703-5000. (201) 544-3465.

POWER

1989 IEEE/PES TRANSMISSION AND DISTRIBUTION CONFERENCE AND EXPOSITION. Apr. 2-7, New Orleans Convention Center, New Orleans, LA. Contact: Donald Preston, General Chairman 1989 IEEE/PES T&D Conference, Louisiana Power & Light Company, P.O. Box 6008 (L-319), New Orleans, LA 70174-6008. (504) 363-8735.

AMERICAN POWER CONFERENCE. Apr. 24-26, Palmer House, Chicago, IL. Contact: Dr. Robert W. Porter, American Power Conference, Illinois Institute of Tech., Chicago, IL 60616. (312) 567-3203.

1989 POWER ENGINEERING SOCIETY SUMMER MEETING. July 9-14, Sheraton/Marriott/Hyatt Regency/Queen Mary, Long Beach, CA. Contact: E.F. Solorzano, Los Angeles Dept. of Water & Power, P.O. Box 111-Rm. 1236, Los Angeles, CA 90051. (818) 352-7864.

RELIABILITY

1989 INTERNATIONAL RELIABILITY PHYSICS SYMPOSIUM. Apr. 11-13, Hyatt Regency Hotel, Phoenix, AZ. Contact: Bruce Euzent, General Chairman, 1989 IRPS, Intel Corp., 2250 Mission College Blvd., SC9-06, P.O. Box 58125, Santa Clara, CA 95052-8125. (408) 765-9400.

SOLID STATE

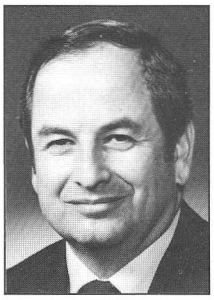
EIGHTH BIENNIAL UNIVERSITY/GOVERNMENT/INDUSTRY MICROELECTRONICS SYMPOSIUM. June 12-14, Massachusetts Microelectronics Center (M^2C), Westborough, MA. Contact: Richard B. Gold, General Chairman, Massachusetts Microelectronics Center (M^2C), 75 North Drive, Westborough, MA 01581. (508) 870-0312.

1989 IEEE GAAS IC SYMPOSIUM. Oct. 22-25, Sheraton Harbor Island Hotels, San Diego, CA. Contact: Kenneth Slege, Code 6852, US Naval Research Laboratory, Washington, DC 20394. (202) 767-3894.

MISCELLANEOUS

SECOND INTERNATIONAL CONFERENCE ON ENGINEERING MANAGEMENT Sept. 10-13, Sheraton Centre Hotel, Toronto, Canada. Contact: Brian L.G. Lechem, Chairman, Conference Organizing Committee, 245 Fairview Mall Drive, Suite 600, Willowdale, Ontario, Canada M2J 4T1.

Special Articles for the MTT Newsletter



by Zvi Galani

The MTT Newsletter staff is very interested in obtaining feature articles dealing with current topics in the technical and professional areas of interest to MTT members. The idea is to provide the members with a general understanding of the topic and its significance in current and future activities in the microwave field. I would like to emphasize, however, that these special articles will cover topics in a broad, general sense. Specific design techniques and applications will be covered in papers appearing at the MTT Symposium and in the Transactions.

If you know of a topic that is current and/or you are willing to contribute an article to the Newsletter, please contact:

Zvi Galani
Raytheon Company
Mail Stop CF1-49
Hartwell Road
Bedford, MA 01730
(617)274-4184

OR

Peter Staecker
M/A-COM, Inc.
52 South Avenue, Bldg. 7
Burlington, MA 01803
(617)272-3000, X1602

This issue features the second part of the article "Monolithic Microwave Integrated Circuits" by Raymond S. Pengelly. It presents numerous examples of MMIC circuits and describes the MIMIC program sponsored by the Department of Defense.

Several feature articles are in the process of preparation for future issues of the Newsletter, dealing with the following topics:

- Frequency synthesizers
- Beamed power
- Transmission line transformers

The editorial staff of the Newsletter hopes that these articles will be informative and useful to the MTT-S community.

Your comments and suggestions are welcome.

1990 IEEE Microwave Theory and Techniques Society Undergraduate Scholarships

- For children of MTT-S members
- Not limited to engineering
- $1,000 - $2,500 each
- Renewable for 4 years
- Given to meritorious students based on PSAT/SAT test scores, academic record, GPA, class rank, leadership, career goals, significant extracurricular and community activities.
- Application forms for the IEEE Microwave Theory and Techniques Undergraduate Scholarship can be obtained from the Citizens' Scholarship Foundation of America (CSFA).
- Requests for applications forms should be made in writing before January 1, 1990 and refer to the MTT-S Undergraduate Scholarship.
- Complete applications must be sent to CSFA and post marked before February 1, 1990.

Citizens' Schoarship Foundation of America
1505 Riverview Road
P.O. Box 297
St. Peter, Minnesota 56082
Telephone: (507) 931-1682

For further information on the Scholarship, contact:

Dr. Reynold Kagiwada
3117 Malcolm Avenue
Los Angeles, CA 90034
(213) 814-1970

☐ **One in four workers** in the US is familiar with computers. *Trend:* Taking work home. Some 27 million Americans now opt to work full- or part-time in a home office. One-third of all new businesses registered in 1988 were home-based.

U.S. News & World Report, 2300 N St. NW, Washington, DC 20037. Weekly. $39.75/yr.

☐ **Don't list references** on your resume. References who are contacted too often get apathetic. *Better:* Give interested employers your references only when they ask for them. *Important:* Let each reference know, each time, that he/she may be called. Never include anyone as a reference who has not given permission. You don't want *just* a reference, you want an *enthusiastic* reference.

Robert Half, chairman, Robert Half International, Inc., recruiters, 111 Pine St., San Francisco 94111.

1990 IEEE Microwave Theory and Techniques Society Fellowships and Grants-In-Aid

GRADUATE FELLOWSHIPS

- Several $5,000 fellowship awards each year
- For graduate research studies in microwave engineering on a full-time basis
- Applicants must have attained high academic achievement in engineering or physics
- Award can be granted *in addition* to any other support received by student
- Award cannot be used for equipment purchase, travel, supplies, etc.
- Award made to institution for support of named student
- Faculty supervisor must be MTT-S member

Application deadline: 23 October 1989

EDUCATIONAL GRANTS-IN-AID

- For individual members of MTT-S
- Number and amount to be based on proposals submitted, proposed activity, financial justification, and Society budget
- Applicant must be MTT-S member of 5 years standing
- Applicant must be a full-time employee of a degree granting institution of higher learning or a not-for-profit research institution
- Emphasis is on supporting junior faculty members
- Award made to institution for support of named individual research activity (i.e., faculty member, etc.)
- Award may be used for equipment, travel, supplies, or individual use, directly related to a clearly defined microwave activity
- Funds cannot be carried over into second year

Application deadline: 07 November 1989

For applications for the Fellowships and Grants-in-Aid contact:

Dr. Jorg E. Raue
Chairman, MTT-S Educational Awards Committee
TRW, Electronics Systems Group, R5/1291
One Space Park
Redondo Beach, CA 90278
(213) 813-8224

Requests for application materials must be received no later than 22 September 1989.

Education Committee Highlights

by Reynold Kagiwada
Chairman,
Education Committee

The MTT-S Education Committee is responsible for the promotion and coordination of activities furthering the cause of education as it relates to the Society and the field of microwaves. The committee institutes and administers educational-aid programs which are wholly or partially sponsored by the Society. The committee supports educational activities at the undergraduate/graduate level and continuing education for the Society membership. The Education Committee has various activities to fulfill these objectives.

For 1989, the chairmen for these activities within the Education Committee are:

- Dr. Jorg E. Raue
  - — Graduate Fellowhsip Program
  - — Grants-in-Aid Program
- Dr. Reynold Kagiwada
  - — Undergraduate Scholarship for the Children of MTT-S members
  - — Representative to IEEE EAB TAAC

Some brief news about these activities:

— Jorg Raue has received several applications for 1989 Graduate Fellowship and Grants-In-Aid. His report is presented to the right.

— 1989 Undergraduate Scholarship applicants for the children of MTT Society members have been received. The Citizen's Scholarship Foundation of America, Inc. (CSFA) is busy evaluating the nine applicants for the scholarshps. The recipients selected by CSFA for the award will be reported in the next Newsletter.

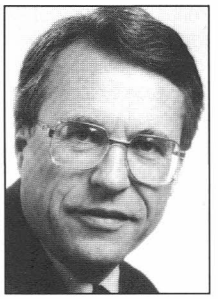
— The announcement of the 1990 Undergraduate Scholarship, Fellowships and Grants-In-Aid are published elsewhere in this Newsletter. If you have any suggestions or questions please contact Reynold Kagiwada, (213) 814-1970.

Nutrition

☐ **Unhealthy school lunches.** *Problem:* Government agencies promote poor menus by selling less-healthy foods at reduced prices . . . or giving it away. *Examples:* The Department of Agriculture charges schools for low-fat cheese but provides high-fat cheese free . . . Congress, pressured by milk producers, requires schools to serve *whole* milk—low-fat milk is optional. *Result:* The average school lunch contains 39% fat and 1,244 mg sodium—more than *double* recommended daily limits.

Public Voice for Food and Health Policy, a consumer group headquartered in Washington, DC, quoted in *Vegetarian Times*, Box 570, Oak Park, IL 60303. Monthly. $24.95/yr.

Educational Awards



by Jorg Raue
Chairman,
Educational Awards

The third annual evaluation cycle for the educational awards was completed on December 21. The quality of the applicants again was excellent.

For 1989, four $5,000 MTT-S Fellowships and one $10,000 Grant-in-Aid were awarded.

1. Fellowship awards, $5,000 each

Recipient	Institution
Joel Birkeland	University of Texas, at Austin
Cynthia Furse	University of Utah
Kerry Litvin	Cornell University
William McKinzie	UCLA

All four recipients are PhD students in electrical engineering, with microwave oriented research topics and with outstanding academic credentials. Joel Birkeland's research area is quasi-optical planar FET oscillators, Cynthia Furse is pursuing backscatter RCS, Kerry Litvin's research focuses on millimeter-wave monolithic MODFETS, and William McKinzie is researching printed slot-type circuits and antennas employing full wave solutions.

2. Grant-in-Aid

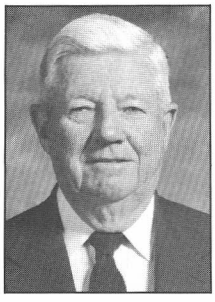
A $10,000 Grant-in-Aid was awarded to Robert Strangeway, an Assistant Professor in the Electrical Engineering department at the Milwaukee School of Engineering. The grant contributes towards the purchase of a microwave network analyzer and S-parameter test set. The remainder of the necessary funds was committed by the Milwaukee School of Engineering. The equipment will support the 5 microwave courses currently offered in electrical engineering and electrical engineering technology as well as microwave oriented senior projects in both programs.

For the 1989/90 awards cycle, the closing date for fellowship applications is October 23, 1989, the closing date for grant-in-aid applications is November 7, 1989. (See separate announcement on page 16 for additional details). Requests for information and application materials must be received no later than September 22, 1989.

☐ **Grapefruit lowers cholesterol.** *Findings:* Subjects with very high cholesterol levels were given 15 grams of grapefruit pectin (in capsules) a day. After four weeks, total cholesterol levels were reduced by 7.6%, and LDL *bad* cholesterol levels decreased 10.8%. *Theory:* Regular consumption of up to 15 grams of grapefruit pectin or other pectin-rich foods (oranges, limes, lemons) may help lower cholesterol, especially in people with high cholesterol.

Research at University of Florida, Gainesville, cited in *Runner's World*, 33 E. Minor St., Emmaus, PA 18098. Monthly. $14.97/yr.

King for a Day of the MTT Railroad



by Chuck Swift, Chairman
1989 MTT-S Symposium Steering Committee

My 16 year old, first-born son is in the fifth grade, and recently he came home saying he wanted to play in Little League. Now that I have your attention, I'll go on with my story. Any of you who have worked in volunteer organizations will agree the penalties for suggesting a change in the status quo are:

1. Derision
2. Committee membership

One has to train himself to live with the status quo, no matter how bad things are, rather than accept a position on a committee. In my example, one could wind up as Commissioner of the Little League. No one will ever express thanks or gratitude for the uncompensated hours you put in, but if the hot dog sales decline, or the pastor's son gives up a winning walk, you are sure to hear about it. My advice - sit in the back of the room, never raise your hand, and retain your option to bitch to the Commissioner when hot dog sales don't cover the cost of new bats and balls.

Now that I've shared this sage advice, let me admit I wasn't smart enough to follow it myself, and find myself in the position of

KING FOR A DAY OF THE MTT RAILROAD

Actually, my title is Steering Committee Chairman, 1989 IEEE MTT-S International Microwave Symposium. Pretty fancy, but the compensation doesn't match the title...it's zero. I am King for a Day, but in this strange position, all the expertise one acquires the first time on the job is immediately history, because every subsequent Symposium will have a new Chairman reinventing the wheel. And even though I'm King, the Court doesn't always react to my fists. I wanted to screen the papers so that there would only be three parallel sessions; we will have four. I guess a 'Quarterback' could attend four sessions simultaneously, but the rest of you are going to have problems unless you have a split personaltiy. There was also a negative reaction to my plan for the Committee to wear brown, leather aviator jackets and brown fedoras, a la Howard Hughes. I still haven't conceded defeat on this issue, as I think it would be helpful to the attendees to be able to recognize someone in authority by dressing everyone in similar jackets.

As the politicians will tell you, you don't need 100% acceptance to win; 50% plus one gets you elected, so I've rationalized my defeats. I am pleased that I have been able to make some suggestions which have been accepted. First of all, I had responsibility for selecting the site, and I'm sure those who attend this year's Symposium will concur in my choice. Long Beach is a magnificent setting, with more than adequate facilities for the technical sessions and exhibits. While I can't control the weather, it should also be refreshing in June, with a cool off-shore breeze every afternoon.

I then chose the theme, 'Microwaves Among the Stars,' with the idea our Symposium is taking place in Southern California, home of both Hollywood and the satellite industry. Dr. Robert Eisenhart then generated our logo on his PC, and I think it reflects what is available for leisure activity during your visit. We then expanded upon the theme, and this year will have a Space Exhibit to compliment the Historical Exhibit. TRW, Hughes, JPL, Rockwell and others have promised Bob outstanding artifacts for this exhibit.

Being on a winnning streak, I made three other proposals:

1. In place of standard, professional entertainment at the Awards Banquet, we present the 'One Penny Opera,' a musical spoof of our industry.
2. We eliminate the Head Table at the Awards Banquet.
3. We make the Plenary Session the second session, rather than the opening session, of the Symposium

The Steering Committee voted to go along with all three proposals. I've previewed the 'One Penny' in the last issue of the Newsletter. We're in the rehearsal stage now, and I am confident those who attend the banquet will enjoy it. Elimination of the Head Table was my own observation that those poor turkeys sitting up there can only speak to two people, the person on their left and right, and if you spill soup in your lap, 500 people are witness to this act. Better to be seated at a round table where we can converse like the rest of the room. Scheduling the Plenary Session at 10:30 will allow even the late arrivals to hear our two famed speakers, Dr. Harold Rosen of Hughes and Dr. Simon Ramo of TRW.

So I am 'King for a Day,' but the MTT Railroad has many junctions and spurs, and I'm sure with the best of planning, there will still be delays and frustrations. If you experience one of these incidents, just remember when castigating me that my compensation is zero, and I won't be there next year when the 1990 Symposium convenes. In Dallas, you can bet I won't be going to Chairman John Wassel with any complaints!

1989 MTT-S International Microwave Symposium Technical Program

by Reynold Kagiwada
1989 MTT-S Symposium
TPC Chairman

The 1989 International Microwave Symposium promises to be an outstanding event, as manifested by a record number of papers received. This year's Symposium Technical Program Committee (TPC) received 519 papers, over a hundred papers more than the last two years. Although this resulted in an added burden to the members of the TPC, it was gratifying to have such a large response. There were 240 papers submitted from outside the United States, again giving the Symposium a strong international flavor. The 141 TPC members, broken into 23 subcommittees, had the difficult task of selecting the 298 papers (97 regular length papers, 81 short length papers, 91 Open Forum papers, 17 invited papers and 12 papers presented jointly with the Microwave and Millimeter-Wave Monolithic Symposium). These papers give an excellent view of the progress in microwave theory and techniques covering the lower frequencies with subjects like microwave

continued on page 19

1989 TECHNICAL PROGRAM (continued from page 18)

acoustics and the higher frequencies with optical techniques. In addition, rapidly evolving fields like superconductivity and gallium arsenide materials, devices and circuits are extensively covered.

Format

The format of this symposium is similar to the 1988 Symposium. However for the first time the Plenary Session will be held in mid-morning on Tuesday. This will guarantee that people commuting to the Symposium will have the opportunity to attend. all Symposium registrants, exhibitors and guests are invited to attend the Plenary Session. This year's Keynote address will be presented by Dr. Simon Ramo (TRW) and Dr. Harold Rosen (Hughes Aircraft Company). Their lecture will stress the theme of the Symposium 'Microwaves Among the Stars.' Because of the large number of papers to be presented the format of four parallel sessions will be repeated from 1988. The Symposium will retain the features adopted earlier such as Focused Sessions, European Microwave Session, Open Forum Sessions, Panel Sessions, Workshops and 90 minute sessions, consisting of regular length papers (20 minutes), and short length papers (10 minutes).

This year the Focused Sessions will cover four topic areas: Optical Interaction with Microwave Circuits, Microwave Superconductors, High Power Technology and Future Trends in SAW Products. Some of these focused sessions will begin with an invited paper presented by a recognized leader in that area. These six focused sessions are:

- 'Optical Interaction with Microwave Circuits I'
- 'Optical Interaction with Microwave Circuits II'
- 'Trends in Microwave Acoustics'
- 'Microwave Properties of Superconductors'
- 'Microwave Applications of Superconductors'
- 'High Power Microwaves'

There will also be a well deserved Special Session honoring Dr. Seymour Cohn. For this session Dr. Kiyo Tomiyasu will give the opening invited paper on 'An Admirable Microwave Engineer.' This paper will be followed by three invited papers by G.L. Mathaei, W.H. Harrison and J.K. Hunton.

The European Microwave Session will feature three outstanding papers:

- 'Active Microwave Imaging,' by Professor J.C. Bolomey
- 'Modeling of Microwave and Millimeter-Wave Passive Components,' by Professor R. Sorrentino
- 'Solid State Local Oscillator Sources for Millimeter and Sub-Millimeter-Waves in Europe,' by Professor A. Raisanen

Special Sessions

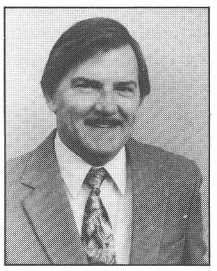
This year, seven panel sessions offer a broad spectrum from 'Entrepreneurship in Engineering,' 'Improving the Time to Market,' and 'Microwave Education: Present Status and Future Trends' to the more technical 'Microwave Superconductor Applications,' 'Heterojunction Devices, Circuits and Reliability,' 'Microwave Hardware Descriptive Language' and 'MMIC Design for Low Cost, High Volume Applications.' A wide diversity of six Microwave Workshops are also offered. On Monday, June 12, these are 'Lightwave Technology,' 'Advances in High Power Equipment for Space Application' and 'High Power Generation and Applications.' For Friday June 16, the workshops are 'Microwave and Millimeter-Wave Synthesizers,' 'High Frequency Interconnections' and 'Microwave Packaging.' In addition the Symposium is introducing an Evening Rump Session. On June 13, Tuesday Evening, there will be a Rump Session on Microwave Characterization of Superconductors.

Topics

Once again, GaAs is heavily featured in the Symposium. Including three joint sessions with Microwave and Millimeter-Wave Monolithic Symposium, a total of eight sessions are devoted to this topic. another three sessions are devoted to solid-state devices and their applications. Other areas covered in the Symposium include: biological effects, CAD, ferrites, field theory, filters, guided waves, optics, measurements, microwave acoustics, microwave high power, MIC, microwave superconductivity, millimeter-wave, passive components and arrays.

This outstanding program could only be made possible by contributions of the authors and the dedicated work of the Technical Program Committee. Special thanks are in order for the efforts of Vice-Chairman Ken Yano, open Forum Chairman Michael Kim and Focussed Session, Panel, and Workshop Organizers John Horton and Ken Conklin.

1989 MTT-S Symposium Special Exhibits



by R.L. Eisenhart
Chairman, Special Exhibits

The symposium will offer two special exhibits this year to supplement the technical sessions. The first is the historical exhibit which has become a tradition over the last few years. The second is a unique, one-time gathering of many items which are 'loosely' relating microwaves to space (as in the heavens). This is our 'Microwaves among the Stars' exhibit.

The Historical Exhibit

This exhibit covers the development of microwave theory, devices, and systems, dating back to pre-1900. 1989 will be the 10th anniversary of the exhibit at the Symposium. It was started at the request of Steve Adam, the then AdCom President who suggested a display of historical items for the 1980 MTT-S Symposium in Washington D.C. Ted Saad took on the challenge of putting the exhibit together and did practically everything for the first eight years. Today our large collection is housed in the Historical Electronics Museum near Baltimore, which is sponsored by Westinghouse. Ted Nelson, Steve Stitzer and Warren Cooper are the responsible individuals we (MTT-S) can thank for taking care of our 'history.'

A second major part of the Historical Exhibit is the Monolithic Microwave Integrated Circuits (MMIC) collection, sponsored by Bob Pucel of Raytheon. This will be the third year for the MMIC items. In addition there will be a special collection of about 30 slide-rule type calculation aids used for a variety of applications. These will be on temporary loan from Rob Geoffroy of Sanders Associates who has put the colleciton together.

The Historical Exhibit contains all sorts of hardware, pictures, and various other artifacts which are displayed along with descriptive information. Get a feel of what it was like before network analyzers, calculators, W-band, and CAD. See photographs of many of our 'senior' members in their earlier years. Visit the special

continued on page 20

SPECIAL EXHIBITS (continued from page 19)

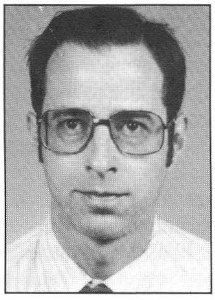
reading room and skip through some of the reports and other documentation which led us to the present. Relax in front of the TV in the video-theater and see a documentary or two on our technology Even if you visited last year, come see the more than 30 new items which have been added along with many new video tapes.

The Historical Exhibit will be located in the Catalina Room, immediately adjacent to the technical sessions. The adjoining Monterey Rooms will be home for the reading and TV viewing areas. This exhibit will be open from 9:00 am to 5:30 pm, Tuesday and Wednesday and from 9:00 am to 4:00 pm on Thursday.

The 'Microwaves Among the Stars' Exhibit

In keeping with our theme this year we will have a special exhibit of space-related objects. A unique collection of items on loan from local aerospace companies will be displayed. Hughes Aircraft, TRW, Rockwell International, McDonnell Douglas, and the Jet Propulsion Laboratory have all made commitments to this exhibit. For example see a showcase with models of all of the Hughes Satellites from the early tiny Syncom to the latest designs. Don't miss the actual Syncom prototype which will also be displayed. Models of other satellites, space photographs, and video tapes which you would never otherwise have access to will be among the subjects shown. A display on the Space Station design will be included. These will be located in the lobby areas of the convention center and be available for viewing during all open hours.

Automatic RF Techniques Group News



by Raymond W. Tucker, Jr.
ARFTG Liaison

The Automatic RF Techniques Group (ARFTG) is an independent professional society that is affiliated with MTT-S as a conference committee. ARFTG's primary interests are in computer-aided microwave analysis, design and measurement. ARFTG holds two conferences each year, one in conjunction with the MTT-S International Microwave Symposium, and a second in the late Fall.

33rd ARFTG Conference Announcement

The Automatic Radio Frequency Techniques Group will hold its 33rd technical conference on Thursday, June 15 and Friday, June 16, 1989 in conjunction with the International Microwave Symposium in Long Beach, California. All ARFTG Conference activities will take place at the Sheraton Long Beach Hotel. Technical sessions will begin at 1:00 pm on Thursday. The Awards Banquet will be held on Thursday evening. The ARFTG manufacturers' exhibits will open on Friday morning and the technical session will continue.

The focus topic for this conference is *Microwave Automated Test Equipment as a Productivity Multiplier.* Appropriate papers will describe techniques, both hardware and software, which minimize RF automated test equipment design, development or measurement time. Use of modular hardware and/or software, specialized software development tools, or other techniques to improve productivity could be discussed. In addition other papers on automated RF and microwave measurement and design will be presented.

33rd ARFTG Conference Schedule

Thursday, June 15, 1989, Sheraton Long Beach Hotel

1:00 pm - 5:00 pm	Technical Session Salon B
6:00 pm - 7:00 pm	Banquet Reception Foyer Salon B
7:00 pm - 10:00 pm	Award Banquet Salon A

Friday, June 16, 1989, Sheraton Long Beach Hotel

7:30 am - 8:30 am	Continental Breakfast Salons C & D
7:30 am - 8:30 am	Exhibits Salons C & D
8:30 am - 11:45 am	Technical Session Salon B
12 Noon - 1:15 pm	Lunch (included) Terrace
1:30 am - 3:30 pm	Technical Session Salon B

Manufacturers interested in exhibiting their products, contact the Exhibits Chairman:

Mr. William Pastori
EATON Corporation
5340 Alla Road
Los Angeles, CA 90066

Registration material is contained in the MTT-S International Microwave Symposium Advance Program.

The Conference fee includes the Technical Sessions, the ARFTG Awards Banquet on Thursday, continental breakfast, and sit down lunch on Friday. Spouses of preregistered ARFTG attendees are invited to the ARFTG Banquet at no additional cost. A post Conference Digest is also included in the fee. The digest is mailed approximately 90 days after the Conference.

For further information contact the Conference Chairman:

Mr. Mark Roos
EIP Microwave, Inc.
2731 N First Street
San Jose, CA 95134
(408) 433-5900

This ARFTG Conference promises to be outstanding, with an excellent Technical Program, Exhibit and Awards Banquet—plan to attend!!

Join ARFTG

ARFTG brings you the latest techniques in RF, Microwave and Millimeter Wave Analysis, Design and Measurements. State-of-the-Art papers are presented twice a year. If you are involved in automated techniques, come and join your peers and keep current with our ever-evolving technology. For more information on ARFTG, write: ARFTG, RR- 1, Box 204A, Ava, NY 13303.

☐**Peanuts are overlooked** as a health opportunity. *Three tablespoons of peanut butter (enough for a sandwich) contain:* 13.5 grams of protein (about the same amount as two eggs or 12 ounces of milk)...four grams of fiber (the same as two slices of whole wheat bread). Although 38% of peanuts' calories are from fat, it is largely unsaturated fat, which helps to *clear* harmful cholesterol from your blood.

Hippocrates, 475 Gate Five Rd., Sausalito, CA 94965. Six issues. $24/yr.

☐ **Fermented foods** (sourdough, sauerkraut, yogurt, etc.) help maintain the level of intestinal flora (good intestinal bacteria), which help prevent stomach disorders, including constipation, colitis, ulcers and hemorrhoids.

Stay Young: How to Look Good, Feel Better and Live Longer, by Frances Sheridan Goulart, Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. $9.95.

1989 Microwave and Millimeter-Wave Monolithic Circuits Symposium

by Reynold Kagiwada
General Chairman,
1989 MMWMC Symposium

The 1989 IEEE Microwave and Millimeter Wave Monolithic Circuits Symposium (MMWMC) will be held Monday and Tuesday, June 12 and 13, 1989. The Monday sessions of this, the Eighth Annual Symposium will be held at the Long Beach Convention Center, Long Beach, California. The Monday evening panel sessions will be held at the Long Beach Hyatt Regency. On Tuesday the symposium will be held jointly with the IEEE Microwave Theory and Techniques International Microwave Symposium again at the Long Beach Convention Center.

The Technical Program Committee, under the able Chairmanship of Dr. Alejandro Chu, has selected thirty-two contributed papers, representing the state-of-the-art in monolithic microwave and millimeter-wave IC technology. This outstanding program is divided up into eight sessions covering the areas of low noise amplifiers, monolithic power amplifiers, non-linear circuits, advanced circuits and applications, control circuits, receivers and mixers, millimeter-wave amplifiers and broadband IC's. An invited paper opening the Symposium titled 'Progress of MMICs in Japan' will be given by Masayoshi Aikawa, Miroyo Ogawa and Takayuki Sugeta from NTT. This paper will address current and future direction of GaAs technologies in Japan. For the first time this Symposium is also having three panel sessions on Monday evening:

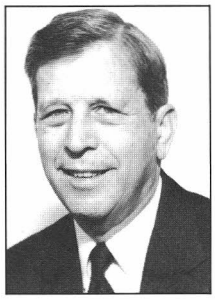
- 'MIMIC Program Benefits to the MMIC Industry' organized by Eliot D. Cohen (DARPA)
- 'FETs Beware Advancing Bipolar Technologies for High Frequency Applications: Si vs GaAs vs InP' organized by Michael Kim (TRW)
- 'Computer-Aided-Engineering for MICs and MMICs' organized by Octavius Pitzalis, Jr. (EEsoF Inc.)

This year's social program will include a reception for Symposium participants and their guests on Sunday evening, a hospitality suite for guests during the Symposium, continental breakfast for attendees, and beverage service during breaks. The Sunday evening reception is between 7 and 10 p.m. in the Hyatt Regency Seaview. For further information consult the MTT International Microwave Symposium Advance Program.

The Technical Program Committee, with the help of the MTT Symposium Committee are to be commended for assembling an outstanding program. On behalf of the Steering Committee, I encourage you to attend the 1989 Microwave and Millimeter-Wave Monolithic Circuits Symposium in Long Beach; you will find it to be a rewarding experience. If you did not receive registration material by mail, contact:

Mr. Dale Dawson
Registration and Local Arrangements Chairman
c/o LRW Associates
1218 Balfour Drive
Arnold, MD 21012

Special Session In Honor of Dr. Seymour B. Cohn



Seymour B. Cohn
Life Fellow, IEEE;
Honorary Life Member,
MTT-Society

This year's MTT attendees will have the opportunity to participate in honoring one of the microwave community's most distinguished members and prolific contributors: Seymour B. Cohn. A Special Session in honor of Dr. Cohn will be held on Wednesday, June 14, at 1:30 pm in the Hyatt Regency Hotel.

Four invited papers will be presented, and comments and testimonials from the audience will be encouraged. The papers are as follows:

'An Admirable Microwave Engineer'
by Dr. Kiyo Tomiyasu

'An Overview of Some Important Contributions to Microwave Engineering'
by Dr. George L. Matthaei

'The Rantec years'
by William H. Harrison

'Novel Contributions to Microwave Circuit Design'
by J. Keith Hunton

These presentations will trace Dr. Cohn's remarkable career from the postwar years to the present, highlighting many, but by no means all, of his manifold contributions to microwave technology.

It is expected that Dr. Cohn's many colleagues and friends will want to attend this session. The session will, however, have much to offer for all members of the microwave community, particularly those interested in the evolution of microwave circuit technology. Some, at least, will be amazed at how many of the microwave circuit concepts which are now taken for granted were originally proposed by Dr. Seymour B. Cohn.

Peter LaTourrette

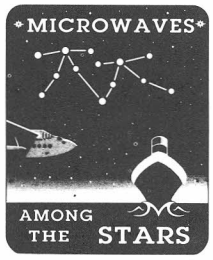
Your travels

☐ **If you want a non-smoking seat** on an airplane and the only seats left are in the smoking section, the airplane *must* create a nonsmoking row. . . thanks to a new Federal Aviation Administration (FAA) rule.

Conde Nast Traveler, 350 Madison Ave., New York 10017. Monthly. $15/yr.

☐ **Travel in a group of 10 or more,** and you can probably negotiate significant discounts on most airfares: Figure on 40% or more off full coach tabs and 5%-10% off the highly restrictive Max-Saver rates. Good group buys are also available from hotels and car-rental companies.

NOTICE



1989 IEEE/MTT-S International Microwave Symposium

June 12 - 16, 1989 Long Beach, California

★ ★ ★ MICROWAVE WEEK ★ ★ ★

1989 IEEE/MTT-S
INTERNATIONAL MICROWAVE SYMPOSIUM
JUNE 13 - 15, 1989

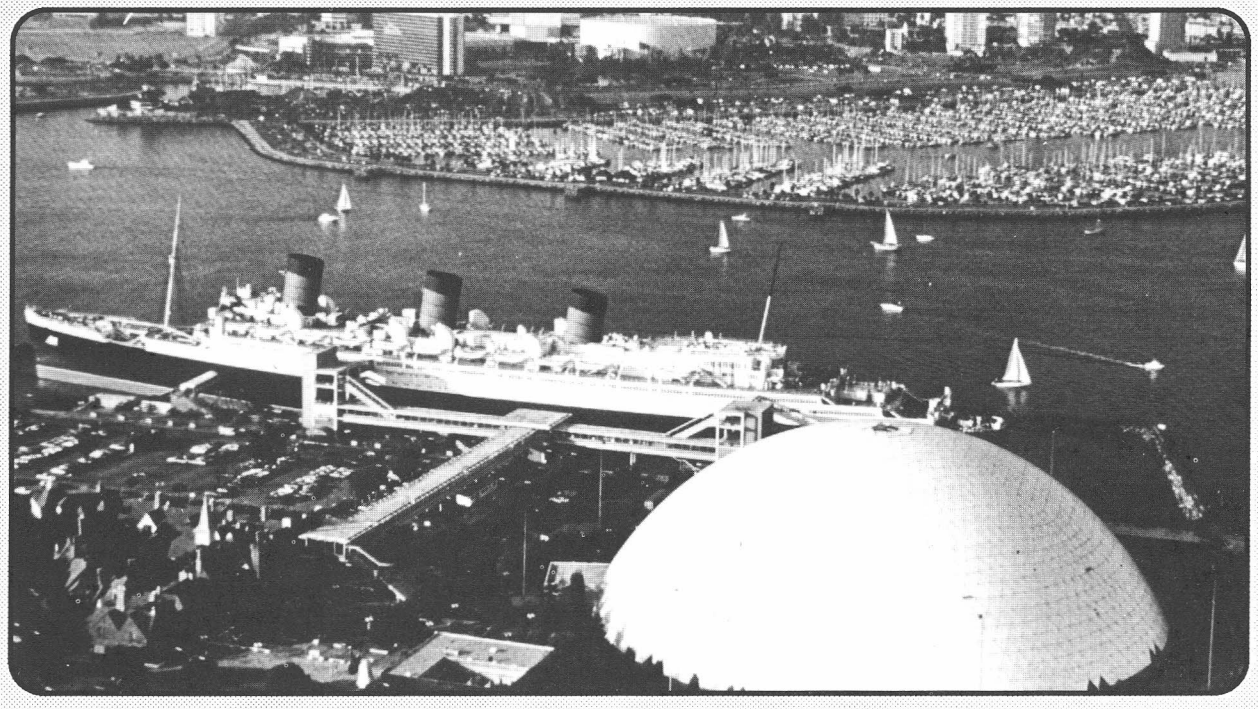
- MTT-S TECHNICAL PAPERS
- MTT-S SPECIAL SESSIONS
- MTT-S WORKSHOPS
- MTT-S PANELS
- MTT-S EXHIBITION

JOINT WITH

1989 MICROWAVE & MILLIMETER WAVE MONOLITHIC CIRCUITS SYMPOSIUM
JUNE 12 - 13, 1989

AND

33RD ARFTG CONFERENCE & EXHIBITION
JUNE 15-16, 1989



Don't miss the boat....

Whether a landlubber or of the nautical bend, you'll be missing the boat if you don't attend the 1989 IEEE/MTT-S International Microwave Symposium in Long Beach, CA, USA. The *crème de la crème* of microwave events, this symposium promises to be intellectually and socially exciting. Joining forces with the Monolithic (MMMC) Symposium and ARFTG, the symposium will present almost 300 technical papers, seven workshops, seven panels, MMMC technical sessions and panels, ARFTG technical sessions, and an array of social activities. The MTT-S Exhibition with over 450 microwave exhibitors will also be a part of this microwave extravaganza, truly **"Microwave Week"**.

Please refer to the Schedule of Events on the facing page. If you plan to attend, **please be sure to complete the Conference and Housing Registration forms which have been mailed to you in the Symposium Advance Registration flyer or Program and send them in right away.** If you do not receive either of these by April 21, 1989, please call the Symposium Hotline **1-800-MICROWAVE.**

So be it by land, sea, or air, the Steering Committee and I invite you to partake in a memorable week, one you won't want to miss.

Chuck Swift

Chuck Swift,
Chairman, 1989 IMS
Steering Committee

1989 IEEE/MTT-S IMS ★ Microwave Week ★ Schedule of Events

SUNDAY, JUNE 11 **Registration** 4:00-9:30 p.m. LBCC — **MMMC Reception** 7:00-10:00 p.m. Hyatt Regency: Seaview Room

MONDAY, JUNE 12 **Registration** 7:30 a.m.–9:30 p. m. LBCC (Long Beach Convention Center)

MTT-S Workshops: 8:30 a.m.–5:00 p.m.

WS1. Optical Microwave Circuit Interactions (Tutorial) HRRR: DEF	WS2. High Power Passive Equipment for Satellite Applications HRRR: A	WS3. High Power Microwave Generation Applications HRRR: BC

MMMC Technical Sessions: LBCC

I. Low Noise Amplifiers	9:00 a.m.–10:20 a.m.	Terrace
II. Monolithic Power Amplifiers	10:50 a.m.–Noon	Terrace
III. Non-linear Circuits	1:30 p.m.–3:00 p.m.	Terrace
IV. Advanced Circuits/Appl.	1:30 p.m.–2:30 p.m.	California
V. Control Circuits	3:10 p.m.–4:30 p.m.	Terrace

VI, VII, VIII Joint Sessions with MTT-S. See Sessions A, E, I.

MMMC Panel Sessions:
Computer-Aided Engineering 7:30–9:30 p.m. HRRR:DEF
FETS Beware, Advancing Bipolar Tech. 8:00–10:00 p.m. HRRR:BC
MMMC Program Benefits 8:00–10:00 p.m. HRRR:A

MICROWAVE JOURNAL COCKTAIL RECEPTION
6:00–8:00 p.m. Spruce Goose

TUESDAY, JUNE 13 **Registration** 7:30 a.m.–5:00 p.m. LBCC

Terrace	California	Center	Pacific
A Receivers and Mixers 8:30-10:00 a.m. Joint Session MMMC	B Phased & Active Array Technology 8:30-10:00 a.m.	C Ferrite Applications 8:30-10:00 a.m.	D Bio. Effects and Medical Applications 8:30-10:00 a.m.
Plenary Session 10:30-Noon	MTT-S Panel: PS1. Recent Advances in MW and MM-Wave Superconductor Appl. 12:10 - 1:45 p.m. LBCC: California		
E Millimeter Wave Amplifiers 2:00-3:30 p.m. Joint Session MMMC	F Optical Inter. w/Microwave Circuits 2:00-3:30 p.m.	G Passive Components 2:00-3:30 p.m.	H Trends in Microwave Acoustics
I Broadband ICs 4:00-5:30 p.m. Joint Session MMMC	J Opt.Inter.w/Microwave Circuits II 4:00-5:30 p.m.	K Passive Components II 4:00-5:30 p.m.	L Open Forum 4:00-6:00 p.m. LBCC: Alamitos & Cerritos

MTT-S Panels: PS2. Heterojunction Devices 7:30-9:30 p.m. HRRR:BC — PS3. Microwave Education 7:30-9:30 p.m. HRRR:DEF

MTT-S Workshop: WS4. Microwave Characterization of Superconductors 7:30-9:30 p.m. HRRR:A

WEDNESDAY, JUNE 14 **Registration** 7:30 a.m–5:00 p.m. LBCC

M Advanced GaAs 8:30-10:00 a.m.	N Microwave Prop. of Superconductors 8:30-10:00 a.m.	O Computer-Aided Modeling 8:30-10:00 a.m.	P Advanced Filter Technology 8:30-10:00 a.m.
Q European Microwave Session 10:30-Noon	R Microwave App. of Superconductors 10:30-Noon	S CAD Methods 10:30-Noon	T Filter Applications 10:30-Noon

MTT-S Panels: PS4. Entrep.and the Engineer 12:10-1:45 p.m LBCC: Pacific — PS5. Microwave Hdwr. Descript. Language 12:10- 1:45 p.m. LBCC California

U Lightwave Links 2:00-3:30 p.m.	V Anal-Meth. for Guiding Structures 2:00-3:30 p.m.	W Millimeter-Wave Source Tech. 2:00-3:30 p.m.	X Special Session/Seymour Cohn 2:00-3:30 p.m.
Y Manufacturing MW Components 4:00-5:30 p.m.	Z Leakage/Pkg.Mode 4:00-5:30 p.m.	AA MW Amplifier Technology 4:00-5:30 p.m.	BB Microwave Inter. Circuit Measurement 4:00-5:30 p.m.

INDUSTRY COCKTAIL RECEPTION
5:45-7:15 p.m. Hyatt Regency Promenade Deck

MTT-S ANNUAL AWARDS BANQUET
7:30 p.m. Hyatt Regency Ballroom

THURSDAY, JUNE 15 **Registration** 7:30 a.m.–5:00 p.m. LBCC

CC Advances/FET Amplifiers 8:30-10:00 a.m.	DD High Power Microwave 8:30-10:00 a.m.	EE Microwave Measurements 8:30-10:00 a.m.	FF Losses in Guided-Wave Structures 8:30-10:00 a.m.
GG Power FET Amplifiers 10:30-Noon	HH Microwave Integrated Circuits I 10:30-Noon	II HEMT Technology 10:30-Noon	JJ Time Domain and Electromagnetics 10:30-Noon

MTT-S Panels: PS6. MMIC Design for Low Cost/High Vol. 12:10-1:45 p.m LBCC: Pacific — PS7. Improving Time to Market 12:10-1:45 p.m. LBCC:California

ARFTG: Technical Sessions 1:00-5:00 p.m. Sheraton: Salon B

KK FET Devices & Applications 2:00 - 3:30 p.m.	LL Microwave Intregrated Circuits II 2:00-3:30 p.m.	MM Solid State Device/Circuits 2:00-3:30 p.m.	NN Microwave Systems Applications 2:00-3:30 p.m.
OO Monolithic Integrated Circuits 4:00-5:30 p.m.	PP Open Forum 4:00-6:00 p.m. LBCC: Alamitos and Cerritos	QQ Solid State Circuits 4:00-5:30 p.m.	

ARFTG Awards Banquet 7:00–10:00 p.m. Sheraton Hotel: Salon A

FRIDAY, JUNE 16 **Registration** 7:30 –10:00 a.m. LBCC

MTT-S Workshops: 8:30 a.m.-5:00 p.m.

WS5. High Frequency Interconnections HRRR:DEF	WS6. High Power Microwave and Millimeter Synthesizers HRRR:BC	WS7. MMIC Package Standards HRRR: A

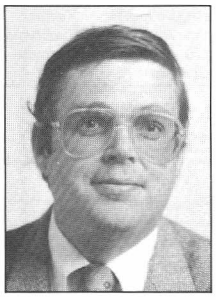
ARFTG Sheraton Hotel
7:30 a.m.–8:30 a.m. Continental Breakfast
7:30 a.m.–3:00 p.m. Exhibits
8:30 a.m.–11:45 a.m. Technical Sessions

12:00–1:15 p.m. Lunch
1:30–3:30 p.m. Technical Sessions

LBCC = Long Beach Convention Center
HRRR = Hyatt Regency-Regency Room

★ FOR INFORMATION CALL SYMPOSIUM HOTLINE 1-800-MICROWAVE ★

Monolithic Microwave Integrated Circuits—Part II



by Raymond S. Pengelly
Executive Director of Design,
RF and Microwave Products
Tachonics Corporation
107 Morgan Lane
Plainsboro, NJ 08536
(609) 275-2550

Part I of this article presented a review was given on the design of active and passive components with gallium arsenide microwave integrated circuits together with a brief history of the development of such circuits since the early 1970's.

Part II of this article includes several examples of various classes of MMIC's including multi-function chips, projections for the future of the GaAs IC industry and the effects of the Department of the Defense MIMIC program on the producibility of MMIC's.

5. COMPUTER-AIDED DESIGN

Computer-aided design, optimization, sensitivity and tolerance analysis of MMICs have become particularly important in recent years as the industry has reached production status. Contemporaneously, there has been a revolution in powerful 'desktop' and micro-computers, which has led rapidly to the acceptance of microwave CAD in the general laboratory. Equally influential advances in mainframe systems have led to the implementation of techniques—particularly in the area of nonlinear device modeling and circuit analysis—that have resulted in successful single-iteration design of traditionally difficult circuits such as power amplifiers, mixers, and oscillators.

When MMIC research started in the early 1970s, most circuit design was achieved by modeling active and passive components from measured data. Most of this data was collected by using either manual or semi-automatic network analyzers. The modeling was accomplished by means of 'in-house' programs running on mainframe computers. Network synthesis and computer-aided design and optimization routines were mainly confined to 'in-house' facilities. It was recognized early in these research programs that the theoretical equations used to model ranges of components such as spiral inductors and interdigital capacitors were inadequate because they were based on previous needs of the electrical industry.

Only in the last two or three years has much of the theoretical work begun in the late seventies reached fruition. The situation today has matured considerably. Now there are a number of commercial CAD and software packages available as well as a large number of programs geared specifically for analyzing MMIC components.

Computer-aided design of MMICs has become mandatory allowing not only the performance of the IC required to be simulated and achieved but also maximization of circuit yield and the minimization of circuit sensitivity to process variations. Until recently most linear analysis and optimization software was not able to cope with many of the CAD features required such as circuit node population, unrestricted noise analysis, accurate models for MMIC structures and coupling between components because of the packing density of the circuits. During the last year, in particular, new versions of software (such as Libra™ and Supercompact™) have become available that allow the MMIC design engineer greater CAD flexibility and accuracy. In particular, programs such as LINMIC + are able to predict coupling between components as well as analyze three-dimensional structures such as 'planar' transformers, stacked spiral inductors (ref. 1) etc.

6. SOME EXAMPLES OF MONOLITHIC CIRCUITS

In order to give the reader some idea of the range of circuits and subsystems that have been developed using GaAs MMIC technology, this part of the article gives a review of amplifiers, attenuators, switches, phase shifters, mixers, oscillators and integrated multi-function ICs such as receivers and transceivers.

6.1 Amplifiers

The realization of small-signal and power amplifiers in MMIC form has probably received more attention from designers than any other type of circuit. Many different types of amplifiers have been produced including very wideband distributed designs, medium power designs using 'tree' or 'cluster-cell' structures and narrow-band low-noise designs using conventional reactive matching networks.

Fig. 1 shows a typical broadband 'gain block' using 0.5 um gate length FETs to produce gains greater than 14 dB from 1 to 6 GHz with a noise figure of 5.5 dB. This amplifier employs feedback between the gate and drain of each FET to lower the input and output reflection coefficients of the circuit. Each FET is fed in series at DC so that the MMIC can operate from a standard 12 volt power supply. The IC measures 65 x 65 x 0.2 mils.

Fig. 2 is an example of a distributed or travelling-wave amplifier designed to operate over the 2 to 18 GHz frequency range with

continued on page 25

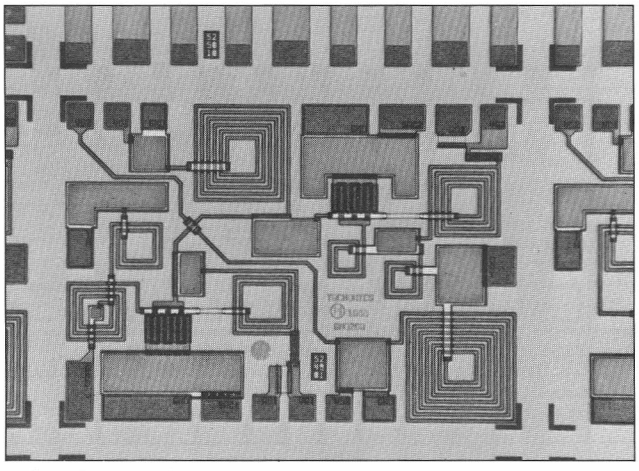


FIGURE 1. 1-7 GHz MMIC Feedback Amplifier

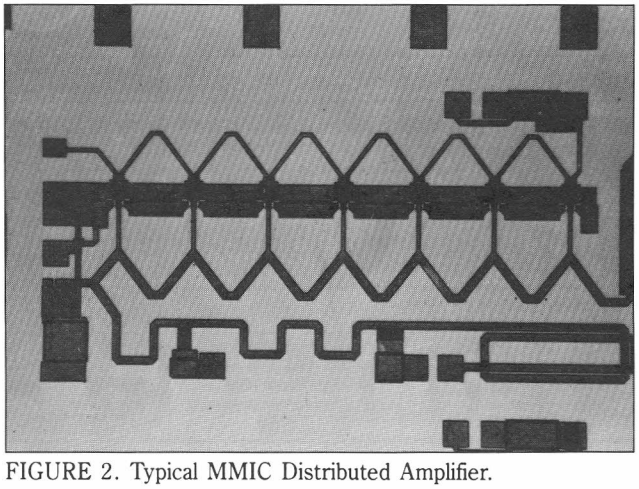


FIGURE 2. Typical MMIC Distributed Amplifier.

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a gain of 5 dB and a noise figure of 8 dB. Unlike conventional cascaded amplifiers where the output of one FET stage is fed into the input of the following one, a distributed amplifier operates whereby each FET becomes part of an artificial transmission line. The parasitic capacitances of the FETs are 'absorbed' into this active transmission line by connecting the gates and drains of each FET together with inductors (realized as either lumped components or high impedance microstripline.) The circuit schematic of such an amplifier is shown in Fig. 3(a). Fig.3(b) shows a similar scheme where 'cascode' connected FETs are used. In this structure a common source FET is connected to a common gate FET in each section of the amplifier. Such a cascode arrangement has a number of advantages including higher output impedance, higher reverse isolation, interstage tuning, and gain control by varying the applied gate voltage to the common-gate connected FETs. Fig. 4 shows a microphotograph of such an amplifier consisting of two stages (ref. 2). This circuit had a gain of 17 dB over 2 to 18 GHz with a noise figure of less than 6 dB within a chip size of 64 x 78 mils.

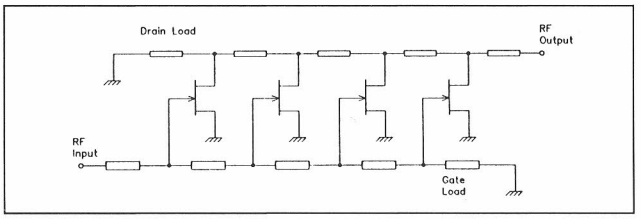

FIGURE 3(a). Conventional Distributed (Travelling-Wave) Amplifier Using Common-Source MESFETs.

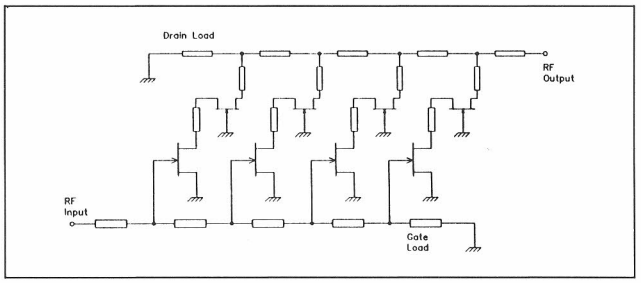

FIGURE 3(b). Distributed (Travelling-Wave) Amplifier Using Cascode Connected MESFETs.

Fig. 5 shows a photograph of a 3-stage low-noise amplifier developed as part of a MMIC chip set for an L-Band Transceiver application (ref. 3). The MMIC had 23 dB gain over 1050 to 1400 MHz with a noise figure of 3 dB. This IC was produced with 2 micron gate length FETs. The chip measured 160 x 96 mil. More recent designs employing 1 micron FETs have produced noise figures as low as 1.4 dB. (ref. 4).

There have been numerous reports of MMIC power amplifiers. In current designs much emphasis is being placed on optimization of DC to RF power conversion efficiency (so-called 'power-added' efficiency). This is important for a number of reasons—the minimization of the amount of DC power required and the minimization of the amount of heat that is generated and has to be effectively removed. The latter is important for two reasons—firstly, in many applications it is difficult to effectively remove heat (e.g. airborne, phased array radars where there are many heat sources present in close proximity) and secondly, the heat has to be removed from the FET channels through the GaAs substrate. Since GaAs is not a good thermal conductor, this heat has to be spread out for removal by making the FETs physically large, thus occupying more GaAs area.

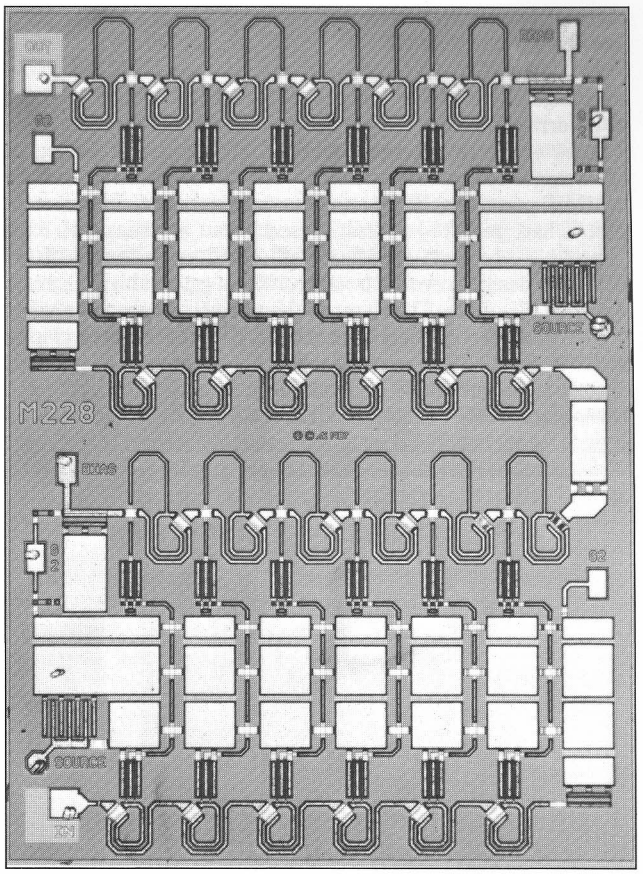

FIGURE 4. 2-Stage Cascade Distributed Amplifier.

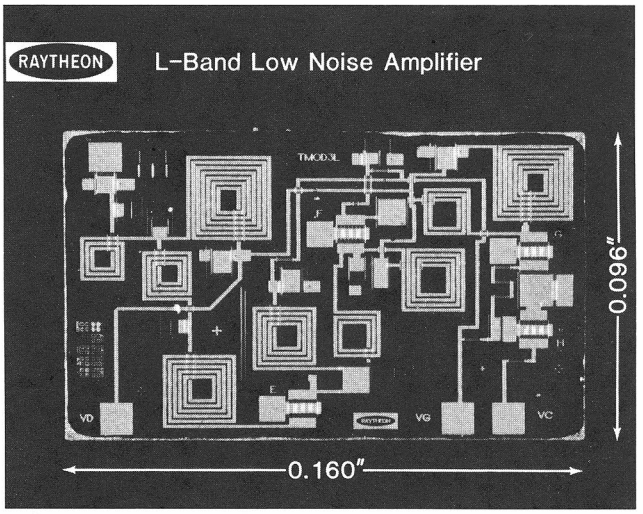

FIGURE 5. L-Band MMIC Low-Noise Amplifier.

A typical example of a MMIC amplifier giving high RF output power is the X-Band push-pull design of Fig. 6. Developed in 1985 by Texas Instruments, this amplifier achieved 3.2 watts output power with 14 dB power gain over a 1.2 GHz bandwidth centered at 9.5 GHz. The circuit had a power added efficiency of 26%. This amplifier employs push-pull amplification whereby the input RF signal is divided into two anti-phase, equal amplitude signals which are amplified separately and then combined using an output balun. Push-pull amplifiers eliminate the need for critical RF grounding and allow for easier impedance matching. The concept also allows the cancellation of second harmonic signals and has the interesting

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advantage that it allows balanced loads such as a dipole antennas to be driven directly.

Some of the recent work achieved at the Central Research Laboratories of Texas Instruments shows the advances being made in MMIC power amplifiers at higher frequencies. Camilleri et al. (ref. 5) have reported a MMIC based 1 watt amplifier with 5 dB gain and 550 milliwatt amplifiers with 27 dB gain operating at 34 GHz. The designs revolve around a 400 um gate width FET stage shown in Fig. 7 (a). This stage is then combined six times using travelling-wave combiners to produce a Ka-band amplifier chip as shown in Fig. 7 (b). The chip, occupying 19 sq.mm. of GaAs, is capable of providing 600 mW output power with 3 dB gain and 8.5% power added efficiency. The maximum gain that can be achieved from the chip is 5 dB with reduced output power level of 320 mW. By taking four of these chips and combining them in pairs between resistive splitters, over 1 watt of power with 5 dB gain was achieved.

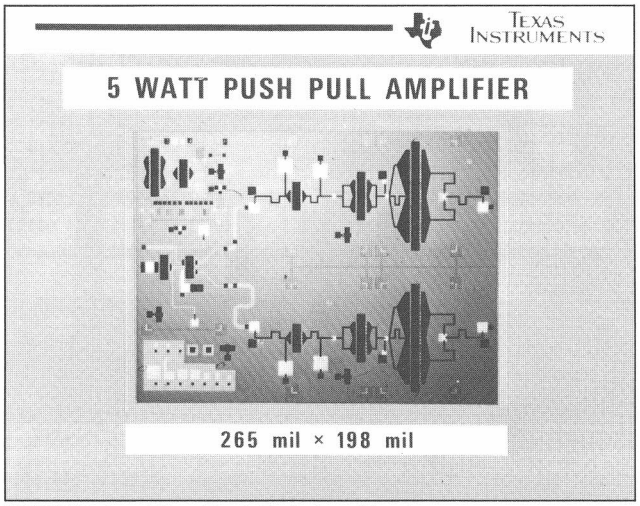

FIGURE 6. 5 Watt Push-Pull Amplifier.

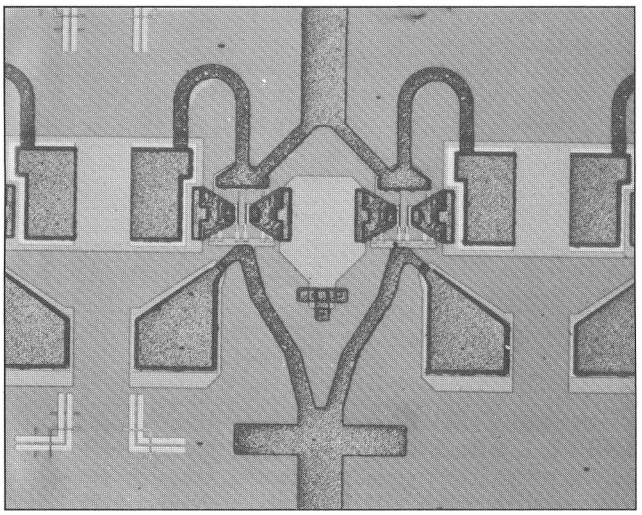

FIGURE 7(a). 400 μm Gate Width FET Stage.

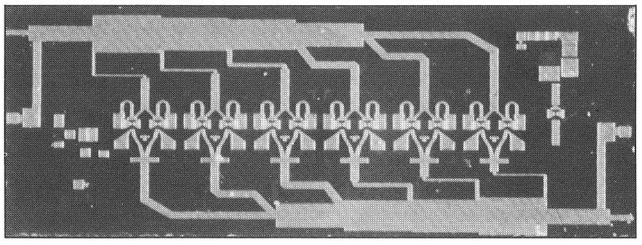

FIGURE 7(b). Ka-Band Amplifier.

Phased array radar systems require precise amplitude control in order to achieve transmit/receive sidelobe levels demanded by the modern electromagnetic environment. Snow and Komiak of General Electric have described a novel variable gain power amplifier which uses dual-gate FETs having different gate-widths in strict ratios (so-called 'segmented dual-gate FETs). The X-Band variable power amplifier shown in Fig. 8 is a two-stage design consisting of a 1.4mm segmented dual-gate device of 100 um unit gate finger width driving a pair of 1.4 mm devices. The gate and drain bias networks are integral to the design and are used as impedance matching transformers. Chip size is 144 x 100 mils with an off-chip output matching network (used for lower loss than that obtainable on GaAs) which measures 1.7 x 2.1 mm. Small signal gain was 14.5 dB $\pm$ 1.5 dB from 7 to 11.5 GHz with a 35 dB gain control range. The amplifier also exhibited a maximum output power of 1/2 watt with 10 dB dynamic range and minimum power added efficiency of 15%.

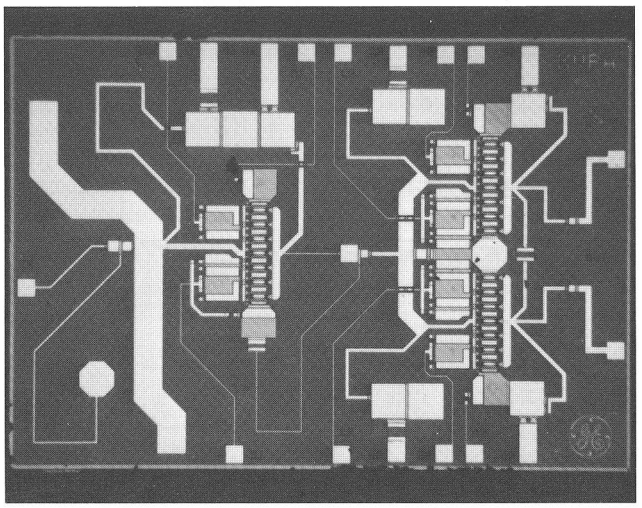

FIGURE 8. X-Band Variable Power Amplifier.

6.2 Attenuators & Switches

The MESFET has been used very successfully as a voltage-controlled resistor in control circuit applications such as attenuators and switches. In many microwave subsystems attenuators are needed in automatic level functions, automatic gain control and amplifier temperature compensation. Equally important are switches which are used in phased-array transceiver modules, in digital phase shifters and attenuators, switching matrices for TDMA (time-domain, multiple access) communications, multi-spot beam satellites, frequency-hopping transmitters and instrumentation.

Fig. 9 shows the basic configurations of three types of voltage-variable attenuators—the tee(T), pi and bridged-T. By controlling the resistances in the series and shunt FETs it is possible to vary the attenuation of the circuits while still retaining a matched condition. Fig. 10 shows a bridged-T type of attenuator which operates to over 12 GHz with greater than 12 dB attenuation range and better than 17 dB return loss in all attenuation states. The chip has a size of only 25 mil square—such small chip sizes together with high yields due to circuit simplicity result in MMICs having low production costs. Such attenuators can be used in very small

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temperature compensation modules used to offset the inherent variation in gain of FET amplifiers with temperature. Fig 11 shows such a temperature-compensation module using low-cost thick-film technology with a GaAs MMIC attenuator, temperature sensor, silicon band-gap reference and Si operational amplifier contained within a 270 mil square substrate.

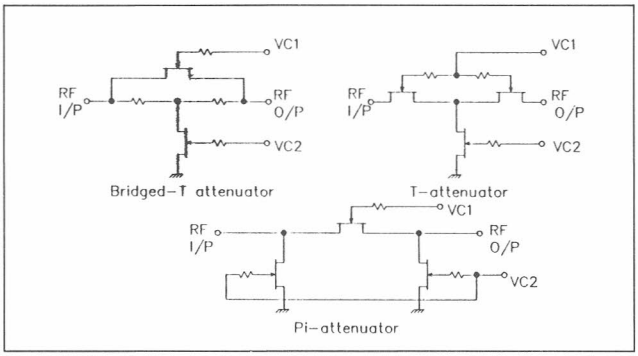

FIGURE 9. Different Types of Voltage-Controlled Attenuators.

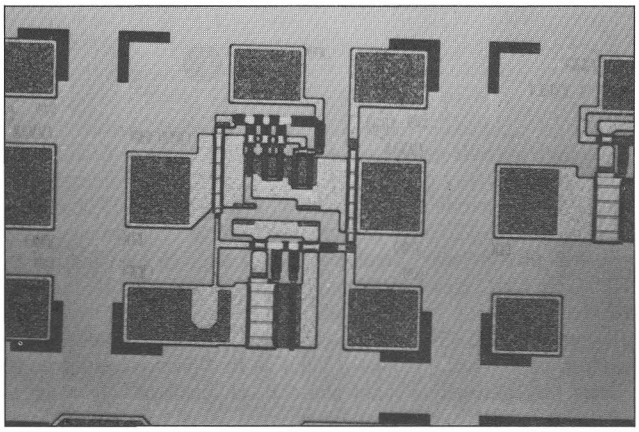

FIGURE 10. MMIC Bridged T—Attenuator.

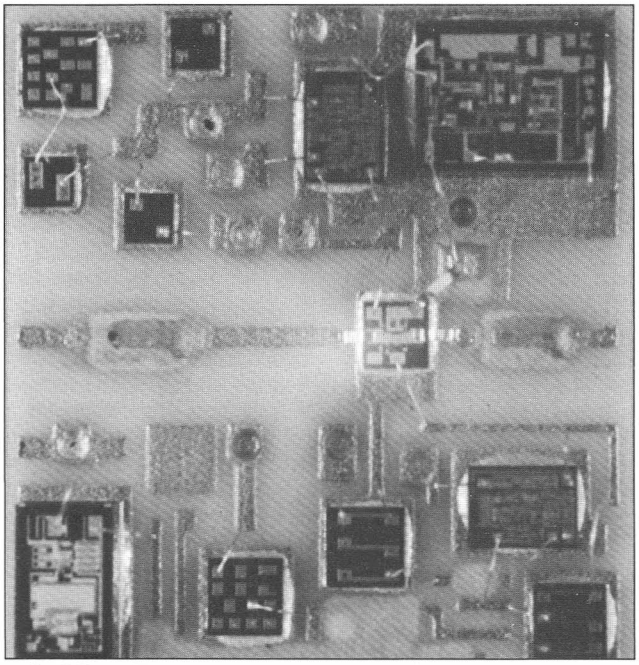

FIGURE 11. Temperature Compensation Substrate Using MMIC Attenuator.

Perhaps the most popular commercial GaAs IC at the present time is the MMIC switch. The circuits use the two extreme states of the MESFET as a voltage controlled resistor—namely when the FET channel is fully depleted of electrons in its 'pinched-off' state and when the channel is fully open in its 'on' state. Unlike the PIN diode the MESFET does not require any substantial control current and because the control port (the gate) is separate from the RF ports (source and drain) control circuitry is simpler with the coupling of the control voltage to the RF lines being very small. Recently a number of MMIC switches have been introduced that are rivaling the low insertion loss of PIN diode circuits at frequencies to 20 GHz. Most switches use a combination of shunt and series FETs to give the best compromise between insertion loss, bandwidth, isolation, speed and RF power handling. Fig. 12 shows a typical example of such a switch—a DC to 7 GHz single-pole, four throw device within a chip area of 100 mil square. Such a chip replaces a multi-PIN diode SP4T occupying approximately 1 sq. inch depending on frequency. Switches offering losses below 0.2 dB and power handling capabilities greater than 10 watts CW have been reported (ref. 6 and 7, for example).

The frequency of operation of MESFET-based switches has reached at least 40 GHz. For example, in 1987, Schindler et al (ref. 8) reported SPDT switches operating from DC to 40 GHz employing 0.35 um gate length FETs. The chips were small measuring 33 x 50 mils. The insertion loss was less than 3 dB with an isolation greater than 23 dB to 40 GHz. A similar 20 to 40 GHz switch had a loss of less than 2 dB with greater than 25 dB isolation.

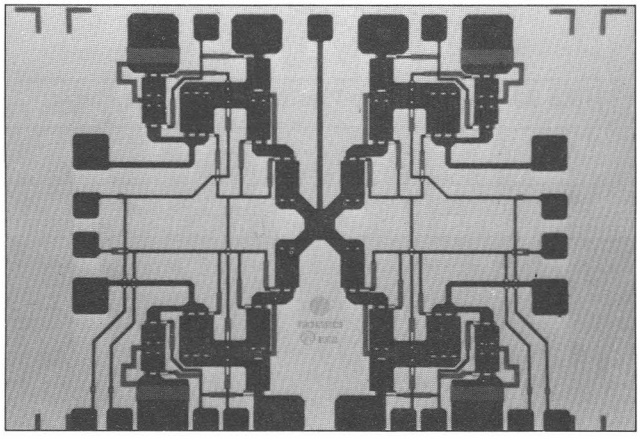

FIGURE 12. DC-7 GHz SP4T MMIC Switch.

6.3 Phase Shifters

All transmit/receive modules for phased-array radar systems require digital and/or analog phase shifters. Much attention has, therefore, been focused on such circuits in MMIC form. Although there has been a great deal of work done on a number of phase shifter designs just two will be described here—the high-pass/low-pass circuit and the segmented dual-gate FET-based vector modulator.

Highpass/low pass circuits

Broadband phase shift can be achieved by switching between low-pass and high-pass filter sections. For GaAs MMICs the MESFET again provides a convenient switch. A number of such switched sections can be cascaded to provide a multi-bit digital phase shifter, n-bits providing $2^n - 1$ phase states. Fig. 13 shows the easiest implementation for such a phase shifter where LC sections are individually switched by SPDT FET switches. Another,

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more elegant approach, is to include the switching FETs within the lumped element circuit. For example, consider the circuit in Fig. 14 where FETs F1, F2 and F4 are 'on' and F3 and F5 are 'off,' producing a 3-element T low-pass filter. In this state F5 is used as a capacitive shunt filter element. The capacitance of F3 is an undesirable parasitic. Since F3 can be made quite small, its capacitance can be minimal. L1 and L2 become inductive series filter elements. To realize a 3 element high-pass filter, the biases are reversed. In this state F1 and F2 are used as capacitive series filter elements. Capacitors C1 and C2 are used to increase the capacitance across F1 and F2. The capacitance of F4 is undesirable and can be minimized by making F4 of small gate width. L3 then becomes a shunt inductive element. Fig. 15 shows a 3-bit MMIC phase shifter covering 6 to 18 GHz using such concepts produced by Schindler et al of Raytheon in 1985. The 3-bits were 45, 90 and 180 degrees. The RMS average phase error of this MMIC phase shifter (which measured 49 x 87 mils) over the frequency band was 8.5 degrees.

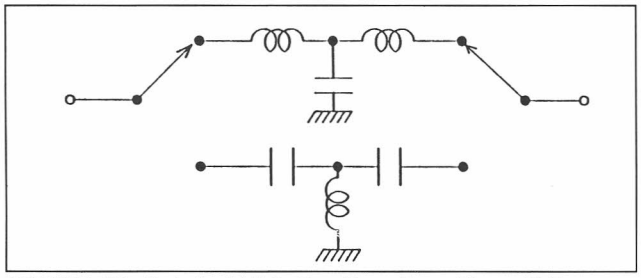

FIGURE 13. Switched High Pass/Low Pass Phase Shifter.

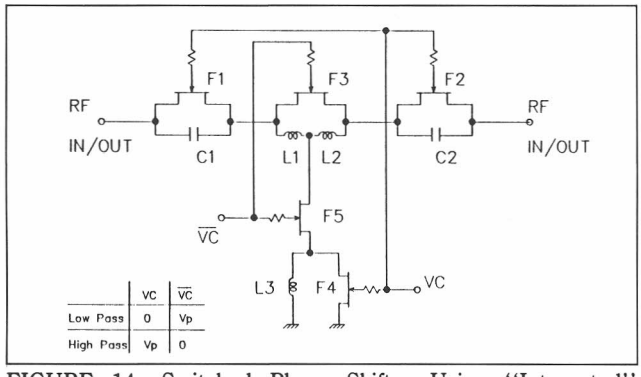

FIGURE 14. Switched Phase Shifter Using "Integrated" MESFETs.

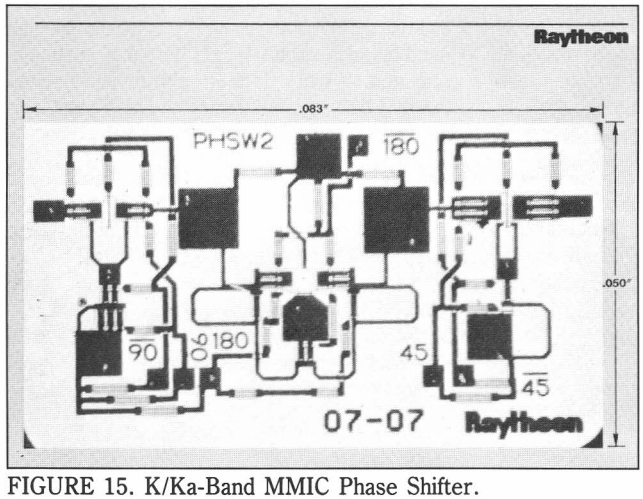

FIGURE 15. K/Ka-Band MMIC Phase Shifter.

Segmented dual-gate FET circuits

Active circuit techniques can be used to produce wideband phase shifters. Such circuits as differential amplifiers to produce anti-phase signals are well known from Si IC usage but in order to produce any phase shift within 360° in an analog fashion it is necessary to use vector modulation whereby two quadrature vectors of differing magnitudes are added to produce a resultant vector with a phase angle determined by the relative amplitudes of the two input vectors. The amplitudes of these vectors can be adjusted using either variable gain or attenuation. MESFET attenuators based on the T- or bridged-T circuits have been used as well as dual-gate FETs where gain control is achieved using the second gate. This control is non-linear and its effect on FET gain can vary from wafer batch to batch depending on process stability. Also, the gain and phase of the FETs change depending on biasing and geometry.

Hwang et al (ref. 9) introduced a novel circuit technique in 1984 to overcome these limitations. Fig. 16 shows the so-called 'segmented-dual-gate-MESFET device' (SDGFETs) where dual-gate FETs are operated in their 'on' or 'off' modes only by switching the gate voltage from zero volts to the pinch-off voltage. Segments are integrated together by connecting all the first gates, sources and drains of the FETs. The gain of the device is proportional to the gate width of the turned-on segments. By selectively controlling the respective second gates, the gain of the device is exactly programmed by the gate width ratios, not by bias voltages. The device is, therefore, effectively process independent. Active wideband attenuators using such techniques have been produced covering L, C and X bands. The same technique has been used to produce variable-gain amplifiers at L-Band, C/X and X/Ku bands with precise binary control (Snow et al, ref. 10). For example, the C/X-band variable gain amplifier, shown in Fig. 17, consists of a six-bit SDGFET with integral bias and matching circuits. Chip size was 56 x 60 mils. Small-signal gain was 5.5 dB from 5.5 to 10.5 GHz with a gain control range of better than 33 dB. Incidental phase variation with gain state were less than 6° over a 20 dB control range. Such circuits allow accurate adjustment of the vectors in a vector modulator such as that shown in Figure 18 allowing the generation of any phase in one quadrant. The remaining three quadrants can then be covered using switched 90° and 180° phase shifters.

Indeed, there are now a range of phase and amplitude control circuit techniques available that allow the realization of mixed analog and digital controlled MMICs. Such an example is the C-Band phase and gain control MMIC from General Electric (ref. 11) that employs variable gain amplifiers and digital phase shifters to produce 31 dB gain with 20 dB gain control from 5 to 6 GHz with a 6-bit phase shifter having an RMS error of less than 3°.

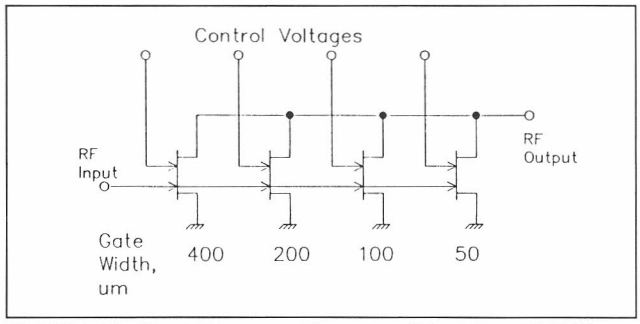

FIGURE 16. Circuit Diagram of Segmented Dual-Gate FET Binary Attenuator.

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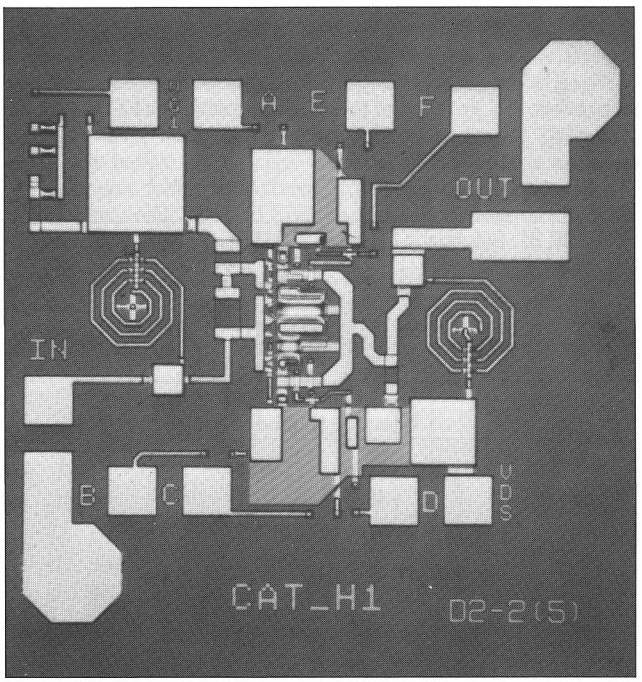

FIGURE 17. Variable Gain MMIC Amplifier.

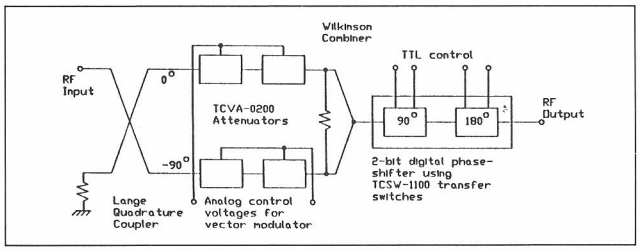

FIGURE 18. Vector Modulator Using MMIC "Building Blocks."

6.4 Mixers

A wide range of mixers have been produced in GaAs using a variety of active devices and circuit techniques. These circuits have been used successfully to both down-convert and up-convert signals as well as in phase discrimination. The type of circuits used depend very much on the frequency of operation—planar diodes have been extensively used at millimeter-wave frequencies (ref. 12 and 13), single-gate and dual-gate FETs in both single-ended and balanced configurations at lower frequencies. This article concentrates on the FET mixer. At low signal frequencies DC coupled differential amplifiers are used to generate anti-phase RF and local oscillator (LO) signals to be used as the inputs to a double-balanced mixer cell also using FETs (Fig. 19(a)). Fig 19(b) shows a microphotograph of such a mixer developed at Tachonics operating over the 200 MHz to 3 GHz signal frequency range with an intermediate frequency coverage of DC to 1 GHz. The advantage of such a FET balanced mixer is that it has 10 dB gain due to the use of a differential RF input amplifier and good conversion efficiency (rather than the usual poor conversion loss of a passive mixer). Also the RF and LO signals are suppressed by summing the output of two mixers (one driven at 0°, the other at 180° RF and LO).

The dual-gate FET has been used very often as the mixing element in MMICs. Unlike the single-gate FET mixer which requires quite high levels of LO drive, the dual-gate FET mixer uses a second MESFET for LO power injection where this device acts as an amplifier. LEP, for example, have developed a number of such mixers (ref. 14) for low-cost, 12 GHz direct broadcast satellite applications. The signal is converted from the 11.7 to 12.5 GHz frequency band down to the 950 to 1750 MHz band using a 10.75 GHz, 10 mW oscillator. The mixer used two 0.8 um gate length FETs and achieved a conversion gain of 2 dB with a noise figure of 8 dB. Recently, interesting work has been completed on wide-band double-balanced dual-gate FET mixers using both MESFETs and HEMTs (High-Electron Mobility Transistors) (ref. 15, 16). For high frequencies the traditional differential amplifiers used for the generation of 0° and 180° signals at RF and LO cannot be used because of parasitic effects. Pavio et al (ref. 16) have described the use of a distributed active balun circuit shown in Fig. 20(a) which enables amplitude flatness to within ±1 dB and phase accuracy to within ± 30° to be maintained over 2 to 18 GHz. Using, also a 0.5 micron gate-length dual-gate FET distributed wideband mixer (Fig. 20(b)) a conversion loss of less than 4 dB was maintained over 2 to 18 GHz with a mean LO and RF suppression of 20 dB. (LO power requirements were about 20 mW).

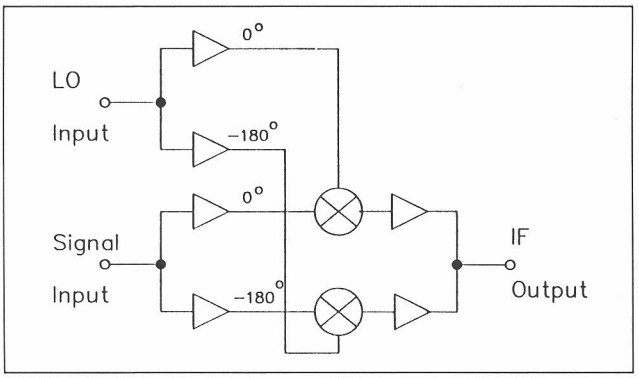

FIGURE 19(a). Block Diagram of Balanced Active Mixer.

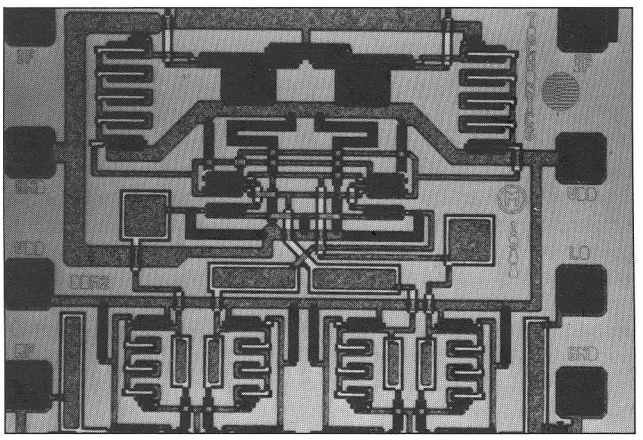

FIGURE 19(b). GaAs MMIC Mixer.

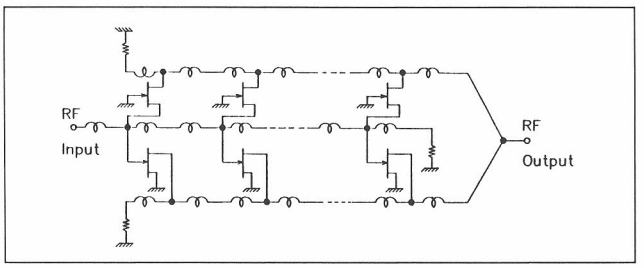

FIGURE 20(a). Lumped Element Equivalent Circuit of Active Distributed Balun.

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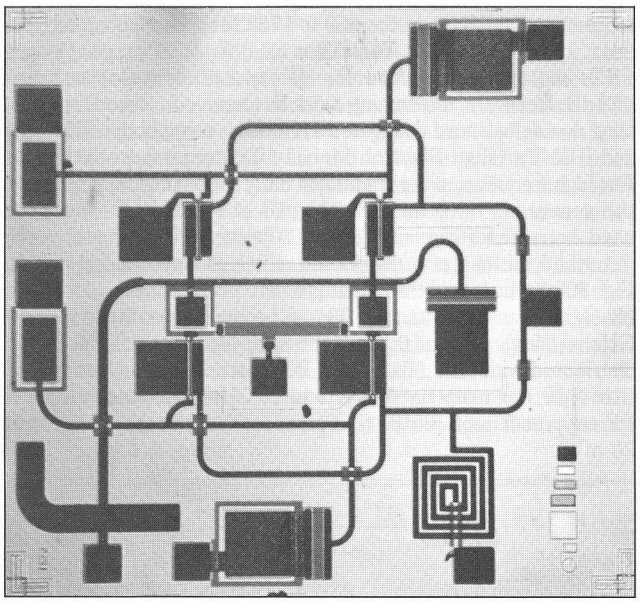

FIGURE 20(b). Double Balanced Dual-Gate FET Distributed Mixer.

6.5 Oscillators

In order to allow the manufacture of completely integrated up- or down-converters it is necessary to also produce MMIC compatible oscillators. Two main types of oscillator circuit have been developed—fixed frequency (often using dielectric resonators for short and long-term stability) and voltage-controlled oscillators (often associated with synthesizer applications). Several workers including Scott et al (ref. 17) have shown that MMIC techniques can be used successfully to produce broadband tuneable VCOs over the 2 to 18 GHz band. Moghe and Holden (ref. 18) have also described MMIC circuits in C, X and Ku-bands that employ an oscillator, amplifier and associated bias circuitry on the same chip. This gives some advantages such that the negative resistance oscillators can be stabilized or tuned using off-chip dielectric resonators or varactor diodes. The buffer amplifiers isolate the resonator from the load attached to the oscillator and prevent frequency pulling. Since the amplifiers are designed to operate in saturation they also provide constant output power with frequency and minimize variations with temperature. Table 1 gives some performance summaries for some of the Dielectric Resonator Oscillators (DROs) produced by Pacific Monolithic. Low phase noise in the C-band DRO is obtained because of the high level of reflection gain allowing the dielectric resonator to be decoupled from the microstrip coupling line to maximize the loaded Q of the resonator.

Push-pull and push-push circuit design techniques have also been adopted for MMIC oscillators. In these configurations the oscillator circuit is 'mirrored' so that each side of the circuit operates 180° out of phase with the other forming a virtual ground along the center line of the circuit (Fig. 21). The signals at the output are combined in a balun whilst the dielectric resonator is placed between two microstriplines on a substrate to which the MMIC is attached.

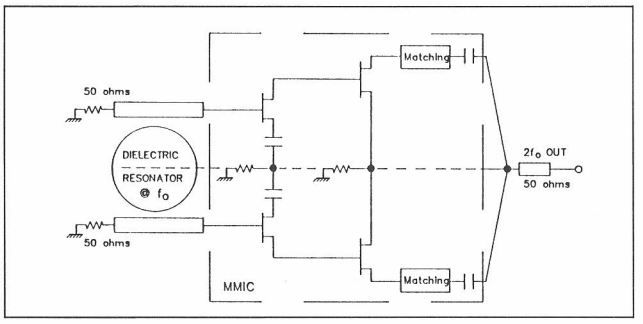

FIGURE 21. Schematic Diagram of MMIC Push-Push Dielectric Stabilized Oscillator.

Table 1 Summary of Typical MMIC DRO Performance

Parameter	Frequency Band C-band	X-band	Ku-band	Units
Frequency	5.027	10.74	13.12	GHz
Output Power	+12	+16	10	dBm
SSB Phase Noise				
100 kHz	−115	−110	−100	dBc/Hz
10 kHz	−88	−80	−70	dBc/Hz
Frequency Pulling	0.02	0.02	0.001	% (3:1 VSWR)
Bias Voltage	8	4	11	Volts
Bias Current	19	65	35	mA
Frequency Stability	±2	±4	±5	ppm/°C
Power Flatness	±0.75	±1	±0.5	dB

6.6 Multi-function MMICs

The major advantage to be gained from monolithic microwave technology will come about when high levels of integration can be produced at affordable costs with acceptable performance. Considerable work has been completed in research laboratories in this area and this section of the article looks at three examples of MMICs performing multiple functions within one IC.

Transceiver ICs

A good example of the integration of a number of functions within a single chip to produce a complete transceiver is the X-Band circuit reported by Wisseman et al in 1987 (Ref. 19). The complete Tx/Rx chip contains 25 FETs, 24 resistors, 43 capacitors and 48 through GaAs via holes (shown in Fig. 22). The chip dimensions were 520 x 180 x 6 mils. Fabrication yield is obviously of prime concern in such a chip because of its large size. The best wafers processed by Texas Instruments in this development work yielded 32 percent yield. Table 2 summarizes the performance achieved with this chip. The complete chip consists of a 4-bit phase shifter, transmit/receive switches, low-noise amplifier and power amplifier. The phase shifter uses switched lines for the 45°, 90°, *and 180°* bits with a loaded line circuit for the 22.5° bit. The low-noise amplifier, consisting of three stages, used a common-gate FET for the first stage followed by two common-source stages resulting in a 2.4 dB noise figure with 21 dB gain over 8.5 to 9.5 GHz. The power amplifier design consisted of four gain stages using 300, 600 and 1500 μm gate width FETs. This amplifier achieved 800 mW of output power with 30 dB gain at a power added efficiency

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of 35%. The complete Tx/Rx circuit generated 500 mW of power in transmit mode with 20 dB gain and an overall efficiency of 12.5%.

Such Tx/Rx MMIC 'modules' can be made physically smaller by advanced circuit techniques. One of these is the novel employment of FETs and inductors combined together as reported in ref. 20. Such techniques together with improved process yields are necessary before 'single-chip' Tx/Rx modules become a reality in production. (ref. 21) As described later in this article much effort is now being directed towards this goal during the MIMIC program.

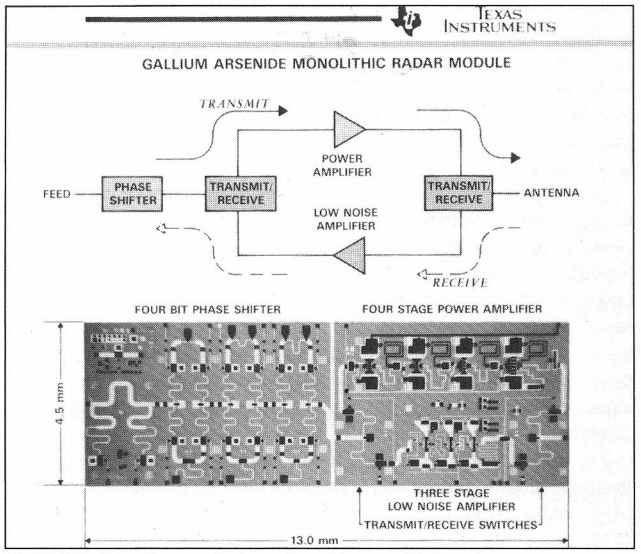

FIGURE 22. Transmit/Receive Chip at X-Band.

Table 2. Measured Performance of Single-chip T/R Module

Parameter	Transmit	Receive
Gain (small-signal)	24 dB	18 dB
Gain (large-signal)	20 dB	—
Output Power	500 mW	—
Efficiency	12.5%	—
Noise Figure	—	5.5 dB

Downconverters

Two types of frequency converter are described here—the first is an X-Ku band downconverter whilst the second is a X-Ku band upconverter.

Fig. 23 shows the diagram of a single-chip 12 GHz direct broadcasting receiver consisting of an amplifier covering the 11.7 to 12.5 GHz band, a filter to reject the image frequency band of 9 to 9.8 GHz, a stable local oscillator at 10.75 GHz, a mixer circuit and an IF amplifier covering the frequency range of 0.95 to 1.75 GHz. (ref. 22). The three-stage low-noise amplifier was designed using high-pass and low-pass matching circuits so that much of the image rejection filtering is contained within this amplifier. The mixer was designed using a dual-gate MESFET with the IF amplifier coupled directly to the mixer output since considerable gain can be achieved by using unmatched FETs occupying the same area as the usual IF matching circuitry. IF output matching was achieved using a source-follower (common drain) FET configuration. The complete equivalent circuit of the receiver is shown in Fig. 24.

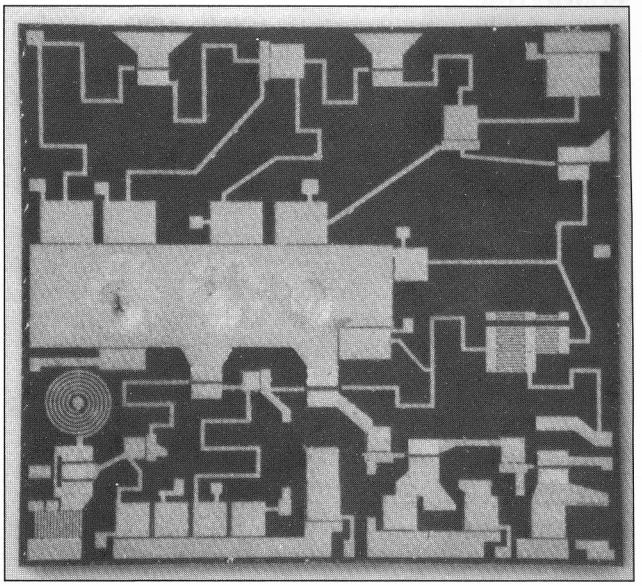

FIGURE 23. Single Chip DBS Receiver.

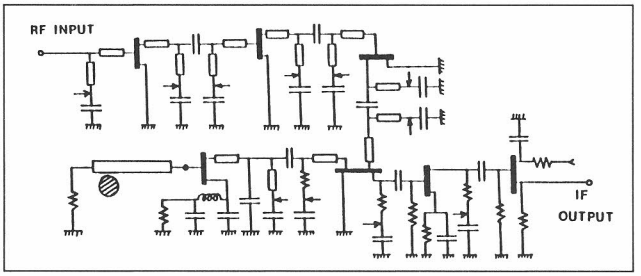

FIGURE 24. Diagram of Integrated DBS Receiver MMIC.

The topology of multi-function MMICs is very important in order to minimize parasitic coupling caused by the close proximity of components. The receiver chip was organized around a gold-plated area with three via holes etched through the GaAs. This area not only acts as a ground plane but also as a shield between the low-noise amplifier and the local oscillator. The resultant receiver chip, measuring 100 mil square, had the performance summarized in Table 3.

Table 3. Measured Performance of Single-chip DBS receiver

Parameter	Performance
Conversion Gain	35 db
Noise Figure	< 4.5 dB
Input VSWR	< 1.8:1
Output VSWR	< 1.4:1
Output power at 1 dB compression	0 dBm
DC power consumption	450 mW

The second example is that of a monolithic upconverter consisting of a two-stage RF amplifier, a broadband, transformer coupled, double balanced Schottky-diode mixer and a two-stage LO buffer amplifier in a chip which measures 96 x 48 mils. For

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frequency upconversion the low frequency input signal is fed into the IF port of the mixer. A block diagram of the upconverter is shown in Fig. 25. (ref. 23). Since the diode mixers used do not have a good wideband match over the 8 to 16 GHz frequency range of the upconverter the LO amplifier is used to produce a good match at the LO port. The RF amplifier used was push-pull, having the virtual ground previously mentioned, conveniently supplying signals to the double-balanced mixer. The LO buffer amplifier was a similar push-pull circuit. Planar transformers described above were used to couple signals into the diode quad. A summary of the performance of the MMIC upconverter given in Table 4.

Table 4. Measured Performance of X/Ku-band UpConverter MMIC

Parameter	Performance
Frequency Range	8 to 16.5 GHz
Conversion Gain	10 dB
Gain Flatness	± 1 dB
Third order intermod. products (−20 dBm I/Ps)	−46 dBc
Input VSWR	< 2.5:1
Output VSWR	< 2:1
LO Port VSWR	< 2:1

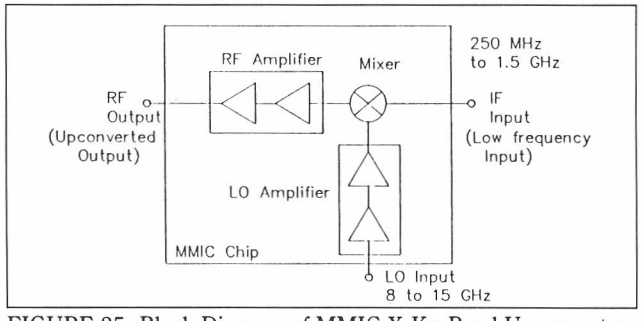

FIGURE 25. Block Diagram of MMIC X-Ku-Band Upconverter.

7. THE MIMIC PROGRAM

It has been clearly demonstrated by the remainder of this article that MMIC design and technology has reached a significantly mature stage in its development growth. For many Department of Defense (DoD) electronic systems including smart weapons, decoys and phased array radars, the timely and effective deployment of MMIC-based low-cost systems is essential. In late 1986, therefore, the DoD set up the Microwave and Millimeter Wave Monolithic Integrated Circuits (MIMIC) program. This program is seven years long such that by 1994 a comprehensive microwave and millimeter-wave technology, design and manufacturing base will be established. A so-called Phase 0 program definition phase was conducted in 1987 and Phase 1 awards have been made to a number of industry teams as a direct outcome of work in Phase 0. Two other phases are planned—Phase 2 which is a three year hardware manufacturability demonstration program and Phase 3 which is a parallel support program investigating technology support in such important areas as cost-effective and improved packaging, automated test equipments and improved material growth techniques.

The first phase, which was awarded to four prime contractors in May 1988, is directed toward the development of improved processing technology, computer aided design and manufacturing capability; the establishment of pilot lines and foundries with computer aided manufacturing tools and testing facilities. The four teams are headed by Hughes/General Electric, ITT/Martin Marietta, Raytheon/Texas Instruments and TRW. All of the teams are developing brassboards to demonstrate the maximum performance capability of the GaAs die and modules developed during the program.

Table 5 shows some of the highlights of the Phase 1 program. In some of the studies conducted during Phase 0 of the MIMIC program cost savings of around $400 were projected for a MMIC-based transceiver module in comparison to a hybrid-based unit. With an anticipated production run of 300,000 units this results in a potential cost saving of $120 million. A typical MMIC application in a solid-state transmit/receive array is shown in Fig. 26. The complete brassboard, containing four T/R modules and control circuitry will be housed in a single hermetic sealed housing.

The MIMIC program will only be successful if it can demonstrate significant impact on the cost, performance and reliability of a number of major military systems. Of great importance is the ability of the team members to provide MMICs in a timely fashion that meet performance requirements in terms of quality and reproducibility such that the technology will gain widespread acceptance in the military marketplace.

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Table 5. MIMIC Phase 1 Teams, Contract Values and Main Program Emphasis

Prime Contractor	Team Members	Contract Value $ million	Brassboard Demonstrations
Hughes/GE	E-Systems, Hercules, AT&T, M/A-COM, Harris, EEsof, Cascade	50.5	T/R modules for radar—Advanced Tactical Surveillance Radar, Global Positioning System, Advanced mm-wave Seeker
ITT/Martin Marietta	Alpha, Harris, Watkins Johnson, Pacific Monolithic	49.28	Circuits for smart weapons and comms.—Airborne Self-Protection Jammer, SHF Satcom Manpack, Sense and Destroy Jammer
Raytheon/TI	Aerojet, Airtron, Compact, Consilium, GD, Magnavox, Norden Teledyne	68.8	Wideband T/R modules for EW—Transmitter Array for X/Ku-bands
TRW	Honeywell, Hittite, General Dynamics	57.5	Receiver components for smart weapons—Multiple Launch Rocket System, Multi-option fuze for Artillery

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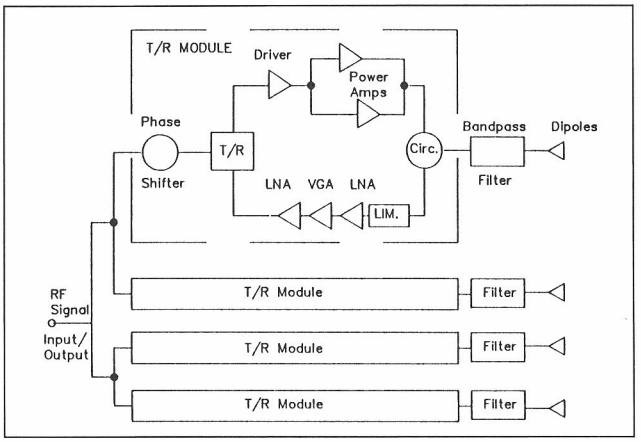

FIGURE 26. Solid State Active Phased Array Using GaAs MMICs.

8. CONCLUSIONS

This article has attempted to bring together a number of aspects of GaAs MMIC research, development and production. Considerable steps have been taken with MMIC technology in the last few years particularly in the area of manufacturability. This article has shown that MMICs are able to perform numerous circuit functions and has given examples of where the technology is being inserted into both commercial and military systems. The impact of the DoD-sponsored MIMIC program will have significant impact on the cost-effectiveness of microwave and millimeter wave ICs. Already MMICs are starting to be used in considerable quantities where they have been accepted as a means of producing significant cost and performance advantages in commercially available microwave products.

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Book Review

Microwave Solid State Circuit Design, *by I. Bahl and P. Bhartia, Wiley Interscience, 1988, ISBN 0-471-83189-1.*

This book is one of the most, if not the most, comprehensive reference books on microwave solid state circuit analysis and design. Unlike many microwave books published in the recent past, which tend to discuss a certain microwave related topic, such as computer aided design, extensively, all aspects of the items modern practical microwave engineers need to deal with are included except for the system design. This book is written essentially for planar microwave integrated circuits, both hybrid and monolithic configuration.

This book consists of 17 chapters written by twelve authors who are individually well recognized in the areas of their topics. Excluding the Introduction, the remaining 16 chapters can be divided into five areas. The first one is Transmission Media and Passive Components (Chapters 2-6). The second area is Solid State Devices (Chapters 7 and 8). The third area is Component Design (Chapters 9-13). The fourth is Integrated Circuit Design (Chapters 14 and 15). The fifth area treats the interrelation of microwaves with other waves, such as optics (Chapter 16) as well as prediciton of future trends (Chapter 17) as a conclusion of the book.

The first part contains five chapters. Chapter 2, 'Transmission Lines and Lumped Elements,' (by I.J. Bahl) is written with all the theoretical details intentionally omitted. The subjects on the uniform transmission lines are characterized in terms of appropriate closed form expressions. Knowledge of the propagation characteristics of planar transmission lines is the utmost basis for any planar circuit design. Characteristics of the discontinuities are presented. The information presented is essentailly based on the quasi-static approximation. Obviously, there is a limitation on these models. More rigorous dynamic solutions to these problems are currently being worked out and some references are given in the text. Inclusion of a complete section on the lumped element in this chapter s a very useful feature. These lumped elements are very useful in practical design, particularly in monolithic circuits. Treatment of these elements in this book is quite timely, although the information is still limited.

Chapter 3 by A.K. Sharma and A.P.S. Khanna treats resonators. After general descriptions of resonators, planar microstrip resonators are described. Useful design parameters are provided in the form of formulas and graphs. The next subject is the dielectric resonator which is currently the workhorse for planar resonators due to its high Q that cannot be attained by microstrip resonators.

Chapter 4 by P. Wahi deals with impedance-matching networks. Although the materials treated here are of a classical nature, they provide the foundation for the passive circuit design. They rarely appear in modern textbooks of microwaves in as comprehensive a manner as in this volume. For this reason, reading this chapter is an enjoyment.

Chapter 5 on hybrids and couplers by P. Bhartia and P. Pramanick presents basic design concepts as well as descriptions of specific configurations developed in the recent past, including a rather complicated but useful de Ronde coupler. Chapter 6 written by E.L. Griffin and I.J. Bahl, on the other hand, treats filters and multiplexers. Basic design procedures similar to those one may find in the book by Matthaei, Young and Jones are summarized. The section on numerical techniques is very illuminating in that many of these techniques can be implemented in a CAD package and are useful particularly when high performance filters are needed.

The second part of the book consists of two chapters written by R.J. Trew. They deal with three-terminal devices (Chapter 7 Active Devices) and two-terminal devices (Chapter 8 passive Devices). The word 'Passive Devices' used here does not mean filters and couplers made of passive transmission lines. It is used here for pn junction diodes, Schottky diodes, varactors, pin diodes, etc. which are used for control functions of microwave signals. Chapter 7 deals with bipolar transistors and field effect transistors. Other popular devices such as Gunn and IMPATT are not treated. These chapters essentially present the physics of the devices and information useful to circuit designers such as equivalent circuit, device model, noise characteristics in a format suitable for microwave engineers. Operating principles of the MESFET are well presented in many illustrations. One minor criticism is the omission of HEMT devices. Page limitations may not have allowed the inclusion of these devices, however. The role of this second part to the third part described below is somewhat similar to that of Chapter 2 to the remaining chapters in the first part, in the sense that both provide the foundations for the component design chapters that follow.

The third part of this book contains five chapters and is concerned with microwave circuit designs of components realized with those semiconductor devices described in Chapters 7 and 8. Chapter 9 by A.P.S. Khanna describes oscillator design. The first part of this chapter contains many standard concepts in modern oscillator design, including the negative resistance idea, stability circle and oscillation condition. Considerable pages are spent for dielectric resonator oscillators (DRO), a typical narrow band oscillator, YIG tuned oscillators and varactor tuned oscillators, examples of wideband tunable oscillators. A section on oscillator measurement is useful, particularly for students and less experienced engineers because treatment of an oscillator is somewhat different from that of an amplifier.

Chapter 10 by Bahl and Griffin deals with amplifier design, one of the most widely explored topics in recent history of microwave engineering. The approach is a standard one. However, the section on biasing networks is very useful as this important subject is often not described. The design of a power amplifier is well written. The authors emphasize the importance of considering both the device and circuit points of view. Inclusion of the section on power-combining techniques is very timely, though these several pages are not enough to cover this expanding field of engineering very extensively.

Chapter 11 by J. Irvine on detectors and mixers is suited for those who would like to understand the basic operating principle of detectors and mixers without spending too much time on this rather broad topic. The chapter provides many examples mainly in the form of equivalent circuits. Particularly for more complicated forms of mixers such as balanced mixers, physical realization of these equivalent circuits in usable mixers require certain degrees of experience. However, this is where engineering ingenuity can be demonstrated. This chapter is a first step to such an exciting endeavor.

Control devices such a switches, phase shifters, limiters and variable attenuators are treated in Chapter 12 by K.C. Gupta. These circuits treated in this chapter are made of PIN diodes and MESFET. The chapter first describes the equivalent circuit of these devices. Then each topic is introduced in the form of equivalent circuits. Chapter 13 by R.G. Harrison treats frequency multipliers and dividers. The former is one of the options to obtain a high frequency signal with a reasonable cost, as the direct generation of a high frequency signal becomes increasingly more difficult and costly. The frequency divider is used, among other applications, in important areas such as phase lock loops.

The fourth part treats the integrated circuits and is made up of two chapters. Chapter 14 is on computer-aided design and is written by K.C. Gupta. CAD is a useful tool for hybrid microwave

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BOOK REVIEW (continued from page 34)

integrated circuits. However, it is a virtual necessity for monolithic integrated circuits which do not permit easy post-production tweaking. Optimization techniques, an important topic for CAD, are discussed in this chapter. In addition to the linear small signal circuit design, the author presents CAD for nonlinear circuits, including the popular harmoic balance method.

Chapter 15 by M. Kumar and I.J. Bahl is on microwave integrated circuits. The authors clearly state that the microwave integrated circuits are the 'system on the chip' consisting of the devices and components described in earlier chapters. In fact, the content of this chapter is very system oriented. The authors start from the materials and the mask layout and fabrications and then describe hybrid microwave integrated circuits. Design considerations and examples are included. However, the forte of the authors is clearly in the section on monolithic microwave integrated circuits. The excitement of the authors heavily involved in the development of this state-of-the-art technology is felt in their writing. Many recent examples of monolithic integrated circuits are presented in this chapter. In addition, a very objective comparison of the hybrid versus monolithic integrated circuits is included.

The fifth, and last, part deals with more futuristic topics. In the opinion of this reviewer, the future of microwave technology is in some sense dependent on the successful implementation of the topics dealt with in Chapters 16 and 17. Chapter 16 by P. Wahi is on microwave optics, acoustic and magnetostatic circuits. This chapter reviews the state of the art of many concepts using the interactions of microwave, optics, acoustic waves and magnetostatic waves. Although most of the topics reviewed are in laboratory demonstration stages, it is important to nurture these technological developments. Chapter 17 by Bahl is a short summary of the book in the form of future predictions of microwave circuits in the areas of monolithic integrated circuits, microwave optical interactions, microwave acoustics and magnetostatic wave technology.

In the Preface, the editors mention that the book is intended for a senior or graduate level textbook. In the reviewer's opinion, this book would be a good choice for a laboratory-oriented microwave course. This is evident from the emphasis of the book which is clearly not theoretical. For this reason, this book, particularly chapters dealing with passive components and amplifiers, are suited for a senior level course. At the graduate level, it is desirable that the students take one or two courses which are more analysis and theory oriented before or at the same time they take a practical course based on this textbook. Students with such a background should expect to be in strong demand from industry, the prosperity of which is critically dependent on well educated and well trained professional students. In addition, this book is very useful for practical engineers particularly for those trying to get into the exciting areas of microwave integrated circuits. They can learn quickly from this book. Since each chapter is more or less independent, the book serves as a good source of reference. Those who need more detailed information can learn from the references listed at the end of each chapter. Finally, this book is an excellent textbook for a short course ranging from two to four days in duration and intended for practical engineers.

Reviewed by Dr. Tatsuo Itoh.

Tatsuo Itoh is Professor of Electrical Engineering at The University of Texas. He was Editor of *IEEE Transactions on Microwave Theory and Techniques* from 1983-85 and is currently AdCom Vice-President.

Communicating Under Stress

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Bill is about to present a report on his group's work to the president and other members of top management. Jim has just been promoted, and he's preparing to hold his first meeting with his new staff. Rachel's boss has just asked her to come in and give him a quick rundown on an idea she's been refining for weeks. These people have one thing in common: stage fright!

The meetings they're facing are not uncommon, especially for active, ambitious business people. But that doesn't mean they're not petrifying. Imagine—in a single encounter, you have to convince other people that you know what you're talking about, and that it's worth their time to listen! It's exactly like preparing to walk out onstage and immediately capture the attention of an unknown audience. If you're not superhuman, you're scared stiff.

All actors admit to stage fright. But the good ones know how to control it. The techniques they use are not limited to the theater. They work equally well in the conference room or the boss's office. Here are two that will help you quiet your fears and reach your 'audience'—no matter how formidable it may be.

Assume the role of authority

Before you go into any interview or meeting, take a moment alone. Then make these three statements quietly to yourself:

1. I know enough to present this well.
2. I believe in myself.
3. I believe in them (or him or her).

This is not theatrical witchcraft; it's basic psychology. You're using your conscious mind to calm your subconscious, which is at the moment sending out nervous tremors. You're replacing irrational fear with a sense of authority based on facts.

Statement 1 *is* true. If you didn't know enough, you wouldn't be in a position to talk to these people in the first place. Remind yourself that your message is important and that you are the best one to deliver it. As you start thinking about your subject, you'll stop worrying about yourself.

Say Statement 2 out loud. Repeat it over and over until you really believe it. You're using the conscious mind again, to convince the subconscious that the person it's running is a winner! Once you've convinced it, you will feel your confidence grow.

Do the same with Statement 3. Tell yourself firmly that the people to whom you are about to speak are good, honest, and fair. In so doing, you will make them respond well to you.

Psychologists have found that our response to other people depends greatly on *their* perception of us. If someone sees you as honest and good, you are likely to react in two ways. First, you will *feel* honest and good, and will behave decently to him. Second, you will tend to think of *the other person* as honest and good—and will treat him as such.

If, on the other hand, that person sees you as untrustworthy, you will consider him untrustworthy.

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COMMUNICATING (continued from page 35)

Trust and respect the people you are about to meet, and you can expect trust and respect from them, too.

Repeat the three statements two or three times, by yourself, until you feel calm and positive about the meeting. It won't take long.

Be deliberate

Quick, truncated speech and movements communicate nervousness. Even if you have achieved a confident calm, you may still have a habit of talking fast or moving jerkily. Your voice and gestures could then express a tension you don't feel. And your listeners will see you as nervous and unsure of your material. Or—you may still be a bit nervous! Either way, deliberate speech and movement will help you settle any remaining jitters and will communicate poise and control.

From now on, cultivate deliveration. You can do this easily in three steps:

1. *Speak more slowly and evenly in everyday conversations.* If possible, make a tape recording of yourself talking at home or with a friend. If you actually hear yourself talking in a hurried or staccato way, you'll be more determined to slow down!

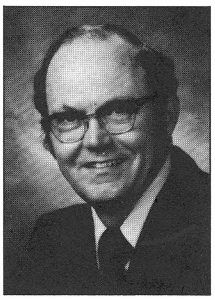
2. *Finish every gesture you make.* If you start to raise your hand, don't drop it midway. Raise it, and bring it back deliberately. Imagine that you are tracing a complete shape in the air.

3. *Replace nervous movements with expressions of calm.* If you find yourself drumming your fingers or tapping your foot, take a deep breath and smile. If the nervous jitters return, turn them into a small gesture that traces a whole shape.

When we're afraid, our thoughts and gestures tend to go out of control. These techniques will enable you to take charge of them and direct them to express confidence, discipline, and calm. In so doing, you will replace wild fears of failure with a quiet determination to communicate your message. And your audience will listen.

Cheryl Reimold is author of more than 100 articles and several books, including How To Write a Million-Dollar Memo *and* Being a Boss. *Her firm, PERC Communications, offers businesses in-house workshops and courses in communications, writing, negotiation, and creative problem solving. For information, please contact her at the address listed above.*

PCs for MTT



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SOME MISCELLANEOUS COMMENTS

Although the comments which follow are addressed to the 'MAC' aficionados, I think that there are enough of you now to justify their inclusion here.

Dr. Alfy Riddle, Avantek M/S M38, 481 Cottonwood Dr., Milpitas, CA 95035, (408) 943-7802

Accelerators: The *Levco Prodigy* boards work great, and I now recommend people get an SE so the installation is easier. I also have a *Radius* board at home, and although all the software I have runs fine on the *Radius* I believe the *Levco* product is better in both hardware and software (for example you may revert the Mac to a pure 68000 mode).

Mathematics: I am sure you have seen *Mathematica* by now. I am trying to get Avantek to buy it. Meanwhile I have enjoyed using *MatLab*. The version by QED Assoc [(805) 823-9459] in New Mexico is the most affordable ($50) but has the least macro capability. There are also versions by Puma software ($350) and of course Moler's MathWorks ($800).

Extend: A friend of mine has written some software that I use more and more. I have sent you a demo disk so you could try it. The program is basically a continuous system modeling program with a graphical interface. However, since this program includes a compiler and drawing program the user may create his own libraries of elements (with icons) to create factory models, microwave receivers, etc. The ease of building dialogs, buttons, spreadshseet tables and other user-friendly items has to be seen to be appreciated. Recently I took one of Maas mixer spur analysis programs and put it into Extend just because it was the fastest way to create an easy-to-use program. The compiler language is similar to C, but is object oriented. I copied an FFT routine written in C directly into it and only had to change the comments and the variable declarations. *(editor's comment: I have experimented a little with Extend, and it does look interesting. Perhaps Dr. Riddle will agree to provide a review in the near future).*

Programming: If you have not seen *FaceIt* (Dan Dampmeier FaceWare 1310 N. Broadway, Urbana, IL 61801), you should. It is by far the easiest way to take old FORTRAN code (or *ZBasic, LightspeedC,* et .) and add on a full screen text editor, graphics, menu support, printing support, spreadsheet windows. It is a bit crude to use, but it can save months by giving you a real Macintosh application in an afternoon.

FORTRAN: I sill have to use FORTRAN a lot at work. I have *MacFORTRAN* (Microsoft), *DCM MacTran77,* and *Language Systems FORTRAN.* Each has advantages, and all leave something to be desired. *MacFORTRAN* is supported by FaceIt, but has a painful interface when you change to a MacII or an accelerator card). *DCM MacTRAN* has evolved into a nice product. Its integrated environment has a source-level debugger, can call SANE or the 68881 directly, and can have code segments greater than 32K (very important for running VAX or mainframe code). The Language Systems *FORTRAN* runs under MPW and so has many tools available. It also has the best support of linking to to C or Pascal code. It cannot have code segments greater than 32K bytes. None of the FORTRAN compilers have a smooth interface to the Mac Toolbox.

HyperCard: I use this program to hold my references database, do basic math, and do graphic simulations for students (I teach at Santa Clara University). My references include the author(s), title, journal, data, a short description, and drawings if needed. HyperCard can do a complete search of all words in 1200 references (about 650K bytes) in 21 seconds. I hope the IEEE will put their CD ROM databases into *HyperCard.* I am working on an automated reference list generator such as is available from Refer on a UNIX system. *HyperCard* is also great for math and simulations. The interpreted language is slow, but very easy to use. You can also bring in compiled code (CXMDs).

Overall comments: *LightspeedC* is the best development system I have used. Bar none. Extend is my second favorite because it does the user interface and allows me to concentrate on the math. I also love using *HyperCard*—if it were faster at math and had engineering notation support it would probably be used 95% of the time.

continued on page 37

PCs FOR MTT (continued from page 36)

PCs Used to Factor 95-Digit Number!

The following press release was sent to me by Dr. Kosmos D. Tatalias of Atlantic Aerospace Electronics Corporation, 6404 Ivy Lane, Suite 300, Greenbelt, MD 20770-1406, (301) 220-1501 concerning a recent accomplishment in factoring large numbers reported by a friend from graduate school, Dr. W. R. Alford. Although we have become somewhat used to hearing about such things being done on mainframes, the factoring in this case was done using PCs.

"November 4, 1988
Athens, GA

At 8:05 PM on October 23, Dr. William R. Alford and Dr. Carl Pomerrance, mathematicians at the University of Georgia, factored a 95-digit number using Zenith personal computers. The number, the 95 digit cofactor of $2^{332} + 1$ and the 'third most wanted' number on the list kept by the Cunningham Project, is

43055904740291867153655783723852173273815964112247732907377829959694155032689325804961849144897

which has the factors

14767589550320172808742174828062347720350769

and

291554779434372111217344648262852905777597969213211 3

Dr. Alford programmed in assembler language a new variation of Dr. Pomerance's quadratic sieve factoring algorithm. The program used the Zenith microcomputers in the departments of Mathematics and Computer Science at the University of Georgia. His program incorporates highly sophisticated programming techniques designed to push the microcomputer to its ultimate performance.

This factorization is part of a continuing effort by mathematicians around the world to develop new and more powerful methods to factor large numbers. This result is most surprising because it was done on personal computers, the most humble machines in the computing world. Other recent results have been the factorization of a 92-digit number by a research group in Amsterdam, Holland using a NEC supercomputer and the factorization of 96- and a 100-digit numbers by a group in Palo Alto, CA using hundreds of computers (from workstations to supercomputers) around the world. All of these factorizations used Dr. Pomerance's algorithm, but without the new variation.

Factoring large numbers has been an area of intense research by mathematicians for centuries. It is presently important because of its relationship to code breaking. The recently developed RSA code allows the easy encoding of messages which impossible to decode without knowing how to factor a large number. Factoring results are used by business and government to break codes and to know how secure their own codes transmission are.

Dr. William R. Alford
Dr. Carl Pomerance
Department of Mathematics
University of Georgia
Athens, GA 30602
(404) 542-2591 or 542-2631 "

BUSINESS WEEK EXCERPTS

Eureka! Now there's a Laptop for the Blind

The February 8, 1988 issue of *Business Week*, page 88E has a story about a PC called Eureka that offers a synthesized voice that calls out the letter or number that is typed on a special braille keyboard. The $2,300 computers, from Robitron Pty. Ltd., a peripherals maker in Melbourne, Australia, runs software designed for IBM's PC and stores up to 300 pages of text. Eureka also contains a key-activated, built-in modem that automatically dials phone numbers. The Baltimore-based National Federation of the Blind was to have run an article on Eureka in April, 1988.

User-Friendly PCs for the Handicapped

In a similar vein, according to *Business Week* of February 22, 1988, page 154A, some 400 computer makers are stepping up efforts to eliminate barriers by developing machines for people with impaired vision or limited use of their arms. For example, IBM Special Needs Systems unit has introduced its first product, Screen Reader. It works on an IBM PS/2 computer and has a synthesized voice to speak words and numbers that appear on the computer's screen. The pitch or speed of the voice and other controls are available via a special18-key keyboard. The keyboard, software, and documentation were to be available in early 1988 at a price of $600, with the synthesizer separately priced at $250 or more.

Hearing Aid with Sound-Crunching Computer

Of the 17 million Americans hard of hearing, only about 20% wear hearing aids, partly because current hearing aids don't correct the problem for most people. Developed by Nicolet Instrument Corp. in Madison WI and the University of Wisconsin, the Phoenix is the first fully hearing aid to process sound with an attached, pocket-sized computer. The earpiece sends sounds it receives to the computer which converts it to digital format. The digitized sound in turn is enhanced and replayed through the earpiece. Aside from being claimed to more precisely 'break down' the sound than traditional hearing aids, Phoenix, priced at $1,800, also extends the low-frequency cutoff down to 200 Hz, a full octave lower than current aids. *Business Week*, December 21, 1987, page 110D.

Pattern Recognition a Crystal Ball?

Signal processing is specialty familiar to most EE's, even EMer's, but we'd normally associate that activity with such things as inverse scattering and target recognition. Now pattern recognition is finding a role in business. Software developer Raden Research Group Inc., a New York based company, claims that its Prism package helped an unidentified client double its money in US Treasury-bond futures in four months. The program uses past trading data to help identify the most important factors affecting futures prices. Hey, we (at LLNL) once used Prony's Method to analyze sunspot cycles and could fit past data really well. The future was (and is) another problem. This sounds like a problem for *neural* computing. *Business Week*, December 14, 1987, page 90H.

Keeping Computer Secrets Secret

It's long been recognized that computer circuits can emulate radio broadcast systems more closely than might be acceptable to some users, including not only the military but banks, insurance companies, and data-processing companies. By using what amounts to a remote VDT and a decoder, hackers can intercept stray emissions and display the information on their own terminal. DataProtek Inc. of Boca Raton, FL says it has a way to screen out these stray emissions with a plastic shell fitted with filters and metal wires that encloses the entire computer. Glass is used to cover the screen and the floppy disk-drive slots, and there is also a layer of plastic over the keyboard. Cost of the shield, about $700, is much less than that for 'Tempestizing' a PC the cost of which can be as much as $4,000. *Business Week*, February 29, 1988, page 74A.

continued on page 38

PCs FOR MTT (continued from page 37)

Socratic Computers for CAI

Computer-based instruction can be effective but it can also be a challenge to produce software that is *stimulating* rather than *boring*. Artificial intelligence researchers at Yale University are developing software that will teach by the Socratic method—a technique that encourages students to discover new knowledge on their own. When asking the program a specific question, rather than giving a direct reply it may instead 'lead you by the nose' through a question-and-answer session. A program for teaching biology to children starts by helping them to create their own animal. If a student starts with a cow's body but specifies larger ears, the program 'tells about rabbits and the value of big ears' according to Roger C. Schank, chairman of Yale's Computer Science Department. *Business Week*, March 7, 1988, page 121.

Are You Ready for Digital Paper?

We have come to expect the cost of mass storage to steadily decline, a phenomenon that has prevailed throughout the computer era. A recent advance in this area has been devised by Britain's Imperial Chemical Industries PLC, dubbed *digital paper,* which is really a new optical storage medium. It is claimed that digital paper will cut the cost of recording data to about 0.5¢ per megabyte of data, around 1/30 the cost of magnetic tape. The material is an inexpensive plastic film that comes in flexible sheets like paper, and stores data in much the same way used by optical disks, i.e. pits burned by a laser. In its current form, digital paper is a nonerasable medium. A cartridge-based storage device that uses digital paper is being developed with Utah-based Iomega Corp. CREO Products Inc., a Canadian startup, is building a storage drive using digital paper that will be able to record 1 terabyte of data. *Business Week,* March 14, 1988, page 92K.

How About Robot Surgeons?

Since the days of writer Jules Verne and the *Flash Gordon* comic strip, we have looked forward to the time when robots would take over those tasks we humans find onerous and thereby free us for more lofty pursuits. One of the more intriguing job assignments developing for robots is that of surgical assistant, specifically to help in hip operations. The 120,000 hip replacements which are performed in the U.S. each year substitute a patient's natural hip joint with a metal and plastic implant. But the prosthesis requires precise fitting to a matching cavity in the bone for maximum strength. The robot, using three pins placed in the hipbone for registration, forms a computerized 3D model using CAT scans. From this, it determines the optimal size, shape, and location of the implant and its cavity, and uses this data to guide a milling machine to cut the artificial joint from a piece of steel. Finally, the robot uses the pins to orient its drilling the cavity into the bone. There is potential for robotic assistance on the head and neck as well. Sounds good so far, but watch out for software bugs! *Business Week,* March 21, 1988, p. 151.

Teaching PCs to Read

It's not a lot of fun typing programs, documents, etc. into a terminal, especially when that labor has already been invested putting that information into printed form. Text scanners have been around for awhile, but not a price affordable to the average PC owner. As an indication that a fix to this particular problem is on the way, Calera Recognition Systems Inc. in Santa Clara, CA, has introduced equipment that gives desktops full-blow text-recognition capabilities. Calera's solution uses their TrueScan plug-in card equipped with microprocessors to interpret the signals from an inexpensive scanner. The scanner recognizes any font and translates the printed text into binary form (presumably ASCI). There is even special software that automatically formats the information being scanned for such programs as Lotus 1-2-3. The retail prices for two versions of the board are $2,495 and $3,495. *Business Week,* October 3, 1988, p. 122E.

Intersocietal Relations

by Ferdo Ivanek, Coordinator

At the January 10-11, 1989 AdCom meeting in Long Beach we reported on recent progress of our activities and on plans for more intensive MTT-S involvement. Intersocietal relations are of increasing importance in view of IEEE's growing influence on developments of vital interest to the MTT-S membership. This calls for more active involvement than we had in the past.

We concluded that MTT-S' past involvement in IEEE intersocietal relations was uneven. It ranged from active in a few areas to marginal in other areas. We therefore proposed to strengthen MTT-S' intersocietal activities in the following way:

- Sharpen focus on areas of primary interest to membership.
- Involve a greater number of interested members.

The implementation is proposed with the following action items:

- Strengthen MTT-S representation on committees of primary interest.
- Organize groups of interested MTT-S members to address the major issues and to support the work of the appointed society representatives.
- Identify commonalities between the issues before the various IEEE committees on which the MTT-S is represented and coordinate the activities of our representatives.

The AdCom agreed with the proposed strategy and implementation plan. We are pleased to report progress in strengthening the MTT-S representation in several areas. Some of the changes and additions made after the January 1989 AdCom meeting have already been shown in the table on page 57 of the Number 123 Newsletter. The table (top right) includes the most recent changes and additions (in boldface type).

I would like to point out that we not only found highly qualified replacements for those who were unable to continue, but were also able to add alternates on some committees. While there is more to be done in strengthening the MTT-S representation, we are already in a strong enough position to start implementing the other two action items listed above.

I had preliminary discussions with some of our representatives about involving a greater number of interested members and there is clear consensus that this is highly desirable and should be implemented at the earliest possible time. This opinion is shared by those of our past representatives who recently resigned due to other commitments that had to take precedence. All of them agreed to help their successor in any possible way when needed. In this sense they are the first to join the groups we want to form around our appointed representatives.

I invite all representatives to take the initiative in seeking out individual members who are interested in the particular IEEE committee issue(s) and are ready to contribute toward the solution. I also invite all interested individuals to contact the MTT-S representative whom they would be ready to help. If you are interested in an IEEE issue but are unclear about which committee

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INTERSOCIETAL RELATIONS (continued from page 38)

IEEE Board	Committee or Council	Representative
Educational Activities Board	Technical Activities Advisory Committee (EAB-TAAC)	R. Kagiwada
Standards Board	Standards Coordinating Committee	E. Belohoubek
	Standards Coordinating Committee on Non-Ionizing Radiation	J. Osepchuk **D. Paul**
Technical Activities Board		V. Gelnovatch (ex officio)
	Solid-State Circuits Council (SSCC)	P. Greiling V. Gelnovatch
	Steering Committee of the Journal of Lightwave Technology (JLT)	N. Dietrich **P. Stabile**
United States Activities (USA)	Aerospace R&D Committee	W. Brown **S. Okwit**
	Committee on Communications and Information Policy (CCIP)	F. Ivanek
	Defense R&D Committee	D.N. McQuiddy, Jr. G. Thoren
	Energy Committee	W. Brown
	Engineering R&D Committee	H. Sobol R. Gutman
	Health Care Engineering Policy Committee	K. Carr
	Committee on Man and Radiation	**R. Petersen**
	Professional Activities Council for Engineers (PACE)	L. Medgyesi-Mitschang R. Moore

deals with it, do not hesitate to contact me. I may not have a ready answer, but should be able to find out for you and refer you to the corresponding MTT-S representative.

In addition to contacts by mail or over the telephone I suggest personal contacts during the forthcoming Symposium in Long Beach. I was thinking even of organizing a meeting of MTT-S representatives and other interested members, but I gave up on this idea. There are already too many meetings scheduled during that week and I am not convinced that we do need a separate meeting. It is the opportunity for personal contacts that counts. If really needed, we should have no difficulty improvising a meeting on the spot. However, I am ready to accommodate convincing proposals in a more organized way, and I may be in a position to make the necessary meeting arrangements if I hear from you sufficiently in advance of the Symposium.

The third action item, namely that of identifying commonalities and coordinating the activities of MTT-S representatives, requires more space than I can afford this time. I leave it for the next issue of the Newsletter, but I would like to mention that we started discussing it and expect some progress during this year. Please let me know if you have specific proposals for consideration at this time.

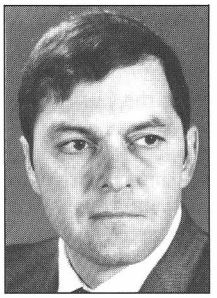
☐ **After a business trip,** arrange to spend time alone with each family member. *Benefit:* This demonstrates that, despite your need to travel, you still want to be close to them. Travel is only one part of the frequent traveler's life—and is not an excuse to exempt yourself from participating in family activities.

The Phantom Spouse: Helping You and Your Family Survive Business Travel or Relocation by Denise V. Lang Dodd, Mead & Co., 6 Ram Ridge Rd., Spring Valley, NY 10977. $17.95.

☐ **Nonskid socks for toddlers** are expensive. *Cheaper alternative:* Draw several stripes on the bottom of each sock with a *plastic pen* used to draw on tee-shirts. The resulting raised design serve as a de-skidder...at a fraction of the cost of new nonskid socks.

Francine Gonzalez, Council Bluffs, IA, writing in *Parents*, 685 Third Ave., New York, 10164. Monthly. $20 yr.

TAB Highlights



by Vladimir G. Gelnovatch
President, MTT-S
Administrative Committee

The 1989 winter TAB meeting was held in Washington, DC on February 18-20. The format of the meeting was slightly changed from previous meetings with the goal of spending more time for informal working/discussion sessions and less time for formal business. Clearly this is aimed at eliciting more response from the IEEE constituency. The first day was devoted to a TAB publications workshop, the second to a Society Presidents' Workshop and Presidents' Forum, the third to TAB business/OpCom meeting. Topics developed during the first and second day could be brought to action on the third.

The Society Presidents' Workshop produced a number of topics which were of importance to most societies. After careful consideration these were pruned down to five subjects:

(1) Chapter Initiatives
(2) Administrative Services
(3) Small Societies
(4) Transnational (International) Activities
(5) Division Vitality

Intensive breakout sessions were held on each of the above topics and various action items generated. The undersigned participated in the Transnational Session since this topic is so germane to MTT-S AdCom's initiative this year to produce a global growth plan (MTT-2000). It was noted that only 20% of the IEEE membership is from outside the United States. Attempts at establishing IEEE representation outside the United States have run into conflict with local societies. The problem appears to be on two levels, technical and professional. Since the IEEE within the United States offers both levels to U.S. IEEE members, it could directly compete with the non-U.S. societies which are usually professional services only. The conclusion to this paradox is to offer national professional societies only the IEEE technical services and not compete on the professional services level. Another conclusion was the establishment of offices overseas. The Computer Society already has an office in Brussels and Tokyo, and it seems to be working in increasing non-U.S. membership. The question whether this should be done on a society level or IEEE level was never quite answered. Finally, local non-U.S. conferences should be encouraged and major Society Symposia should be held outside the United States as frequently as possible.

The Society Presidents' Forum followed the Workshops. As in previous years it was only open to Society presidents and strictly informal. Approximately a dozen motions were drafted to be introduced at the TAB business meeting. These motions were the outgrowth of issues brought out at the workshops. The following motions, from the Presidents' Forum passed successfully at the TAB business meeting: A) Training sessions (video tapes) by HQ personnel to orientate new society officers, B) Creation of a staff function to help societies with conference budget management, C) Establishment of E-mail between HQ and society officers, D) Establishement of IEEE offices outside the United States, and E) Establishment of an ad hoc committee to increase non-U.S. participation.

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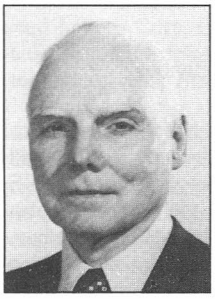
TAB HIGHLIGHTS (continued from page 39)

The TAB business meeting followed the two previous events and approved a number of other non-society president introduced motions in addition to the ones already mentioned above. Specifically, the EAB will be reorganized and reduced in size from 51 to 17 members. They had generated huge deficits over the 21 years of their existence and it was felt that their functions were disfranchised from society constituency. A motion was passed which encourages TAB to cooperate more with the building construciton industry. The rationale was that this industry continues to embrace electronic disciplines to help them with their profession and could use our help. A motion to make mandatory travel expense allowances for location specific awards went back to committee for re-drafting. Finally, the Acoustics, Speech and Signal Processing Society asked to change their name to just Signal Processing Society. There was a consensus that most presidents wanted to take this change back to their respective AdCom's and the motion was tabled for the June TAB meeting in San Francisco.

The IEEE Aerospace Research and Development Committee



by William C. Brown
MTT-S Delegate Member

The Aerospace Research and Development Committee is a committee of the IEEE United States Activities Board (USAB). Its charter is 'to develop and disseminate positions on aerospace research and development policies and programs in the United States within the scope of, or affecting, IEEE technical expertise.' Its membership consists of delegates from the IEEE Groups, Societies, Regions, Divisions or Boards as well as members at-large.

Microwaves permeate so many aerospace activity areas such as communications, radar, microwave sensing of the Earth and atmosphere, microwave beamed power transmission, etc., that there are many areas of mutual interest between the membership of the MTT-S and the Aerospace R&D Committee. Communications is obviously an important area and, in fact, has dominated the interests of the committee for the past two years. Such space applications as the Advanced Communications Technology Satellite, known by its acronymn as 'ACTS' have been reviewed by the committee.

Membership in the IEEE Aerospace R&D Committee presents an opportunity to discuss and give visibility to important but overlooked areas of aerospace electronic technology that could have a major impact upon the future development of space. Currently the Committee is reviewing the combining of electric propulsion with microwave technology to see if it cannot break an important barrier to the future development of space: the high cost of transportation from low earth orbit to geosynchronous orbit and beyond. The currently used chemical rocket propulsion requires that very large amounts of propellant be brought from Earth to low earth orbit to place a small payload into geosynchronous orbit. An expedition to Mars requires extensive tank farms for the cryogenic storage of propellants that would represent at least twenty payloads for the current shuttle.

Electric propulsion accelerates mass to velocities that may be ten to twenty times that of chemical propulsion, reducing the mass of propellant required for a given thrust by that factor. However, the advantages of electric propulsion may be nullified by the high mass of the electric power sources that must be carried along for the electric thrusters. For example, the projected mass of the nuclear power source now under development is 30 times the mass of the ion thrusters themselves.

Beamed power transmission, in principle either by laser or microwaves, may be a solution to the power source problem. Beam power technology was recently reviewed in early March 1989 in a three-day workshop on beam technology at NASA's Langley Research Center, that reflects the growing interest in beam power technology. Although laser receptor technology as a power source is still in its very early development phase, microwave technology has produced a receptor carried on board the space vehicle called the 'rectenna' that intercepts the microwave beam and converts it to DC power with a mass that matches that of the ion thruster, each either creating or consuming a kilowatt of power for each kilogram of its own mass. The rectenna captures the incident microwave energy and converts it to DC power with an overall efficiency of 85% so that no cooling other than direct passive radiation into space is required.

For the first time, then, it is possible to think in terms of low cost transportation between low earth orbit to geosynchronous orbit which is a choice area of space real estate for communication satellites and future space developments such as the Solar Power Satellite that converts the sun's energy to microwaves in geosynchronous orbit and forms it into a beam for transporting the energy to earth.

The sources for the electronically steered microwave beams that track the interorbital vehicle on its upward spiralling trajectory are located on the equator to maximize the dwell time between the microwave beams and the vehicle while it is in low earth orbit. This location adds an international aspect to the use of beamed microwave power and also suggests using such beams to power 'Orbiting Industrial Parks' in low earth orbit, therewith creating an equatorial beltway of space industry as well as a gateway to deeper space.

All done by microwaves! Fascinating, isn't it? But this is an example, albeit not a typical one, of the kinds of things that come before the Aerospace R&D Committee, and upon which it will eventually base a position and take some action.

Your fitness

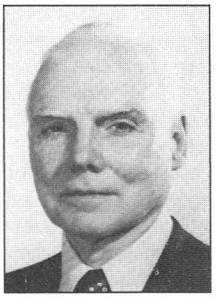
☐**Foods to avoid before exercise:** Foods high in fat or protein (cause cramping and bloating)...sugary drinks, within one hour before exercise (can impair muscle performance)...alcoholic beverages (impair coordination and judgment and promote urination, which increases dehydration).

Cooking Light, 820 Shades Creek Pkwy., Birmingham, AL 35209. Six issues. $12/yr.

☐ **Stretching cold muscles** before you exercise can injure them. *Better:* Warm up before *any* type of exercise to gradually increase your heart rate and blood flow, which raises the temperature of muscles and improves muscular function. *Recommended:* Warm up for five to 10 minutes before you stretch by doing a slightly less vigorous rehearsal of the activity you intend to perform. *Sign of adequate warm up:* A light sweat. *Also important:* Cooling down after exercise, which reduces muscle stiffness and prevents blood pressure from abruptly dropping. Gradually slow down as you jog, swim or pedal a final lap...or stretch gently for five to 10 minutes.

University of California, Berkeley Wellness Letter, 632 Broadway, New York 10012. Monthly. $15/yr.

IEEE Energy Committee



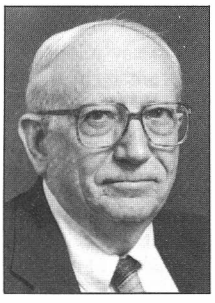
by William C. Brown
Representative

The IEEE Energy Committee has a charter and objectives in the energy area that is similar to the Aerospace R&D Committee in the aerospace area. Its basic concern is, of course, large amounts of energy for use on earth. But this energy can be of many kinds such as the fossil fuels of coal, oil, and gas; electric power from various fuel sources; renewable energy sources such as hydropower, solar energy, etc. As would be expected the committee was originally dominated by representatives from the electric power industry but it has gradually expanded its energy interests to include solar and other renewable resources.

A representative from the MTT-S to such a group would seem unlikely but the MTT-S Society's involvement resulted from a position statement prepared on the concept of the Solar Power Satellite in the late 1970's. The Energy Committee obviously needed some microwave expertise within its group to evaluate the microwave beam subsystem of the Solar Power satellite concept, and your delegate was appointed to the Energy Committee for that purpose. Eventually a Subcommittee on Space Power was created which has a broader charter than power generated in space for use on earth, and last year the Subcommittee arranged for a briefing of the Committee by individuals that represented several aspects of space generated power including space nuclear power sources.

Because of the various problems that currently-used methods to generate electrical power introduce in the form of enhanced greenhouse effect from CO_2 emissions and perceived danger of nuclear radiation, the attitude of the energy Committee toward alternate sources of electric power is growing more positive.

Periodicals Committee Report



by Chester L. Smith
Division IV Representative

The Technical Activities Board is rearranging some of their committees, the Periodicals Committee being one of them. The Division Representatives will be members of the IEEE Publications Board (PUB) the Periodicals Committee (PC) and the Society Publications Committee (SPC) will be merged into one working group of the 'PUB.' What all this comes down to is that the current one-day stands at IEEE Headquarters will now be two-day meetings instead. Perhaps a side effect will be that my reports to the Division IV Societies may be somewhat longer.

Page Charges in Transactions

There has been some dissatisfaction with the current formula for charges to the Societies based on the page counts. The contention being that the current formula tends to favor the smaller societies over those that have a heavier paper load. The combined PC/SPC group recommends a review by the finance people and TAB.

Transactions Technical Content

Both PC and SPC have a line in their respective charters requiring them to assue that the papers and the technical materials in IEEE Journals/Transactions/Letters and Magazines are of " 'quality' and that 'adequate' standards are maintained" and where, in the opinion of these committees something has fallen down to recommend to TAB an 'appropriate action.' There was a lively discussion of the relative differences in material published in the largely non-archival Newsletters and the more permanent materials such as Conference records, Magazines, Transactions, and now, of course, Technical Letters.

The concensus of the Committee was that there are about four levels of discrimination within this set of publications. Newsletters are just that, news of the doings of the Society including announcements of events, of outings, awards and an occasional paper of a non-archival nature. Conference records are somewhat intermediate in that there may be some review before a paper is accepted, but conference papers do not, nor indeed should not receive the detailed and agonizing scrutiny of the more formal published material. Conference records are, however, catalogued and are offered for sale through IEEE Services in Piscataway, NJ. Articles in magazines are expected to be screened by an editorial board which is then responsible for the technical content. Also, magazine editors are free to solicit and pay for material, if need be, and to seek advertising in support of the publication. Transactions papers are expected to receive a full and careful peer review by experts knowledgeable in the technical area of the paper. The Publications Board was somewhat upset when three pages of picnic photographs appeared in a recent issue of the Transactions of one of the Societies.

Since what constitutes 'Transaction worthy' material is somewhat subjective, considerable time was spent trying to draft language that would convey what was wanted without either being too restrictive and legalistic or so loose that almost anything could go. In general, the Technical Activities Board will be asked to implement a policy where material clearly of a conference record-type would not be allowed under the cover of a Transactions. In addition to the review there was the question of appearance. Transaction papers are to be in the same formatting as the current typeset material so that all the Transactions of the IEEE are uniform in appearance, paper quality and the like. The Transactions are the premier publications of the Insitute and the sense of the committees is that uniform standards must be imposed.

One topic that received considerable airing was that of a worthwhile paper appearing first in a Conference Record and being republished in a transaction. This would be permissable if the paper were subjected to the full peer review subsequent to the conference but before being published. Naturally, the same paper should not be published simultaneously in two different Transactions and joint issues between two societies are not allowed as this creates some hard feelings among librarians who feel they have been made to buy the same material twice.

continued on page 42

PERIODICALS COMMITTEE REPORT

(continued from page 41)

This whole area is an on-going subject for discussion and debate and while consensus on some points have been worked through, mostly the 'jury is still out' and inputs from the societies and individual members would be most welcome.

New Publications

The request of the Antennas and Propagation Society to begin publication of *The IEEE Antennas and Propagation Magazine* with the January 1990 issue was approved. The A&P Magazine will be published six times per year. There were some questions concerning the mechanics of the operation raised and these will be worked with the A&P Society and the Division IV Director. W. Ross Stone is to be the editor.

Another magazine, *The IEEE Lightwave Communication Systems Magazine* will also begin publication in January 1990 on the same schedule. This magazine, edited by Stewart Personick of Bell Communications, will deal with applications for lightwave technology in communications systems and networks.

The committee received a request to approve a new trans-society Transaction on Neural networks. This will be something new in that some ten societies will be sponsoring these transactions, but not as a society of any one origin. The reason for this is that network investigations are underway in a number of societies with differing objectives, but there does not seem to be sufficient cohesion in the field to form a special IEEE Society specifically on this subject and the individual sponsoring societies are comfortable with the arrangement.

Future Meetings

The next two meetings of the publications Board have been set for May 1 and 2 and the 16th and 18th of September.

The Changing Demographics — Its Impact

by Betty M. Vetter
Executive Director
Commission on Professionals in Science and Technology
Washington, D.C.

(Ed. note: The following is the first of two excerpts from an address by Ms. Vetter to the National PACE conference held in Phoenix, September 3, 1989. The full text of the address is available from Louis Medgyesi-Mitschang, MTT PACE representative.)

At the outset, let me state that I do not know, any more than you do, whether the 1990s will be a period of shortage, surplus, or balance of engineers in respect to available engineering jobs. There are too many unknowns in the equation for forecasting the future, ... What I am sure of is that there will be fewer engineering graduates coming out of school for at least the next decade and a half than we had in the middle 1980s; and that the long period of relative balance between the supply of engineers and the demand for their services will end.

Over the decade from 1975 to 1985, the number of bachelor's graduates in engineering doubled, including a ten-fold increase in the number of women graduates and a tripling of graduates from the underrepresented minority groups. the number of foreign graduates also doubled, at all three degree levels. Of course, we must keep in mind that we're double counting all the women who are either foreign or minority. There is no indication that the quality fo engineering graduates dropped as these changes occurred.

Electrical/electronic engineering grew by leaps and bounds over the decade. Even in 1975, more bachelors degrees were awarded in EE than in any other field, and by 1987, one third of all engineering degrees were in this specialty. Because the number is still climbing in this field, while dropping for engineering overall, we cannot yet anticipate for sure when EE degrees will stop growing. However, 1987 may have been the peak.

The excellent job market for new graduates in engineering throughout most of the decade attracted an increasing proportion of the college population, so that by 1985, almost eight percent of all bachelor's graduates earned their degree in engineering, ... However, by 1986, all of the numbers and most of the percentages had turned downward. The college age population peaked in 1983. The proportion of all bachelor's degrees that were in engineering started down in 1986.

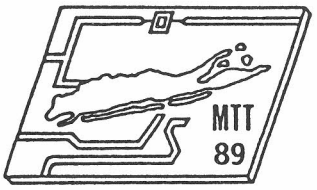
The size of the college age population will continue to shrink in most of the years through 1996, for a total drop of about 25 percent, and then hold about at that level until about 2005 before starting up again. More immigration might increase the group faster.

Declining interest in engineering and in computer science among college students of both sexes also has been reported for the past 5 years in the annual study of American freshman, carried out by UCLA and the American Council on Education. Student interest did not move to any other science field - it did move to business.

Why are American students of both sexes and including all non-Asian racial and ethnic groups showing less interest in engineering and computer science than they did a few years ago? Obviously a first reason is the decline in job offers to graduates that has occurred over the past three years. Freshmen react to the current job market, even though they will graduate into a different job market four years later. The next large rise in demand for engineering graduates will undoubtedly coincide with a trough in engineering degree production as it has so many times in the past. American industry never seems to worry much about that, in advance.

Finally, a word about the freshman class in the year 2000. These children, born in 1982, have just finished first grade. 24% of them live below the poverty line. 12% have physical or emotional handicaps. 8% do not yet speak English. More than half will live in a one-parent home before they graduate from high school. Only 35% of them are white, non-Hispanic boys. They are the PhD class of 2012, and the age cohort is just 14% smaller than for the PhD class of 1987.

Will we need more engineers and scientists, to say nothing of physicians and teachers and philosophers, than we are likely to produce over the next few decades if we just let nature take its course? I do not know. But I do know that we will not have the best technological workforce we could have if we don't utilize more of the talent that resides in the growing 65% of the college age population that is not white and male. If America is to recover its technological leadership, or even maintain technological competitiveness in today's world, it must utilize the talent of all of its citizens as well as its immigrants.



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