IEEE SOCIETY ON
MICROWAVE THEORY
AND TECHNIQUES

NEWSLETTER

Number 120
Winter 1988

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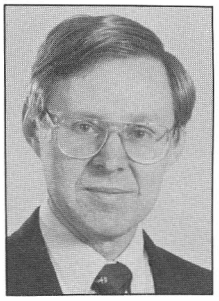
EDITOR'S NOTES



by Peter W. Staecker

Here it is, time to throw out your old MTT Committee Directory, and replace it with a new one. New Fellows, MTT Awards recipients, Chapter Chairpersons, newly-elected AdCom Officers and Members, and new MTT members, congratulations, and welcome! I am writing this after the January TPC and AdCom meeting, and pass on my assurances that this year's Symposium in New York in June will be a great one. This observation is made as much from the quality of the papers I observed as by the nervousness of Chuch Buntschuh, who has compiled a pile of articles to introduce you to this year's activities in the Big Apple. My memories of a TPC luncheon conversation in January 1983 are still strong, when Chuck was soliciting advice on the perils of assuming the position of chairman of the Symposium Committee. Too late now, buddy.

Without preempting any of Walt Gelnovatch's future columns on AdCom Highlights, I think I can report this tidbit of the January meeting: A straw poll conducted to determine the sense of AdCom on the subject of low-calorie meals served during meetings was passed, (unanimously, I think). It should be noted that the vote was taken *after* lunch.

This issue includes the second and final part of the survey article on Noise by Hank Paczkowski and Jim Whelehan, and represents a very large effort on their part. Cheryl Reimold discusses integrity in personal communications in her article, which is of interest to anyone who talks, and Bill Brown reports in some more technical detail on the successful experiment conducted by the Canadians on microwave-powered flight, an event which was covered recently in **Newsweek.**

Last year the Newsletter cost approximately $6.50 per member (As a reference point, the Transactions costs $19.50). We are looking at ways to hold these costs constant, and have begun by asking other newsletter editors what their production costs are. So far, the best solution seems to be to control the number of pages.

Finally, the news you have all been waiting for, the results from the **Yearly Transactions Index Questionnaire** are in. With 11 replies to an obviously lukewarm topic, the distribution is as follows:

European Microwave Conference:	9
Cornell Conference:	5
GaAs IC Conference:	5
Infrared and MM Wave Conference:	3
ISSCC:	1
International Symposium on Circuits and Systems:	1

LETTERS

The response from RadLab Alumni to the article in the Fall MTT Newsletter was gratifying, and prompts the necessity for this column. I have taken the liberty of printing the following letters, because I wanted to share with you the enthusiasm and vigor of these people as the 50th anniversary of their organization approaches. I would also like to acknowledge letters from Harold Fleischer, Ivan Getting, Dorothy Gillette, Raymond B. Montgomery, Bill Schwann, Woody Strandberg, Henry Torrey, and Harold Webster, and telephone calls from Warren Henry, Bill Kelly, and Anne Pettingill Satterfield with information about colleagues.

"It's a long way to 1991 but it's not too early to get together people that might be "still around" at that time. I think the video interviews are great. Don't forget to get Rabi, Ed Purcell and particularly those who participated in the President's Scientific Advisory activity which I think was almost two decades a wonderful distillation of tactics learned in the radar days."

Britton Chance

"Thank you for the notice about MTT-S' plan for celebrating the 50th anniversary of the founding of the MIT Rad Lab. I will be happy to assist in any way I can."

Donald G. Fink

"I just got back from Georgia and have taken a quick look at your invitation to participate in a reunion of the MIT Rad Lab in 1991. I expect to be around then and would like to help you make this a fun thing for the survivors and perhaps more ???"

W.A. Higinbotham

"Thank you for your letter concerning the proposed 50th anniversary celebration of the MIT Rad Lab. I must admire your advanced planning efforts, and hope that I - and others - will be able to make the trip to Boston in 1991. I have added a couple of sheets with corrections or additions for your list of Rad Lab personnel. It occurs to me that your list may have derived from those who visited at the first reunion, and it seems to me that other addresses were available then, including people who were unable to attend. Perhaps such a list could be found."

Morgan A. Gunst, Jr.

continued on page 3

LETTERS (continued from page 2)

"Thank you for your article about the Rad Lab anniversary celebration. I look forward to it. Please let me know if there is any intention to compile a list, perhaps with at least group identification, of people who have died since 1945. I could furnish at least a partial list for Division 11, if it should be wanted."

J.A. Pierce

"I was happy to receive your letter concerning the 50th Anniversary celebration of the MIT Rad Lab in 1991. There are matters concerning two people that I want to call to your attention.

E.G. Bowen - doubt that this Australian address is correct. True, he went to Australia after the War but did not stay long. I met him at the MIT Faculty Club in the 1950's and assumed that he was visiting USA. But at the 30th Anniversary of Rad Lab he told me that he had been a U.S. Citizen for 25 years. He was then living near Washington D.C. Somebody at MIT must know his present address.

Edward ("Taffy") Bowen was a great guy. It was he who brought the British magnetron in a suitcase to Bell Labs. He sailed from England and his ship was not torpedoed!

There is a serious omission:
Denis M. Robinson
19 Orindo Avenue
Arlington, MA 02174

Dr. Robinson was the British liaison officer RL41-45. It was from him - or through him - as well as from E.G. Bowen that Dr. Guerlac got a great deal of information for the early history of British radar. He went to England in 1945 and returned to U.S.A.

I look forward to the 1991 MTT-S International Microwave Symposium."

Helen L. Thomas

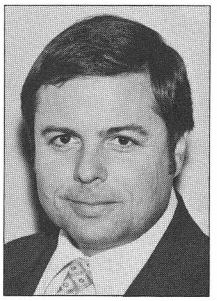
—see book review on pg. 54 on Guerlac's work—Ed.

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.

OUTGOING PRESIDENT'S REPORT



by David N. McQuiddy

It has become a tradition that the outgoing president be provided the opportunity to describe from his perspective the events that took place during his watch. As I look back over the events of 1987, I find that the accomplishments can be attributed to the hard work of a number of Society members and the tasks not completed to lack of action and/or direction on my part. Viewing the past year in retrospect, is is much clearer how the resources of our Society could have been better managed to attain its goals and objectives.

Our financial reserve exceeded 1M dollars for the first time in February 1987. This accomplishment is the result of the hard work of past Symposium Local Steering Committees, the support of the Microwave Industry, and the fiscal responsibility exercised by the AdCom. A more formal budgeting process was initiated in 1987 with the seven AdCom Committees Chairmen actively involved. The 1988 MTT-S budget is the first forecast of income and expenditures to be established by the AdCom members responsible for their control. This represents a good start; however, additional effort is required to arrive at the optimum budgeting process to support our needs.

The Membership Services Committee has continued to emphasize membership growth. Their efforts have been rewarded this year as our Society has achieved the highest growth rate among the 36 Societies and Councils of the IEEE. Our membership reached the 10,000 member level in October for the first time ever and the year ended with 10,578 individuals on the roles representing a 12% growth for the full year.

The AdCom formally approved a plan to recognize the 100th anniversary of Hertz's experiments into the nature of electromagnetic waves. An exhibit, using full scale replicas of Hertz's original experimental apparatus, will be on display at the 1988 International Microwavve Symposium. The IEEE Life Member Foundation, MTT-S, and the Microwave Industry have all contributed financially to make this exhibit possible.

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PRESIDENT'S REPORT (continued from page 3)

Merit Scholarships have been established by MTT-S for the children of MTT-S members. Two awards for $1,000 each were awarded in 1987, and one 1986 award for $2,500 was continued for another year. Scholarships for 1988 are being processed through the Citizens Scholarships. Foundation of America, the new plan administrator. Thus far, seven applications have been received for the two awards to be made next year. Also, two graduate fellowships, each for $10,000, and one grant-in-aid for $10,000 were awarded in 1986 by MTT-S Ad-Com.

A plan to define the role our Society should play in the formation and direction of a Microwave Industry Trade Association was not completed. This task remains as one that should receive serious attention by AdCom during the new year. Independent action in this arena has already surfaced as a group has recently formed in New Jersey to explore the creation of this type of association.

Steve March has completed three consucutive three year terms on AdCom, the maximum allowed by our By-Laws. His service as Newsletter Editor and Treasurer involved a significant commitment of time and effort and was accomplished in a commendable manner. In addition, his duties as the 1987 International Microwave Symposium Steering Committee Chairman required almost a full time effort during those months prior to the Symposium. The outstanding success of the Symposium was in no small measure a result of Steve's dedication. His contributions to our Society are certainly appreciated.

A new year has begun and the responsibilities of the office of MTT-S President are in the able hands of Barry Spielman. I am grateful to all of you who have served MTT-S during 1987 and helped to make it another good year in the life of our Society.

for your home

Fix a small appliance only if the repair bill will be less than *one-third* the original cost of the item. Otherwise, it's usually cheaper to buy a new one. *Major appliances:* Pay for a repair if it is less than *half* the original cost.

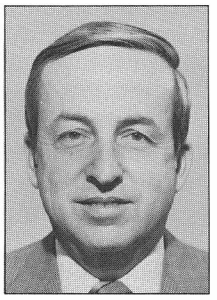
John S. McDermott, executive vice president, The National Appliance Service Association.

To prevent a lightbulb from sticking in a socket, spray a *light* coat of silicone lubricant on the base of the bulb before screwing it in.

Rust spots on tubs can often be removed with Naval Jelly. Let the jelly sit on the spot. Then scrub hard with a pumice stone.

Rodale's Practical Homeowner, 33 E. Minor St., Emmaus, PA 18098. Nine issues $9.97/yr.

DIVISION IV DIRECTOR'S REPORT



by Gary A. Thiele

The Board of Directors of the IEEE met for two days in Orlando, November 22 and 23. There are a number of items I would like to report to you.

IEEE Elections

The Board, taking note of the members' majority vote for the proposed constitutional amendment, debated at length the number of candidates to put up for President-elect and Vice-President in 1988, and how best to do so. As a result of this debate, the Board voted to use approval voting in 1988. In a certain sense, this is a new concept in voting procedure, although it is presently used by a half dozen or so states. Approval voting means that you can vote for as many, or as few, candidates as you approve of. For example, there will be three candidates for Executive Vice-President in 1988. Under approval voting you could vote for zero, one, two or three candidates. Obviously voting for all three would have the same effect as voting for zero. Thus, the real voter decision is whether to vote for one or two. Either choice is a valid vote (which makes this a friendly change in voting procedure).

After hearing testimony from an outside expert in voting procedures, the Board decided to use approval voting in 1988 since approval voting provides the best way for the majority view to prevail in contests were there are three or more candidates without the need for expensive run off elections. Additionally, it is a procedural change that will not result in an increase in invalid ballots.

Approval voting will be sort of an experiment in 1988 to see how well it works, how well the members like it, and to see if it will generate increased interest in the elections as evidenced by the number of ballots cast. Please give it a try, and after you have done so, let us know how you like it.

Fellow nominations

I would like next to say a few words about Fellow nominations. The Board approved 200 Fellow nominations out of 361 nominated. This is larger percentage than the usual 35-40% that are approved. This reflects an attempt by the Fellows Committee to open up the Fellow process to practitioners as well as to research

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DIRECTOR'S REPORT (continued from page 4)
oriented nominations. This is a good news. The bad news is that the 361 nominations for 1987 is down from 403 the previous year. There is a lot more talent out there than that! I hope to see the number of nominations improve this year. Nominators should be aware that 64% of all nominations ultimately make it on the second or third try. So, don't give up after the first round! Make the nomination stronger and put it back in. Also nominators, you should contact potential references, not the nominee. In the last several years I have been contacted four times by nominees asking if I would be a reference. While that may be normal practice in some situations, it is not the correct practice for Fellow nominations.

Follow-up

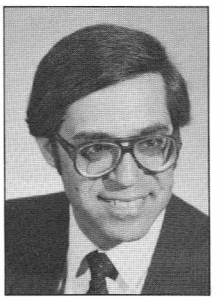
Next, I would like to follow up on two items I have mentioned in some previous newsletters. As a member of the Board, I am expected to attend at least four Board related meetings per year. These meetings, which include TAB and TABopCom meeting, extend over 5 or 6 days each time. In addition, each of the 5 Societiesin Division IV has at least two administrative meetings per year. And further, for 1988 I will be a representative of the Board of Directors on the EAB (Educational Activities Board), which meets at least three times a year. To keep my travel within tolerable limits I have chosen not to routinely attend Society administrative meetings because, in part, most matters that come before the Board are not the same things that come before the Societies at their meetings. There are some disadvantages in this, one of them being reduced communication between the Board and the Societies. Thus, in my second year, fortified by greater familiarity with the directorship and the issues before the board, I will attempt to attend some of the Society administrative meetings.

The final item I would like to report on is the progress on the matter of reviewing the operation of the IEEE. This year's President, Henry Bachman, has taken a personal interest in this matter and is off to a significant start in conducting a review. He will be able to spend even more time on the review in 1988 once his Presidential duties are behind him. The Board is quite interested in this issue and will be following it closely, having already participated in the initial phase with President Bachman.

Homeowners are increasingly vulnerable to lawsuits. Jury awards exceeding $1 million have soared ninefold in seven years. *Self-defense:* Raise your homeowner insurance coverage to at least $300,000 (the old standard was $100,000). The extra permium can be as little as $7/year. *For very high net worth individuals:* Also buy a $1 million umbrella liability policy ($150-$225/year). You can offset the cost by increasing your deductible. *Other ways to avoid trouble:* Don't hire a carpenter, painter or other laborer unless he shows you a "certificate of insurance" ... buy a workers compensation insurance policy for any housekeeper or baby sitter not covered by your regular homeowner policy (required by law in some states) ...don't let intoxicated guests keep drinking (send them home in a cab).

Harvey Seymour, Insurance Information Institute, 110 William St., New York 0038

INCOMING PRESIDENT'S REPORT



by
Barry E. Spielman

As I am about to assume the duties and responsibilities as AdCom President for the MTT-S, much of AdCom's current operation is strong and deserving of continuation and follow-through. One such area relates to its administration of financial matters. The ambitious pursuit in the area of "budget" by outgoing AdCom President, Dave McQuiddy, has put AdCom's financial operations on an even more firm footing than before. Consistent with his thrust, AdCom will seek to formulate and implement procedures and mechanisms for prioritizing expenditures consistent with the newly-formulated budget. These measures are intended to provide utilization of financial resources in providing our membership with services.

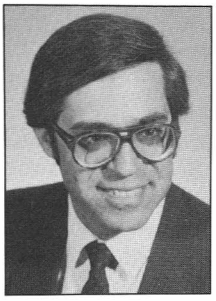
A second area in which I hope to intensify AdCom's efforts relates to services provided to membership in areas I refer to as "emerging" technologies. An example where MTT-S has effectively provided such service in the past relates to the microwave and millimeter-wave monolithic integrated circuit area. The MTT-S sponsored symposium treating this area was started just a few years ago, but already serves a very large segment of our membership. This year in Las Vegas the attendance reached 950.

Yet there are other emerging technologies with significant import or potential import to our members. Some examples of these include: 1) the emergence of higher transition-temperature superconducting materials: and 2) picosecond optical techniques for on-chip characterization and testing of microwave and millimeter-wave structures (e.g. devices, circuits, components). It is my hope to facilitate AdCom's ability to scope, implement, and provide effective technical service to the MTT-S membership in such technical areas.

A slow jog burns only about 10% fewer calories than a fast run over the same distance. *Example:* A 160-pound runner burns 99 calories covering a mile in 10 minutes and 40 seconds, and 110 calories if he finishes in five minutes and 20 seconds.

Nutrition Education for the Patient by Lynn Caldwell, George F. Stickley Co., 210 Washington Square, Philadelphia 19106. $17.50

AdCom HIGHLIGHTS



by
Barry E. Spielman

In depicting highlights of the AdCom meeting held in Boston on October 1-2, 1987, the annual election of AdCom members and officers must be included. The ultimate slate of nominees considered for seats on AdCom was comprised of fifteen highly qualified candidates spanning industry, university, and government sectors as well as widespread geographical location.

Although the high quality of candidates made selection difficult, when balloting was complete the following individuals were elected to fill three-year AdCom terms:

Tatsuo Itoh
Ralph Levy
Robert Moore
Jorg Raue
Martin Schneider
Peter Staecker

Additionally, Gary Lerude was elected to fill a one-year vacancy on AdCom. In the election of officers for AdCom, Barry Spielman was elected to serve as President for the 1988 calendar year. Walt Gelnovatch was elected to serve as Vice President for the same period.

All of us who are affiliated with the Society have tremendous respect for the newly elected members and officers. At the same time all of those who work with this committee wish to express our deep gratitude and appreciation to Steve March who steps down from AdCom at the completion of this year. Steve has been extremely active and effective in various duties for AdCom over many years.

Another facet of AdCom activity which generated considerable attention relates meetings and symposia. Charles Buntschuh, Chairman for the 1988 International Microwave Symposium to be held in New York provided and update of activity by his Steering Committee. Of special interest at this symposium is a planned Feature Session and Exhibit focused on the Hertz Centennial. The exhibit, consisting of Hertz artifacts and replicas of experiments is being transported to the Symposium from the Science Museum in London under the leadership of John Bryant and the administrative responsibility of Ray Camisa.

Ted Saad has led MTT-S in establishing the historical exhibit which has been annually displayed at the International Microwave Symposium. Ted reported that he is seeking gradual transition of responsibility for fielding this well established but growing exhibit to a committee. Also, Ted sought and received approval to ship the MTT-S Historical Collection to the Historical Electronics Musuem, Inc. of Baltimore for remounting the artifacts to simplify the displaying, packing, and shipping of this collection.

Other items relating to symposia included the following: Walter Cox brought to AdCom's attention two sites offering to field the 1994 International Microwave Symposium. These proposed are San Diego and San Francisco. Further consideration of these proposals will take place during the January, 1988 AdCom meeting in New York. Also, provided was a preliminary budget for the 1989 International Microwave Symposium to be held in Long Beach, CA. Dick Sparks summarized activity by MTT-S abroad. During this summer Dick reported on a successful microwave symposium held last July in Rio de Janeiro for which MTT-S was a cooperating sponsor. Finally, Bob Moore provided a "wrap-up" on his very successfully session at the 1987 International Microwave Symposium on "Financial Planning for Engineers - Implications of the New Tax Law". He also described plans to conduct a session at the 1988 microwave symposium on "U.S. Competitiveness."

Under the aggessive leadership of Martin Schneider, AdCom's Membership Services Committee reported on vigorous activity in both membership development and Distinguished Lecturer service.

It was reported that MTT-S has risen to become the seventh largest society in IEEE with 9,445 members at the end of 1986. Also, MTT-S was the fastest growing society of IEEE in July and August with a growth rate of 11.7% compared with the previous year, while the Institute membership growth rate was 4.0% for the same period.

Mario Maury, who leads MTT-S publicity and public relations effort reported that his committee expects to complete projects on a Distinguished Microwave Lecturer brochure and on MTT-S Membership brochure by the end of the year.

Finally, Reynold Kagiwada provided an extensive report on activity by the MTT-S Technical Committees. Two of these committees have taken shape rather recently. One is the MTT-12 committee on Microwave and Millimeter-Wave Packaging, co-chaired by Bert Berson and Fred Rosenbaum. The other is the MTT-17 committee on Manufacturing Technology, chaired by Steve Temple.

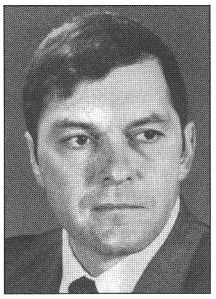
Audit Odds

Your risk of an IRS audit depends on where you live. The IRS audited 1.1% of all individual taxpayers in 1986—but the audit rate varied from a maximum of 2.61% in Nevada to a low of 0.47% in Rhode Island.

Highest-risk states *(audit rate above 1.3%);* AK, AZ, CA HI, ND, NV OK, TX, UT, WA, WY. ***Medium risk*** *audit rate 1.3%-0.9%);* AL, CO, DE, FL, GA, ID, KS, LA, MD, MT, NH NM, NY, OR TN. ***Lowest risk*** *(audit rate below 0.9%);* AR, CT, IA, IL, IN, KY, MA, ME, MI, MN, MO, MS, NC, NE, NH, OH, PA, RI, SC, SD, VA, VT, WI, WV.

Internal Revenue Service figures compiled by *The Wall Street Journal*, 2300 Liberty St., New York 10281. Weekdays, $119/yr.

AdCom ELECTIONS

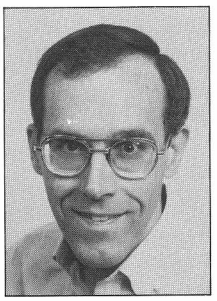


by
Vladimir G. Gelnovatch

The annual Fall Election meeting of the MTT-S was held in Boston, MA on October 2, 1987. A total of seven highly qualified members were elected to membership on the ADCOM of MTT-S. Six were elected to three year terms and one was elected to a one year term. For 3 year terms, the re-elected members were Jorg Raue, Martin Schneider, Tatsuo Itoh, Peter Staecker and Ralph Levy. Bob Moore was newly elected to a three year term. The one year vacancy left behind by out-going President, Dave McQuiddy was filled by Gary Lerude. The voting for both the 3 year and 1 year terms was close and required five and three ballots respectively. The nominees were taken from a slate of 14 proposed by the nomination committee and one proposed from the floor by direct nomination. There were no petition candidates this year. The re-elected members have demonstrated a keen history of contributions to the MTT-S and will go on to become senior statesmen while the two new members will bring new ideas and initiatives.

In order that you may meet the two new members of MTT-S ADCOM, their bio-sketches are enclosed. The bio-sketches of re-elected members have been published in previous Newsletters.

In additional elections, a President and Vice-President for 1988 have been elected. Barry Spielman was elected to the position of President, while Vladimir G. Gelnovatch was elected Vice-President.



D. Gary Lerude joined the Microwave Laboratory at Texas Instruments in 1978. He is currently engineering manager of the Microwave Military Components department, responsible for the technical development and support of GaAs foundry services, GaAs FETs and MMICs, and components offered for external sale by TI.

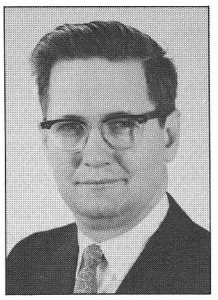
Prior to this assignment, Mr. Lerude was responsible for the development of broad bandwidth GaAs MMICs for military applications. In conjunction with this role, he has held a number of program management positions within the Microwave Laboratory, including:

- Affordable, Wideband GaAs Power MMICs (NRL)
- Monolithic Phased Array Jammer (AFWAL)
- HARM Monolithic IF Amplifier Development (NAVAIR)
- GaAs MMIC Manufacturing Technology Program (NRL)
- Band 9/10 Power Amplifier Development

As a microwave design engineer within the Microwave Laboratory, Mr. Lerude supported the development and qualification of a dual-channel frequency converter for HARM. His contributions included microstrip filter design and development of an automated test system for mixer gain and phase matching measurements.

Before joining TI, Mr. Lerude spent three years with the IIT Research Institute, where he supported the development of radar test beds for the Air Force Electronic Warfare Anechoic Chamber (EWAC) at Wright Patterson Air Force Base.

Mr. Lerude has presented papers at the Producibility of Microwave and Millimeter Wave Integrated Circuits and ARFTG conferences and has participated in two MTT-S Symposium workshops. He was 1987 MTT-S Administrative Committee Secretary and is a member of the 1990 International Microwave Symposium Steering Committee. Also, he has been active in supporting the Dallas IEEE section with MIDCON.



Robert A. Moore received his Bachelor of Science in EE from the University of Alabama in 1954. He received the MS and PhD, in EE, respectively in 1956 and 1960 from Northwestern University.

Except for a six-month assignment at Ft. Monmouth, three months in the basic officers course and three months in the Signal Corps Engineering Lab, Dr. Moore has been with Westinghouse since 1958. His first assignment involved microwave propagation studies related to ground-based radar systems. Since then, he has served at various levels while conducting research, development and pilot production of microwave related devices at the Advanced Technology Laboratory and with Subsystems activities. During this time, he has conducted research and development on microwave, microwave acoustic and ferrite device technology for applications in radar and EW systems. He established the microwave acoustics laboratory at the Westinghouse Advanced Technology Laboratory (ATL) and led the overall corporate program in coordinating R&D, and applications for over a decade. He was instrumental in establishing the first microwave integrated circuits laboratory at Westinghouse ATL which, at that time, was one of the largest producers of MICs in the industry.

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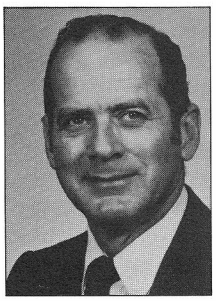
ADCOM ELECTIONS (continued from page 7)

Dr. Moore is presently responsible for identifying and establishing programs to exploit microwave technologies for EW and radar systems. Key program areas include channelizers for EW, stable oscillators for radar, film bulk acoustic resonators for MMIC filters and automatic adjustment equipment for microwave modules in production. Dr. Moore is a registered professional engineer in Maryland. He has over sixty technical papers and twenty-five patents. He has received two IR100 best products awards.

Dr. Moore is a Senior Member of the IEEE, the MTT and UFFC Societies. He is also a member of Tau Beta Pi, Eta Kappa Nu, Sigma Pi Sigma and Sigmi Xi. He is a past MTT-S local chapter chairman, has served the Administrative Committee on various non-voting committee positions and for the past three years has organized the professional panel session for the International Microwave Symposium. He is Membership Services Chairman for the UFFC-S and was General Chairman for the Ultrasonics 1986 Symposium in Williamsburg. Dr. Moore is on the USAB Technology Transfer Committee studying issues related to release of information and hardware export.

MTT-S AWARDS



by C.T. Rucker

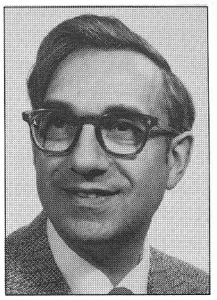
One of the more rewarding activities within MTT-S is the selection of MTT-S members for special recognition. At the October meeting of the Administrative Committee the recipients were chosen for the Microwave Career Award, the Distinguished Service Award and the Microwave Prize.

Microwave Career Award

The Microwave Career Award is the highest award given by the Microwave Theory and Techniques Society. It is given to an individual for a career of meritorious achievement and outstanding technical contribution in the field of microwave theory and techniques. The eligibility requirements are publication in technical journals, presentations of lectures and a distinguished career of contributions to the microwave field. This award is given only to those individuals who have distinguished themselves over a long period of time.

The award consists of a certificate, a plaque, a cash sum of two thousand dollars and a feature publication in the IEEE Transactions on Microwave Theory and Techniques.

The Administrative Committee of the Microwave Theory and Techniques Society has selected a worker who is well known in MTT-S circles, Leo Young, as the recipient of the 1988 Microwave Career Award, "for a career of meritorious achievement and outstanding technical contribution in the field of microwave theory and techniques."



Leo Young came to the United States from England in 1953, to join the Westinghouse Electric Corporation in Baltimore, Maryland.

Leo had been trained as a physicist at Cambridge University, England, where he also attended a few courses in electronics. He had become excited by the new field of microwaves which had recently proved so important in winning the war. He turned his attention to the latest applications of radar, and began to design antennas and waveguides in the research laboratories of A.C. Cossor and Decca Radar in London. The MIT Rad. Lab. series of books were just being published and each one was awaited eagerly by the small microwave community. The latest developments were still coming from the U.S., and so he set sail from Southhampton with his new bride to continue his research here.

Westinghouse encouraged its engineers to continue their academic education, and Leo was fortunate in having his first American course on antennas given by the late Don King at The Johns Hopkins University, where he also studied microwave networks under Bill Huggins. He received the Westinghouse Electric Corporation's B.G. Lamme Graduate Scholarship in 1958, and the Doctor of Engineering degree Johns Hopkins in 1959. His dissertation kindled his interest in microwave and optical filters, and a year later he joined Seymour Cohn, George Matthaei, Ted Jones and others at Stanford Research Institute in Menlo Park, California, to continue this work and co-author a book on microwave filters, then in the planning stage. He remained at SRI for more than twelve years, and during that time became active in the Microwave Theory and Techniques (MTT) Group (now Society) of IEEE, receiving the Microwave Prize in 1963 (right here in New York just 25 years ago), was elected IEEE Fellow in 1968, became Chairman of the MTT Administrative Committee in 1969, and Director of Division IV on the IEEE Board of Directors from 1971 to 1974.

The MTT Group (Society) has always shown a strong interest in professional activities, and Leo carried that message to the IEEE Board, helping in 1972 and 1973 to institutionalize a framework of professional activities within the largest engineering society in the world. He became chairman of the new United States Activities Committee (later, Board—USAB) in 1974., He continued to take a specific interest in IEEE pension ac-

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MTT-S AWARDS (continued from page 8)
tivities, and remained chairman of the IEEE Pensions Committee under USAB from 1974-1978. During that period, and as a result of these IEEE activities, he co-authored with his late wife, Fay, a popular book on pension plans. He was elected 1979 Executive Vice-President of IEEE, and (by petition) 1980 IEEE President.

In 1973 he joined the U.S. Naval Research Laboratory (NRL) in Washington, D.C. where he remained until 1981, when he came to the Office of Secretary of Defense (OSD) as Director for Research and Laboratory Management. At NRL he continued to work in microwaves and electronics, and played an advocacy role for millimeter waves. At OSD, Leo has had responsibility for basic research, university relations, and laboratory management policy, set up under the direction of Under Secretary Richard DeLauer the DoD-University Forum to improve the quality of the dialog with universities, organized the DoD Small Business Innovation Research program, chaired the IR&D Technical Evaluation Group, provided oversight to the Defense Technical Information Center, and has had many other assignments. His current interests are mainly in the area of technology transfer, design and manufacturing processes, and computer aided logistics support.

Leo was married in Sunderland, England, in January 1953, to Fay Lilian Merskey, who passed away in May 1981. They had three children, Philip, an economist, Sarah, a computer scientist, and Joe, a medical student. In 1983 Leo married Ruth Breslow, also widowed and with three grown children. They had lived only a few miles apart for many years, but never met until introduced through an IEEE connection.

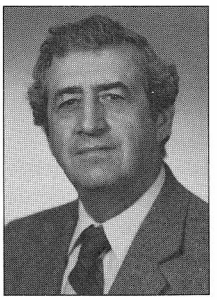
Leo has authored or edited fourteen books, mainly on microwave subjects, and about one hundred papers, holds over twenty patents, is an honorary life member of the Microwave Theory and Techniques Society, was a member of the Board of Governors of the American Association of Engineering Societies, is a Fellow of the American Committees of the National Academy of Sciences and National Academy of Engineering, was chairman of NSF's first Engineering Advisory Committee, has served on committees of NASA, OSTP, and several universities (Johns Hopkins, University of California, MIT). He has traveled extensively abroad, spent a Sabbatical year at the Technion, was Distinguished Microwave Lecturer at the IEE summer school at Leeds University, England, NATO/AGARD lecturer at the University of Bologna, Italy, and has given talks at the universities in India, Egypt, Europe, as well as in the United States. He believes that the way to peace and prosperity is through education and the scientific disciplines, particularly the professional application of engineering knowledge, which is so well exemplified by the members and charter of IEEE.

Microwave Application Award

The Microwave Application Award is presented periodically for an outstanding application of microwave theory and techniques. The eligibility requirements are creation of a new device, component or technique, novel use of components, or both.

The award consists of a certificate, a cash sum of one thousand dollars, and a feature publication in the IEEE Transactions on Microwave Theory and Techniques.

This year, co-recipients L.S. Napoli of RCA and M. Fukuta of Fujitsu Ltd. will be cited "for recognition and demonstration of the potential of GaAs Field Effect Transistors for power applications." Both authors reported a significant FET power device at the International Solid State Circuits Conference held February 15, 1973. Napoli's device delivered 0.80W at 4GHz with 4-5dB of gain while Fukuta's delivered 1.60W at 2 GHz with 5dB gain.



Louis S. Napoli graduated from Rutgers University with a BS and MS degree in Electrical Engineering in 1959 and 1961. During that period he was elected to several of the Engineering and Scientific honor societies. In April 1986, the Engineering Society of the Rutgers Alumnae Association honored him for "Distinguished Achievement in the Field of Engineering."

During his career as a Member of the Technical Staff at RCA Laboratories, (now David Sarnoff Research Center, a subsidiary of SRI International), Mr. Napoli specialized in research related to microwave phenomena in electron devices. Most notably, wave propagation in gaseous plasmas, transferred electron devices, avalanche transit-time devices, and GaAs Schottky-barrier FETs. RCA Laboratories issued him 4 Achievement Awards for unique contributions in these areas. He has been granted more than 25 U.S. patents and has written more than 30 technical articles.

In 1963, Mr. Napoli was appointed Head of the Microwave Components Group that developed a variety of avalanche transit-time devices for phased-array radar and satellite communications applications. He then headed a research group and later became engineering manager and manufacturing base for a solar-electric concentrator business. Subsequently, he acted as engineering manager of a variety of radiation-hardened microprocessor components which culminated in a family of 4K and 16K radiation-hardened CMOS/SOS memories, gate arrays, and other logic products for the Solid State Division of RCA.

In 1983, Mr. Napoli was appointed Head, LSI Memories and Devices Research, in the Integrated Circuit Technology Laboratory where he was responsible for the design and development of advanced CMOS random access memory, nonvolatile memories, SOS CCD memories, and radiation-hardened CMOS/SOS memories, and for short-channel MOS modeling and device development.

Presently, Mr. Napoli is Director of the Integrated Circuit Research Laboratory. He is responsible for the development of technology, devices, and circuits for

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MTT-S AWARDS (continued from page 9)
CMOS ICs including gate arrays, nonvolatile IC products, radiation-hardened IC products and power MOS.

Masumi Fukuta was born in Gifu, Japan on December 25, 1940. He received the B.S. degree in electrical engineering from Nagoya University, Nagoya, Japan in 1977.

In 1963 he joined Kobe Industries Co. which later merged with Fujitsu Ltd. Since joining the company he has been working in the field of semiconductor devices including Si RF power Transistors, Si ICs, and Si MOSFETs. In 1967 he invented and made a series of products "the mesh emitter transistor."

Since 1972 he has been engaged in developing low-noise and power GaAs FETs and GaAs integrated circuits in Fujitsu laboratories.

At ISSCC '73 he presented the first paper of power of GaAs FET titled "Mesh Source Type Microwave Power FET". From 1979 to 1980, he supervised development of HEMT devices that is his last job in the laboratories. He moved from Fujitsu Laboratories to Compound semiconductor division, Fujitsu in 1980. In the division, he promotes the producibility of compound semiconductor devices including power GaAs, FETs, HEMTs, GaAs ICs, laser diodes and detectors.

He is now deputy general manager of Compound Semiconductor Division, Fujitsu. He holds 20 patents on semiconductor devices.

Dr. Fukuta received a prize medal from the Minister of Science and Technology in Japan in 1975 for outstanding contributions in the development of power GaAs FETs.

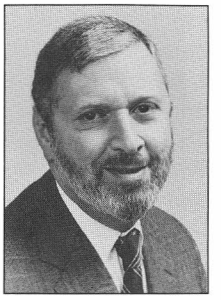
Distinguished Service Award

The Distinguished Service Award was initiated In 1983 to honor those whose service to MTT-S and IEEE has been extraordinary. Beginning in 1983 with Ted Saad, the award has recognized Al Clavin, Pete Rodrigue, Hal Sobol and Kiyo Tomiyasu, all vital contributors to the Society and the Institute.

The Distinguished Service Award is made to an individual who has given outstanding service for the benefit and advancement of the Microwave Theory and Techniques Society. The eligibility requirements are service in one or more of the following areas: the Administrative Committee, publications, meetings and symposia, chapter leadership, committee chairman, committee member, editor, lecturer or other distinguished service. Factors considered are: leadership, innovation, activity, service duration, breadth of participation and cooperation. The individual must be a member of the IEEE and a member of the Microwave Theory and Techniques Society.

The award consists of a certificate, a plaque and a feature publication in the IEEE Transactions on Microwave Theory and Techniques.

The Administrative Committee of the Microwave Theory and Techniques Society has selected Fred J. Rosenbaum as the recipient of the Distinguished Service Award "for his outstanding and dedicated service to the Society." Dr. Rosenbaum has met every criterion in the above list, and more. We are pleased to confer the Distinguished Service Award on one who has served MTT-S in such a dedicated fashion.



Fred J. Rosenbaum (S' 57 - M' 63 - SM' 70 — F' 79), Professor of Electrical Engineering at Washington University, St. Louis, was born in Chicago, Ill. on 15 February, 1937. He was educated at the University of Illinois and received the Ph.D degree in 1963. He joined the faculty at Washington University in 1965 after two years as a research scientist at the McDonnell Aircraft Co. Research Laboratory. At the University he established the Microwave Laboratory and through the years has trained many undergraduate and more than 35 MS and D.Sc students on microwave topics. He is a consultant to industry and from 1983 to 1985 served as Chief Scientist of Central Microwave Co.

He has worked on ferrite circulators and phase shifters, Gunn effect oscillators and amplifiers, integrated optics, microwave bio-effects, and FET - devices, - circuits, and - oscillators. Recent activities have been devoted to the study of nonlinear microwave circuits, scattering from three dimensional discontinuities in transmission lines, and packaging design for microwave components. He and his students have published some 50 papers and he has presented a like number of talks at professional meetings.

Professor Rosenbaum has been honored with the U. of I. Electro - Physics Laboratory Alumni Award, the U. of I. Electrical Engineering Alumni Association Distinguished Alumnus Award, the University of Queensland D.E. Evans Visiting Fellowship, Washington University School of Engineering Outstanding Professor of the Year (1978) and the IEEE Centennial Medal. In 1979 he was a member of the IEEE delegation to the USSR Popov Society meeting in Moscow.

Microwave Prize

The Microwave Prize is awarded to the author of that paper, published in the IEEE Transactions of Microwave Theory and Techniques, Proceedings of the IEEE, or other official IEEE publication, which is judged to be the most significant contribution in the field of interest of the Society. The paper must have been published during the period January 1 to December 31 of the year preceding the annual meeting of the Administrative Committee at which the award is considered. The award consists of a suitable certificate, a cash sum of one thousand dollars, and a feature

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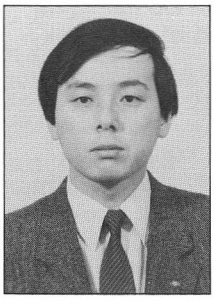
MTT-S AWARDS (continued from page 10)
publication in the IEEE Transactions on Microwave Theory and Techniques. If the paper as published has more than two authors, a certificate is presented to each author and the cash sum of five hundred dollars is provided to each.

The 1988 Microwave Prize will be awarded to Dr. Kazuhiko Honjo and Dr. Mohammad Madihian for their paper "GaAs-Monolithic IC's for an X-Band PLL-stabilized Local Source," IEEE MTT-S Transactions, Vol. MTT-34, No. 6, pp. 707-713, June 1986.



Kazuhiko Honjo (M' 82) was born in Saitama, Japan, on October 28, 1951. He received the B.E. degree from the University of Electro-communication, Tokyo, Japan, in 1974. He received the M.E. and D.E. degrees in electronic engineering, from the Tokyo Institute of Technology, Tokyo, Japan, in 1976 and 1983, respectively.

He joined the Central Research Laboratories, NEC Corporation, Kawasaki, Japan, in 1976. He has been involved in the research and development of TRAPATT oscillators, GaAs FET circuit technology for high-power, low-noise, broad-band amplification, oscillation, mixing, and frequency division, GaAs MMIC techology including device design, process, and testing. Presently, he is engaged in the research and development of heterojunction bipolar transistor (HBT) and its integrated circuits both for digital and microwave applications. He is now Research Manager of the Ultra-high-speed Device Research Laboratories, NEC, and is leading a HBT research group.

Dr. Honjo is a co-recipient of the 1983 Microwave Prize granted by the MTT Society. He also received the Young Engineer Award from the Institute of Electronics, Information and Communication Engineers of Japan, in 1980.

for your travels

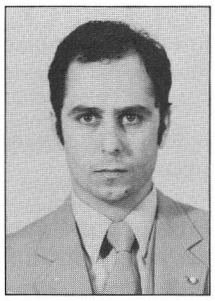
Leave the cotton in pill bottles while you're traveling. It keeps them from rattling around and crumbling. Plastic bottles are better than glass ones (and pills are better than liquids).

The Healthy Traveler by Beth Weinhouse. Pocket Books, 1230 Ave. of the Americas, New York 10022. $6.95

...and your fitness

A banana a day can help prevent a fatal stroke. *Theory:* Potassium allows the brain to survive longer during oxygen deprivation.

Study at the University of California at San Diego, cited in *Health*, 3 Park Ave., New York 10016. Monthly: $22/yr.



Mohammad Madihian (S '78-M' 83) was born in Tehran, Iran, on January 3, 1954. He received the B.Sc. degree from the Iran College of Science and Technology, Tehran, Iran in 1976, and the M.Sc. and Ph.D. degrees from Shizuoka University, Hamamatsu, Japan, in 1980 and 1983, respectively, all in electronic engineering. During graduate study, he has worked on research and development of phase-sensitive detectors, phase filters, microwave solid-state oscillators, and power combiners.

In 1983, he joined the Central Research Laboratories, NEC Corporation, where he has worked on research and development of GaAs HIC's and MMIC's, and is currently involved in research and development of analog and digital AlGaAs/GaAs HBT circuits. He is the Supervisor of the Ultra-high-speed Device Research Laboratories, NEC Corporation.

Dr. Madihian is a member of the Institute of Electronics and Communication Engineers of Japan.

Newly-Elected Fellows

I am pleased to report that ten of those whose nominations were evaluated by the Society this year were elected to Fellow Grade as of January 1, 1988. It is appropriate that we give special recognition to these ten by noting their names and citations below.

Robert W. Bierig
For leadership in the research of GaAs device and MMIC technology.

Berthold G. Bosch
For contributions to microwave electronics and gigabit circuits.

Walter R. Curtice
For contributions to the modeling and simulation of GaAs field-effect transistors.

Kuldip C. Gupta
For contributions to microstrip circuits and antennas.

David B. Leeson
For contributions to the theory and practice of stable microwave signal sources for communications and radar.

Yoshiyuki Naito
For contributions to microwave components, absorbers and nonreciprocal devices, and for leadership in education.

Song-Tsuen Peng
For contributions to the scattering and guidance of electromagnetic waves by dielectric structures.

Saul W. Rosenthal
For scientific and leadership contributions to the interactions between microwave radiation and biological systems.

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James J. Whelehan, Jr.
For contributions toward the development of low-noise microwave and millimeter wave receivers.

Ingo Wolff
For contributions to the analysis and design of microwave and millimeter-wave components.

Newly elected Fellows will be given the opportunity to be recognized further at this year's Symposium Awards Banquet. I look forward to that time.

Fifteen additional MTT-S members, whose Fellow nominations were evaluated by a Society other than MTT-S, were also elected to Fellow Grade. They are:

Name	Evaluating Society
Hamilton W. Arnold	AP
Joseph A. Calviello	ED
Harry M. Cronson	IM
John B. Damonte	AP
Kenneth R. Foster	EMB
Russell H. Logan	AES
Felix K. Schwering	AP
Dipak L. Sengupta	AP
Lotfollah Shafai	AP
Sadakuni Shimada	LEO
Bruce M. Thomas	AP
Gerasimos N. Tsandoulas	AP
Malcolm R. Uffelman	AES
Herman van de Vaart	UFFC
Pei-da Ye	LEO

Finally, a reminder, IEEE Fellow nomination kits can be obtained by writing:

Staff Secretary
IEEE Fellow Committee
345 East 47th Street
New York, NY 10017
(212) 705-7750

Management of the Telephone

The telephone can be a very useful instrument. It can provide a welcome interruption in a demanding day. It offers you an opportunity to hear the "music" of your own voice. But talking on a telephone is not always productive.

Some ideas on making sure that you use the telephone and not the other way around:

1. **Keep a faithful log** of incoming calls for one week. Enter into it who called, when, and how much time you spent on the phone. Do the same for calls you originate. At the end of the week, answer these questions:
   - Who called you?
   - Whom did you call?
   - How much time did the calls consume?
   - What percentage of calls was really important?
2. **Use your telephone properly** as a time-and-energy saver. It can do everything a letter can, and more cheaply. Frequently it can be an effective substitute for travel and face-to-face business meetings. And through teleconferencing, it can even replace small meetings.
3. **Bunch your calls.** By establishing period of time each day for placing and receiving calls, you can eliminate annoying interruptions sprinkled throughout the day. For most people, the best time to call is in the morning. They are likely to be at their desks. They are fresh, and usually friendly. Encourage people to call you then.
4. **Jot down the main points** you want to cover before lifting the receiver. You'll be less likely to forget an important point. You can keep the call businesslike. You'll save time and money.
5. **Use an inexpensive three-minute egg timer** to limit your calls. There is very little that can't be covered in three minutes of purposeful conversation. Don't rush or speak too rapidly. But see if you can't reduce the time spent on calls.
6. **Set the tone immediately.** Ask for the party by name and identify yourself. Once the other person gets on the line, get down to business: "Mary? John, I'm calling about ..."
7. **Give the other person your undivided attention.** That means not shuffling papers or scanning newspaper headlines or talking to someone else in your office. Simple courtesy dictates that you give the other person your full attention.
8. **Once you've covered your business,** conclude your conversation. Simply thank the other person and hang up. If he or she makes it impossible for you to get off the phone, it's perfectly permissable to plead pressing work.
9. **In a crunch, let someone else take your calls** and screen them. If there are any people you must speak to, prepare a list of their names so that your assistant can put them right through.

1987 MTT FELLOW LIST

G. Abraham
3107 Westover Dr. S.E.
Washington, DC 20020
(202) 767-3521

Saburo Adachi
Tohoku University
Dept. of Elec. Eng.
Sendai
Japan
022-222-1800

Stephen F. Adam
1413 Brookmill Rd.
Los Altos, CA 94022
(415) 965-4020

R.J. Adams
10114 Livingston Rd. S.E.
Fort Washington, MD 20744
(202) 767-2310

N.G. Alexopoulos
554 14th St.
Santa Monica, CA 90402
(213) 825-1027

A. Alford
71 Bacon St.
Winchester, MA 01890

J.L. Allen
Kaman Sciences Corp.
P.O. Box 7463
Colorado Springs, CO 80933
(303) 599-1728

Dietrich A. Alsberg
123 Pine St.
Lincroft, NJ 07738
(201) 747-6803

Helmut M. Altshuler
2250 Bluebell Ave.
Boulder, CO 80302
(303) 442-8769

Dean B. Anderson
8521 Colima Rd.
Whittier, CA 90605
(213) 693-4946

D.J. Angelakos
U. of Cal. Cory Hall
Electronics Res. Lab.
Berkeley, CA 94720
(415) 643-6077

F.R. Arams
LNR Communications, Inc.
180 Marcus Blvd.
Hauppauge, NY 11788

E.A. Ash
Imperial College of Sci. & Tech.
London SW 2AZ
England

J.R. Ashley
Sanders Associates, Inc.
95 Canal St.
CS 2004
Nashua, NH 03061

Ali E. Atia
COMSAT
950 L'Enfant Plaza S.W.
Washington, DC 20024
(202) 863-6642

M.P. Bachynski
MPB Technologies, Inc.
1725 North Service Rd.
Trans-Canada Highway
Dorval, Que, Canada H9P 1J1
(514) 683-1490

E. Bahar
Univ. of Nebraska
Elec. Eng. Dept.
WSEC 209N
Lincoln, NE 68588
(402) 472-1966

C.A. Balanis
Arizona State Univ.
Dept. of Elec. & Comp. Eng.
School of Engineering
Tempe, AZ 85287
(602) 965-3909

A. Ballato
150 Atlantic Ave.
Long Branch, NJ 07740
(201) 544-2773

K.G. Balmain
Univ. of Toronto-Dept. EE
Toronto, Ont., Canada M5S 1A4
(416) 978-3127

J.W. Bandler
Dept. Elec. Eng.
Mc Master Univ.
Hamilton, Ont., Canada L8S 4L7
(416) 525-9140

H.M. Barlow
13 Hook-Field
Epsom Surrey KT19 8JQ
England

Frank S. Barnes
Dept. ECE
Campus Box 425
Univ. of Colorado
Boulder, CO 80309
(303) 492-8225

David K. Barton
180 Prospect Hill Rd.
Harvard, MA 01451
(617) 862-3000

R.H.T. Bates
Univ. of Canterbury
EEE Dept.
Christchurch
New Zealand
03-482009-336

Carl E. Baum
5116 Eastern S.E.
Unit D
Albuquerque, N.M. 87108
(505) 844-9816

A.C. Beck
Paradise Palms
398 Paulus Ct.
Boca Raton, FL 33486

A.H.W. Beck
Univ. Eng. Dept.
Trumpington St.
Cambridge
England

Nicholas A. Begovich
136 Miramonte Dr.
Fullerton, CA 92635
(714) 526-5724

E.F. Belohoubek
37 Kingsley Rd.
Kendall Park, N.J. 08824
(609) 743-2629

Heinz Beneking
Dept. of Elec. Eng. & Comp. Sci.
EECS Bldg., Rm. 2241
Beal Ave.
Ann Arbor, MI 48109

Alexander B. Bereskin
Rhodes Hall-30
Univ. of Cincinnati, OH 45221
(513) 475-4013

J.R. Biard
Honeywell Opto
830 East Arapaho Rd.
Richardson, TX 75081
(214) 234-4271

David M. Bloom
Stanford University
E.L. Ginzton Lab.
Stanford, CA 94305

E.F. Bolinder
Kyrkasvagen 9
436 00 Askim
Sweden
031-810100

D.M. Bolle
Dean College of Eng. Phys. Sci.
Packard Labs. #19
Lehigh Univ.
Bethlehem, PA 18015
(401) 861-4025

R.C. Booton, Jr.
TRW ESG
1 Space Park E2/5043
Redondo Beach, CA 90278
(213) 535-2103

C.R. Boyd, Jr.
P.O. Box 1245
Santa Maria, CA 93456

E.M. Bradburd
White Birch Dr.
Pomona, NY 10970
(201) 284-3088

Frank A. Brand
249 Alexander Palm Rd.
Boca Raton, FL 33432

A.D. Bresler
12 Helene Ave.
Merrick, NY 11566
(516) 595-3560

W.B. Bridges
128-95
Calif. Inst. of Tech.
Pasadena, CA 91125
(818) 356-4809

W.C. Brown
6 Perry Lane
Weston, MA 02193

John H. Bryant
1505 Sheridan Dr.
Ann Arbor, MI 48104

C.M. Butler
Dept. of Elec. & Computer Eng.
Clemson University
Clemson, SC 29634
(803) 656-5922

Kenneth J. Button
M.I.T.
Box 72, M.I.T. Branch
Cambridge, MA 02139
(617) 253-5561

C.K. Campbell
McMaster Univ.
Dept. of Elec. & Computer Eng.
1280 Main St. West
Hamilton, Ont., Canada L8S 4L7

H.J. Carlin
Cornell Univ. School of E.E.
Phillips Hall
Ithaca, NY 14853

Kenneth L. Carr
Woodside Rd.
Harvard, MA 01451
(617) 272-3000

Paul H. Carr
178 Old Billerica Rd.
Bedford, MA 01730

Martin Caulton
15115 Interlachen Dr., #1003
Silver Spring, MD 20906
(301) 871-3027

William Chang
Univ. of California C-014
Dept. of Elec. Eng. & Comp. Sci.
La Jolla, CA 92093
(619) 452-2737

Kun-Mu Chen
Michigan State University
Dept. of E.E.
E. Lansing, MI 48824
(517) 355-6502

R.A. Chipman
3547 Rushland Ave.
Toledo, OH 43606
(419) 474-7748

M. Chodorow
Stanford Univ.
Ginzton Lab.
Stanford, CA 94305

Peter J.B. Clarricoats
Univ. of London
Queen Mary College
Mile End Rd.
London E1 4NS
England

Alvin Clavin
260 Surf View Court
Del Mar, CA 92014

M. Cohn
Westinghouse Def. & Space Ctr.
Box 1521, MS 3717
Baltimore, MD 21203
(301) 765-7271

S.B. Cohn
300 S. Glenroy Ave.
Los Angeles, CA 90049
(213) 472-5206

Paul D. Coleman
710 Park Lane
Champaign, IL 61820
(217) 333-2765

R.E. Collin
Case Inst. of Tech.
10900 Euclid Ave.
Cleveland, OH 44106
(216) 368-6437

A.A. Collins
Merle Collins Foundation
P.O. Box 792308
Dallas, TX 75379
(214) 661-2928

William T. Cooke
5901 Dovetail
Agoura Hills, CA 91301

H.W. Cooper
7211 Windsor Lane
Hyattsville, MD 20782
(201) 927-7681

H.V. Cottony
5204 Wilson Lane
Bethesda, MD 20814
(301) 654-1705

E.G. Cristal
Hewlett-Packard Co.
1501 Page Mill Rd.
Palo Alto, CA 94304
(415) 857-7957

James A. Cronvich
101 Colonial Club Dr.
Harahan, LA 70123
(504) 865-5785

W.F. Croswell
625 Manor Place
W. Melbourne, FL 32904
(305) 727-4295

A.L. Cullen
3 Felden Drive Felden
Hemel Hempstead Herts
England

C.C. Cutler
Ginzton Lab.
Stanford Univ.
Stanford, CA 94305
(415) 723-0261

Louis J. Cutrona
13339 Barbados Way
Del Mar, CA 92014
(619) 481-7409

G.C. Dalman
Phillips Hall
Cornell Univ.
Ithaca, NY 14853

Richard W. Damon
1623 Main St.
Concord, MA 01742
(617) 369-2087

J.W. Dees
Georgia Inst. of Tech.
O.C.A.
Atlanta, GA 30332
(404) 894-4810

J.E. Degenford
Westinghouse Adv. Tech Lab.
3902 MS, Box 1521
Baltimore, MD 21203
(301) 765-7334

Edgar J. Denlinger
Seven Wheatston Court
Princeton Jct., NJ 08550
(609) 734-2481

G.A. Deschamps
920 W. Charles St.
Champaign, IL 61820
(217) 333-2064

Lawrence E. Dickens
Herley Microwave Systems, Inc.
10 Industry Dr.
Lancaster, PA 17603
(717) 397-2777

Sven H.M. Dodington
1 Briarcliff Rd.
Mtn. Lakes, NJ 07046
(201) 334-3793

M.R. Donaldson
1833 Almeria Way S.
Saint Petersburg, FL 33712
(813) 974-2581

W.L. Doxey
126 Locust Ave.
W. Long Branch, NJ 07764

Edward C. Du Fort
2121 Domingo Rd.
Fullerton, CA 92635
(714) 732-2588

R.H. Duhamel
12001 Rhus Ridge Rd.
Los Altos Hills, CA 94022

J.W. Duncan
1323 Orleans Dr.
Placentia, CA 92670
(213) 535-3055

J.D. Dyson
Univ. of Illinois
E.E. Dept.
Urbana, IL 61801
(217) 333-2310

L.F. Eastman
Cornell University
425 Phillips Hall
Ithaca, NY 14853
(607) 255-4369

H.A. Ecker
3267 Ivanhoe Dr. N.W.
Atlanta, GA 30327
(404) 441-4625

W.A. Edson
SRI International
333 Ravenswood Ave.
Bldg. G
Menlo Park, CA 94025
(415) 859-4298

Glenn F. Engen
Natl. Burearu of Standards
723.01
Boulder, CO 80303
(303) 497-3511

Mark K. Enns
Electrocon International, Inc.
611 Church St.
Ann Arbor, MI 48104
(313) 761-8612

Rufus G. Fellers
Univ. of South Carolina
College of Engineering
Columbia, SC 29208
(807) 777-2574

A. Fong
1328 Parkinson Ave.
Palo Alto, CA 94301

Timothy T. Fong
3 Earlymom
Irvine, CA 92714
(213) 536-1491

A.G. Fox
10 Conover Lane
Rumson, NJ 07760

Carl L. Frederick, Sr.
3560 Chiswick Court
Silver Spring, MD 20906

Hatsuaki Fukui
53 Drum Hill Dr.
Summit, NJ 07901
(201) 582-6281

James J. Gallagher
2199 Starcross Court
Dunwoody, GA 30338

O.P. Gandhi
Univ. of Utah
Dept. of Elec. Eng.
Salt Lake City, UT 84112
(801) 581-7743

Fred E. Gardiol
Ecole Polytech Federale
16 Ch De Bellerive
Ch 1007 Lausanne
Switzerland
021-47-26-70

Robert V. Garver
12205 Green Ridge Dr.
Boyds, MD 20841
(202) 394-1403

L.F. Gaudernack
World Distribution Sys. Corp.
P.O. Box 2050
100 CB Amsterdam
Netherlands

Thomas K. Gaylord
Georgia Inst. of Tech
School of Elec. Eng.
Atlanta, GA 30332
(404) 894-2931

V. Gelnovatch
Allaire Rd., R.D. 1, Box 182
Belmar, NJ 07719
(201) 554-4883

Horst W. Gerlach
545 Eton Lane
Springettsbury Township
York, PA 17402

William J. Getsinger
Star Route Box 36B
Bozman, MD 21612
(301) 745-3485

J.W. Gewartowski
AT&T Bell Labs.
555 Union Blvd.
Allentown, PA 18103
(215) 439-7045

E.S. Gillespie
17835 Minnehaha St.
Granada Hills, CA 91344
(213) 885-2190

A.B. Giordano
Polytechnic University
333 Jay St.
Brooklyn, NY 11201
(718) 643-4518

Joseph A. Giordmaine
AT&T Bell Labs.
MH/C324
Murray HIll, NJ 07974
(201) 582-2173

E.J. Glenner
GTE Network Systems
2500 W. Utopia Rd.
Phoenix, AZ 85027
(602) 582-7792

John Granlund
2814 Huntington Rd.
Charlottesville, VA 22901
(804) 296-0270

Paul Greiling
Hughes Res. Labs.
MS RL 55
3011 Malibu Canyon Rd.
Malibu, CA 90265
(213) 317-5321

Al Gross
HC63 Box 417
Spring Valley
Mayer, AZ 86333
(602) 869-6174

Richard W. Grow
Univ. of Utah
Elec. Eng. Meb. Room 3054
Salt Lake City, UT 84112
(801) 581-7634

R.W. Gundlach
Klopstockstr 6
1 Berlin 37
West Gernamy

A.W. Guy
18122 60th Pl. N.E.
Seattle, WA 98155
(206) 543-1071

G.I. Haddad
The Univ. of Mich.
Dept. of E.E.
Ann Arbor, MI 48109
(313) 764-7139

Michael Hamid
Univ. of Manitoba
Dept. of EE
Winnigpeg, Manitoba
Canada R3T 2N2
(204) 474-9641

Peter W. Hannan
Hazeltine Corp MS1-8
Greenlawn, NY 11740

R.D. Hansen
Box 215
Tarzana, CA 91356
(213) 345-0770

Roger F. Harrington
Syracuse University
ECE Dept. Link Hall
Syracuse, NY 13210
(315) 423-4391

G.R. Harrison
Electromagnetic Sciences, Inc.
125 Technology Park/Atlanta
Norcross, GA 30092
(404) 448-5570

Wolfgang Harth
Tech. University of Munich
Arcisstr 21
Munich
West Germany

G.S. Heller
Brown University
Div. of Eng.
Providence, RI 02912
(401) 863-1415

R.E. Henning
400 Ponce de Leon
Clearwater, FL 33516
(813) 974-2581

Eric Herz
14 Magnolia Dr.
Rye Town, NY 10573
(212) 705-7910

A. Hessel
2128 E. 14 St.
Brooklyn, NY 11229

Ralph E. Hiatt
1869 Field Rd.
Charlottesville, VA 22903
(313) 662-6425

James Stewart Hill
263 N. Main St.
Hudson, OH 44236
(703) 451-4619

M.E. Hines
M/A-COM, Inc.
Burlington, MA 01803
(617) 272-3000

Samuel Hopfer
17 Casuto St.
Jerusalem
Israel

John B. Horton
5434 Montemalaga Dr.
Rancho Palos Verde, CA 90274
(213) 535-8372

Harlan Howe, Jr.
Bootleg Farm
P.O. Box 604
Boxborough, MA 01719
(617) 272-3000

Masaru Ibuka
Sony Corp 7-35 Kitashinagawa-
6 Chome Shinagawa-Ku
Tokyo
Japan
03-448-2001

A. Ishimaru
Univ. of Washington
EE Dept. FR-10
Seattle, WA 98195
(206) 543-2169

Tatsuo Itoh
Dept. of Electrical Eng.
Univ. of Texas
Austin, TX 78712
(512) 471-1072

David H. Jacobson
Allied Electronics Co. Ltd.
P.O. Box 935
1460 Boksburg
South Africa

Richard C. Johnson
Micro-J Inc.
467 Tenth St. N.W.
Atlanta, Ga 30318
(404) 894-3516

Howard S. Jones, Jr.
3001 Veazey Terr. N.W.
Apt. 1310
Washington, DC 20008
(202) 829-2570

W.K. Kahn
George Washington Univ.
Washington, DC 20052
(202) 994-7186

Gideon Kantor
10702 Kenilworth Ave.
Garrett Park, MD 20896
(301) 443-3840

Shoei Kataoka
Eng. Ctr./Sharp Corp.
2613-1 Ichinomoto-Cho
Tenri-City Nara 632
Japan
07436-5-1321

Irving Kaufman
Arizona State Univ.
Dept. Elec. & Comp. Eng.
Tempe, AZ 85281
(602) 965-3694

K.C. Kelly
6944 Kester Ave. #105
Van Nuys, CA 91405
(213) 886-1501

A.R. Kerr
Natl. Radio Astronomy Observ.
2015 Ivy Rd.
Charlottesville, VA 22903
(804) 296-0363

Hiroshi Kikuchi
3-8-18 Komagome
Toshima-Ku
Tokyo
Japan

Hisao Kimura
2-1-1 Hodakubo
Hino Shi
Tokyo 191
Japan
0425-91-5111

Ray J. King
Lawrence Livermore Natl. Labs.
Eng. Dept. L-156
Livermore, CA 94550
(415) 423-2369

Ronold W.P. King
92 Hillcrest Pkwy.
Winchester, MA 01890
(617) 729-5616

Werner Kleen
Denningerstr 36
8 Munich 80
West Germany
089-983935

Reinhard H. Knerr
3015 Warba Dr.
Orefield, PA 18069
(215) 439-7505

Charles M. Knop
10500 W. 153 St.
Orland Park, IL 60462
(312) 349-3300

V. Prasad Kodali
D II/326 Pandara Rd.
New Delhi 110-003
India
9111-615317

J.A. Kong
Mass. Inst. of Tech.
Dept. of EE
Room 36-393
Cambridge, MA 02139
(617) 213-5625

Y. Konishi
1-29-4 Kamitsuruma
Sagamihara
Kanagawa 228
Japan
0473-79-1111

Nobuaki Kumagai
Osaka Univ.
Dept. Ele. Comm. Eng.
Yamadakami-Suita City
Osaka
Japan
06-877-5111

W.H. Kummer
1310 Sunset Ave.
Santa Monica, CA 90405
(213) 399-5606

H.J. Kuno
28009 Seashell Way
Rancho Palos Verde, CA 90274

K. Kurokawa
Fujitsu Laboratories, Ltd.
1015 Kamikodanaka
Nakahara-Ku
Kawasaki
Japan
044-777-1111

R. La Rosa
314 Oak St.
South Hempstead, NY 11550
(516) 351-4342

Peter D. Lacy
Wiltron
490 Jarvis Dr.
Morgan Hill, CA 95037
(415) 969-6500

R.E. Lafferty
9 Whitewood Dr.
Morris Plains, NJ 07950

P.M. Lapostolle
3 Rue Victor Daix
Neuilly Sur Seine 92200
France

Vincent Learned
Palomar Mountain, CA 92060
(619) 265-5718

Matthew T. Lebenbaum
80 Whitehall Blvd.
Garden City, NY 11530

Ralph Levy
KW Engineering, Inc.
4565 Ruffner St.
San Diego, CA 92111
(619) 571-8444

Hans J. Liebe
380 Fox Dr.
Boulder, CO 80303
(303) 497-3310

Charles A. Liechti
Rockwell International Corp.
Science Center
1049 Camino Dos Rios
P.O. Box 1085
Thousand Oaks, CA 91360
(805) 373-4745

James C. Lin
Univ. of Illinois Chicago
Bioengineering Dept.
Chicago, IL 60680
(312) 996-2331

Yuen Tze Lo
EE Dept., Univ. of Illinois
Urbana, IL 61801

J-A-M Lyon
Univ. of Michigan
3241 EECS Bldg.
Ann Arbor, MI 48109

A.B. Macnee
1911 Austin Ave.
Ann Arbor, MI 48104
(313) 764-4328

R.J. Mailloux
98 Concord Rd.
Wayland, MA 01778
(617) 861-3710

T. Makimoto
Setsunan Univ.
Dept. of Elec. Eng.
Fac. Eng. 17-8 Ikeda-Nakamachi
Neyagawa Osaka 572
Japan
0720-26-5101

Nathan Marchand
Marchand Elec. Labs.
311 RIversville Rd.
Greenwich,. CT 06831
(203) 869-4183

Rovert Mattauch
2455 Foxpath Ct. Westwoods
Charlottesville, VA 22901

George L. Matthaei
Univ. of California
Elec. Eng. & Comp. Sci.
Santa Barbara, CA 93106
(805) 961-3504

F. Mayer
92/98 Bd. Victor Hugo
92115 Clichy
France
1-893-44-44

P.E. Mayes
1508 Waverly Dr.
Champaign, IL 61821
(217) 244-0543

R.E. McIntosh
Univ. of Massachusetts
Dept. of Elec. & Comp. Eng.
Amherst, MA 01003

David N. McQuiddy, Jr.
2409 Mesa Dr.
Richardson, TX 75080
(214) 995-2808

K.K. Mei
Univ. of Calif.
Dept. of EE
Berkeley, CA 94720
(415) 642-4106

P. Meier
63 Aintree Rd.
Westbury, NY 11590

Robert G. Meyer
Univ. of Calif.
Elec. Engnr.
Berkeley, CA 94720

Thedore G. Mihran
Gen. Elect. Co.
Bldg. KW-C 1319
Corporate Res. & Dev.
Schenectady, NY 12345
(518) 385-4497

Edmund K. Miller
Rockwell International Corp.
1049 Camino Dos Rios
P.O. Box 1085
Thousand Oaks, CA 91360
(805) 373-4297

S.E. Miller
67 Wigwam Rd.
Rumson, NJ 07760

Fumio Minozuma
3-10-705 Shibuya 3-Chome
Shibuyaku
Tokyo 150
Japan

Raj Mittra
Univ. of Illinois
Dept. of Elec. & Comp. Eng.
1406 W. Green St.
Urbana, IL 61801
(217) 333-1202

Shota Miyairi
c/o Denki Gakkai
1-12-1 Yurakucho
Chioda-Ku Tokyo
Japan
03-201-0983

Kazuhiro Miyauchi
3-17-41 Shimo-Ochiai
Shinjuku
Tokyo 161
Japan
03-260-4271

Louis F. Moose
Box 159, Rt. 5
Quakertown, PA 18951

Kiyoshi Morita
2-1-24 Zushi
Zushi-Shi
Kanagawa-Pref
Japan

A.S. Mostafa
Alexandria Univ.
Faculty of Eng.
Alexandria
Egypt

G. Mourier
Thomson-CSF-TDH
2 Rue Latecoere
78140 Velizy Villa Coublay
France
946-9690

C.A. Muller
Odinksveld 8
7491 HD Delden
Netherlands

James H. Mulligan, Jr.
12121 Sky Lane
Santa Ana, CA 92705

William W. Mumford
4 Craydon St.
Morris Plains, NJ 07950
(201) 538-7392

N.S. Nahman
Picosecond Pulse Labs
P.O. Box 44
Boulder, CO 80306
(303) 443-1249

Tsuneo Nakahara
Sumitomo Electric Inds. Ltd.
1-3 Shimaya 1-Chome
Konohana-Ku Osaka 554
Japan

H.C. Nathanson
Westinghouse Corp.
Res. & Dev. Center
Beulah Rd.
Pittsburgh, PA 15235
(412) 256-7544

J. Nishizawa
Res. Inst. of Elec. Comm.
Tohoku Univ.
Katahira 2-1-1 Sendai 980
Japan
022-222-5452

Tatsuji Nomura
3-3 Sakuradai
Nerima Ku
Tokyo
Japan

J.B. Oakes
3890 Jennings Chapel Rd.
Woodbine, MD 21797
(703) 841-8861

Kanichi Ohashi
Iwatsu Electric Co. Ltd.
7-41 1-Chome Kugayama
Suginam-Ku
Tokyo 168
Japan

Sogo Okamura
4-12-15 Numabukuro
Nakano-Ku
Tokyo 165
Japan
03-294-1551

Herman C. Okean
LNR Communications, Inc.
180 Marcus Blvd.
Hauppauge, NY 11788
(516) 273-7111

T. Okoshi
Univ. of Tokyo, Dept. of EE
Bunkyo-Ku
Tokyo
Japan
03-812-2111

Seymour Okwit
LNR Communications, Inc.
180 Marcus Blvd.
Hauppauge, NY 11788

A.A. Oliner
Polytechnic Institute of NY
333 Jay Street
Brooklyn, NY 11201
(718) 643-2111

H.G. Oltman
23411 Dolorosa St.
Woodland Hills, CA 91367
(818) 341-4010

Murray Olyphant, Jr.
8609 Hidden Bay Trail
Lake Elmo, MN 55042
(612) 733-1689

John M. Osepchuk
248 Deacon Haynes Rd.
Concord, MA 01742
(617) 863-5300

D.T. Paris
Georgia Tech.
School of EE
Atlanta, GA 30332

Don Parker
4500 Park Allegra
Calabasas, CA 91302
(213) 615-2576

W.T. Patton
152 Ramblewood Rd.
Moorestown, NJ 08057
(609) 778-2730

P. Penfield, Jr
17 Bradford Rd.
Weston, MA 02193

Barry Perlman
22 Washington Dr.
Cranbury, NJ 08512
(609) 734-2661

Leon Peters, Jr.
1410 Lincoln Road
Columbus, OH 43212

John E. Pippin
Electromagnetic Sciences, Inc.
125 Technology Park/Atlanta
Norcross, GA 30092
(404) 448-5770

Louis Pollack
15321 Delphinium Ln.
Rockville, MD 20853
(301) 929-1295

Wilbur L. Pritchard
9201 Laurel Oak Dr.
Bethesda, MD 20817
(301) 652-4660

R.A. Pucel
427 South St.
Needham, MA 02192

John F. Ramsay
212 N. Townsend St.
Apt. 104
Syracuse, NY 13203

Jorg E. Raue
28813 Rothrock Dr.
Rancho Palos Verde, CA 90274
(213) 535-7409

Herbert J. Reich
8 Park St.
Groveland, MA 01834

I. Reingold
409 Runyon Ave.
Deal Park
Deal, NJ 07723
(201) 543-3937

John D. Rhodes
The Univ. Dept. of Elec. and
Electronic Eng. LS2 9JT
Leeds
England

H.J. Riblet
10 Michigan Dr.
Natick, MA 01760

L.J. Ricardi
750 W. Sycamore Ave.
El Segundo, CA 90245
(213) 216-5776

Robert A. Rivers
52 Orlando Ave.
Winthrop, MA 02152

Peter N. Robson
46 Canterbury Ave.
Sheffield
England
0742-768555

George P. Rodrigue
GA Inst. of Tech.
School of EE
Atlanta, GA 30332
(404) 894-2944

H.A. Rosen
14629 Hilltree Rd.
Santa Monica, CA 90402

F. J. Rosenbaum
445 Oakley Dr.
St. Louis, MO 63105
(314) 889-6157

Charles T. Rucker
GTRI Georgia Tech.
EML PSD
Atlanta, GA 30332
(404) 894-3420

Carl R. Ryan
Motorola, Inc.
2501 S. Price Rd.
Chandler, AZ 85248
(602) 892-2100

R.M. Ryder
21 Sunset Dr.
Summit, NJ 07901

Theodore S. Saad
3 Huron Dr.
Natick, MA 01760
(617) 653-0844

Rudolf Saal
Chairman–Inst. Netzwerktheorie
Tech. University
Arcisstrasse 21
D-8000 Munich West Germany
89-2105-8501

C.T. Sah
Univ. of Illinois
Dept. of Elec. Eng.
1406 Green St.
Urbana, IL 61801

S. Saito
15-6 Kamiuma 5-Chome
Setagaya-Ku
Tokyo 154
Japan

Adel A.M. Saleh
AT&T Bell Lab.
Box 400
Holmdel, NJ 07733

E.W. Sard
49 Harriet Lane
Huntington, NY 11743
(516) 595-4215

Gentei Sato
4-1-37 Kamikizaki
Urawa Saitama-Ken
Japan

R. Sato
Tohoku Gakuin Univ.
1-13-1 Chuo
Tagajo 985
Japan

Erwin Schanda
Inst. of Applied Physics
Sidlerstrasse 5
3000 Berne
Switzerland
031-658910

A.C. Schell
14628 Dunbarton Dr.
Upper Marlboro, MD 20772
(617) 861-3700

S.P. Schlesinger
Columbia Univ.
Dept. of Elec. Eng
New York, NY 10027
(212) 280-3103

Ernst F. Schloemann
38 Brook Road
Weston, MA 02193
(617) 860-3041

K.J. Schmidt-Tiedemann
Philips Forschungslabor
Vogt-Kolln-Strasse 30
2 Hamburg 54
West Germany
040-5493710

H.J. Schmidt
Inst. Fur Hochfrequenztechnik
der Rwth
Melatenerstrasse 25
D 51 Aachen
West Germany
0241-807931

Martin V. Schneider
46 Line Rd.
Holmdel, NJ 07733
(201) 949-2503

Manfred R. Schroeder
Buergerstrasse 42-44
34 Goettingen
West Germany
0551-397713

Harald Schutz
13801 York Rd.
Box V-3
Cockeysville, MD 21030
(301) 377-5725

Harold Seidel
40 Skyline Dr., RD 2
Wareen
Plainfield, NJ 07060
(201) 386-6753

T. Sekiguchi
Tokyo National Tech. Coll.
1220-2 Kunugida-Machi
Hachioji-Shi
Tokyo 193
Japan
0426-61-3066

S. Sensiper
6011 Holt Ave.
Los Angeles, CA 90056
(213) 670-3713

Hans Severin
Ruhr Univ. Bochum.
Inst. F HF Techn. Geb. 1C
D-4630 Bochum 1
West Germany
0234-7002842

Gustave Shapiro
3704 Munsey St.
Silver Spring, MD 20906

W.M. Sharpless
63 Riverlawn Dr.
Fair Haven, NJ 07701
(201) 741-5852

J.P. Shelton, Jr.
11000 Oakton Woods Way
Oakton, VA 22124
(703) 841-9267

Liang-Chi Shen
Univ. of Houston
EE Dept.
Houston, TX 77004

James E. Shepherd
P.O. Box 27
Concord, MA 01742
(617) 369-3140

A.J. Simmons
P.O. Box 103
Winchester, MA 01890

George Sinclair
85 Mary Street
Aurora, Ontario
Canada L4G 3G9
(416) 727-0165

Glenn S. Smith
Electrical Engineering Dept.
Georgia Inst. of Technology
Atlanta, GA 30332
(404) 894-2922

A.K. Smolinski
Polna 54 M 48
00644 Warsaw
Poland

Harold Sobol
7031 Hunters Ridge Road
Dallas, TX 75420
(214) 996-5881

Isao Someya
NEC Corporation
4-1-1 Miyazaki Miyamaeku
Kawasaki 213
Japan

Peter I. Somlo
c/o National Measurement Lab.
P.O. Box 218
Lindfield NSW 2070
Australia
02-467-6505

Gunther U. Sorger
25 Lerida Ct.
Menlo Park, CA 94025
(408) 730-2880

Fred Sterzer
RCA Labs
Princeton, NJ 08540

G. Strull
Westinghouse Elec. Corp.
P.O. Box 1521-ATL, MS 3519
Baltimore, MD 21203
(301) 765-7321

M. Strutt
Kraebuehlstr 59
Zurich 8044
Switzerland
252-2055

Y. Suematsu
Tokyo Inst. of Tech.
2-12-1 O-Oakayama Meguro-Ku
Tokyo 152
Japan
03-726-1111

K. Suetake
10-11 3-Chome Minami
Meguro-Ku
Tokyo 152
Japan
045-481-5661

Masao Sugi
Sumitomo Electric Ind. Ltd.
Taya Cho 1 Tozukka Ku
Yokohama Kanagawa Ken
Japan
045-851-1281

C. Burke Swan
AT&T Bell Labs
555 Union Blvd.
Allentown, PA 18103
(215) 439-7849

Calvin T. Swift
55 Cherry Lane
Amherst, MA 01002
(413) 545-2136

R.S. Symons
290 Surrey Pl.
Los Altos, CA 94022

Geo Szentirmai
1353 Sarita Way
Santa Clara, CA 95051
(408) 554-1469

Chen-To Tai
1155 Arlington Blvd.
Ann Arbor, MI 48104
(313) 764-0500

Michio Takaoka
The Fujikura Cable Works Ltd.
5-1 Kiba 1-Chome Koto-Ku
Tokyo 135
Japan
03-647-1111

T. Tamir
333 Jay St.
Brooklyn, NY 11201
(718) 643-4895

Ikuo Tanaka
4-20-5 Fujishiro-Dai
Suita
Osaka 565
Japan

Jesse J. Taub
115 Northgate Circle
Melville, NY 11747

G.A Thiele
Univ. Dayton
KL 262
300 College Park Ave.
Dayton, OH 45469
(513) 229-2243

T.E. Tice
545 N. Miller St.
Mesa, AZ 85203
(602) 965-5974

F.J. Tischer
2313 Wheeler Rd.
Raleigh, NC 27612

M.E. Tiuri
Takojantie 1F
02130 Tapiola
Finland
90-4512545

K. Tomiyasu
GE Co-Valley Forge Space Ctr.
P.O. Box 8555
Philadelphia, PA 19101
(215) 354-5740

E.N. Torgow
9531 Donna Ave.
Northridge, CA 91324
(818) 349-5168

C.H. Townes
Univ. of Calif.
Dept. of Physics
Le Conte Hall
Berkeley, CA 94720
(415) 642-1128

Michiyuki Uenohara
4-22-14 Minamiyukigaya
Ota-Ku
Tokyo 145
Japan
03454-1111

A. Uhlir, Jr.
Dept. of Electrical Eng.
Tufts University
Medford, MA 02155
(617) 628-5000

Fawwaz T. Ulaby
Univ. of Michigan
Radiation Lab.
Dept. of Electrical & Comp. Eng.
4072 East Engineering Bldg.
Ann Arbor, MI 48109

H.G. Unger
Inst. fur Hochfrequenztechnik
Technische Universitat
33 Braunschweig
West Germany
0531-391-2422

J.G. Van Bladel
Univ. Ghent
Sint Pietersnieuwstraat 41
B-9000 Ghent
Belgium
091-233821

A.S. Vander Vorst
Univ. Catholique de Louvain
Batiment Maxwell-Elec. Hyperfre
B1348 Louvain la Neuve
Belgium
010-432300

J.R.M. Vaughan
2 Sequoia Way
Redwood City, CA 94061
(415) 591-8411

D.L. Waidelich
Univ. of Missouri
Dept. of Elec. & Comp. Eng.
Columbia, MO 65211
(314) 882-6074

J.R. Wait
Univ. of Arizona
Dept. of Elec. Eng. & Comp.
Tucson, AZ 85721
(602) 621-6170

C.H. Walter
13208 Tining Dr.
Poway, CA 92064
(619) 592-3254

Chao C. Wang
12 Chestnut Ridge Rd.
Holmdel, NJ 07733
(201) 264-1453

Shyh Wang
EECS Department (Cory Hall)
Univ. of California
Berkeley, CA 94720

Hugh E. Webber
4304-E Valley Ave.
Pleasanton, CA 94566

E. Weber
P.O. Box 1619
Tryon, NC 28782

Sander Weinreb
1506 Grove Rd.
Charlottesville, VA 22901
(804) 296-0231

Bruno O. Weinschel
P.O. Box 576
Gaithersburg, MD 20877
(301) 948-3434

James O. Weldon
5205 Park Ln.
Dallas, TX 75220
(214) 381-7161

R.J. Wenzel
5431 Lockhurst Dr.
Woodland Hills, CA 91364
(818) 889-3232

Harold A. Wheeler
59 Derby Place
Smithtown, NY 11787
(516) 261-7000

Lawrence R. Whicker
1218 Balfour Dr.
Arnold, MD 21012
(301) 765-7264

J.R. Whinnery
Univ. of California
EE Dept.
Berkeley, CA 94720

J.F. White
7 Hadley Rd.
Lexington, MA 02173

A.E. Williams
COMSAT Labs.
2230 Comsat Dr.
Clarksburg, MD 20871
(301) 428-4067

Richard C. Williamson
MIT Lincoln Lab
Rm. C-317, P.O. Box 73
Lexington, MA 02173
(617) 863-5500

Donald R. Wilton
Dept. of Electrical Eng.
Univ. of Houston
University Park
Houston, TX 77004
(713) 749-1875

James C. Wiltse
Georgia Inst. of Technology
Georgia Tech. Res. Inst.
Atlanta, GA 30332
(404) 894-3494

William R. Wisseman
5747 Melshire Dr.
Dallas, TX 75230
(214) 995-2451

E.A. Wolff
1021 Cresthaven Dr.
Silver Spring, MD 20903

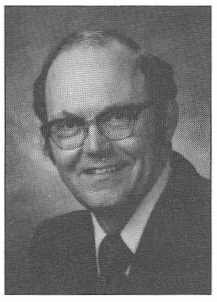
Eikichi Yamashita
Univ. Elec. Comm.
1-5-1 Chofugaoka Chofu-Shi
Tokyo 182
Japan
0424-83-2161

Leo Young
6407 Maiden Lane
Bethesda, MD 20817
(202) 697-3228

Dr. Karl H. Zaininger
Siemens Corp.
Res. & Support Inc.
Princeton Forrestal Ctr.
105 College Rd. East
Princeton, NJ 08540
(609) 734-6500

L.T. Zitelli
770 Northampton Dr.
Palo Alto, CA 94303

PCs for MTT



E.K. Miller
Rockwell Internatonal Corp.
1049 Camino Des Rios
P.O. Box 1085
Thousand Oaks, CA 91360
(805) 373-4297

Software Exchange

When this column began a few years ago, I was unable to find a similar feature in other IEEE publications. Recently, I was sent some samples of a new column of the IEEE Circuits and Devices Magazine which began with the November 1986 issue. The column, titled "The PC in Electrical Engineering", is written by Dr. Miles A. Copeland, Department of Electronics, Carleton University, Ottawa, Ontario, Canada K1S-5B6, telephone (613) 564-4388. To quote from Dr. Copeland's first column, he intends to concentrate on three major themes:

1) Review of PC software both proprietary and public domain, that is of interest to the electrical engineering community.

2) Contributions by an organization willing to share information about their PC user environment. This is intended to be complementary to theme (1) and an organizational view can be taken, such as how an assembly of PCs has been integrated for communications or teaching in an industrial organization or university. This context can also include review of PC software that has been in use for a period of time in that organization.

3) Discussion of hardware. This theme is of lower priority, but may arise where it has a bearing on the viability of using the PC for the purposes stated, or where particular PC configurations are required.

After stating that he is looking for "subeditors" to take over the column periodically, Dr. Copeland mentions that he is hoping to promote software exchange. A colleague in his department, Dr. Tad Kwasniewski, telephone (613) 564-6753, is the contact for this activity, either using telephone file transfer via Kermit, or by regular mail. Judging by excerpts that I have seen of his January and May 1987 columns (my request for copies of past columns has so far remained unanswered, possibly because of problems with the mail in Canada), Dr. Copeland has been quite successful. The January column contained reviews of two about-to-be-published books on using PCs in engineering by Dr. J.R. Greenbaum and Dr. J.C. Nash. The latter has extended reviews of two proprietary SPICE packages PSPICE (by MicroSim) and IS SPICE (Intusoft). Dr. Copeland also provides his own assessment of these packages, including some benchmarking. He has also agreed that information included in his column is welcome to PCs for AP, so that as soon as the mail problem is resolved, I hope to give you more details.

There is an interesting article concerning software distribution in the May 1987 issue of Communications of the ACM by J.J. Dongarra and E. Grosse titled "Distribution of Mathematical Software via Electronic Mail". A new system, netlib, has been initiated "to provide quick, easy, and efficient distribution of public-domain software to the scientific computing community on an as-needed basis." The software is accessed by sending a request via electronic mail to *netlib@anl-mcs* on the Arpanet or to *research!netlib* on the UNIX UUCP network. Gateways are also provided to foreward mail from other networks such as CSNET, Telenet, and BITNET. The two addresses above are respectively at Argonne National Laboratory near Chicago, Illinois and at the AT&T Bell Labs in Murray Hill, New Jersey.

A request is made up of lines of one of the following forms:

send Index.
send index from *library.*
send routines from *library.*
find *keywords.*

The amount of public-domain software now available through netlib is impressive.

Fred Deadrick of LLNL was kind enough to download some EISPACK routines for me to try out on the Macintosh, but I haven't yet gotten around to testing them. At any rate, Fred was able to establish that Arpanet file transfers do work and provide access to the software listed above.

As benefits of the netlib approach are cited the lack of administrative channels needing to be threaded, the absence of human intervention thus making it possible to get software at the requestor's convenience, availability of the most up-to-date version, and access to individual routines rather than needing to collect the whole package in which the routine(s) reside. On the other hand, it must be noted that netlib is simply a clearinghouse, so *caveat emptor.*

Future plans include the possibility of adding associate editors who might wish to augment the collection in areas of special interest. This might include electromagnetics codes, as one example. Also, consideration is being given to adding other depositories, which might be especially useful for other countries where access to US electronic mail networks is impractical. We might want to consider using netlib for codes of interest to AP, MTT, and EMC.

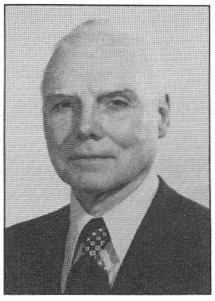
Spreadsheets

If you're interested in using spreadsheets in engineering and you have a really good memory, you may recall that in the June 1984 column I cited several books that discussed such applications. Recently, Dan Higgins [1940 Veronica Springs Rd., Santa Barbara, CA 93105, Tel. (805) 682-5248], sent me a reprint which describes modeling transmission-line transients using a spreadsheet, in this case Microsoft's Excel™ Dan's paper is titled "Calculating Transmission Line Transients on Personal Computers", and is in the symposium record of the 1987 IEEE International Symposium on Electromagnetic

continued on page 20

Compatibility, Atlanta, GA, p. 260-265. The time-dependent transmission-line equations are solved in a "leapfrog" grid, and the computed results plotted using the graphics built into Excel. As Dan points out, the convenience provided by using a spreadsheet for such calculations is paid for somewhat by decreased running speed compared with a specialized program. Using 20 spatial cells, about 2.5 seconds per time step are needed for the spreadsheet calculation whereas a compiled Forth program does the same problem more than 25 times faster.

CAN AN AIRPLANE FLY FOREVER?



by William C. Brown

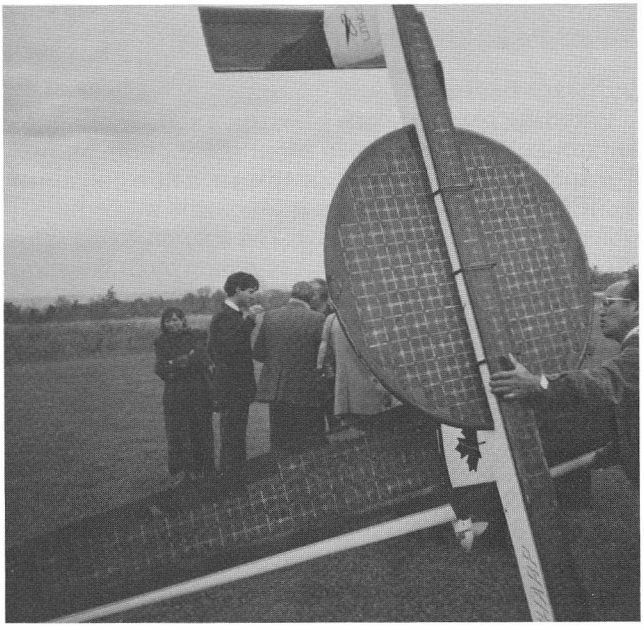
This rheotorical question deserves an equally rhetorical answer: "Yes!- if it is powered by the weightless fuel derived from a microwave beam".

"Can an airplane fly forever?", was the caption of a story in Newsweek magazine published on September 28, 1987 in anticipation of a successful demonstration of a microwave-powered airplane by the Canadian Communications Research Center. Actually, before the article was published, the Canadian team had already made electronic and aeronautical history with the first free flight of a microwave-powered airplane on September 17.

On October 6th the Canadian government gave a demonstration of the airplane and the microwave system to the international news media which I attended and will describe in this article. Because of my early association with the Canadian program started in 1981 I had been invited to attend the demonstration as their guest, and in anticipation had arrived the previous evening. A member of their team, John Martin, picked me up at my motel at 6:30 in the morning and drove me to the site at the Communications Research Center in Ottawa where the demonstration was scheduled to get underway at 8:00 A.M. It was a chill, gray day and threatening rain. Many of the media personnel were already there, sipping coffee and warming themselves in the tent which had been erected for such a contingency.

Sharply at 8:00, Canada's Communications Minister, Miss Flora MacDonald, stepped up to a podium in the middle of the flight field and briefly described the anticipated demonstration. She also addressed the longer range purposes and objectives of the Canadian program with the acronym SHARP-for Stationary High Altitude Relay Platfrom.

"I am proud to participate in launching what we believe is a unique aircraft," Miss MacDonald said. "When fully developed, it is expected to be capable of flying at heights up to 20 km above the earth for months at a time. It was developed by Department of Communications researchers to fill a need for a less-expensive complement to communications satellites."



Members of the Canadian Communications Research Center display microwave rectenna to the media at the historic demonstration of the free flight of a microwave beam powered airplane at Ottawa, Canada on October 6, 1987. The rectenna, attached to the bottom of the airplane, is the critically important component that absorbs energy from a microwave beam and efficiently converts it to DC power to drive an electric motor attached to a propellor.

After the Minister's introduction, the airplane was carried from the hangar. It was an 1/8 scale of the full sized high altitude airplane. The model closely simulated the essential design parameters of the high altitude airplane. Such an airplane must have a large wing area relative to its weight to enable it to fly slowly in circles small enough to be tracked by an electronically steerable microwave beam. At such slow speeds it can fly on relatively low power-15 to 25 horsepower at 70,000 ft. altitude. The scale model to be flown that day had a fifteen foot wing spread but weighed only ten pounds. The maximum electric power used by the motor was 150 watts, and this produced about 100 watts of propulsive power after motor and propellor inefficiencies were taken into account.

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The airplane was launched by hand and flown up over the microwave beam on battery power. When the plane was positioned within the scanning range of the microwave beam, the microwave beam locked onto the airplane and used a closed-loop optical system to track the airplane. Then the battery power was turned off and the airplane continued to fly on power absorbed from the microwave beam by the "rectenna", the special device that absorbs the microwave power and simultaneaously converts it to DC electric power at 85% efficiency to drive the electric motor.

The flight of the airplane was controlled from the ground by a Canadian champion in the art of radio-controlled model aircraft. Once the microwave beam was captured, the airplane could be flown anywhere within the 50^0 cone angle of the mechanically steerable transmitting antenna, demonstrating the non-directive property of the rectenna receiving device.

I was particularly interested in the Canadian approach to designing the all-important rectenna and interfacing it with the airplane. Basically, the rectenna consists of a sandwich of a foreplane, a reflecting plane, and a spacing of about two centimeters between them which can be void of material or filled with a low-mass foam material with low dielectric constant and low loss. The thin-film, etched-circuit foreplane is the key portion because it performs the functions of absorbing the microwave power, rectifying and filtering it to ripple-free DC power, and bussing the DC power. The reflecting plane is a metallized film serving only to boost the rectenna collection efficiency to 100%

The laboratory-produced foreplane sections that we in the New Products Center at Raytheon had supplied the Canadian team several years ago and upon which they based their rectenna work were linearly polarized and made use of a special high quality GaAs Schottky barrier diode as a rectifier. Unable to obtain such diodes at an acceptable cost level, the Canadian team made use of lower power and less efficient silicon diodes, used in a replacement ratio of 4 to 1. They also solved the compatibility problem between a circling airplane and a linearly polarized rectenna by designing a two-ply construction consisting of two foreplanes oriented 90^0 with respect to each other. The resulting cross-polarized foreplane assemblies were then cemented onto the underside of wings and a large disc attached to the fuselage of the airplane. The total foreplane weight was a little over one pound.

All of the 420 rectenna elements comprising a rectenna area of approximately one square meter were operated in parallel to energize the motor that had an input resistance of one ohm when operating. Such an arrangement provided a high level of redundancy and eliminated diode failure as a problem. None of the eight microwave-powered flights that were made prior to the public demonstration were interrupted because of rectenna problems, even though the rectenna was hard-wired to the electric motor with no intervening power conditioning.

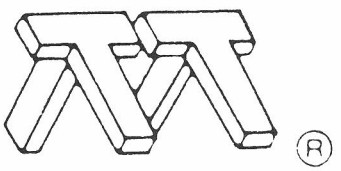
Although of less interest to our Society, the Canadian activity on the airplane design was also outstanding. The design used in the demonstration was the fifth reiterative design to be wind-tunnel or flight tested, but an improved design incorporating a canard in the front has already been flight tested. The Canadian design approach features a high aspect ratio wing for flight efficiency and compensates for the inappropriateness of such a wing for rectenna mounting with a large disc attached to the fuselage. A disc, however, is a very inefficient lifting body and must be trimmed for zero lift to minnimize drag.

While the Canadian rectenna and air frame developments are impressive, they have been compelled for economic reasons to improvise the transmitting antenna for the demonstration from technology that is not directly applicable to the transmitting facility for the full scale, high altitude system or even for the intermediate system. Hence, the choice of a suitable transmitter approach to a full scale system which, hopefully, could be tested in the intermediate system, is of immediate importance in the planning exercises.

I went to Ottawa expecting to see a historical event, the first free flight of a microwave-powered aircraft. But then I realized that historical event was just part of the larger Canadian SHARP program that has developed a lot of momentum. The Canadian team that had to be capable and broad-based to successfully integrate many different disciplines into a successful demonstration have accumulated an impressive amount of experience and know-how that positions them well for the next stage they are now planning—a half-scalelane of sixty foot wing span together with a microwave subsystem capable of flying the airplane at an altitude of two miles, to be completed in two years. The momentum that they have contrasts sharply with any programs in the United States which can, at best, be described as being in the study stage.

How long can an airplane fly? Not forever, of course, but the highly redundant all-electric, propellor-driven propulsion system should have a life expectancy of 10 years, barring failure of its few mechanical parts, limited to the motor bearings and the gear train driving the propellor. The mission endurance of the airplane will initially be limited by some fatigue aspect of the aircraft itself or of the payload. But such failure modes can probably be alleviated with experience and time. If the SHARP system is developed, I would venture a year as the most probable on-station endurance time for an airplane in a mature system.

In the meantime we congratulate our Canadian colleagues for their historical achievement and for their successful pioneering in a new field that could be of great significance to our Society as it unfolds and develops.



IEEE MICROWAVE THEORY AND TECHNIQUES SOCIETY

David N. McQuiddy, Jr.
1987 President

PLEASE REPLY TO:
Texas Instruments
P.O. Box 660246, MS 245
Dallas, TX 75266 USA
(214) 995-2808

3 November 1987

Dr. Ronald Barrington
Director General, Communications Technologies
Communications Research Centre
P.O. Box 11490, Station H
Ottawa, Ontario K2H8S2
Canada

Dear Dr. Barrington:

On behalf of the Administrative Committee of the IEEE Microwave Theory and Techniques Society, I congratulate you and your staff for the successful demonstration of the first free flight of a microwave powered aircraft. This is indeed exciting news to our Society that specializes in microwave technology and its applications.

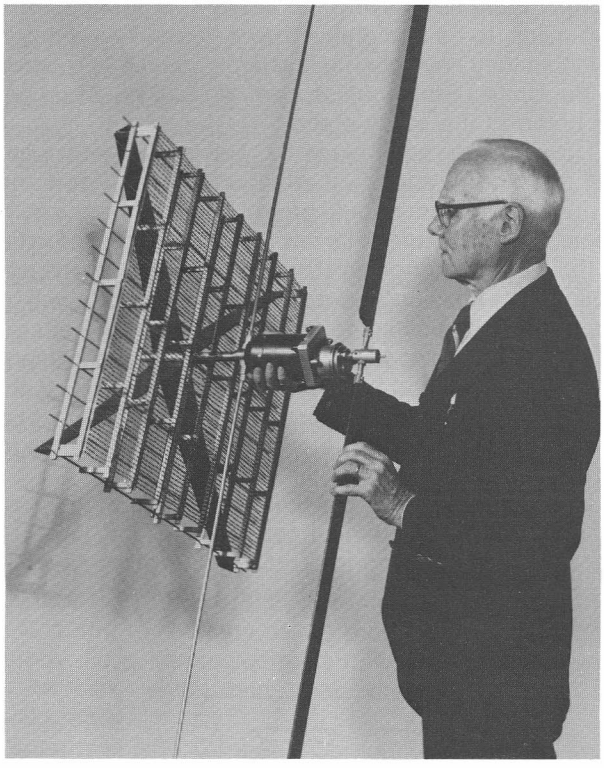
Microwave powered aircraft could be a significant new area for microwave applications in the future and we're looking to provide a forum at our next Microwave Symposium for publishing your results.

Your successful completion of the full scale system will provide an economical means of performing communication and surveillance functions and will do much to enhance our knowledge of the earth's upper atmosphere. We are proud of your achievements.

I'm gratified that you had invited Mr. W.C. Brown to witness your successful demonstration. Mr. Brown has pioneered in microwave-power applications and it was most fitting for him to attend this historic event.

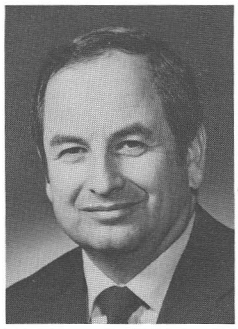
Sincerely yours,

David N. McQuiddy, Jr.



Bill Brown is not stranger to microwave-powered aircraft. Here he is shown holding a microwave-powered helicopter flown in 1964, with primitive rectenna now replaced with the light-weight film-type used on the Canadian airplane.

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 M1-41
Hartwell Road
Bedford, MA 01730
(617) 274-4184

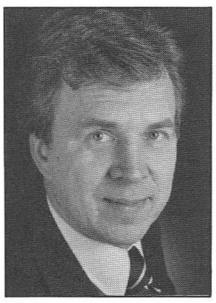
OR

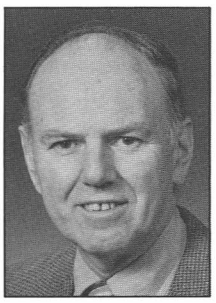
Peter Staecker
M/A-COM, Inc.
52 South Avenue, Bldg. 7
Burlington, MA 01803
(617) 272-3000, X1602

Don't rush to fill gaps in conversation. Although movies and TV present snappy dialogue that never pauses, inserting comments whenever someone else trails off disrupts his thinking ... and prevents him from saying things it may be to your advantage to hear.

The First Five Minutes by Norman King, Prentice-Hall Press, 1 G&W Plaza, New York 10023. $16.95.

UNDERSTANDING NOISE PART II





by Henry C. Paczkowski and James Whelehan
Eaton Corporation AIL Division
Melille, NY 114747

INTRODUCTION

Part I of this tutorial paper presented the basic concepts of thermal noise and how it affects system performance, as well as the fundamentals of system-level noise analyses. Part II continues with a discussion of antenna noise, a description of low noise devices that are commonly used in modern receiving systems and noise figure measurements. Noise considerations and measurements in optical receivers will also be presented, as well as an overview of the effects of phase noise and digital noise on system performance.

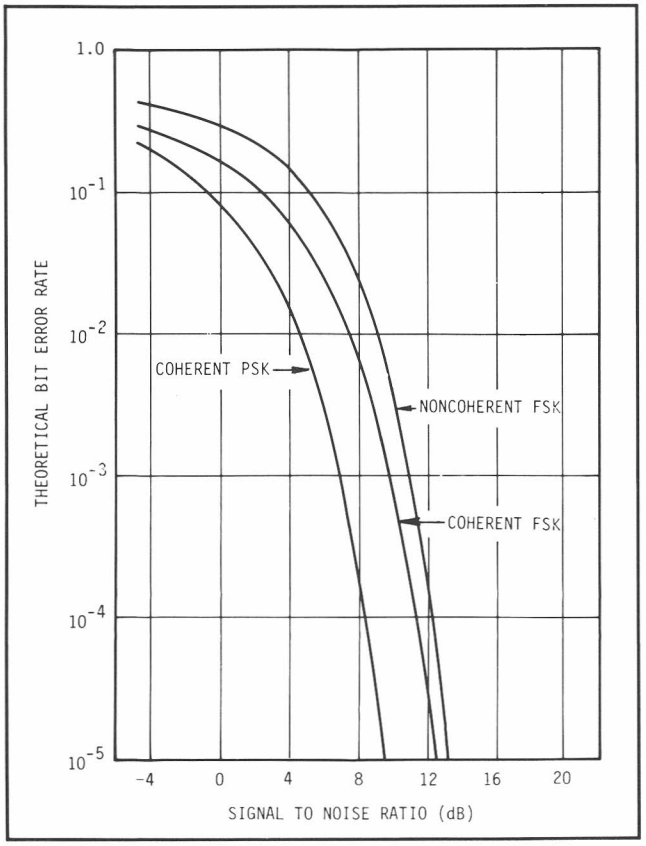


FIGURE 1. Bit Error Rate vs. Signal-to-Noise Ratio

These different types of noise (thermal, phase and digital) degrade information transfer and reduce the system signal-to-noise ratio (SNR). A perfect receiver would have an output signal-to-noise ratio that is exactly equal to the input SNR, an ideal but impractical situation. SNR is the fundamental parameter on which we focus our system design objectives, and the concepts of noise figure, noise temperature, and tangential system sensitivity presented in Part I of this article are the analytical tools that are used in quantifying SNR performance for sensitivity calculations. SNR can also be used as a design criteria for other system performance specifications.

For example, a digitally-modulated communications system can be evaluated by the bit error rate (BER) which is a function of the system's SNR. If the SNR is decreased, the BER increases and a degradation in the digital transmission of a communication message occurs. A theoretical plot of the BER for communication systems using different modulation techniques as a function of SNR is shown in Figure 1. In electronic the ability to precisely locate a target representing a potential threat is very important. A phase comparison angle-of-arrival (AOA) system is often used for this direction-finding task. Frequency error, phase measurement error, and noise all contribute to the overall AOA error. However, the rms AOA error, ε_n, due to noise [1] is:

$$\varepsilon_n = \frac{\lambda}{\pi d\,(2\ SNR)^{1/2}} \qquad (1)$$

where: λ = wavelength of the received signal
d = distance separating the two antennas in the phased array
SNR = signal-to-noise ratio

The higher the SNR, the lower the AOA error. EW receiving systems require a minimum value of SNR for detection, and also require some higher value of SNR to perform other measurement functions, such as time of arrival (TOA), pulse width (PW), pulse amplitude (PA), frequency, and AOA. The system designer must be capable of performing these interrelated system trade studies using the most economical system architecture.

ANTENNA NOISE TEMPERATURE EFFECTS

The importance of antenna noise temperature in determining overall system sensitivity (or system operating noise temperature) was shown in Part I for different types of receivers. Antenna noise temperature is a measure of the available noise power from the antenna terminals and, as described in Part I, is very similar in concept to the equivalent noise power from a resistor immersed at a particular bath temperature. From (3) of Part I,

$$T_A = \frac{P_R}{kB} \qquad (2)$$

continued on page 24

UNDERSTANDING NOISE (continued from page 23)

where:

P_R = power available from the antenna terminals
k = Boltzman's constant = 1.23 x 10^{-23} joule-sec
T_A = equivalent antenna noise temperature
B = bandwidth of the receiver system

The equivalent noise temperature of an antenna is determined by summing all the natural radiating noise sources within the antenna pattern. These semicoherent noise sources include cosmic noise, the ionosphere, the troposphere, galactic noise and the sun (collectively called sky noise or sky temperature), as well as losses and ground noise which couple into the side and back lobes of antenna. The sky noise temperature of an ideal antenna can generally be determined if the antenna pointing angle, operating frequency, and environmental conditions are known. A nonideal antenna with resistive losses, spillover and minor sidelobes will have reduced gain and a higher equivalent noise temperature. A plot of sky noise for an ideal low noise ground station antenna from 100 MHz to 100 GHz [2] is shown in Figure 2.

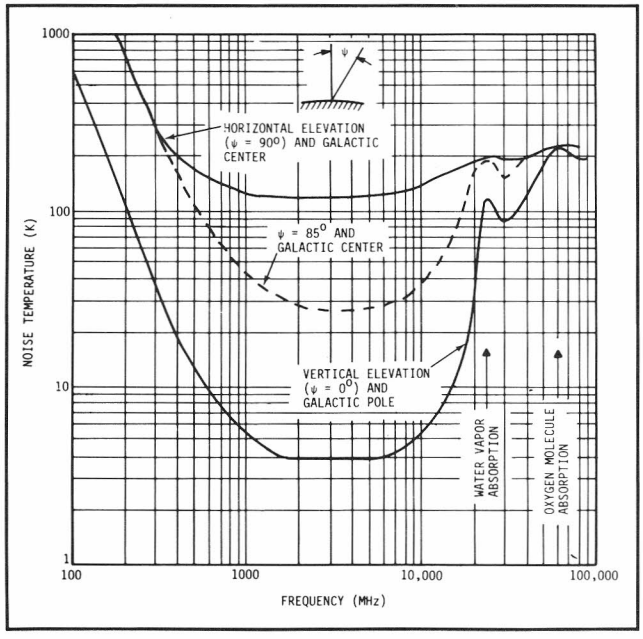


FIGURE 2. Sky Noise Temperature as a Function of Frequency and Elevation

The required noise temperature of a receiver should be carefully chosen when designing a system because receiver costs increase rapidly with relatively small improvements in sensitivity. For example, using the formula:

$$\Delta S\ (dB) = 10 \log \frac{T_{e_2} + T_A}{T_{e_1} + T_A} \qquad (4)$$

where:

ΔS = system sensitivity improvement (dB)
T_A = equivalent antenna noise temperature
T_{e_2} = Receiver Noise Temperature (higher)
T_{e_1} = Receiver Noise Temperature (lower)

it can be shown that a 3 dB improvement in receiver sensitivity (by reducing the noise temperature from 600K to 300K) yields an improvement of only 1.8 dB in system sensitivity for an antenna noise temperature of 300K. For an antenna noise temperature of 50K, the improvement in system sensitivity would be 2.7 dB.

MODERN RECEIVER FRONT ENDS

The following types of low noise front ends are described in this paper:

- Masers
- Parametric Amplifiers (Paramps)
- FET Amplifiers
- Mixers

Typical noise performance for state-of-the-art masers, paramps and FET (HEMT) amplifiers are shown in Figure 3 as a function of signal frequency. Note that the noise performance for paramps and HEMT amplifiers is shown for both room temperature and cryogenically cooled (20K) operation. As indicated in the figure, masers provide the lowest possible noise

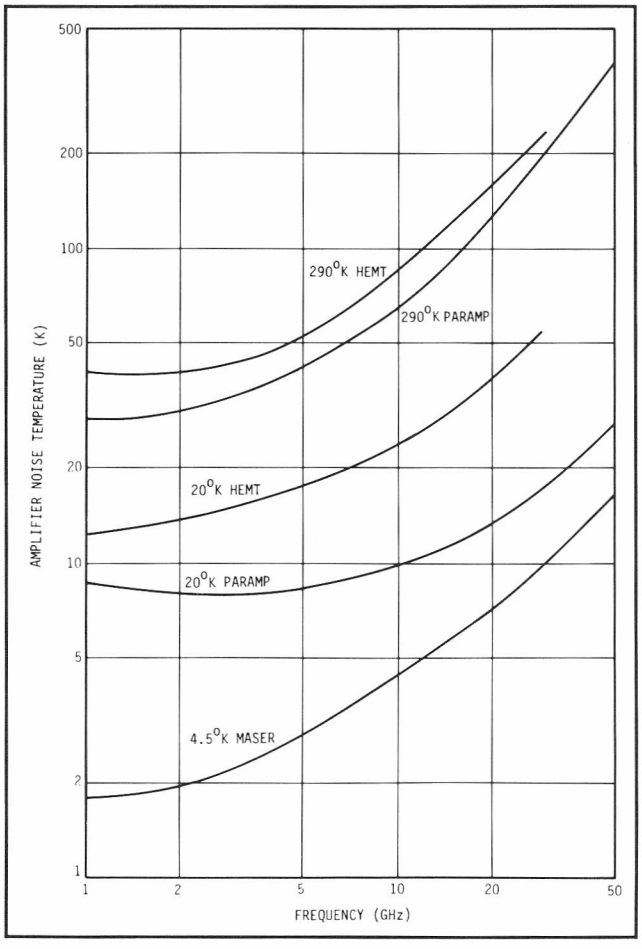


FIGURE 3. Noise Performance of Modern Receiver Front End

continued on page 25

UNDERSTANDING NOISE (continued from page 24)

temperature, while paramps and HEMT amplifiers provide higher noise temperatures (at reduced cost and complexity). Mixer noise performance will be considered separately, since the overall noise performance is highly dependent on the choice of IF amplifier center frequency and type.

Masers

Masers are the lowest noise microwave amplifiers known [3]. However, because of their high cost and the need to operate at liquid-helium temperatures (typically 4.5K or less), they are used only in applications where the ultimate in receiver sensitivity is required, such as inter-planetary spacecraft communications, planetary radar, and some radio astronomy applications.

Maser applications in field use today are typically either the travelling-wave or reflected-wave types — these have a much greater gain-bandwidth product than is available from cavity masers. Typically, the maser is cooled to 4.5K with a closed-cycle helium refrigerator, although open-cycle helium dewars are occasionally used.

The Deep Space Network (DSN) operated by Jet Propulsion Laboratory is the largest single user of low-noise maser amplifiers, with twenty-seven 2.3 and 8.45 GHz traveling-wave masers and three 23 GHz reflected-wave masers operating nearly continuously on nine steerable parabolic antennas with diameters of 34 m or 65 m [4], [5].

A recently-developed DSN 8.45 GHz traveling-wave maser amplifier [6] provides 4K noise temperature (at room temperature input connector) and approximately 46 dB gain across a 100 MHz instantaneous bandwidth as shown in Figure 4. One channel of this maser is shown schematically in Figure 5. The signal circuit consists of coaxial input and output lines connected to a slow-wave structure having a long row of half wavelength copper strips. This slow-wave structure is sandwiched on one side by a slab of single crystal ruby maser material and on the other side by a ferrite isolator strip, supported by sapphire and alumina materials. The slow-wave structure lengthens the interaction time of the input microwave signal with the maser material, and the isolator strip prevents regenerative amplification or oscillation by absorbing undesired signal frequency waves traveling in the backward direction.

The sandwiched slow-wave structure is enclosed in a rectangular channel which acts as a waveguide transmission line at the pump frequency. Pump energy is fed into one of this channel and illuminates the entire length of ruby maser material.

The reflected-wave maser is unique among maser designs in that it can provide a very large instantaneous bandwidth (up to 500 MHz) and waveguide-band tuning ranges at the higher microwave frequencies (approximately 12 GHz and above) [7]. Tunable 18 to 25 GHz reflected-wave masers [8], [9] have been implemented in a large number of radio astronomy facilities worldwide. A scaled-down version of this reflected-wave maser has been developed for 43 GHz operation at the National Radio Astronomy Observatory and a 43 GHz traveling-wave type maser amplifier is operating at MIT's Haystack Observatory.

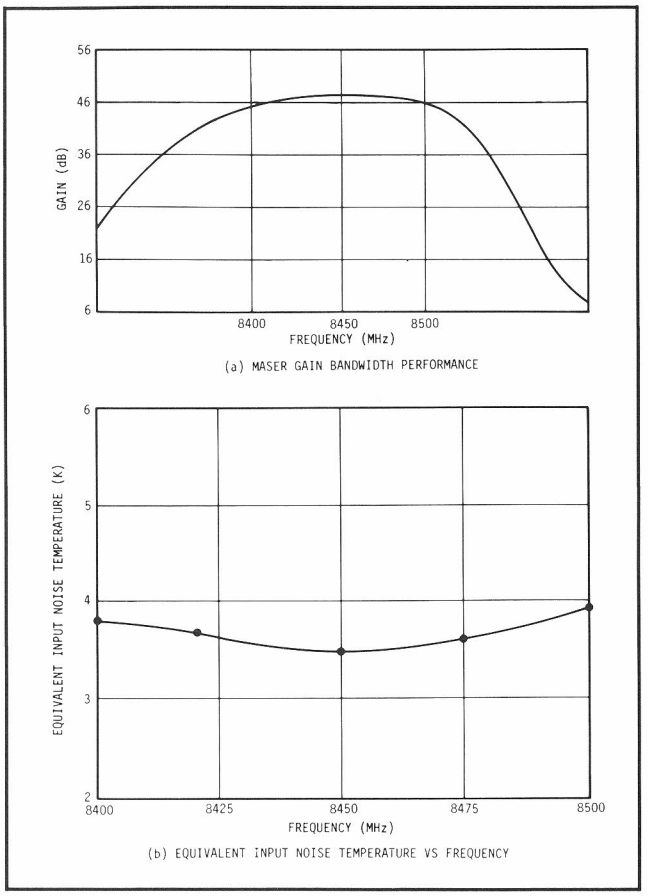


FIGURE 4. Gain and Noise Performance of X-Band Traveling Wave Maser

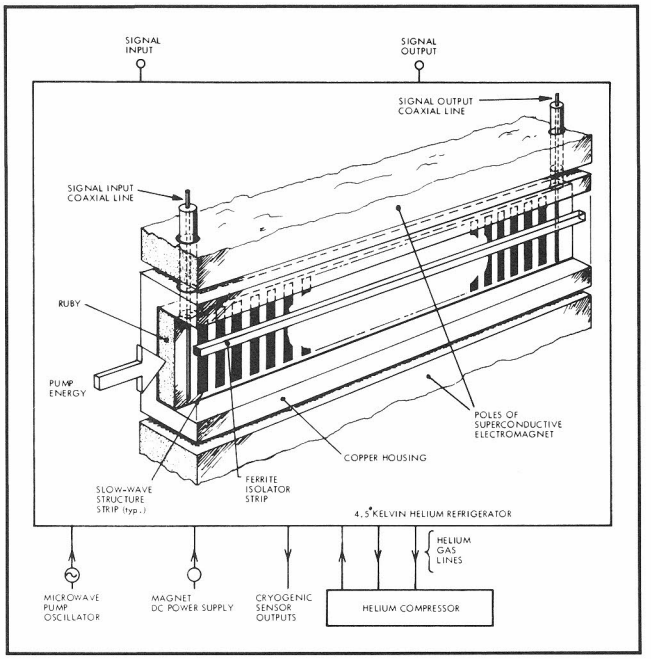


FIGURE 5. Schematic Representation of Modern Traveling-Wave Maser Amplifier

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Parametric Amplifiers

Two basic types of paramps that will be discussed are the so-called "degenerate" and "nondegenerate" amplifiers. The nondegenerate paramp is the type commonly used in communcations and radar applications. The degenerate type is used in specialized double-sideband applications where the "signal" is relatively broadband noise, such as in radio astronomy. Both types of paramps and their noise performance will be presented.

Paramps use the non-linear capacitance variation of a reverse-biased varactor diode to provide the basic amplification mechanism. As shown in Figure 6, the varactor is "pumped" at frequency f_p, which is usually an order of magnitude higher than the frequency, f_s, of the signal to be amplified (for a nondegenerate paramp). The paramp requires an "idler" circuit which permits varactor current flow at the difference frequency between the pump and signal frequencies. This idler component is generated by the mixing of f_p and f_s due to the nonlinear varactor reactance. Analysis of the energy considerations in the circuit of Figure 6 shows that energy from the pump circuit is transferred to the signal circuit, thereby providing gain at the signal frequency [10]. In effect, the pumped varactor appears as a negative resistance at the signal frequency. The nonreciprocal three-port ferrite circulator shown in Figure 6 is then used to direct the reflected (amplified) RF signal to the output port.

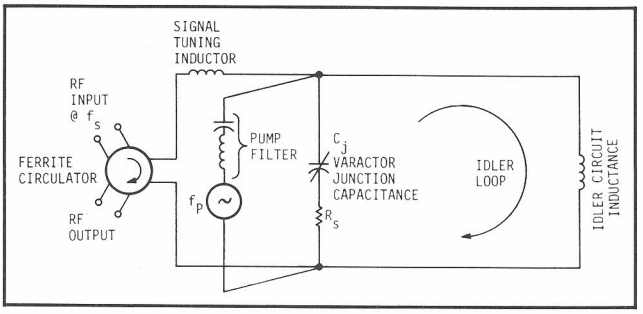

FIGURE 6. Basic Parametric Amplifier Current

The noise temperature T_e of the basic nondegenerate parametric amplifier (less circulator loss) is provided by the following expression [1]:

$$T_e = \left(\frac{\frac{f_s}{f_i} + \frac{f_s f_i}{M^2}}{1 - \frac{f_s f_i}{M^2}} \right) T_D \qquad (5)$$

where:

f_s = signal frequency
f_i = idler frequency $= f_p - f_s$
M = varactor figure of merit = a f_c
a = varactor nonlinearity ratio

f_c = varactor cutoff frequency
T_D = varactor junction temperature (absolute)

The varactor cutoff frequency is defined by the expression:

$$f_c = \frac{1}{2\pi R_S C_0} \qquad (6)$$

where:

R_S = varactor equivalent series resistance
C_0 = effective operating junction capacitance

High-quality GaAs Schottky varactors have operating cutoff frequencies in excess of 1000 GHz [12]. These devices are capable of providing an LNA noise temperature of less than 30K at C-band (3.7 to 4.2 GHz) when thermoelectrically cooled to −38°C. A typical communications satellite ground station LNA that uses a thermoelectrically cooled paramp stage followed be a FET post-amplifier is shown in Figure 7. This LNA covers the 3.7 to 4.2 GHz band with a noise temperature of under 30K and an associated gain of 60 dB.

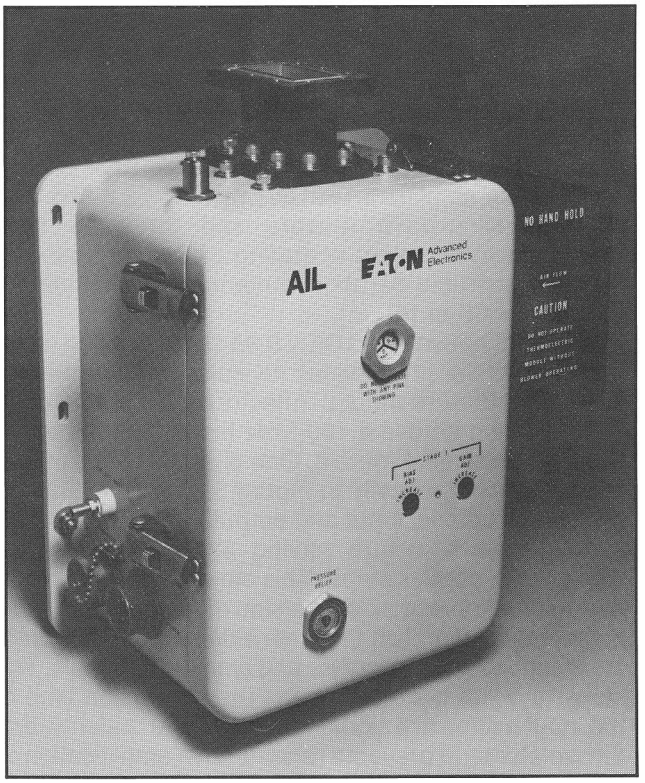

FIGURE 7. Thermoelectrically Cooled Paramp LNA

Because a parametric amplifier requires the use of a nonlinear capacitive reactance for its basic operation, it is a relatively narrow-band device. The balanced parametric amplifier which uses the self-resonant frequency of the varactor for the idler circuit is capable of providing a bandwidth of approximately 10% to 15% [13].

The degenerate parametric amplifier, in which the pump frequency is twice the signal frequency, is useful in double-sideband applications such as radio astronomy. The theoretical double-sideband noise

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temperature T_e of a degenerate paramp (less circulator loss) is given by the following expression:

$$T_e = \frac{T_D}{\frac{M}{f_s} - 1} \qquad (7)$$

where the terms are defined as for equation 5. The degenerate configuration is capable of providing lower noise performance in double-sideband applications.

Other factors that are of importance in evaluating the performance of a receiving system are those that affect the dynamic range and spurious outputs. The output level of a parametric amplifier at which the gain compresses by 1 dB is typically −15 dBm, while the third-order intercept point is typically 0 dBm (referred to the output).

FET Amplifiers

Since the introduction of the first GaAs MESFETs in the early 1970's, which attained a noise figure of 2.8 dB at 3 GHz, the MESFET, and recently a variation of it, the high-electron mobility transistor (HEMT), have become the premier three-terminal devices for low noise amplification. Since those early days, the noise figure improvements have been meteoric and today we are witnessing HEMTs emerging from the laboratory with noise figures which rival the noise performance of those early devices but at 50 GHz!

In 1980, the first HEMT was reported by Fujitsu [14] and with it the promise of vastly higher frequency capability extending up to and beyond 60 GHz, with superior gain and noise figure performanc. The HEMT quickly surpassed the MESFET in performance in the millimeter wave range with reports [15] of useful gain at 60 GHz. These improvements are largely a result of the significantly higher carrier mobility of the HEMT's two-dimensional electron gas.

The next few paragraphs briefly address the mechanisms which are responsible for noise generation in the MESFET and HEMT.

MESFET

The noise theory of the microwave MESFET is largely based on the work of Van der Ziel [16], [17] who analyzed a long gate, constant mobility model. Statz, et al, [18] modified this theory to account for diffusion noise which is the dominant noise mechanism in the submicron gate length microwave MESFET that experiences velocity saturation of the carriers.

Van der Ziel showed that, in the absence of velocity saturation, the noise is thermal in origin, and can be represented primarily by two white noise generators, one in the drain circuit and one in the gate circuit as shown in Figure 8.

Neglecting high field diffusion noise, the noise current generator in the drain circuit can be described by:

$$\overline{i_{nd}^2} = 4k\,T_0\,\Delta f\,g_m\,P \qquad (8)$$

where:

$\overline{i_{nd}^2}$ = mean square value of noise current
k = Boltzmann's constant
T_0 = lattice temperature (Kelvins)
g_m = transconductance (Siemens)
P = (dimensionless) factor depending on geometry and bias

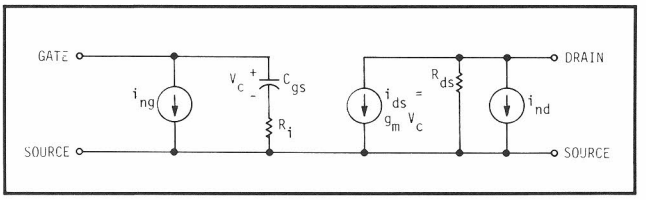

FIGURE 8. Simplified Noise Model for MESFET

The gate noise generator, which represents the noise induced on the gate electrode by the passing thermal fluctuations in drain current, is partially correlated with the drain noise current generator, and can be expressed by:

$$\overline{i_{ng}^2} = 4k\,T_0\,\Delta f\,\omega^2\,\frac{C_{gs}^2}{g_m}\,R \qquad (9)$$

where:

$\overline{i_{ng}^2}$ = mean square value of gate current
C_{gs} = gate-source capacitance (Farads)
R = (dimensionless) factor depending on geometry and bias conditions
ω = radian frequency (= $2\pi f$)

Since the two noise currents, i_{nd} and i_{ng} are caused by the same noise voltages in the channel, there is partial correlation defined by a correlation factor C.

Using the model of Figure 8, the minimum noise figure F_{min} of the intrinsic MESFET can be expressed by:

$$F_{min} = 1 + 2\sqrt{PR\,(1-C^2)}\,\frac{f}{f_T} + 2\,g_m R_i P\left(1 - C\sqrt{\frac{P}{R}}\right)\frac{f^2}{f_T} \qquad (10)$$

where, f_T is the unity current gain point given by:

$$f_T \sim \frac{1}{2\pi}\,\frac{g_m}{C_{gs}} \qquad (11)$$

and R_i reflects effects of channel resistance. P, R and C are functions of bias and geometry of the FET device. For $f < f_T$ the second term is negligible.

From this operation, it can be seen that reducing C_{gs} and/or increasing g_m will reduce F_{min}. This can be accomplished by reducing the gate length.

The noise figure dependence on drain current, I_D, typically follows the curve in Figure 9. For I_D/I_{DSS} approximately 0.15, where I_{DSS} is the saturation current, the noise figure is minimum. Above this current a considerable amount of diffusion noise is generated; below

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this current g_m drops off rapidly. At this bias, substantial noise cancellation occurs at the drain, expressed by the factor $(1 - C^2)$ in equation (10), which accounts for the superior noise performance of the MESFET.

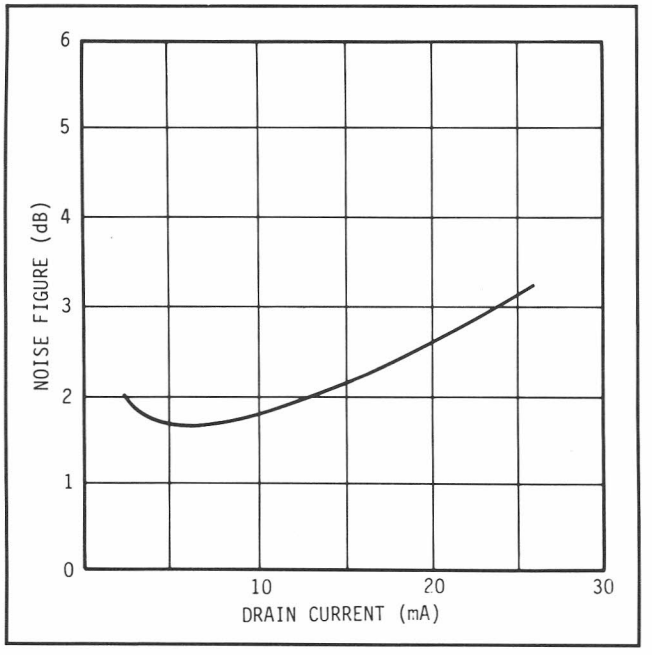

FIGURE 9. MESFET Noise Figure Dependence on Drain Current

In a more complete noise model of the MESFET, the parasitic gate metal and source resistances, R_{gm} and R_S, respectively, generate thermal noise and affect the noise behavior of the device. Also, at frequencies below 3 GHz, the diffusion noise model does not correctly predict the F_{min} dependence on the frequency. In this region, frequency-dependent hot electron noise better explains the observed behavior [19].

HEMT

The HEMT's superior noise performance is attributable to much higher g_m, a consequence of the higher carrier mobility. The F_{min} dependence on g_m, shown in (10), makes this clear. The noise model in Figure 8 is also applicable to the HEMT. In the constant mobility region of the channel, the drain noise is thermal in nature; in the constant velocity region of the channel diffusion noise is the primary noise mechanism. But, unlike the MESFET which generates greater amounts of diffusion noise with increasing bias, the high field diffusion noise decreases very rapidly as the electric field increases above E_S, the point at which velocity saturation of the carriers occurs. For this reason, the noise contribution from the constant velocity region can be ignored [20]. The induced gate noise in the HEMT is also thermal and proportional to ω^2 as in the MESFET.

The HEMT's noise figure dependence on drain current resembles that of the MESFET (Figure 9) but the increasing F_{min} with increasing current is not caused by diffusion noise but is a consequence of the different relationship between the bias and the charge density in the HEMT's conducting layer. Brookes [20] derives expressions for P, R, and C in terms of bias point and geometry.

The HEMT is clearly superior to the MESFET at 300 K and shows more rapid improvement in performance when cooled to 77 K. The HEMT exhibits 3:1 transconductance advantage at 77 K relative to a MESFET which suggests that larger reductions in noise figure are possible when the device is cooled.

Typical values for -1 dB compression point and 3rd order intercept point for MESFET/HEMT Low Noise Amplifiers are $+10$ dBm and $+20$ dBm, respectively (referred to the output).

Figure 10 shows the minimum noise figure to today's state-of-the-art MESFET and HEMT devices as a function of frequency [21]. The data points are representative of the best reported performance to date in the laboratory; it should be noted that this performance is not representative of commercially available devices as yet. The figure also shows the projected noise performance for both advanced MESFET and advanced HEMT devices in 1990-1995 time frame.

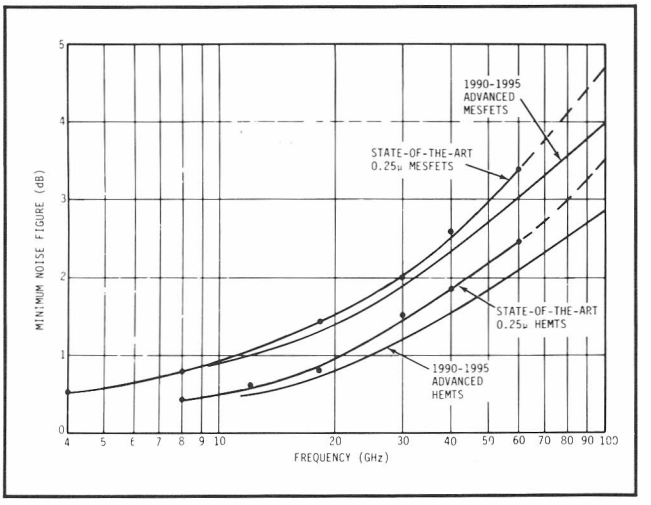

FIGURE 10. Minimum Device Noise Figure vs. Frequency

Mixers

Almost all receiving systems are of the superheterodyne type, wherein the desired RF signal is converted to an intermediate frequency as shown in Figure 11. The mixer is a device that heterodynes the RF input signal with a local oscillator (LO) to provide an intermediate frequency (IF) output which is given by:

$$f_{IF} = \pm (f_{LO} - f_{RF}) \qquad \textbf{(12)}$$

For a fixed LO frequency and a fixed IF frequency, the mixer responds to RF frequencies which are spaced by the IF frequency from the LO as illustrated in

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Figure 12. If only one of these responses is desired, a filter is generally employed ahead of the mixer as shown in Figure 13. In this example, a band-pass filter is designed to provide the required rejection while providing low-loss in the RF band.

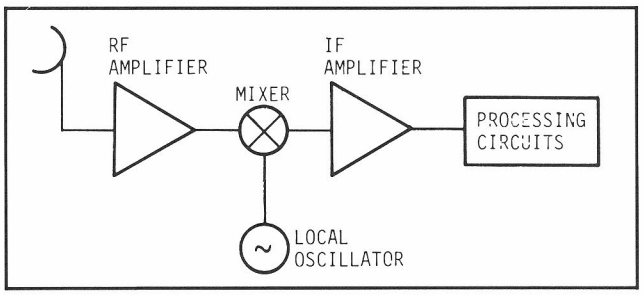

FIGURE 11. Basic Receiver Block Diagram

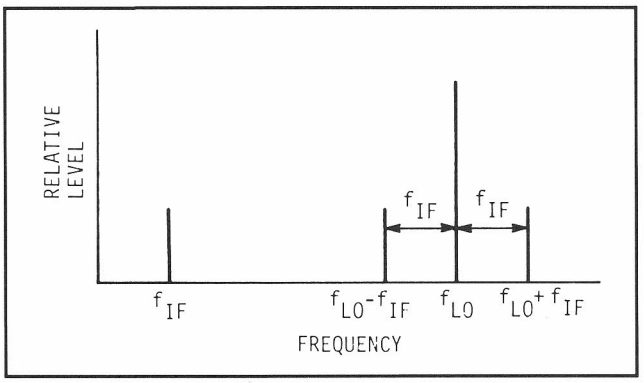

FIGURE 12. Basic Mixer Responses

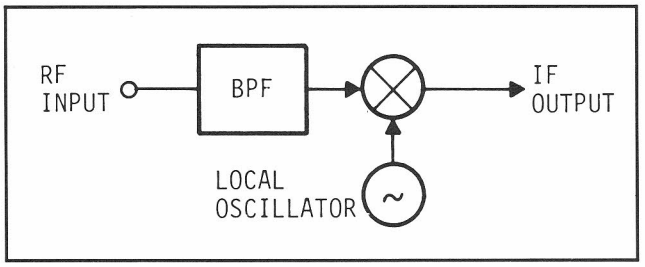

FIGURE 13. RF Band-Pass Filter Provides Image Rejection

The mixing process requires the use of some nonlinear element. Most modern high-performance mixers use Schottky barrier diodes that are conductance modulated by the local oscillator. Because mixers employ a time-varying conductance (rather than reactance), they are fundamentally broadband devices. Figure 14 shows the measured conversion loss of a balanced mixer that covers the full 26 to 42 GHz band.

The noise figure, F, of a single-sideband mixer front-end such as that shown in Figure 13 can be shown to be:

$$F = L_f L_c (t_m + F_{IF} - 1) \qquad \textbf{(13)}$$

where:

L_f = filter insertion loss (power ratio)
L_c = conversion loss of mixer (power ratio)
t_m = noise temperature* ratio — 0.8 to 1.2
F_{IF} = IF noise figure (power ratio)

*Ratio by which the actual noise output power from the mixer exceeds its thermal output noise power, assuming the mixer and signal source temperature are at 290 Kelvin [22].

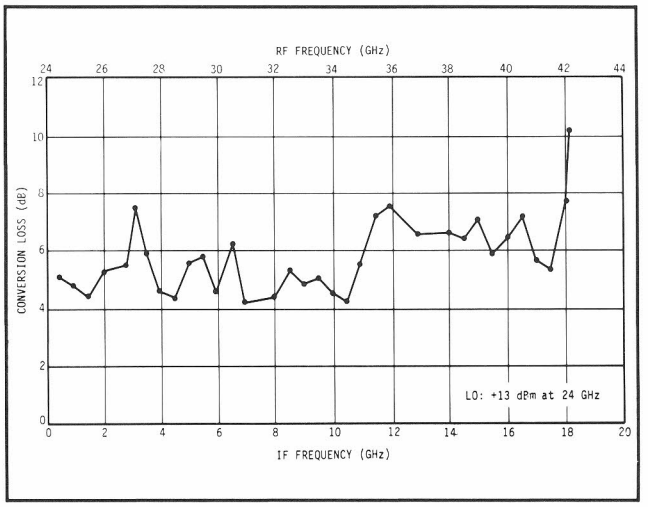

FIGURE 14. Measured Conversion Loss of Wide-Band Mixer

Conventional mixers can have conversion loss values of 4 to 5 dB over relatively large bandwidths (>30%) up to 100 GHz.

Lower values of conversion loss (<3 dB) over narrow RF bandwidths (~15%) are possible by providing optimum image band reactive termination internally within the mixer (the so-called "image-enhanced" mixer). The RF signal mixes with the second harmonic of the LO within the mixer to generate the "image" frequency. If terminated reactively, this signal image at the frequency mixes with the RF and the resultant IF signal reduces the conversion loss of the mixer by as much as 1 to 2 dB.

Mixer front-ends are generally employed in system that do not require the lower noise performance provided by the addition of a low-noise RF amplifier such as those previously described. In addition, millimeter-wave receiving systems operating above ~24 GHz generally use mixer front-ends since low-noise amplifers are not readily available that would provide a significant improvement in system noise performance. Figure 15 shows the theoretical noise performance of image-enhanced mixer front-ends (including IF amplifier noise contribution) over the frequency range of 20 to 100 GHz.

In applications where double-sideband operation is permissable (such as radiometry), an improvement in sensitivity may be obtained since received energy in both sidebands is converted in to useful IF output. The

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noise figure, F, for a double-sideband mixer front-end is given by:

$$F = \frac{L_c}{2}(t_m + F_{IF} - 1) \qquad (14)$$

where the terms are as previously defined in equation (13).

Comparison of the above equation with that for single-sideband operation [equation (13)] shows that for the same mixer characteristics, the noise figure is reduced by a factor of 2. In addition, the loss of the image-reject filter is eliminated in this approach.

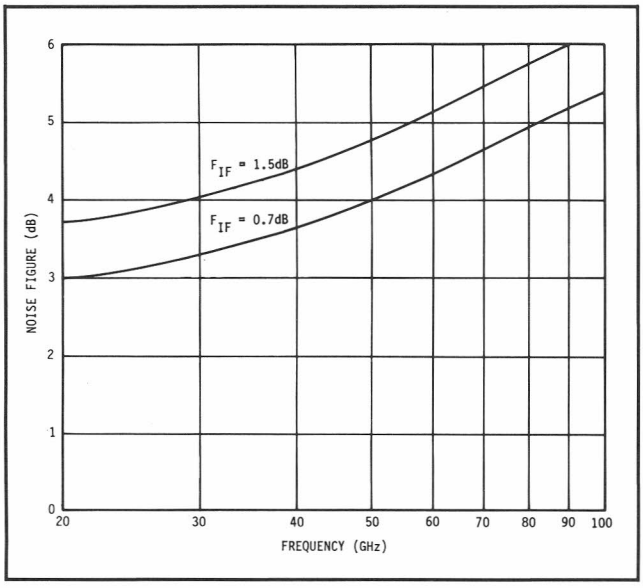

FIGURE 15. Theoretical Noise Performance of Image-Enhanced Mixers

Another source of noise in receivers using mixers is local oscillator noise, which has both amplitude and phase components. Balanced mixer designs provide approximately 20 to 30 dB of local oscillator AM noise suppression, which is usually adequate to provide negligible system noise performance degradation.

Cryogenic Cooling

Extremely high-sensitivity receiving system front ends, such as those used in radio astronomy or deep-space communications ground stations, employ cryogenic cooling techniques to obtain the lowest possible system noise figure. As indicated earlier, masers require cooling of the ruby to ~4.5 K to provide maser amplification. A closed-cycle refrigeration system which uses helium as the refrigerant is usually utilized, as illustrated in Figure 16. This photo shows the vacuum housing, as well as the helium gas manifold, which are parts of the overall maser assembly.

Although the other front-end types discussed earlier in this paper do not require cryogenic cooling for their basic operation, cooling does provide a significant enhancement in their noise performance. Parametric amplifiers, FET/HEMT amplifiers and mixers all have better noise performance when cooled. Some of this improvement in performance was shown in Figure 3.

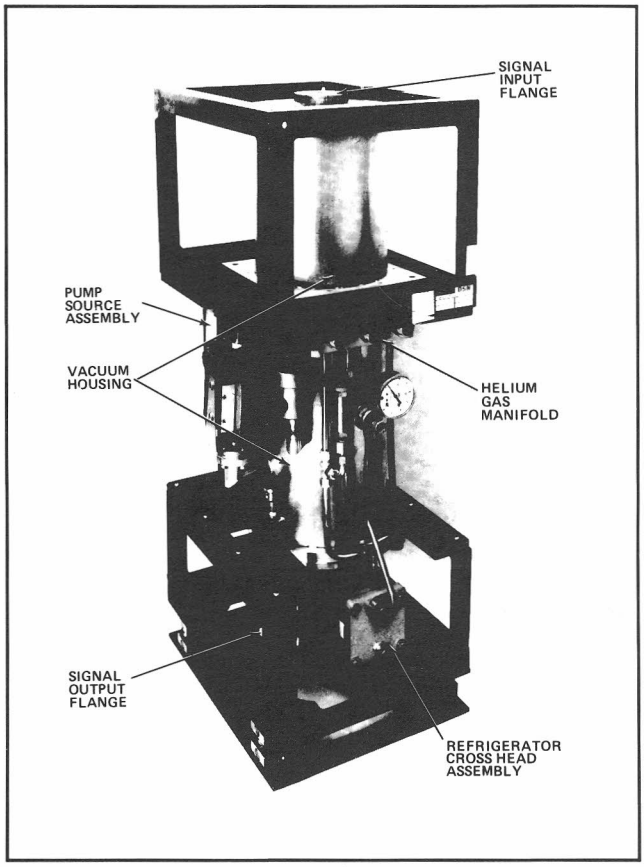

FIGURE 16. X-Band Maser Assembly

NOISE FIGURE /NOISE TEMPERATURE MEASUREMENTS

The most common method used to measure noise figure uses the "Y" factor measurement technique. Here, the change in noise output power is measured with a set of known noise standards sequentially connected to the input of the system. This is illustrated in Figure 17.

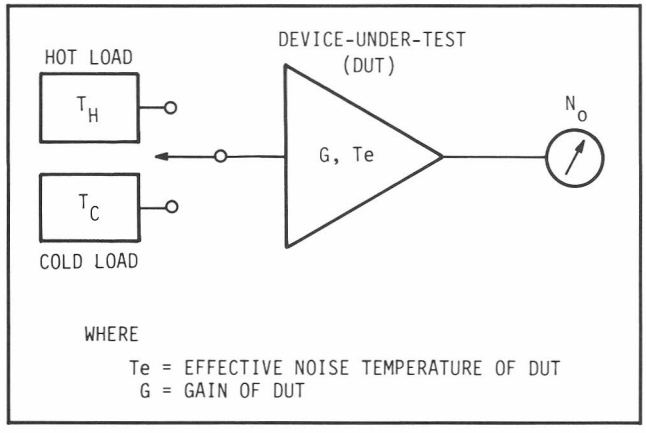

FIGURE 17. Simplified Noise Temperature Setup

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Several precautions must be observed to minimize potential error sources. The factors that are important are:

- The accuracy of the noise generated in the loads used in the measurement.
- The accuracy to which the "Y" factor can be measured.
- The accuracy to which the gain (or loss) of the component is measured.

The accuracy to which the above parameters must be measured is a function of the noise figure being measured and the accuracy required.

The "Y" factor measurement is not a direct measurement of either noise figure or noise temperature. Referring to Figure 17, "Y" is the ratio of output noise powers when each of two unknown noise sources is connected to the input of the device or system being measured. The Y factor is given by:

$$Y = \frac{N_{O\ HOT}}{N_{O\ COLD}} = \frac{T_H + T_e}{T_C + T_e} \qquad (15)$$

or

$$Y\ (dB) = 10 \log \frac{T_H + T_e}{T_C + T_e} \qquad (16)$$

where:

T_H = temperature of the hot load (Kelvins)
T_C = temperature of the cold load (Kelvins)
T_e = effective input noise temperature of the system being measured

Once the "Y" factor has been accurately measured, the noise temperature, T_e, is obtained from the following:

$$T_e = \frac{T_H - Y\,T_C}{Y - 1} \qquad (17)$$

If noise figure is required, noise temperature and noise figure use directly interchangeable as per (9) of Part I:

$$T_e = (F - 1)\ 290 \qquad (18)$$

or

$$F = 1 + \frac{T_e}{290} \qquad (19)$$

In general, noise temperature is used for systems with noise temperatures of 300 K or less, noise figure is used for systems with noise figure of 3 dB or greater (3 dB noise figure equates to a 290 Kelvin noise temperature).

If noise figure is measured using either gas discharge tubes or solid state noise sources, it can be calculated from the following:

$$F(dB) = 10 \log \frac{ENR}{Y-1} = ENR\ (dB) - 10 \log\ (Y-1) \qquad (20)$$

where:

ENR = Excess noise ratio with noise source "on"

$$= \frac{T_H}{290} - 1$$

It is assumed for this measurement that the "cold load" (noise source "off") is 290 K, and that the noise temperature of the noise source in the "on" state is T_H Kelvins.

OPTICAL RECEIVERS

This section presents a discussion on noise sources associated with infrared detectors, and performance tests used to evaluate optical receivers. The limiting noise in an infrared receiver consists of detector noise, amplifier noise or background noise. Careful design of the detector preamplifier and its coupling to the detector can reduce amplifier and electronic systems noise contributions to less than that in the detector. The objective of an optimum detector is to reduce the internal noise of the detector to a level at which the fluctuations of the incoming background radiation is the limiting noise contribution. In practice this cannot be done in all cases and the detector noise contribution limits system sensitivity.

Noise Sources In Optical Detectors

Noise due to the infrared detector will arise from various mechanisms such as Johnson noise, G-R (generation-recombination) noise, shot noise and 1/f noise. Several of these noise sources may be present simultaneously in the same detector type and dominate at different detection frequencies. When no bias is applied to the detector, the only internal noise which must be considered is the Johnson noise or thermal noise. The Johnson noise power is dependent on the temperature of the detector and the bandwidth of the infrared receiver. The short circuit thermal noise current, i_T, is given by:

$$i_T = \left(\frac{4kTB}{R}\right)^{1/2} \qquad (21)$$

where:

k = Boltzmann's constant
T = absolute temperature of the detector
B = system bandwidth
R = detector resistance

All other forms of noise in the detector arise from currents flowing in the detector due to the application of bias. The first bias-generated noise is G-R noise which is found in extrinsic photoconductive detectors. Generation-recombination noise is caused by fluctuations in the rates of thermal generation and recombination of free carrier in a semiconductor causing a fluctuating carrier concentration and therefore fluctuating detector resistance. The short circuit G-R noise current is given by:

$$i_{G\text{-}R} = 2I_B \left[\frac{\tau B}{N_O\,(1 + \omega^2\,\tau^2)}\right]^{1/2} \qquad (22)$$

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where:
I_B = detector bias
τ = free carrier lifetime
N_O = total number of free carriers in sample
ω = radian frequency = $2\pi f$

The second bias-generated noise in semiconductor optical detectors is shot noise which is caused by the diffusion of carriers in photo-diodes. The shot noise current is given by:

$$i_S = (2\, q\, I_O B)^{1/2} \qquad (23)$$

where:
q = electronic charge
I_O = reverse bias saturation current

The other form of noise found in all semiconductor detectors, which is not amenable to analysis, is 1/f noise. This noise is characterized by a fall-off of noise power with increasing frequency. An expression for the 1/f noise current, $i_{1/f}$, is given by:

$$i_{1/f} = \left(\frac{K_1\, I_B^{\alpha}\, B}{f^{\beta}} \right)^{1/2} \qquad (24)$$

where f is the operating frequency.

This expression contains three factors (α, β and K_1) which are dependent on the detector of interest and must be characterized by measurement. The 1/f noise appears to be associated with potential barriers at the contacts.

The combination of these noise sources represents the total detector noise, which is the root sum square of the individual noise components represented by:

$$i_N = (i_T^2 + i_{G\text{-}R}^2 + i_S^2 + i_{1/f}^2)^{1/2} \qquad (25)$$

Detector D*

A figure of merit for infrared detectors using the detector noise and signal response is the D* ("dee-star"), defined as the rms signal-to-noise ratio in a 1-Hz bandwidth per unit rms incident radiant power per square root of detector area. This quantity is area independent and can be used to compare performance of difference detector types with different areas. In terms of the measurement parameters, D* is given by [23]:

$$D^* = \frac{(A_D\, B)^{1/2}}{P} \left(\frac{S}{N} \right) \qquad (26)$$

where:
A_D = detector area
P = incident radiant power
S = rms signal voltage or current
N = rms noise voltage or current

D* can be defined in terms of either monochromatic radiation or blackbody radiation depending on the systems applications.

Detector Performance Tests

The standard equipment used to measure important detector parameters is shown in Figure 18. A 500 K blackbody is commonly used as a stable source of infrared radiation with known spectral characteristics. In order to detect the radiation, an optical modulator or chopper is used. The chopped signal is detected, amplified, and measured on a spectrum analyzer at the chopper frequency in order to determine detector responsivity.

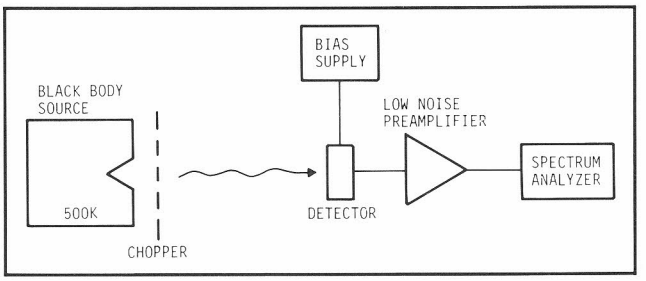

FIGURE 18. Simplified Optical Detector Test Setup

The detector noise voltage is also measured on the spectrum analyzer to provide the S/N for a known input power. This measurement together with the detector area and spectrum analyzer bandwidth provides the information required to calculate the D*.

For a particular system application, a receiver sensitivity can be defined in terms of its sensitivity to incoming radiation. The NEI (noise equivalent irradiance) serves as a measure of this sensitivity and is expressed in watts/cm².

The expression for NEI is given as [23]:

$$NEI = \frac{P}{A_C} \quad \frac{1}{S/N} \qquad (27)$$

where:
P = incident irradiance (watts)
A_C = receiver collection aperture
S/N = voltage or current signal-to-noise ratio

PHASE NOISE

All practical oscillator sources have an undesired phase (or frequency) modulation imposed on the carrier due to oscillator internal noise. This phase noise is particularly important in affecting system performance in frequency conversion applications which are required to operate with signals over a wide dynamic range.

Referring to Figure 19, the local oscillator phase noise sidebands are directly transferred to the desired signals at the IF port due to the mixing process. Note that the noise sidebands transferred to the larger signal, f_1, in Figure 19 increase the noise power at the mixer

continued on page 33

UNDERSTANDING NOISE (continued from page 32)

output at frequencies close to the signal. This effectively degrades the receiver sensitivity to a weaker nearby signal, such as f_2. Thus, one effect of local oscillator noise is to cause receiver desensitization due to a strong signal. This is a particular problem in multichannel communication receivers where a strong signal in one channel affects the sensitivity in adjacent channels.

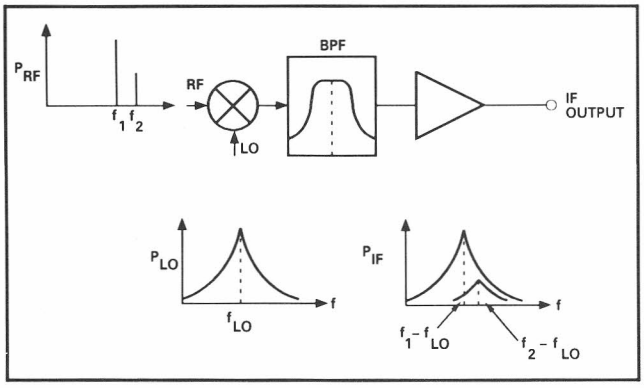

FIGURE 19. Effect of LO Noise on Receiver Sensitivity

In digital communication systems using a form of PSK modulation, phase noise close to the carrier is important. The bit-error rate performance of the system is degraded by the phase jitter caused by local oscillator phase noise. The maximum allowable phase noise is usually specified in terms of the total equivalent rms degrees of phase noise modulation within the channel bandwidth for these systems. The effect on bit error rate (BER) is directly additive to the receiver thermal noise for values of phase noise less than 5 degrees rms [24]. A plot of theoretical BER as a function of SNR for several different modulation techniques was shown in Figure 1.

Doppler radar systems use the frequency shift of the return echo to determine the velocity of a target. Local oscillator phase noise causes the large "clutter" return from stationary objects (such as the ground, buildings and other structures) to mask the desired target signal, thus limiting sensitivity by establishing a minimum signal level that must be returned by a target in order to be detectable. Furthermore, phase noise spreads the target return energy, thereby degrading system range resolution.

Noise Spectrum

The phase noise performance of a source is usually presented as the Single Sideband (SSB) power spectral density as a function of modulation frequency (or offset frequency from the carrier). For a small modulation index, the single sideband-to-carrier ratio, in dB, can be shown to be given by the following expressions [25]:

$$\text{SSB (dBc)} = 20 \log\left(\frac{\Delta\Phi\text{peak}}{2}\right) = 20 \log\left(\frac{\Delta\Phi\text{rms}}{\sqrt{2}}\right) \quad \textbf{(28)}$$

where $\Delta\Phi$ represents the phase deviation in radians.

A typical oscillator phase noise spectrum [26] is shown in Figure 20. This plot shows three regions of varying noise power slope. The 9 dB/octave slope closest to the carrier is due to 1/f noise (flicker noise) which predominates at offset frequencies up to f_α in Figure 20. The slope then changes to 6 dB/octave from the point up to the feedback loop half-bandwidth. At that frequency, the slope becomes flat up to a limit imposed by subsequent filtering. It should be noted that for the example shown in Figure 20, the 1/f effects predominate for frequencies lower than the feedback loop bandwidth. For a high-Q oscillator, it is possible for the 1/f noise to predominate out to an offset frequency exceeding the feedback loop half-bandwidth. In that case, the 6 dB/octave slope region would not be observed. That type of spectrum would also be obtained if the noise floor due to the following amplifier stages or test equipment obscures the internal oscillator noise.

The design of oscillators with low phase noise therefore requires selection of an active element which has low 1/f variations, as well as the use of a high-Q feedback network (such as in cavity-resonator or dielectric-resonator stabilized oscillators). The detailed design of low noise oscillators is outside the scope of this article and is covered in more depth in references 25 and 26.

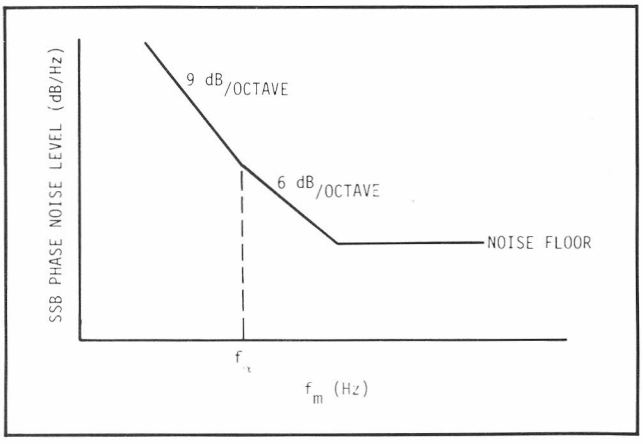

FIGURE 20. Typical Oscillator Phase Noise Spectrum

Phase Noise Measurements

Since the phase noise requirements of a source can vary depending upon the application, the method of phase noise measurement is dependent on the quality of the source. Therefore, measurement of very stable sources with low SSB noise requires better test equipment and techniques. The measurement of phase noise and or oscillator stability is treated in many references [24, 25, and 27]. There are basically two methods of phase noise measurement: direct and carrier removal. The latter method is also referred to as a translation or demodulation method because it relies on techniques to remove the carrier and measure the residual noise.

A spectrum analyzer can be used for direct measurement of the SSB phase noise of any source. Although

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UNDERSTANDING NOISE (continued from page 33)

this is the simplest approach, there are several limitations in this method. The analyzer display presents the noise sum of both the Device Under Test (DUT) and all oscillators internal to the analyzer. Therefore, this method is useful only when the noise of the DUT is sufficiently higher than the analyzer. Since most spectrum analyzers specify the composite sideband noise, it is easy to determine when the analyzer is applicable.

Other limitations of the spectrum analyzer are related to the amplitude response. The logging display accuracy represents an error which can affect the results for sources integrating the phase noise over several kilohertz. Also, when a spectrum analyzer is used to measure sideband noise, the AM noise of the unit should be at least 10 dB below the FM noise. Since spectrum analyzers measure total noise power, the actual results of FM or phase properties are contaminated by the inclusion of amplitude noise.

The purpose of carrier removal techniques is to measure SSB noise beyond the dynamic range of the spectrum analyzer. Removing the carrier allows measurement with a wave analyzer over the dynamic range of the sideband noise. The basic autocorrelation technique for carrier removal uses a double-balanced mixer as shown in Figure 21. The phase shifter is adjusted for a dc null at the output of the mixer to obtain maximum sensitivity of the test setup to FM noise. The mixer output is fed to a wave analyzer which measures the power level at each offset from zero frequency. Calibration of the setup and other carrier removal techniques are discussed in detail in references 25, 27, and 28.

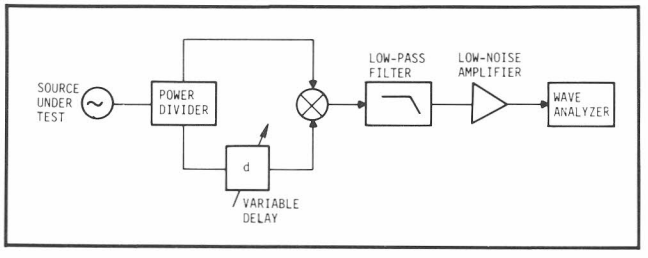

FIGURE 21. Phase Noise Measurement Setup

DIGITAL NOISE

A major advantage of digital signal processing over analog techniques is that the data (useful information), once digitized, is much less subject to errors caused by spontaneous fluctuating noise. However, digital circuitry is subject to other types of noise sources. In addition, whenever there is close integration of digital and analog circuits, there is data corruption due to the proximity of digital state changes. As modern day systems employ an increasing amount of digital functions, digital noise becomes an important consideration in system analysis and design. This section defines digitally-related noise and describes its effect on the performance of a system.

Noise, as it relates to digital circuits, may be categorized into noise due to the digitization process, noise due to non-ideal digital transmission lines, noise coupled into the analog portion of a system due to the proximity of digital circuitry, and noise which is not defined as direct corruption of a waveform, but as a corruption of data or information which is a function of the digital algorithm used.

There are three sources of information degradation in the analog to digital conversion process: quantization noise, impulse noise, and variation in the reference voltage at the A to D converter.

When a continuous analog signal is quantized, the original signal can never be exactly reproduced because of the finite number of levels utilized. The resulting error is defined as quanitzing noise. In selecting a digitization process, trade-offs have to be made between sampling frequency, number of levels and minimum quantizing error. The maximum sampling frequency depends on the speed of the digital circuits. The number of levels are limited to the digital word size (number of bits) and the complexity constraints of the digital processing. As shown in [29] for equal-level digitization spacings, the rms quantizing noise at the output is equal to quantizing increment divided by $\sqrt{12}$.

Impulse noise is due to spurious pulses coupled from the digital portion of the A to D conversion circuit into the signal lines of the analog input. Switching transients are generated in the digital circuitry each time a state-change occurs. High-level transients that are coupled into the analog input signal lines will severely degrade the digital output data. Careful grounding and shielding using prudent EMI practices must be employed in the design of the A/D converter and its associated circuits [30, 31]. Typically, separate analog and digital grounds are used to prevent coupling through ground loops. In addition the effect that digital control signals have on RF and analog signals must be considered. The performance of systems is affected by the finite isolation between digital control signals and analog information in components such as amplitude/phase modulators and switches. The effect becomes particularly important when the significant frequency components in the control signal approach or overlap the frequency range of the analog signals. Good filtering and layout design practices must be followed to prevent the control signal from coupling into the analog circuitry.

Since quantization is performed with respect to a fixed reference input level, it is important to keep variations and noise on the A/D converter reference input line below the quantization error of the process. This requires reference voltage buffering to provide a low impedance source and adequate bypass networks to eliminate power supply noise.

Another source of noise in a digital system is related to the digital data transmission path. With clock rates operating in the MHz to GHz region, improperly designed transmission lines may seriously degrade digital waveforms to the point where spurious "zeros" and "ones" are generated. To minimize the error due to this source, good transmission line design practices

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UNDERSTANDING NOISE (continued from page 34)

must be followed, including shielding, grounding, and source and load impedance matching [32].

In analyzing the performance of digital processing, "noise" which is a function of the digital algorithm used must be considered. Whereas the noise discussed above could be seen as a degradation of an ideal waveform, algorithm-related noise is the result of the digital implementation of system functions. We refer the reader to the extensive discussions of these sources in references 33 and 34. The source of the "noise" can be generally attributed to the effect of finite digital word lengths.

CONCLUSIONS

Noise is still a mystery to many engineers, and misconceptions in both analysis and measurement techniques can lead to degraded system performance or excessive system cost for an LNA where extremely low noise performance is not required. Ideas on noise figure measurement presented in 1961 [35] are still useful today and the system engineer must be fully aware of the numerous pitfalls that await him.

The subject of noise, including noise sources, analysis, system effects, and implications could fill volumes and still be incomplete. This survey paper, therefore, has presented a broad overview of this vast subject and, necessarily, has included some simplifying assumptions to explain certain basic concepts. As indicated above, exciting new developments in low noise devices and circuits continue to expand the tools available to the designer in configuring new receiver systems. The recent rapid advances in high critical temperature superconductors will undoubtedly lead to an entire new class of ultra-low noise devices for systems of the future.

ACKNOWLEDGEMENTS

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Papers are sought describing work not previously published which can be either theoretical, technical or applications oriented. Papers will be in English. The time slot for a paper is 15 minutes + 5 minutes for discussion and questions. Authors are requested to submit six typed copies (single-spaced) of a three-page summary. The summary should include a concise statement of the work under review, emphasising what is new as well as the techniques being employed, together with the main conclusions and where appropriate a few essential figures should be added.

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FAKE DIALOGUES AND "REAL" MESSAGES

by Cheryl Reimold
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Cheryl Reimold is president of PERC Communications, a communications firm that conducts in-house courses on effective writing and speaking for businesses and other associations. For information, please contact her at the address listed above.

The words we use often hide our real message, but the real message is the one that gets understood.

Let's say you are taking a trip with an associate. On the way, you start talking about the problems with the visit — how difficult it will be to see the right people, how much your boss expects from you, how impossible it will be to get the information he wants. Your associate responds soothingly that you should have no trouble getting to see your people, provided you explain your mission to the VP in charge. He says he does not think the boss at home expects more than basic information. He is sure you will have no real problem. Judging from the words alone, you are outlining some problems facing you, and your associate is offering possible solutions to them.

But the dialogue is actually about something totally different. Your associate was the one who originated the idea of making this trip and obtaining the information. However, he will be with you only one day; he departs the next day for a conference, leaving you to get the information and make the subsequent report. You are furious about this. You want to make him feel guilty—guilty enough to cancel his conference plans and stay on with you at the plant where, you strongly believe, his duty lies.

Now, you know your real message is, "You started this. You've got to see me through it." And he hears that message loud and clear. In fact, his remarks are designed not to solve your problems but rather to fend off your attacks. He is rejecting your implied accusations by saying that you are making a big fuss over nothing.

Since both of you know what the argument is really about, what is the problem? There are actually several problems; three of the more obvious ones are as follows:

- Dishonesty destroys communciation. You and your associate are playing a game, the goal of which has nothing to do with the problems you are ostensibly discussing. You are trying to make him feel guilty. He is trying to make you look unreasonable. Both of you are aware of the other's goals, and both are fighting hard not to be bested. This dialogue is the opposite of communication; communication is a sharing of thoughts and feelings. At the end of a good discussion, participants feel warm about each other, knowing they have given and received something of value. This fake dialogue is a fencing match. At the end of it, no matter how you conclude, each of you will feel a little worse about the other.

- Your plan is doomed from the start. The one who starts a fake dialogue wants the other to take his statements seriously and respond to them as if they were the real message. Taking the example above, you would hope that your associate would consider the magnitude of the problems you raise and conclude that he must stay to help you deal with them. According to the plan, he would think he had arrived at this conclusion himself. He would have no idea that you had engineered the discussion to lead him there. But, your tone, body language, gestures, and expressions would give you away. The associate would get your real message soon. He would resent your attempts to manipulate him. And he would be angry with you for showing so little trust in him. We do not play these games with people we trust. So, he would fight hard not to give what you want.

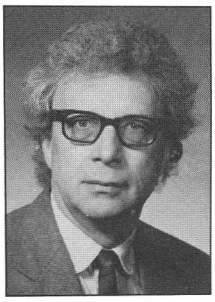
- The discussion goes nowhere. Because both speakers are fully concentrated on the real issue, neither takes the subject of the discussion seriously. In our example, neither of you is focused on solving the problems you raised. You are using them to make him feel guilty. And he is just saying whatever he can to reject the guilt. Consequently, this discussion is a total failure. It does not advance understanding. It does not yield solutions. And it certainly does not solve the real problem of the person who started it.

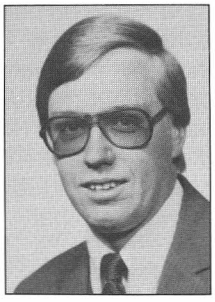
How often do we have dialogues in which the real subject is not the one under discussion? All day long. The "fake dialogue" is probably the greatest source of our communication breakdowns. We do not tell people what we want because because we are afraid they won't give it to us. Instead, we try to engineer dialogues that lead the other person to do as we wish without realizing that we've tricked him into doing so. It almost never works.

Try something with me. For the rest of this day, make a mental note whenever you find yourself saying one thing but meaning another. Also note when someone else does this to you. Do the same tomorrow, but then stop the dialogue as soon as you realize it is a fake one. Either state the real message gently and honestly or talk about something else. Do this for at least a week and see what happens to your relationships. Note how people react to you. Watch how your work, and that of your associates, proceed.

I think you'll be surprised. I'd love to hear how it works for you!

MEMBERSHIP SERVICES





by Martin V. Schneider, Chairman, and Steven J. Temple, Co-Chairman

MTT-S Passes 10,000 Member Mark

At the end of November 1987 MTT-S had 10,321 members and ranked first in membership growth rate among the 33 IEEE Societies. Thanks to the efforts of the Distinguished Lecturers and our Membership Development Chairman, the number of members has increased steadily at an annual rate of 13.5 to 13.8% over the last three months. The Institute membership increased by 4.7% to 288,060 during the last twelve months.

Distinguished Lecturer on Superconductivity

During its recent executive meeting in Boston, AdCom appointed a new 1988/89 Distinguished Microwave Lecturer who will be available to give talks on the timely topic of "Microwave and Gigabit Superconductive Electronics". The lecturer, Arnold H. Silver from the TRW Space and Technology Group at Redondo Beach, California, is the inventor of the SQUID and is well known to low-temperature researchers for his contributions on superconductive devices and circuits for both analog and digital applications. We are fortunate to have Arnold as a new member on our transnational team of IEEE lecturers and we wish him success with his new assignment.

The 1987/88 Distinguished Lecturers, Dave Barton and Rolf Jansen, began their tours in fall 1987 after receiving about fifty requests for talks to chapters on the topics of "Technology Trends in Microwave Radar" and "CAD of Hybrid and Monolithic Microwave and Millimeter-Wave MICs". In 1987 Dave Barton gave nine talks to chapters in the United States and Rolf Jansen presented fourteen lectures to groups in the USA and Europe.

Reinhard Knerr who is our 1988/89 Distinguished Lecturer on "Lightwave Communications" has already received ten invitations from domestic chapters and given well-attended lectures in Denver, Philadelphia and Albany.

Free Membership for New MTT-S Members

New members joining MTT-S will receive free MTT-S membership to the end of 1988. This should stimulate your colleagues and friends to join MTT and benefit from the educational opportunities that the Society has to offer. It should also be noted that the four fastest growing chapters will receive a $200 award and a plaque at the International Microwave Symposium in New York in May 1988. The MTT membership information and application forms can be ordered from

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New Chapters

The following new chapters were formed in 1987:

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The total number of chapters is currently 58, and the increase in the number chapters in one year was 9.4%. New chapters which are presently being formed are:

Australia	Taiwan
Austria	France
Central Virginia	South Korea

Financial Support to Chapters

In 1987 a total of nineteen chapters requested and received $9,950 for covering the expenses of organizing meetings. Chapters which receive limited or insufficient financial support from their sections can apply for up to $500 from MTT-S in 1988. The request with a description of appropriate expenses should be mailed to:

Steven J. Temple
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Financial support of up to $1,000 is also available to chapter chairpersons who wish to attend the 1988 International Microwave Symposium in New York and cannot receive the required funding from their employer. Requests for financial support to attend the Symposium should be submitted to Steve Temple.

Microwave Lectures 1988-1990

In order to meet the growing needs of our chapters for lectures related to microwave and millimeter-wave technology, the membership services team has approached a number of experts to give talks on timely topics to our membership. Several topics ranging from remote sensing with microwaves to quantum noise in microwave and millimeter-wave electronics are listed with the names and biographies of the speakers in this newsletter. We are planning to extend this list in the future and are interested in receiving suggestions of titles for additional talks from our members.

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MEMBERSHIP SERVICES

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Data Base on Chapter Meetings and Officers

Our chapter records officer, Zvi Galani, maintains a data based on recent technical meetings and the names and addressses of the current chapter officers. He has plenty of disk space available and is grateful for receiving your meeting reports which will be published in the next MTT Newsletter. We also need updates on new officers to inform them on opportunities for inviting speakers and new services offered by the IEEE and MTT-S. Please send all reports directly to:

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Problems to be Solved

Although MTT-S showed a spectacular growth in 1987, a number of problems remain to be solved in 1988 and beyond. A persistent concern of our chapter records officer, Zvi Galani, is that many chapter meetings are not being reported and communications from some of our chapters are minimal or nonexistent. As a consequence of the inadequate reporting, our society was only ranked as number nine in terms of reported chapter meetings from 33 IEEE societies. We also received a relatively low grade in retaining members, for example, the retainment was 85% in 1986 with a resulting rank of number five. The membership services team is confident that with your cooperation and our increased efforts in improving the services to all members, MTT-S will become number one in 1988.

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Chairman
Martin V. Schneider
AT & T Bell Laboratories
P.O. Box 400, HOH L261
Holmdel, NJ 07733
(201) 949-2503

Co-Chairman
Steven J. Temple
Raytheon Company
Hartwell Road,
Mail Stop M1-16
Bedford, MA 01730
(617) 274-4736

MTT-S Newsletter Editor
Peter W. Staecker
M/A-COM Inc.
52 South Avenue,
Mail Stop 704
Burlington, MA 01803
(617) 272-3000 Ext. 1602

Chapter Records
Zvi Galani
Raytheon Company
Hartwell Road
Mail Stop M1-41
Bedford, MA 01730
(617) 274-4184

Membership Dev.
Alton L. Estes
Texas Instruments
M/S 404
North Central Expressway
Dallas, TX 75266
(214) 995-5230

International Liaison
Richard A. Sparks
Raytheon Company
50 Apple Hill Drive
Tewksbury, MA 01876
(617) 858-1355

Distinguished Microwave Lecturers 1987/1989

"Technology Trends in Microwave Radar"

David K. Barton, Anro Engineering Consultants
5 Militia Drive, Suite 104
Lexington, MA 02173
(617) 862-3000

"Lightwave Communications"

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

"CAD of Hybrid and Monolithic Microwave and Millimeter-Wave MICs"

Rolf H. Jansen, Industrial Microwave & RF Techniques Inc.
Neanderstrasse 5
D-4030 Ratingen 1,
West Germany
Phone 49-2102-83095

"Microwave and Gigabit Superconductive Electronics"

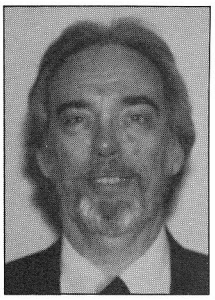
Arnold H. Silver
TRW Space & Technology Group
One Space Park, MS R1/2170
Redondo Beach, CA 90278
(213) 812-0115

Year	Distinguished Lecturer	Topic	Talks Given	Declined Invitations
1980/81	Robert Pucel	GaAS Microwave Monolithic Circuits	28	None
1981/82	Ferdo Ivanek	Microwave Communications Technology	40	None
1982/83	J. Giordmaine	Integrated Optoelectronics	19	2
1983/84	Steve Adam	Microwave Metrology	50	10
1984/85	Paul Greiling	High Speed IC Performance Outlook	54	5
" "	Sander Weinreb	Radioastronomy Challenge to Microwave Engineer	32	10
1985/86	Ken Carr	Microwave Detection and Treatment of Cancer	65	12
1986/87	John Bryant	The First Century of Microwaves 1886-1986	48	2
" "	Edward Niehenke	GaAs-Key to Modern Microwave Technology	62	None
1987/88	David Barton	Technology Trends in Microwave Radar	9	3
" "	Rolf Jansen	CAD of Hybrid and Monolithic MICs and MMICs	14	1
1988/89	Reinhard Knerr	Lightwave Communications	3	None
" "	Arnold Silver	Microwave and GB Superconductive Electornics	None	None

Membership and Chapter Growth Statistics

Year	Membership Year End	Change From Previous Year	Number of Chapters
1980	6429	8.36%	38
1981	6635	3.20%	39
1982	6968	5.02%	38
1983	7435	6.70%	42
1984	8064	8.46%	43
1985	8715	8.07%	46
1986	9445	8.38%	53
1987	10578	12.00%	58

WHAT ABOUT RETAINMENT?



by Alton L. Estes

Why Be Concerned?

Total active MTT-S Members enrolled for the first eleven months of 1987 could have increased 23.8 percent over the final 1986 active membership statistics. Instead, MTT-S active membership increased 9.3 percent over the December 31, 1986 numbers. Why the unfavorable ratio of 2.6 to 1.0 between what could have happened and what occurred? Answer: exactly 1,538 IEEE Members declined to retain their MTT-S membership for 1987 as of November 30, 1987. This answer is part of the concern that spurred this article to be written.

Obviously retainment is a measure of the effectiveness of any Society, but it is not the only measurement. It probably appears to most MTT-S Members that most concerns of any technical Society are those dealing with information about technology: holding meetings, writing and presenting papers, etc. Also, Societies seem to be primarily interested in how many papers are presented, how many meetings are held, how many members are present at meetings, and the quality of the papers. MTT-S AdCom's Membership Services Committee has been emphasizing these concerns.

In addition, numerous reports and articles have been written for AdCom and the MTT-S Newsletter about membership: growth, ways to add members, and the membership drive itself. And, in particular, some membership statistics have been emphasized: how many members are in the Society, and what the growth is. These and other membership statistics have not been overly emphasized, but perhaps membership retainment statistics and emphasis focused on improving retainment have been under-emphasized as perceived by the MTT-S Members. If this perception exists then read on for further clarification as to the Society emphasis on retaining members. If the opposite perception exists, then read this article to gather more facts to support that perception. The fact is, our Society emphasizes increasing membership retainment as much as (or more than) enrolling new members. In any event, the foregoing should have supported the idea that all MTT-S members should be concerned about retainment enough to read this article on retainment before drawing conclusions such as:

- not enough emphasis by MTT-S on retaining members;
- too little concern by MTT-S about providing services to present members;
- or, too much spent to add new members, thereby reducing resources that could be used to provide services to present active members.

This article is an attempt to bring into proper perspective the actual emphasis placed on retainment by all the MTT-S leadership from Chapter Chairmen to AdCom and its committees. In the past and right up to the present, much has been discussed, written, and done to understand and improve retainment. This statement is true for IEEE and its Societies. Some of this will be reviewed; however, this article is written mainly to accomplish two things. First, to document the baseline retainment statistics that have been gathered in 1987. This data base will be used to evaluate future retainment activities. Second, to detail for the general membership the outcome of the investigations by Membership Development as to what can be done to increase MTT-S membership retainment. Maintaining membership by increasing the retainment of our members is just as worthy a cause as increasing our membership by enrolling new members to replace those members who decline to re-enroll. And, for most of the same reasons:

- in order to maintain a skilled and enthusiastic Membership so as to enhance the value, the technical scope, and the effectiveness of the Society.

Maintaining membership has a significant, positive impact on the overall health of our Society. Maintaining membership is both keeping (retaining) members and adding (enrolling new) members.

1987 MTT-S Retainment Actions

Some MTT-S members have raised questions concerning membership statistics over the past year. The questions are asked due to concern about getting the most out of our resources that are expended to add members. Evaluations have been conducted, and are presently being conducted on a yearly basis to determine the costs versus growth benefits of the "free" membership incentive used to promote added membership growth. To assist evaluating MTT-S growth and the costs associated with the growth, the Membership Services Committee was asked by AdCom to list and maintain records of certain membership statistics starting in 1987. These categories were: number of new members, reinstated members, arrears paying members, resigning members, members in arrears, and deceased members. The statistics for the first eleven months of 1987 are listed in the following table.

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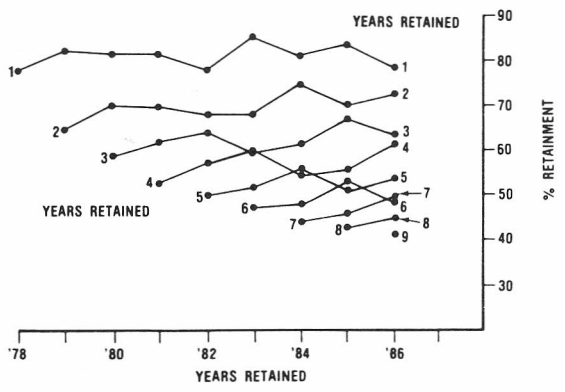
1987 IEEE MICROWAVE THEORY AND TECHNIQUES
SOCIETY MEMBERSHIP STATISTICS

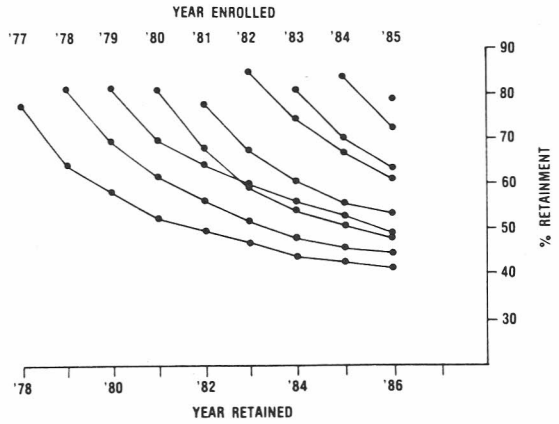
ADDITIONS	JAN	FEB	MAR	AP	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
NEW TO IEEE/MTT	100	88	68	99	86	118	72	92	167	105	101	1096
NEW TO MTT	113	138	72	96	49	205	30	40	51	203	153	1150
TOTAL NEW MEMBERS	213	226	140	195	135	323	102	132	218	308	254	2246
REINSTATEMENTS IEEE/MTT	3	11	3	4	5	3	1	2	0	1	2	35
REINSTATEMENTS MTT	11	9	2	6	3	76	5	4	15	10	13	154
ARREARS PAID IEEE & MTT	5	1	271	83	117	61	27	11	28	12	8	624
ARREARS PAID MTT	6	17	9	6	8	12	1	2	0	6	7	74
TOTAL ADDITIONS	238	264	425	294	268	475	136	151	261	337	284	3133
DELETIONS												
ARREARS IEEE & MTT	0	944	0	413	0	0	0	62	0	0	0	1419
ARREARS MTT ONLY	598	114	30	14	0	0	0	0	1	1	1	759
TOTAL ARREARS	598	1058	30	427	0	0	0	62	1	1	1	2178
RESIGN IEEE & MTT	16	3	0	1	0	0	0	2	0	1	0	23
RESIGN MTT ONLY	0	2	1	3	2	0	0	4	1	1	0	17
DECEASED	36	0	1	0	1	1	0	1	1	1	0	42
TOTAL DELETIONS	650	1063	32	434	3	1	0	69	3	4	1	2257
ARREARS THIS/LAST YEAR:												
ARREARS THIS YEAR IEEE & MTT	38	979	654	966	827	746	694	746	714	698	684	684
ARREARS THIS YEAR MTT	1321	831	908	811	825	832	855	852	857	855	854	854
TOTAL ARREARS THIS YEAR	1359	1810	1562	1777	1652	1578	1549	1598	1571	1553	1538	1538
TOTAL ARREARS IN 1986	789	1651	1297	1483	1361	1346	1320	1371	1342	1330	1318	1318

Of particular concern to some members is the efficiency of the MTT-S "free" membership offer in attracting members who are retained in the years to come. Membership Development, in the process of gathering the statistics for 1986 to analyze the retainment of new "free" enrolling members, discovered that only 425 of 1,952 new members actually enrolled "free" in 1986. Furthermore, IEEE will not be able to identify how many of these 425 members retain their membership in 1987 since no "tracking code" was used on the application forms. A tracking code is present on all 1987 MTT-S Membership Information & Application forms. All new members enrolling "free" in 1987 will tracked as to whether they retain their membership in the next few years. To evaluate the efficiency of the "free" membership offer to induce members who are retained, Membership Development analyzed the past ten years' MTT-S new member enrollment and retainment statistics provided by the IEEE. These statistics will be used to develop a retainment baseline for benchmarking future retainment. Two plots follow which display MTT-S new member retainment. The first plot allows the evaluation of the retaining performance of members first enrolling in any year from 1977. The second plot is useful in evaluating the expected retainment performance for members who have been continuously enrolled for one through nine years. These statistics do not account for members who drop out but again enroll a year or more later. It appears the MTT-S retains about 80 percent of newly enrolled members after their first year of membership. It also appears the MTT-S retains over 50 percent of newly enrolled members after five years.

NEW MEMBER RETAINMENT



NEW MEMBER RETAINMENT



In order to evaluate why some members do not enroll again with our Society, a letter and surveying questionnaire was sent to the 480 Members from Regions 1 through 6 who had dropped their MTT-S membership but not their IEEE membership. The response summary follows.

SUMMARY OF "ARREARS RENEWAL NOTICE"
RESPONSE TO QUESTIONNAIRE

480 'ARREARS RENEWAL NOTICES" & QUESTIONNAIRES MAILED TO 1986 MTT MEMBERS WHO DROPPED MTT BUT NOT IEEE

98 RESPONSES RECEIVED

RESPONSE SUMMARY

25 RENEWED WITH MTT (NO COMMENTS WERE MADE BY 15 RENEWING MEMBERS)

62 ACCEPTED NEW RESPONSIBILITY OTHER THAN MICROWAVE ENGINEERING

7 RETIRED

2 UNEMPLOYED

1 WIFE IS MTT MEMBER SO HE FEELS HE DOES NOT NEED THE JOURNAL

1 RECENTLY DECEASED

18 DISSATISIFIED WITH MTT TRANSACTIONS AS BEING TOO SPECIFIC OR ACADEMIC FOR THE PRACTICING ENGINEER (6 OF THESE HAD TAKEN OTHER RESPONSIBILITIES OTHER THAN MICROWAVE ENGINEERING)

16 ENJOYED THE TRANSACTIONS BUT 13 DID NOT RENEW. SOME COMMENTS INCLUDED: WAS BUILDING A HOUSE AND NEEDED TO CUT BACK EXPENSES. ANOTHER HAD JUST RECENTLY RETIRED

5 STATED IEEE & MTT EXPENSES WERE TOO HIGH FOR THE BENEFITS GAINED

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RETAINMENT (continued from page 40)

Reviewing the summary discloses that when a Member's technical interests or work changes, so does his enrollment in technical Societies such as our MTT-S. This survey further supports two other surveys explained in the article entitled "Members Do The Society Hop" on page 11 of the recent October issue of "The Institute". It appears that two thirds of those in the surveys have taken a new responsibility which is no longer in line with the technical interests or services of the Society from which the members is in arrears.

Back to retainment. If two thirds of those who are in arrears and drop out of our Society are merely changing jobs and enrolling in other Societies...then...what about the other one third who drop out but are still involved in the field?

An attempt to answer the foregoing question was made in 1987. An analysis of the available Institute Society Membership statistics was performed in order to compare the MTT-S retainment rate with other Societies for 1986. In addition, the Society ranks for Membership size, growth rate, multiple Society Memberships, and numbers of technical meetings per thousand members were compared to the retainment rank. The resulting summary for the top sixteen IEEE Societies and the bottom ten IEEE Societies follows.

1986 IEEE SOCIETY RETAINMENT SUMMARY

TOP SIXTEEN SUMMARY

SOCIETY	RETAINMENT		SOCIETY RANK			
	RANK	%	SIZE	GROWTH	MULTIPLE MEM'SHIPS	CHAPTER '85 MEETINGS
PE (31)	1	88.7	3	10	33	4
EI (32)	2	86.1	33	8	13	13
MAG (33)	3	85.4	22	11	27	3
AP (03)	4	85.2	12	6	14	8
MTT (17)	5	85.0	9	5	19	9
EMC (27)	6	84.5	24	9	24	10
ED (15)	7	84.3	7	20	30	21
NPS (05)	8	83.6	25	16	25	32
IA (34)	9	83.5	6	32	31	6
COM (19)	10	82.9	2	3	26	16
ED (25)	11	82.7	29	13	7	1
LEO (36)	12	82.7	18	1	28	15
VT (06)	13	82.6	28	17	17	2
AES (10)	14	82.3	11	2	22	11
R (07)	15	82.2	20	19	23	5
ASSP (01)	16	82.2	5	4	11	17
AVERAGES:						
TOP TEN SOCIETIES		84.9	14.3	12.0	24.2	12.2
LOW TEN SOCIETIES		76.2	14.3	23.4	13.8	22.1

1986 IEEE SOCIETY RETAINMENT SUMMARY (CONTINUED)

BOTTOM TEN SUMMARY

SOCIETY	RETAINMENT		SOCIETY RANK			
	RANK	%	SIZE	GROWTH	MULTIPLE MEM'SHIPS	CHAPTER '85 MEETINGS
CHMT (21)	24	78.5	21	15	20	18
SMC (28)	25	77.9	19	27	2	20
EM (14)	26	77.7	10	30	18	12
EMB (18)	27	77.5	13	22	29	31
IE (13)	28	77.1	16	12	10	25
IM (09)	29	76.5	15	26	5	24
SIT (30)	30	74.9	23	33	6	14
CE (08)	31	74.4	14	25	12	30
CS (23)	32	74.3	8	21	21	19
CAS (04)	33	72.9	4	23	15	28

Summary: Maximizing Society Retainment

Providing services to our members appears to be part of the answer to increase retainment of Members. Also, involvement of the Members themselves seems to be part of the answer. What does this mean in terms of goals?

- INCREASE RETAINMENT TO 90 PERCENT BY 1990
- ATTAIN 70 CHAPTERS BY 1990
- ATTAIN 87 PERCENT MEMBERS AFFILIATED WITH CHAPTERS BY 1990
- ATTAIN 22 MEETINGS PER THOUSAND MEMBERS BY 1990
- ATTAIN SIX NATIONAL DISTINGUISHED LECTURERS PER YEAR STARTING IN 1988

Chocoholics may suffer from a deficiency of magnesium, a natural tranquilizer. *To quell chocolate cravings:* Take a calcium/magnesium supplement, or eat magnesium-rich foods such as green vegetables, whole grains and soybeans.

Cosmopolitan, 224 W. 57th St., New York 10019. Monthly. $24/yr.

MEMBERSHIP DEVELOPMENT

by Alton L. Estes

Growth Rate Continues Above Thirteen Percent

The Society Membership has continued to increase steadily this year through November when compared on a month-by-month basis to the 1986 Membership results. The MTT-S membership growth rate (compared to the other 32 IEEE Societies) varied between second and third place for the first six months of 1987. As can be observed in the following Table, the MTT-S became the fastest growing IEEE Society in July 1987. At the end of November, the MTT-S continued to be the fastest growing IEEE Society with a 13.5% membership growth over the November, 1986 MTT-S membership results. This growth compares favorably to the Institute membership growth rate of 4.5% for the same period. In addition, MTT-S is currently the 6th largest Society with 10,321 active members and will be the 5th largest Society when the December new member enrollments are tabulated. The MTT-S was the 9th largest Society at the end of 1986 with 9,445 active members. More than 275 new members are expected to enroll with the MTT-S in December. Therefore, the 1987 MTT-S membership is expected to reach a new record high of over 10,596 members and set a MTT-S annual growth rate of over 12 percent.

The meaning of membership statistics

Due to the efforts of many active MTT-S members, the MTT-S Membership Development activities are a success. The 10 percent membership growth goal set for 1987 will occur. The MTT-S will jump past four IEEE Societies in total membership during 1987 and will end 1987 ranked as IEEE fastest growing Society.

What does all this mean to you, the member? It means a more effective Society in terms of achieving more for our members — better meetings and discussions, more professionally written and presented papers. Also, more tutorials, workshops, and conferences will occur due to the membership increase and to the increase in Society Chapters. All of this at less cost than the year before, especially when inflation is considered. Thanks to all who participated in making this year's membership development a success and therefore added much to the quality of the services our Society provides for our members.

Free Membership For New MTT-S Members

New members joining MTT-S will receive free MTT-S membership to the end of 1988. These new members may be IEEE members that do not currently belong to the MTT-S or they must joining the IEEE and the MTT-S concurrently. This free membership offer should stimulate your colleagues and friends to join MTT-S and benefit from the educational opportunities that the Society has to offer. Adding an MTT Society membership provides an opportunity to interact with professionals of similar interests and to participate in some of the most meaningful and rewarding activities of the IEEE and the Society. Please contact Bill Hunter for membership applications at the following address.

Mr. William Hunter, Coordinator
IEEE Membership Development
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
U.S.A.
(201) 562-5522

Student Membership Drive

Membership development has initiated a MTT-S Student Membership drive for 1988 with the goal of increasing the MTT-S student membership by at least 200 members over the 1987 results. This increase represents a 14 percent growth rate over the 1987 enrollment results.

Other Activities

Many other Membership Development activities have occurred this year and a summary of this activity would be too lengthy for this newsletter. However, most of this activity is described within the minutes of the recent Adcom meetings. Ask your Chapter Chairman to let you look at his or her copy of the minutes if you are interested in more details about membership statistics (such as retainment, Chapter membership, arrears, reinstatements, etc.) or other Membership Development activities and tasks.

MICROWAVE THEORY AND TECHNIQUES SOCIETY
TOTAL ACTIVE MEMBERS

							CHANGE FROM 1986		SOCIETY GROWTH
MONTH	1982	1983	1984	1985	1986	1987	TOTAL	PERCENT	RANK
JANUARY	6256	6711	7085	7751	8370	9033	663	7.9	3
FEBRUARY	5651	6085	6407	6971	7437	8234	797	10.7	2
MARCH	5947	6468	6847	7465	7959	8627	668	8.4	3
APRIL	5751	6336	6698	7356	7948	8490	542	6.8	2
MAY	5914	6465	6899	7512	8211	8755	544	6.6	2
JUNE	6067	6577	7076	7728	8346	9229	883	10.6	2
JULY	6152	6649	7134	7770	8443	9365	922	10.9	1
AUGUST	6227	6707	7152	7827	8454	9447	993	11.7	1
SEPTEMBER	6298	6811	7297	7943	8530	9705	1175	13.8	1
OCTOBER	6466	6972	7500	8150	8825	10038	1213	13.7	1
NOVEMBER	6684	7145	7786	8475	9097	10371	1224	13.5	1
DECEMBER	6968	7435	8064	8715	9445				

GALLIUM ARSENIDE - KEY TO MODERN MICROWAVE TECHNOLOGY

by Edward C. Niehenke

DISTINGUISHED MICROWAVE LECTURER (1986-1987)

It has been a pleasure to present my lecture, "Gallium Arsenide - Key to Modern Microwave Technology" to 62 groups and 2932 people. Since my last newsletter report, I completed my lecture series with lectures in Brazil, Maryland, and Japan. I want to personally thank each MTT chapter chairman or host for the hospitality extended to me during my visits. I have many fond memories during this lecture series and have met many gracious and talented people. I want to thank the Microwave Theory and Techniques Society for selecting me and affording this honor, and to Westinghouse Electric Corporation for providing me the time and financial resources to make this lecture series possible. The report on my recent lectures and final statistics follows:

Brazil Lectures

Sao Paulo, my first stop in Brazil, is the fourth largest city in the world, with a population of 15 million, and the city of the 1988 Brazilian International Microwave Symposium. Antonio Carlos Baptistella, a medical doctor and electrical engineer, was my guide through the city. He told me that Pedro Alvares Cabral arrived here from Portugal with a fleet of sailboats to colonize Brazil. Portuguese is still the spoken language, and many European inhabitants are found here.

Antonio drove me to the Sao Paulo University, where Dr. Jacobus Swart gave me an in-depth our tour of the Microwave Electronics Laboratory. Their research includes the study of advanced processing and materials for microelectronics, mostly with silicides. A lot of laboratory equipment and processing is found here including Auger Electron Spectroscopy (AES), X-ray diffraction, Rutherford back scattering, plasma etching, and sputtering. Celso Gonzales showed me their 32-bit UNIX microcomputer developed here that operates in real time.

The next day, I met Jose Kleber Pinto, the head of the microwave division at the University. The extensive microwave development at the university included LNAs, mixers, oscillators, and high power amplifiers for the 4/6 GHz satellite downlink/uplink equipment for the Brazil Telephone company. All of this work is on soft board. I saw a 70 degree noise figure LNA at 4 GHz using the NEC 137 FET. NEC and Phillips have subsidiaries in Brazil.

A team of engineers including Denise Consoni, Marcello Handro Cordaro, and Hong Lee have been developing MMIC circuits for some three years for the next 12/14 GHz domestic satellite system. Mauricio Cunaha showed me a SAW convolver he developed.

This extensive activity at the University spurred me to ask many questions. I discovered that the government funds the universities to undertake the development of projects for Brazil. After the university completes its development, the infformation is transferred to the Telecommunication R & D Center (TELEBRAS). The TELEBRAS then transfers the technology to Brazilian companies who will manufacturing the product. My lecture was well-attended at the university with such notables present as the department head of the University of Leeds of the United Kingdom.

I had a few hours after the lecture to visit the city on foot, so the hotel manager purchased some local money for me to buy my family presents. When I received the money, it was in two forms, cruziero and mil cruziero. The latter currency is 1000 times more valuable than the former. I also received much more money than that of the published exchange rate. The reason for this is that the inflation rate is very high (30 percent each month) and there is a black market for money, which every one knows about.

That evening, I met Sergio Eduardo Fronterotta, the IEEE director of this region, Valbert Pereira A. Garcia, the IEEE Sao Paulo Section president, Lucia Sihieira, his assistant, and Walter Xavier Berirra, chairman of the Sao Paulo power section. The IEEE in Brazil is eager to have lecturers visit their country and were very cordial and friendly. I learned a great deal about their country during dinner. Just as Maryland is known for crab feasts and bull roasts, Brazil has its barbecues. Waiters come to your table with all sorts of meat on a skewer just brought from the hot open barbecue pit, and slice the meat which is extremely tender and tasty. This procession with about 12 varieties of beef, pork, sausage, and chicken continues on and on.

I found the technical thrust of Brazil similar to that of China. They want to increase their technical base as rapidly as possible. I believe this rapid increase with the borrowing of money to fund the developments has led to the inflation. Unlike the United States, Brazil is allowed to sell land to outside interests to raise money.

continued on page 45

GALLIUM ARSENIDE (continued from page 44)

They have similar problems as we do with trade deficits. I also learned that Brazil has considerable hydroelectric power, and the country is studying the best method to distribute the power from the source in the north to the south.

The next morning, I was driven to Campinas with Lucia Sihieira, Soraya Gersonny, and Marcelo Assef to visit the Campinas University and the TELEBRAS. At Campinas University, Francisco Priuce, the department head, showed me the various research projects which were aimed mostly in the optical areas. Optical lasers and detectors of varying wavelengths using InGaAsP, GaAs, and InGaAs are under research here with thrusts to improve the efficiency of detection and purity of the laser spectrum. Mauro M. G. de Carvalho showed me the MOCVD system he developed and Monice Alonso Cotta explained his research on growing InP on silicon. The lecture here was of great interest to all.

At the TELEBRAS, I was given a tour by Paulo Rodriques, a student I taught at the University of Maryland in 1983. As Disney say, "It's a small world out there". I was driven back to Sao Paulo, and took a plane to the next city, Rio De Janiero.

Louis Conrado, the chapter chairman of the Rio MTT-S chapter picked me up that evening and took me to the hotel and then to the Catholic University of Telecommunications (CETUC) the next morning where I lectured and saw their research projects. Louis showed me his work which included dual gate FET mixers, controlled-gain amplifiers, phase shifters, and dielectric resonator filters. Marbey Mosso used Trans-Tech 1010 for his 100 MHz to 4.5 GHz optical modulator bias filter. Alvaro Augusto de Salles, the chairman of the 1987 Brazil International Microwave Symposium, explained to me his work to understand and improve the efficiency of the avalanche photo diode. I was told the problems the Brazil researchers have in obtaining devices and materials for their work. It takes typically nine months to obtain parts as opposed to a few weeks in the U.S.

At the Brazil International Microwave Symposium, I presented my lecture to record 500 in attendance at the opening plenary session to complete my lecture series in Brazil.

Baltimore Lectures

I lectured to two groups at Westinghouse with a total attendance of 185. The lecture was very informative to the young engineers and they had many questions. This lecture was almost entirely different from my first lecture in this city the previous year, which reflects how this field is rapidly advancing.

Japan Lectures

My wife Betty accompanied me for the first time on this last trip to Japan. The MTT-S chapter officers including Professor Kazuhiro Miyauchi, the chairman, Dr. Masami Akaike, the vice chairman, and Dr. Shigekazu Hori, the secretary/treasurer, as well as Dr. Eikichi Yamashita, the previous chairman, took care of every detail for us.

The first lecture was at the NEC research and development center in Kawasaki. Dr. Kazuhiko Honjo escorted me to the labs where Dr. Hiraku Sakuma briefed me on the thrust of NEC's research which includes ultra high speed device, memory, and sensor research. After my lecture, Dr. Honjo explained his self-aligned heterojunction bipolar transistor (HBT) structure with low parasitic capacitance and resistance which uses SiO_2 sidewalls for structure definition. Dr. Hikaru Hida explained his research on the doped channel hetero MIS (metal-insulator-semiconductor) transistor. He achieved an I_{dss} of 650 mA/mm, a transconductance of 310 mS/mm with an f_T of 45 GHz and an f_{max} of 48 GHz.

K. Ohata presented his research of InP FETs for millimeter wave applications. He achieved a breakdown voltage of 30V and a power capability of 0.5 W/mm with a f_{max} of 64 GHz for a 0.6 micron FET. The FET channel is n type InP with an AlGaAs layer between the TiPtAu Schottky gate and the InP channel. NEC just received its MOMBE machine for advanced processing.

The next lecture was to the MTT-S chapter in Tokyo. With only four days in Japan, Betty and I were veterans at riding the vast subway system which will take you most anywhere. At this lecture the questions from the Japanese dealt not only the technical ones, but with the business opportunities for Japanese exports to the U.S., and the views that the U.S. government has in using Japanese semiconductors. After the meeting, we had a chance to talk at great length to the MTT officers, who were ever so gracious.

The next day Dr. Hisao Hashimoto escorted me to the Fujitsu laboratories in Atsugi, while my wife, a nurse, was escorted by Miss Yoshie Terauchi to the National Rehabilitation Center for the Disabled. At the

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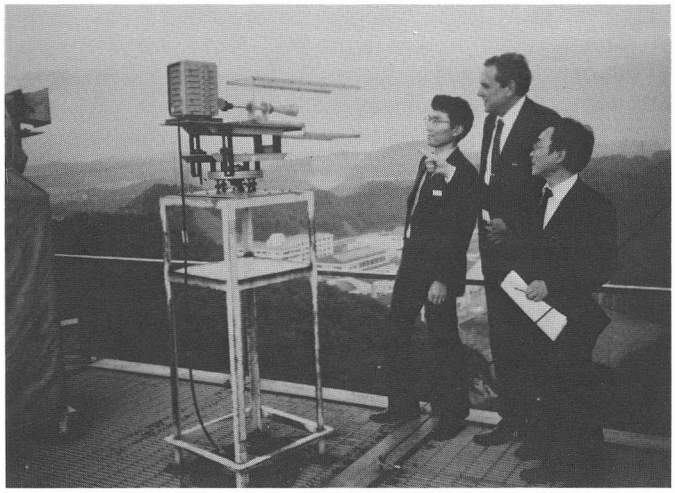
GALLIUM ARSENIDE (continued from page 45)

labs, Dr. Masumi Fukuta briefed me on Fujitsu and their GaAs devices. Fujitsu is famed for its power FETs, and the latest results bear this out with 3-watt, 12 GHz, FET with 48 percent power added efficiency. The HEMT was invented at Fujitsu by Mimura in 1980, and a 23-GHz cooled HEMT amplifier was responsible for the discovery of a new carbon molecule 500 light years away. Dr. K. Katsura Yamada introduced me to their work on microwave communication systems including the mobile radio.

After my lecture, Dr. Masayuki Abe showed me his HEMT work and efforts to achieve uniform GaAs wafer properties, critical for HEMT digital circuitry. Mobility and sheet conductivity were within plus or minus two percent with their home grown MBE system. Out of a sample of 100,000 HEMTs, 90 percent worked. A 16K static RAM was processed with 3.4 ns access time at 77°C.

The next day Dr. Akaike escorted Betty and I to the National Tele and Telegraph (NTT) Research center in Kanagawa. This center is equivalent to the AT&T Bell labs. Dr. Heiichi Yamamota and Dr. Shuichi Samejima explained the the mission of this group at NTT was in communication satellite technology. After my lecture, the scientists presented a mini-symposium outlining their work.

I was very surprised to discover from Dr. Haruhiko Kato that NTT has developed many MMIC circuits for a satellite responder system which receives at 30 GHz and transmits at 20 GHz. The MMIC LNA has a 6-dB noise figure with 4 dB gain at 30 GHz and their mixer has an 8 dB conversion loss at 27-30 GHz. Their oscillator uses phase lock loop techniques eliminating the need for a dielectric resonator and exhibits adequate phase noise of 80 dBc at 1 KHz offset frequency. T. Hirota explained their unipolar transistor and Dr. Misahiro Muraguchi showed me their self-aligned 0.3 micron FET process (SAINT). Finally Dr. Kenji Ueno showed me their antenna facility, where the next generation antenna is undergoing testing. This antenna is shaped to beam the signal to cover the intricate shape of Japan.



Dr. Akaike escorted us to Osaka by way of the bullet train to visit the Advanced Telecommunication Research (ATR) Institute in Osaka. This newly formed institute as explained by the head of the radio systems Dr. Masayoshi Aikawa and by the president Dr. Yoji Furuhama, is to promote creative, fundamentals-oriented research in telecommunications-related areas.

The lecture room was packed and after my lecture I was shown the models of a isolator configured with FETs with broad-band performance.

Dr. Osamu Ishihara escorted me to my final lecture at the Mitsubishi Electric LSI Research and Development Lab in Itami. After replacing my shoes with slippers in the lobby, Dr. Kyoichi Shibayama, the general manager, explained the long history of this company starting with the initial FET development in 1972, FET production in 1979, GaAs MMICs in 1980, three national programs in 1983 including super computers, radiation hardness, and millimeter wave semiconductors. In 1983, a pilot line for GaAs MMICs was established, followed in 1985 with the trial production of X-band 1-watt, 3-dB noise figure modules containing MMICs. In 1986, HEMTs into production followed in 1987 by a three-inch wafer production. They presently have a 30-GHz medium power FET with 150 mW power, gain greater than 4 dB, and a power added efficiency of 15 percent. I presented my final lecture to a room packed to capacity. This was a pleasure to say the least.

PEER

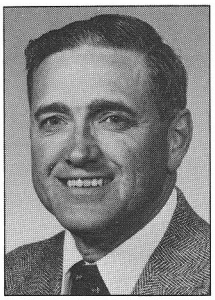
The Professional Engineering Employment Registry Service Center has a new address and new telephone numbers.

PEER, a resume data bank, was designed and is controlled by IEEE in cooperation with other technical and professional societies. Names, addresses and current employers of individuals on the system are coded to ensure complete confidentiality. Employers can search the data base by specifying requirements for particular job openings.

Members interested in the PEER registry may request information in the following ways:

- Write or call the PEER Service Center directly at 138 Old River Road, Andover, MA 01810; Telephone (617) 683-0098.
- Use a touch-tone telephone to access the talking computer. Call (617) 263-6823. When requested, enter the user ID, **200#225#**, and the password, **PEER#** (be sure to enter the '#' sign, as shown).
- If you have a personal computer (or terminal) and a modem, you can enter your resume by calling the On-Line Career Network, (617) 263-3857. Press your **RETURN** key twice and enter the password **PEER** to log on.

TECHNOLOGY TRENDS IN MICROWAVE RADAR



by David K. Barton
ANRO Engineering Consultants
Lexington, MA 02173
(617) 862-3000

DISTINGUISHED MICROWAVE LECTURER (1987-88)

This year's lectures got off to a start on September 17, at the Twin Cities MTT meeting in Minneapolis. There was a good turnout for lunch at the Sheraton Park Place Hotel, and extra tables had to be set up to handle the group. It is always gratifying to a speaker to have such an enthusiastic crowd.

October was consumed with business trips and attendance at the International Radar Conference in London, sponsored by the IEE with IEEE support. While there, I also had a chance to visit Plessey Radar on the Isle of Wight, where there is a good deal of advanced radar work going on. One of their projects is a solid-state radar using 900 GaAs MMIC modules for transmitting and receiving. This radar was described in a paper given at the radar conference.

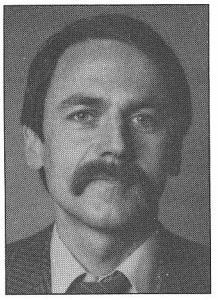
My lecture activity picked up in November, with sessions at the Baltimore Chapters of AP and MTT, on November 11, at the New Jersey Coast MTT/ED/LEO meeting at noon on November 12, and the North Jersey MTT and AP Chapters that evening. The following day, I drove out to Farmingdale, Long Island to speak to a mixed student and industry group at the Polytechnic University of New York. Then, on November 16, I visited the University of Massachusetts at Amherst. This is one of the universities which is participating in a program of high level training in microwave electronics, in support of the high technology organizations in the Boston area. It is one of the few places where students are getting hands-on experience in radar, and since it is part of the state university system there are no restrictions on participation by students from overseas or others who lack security clearance.

In addition to the six lectures already presented, I have scheduled 27 others during the period from December through May, and have just three requests remaining to be scheduled.

The lecture itself is a little different from other MTT lectures, since I have chosen to emphasize the relationship of new microwave technology and devices to radar system requirements and performance, primarily in the air surveillance and tracking areas. Along with the contributions made by many modern components, there are drawbacks which are encountered when new technology is adopted with excessive exuberance and insufficient system engineering. One example of this is the microwave phased array surveillance radar which scans so fast that it doesn't provide time for adequate signal processing. Another is the solid-state transmitter using such long pulses that they mask small targets before they come within detection range. Important positive contributions are reliable low-noise RF preamplifiers, microwave oscillators with very low phase noise, solid-state RF sources with adequate peak power to replace tube transmitters, and multiple-beam feed networks for monopulse tracking and adaptive nulling of interference.

It is my hope that the combination of critical and constructive comments presented during the lectures, along with discussion and questions afterwards, will help the microwave engineer match his circuit and device knowledge to the needs of the radar user, who now, at the end of a long chain of development and procurement, often receives equipment unsuited to his needs.

CAD OF HYBRID AND MONOLITHIC MICROWAVE AND MILLIMETER — WAVE MICS



by Rolf H. Jansen
Industrial Microwave and RF Techniques, Inc.
Neanderstrasse 5
D-4030 Ratingen 1
West Germany
Phone 49-2102-83095

DISTINGUISHED MICROWAVE LECTURER (1987/1988)

As one of the two 1987/1988 Distinguished Microwave Lecturers, my regular schedule was originally planned to start September 1987. However, with the first invitations arriving as soon as May 1987, I started early in June on the way to this year's MTT-Symposium giving two lecturers in New Jersey, one to the New Jersey Coast Chapter and another one to the Princeton MTT-Chapter. This was a very enthusiastic start and the interest and response of the audience was really great.

After the summer holidays I continued lecturing in Italy with two presentations for the mid Italy and South Italy IEEE sections respectively, in Rome and in Palermo, Sicily. To the meeting in Palermo, I went together with Dr. Itoh of the University of Texas at Austin and we both received a particularly warm welcome there and enjoyed the excellent Italian hospitality of our colleagues in this beautiful and historic part of Southern

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JANSEN (continued from page 47)
Europe. As a technical point of interest the Palermo group is part of the Electronic Research Centre in Sicily (CRES).

Following these initial activities I went to the U.S. East Coast for a first condensed series of seven lectures given in the time of October 15 to October 22, 1987. My lectures again started off with the very enthusiastic audience at a meeting of the Twin Cities MTT-Chapter in Minneapolis. From there I went on to the Baltimore Chapter giving a presentation at Westinghouse and having an interesting insight into the microwave work done there and I also had two hours left to visit the historical exhibition of microwave equipment nearby. Further presentations were given for the student chapter at Texas A & M University in College Station, Texas, the Washington/North Virginia MTT-Chapter, the Microwave Community at the National Radio Astronomy Observatory in Charlottesville, Virginia, the North Jersey Chapter in Newark and finally the Boston MTT-Chapter. The audiences typically had a size of 30 - 50 attendees, the interest In the topic of my talks was considerable and the discussions I had and the personal contacts I made along with my visits were really a great experience for me. Though this trip appeared to me as a big workload when I started it, I came back home very satisfied and charged up with new impressions and ideas. I have to thank all these MTT-officers and microwave colleagues who helped to make my lecturing series successful and let me feel that there is a well-supported MTT-Society worldwide.

In November 1987 I made a brief trip to Israel giving an opening presentation there for a one-day-symposium organized by Dr. A. Madjar, the Chairman of the Israel Joint MTT/AP-Chapter. Another lecture was given in November 1987 to the Student Chapter at the Technical University of Munich here in Germany which gave me the opportunity at the same time to cooperate with my colleague Professor Russer, Chairman of our West Germany Chapter, on the planning and preparation of our own Chapter activities for 1988/1989. In a few days I shall go to Paris to meet two groups of Microwave people there, to lecture them on Microwave CAD, support them in setting up their own French Chapter and build up a cooperation with our German Chapter at the same time. The total of 14 presentations reported here has been complemented by myself in giving another five industry/conference presentations and a one-day seminar.

Presently I have about 15 further invitations to present my lectures in the first half of 1988. Mid-January 1988 I shall try to attend the ADCOM-meeting in New York and I am presently organizing to combine that with two presentations. A one-week visit to Japan is now being prepared for February 1988 and I am organizing a series of eight talks for April 1988 along the U.S. West Coast. The audience there comes from a microwave population which is very much involved and interested in MMIC design for which reason I am looking forward with particilar expectations to this visit.

My schedule for early 1988 is still somewhat flexible and for the time after April 1988 it is only emerging in its beginning. Please, send your requests to me as early as possible since only this allows for efficient travel planning. As it looks now I have the following rough outline for my lecture schedule in 1988:

January-March 1988	Regions 7-10
April-June 1988	USA Chapters
September/October 1988	Regions 7-10
October-November 1988	USA Chapters

Those who are interested in my presentations can make my life easier by trying to stay approximately within the frame of that schedule. I would like to encourage in particular the Chapters of Regions 7 - 10 to contact me for a speaking arrangement. As a West Europe based speaker I might be able to serve some of these easier than this could be done from the U.S.A.

MICROWAVE AND GIGABIT SUPERCONDUCTIVE ELECTRONICS

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

DISTINGUISHED MICROWAVE LECTURER (1988/1989)

Abstract

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 application 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.

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SILVER (continued from page 48)

We will discuss the performance and application 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 herald the widespread use of superconductive circuits. Prospects for development and application of high temperature superconductive electronics, and its possible impact on semiconductor devices will be explored.

BIOGRAPHY

Arnold H. Silver joined TRW Space & 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.

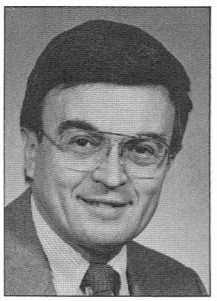
Silver has been active in the development and application of superconductive electronics since his invention of the SQUID at Ford in the early 1960's. At Aerospace, his laboratory pioneered the development of low noise millimeter wave mixers and detectors, including the superconducting-Schottky diode 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 integrated 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 holds numerous patents.

Accepting compliments gracefully is as important as giving them. If you deflect a compliment with a self-deprecating remark, the speaker feels foolish and you feel unworthy of the praise. *Recommended:* Practice replying to compliments with a simple *Thank you.*

Secrets of Strong Families by Dr. Nick Stinnet, professor of family life, University of Alabama. Berkley Publishing, 200 Madison Ave., New York 10016. $3.50.

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 wave length 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 (LAN's). Different network architectures for lightwave LAN's 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.

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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, d'Electronique 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.

MICROWAVE LECTURES 1988-1990

MICROSTRIP CIRCUIT ANALYSIS: THE INTEGRAL APPROACH

by Fred E. Gardiol

Laboratory of Electromagnetism and Acoustics
Ecole Polytechnique Federale (EPFL)
CH-1015 Lausanne, Switzerland
Phone: 41-21-472670

Abstract

Microstrip structures have become the most common way to realize low power microwave circuits. Their technology is simple and well suited for series production, the resulting circuits are rugged, small, lightweight and inexpensive. Semiconductors, dielectric resonators, antennas and active devices can easily be implanted on the same substrate.

Microstrip was until now used at relatively low microwave frequencies (typically below 10 GHz). Recent progress in substrate technology has reduced ohmic and dielectric losses, increasing the frequency range up to K-band with present trends towards millimeter waves. However, substrates cannot become infinitely thin and, as the frequency increases, radiation and surface waves appear at discontinuities of the conductor strip. Low-frequency-like quasi-TEM transmission line approach and enclosed waveguides are no longer valid, since they do not take into account the effects of radiation and of surface waves.

On the other hand, microstrip structures are frequently used as antennas. They become then metallic scatters embedded in an inhomogeneous medium, for which accurate mathematical models are available. The integral equation approach, originally developed for microstrip path antennas, can also be used to analyze general microstrip structures (radiation and surface waves are thus automatically taken into account). The mixed-potential integral equation allows one to study arbitrarily shaped conductors.

The Green's functions that form the kernel of the integral formulation are expressed by Hankel transforms, as introduced by A. Sommerfeld in his pioneering work on radiowave propagation above a lossy earth. An efficient numerical evaluation of these Hankel transforms is based on specifically tailored algorithms. The integral equation is solved by the method of moments, that transforms it into a matrix equation. Several choices for test and basis functions are compared in terms of convergence and accuracy.

The field analysis of a microstrip structure provides in the final step the distribution of the electric surface current in the conductors, in terms of which the circuit parameters are determined: impedance and scattering matrices for the configuration considered. Theoretical and experimental results will be compared for coupled resonators, discontinuities, filters, and other commonly used microstrip components.

BIOGRAPHY
FRED E. GARDIOL

Fred E. Gardiol was born in Corsier-s/Vevey, Switzerland, in 1935. He graduated in Engineering Physics at Ecole Polytechnique de l'Universite de Lausanne in 1960, received the MSEE degree in Electrical Engineering from the Massachusetts Institute of Technology in 1965 and the Doctorate in Applied Science from Louvain University, Belgium, in 1969.

He worked in the semiconductor industry (1960-61) and in high-power microwave ferrite devices (Raytheon SMDO, Waltham, MA 1961-1966). He then joined Louvain University, Belgium, becoming Assistant Professor in 1969. Since 1970 he is Professor of Electromagnetism and Microwaves at Ecole Polytechnique Federale de Lausanne, Switzerland, where he heads the Laboratory of Electromagnetism and Acoustics (LEMA). He was Visiting Professor in Canada, Algeria, Brazil and India.

Professor Gardiol is the author of two books in French (*Electromagnetisme* and *Hyperfrequences*) and two in English (*Introduction to Microwaves* and *Lossy Transmission Lines*). He has written more than 150 technical publications on microwave theory, loaded and open waveguides, microstrip circuits and antennas, electromagnetic field analysis. He organized the fourth European Microwave Conference in Montreux in 1974. He was chairman of the Swiss Section of IEEE in 1975-76, founder and first chairman of the IEEE Swiss Joint MTT and AP Chapter. He is member of Sigma Xi, of the Swiss Electrotechnical Association, IMPI, the French "Club des Microondes", the Swiss Association for Space Techniques and the Swiss Alpine Club. He is Chairman of the Swiss National Committee of URSI and vice-chairman of Commission B of URSI (Field and Waves).

REMOTE SENSING WITH MICROWAVES AND MILLIMETER WAVES

by Erwin Schanda

Institute of Applied Physics
University of Bern, Sidlerstrasse 5
CH-3012 Bern, Switzerland
Phone: 41-31-658910

Abstract

Microwave and millimeter wave radiometry and radar became rather well-established methods in remote sensing during the last few years. This happened partly because they can be employed independent of the time of day and almost independent of weather, and partly because of the important spectral features at these wavelengths of environmental media.

Theoretical studies as well as laboratory and field measurements of rough-surface scattering and emission from agricultural soil and sea surface and of volume scattering and emission from snow and vegetation yield a considerable comprehension of the interaction of microwaves with the molecular properties and the geometrical features of these media. Hence algorithms have been derived which allow the interpretation of air- and space-borne radiometer- and radar-data in terms of natural parameters.

The absorption line of atmospheric constituents in the millimeter wave range can be utilized to measure with radiometers various trace gases and other parameters, like temperature, throughout the strato- and mesophere. Our long-term investigations comprise local and regional observations (including polar regions) of species relevant to the stratospheric ozone chemistry by ground-based and air-borne instruments. For the observation of the global distribution of O_3, H_20, and temperature, a multichannel radiometer is presently under construction for space shuttle flights from 1991 onward.

Some fundamentals of the methods and results of investigations - with emphasis on those carried out by the author's research group - will be presented.

BIOGRAPHY
ERWIN SCHANDA

Erwin Schanda, a native of Austria, received the M.Sc. degree in electronics engineering (Dipl. Ing.) 1957 from the Vienna Technical University and the Ph.D. degree in physics 1968 from the University of Bern, Switzerland.

In 1958 he joined Philips Laboratories in Eindhoven, the Netherlands, for research and development on ferrimagnetic material and its applications to microwave devices. Since 1964 he has been at the University of Bern. As project head, he initiated research activities on solar radioastronomy and microwave remote sensing. He became Associate Professor in 1975 and Full Professor in 1976. From 1976 - 1984 he acted as Director of the Institute of Applied Physics.

Professor Schanda is head of the microwave division of this Institute. Two of his research groups are active in remote sensing:

- Millimeter wave sounding of trace gases and atmospheric parameters in the earth's strato- and mesophere. Development of millimeter-wave sensing units for observations from ground, from airplanes and from space.
- Study of emission and scatter behaviour and related dielectric properties of snow, ice, soil and vegetation. Algorithms for interpretation of microwave remote sensing data from air- and space platforms.

Professor Schanda was invited guest professor at the Universite Paul Sabatier, Toulouse, France, during one semester in 1982. He is member of the International Astronomical Union and the European Physical Society, he was elected Fellow of the Institute of Electrical and Electronics Engineers (1984) and Member of the International Academy of Astronautics (1985).

Erwin Schanda is author of a textbook "Physical Fundamentals of Remote Sensing" (Springer, 1986) and editor-coauthor of books on topics of remote sensing and of electromagnetic waves. He was co-organizer of three URSI-sponsored international symposia on microwave signatures in remote sensing.

QUANTUM NOISE IN MICROWAVE AND MILLIMETER WAVE ELECTRONICS

by Bernard Yurke

AT&T Bell Laboratories
600 Mountain Avenue
Murray Hill, NJ 07974
Phone: (201) 582-4961

Abstract

At elevated temperatures a microwave termination radiates thermal noise with a power proportional to the termination's temperature. At sufficiently low temperatures the noise power radiated by the termination no longer decreases with temperature but instead levels off to a constant value. This temperature independent noise is called zero-point noise or vacuum fluctuation noise and is a manifestation of the quantum mechanical nature of the electromagnetic field. Recently it has become possible to construct electronic circuits, employing Josephson junctions, whose noise performance is sufficiently good that the dominant noise is of this quantum mechanical origin.

Quantum noise presents new challenges to device design. In the quantum world voltages and currents are

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QUANTUM NOISE (continued from page 51)

no longer simply functions of time. They must instead be described by more complicated mathematical objects called operators. As a result, electronic devices operated in the quantum domain can exhibit a richer variety of phenomena than exhibited in the classical world.

We are just beginning to learn how to manipulate and even take advantage of the quantum nature of the electromagnetic field. Recently it has been experimentally demonstrated, at optical frequencies, that quantum states of electromagnetic field, called squeezed states, can be generated which in some sense exhibit less noise than the vacuum fluctuation noise. That is, light has been generated which is less noisy in one of its aspects than complete darkness. Similar experiments are underway at microwave frequencies.

How one generates squeezed states microwave frequencies and how they may be employed to enhance the performance of sensitive instrumentation will be described.

BIOGRAPHY
BERNARD YURKE

Bernard Yurke received his MA (1976) from the University of Texas at Austin where he did thesis work in theoretical molecular physics. He received his Ph.D. (1983) in physics from Cornell University, Ithaca, NY. The thesis work consisted of low temperature experimental work on superfluid ^{3}He and spin-polarized hydrogen.

He joined AT&T Bell Laboratories as a Member of Technical Staff in December 1982. There he has performed experimental and theoretical research in quantum optics and electronics both at optical and microwave frequencies. He has concentrated on the generation and detection of nonclassical states of the electromagnetic field called squeezed states. He collaborated with the first group to experimentally generate such states. More recently he has demonstrated the squeezing of 4.2 K equilibrium noise with a Josephson-junction parametric amplifier operated at 20 GHz.

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MICROWAVE AND MILLIMETER WAVE HEMT DEVICES AND CIRCUITS

by
Heinrich Daembkes
AEG Research Center
Sedanstrasse 10
D-7900 Ulm
West Germany
Phone: 49-731-392-4274

Abstract

The GaAs-based devices and circuits are the key elements of todays' progress in modern communication technology. New developments allow the utilization of increasingly higher frequencies. While the digital applications suffer from yield problems at medium and higher integration levels, the microwave and millimeterwave circuits are eagerly being used and attain acceptable production levels even at low levels of integration. The reason for this is the miniaturisation of the systems, leading to the possiblity of completely new design approaches.

While the first generations of GaAs MMICs are passing the production lines, new GaAs based hetero devices are developed exhibiting some superior characteristics: The High Electron Mobility Transistor (HEMT). Other names of the same device are: Modulation Doped FET (MODFET), Selectively Doped Hetero FET (SDHT), Two Dimensional Electron Gas FET (TEGFET), ...These devices are just entering the commercial market as discrete devices, but some first examples of integrated circuits are already demonstrated for digital and for analog applications.

The talk will start with fundamental considerations of conventional GaAs FETs and discuss the major problems arising with short gate length. Then the basics of heterostructure electronics and band structure engineering will be explained, leading to the understanding of the new device concepts, including new devices which combines lateral and vertical transport mechanisms.

A major part of the presentation will deal with the specific properties of the HEMTs. A review will be given of the different approaches to tailor the desired characteristics. The performance of the different structures will be outlined.

The circuit part will highlight the possibilities of using HEMTs in integrated circuits. A more sophisticated technology is needed but a high degree of flexibility is gained.

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DAEMBKES (continued from page 52)

BIOGRAPHY
HEINRICH DAEMBKES

Heinrich Daembkes received his Dipl. Ing. in electrical engineering from the University of Aachen (RWTH), Germany, in 1976. After working on the design of radio receiver circuits at AEG-TELEFUNKEN he joined the Solid State Electronics Department of the University in Duisburg. There he received the Dr.-Ing. degree in 1983. In his thesis he treated the design, technology, and characterization of GaAs based field-effect transistors.

He joined the AEG Research Center Ulm in 1984 as a senior research engineer. His work was on InP based heterotransistors for optoelectronic integrated circuits.

He is also engaged in the work on new heterodevices on silicon, such as SiGe/Si HEMTs. His present activities include a research professorship at the university of Kassel.

He has published more than twenty five technical papers and holds several patents.

Daembkes is presently editing two IEEE books on "HEMTs: Design and Technology" and on "HEMT Devices and Circuits".

He is a member of the IEEE ED and MTT Societies and of the German Society of Radio German Engineers.

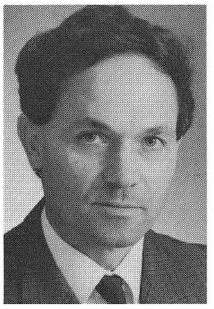
TECHNICAL COMMITTEES

by Reynold S. Kagiwada

This is the second of a series of reports by the Technical Committees of MTT-S. The purpose is to give the membership a better understanding of the role of the various committees and their activities. The first three articles were MTT-S: Lightwave Technology by Chi H. Lee, MTT-6: Microwave and Millimeter-Wave IC's by Ed Niehenke and MTT-15: Microwave Field Theory by Tatsuo Itoh.

In this series, MTT-8: Microwave Network Theory by Alby E. Williams, and MTT-13: Microwave Ferrites by William E. Hord will be covered.

MTT-8: MICROWAVE NETWORK THEORY



by A.E. Williams
22300 Comsat Drive
Clarksburg, MD 20871-9475

The Microwave Network Theory Committee is principally concerned with the theory and design of passive microwave circuits. This includes such components as filters, multiplexers, couplers and matching networks to both passive and/or active circuits. The Committee is not only concerned with both theory and practical realizations but is always looking for new technologies and materials which can play a key role in the advancement of the state-of-the-art. The Committee activities partially overlap both Computer Aided Design (MTT-1) and Field Theory (MTT-15).

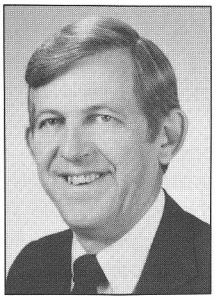
At the 1986 MTT Symposium in Baltimore, MTT-8 sponsored two one-day Workshops on Microwave Dielectric Resonators and Filters and Multiplexers. The second Workshop was organized by Dr. A. Saad of M/A-Com to discuss various aspects of filter and multiplexer design and six invited speakers participated.

At the 1987 MTT Symposium in Las Vegas a Workshop on Dielectric Resonators was organized by Dr. K. Agarwal of MTT-6 and cosponsored by MTT-8. This Workshop concentrated on Oscillator Applications of Dielectric Resonators and represented a timely follow-up to the 1986 Dielectric Resonator Workshop.

At the 1988 New York MTT Symposium, MTT-8 is cosponsoring with MTT-6 and MTT-15 a one day workshop on the topical subject of superconductivity. The organizers have invited a very distinguished group of speakers for the morning session and plan to use the afternoon period for presentations of current measurements and results. We are all looking forward to this pioneering event.

MTT-8 has maintained a very active agenda over the past few years and our committee members remain dedicated to keeping this microwave technology flourishing.

MTT-13: MICROWAVE FERRITES



by W. E. Hord

The Microwave Ferrites Committee is concerned with the development of ferrite materials and the application of these materials to microwave and millimeter-wave devices. The ongoing development of ferrite control components, the use of surface wave devices as signal processing elements and the extension of useful components into the millimeter-wave region are areas which will receive increased attention from the Committee. The Co-Chairmen are presently restructuring the Committee, and a revised membership list will be available early next year.

A workshop on Planar Millimeter Ferrite Structures was sponsored by the Committee in June 1986 at the International Microwave Symposium in Baltimore. This workshop was organized by Mr. Jim Sethares of the Rome Air Development Center. Also in 1986, a review paper entitled "Control and Processing of Microwave Signals Using Ferrites" was published in the Fall MTT Newsletter. This article was prepared by the Co-Chairman of MTT-13.

The Committee has proposed to Mr. John Pierro, 1988 MTT Special Sessions Coordinator, that a panel session concerning "Ferrites at Millimeter Frequencies" be held at the New York Symposium. This session would address the following topics:

Materials and Processes for Millimeter-Wave Ferrite Devices
Ferrite Finline Components
Millimeter-Wave Ferrite Devices
Novel Concepts

We are presently awaiting a decision by the Symposium Committee.

MTT-13 is anxious to increase the activities of the Committee in the years to come. If you have suggestions or comments, please let me know.

Book Review

Radar in World War II, Guerlac, Henry E., The American Institute of Physics/Tomash Publishers, New York, 1987, 1255 pp., $110.00.

"The story of the growth, the activities, and the accomplishments of the Radiation Laboratory of the Massachusetts Institute of Technology were so complex and far reaching that an entire book would be required to describe them. Such a book has, indeed, been written by Dr. Henry Guerlac, who was brought to the Radiation Laboratory for the purpose of compiling its history. Unfortunately, no mechanism for the publication of this extensive and important document is now available."

-Lee A. DuBridge, in his introductory remarks on Organization of the Radiation Laboratory in Volume 28 of the MIT Radiation Laboratory Series (McGraw-Hill, 1953).

Guerlac's massive treatise on the history of radar in the Second World War is indeed now available. The work records the history of Division 14, Radar, of the National Defense Research Committee, during its life, from July 1940 until June 1946. The focal point of the Division was the MIT Radiation Laboratory, whose founding, structure, personnel, and accomplishments are detailed here. Guerlac tells the story from a number of different perspectives:

The early history of radar, starting with first efforts of the British (the magnetron) and their vital role in the development of the US radar program;

The scientific basis and explanation of the physics of radar;

An exhaustive description of the system-as well as component-level activities of RadLab; and finally.

A chronological description of the events of WW II and the influence of radar developments on the outcome of the events of that conflict.

Stories of the people and projects of the MIT Radiation Laboratory reveal the wartime sense of urgency, speed and compromise with which projects were undertaken and completed. This sense of urgency was conveyed by Alfred Loomis's insistent request: "Don't build one, build seventeen!" As RadLab commitments strained its resources, a "red ticket" priority system was implemented to properly order its efforts. By the time the Lab had been closed, 60 "crash" programs had been completed, accounting for 22% of all Division 14 expenditures during the war.

Within this environment, many of the concepts and devices that shaped the future course of microwave theory and techniques were conceived. Waveguide, the magnetron, the rotary joint, the balanced mixer, high voltage pulse techniques, the transmit/receive switch, the concept of the equivalent circuit, and the magic tee were among those developed or invented during the completion of RadLab programs. Terms such as *IFF* and *anti-jam* first found definition in this era. Project Cadillac, an airborne early warning system developed in the later years of RadLab, was the precursor of present AWACs systems.

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BOOK REVIEW (continued from page 54)

The people of this organization were, of course, unique, rivalled collectively in technical power perhaps only by a similar group brought together somewhat later for a program called the Manhattan Project. Both groups were composed mainly of physicists; a few select individuals were members of both. RadLab members Alvarez, Bethe, Purcell, Rabi, and Schwinger later joined an even more select group of physicists as recipients of the Nobel Prize. (It is somewhat ironic that the name Radiation Laboratory was chosen to disguise this group of "harmless" nuclear physicists).

The setting was important: "The Radiation Laboratory came close to realizing a scientist's dream of a scientific republic, whose only limitation was the supply of scientists." Yet the physical plant was austere. On the MIT campus, Building 20 was erected, "a three-story (temporary) building of mill construction with interior walls of transite." The structure is still in use today.

Individual recollections play an important role in the telling of the story. June 5, 1945 found Ed Pollard in England to survey the ground radar situation. Following the urging of John Trump, then director of the British Branch of the Radiation Laboratory, Pollard visited the Microwave Early Warning (MEW) installation at Pear Tree Point, directly across the Channel from the D-Day Invasion area. Later that evening, Pollard found himself viewing the Invasion from the very special vantage point of the controller's scopes, with an overview of the engagement shared and understood by only a select few allied military leaders.

In another incident in the spring of 1940 at Loomis Laboratories where detection research was in its infancy, the focus was on detection of aircraft by UHF waves, but curious scientists were attracted to other moving targets. The success with which the observers detected violations of the New York State speed limit of 50 miles per hour led one of the scientists to remark: "Don't let the cops hear about this."

Guerlac's work, long regarded by historians as the definitive work on the role of radar in World War II, is now available to the public. It is an instructive and exciting perspective of the people and research of the Radiation Laboratory, of special significance to those of us in the microwave field today.

Reviewed by Peter Staecker

Careers confidential

...**Deskbound managers** chain their intuitions by cutting off personal interaction. Prescription: Feel the pulse of your workplace by walking around your office. Trade ideas and problems with others. You'll gain a surer sense of what problems are lurking—and learn how to read between the lines of the documents on your desk.

The Intuitive Manager by Roy Rowan, Little, Brown & Co., 34 Beacon St., Boston 02106. $15.95.

..."**Being managed**" is a basic right in the workplace—for managers as well as for lower-level employees. It means getting the time and attention of a knowledgeable person who is paid to provide it—your boss. It means being trained in a job, being coached, being evaluated, being encouraged when you are bogged down, and being pushed when you are not giving all you should. Employees should insist on being managed with the same forcefulness they bring to their insistence on getting a paycheck.

One-on One with Andy Grove by Andrew S. Grove, president, Intel Corp., G.P. Putnam's Sons, 200 Madison Ave., New York 10016. $18.95.

A SHORT COURSE ON
WORLDWIDE NONIONIZING
RADIATION SAFETY STANDARDS
Their Rationale and Problems
CAPRI, ITALY
May 2-6, 1988
COURSE DIRECTORS
OM P. GANDHI and GIORGIO FRANCESCHETTI

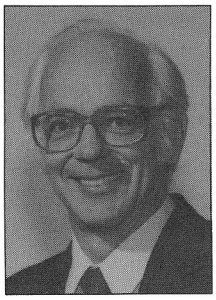
There has been an increasing interest in safety because of the rapidly expanding applications of electromagnetic fields for communications, high-voltage power transmission lines, and for industrial and medical applications of RF and microwaves. The public concern is heightened by disparate safety standards that are used worldwide at the present time. This course will review the knowledge on biological effects of nonionizing radiation from dc to microwaves, and worldwide safety standards with discussions of their rationale and problems.

LECTURERS
G. FRANCESCHETTI, O. GANDHI, M. GRANDOLFO, D. JUSTESEN, K. MILD, S. TOFANI

In addition to formal lectures, a number of short contributed papers will also be acceptable. *For further information, contact Om Gandhi, Department of Electrical Engineering, University of Utah, Salt Lake City, Utah, 84112, (801) 581-7743.*

LOWER MANHATTAN PANORAMA. At the southern tip of Manhattan, the skyscrapers of the financial district serve as a dramatic backdrop to Battery Park, an open area of 21 acres (including Castle Clinton far left), extending from Bowling Green to the junction of the Hudson and East Rivers CREDIT: NY CONVENTION & VISITORS BUREAU

THE 1988 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM



by Chuck Buntschuh

New York City is one of the most interesting, exciting, and fun cities in the world to visit, and we certainly hope to see you there for Microwave Week in May 1988. As is customary, the next issue of the Newsletter will contain a detailed preview of all the technical programs for the week. For this issue, the Steering Committee thought you might like some information on the non-technical aspects of the Symposium and your visit, as well as an early look at the Technical Program as it takes shape. So we have put together several articles here to enlighten you and make your trip more enjoyable and rewarding.

SCHEDULE OVERVIEW

Although at this writing (end of November) many details of the schedule have yet to be worked out, we can give you a big-picture overview of the events of Microwave Week.

The registration booth will open for early arrivals in the Marriott Marquis hotel on Sunday afternoon, May 22, 1988. The technical program will begin on Monday, May 23rd, with four or five workshops in the Marriott. It continues on Tuesday with the first day of the Monolithic Symposium, the ARFTG meeting, and a couple of additional workshops, all also in the Marriott.

On Wednesday, May 25th, the MTT Symposium and the Microwave Exhibition will open in the Jacob Javits Convention Center, where these events will continue through Friday, May 27th. The second day of the Monolithic Symposium will also take place in the Convention Center, joint with the MTT Symposium.

Conference registration will continue in the Marriott on Monday and Tuesday, and move over to the Convention Center on Wednesday. Those registering in the hotel on Sunday, Monday and Tuesday will receive vouchers to pick up the heavy items - the Digest and the Exhibition material - in the Convention Center on Wednesday.

The schedule of offical social events will begin with the Monolithic Circuits Symposium reception on Monday evening in the Marriott. The ARFTG Conference will have its banquet on Tuesday, also in the Marriott. The Microwave Journal reception will also be on Tuesday, location to be announced. The Industry-Hosted Cocktail Reception and the Annual Awards Banquet will be on Thursday evening in the Marriott.

SIGHTSEEING, ETC.

New York presents such a wealth of things to do and places to see, from highbrow to low, that it's impossible even to highlight the top attractions in this article. What you really need is a good guide book - so we will be including a copy of Frommer's 1987-1988 Guide to New York with your conference registration material.

New York is fairly expensive compared to most U.S. cities, and Frommer's Guide will be particularly good in helping you economize. However, its maps leave a lot to be desired, so you might equip yourself with a good street map if you go exploring on your own.

For a good listing of the current events, pick up a copy of the NY Where magazine in the hotel lobby. Theater-goers planning on seeing a hit show would do

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well to consult a Sunday New York Times and write for tickets as far in advance as possible.

For those who have the time during the day, the Guest Program Committee has arranged for seven great tours to introduce you to many facets of the city. These are described in another article in this newsletter.

Since most of you will probably not have the time to see much of the city during the week, we suggest that you stay over for the Memorial Day weekend. Take your guidebook and really do the town. The hotels all have attractive weekend rates, and you are bound to have a wonderful time. On Saturday, the Guest's Program also has arranged a sojourn to Old Bethpage Village on Long Island, which many of you will enjoy.

GETTING DOWNTOWN

If you come to New York by air, you will arrive at one of the three airports serving the city: Kennedy International (JFK), LaGuardia (LGA), or Newark International (EWR). Each terminal at each airport is laid out differently, and at each one there is a myriad of ground transportation options, offering services to Long Island, New Jersey, Connecticut, and Westchester, as well as to downtown, Manhattan. It is enough to bewilder the most experienced traveler. The following information may help you wade through the alternatives and get you on your way smoothly, as well as give you an idea of what it will cost. For those of you coming in on our MTT official airlines, United and Delta--and we hope you all try to--I've provided more explicit directions.

A much-abbreviated form of these directions will appear in the Advance Program, but I suggest you save this article, with its extra detail, for future reference.

Rental Car

Don't!!

You will be able to travel around the city by cab for less money and frustration than it will take just to park a car. For you own enjoyment, please don't even think of driving into New York.

Buses

The most economical transportation downtown is via the Carey Bus Line from JFK ($8) or LGA ($6) and the N.J. Transit Bus from EWR ($5). A little more expensive, but a lot more convenient are the Abbey Transportation and Giraldo Limousine buses from JFK ($11) or LGA ($8), and the NYC Mini Bus from EWR ($12).

The Carey bus stops at each terminal at LGA and leaves for the city every 20-30 minutes from 6:45 A.M. to midnight. At the Delta terminal the stop is just outside Carousel #1 at the baggage claim area. At United, ask at the information booth in the baggage area. You pay the driver on the bus. The bus stops first at Grand Central Station and then goes on to the Marriott Marquis, the Sheraton City Squire and the Hilton.

The Carey bus from JFK stops at each terminal and leaves for Grand Central Station every 20-30 minutes from 6:00 A.M. to midnight. Again, pay the driver. At the Delta terminal, the bus stop is upstairs from the baggage claim area. At United, it is right outside the claim area. At Grand Central you transfer to the LGA to go on to the hotels.

The Novotel and Howard Johnson's are short walks on 51st Street from the Sheraton. The Milford Plaza is next to the Marriott, and the Ramada is a couple of blocks away. Ask the driver for directions. If you're going to the Penta, don't take the Carey bus, but go via Abbey or Giraldo.

From EWR, the N.J. Transit bus stops at each terminal and leaves for the Port Authority Bus Terminal on 42nd Street and 9th Avenue every 15 minutes, 24 hours a day. You buy the ticket at the information counter in the baggage area, which is opposite carousel #4 at United and Continental's carousel #4 next to the claim area. The ticket seller will direct you to the bus stop. From the bus terminal your best s to take a cab to the hotel, which will run $4-$6; although those so inclined will find a walk to the Milford Plaza or Marriott Marquis reasonable.

All in all, the best deals from all three airports are the minibuses, that is Abbey, Giraldo, and NYC Mini Bus. They all stop at each terminal at the airports and stop at all of our hotels--door-to-door, no transfers, no taxicabs. At LGA, Abbey and Giraldo stop at the door right outside Delta's baggage claim area; at United, ask at the information booth. Pay on the bus. At the JFK Delta terminal, go upstairs to the same bus stop Carey uses. If you need help, both companies have courtesy phones downstairs outside the baggage claim area. At the JFK United terminal, there is an information booth in the lobby, and the buses stop just outside the door. Pay the driver. At EWR, both Delta and United, buy your ticket for the NYC Mini Bus at the counter next to N.J. Transit and they will direct you to the bus stop.

At the International Arrivals building at JFK, the bus stops and taxi stand are just outside the door to the left, and well-marked. For international arrivals at other terminals--TWA, PanAM, and British Airways--inquire at the information booth.

The mini bus service at all three airports ends between 11 P.M. and midnight. If your flight get in later than that, you'll have to take a taxi or limo in town, except for the N.J. Transit bus possibility from EWR.

Taxis

If you go by taxi cab, from JFK and LGA be sure to take a so-called medallioned cab, licenced by the NYC Taxi and Limousine Commission. These cabs are yellow and have a blue medallion affixed to the hood. Other, "gypsy", cabs may well cheat the unwary. The fare from LGA is about $15 plus toll ($2), and tip; and from JFK it's about $25 plus toll and tip *(make that about $33 — Ed).* In both cases the fare is metered, so be sure the meter is on. At LGA, the taxi stand is to the right of the bus stop at Delta and to the left, in front of American, at the United terminal. At Delta's JFK terminal, it is downstairs on the baggage claim level; at United it is at the pick-up platform across the road.

In NYC, one fare pays for all passengers, and there is no charge for luggage that can be carried by one person. At LGA there is a formal ride-sharing arrangement

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available at some terminals during certain limited hours. Inquire of the dispatcher near a "Group Rides" sign.

From EWR, taxi fares are flat rates (unmetered). Fares to various destinations are posted at the taxi stands. They are typically $26-$29 to downtown, plus toll ($3), tip, and $1 per piece of luggage over 24" long. The taxi stands are just outside the claim areas at all terminals. Group Rides are available 8 A.M. to midnight; inquire at the taxi stand.

Limousines

The private limousine services are too numerous to mention. Obviously the rates are somewhat higher than a taxi. Figure on $30-$35 plus tip and toll from JFK and EWR, and $25-$30 plus tip and toll from LGA. You had best go to one of the ground transportation counters or use a courtesy phone to book a limo ride, although at busy times drivers will mill through the crowd and solicit customers. You may be able to strike a good deal.

HERTZ CENTENNIAL UPDATE

by John H. Bryant

The first century of microwaves began with the historic experiments of Heinrich R. Hertz at the technical Institute of Karlsruhe, Germany starting in November, 1886 and extending for three years. using what is now called microwave circuits and techniques, Hertz experimentally validated Maxwell's theory of electromagnetism, which had been propounded in 1864, and opened up the electromagnetic spectrum for scientific and practical uses. The results of this work of Hertz, described in a series of papers that are reprinted in the book Electric Waves, 1892, (English translation, Macmillan, 1893, and Dover, 1962) forms the basis for a wide range of products and services represented in diverse industries and institutions today. The sixth paper in the series, "On Electromagnetic Waves in Air and Their Reflection", gained public recognition. It was published in May, 1888.

At its May 25-27, 1988 International Symposium in New York the IEEE Microwave Theory and Techniques Society (MTT-S) is observing the Hertz Centennial with an exhibit and a special session of four papers*. It is planned to videotape the session. Copies of the papers are to appear in the May, 1988 issue of the MTT-S Transactions.

Hertz's original apparatus was donated to the Deutsches Museum in Munich in 1908. Around 1929 a model maker, Julius Orth, in Munich made three sets of replicas. One set of the replicas went to the Science Museum in London, one to Berlin (present status unknown) and one to Chicago for showing at the 1933 World's Fair. After the fair, the Chicago set went to the Museum of Science and Industry, where about half of the items remain today. The set owned by the Science Museum will be on loan to MTT-S for the exhibit.

At the Symposium the exhibit, the **Exhibit Guide,** and posters, will show the apparatus laid out in Hertz's step-by-step discovery process. Following the Symposium the exhibit will be moved to the MIT Museum in Cambridge, Massachusetts, where it will be shown through the summer and fall of 1988 before being returned to the Science Museum.

The IEEE Antennas and Propagation Society plans to show a duplicate of our Exhibit, with photographs in lieu of apparatus, at their Symposium on June 6-10, 1988.

Copies of a draft of the Exhibit Guide were circulated for comment and suggestions, and a presentation was made to the IEEE History Committee. It is a pleasure to note support for the Hertz Centennial activities from the MTT-S AdCom, the 1988 Symposium, the IEEE Life Member Fund, and from companies in our industry.

*

1. Robert S. Elliott, "The History of Electromagnetics as Hertz Would Have Known It."

2. Charles Susskind, "Biography of Hertz."

3. John D. Kraus, "Heinrich Hertz--Theorist and Experimenter."

4. James E. Brittain, "The Legacy of Hertz: Some Highlights in microwave history from 1889 to 1945."

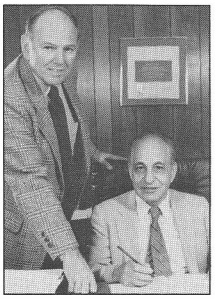
Skin cancer can be completely cured if detected early. Consult your physician immediately if you notice a suspicious sore that doesn't heal within three weeks ... a persistent reddish patch of skin ... smooth bumps that are indented in the center ... shiny, translucent growths ... scar-like white or yellow areas ... darkly pigmented lesions that are changing.

University of California, Berkeley, Wellness Letter, Box 10922, Des Moines, IA 50340. Monthly: $18/yr.

"Age spots" in older people are signs of a zinc deficiency. *Theory:* When the body gets insufficient zinc, damaged blood vessels are not repaired. *Result:* Senile purpura, a purple spotting of the skin. *Foods high in zinc:* Liver, eggs, seafood, whole grains.

Study at East Birmingham Hospital, England, cited in *Prevention,* 33 E. Minor St., Emmaus, PA 18098. Monthly: $12.97/yr.

1988 MTT-S SYMPOSIUM: TECHNICAL PROGRAM



by Jesse Taub and James Whelehan,
Co-Chairmen

Our 1988 MTT-S International Symposium's Technical Program is in the final stages of preparation. As of this writing, (December 1) many contributed papers have arrived. It promises to be an exciting symposium because our microwave field continues to generate new technological challenges. We invite all of you to attend this Symposium in New York City. It will be held from May 23 through May 27, 1988.

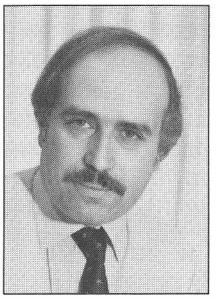
Our varied program will be held at the Marriott Marquis Hotel and the Javits Convention Center. The Microwave and Millimeter Wave Monolithic IC (MMIC) Symposium and the Automatic Radio Frequency Techniques Group (ARFTG) Conference will be held on May 24 in the hotel's conference rooms. In addition, several workshops exploring the frontiers of microwave technology will be held on May 23 and 24 at the Marriott.

The cornerstone of the Symposium, the Technical Program, will focus on the advances that have recently been made. They, together with a European Technology and several luncheon Panel Sessions, will take place in the new Jacob Javitz Convention Center from May 25 through May 27, 1988. The meeting rooms will be in one area and in close proximity to the Industrial Exhibit Area.

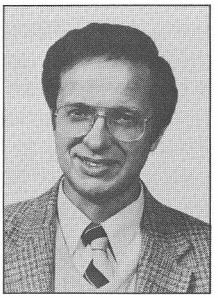
In addition to our contributed papers, several invited talks and focused sessions are planned. John Pierro has organized our Special Sessions activities and Don Neuf has worked on Invited Papers.

The above activities together with plans for Panel Discussions and Workshops are described by them in the following article.

1988 MTT-S SYMPOSIUM: SPECIAL SESSIONS ACTIVITIES



by
John Pierro
and
Don Neuf



This article describes our 1988 Symposium Plans for:

- Workshops and Panel Sessions
- Focused Sessions
- Feature Sessions (sessions dedicated to a historic era or an outstanding individual in microwaves)

These activities offer a wide choice to our membership. We are looking forward to your attendance.

Workshops And Panel Sessions

The Special Sessions Committee of the 1988 International Microwave Symposium has tentatively planned eight workshops and five panel sessions covering a broad range of timely topics, both technical and professional, which we invite you to attend and participate in.

The scientific community's current fascination with superconductivity has aroused those futuristic thinkers among us and served as a stimulus for a workshop on microwave superconductivity which is probably the hottest emerging technology. More traditional, evolving technologies are served as well with workshops on FET and CAD-oriented discontinuity modeling, power amplifier design, packaging, and linearizer techniques. Of a practical bent and timely as well are workshops on designing MMIC's through foundries and high volume microwave applications. We are confident that the panel sessions will arouse both your technical and professional interests with such subjects as ferrites at millimeter-wave frequencies, noise measurements, U.S. competitiveness in world markets, and the business-side of microwaves.

The tentative titles for and organizers of the workshops and panels will be presented in detail later but first it seems appropriate to restate the primary objective of all workshops and panels and that is, in a word, dialogue. Panels and workshops should not be extensions of the regular sessions and thereby degenerate

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1988 MTT-S SYMPOSIUM

(continued from page 59)

into mini-symposia within the main symposium. Their purpose is to provide opportunities for you to interact with acknowledged experts in a particular field, face-to-face, on issues which are important to you and which may never surface in "canned" published presentations. Workshops and panels can potentially be very dynamic if you exploit what they have to offer. Unlike a regular session, there are no real, and should be no perceived, barriers between you and these experts. Avoid coming to them with the mindset of a passive observer—ask questions and get involved! Your contributions may potentially be the undefinable 1% that is ultimately responsible for 99% of the success of these events.

Needless to say we as organizers must do much more to foster an environment which is conducive to interaction and dialogue. To permit this to flourish we must carefully control the number of speakers and the length of their prepared talks to allow more time for your questions. We will be working on this. Secondly, we must ask ourselves are the topics right for these special sessions? The topics should for the most part be on evolving technologies whose progress has been hampered by one or more very visible "bottleneck" problems. Workshops and panels should not be conducted as tutorials.

Unrelated but equally important is the general lack of published proceedings from these special sessions which we will try to correct by encouraging speakers to provide copies of viewgraphs and/or written text which do not contain sensitive or proprietary material.

The eight workshops we have tentatively scheduled are:

Title	Organizer and Affiliation
• FET Structures and their Modeling	Jitendra Goel / TRW
• CAD-oriented Modeling of Discontinuities in Microwave / MMW Transmission Line Structures	K.C. Gupta / University of Colorado, Boulder
• MIC and MMIC FET High Power Amplifier Design Techniques	Edward Niehenke / Westinghouse
• High-Volume Microwave Application	John Eisenberg / John Eisenberg & Associates
• Linearizer Techniques	Allan Katz / Trenton State College
• Superconductivity and Microwaves	E. Belohoubek / DSRC
• Packaging Hybrid and Monolithic Microwave and Millimeter-Wave Components	Bert Berson / Berson and Associates
• Designing MMIC's through Foundries	H. Prather / Electromagnetic Sciences

The subject matter behind some of these titles may not be apparent and some elaboration is warranted. "FET Structures and Their Modeling" will address not only the well-established theory and techniques for the measurement and modeling of MESFET's but that of MODFET's, HBT's, HEMT's and MISFET's as well. "High Volume Microwave Applications" will address the design-to-cost issues which are so important in high volume military and commercial applications such as GPS, radar detector, fuses, GaAs MMIC's for EW, and microwave instrumentation. The workshop titled "Microwave Linearizer Technology" will present developments in both predistortion and feedback/feedforward linearizers, attractive alternatives to the traditional brute-force approach to designing for linearity. Our workshop on "Superconductivity and Microwaves" will assemble a group of internationally known experts to describe the state-of-the art in superconducting materials and the high frequency properties of both high- and low-temperature materials and will outline their potential microwave and millimeter-wave applications.

The five panel sessions we have tentatively planned are:

Title	Organizer
• U.S. Competitiveness in the World Market	R. Moore / WEC
• Noise Measurements	S. Adam / Adam Microwave Consulting
• Ferrites at Millimiter-Wave Frequencies	W. Hord / Microwave Applications Group
• Heterojunction Bipolar Transistor Circuits	F. Sullivan / Raytheon
• The Business of Microwaves: The B Mousetrap is no Longer Enough	B. Berson / Berson and Associates

"U.S. Competitiveness in the World Market" will investigate how both industry and government policies affect our markets abroad. "Hetrojunction Bipolar Transistor Integrated Circuits" will focus both on device technology and the implementation of HBT's in MMIC. This is potentially very exciting because MMIC has been almost exclusively a MESFET-based technology and the availability of a new three-terminal device opens new frontiers.

"The Business of Microwaves ..." will highlight the importance of strategic planning, marketing and gaining support for your ideas within your own company.

continued on page 61

1988 MTT-S SYMPOSIUM
(continued from page 60)

Technical competence in the organizer's view is no longer enough to remain competitive.

Focused Sessions

At the '88 Symposium, we are fortunate to have outstanding leadership in each of three special focused sessions: (1) High Power Microwaves, (2) Fiber Optic Links, and (3) European Microwave Contributions.

The "High Power Microwaves" focused session organized by Jitendra Goel will feature invited papers by Don Reid of Los Alamos, and Joseph Schlesak of Communications Research Center, Ottowa, Canada. The latter contributor is best known for his recent work demonstrating that microwave power could support an airplane at 500 feet. Jitendra's objective is to bring "high power people back to MIT".

John Horton has organized two back-to-back fiber-optic focused sessions dealing with transmission systems. Two four-paper sessions are scheduled (all invited) with speakers from Europe, Japan and the U.S.A. The goal of these sessions is to provide the MTT Symposium attendee with an overview of fiber-optic systems applications which now exist, and provide expert opinions on the future outlook for these systems applications.

This year's European Microwave Conference/MTT liaison person is Professor Vander Vorst. We are expecting an exciting array of invited papers describing activity from our fellow European Workers.

Feature Sessions

1987 marks the 100th anniversary of Hertz's famous experiments which started at the Technical Insitute of Karlsruhe, Germany. John Bryant has secured replica items of Hertz's apparatus from the Science Museum of London, and these will be displayed at the Symposium in May '88. John's special session will have five invited speakers, including one member from Germany.

Dr. Arthur A. Oliner, is a well-known expert in guided wave theory, and a respected member of the MIT leadership. Art is retiring from his research and teaching duties at Polytechnic University (formerly Polytechnic Institute of Brooklyn), after amassing a vast array of professional achievements, including 170 published field theory and guided wave papers. S.T. Peng will help us honor Art's accomplishments with invited talks by Jesse Taub and Alex Hessel, and technical presentations by Tatsuo Itoh and Felix Schwering.

Bicycling can lead to temporary impotence. The bicycle seat compresses critical nerves and blood vesse.s

Dr. Seymour Solomon, Montefiore Medical Center, New York.

DOCTORAL THESIS EPFL NO. 658

Analysis of the frequency stability of oscillators and amplifiers

Presented par M. **Laurent-Guy BERNIER**
at Ecole Polytechnique Federale de Lausanne, 22 December 1986

The thesis presents a novel, more rigorous approach to define and measure frequency stability. It deals with the characterization of frequency standards, whose significance increases steadily following the fundamental role they play in several advanced techniques, in particular in communication systems.

The theoretical part presents the most significant and novel contribution M. Bernier surveys in a thorough and critical manner the present state of the art in metrology, showing a deep understanding of the time/frequency field. The text of his report, presented in a clear and understandable manner, constitutes in itself a valuable reference. The original contribution of Mr. Bernier concerns mainly the modelization of non-stationary random processes of phase and frequency and their characterization. According to experts in the field, this work actually opens a new line of research.

The experimental part develops an original idea for improving the performance of systems to measure phase noise at microwaves. M. Bernier presents a rigorous and thorough analysis of the problem and outlines the best approach one should follow. The practical implementation is for the time being a first approximation, that did not yet produce outstanding new results. It may however lead in due time to interesting technological developments.

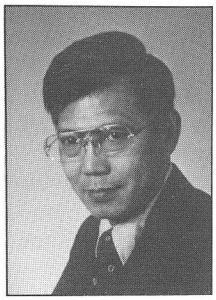
Mr. Bernier was awarded the Prize of the Hasler Foundation, Bern, Switzerland, that acknowledges an outstanding piece of work in fields connected with communications engineering.

Key-words: stability, noise, random processes, oscillators.

Complimentary copies of the thesis, **in French,** are available upon request.

LABORATOIRES
D'ELECTROMAGNETISME
ET D'ACOUSTIQUE EPFL
16, ch. de Bellerive
CH-1007 LAUSANNE/Switzerland
Professeur F. Gardiol

1988 MTT-S-SYMPOSIUM: STUDENT PROGRAMS



by S.T. Peng

The continuous supply of "new blood" is vital to the health of a profession. To keep microwave engineering healthy as a profession, the IEEE Microwave Theory and Techniques Society (MTT-S) has taken great interest and an active role in the education of new microwave engineers. For example, the efforts of MTT-S include: Merit Scholarships for high school students, Best-Paper Awards for undergraduate students and Research Grants for graduate students. In addition, the MTT-S Has always encouraged the participation of college students in its Annual International Symosium. For the first time in its history, the MTT-S is initiating a new Student Program for the next MTT International Symposium, to be held in the Jacob Javits Convention Center, New York city, on May 25 - 27, 1988. Invitations will be extended to high school students to attend the Symposium, thereby stimulating their interest earlier in selecting engineering as a career, particularly electrical engineering.

Specifically, the MTT-S will invite one junior or senior from each high school in the metropolitan New York area to participate in a **Student Program** to be held on **Wednesday, May 25, 1988.** These students will hear interesting talks on history of microwaves, as well as the current and future applications of this technology. There will be a conducted tour of a unique Historic Exhibit with special emphasis on Heinrich Hertz' pioneering experiments, which demonstrated the radio waves for the first time in 1888. In addition, the students will be conducted through the commercial exhibits to give them a practical feeling for modern microwave equipment. Finally, the Society will host a special luncheon for the students, so that they will have a opportunity to interact with practicing engineers as well as meeting internationally prominent microwave scientists and engineers.

To make the students' participation meaningful, a student from each high school will be selected on the basis of the following criteria:

1. The student must, in the opinion of the teaching staff of his/her high school, have achieved a high academic record in science courses.

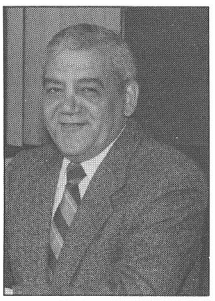
2. The student must demonstrate an interest in investigating a career in engineering by submitting a short essay of one or two pages, including the student's interests, experiences and aptitudes that would make him/her a good engineer.

As an encouragement, the MTT-S intends to honor the student with a prize for the best essay during the student luncheon. The essay of selected students must be sent by January 11, 1988 to:

Professor S.T. Peng
New York Institute of Technology
100 Glen Cove Ave.
Glen Cove, NY 11542
(516) 686-7970

Programs and information concerning the Student Program will be mailed to the selected students in time for the conference. For further information, please contact Professor Peng at the address shown above.

THE 1988 SYMPOSIUM HOTELS



by John Coppola

The 1988 Symposium Local Arrangements Committee has contracted with eight midtown Manhattan hotels to provide accommodations ranging from luxury to economy, all at very attractive convention rates. The locations of the hotels, the Convention Center, and numerous other landmarks are shown in the accompanying map.

Hotel accommodations will be made through our housing bureau on forms which will be included in the Symposium Advance Program, scheduled to go out in early March 1988. To insure getting the convention rate, and your first choice of hotel, we urge you to return your form to the housing bureau before the end of April 1988. It is important to recognize that the housing bureau will not accept telephone requests. You must apply in writing, on the form. Also, applying through the Local Arrangements Committee will not expedite matters, and could slow the process down. However, if you are having non-routine problems of some sort, please call us and we will take care of it. Our housing bureau is excellent and experienced in solving problems. They want you to enjoy your visit to New York. They just insist that problems be channeled through the Local Arrangements Committee.

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1988 SYMPOSIUM HOTELS

(continued from page 62)

As you know, the Marriott Marquis is the headquarters hotel and many of our activities will take place there. It's located in Times Square in the heart of the theater district, and, in fact, it includes its own in-house Marquis Theater. The hotel has 1800 luxurious sleeping rooms and suites, four restaurants, and four lounges. The convention rates will be $123-140 single, $138-158 double.

The New York Hilton is on 53rd Street and 6th Avenue, near Rockefeller Center. It has been largely remodeled in the last few years, and has committed 500 rooms to the Symposium. It has an elegant English restaurant, "Hurlingham's" and a new video night club, "Pursuits", with late night dancing. Its rates are $127 single, $150 double.

The Sheraton City Squire is on the west side of 7th Avenue at 52nd Street--not to be confused with the Sheraton Center, across the street. This hotel has a swimming pool and exercise equipment geared for the fitness buff. Rates here are $120 and $140.

The New York Penta Hotel is across from Madison Square Garden and Penn Station, and is the closest to the Convention Center. Old-timers may remember it as the former Statler-Hilton. It has been completely remodeled, of course. It has retained an antique ambiance and added a European flavor. The "Globetrotter" is a French restaurant, the "Bierstube" features German casual entrees, and the "Moghul" serves Indian and Chinese cuisine. They have a range of rates, $108-128 single, $116-140 double.

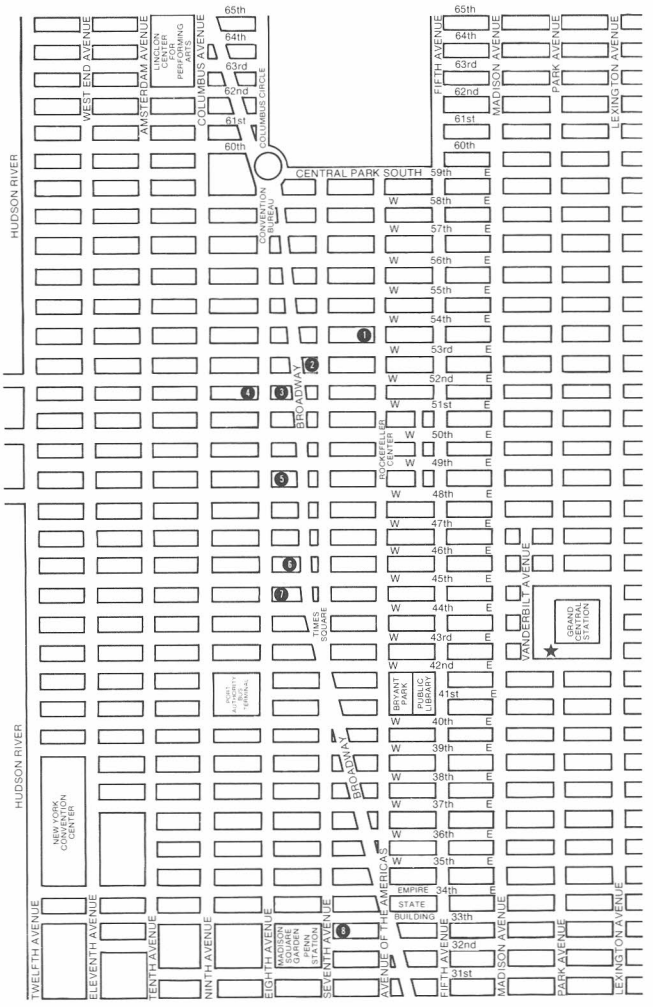
The Novotel, on 52nd Street and Broadway is a relatively new hotel with modern styling and French ambiance. It's close to the theater district and the Marriott. It will run $115 single or double.

The Milford Plaza is an excellent, attractive, clean hotel for the economy-minded. It is across 45th Street from the Marriott, facing 8th Avenue. We have a commitment of 400 rooms at $75 single, $90 double. It has an elegant air about it, lacking in the more familiar economy hotels, the Ramada Inn and Howard Johnson's.

Most of the hotels have special weekend package deals, which are comparable to the convention rates for the weekdays. We want to encourage you to take advantage of this opportunity and to plan on spending the Memorial Day weekend in New York. We will try to provide some specific data on weekend rates in the next newsletter.

Moderate exercise when you have a cold can still be beneficial. *Technique:* Slow down to compensate for the extra exertion required to fill your lungs with air. *Warning:* Exercising when you have a fever or the flu puts you in danger of injury as a result of impaired balance, coordination and cardiovascular function.

The Athlete Within by Dr. Harvey B. Simon, Little Brown & Co., 34 Beacon St., Boston 02106. $19.95.



1988 SYMPOSIUM HOTEL LOCATIONS IN MANHATTAN KEY:

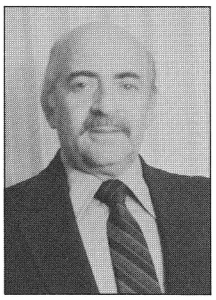
1. New York Hilton
2. Sheraton City Squire
3. Novotel
4. Howard Johnson's
5. Ramada Inn
6. Marriott Marquis
7. Milford Plaza
8. New York Penta

* CARY BUS STOP AT GRAND CENTRAL STATION

Sloppy exercise techniques reduce benefits and increase the risk of injury. *Good form:* Be conscious of the motion of specific joints and muscles ... let up if you feel pain ... keep your abdominal muscles tight and your bottom tucked in ... breathe naturally — don't gasp or hold your breath ... avoid sharp, bouncing movements. If you can't keep the pace without losing your form, *slow down.*

Vogue, 350 Madison Ave., New York 10017. Monthly: $28/yr.

1988 MTT-S-SYMPOSIUM: AIRLINES OFFER INCENTIVES



by Jerry Hausner
Local Arrangements
Co-Chairman
(505) 345-8236

Arrangements have been made with two airlines to team as the official airlines for the 1988 MTT-S International Microwave Symposium. The two airlines are United and Delta. United offers service from all 50 states to New York City and direct non-stop flights from Tokyo. Delta has very few highly competitive routes with United but, since their merger with Western, they fill the gaps left by United. Together they offer you, our membership, excellent transportation service and schedules from anywhere in the country to New York City.

Why do we want an official airline? That's a fair question. There are serveral reasons.

1. Cost savings. Both airlines offer to improve their own best passenger discounts by another 5% and will discount freight for the Society and its exhibitors by 40%. These passengers rates can result in as much as 75% discounts off the regular fare.

For those passengers not qualifying for any published discounts, a 40% discount will be offered for domestic travel to the meeting. This discount will be based on the full non-discounted, round trip day coach rates. Seven days advance reservations and ticketing will be required on this fare along with a maximum stay of 21 days.

2. Free tickets. Both airlines will issue one free ticket for every forty booked via their respective 800 numbers. These are for MTT use. Some will be used by members who need them but the bulk are intended for students who cannot otherwise afford to attend.

3. Ticket raffle. You may win a free ticket for later use. See below.

4. Statistical information on our attendees and ease of making reservations.

Why should anyone go out of their way to use the official airline? The truth is that you don't really have to go out of your way. The setup of the 800 numbers makes it very convenient for anyone to use these airlines. The special reservations desk will accept reservations from an individual, his/her regular travel agent or corporate travel department. The combination of schedules offered by United and Delta result in a flight at almost any time, from anywhere to a New York Metropolitan airport.

To sweeten the pot, United and Delta are each throwing in an extra ticket for a raffle. Names are automatically entered into the raffle when reservations are made via the assigned 800 numbers. These tickets are good for round trip continental U.S. travel prior to December 15, 1988.

These priviledges apply for travel between May 18 and June 3, 1988 and are ONLY available through the special reservations desks. So let's start using the 800 numbers (between 8:30 AM and 8:00 PM EST), reap the benefits and support your Society. Please mention the MTT-S special account number.

Airline	800-	Acct. No.
Delta	241-6760	I0007
United	521-4041	8041H

1988 MTT-S SYMPOSIUM GUESTS' PROGRAM

Dick & Joan Kaminsky Laurie & John Mruz

The Guest's Program for the 1988 MTT-S Symposium will be an exciting and diverse "New York Experience" for all who attend.

By working closely with a major Manhattan-based tour agency, your Guest Program Committee has selected seven of the most popular tour options that are designed to give you a comprehensive exposure to life in the "Big Apple".

Both full and half-day tours are being offered. If you like to get up early and really maximize your sightseeing activities (with lunch), then you will love the full-day tours. For those who enjoy a limited amount of structure, then the half-day options will afford you ample free time to do some restaurant hopping and to take a few self-guided tours with the aid of brochures that we will have for you in the Hospitality Suite located at the Marriott Marquis Hotel. As a special treat, a day-long excursion to Long Island has been arranged for those who plan to remain in the New York area for the Memorial Day weekend.

The Committee will host your Hospitality Suite beginning on Tuesday, Masy 24th at 1:00 P.M. We hope that you will stop by to say "hello" and use the services we offer. We enthusiastically look forward to sharing many of New York's top attractions with you.

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1988 MTT-S GYMPOSIUM GUESTS' PROGRAM

(continued from page 64)

SCHEDULE OF GUESTS' EVENTS

Wednesday, May 25, 1988

TOUR 1 10 A.M. - 3 P.M. MANHATTAN OVERVIEW

Uptown, downtown, crosstown...an all-embracing guided tour of Manhattan. See Wall Street, Greenwich Village, Soho, Chinatown, The United Nations, Harlem and sights in between from your motor coach. Lunch will be served at an "Art Deco" restaurant ...."MAXWELL'S PLUM"

Afternoon

A relaxing, free afternoon to allow for your private walking tours, shopping, museum tours, etc. Visit the Bronx Zoo or restaurant hop. Further information is available in the Hospitality Suite.

Thursday, May 25, 1988

TOUR 2 9 A.M. - 12 Noon HIGHLIGHTS OF THE METROPOLITAN MUSEUM OF ART

One of the world's great art institutionsl. You will be escorted through carefully chosen selections of some of the museum's 240 galleries, viewing collections of paintings, sculpture, furniture, artifacts, etc.

TOUR 3 9 A.M. - 12 Noon BEHIND THE SCENES AT LINCOLN CENTER

Meet an artist. An in-depth tour of this world-famous cultural center. Explore the Metropolitan Opera House, the New York State Theater and Avery Fisher Hall. Then enjoy the opportunity of chatting in person with a performing artist.

TOUR 4 1 P.M. - 4 P.M. GREENWICH VILLAGE - SOHO - ARTIST'S LOFT

With your guide, explore one of the City's most unique neighborhoods. A Mecca for painters and poets, you'll visit an area where trendy Manhattanites now dwell and shop. You'll chat with the owner of a spectacular artist's loft and learn about the life here.

Friday, May 27, 1988

TOUR 5 9 A.M. - 1 P.M. LADY LIBERTY

This symbol of freedom and hope awaits your visit. Climb to the top of the pedestal for a beautiful view of the harbor. The American Museum of Immigration lies at the base of the Statue. A short ferry ride and motor coach ride return you to "mainland Manhattan".

TOUR 6 9 A.M. to Noon THE WORLD OF JEWELERS

Visit a jewelry showroom. Your guide will describe how the rich and famous select their gems and design their settings. Continental Breakfast is included.

TOUR 7 1 P.M. - 5 P.M. CRUISE AROUND MANHATTAN ISLAND

A relaxing three hours on a famous yacht will take you on a 35 mile guided cruise around Manhattan. Pass the World Trade Center, South Street Seaport, Yankee Stadium, etc. A box lunch will be provided.

Saturday, May 28, 1988

AN ADDED NEW YORK EXPERIENCE!!!

ENJOY THE START OF MEMORIAL DAY WEEKEND

TOUR 8 9 A.M. - 5 P.M. OLD BETHPAGE VILLAGE - LONG ISLAND'S PAST

A unique visit into Long Island's past and into American History. Colonial reproductions and dress will enhance your knowledge of Early America. Luncheon at the historic and quaint Milleridge Inn is included.

travel tips

For a lower room rate at a chain hotel, don't use the toll-free number when you make a reservation. A chain's central office rarely offers the best prices for individual hotels. *Better:* Call the hotel directly and ask for the lowest rates.

Travel Smart, 40 Beechdale Rd., Dobbs Ferry, NY 10522. Monthly: $125/yr.

To avoid tobacco smoke on commercial flights (even in nonsmoking areas), book a seat on a Boeing 727 or a DC 10 model 1 or 2. These older planes provide fresh air from *outside* the plane for ventilation. Newer planes, such as Boeing 737s, 747s, and DC10 model 3s, depend almost entirely on recirculated inside air.

Rodale's Allergy Relief, 33 E. Minor St., Emmaus, PA 18098. Monthly: $30/yr.

When taking prescription drugs on a trip, know their brand names *and* generic names. Generic names are more universally known ... facilitating an emergency refill.

The Healthy Traveler by Beth Weinhouse, Pocket Books, 1230 Ave. of the Americas, New York 10022. $6.95.

To beat dehydration while flying, drink one eight-ounce glass of water every hour, plus an extra glass for every cup of coffee or alcoholic drink you consume. *Reason:* Your body loses water at twice its normal rate when you're in a plane ... up to *five ounces* an hour.

NASA consultant Harold Radtke, quoted in *Conde Nast's Traveler,* 360 Madison Ave., New York 10017. Monthly: $15/yr.

1988 MTT-S SYMPOSIUM: FASCINATING NEW YORK

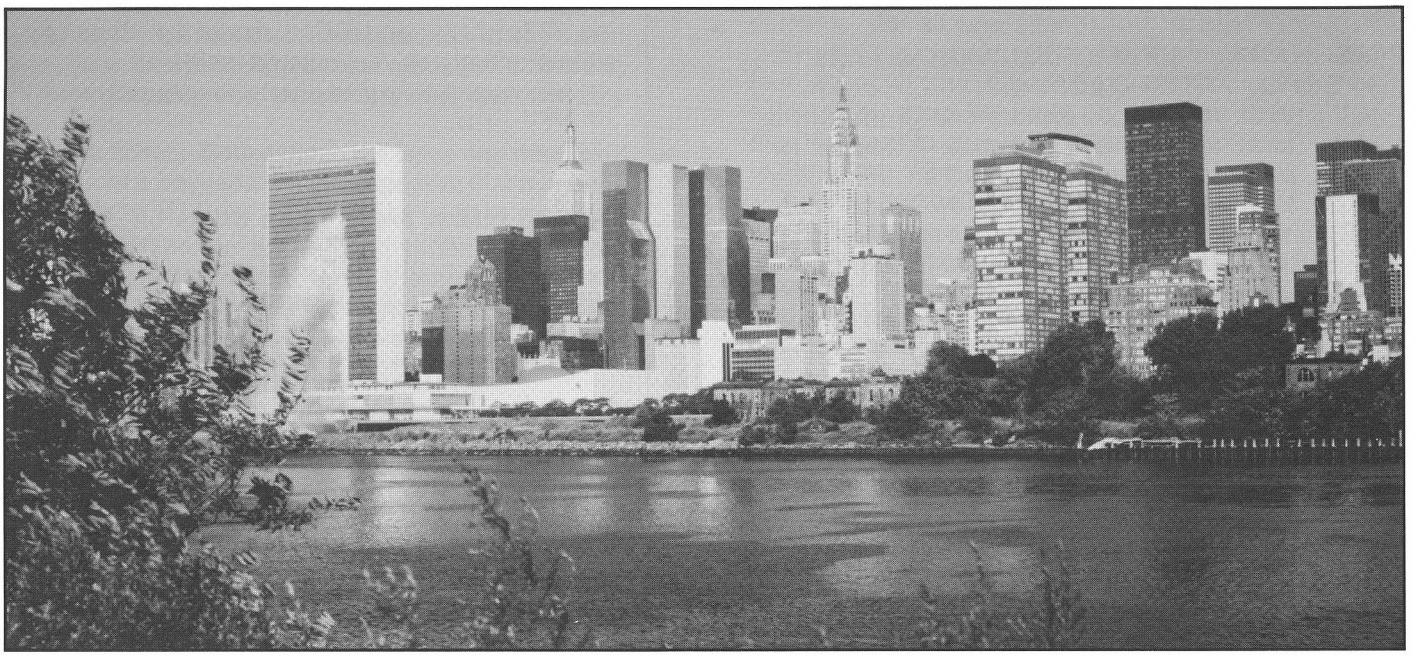
by Bertram D. Aaron
Publicity Chairman 1988.
MTT-S Symposium

Start with beautiful Lincoln Center. The famous Metropolitan Opera, New York City Ballet, New York City Philharmonic, Vivian Beaumount Theatre, its libraries, shops, eating places and varied audio and visual offerings. Then there is Broadway of international fame. And Off Broadway theatre. Yes there is even an Off Off Broadway theatre. Jazz, Rock, Pop in Greenwich Village and elsewhere. Elaborate night clubs or intimate hotel "Rooms" comedy/magic clubs, piano rooms. Proceed to the museums: Metropolitan, Natural History and Planetarium, Whitney, Gugenheim, Cooper, Hewett, Frick, Asia Society, Jewish Museum, Museum of the Barrio, Museum of the City of New York, Museum of Modern Art, National Academy of Design and numerous others. There is the huge New York Public Library. Miles of fascinating art galleries surrounding Christies and Sothebys Auction emporiums. You could take in an auction, they are very, very interesting.

There are several renowned Zoological parks, one in Manhattan in famous Central Park and of course the Bronx Zoo across from the Botanical Gardens. For a fascinating no-cost treat, visit the very interesting art collections and displays in the lobbies and building of the Fortune 500 on Park Avenue. There is a myriad of ethnic neighborhoods. There is little Italy-next to Chinatown-next to the lower East Side of Jewish Ethnicity, the Barrio and more. In all these places you may mingle with the people, purchase wonderful ethnic foods, eat at the sidewalk cafes, buy from fascinating discount houses. For a contrast have afternoon tea at the Helmsley Palace or other luxury hotels. Or visit very interesting but different restaurants like Serendipity with its Frozen Hot Chocolate. There are areas devoted to one product, blocks of wholesale florists, lamps, furniture and decorating showcases. Of course the internationally - known garment district, between the Penta and the Marriott. There are bookstores after bookstores, discount and retail. There are some of the largest and most complete music stores, record and disc stores, camera stores and appliance stores ... all at prices you would not believe. There are places in New York where you can buy almost anything and buy it cheaper than in its native country ... Pay retail? - not the native New Yorker! Yet there are the beautiful streets of famous department stores and boutiques, streets of airline ticket offices, streets of Consulates and Embassies. Did I leave out the United Nations? Fascinating place. There are cruises on the East and Hudson Rivers, both sightseeing and lunch/dinner cruises. The Staten Island Ferry and the Subway. Visit the World Trade Center, look down on helicopters flying below you. The Statue of Liberty inspires awe and deep feelings when seen up close and the nearby immigration museum has a place in many of our lives.

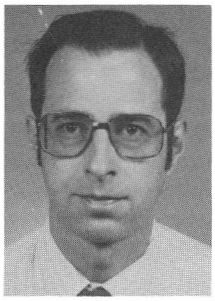
You might travel to the outlying beaches: Jones Beach, Rockaway Beach, Fire Island. Westhampton and East Hampton, Old Bethpage and many many other interesting places in the outlying areas. There are wineries on Long Island and in the Catskills.

The Symposium Committee suggests that you consider staying for the weekend at the special convention hotel rates. Buy a copy of New York Magazine and enjoy the Big Apple.



EAST RIVER SKYLINE. Some of The Big Apple's best known skyscrapers are seen in this view from the Queens side of the East River. Behind the Delacorte geyser, on the left is the distinctive, boxy United Nations Secretariat Building. The high, sleek spire at its right is the Empire State Building, followed by the nipped and tucked, glass-walled United Nations Plaza Hotel. Next is the scalloped, Art Deco tower of the Chrysler Building.
CREDIT: N.Y. CONVENTION & VISITORS BUREAU BB.45.1.K&L

ARFTG UPDATE



by Raymond W. Tucker, Jr.

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.

31st ARFTG CONFERENCE ANNOUNCEMENT

ARFTG will hold its 31st technical conference on Tuesday May 24, 1988 in conjunction with the International Microwave Symposium in New York City. The location of technical sessions, manufacturers' exhibits and the Awards Banquet is still under consideration.

The main topic for this conference is INNOVATIONS IN MICROWAVE TIME-DOMAIN MEASUREMENTS. Appropriate papers will describe automated techniques for both direct (e.g., time-domain reflectometer) or transform (e.g., FFT, Chirp-Z, etc.) measurement of the time-domain response of microwave devices or the application and interpretation of such measurements.

Two invited papers will be presented. The first will be a paper by Harold E. Stinehelfer, Sr. on the History of Time-Domain Measurements. The second will be a tutorial on Time-Domain Measurements by Hewlett-Packard. A panel discussion on Time-Domain Measurements is also planned.

First consideration will be given to papers on the conference topic, papers on other automated measurement and design techniques will be considered if time permits. A post-conference digest will published. The deadline for submission of abstracts is March 15, 1988. Authors wishing to have their paper considered are requested to obtain an "ARFTG Instructions-to-Authors Kit" by contacting the Technical Program Chairman:

Dr. James C. Rautio
(Syracuse University)
4397 Luna Course
Liverpool, NY 13090
(315) 622-3641

Manufacturers are encouraged to exhibit and present technical information related to new products applicable to these areas. Submit technical papers to the above address. Manufacturers interested in exhibiting their products, contact the Exhibits Chairman:

Mr. Gary R. Simpson
Maury Microwave Corporation
8610 Helms Avenue
Cucamonga, CA 91730
(714) 987-4715

For additional information, please contact the Conference Chairman:

Mr. Raymond W. Tucker, Jr.
Rome Air Development Center
Measurements Branch, RADC/RBCM-M
Griffiss, AFB NY 13441-5770
(315) 330-2841

31st ARFTG CONFERENCE SCHEDULE

Tuesday, May 24, 1988
7:30 a.m. - 5:00 p.m. Registration
7:30 a.m. - 8:15 a.m. Speakers Breakfast
7:30 a.m. - 8:15 a.m. Attendee's Continental Breakfast
7:30 a.m. - 5:00 p.m. ARFTG Manufacturer's Exhibits Open
8:30 a.m. - 12 noon Morning Technical Session
12 noon - 1:15 p.m. Lunch
1:15 p.m. - 5:00 p.m. Afternoon Technical Session
6:00 p.m. - 7:00 p.m. Cocktail Party (Cash Bar)
7:00 p.m. - 10:00 p.m. ARFTG Awards Banquet

31st ARFTG CONFERENCE GENERAL INFORMATION

The Conference fee includes a continental breakfast, lunch and the ARFTG Awards Banquet. 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.

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

30th ARFTG CONFERENCE HIGHLIGHTS

The Fall 1987 ARFTG Conference was held at the Holiday Inn Crowne Plaza in Dallas, Texas on December 3 and 4, 1987. The ARFTG Awards Banquet was held on Thursday evening December 3.

The Conference was opened with a welcome by Clyde J. Orrison, from Texas Instruments, who served as the Local Arrangements Chairman. John T. Barr, IV of the Network Measurements Division of Hewlett-Packard and the President of ARFTG welcomed the attendees and introduced the ARFTG Executive Committee. John then introduced the Conference Chairman, Ken R. Bradley of Texas Instruments, who asked the attendees to introduce themselves. Ken then thanked Dwayne Ragle from Texas Instruments, the Technical Program Chairman and the authors for the excellent technical program.

continued on page 68

ARFTG Update Continued from page 67

The main topic selected for this Conference was AUTOMATED MMIC TECHNIQUES. A Panel Discussion on MMIC Measurements was very well received by the attendees. In addition, five focus or special interest groups met on Thursday afternoon. These included: Standards, Pulsed Microwave Measurements, Computer Aided Design, Measurement Software, and MMIC On-Wafer Measurements. Nine technical papers were presented at this Conference. The following is a list of the papers presented:

"MMAVERICtm - A CALIBRATION TECHNIQUE FOR MMICs", H.B. Sequerira, M.W. Trippe, and R. Jakhete, MARTIN MARIETTA LABORATORIES

"EXTENDING THE LOW FREQUENCY MEASUREMENT CAPABILITIES OF THE TSD CALIBRATION", Austin Truitt, TEXAS INSTRUMENTS

"WHERE ARE MY ON WAFER REFERENCE PLANES", Keith Jones, and Eric Strid, CASCADE MICROTECH

"GaAs RF WATER QUALIFICATION USING RF PROBES', William H. Mitchell and Gary Boggen, TEXAS INSTRUMENTS, and W. Allen Davis, UNIVERSITY OF TEXAS -ARLINGTON

"COMPARISON OF VERIFICATION KIT DATA WITH TRAVELING ARFTG KIT", Harold E. Stinehelfer, Sr., RAYTHEON and MADE-IT ASSOCIATES

"COMPUTER AIDED ANALYSIS OF MICROWAVE SYSTEMS", Glenn F. Engen, BOULDER RESEARCH

"AUTOMATED NOISE FIGURE AND S-PARAMETER MEASUREMENTS", Roger McAleenan, HEWLETT-PACKARD

"MEASUREMENT OF EXCESS NOISE FROM A ONE PORT DEVICE", James R. Griffiths and John L. Carney, TEXAS INSTRUMENTS

"AUTOMATIC CONTROL OF DOWN CONVERTER TESTING", Ben R. Hallford, ROCKWELL INTERNATIONAL and TEXAS INSTRUMENTS

On Friday afternoon the group toured Texas Instruments and saw a number of their automated test stations.

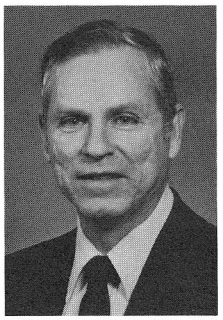
The ARFTG EXHIBITS Chairman, Gary Simpson of Maury Microwave, assembled 15 vendors for the ARFTG Exhibition.

John T. Barr, IV, the newly elected ARFTG President, presided over the Awards Banquet. ARFTG presented its Service Award to Gary R. Simpson of Maury Microwave for his service to the group as Exhibits Chairman. ARFTG presented its Automated Measurement Technology Award to Julius Botka of the Network Measurements Division of Hewlett-Packard for his numerous contributions and innovations to automated microwave measurement hardware and precision standards. ARFTG presented its Distinguished Service Award to Raymond W. Tucker, Jr. of the Measurements Branch of the USAF Rome Air Development Center for his outstanding leadership and service to ARFTG.

JOIN ARFTG

ARFTG brings you the latest techniques in RF, Microwave and Millimeter wave Analysis, Design and Measurement. 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, SLY HILL ROAD, AVA, NY 13303

INTERNATIONAL LIAISON



by R.A. Sparks

1987 SBMO INTERNATIONAL MICROWAVE SYMPOSIUM

Rio de Janeiro was the site of the 1987 International Microwave Conference/Brazil held the week of July 27-31. Organized by the SBMO - Brazil Microwave Society, that was formed about five years ago - this Symposium follows by two years the first international meeting that was convened during July 1985 in the city of Campinas at the Telebras Research and Development Center. The venue for this year's conference was the 5-star Rio Palace Hotel on Copacabana Beach.

Steering Committee Chairman for the meeting was Dr. Alvaro Augusto de Salles, Professor of Electrical Engineering in the Center for Telecommunication Studies, CETUC, at the Catholic University, in Rio de Janeiro.

In addition to the SBMO, supporting and cooperating sponsors included a number of other technical societies as well as several educational, industrial and government organizations. Among the former were the IEEE, MTT and AP Societies through the local joint chapter in Rio; IEE, England; SBT, Brazil Telecommunications Society; the latter included FAPCSP, Sao Paulo State Research Foundation; and the Catholic University of Rio de Janeiro; TELEBRAS and EMHBRATEL through the Brazilian Ministry of Science and Technology through CNPq and FINEP; and the British Council.

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International Liaison (Continued from page 68)

The theme of the 1987 Conference, "Gathering the World through Microwaves," proved a self-fulfilling prophesy with 562 delegates in attendance representing 31 countries around the globe. These figures are to be compared with the 400 delegates from 13 countries in attendance at the 1985 conference in Campinas reflecting a growth of almost 50%. Also of note was the fact that the organizers this year had designated English as the official conference language for all presentations including the published versions that appeared in the 2-volume set of the Symposium Digest. The proceedings are available from IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. Ask for IEEE Cat. No. 87 THO 183-4. The earlier bilingual conference included some presentations and digest papers in Portuguese.

The Plenary Session on Monday 27 July consisted of two parts. Opening Session I-A was chaired by Dr. Salles who is shown in Figure 1 with the plenary session presenters. Invited speakers were Dr. Fernando Vieira de Souza, Director of Telebras Research Center who spoke on "Recent Advances and Future Trends of R & D at Telebras CPqD" and by Mr. Ed Niehenke, 1986/1987 IEEE MTT-S Distinguished Microwave Lecturer, who discussed "Gallium Arsenide - Key to Modern Microwave Technology."

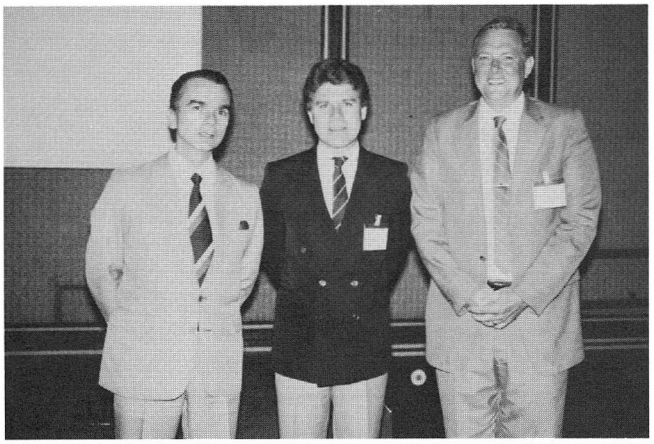

FIGURE 1 Steering Committe Chairman DR. Alvaro A. de Salles (C), with opening session speakers Dr. Fernando Vieira de Souza (L) and Mr. Edward Niehenke (R).

Following a morning coffee break, Plenary Session II-B was opened by Mr. Richard A. Sparks of Raytheon Company and featured two invited speakers, also. Dr. John Forrest from the Independent Broadcasting Authority in the U.K. delivered an interesting paper entitled "DBS Takes Off - A New Microwave Industry." The second speaker was Mr. Ken Carr, of M/A-COM USA, who gave his presentation on the "Application of Microwave Technology to the Detection and Treatment of Cancer."

Following lunch, Figure 2, the main program of the Symposium got underway consisting of three parallel sessions divided into two halves, with a coffee break sandwiched in between. The early afternoon session ran from 1:30 to 3:00 P.M. and the late session lasted from approximately 3:30 to 5:30 P.M. By the end of the first day, four of the regular sessions had covered microwave subjects and two covered antennas.

FIGURE 2 Lunch time in Rio during the SBMO International Microwave Symposium (L. to R.) Ken Carr, Ed Niehenke and Ted Saad.

While the Conference was dominated by microwave papers during the four days (24 sessions in total), related topics on antennas (7 sessions), propagation (6 sessions) and optics (4 sessions) were included also, to accommodate the research activities and interests of the large Brazilian attendance. With the recent establishment of a joint MTT/AP/ED Chapter in the Rio Section of the IEEE, the first such chapter in South America, coordination of international microwave activities has been strengthened. The Symposium afforded an opportunity for AdCOM members to meet with local chapter officers, Figure 3.

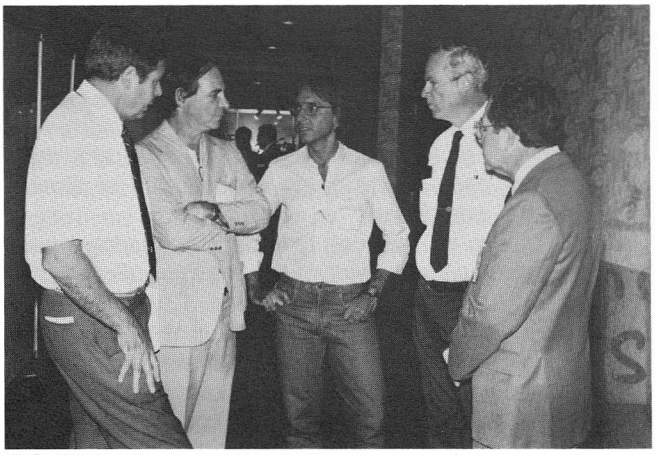

FIGURE 3 Adcom members had the opportunity to meet with local chapter officers in Rio (L. to R.) Dave McQuiddy, President MTT Society; Abelardo Podcameni, Vice Chairman, Rio MTT/AP/ED Chapter; Luiz Fernando Conrado, Chapter Chairman; Dick Sparks, MTT-S International Liaison; Mario Maury, MTT-S Publicity/Public Relations Chairman.

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International Liaison (Continued from page 69)

Supplementing the regular session was an Open Forum poster session that included 12 papers, held from 10:00 A.M. to Noon on Thursday, giving a grand total off 178 presentations over the four meeting days. In addition there were five special topic panel sessions that included:

DBS - Direct Broadcast Satellites
Printed Antennas
Applications of Advanced Microwave and Antenna Technology to Radar Systems
Dielectric Resonators
Applications of GaAs Monolithic Circuit Technology in Brazil.

On Friday, 31 July, a mini-course on "CAD of Microstrip Circuits and Antennas" was conducted by Professor K.C. Gupta of the University of Colorado. More than 40 attendees registered for this session.

Function rooms adjacent to the technical sessions had been set aside for domestic and overseas suppliers to exhibit their products and services. For this initial undertaking 20 companies and technical organizations demonstrated for the first time at a microwave conference in South America.

Balancing the technical sessions was a well organized and popular social program for the delegates and their companions. Monday evening featured a cocktail party sponsored by the exhibitors for all the Symposium participants. This event provided a great opportunity to mingle with friends and make new professional acquaintances from colleagues around the world.

Arrangements had been made to establish a Tour and Travel Agency desk in the registration area enabling convenient visits to be made to the many sightseeing attractions of Rio. Many delegates were afforded the opportunity to vacation to other parts of Brazil following the conference as well.

The Symposium Banquet, held on Wednesday evening was truly the high point of the meeting. Following a delicious dinner, the Conference Chairman, Dr. Alvaro Iles welcomed the attendees and thanked his Steering Committee for their dedicated efforts in organizing the Symposium and making it a success.

On Tuesday evening, the Brazil Microwave Society Executive Committee, Figure 4, held their annual meeting to elect officers and plan future technical activities. SMBO has scheduled a National Microwave Conference in 1988 that will be held in the city of Natal, Rio de Norte and will follow that in 1989 with a third International Microwave Symposium in the city of Sao Paulo to the south of Rio.

17th EUROPEAN MICROWAVE CONFERENCE - ROME 7-11 SEPTEMBER

The MTT Society organized a special invited session of 3 speakers on communications technology in the U.S. The status of developments in satellites, terrestrial and local area networks were reviewed by P. DeSantis, H. Sobol and R. Knerr, respectively.

Discussions were held with the organizers of next years meeting with 3 speakers planned for a 1½ hour session. The 18th European Microwave Conference will be held in Stockholm, Sweden 12-16 September 1988.

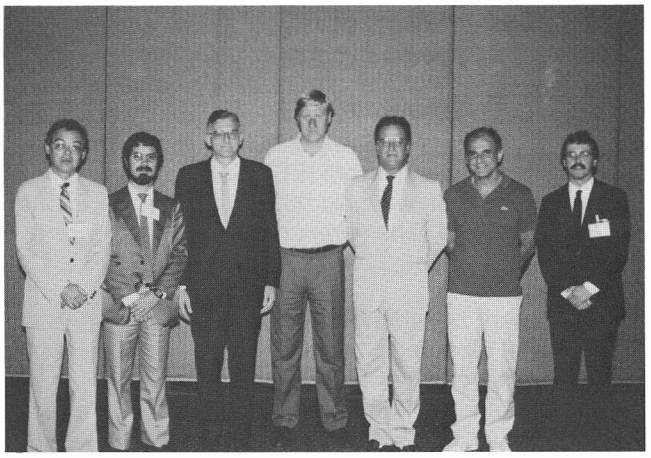


FIGURE 4 SBMO Executive Committee members (L. to R.) Dr. Antonio Octavio M. de Andrade, Second Secretary; Mr. Silvio E. Barbin, First Treasurer; Prof. Attilio J. Giarola, Vice President; Mr. Ricardo Ernesto Shaal, Second Treasurer; Prof. Jose Kleber C. Pinto, President; Dr. Antonio R. Panicali; and Mr. Eduardo Victor Dos S.. Pouzada, First Secretary.

REGION 8 CHAPTER CHAIRMEN'S MEETING

A meeting of Region 8 chapter chairmen was held on Wednesday, 9 September, at the EuMC. While the meeting and dinner were originally planned for the La Casina Valadier, a conflict with the conference had developed requiring re-scheduling of the meeting at the Ergife Place Hotel.

Seven of 9 chapters were represented.

COMMON CAR-REPAIR RIP-OFFS

Dishonest gas stations know tricks to make people pay for repairs or supplies they don't really need. *Common scams:*

- Cutting the fan belt, leaving it hanging by a thread.
- Making the battery boil over by dropping a seltzer tablet into it.
- Spraying oil onto a shock absorber so it appears to be leaking.
- Puncturing a tire with a sharp tool while checking air pressure.
- Inserting the oil dipstick only half way so the level appears to be low.

How to Make Your Car Last Almost Forever by Jack Gillis, Putnam Publishing, 200 Madison Ave., New York, New York 10016. $6.95

WORKSHOP ON TECHNOLOGY IN MICROWAVE EDUCATION

by Tim Healy
Santa Clara University

The first annual workshop on "Modern Technology in Microwave and Communication Education" was held at Santa Clara University, July 20, 24, 1987. The object of the workshop was to study ways in which automatic measuring systems, and computer hardware and software can be used to enhance the teaching of Microwave and RF circuits and systems. The premise of the workshop was that these new technologies offer major new opportunities for education, and that these possibilities need to be examined, and appropriate uses identified. Workshop activities were divided between classroom presentations and laboratory activities.

The workshop was organized by Tim Healy (Director, Microwave and Communications Laboratory, Santa Clara University), who was also one of the seven faculty participants. The others included: Karl Audenaerde (State University of New York, New Paltz), Bill Bennett (U.S. Naval Academy), Mao Lin (San Diego State University), John Mulholland (Villanova University), Bob Owens (San Jose State University), and Dave Voltmer (Rose-Hulman Institute of Technology). In addition, seven students from Santa Clara, participating in an on-going summer study on MMIC characterization, participated in parts of the workshop.

The keynote speaker on Monday was Allen Podell, cofounder of Pacific Monolithics, Inc. who spoke on "Monolithic Microwave Integrated Circuits - From Dream to Reality." The presentation was particularly relevant since many of the measurements made during the week were on large scale physical models of MMIC components.

On Tuesday Dave Rutledge (California Institute of Technology) introduced the new microwave software educational package PUFF, which he recently coauthored with Richard Compton (Cornell University). The package was used very effecitvely throughout the rest of the week. The consensus was that there are certainly many excellent applications for PUFF in the teaching of microwaves and RF, particularly as a complement to one of the more sophisticated commercial CAD packages available today.

On Wednesday Lorenzo Freschet (Hewlett Packard, Santa Rosa) discussed the accuracy enhancement features of the HP 8753. He also offered many helpful suggestions in the Laboratory on the measurement of characteristics of MMIC components.

The primary speaker on Thursday was John Mulholland who offered a number of insights into laboratory measurements based on his long experience in industry, and his translation of that experience into an active microwave laboratory at Villanova. John stressed particularly the importance of establishing a solid background in basic measurements, before introducing automatic measurements.

On Friday, Cary Yang (Director, Microelectronics Laboratory, Santa Clara University) introduced the basics of scanning electron microscopy (SEM), and then led the group on a tour of his new laboratory, which included an SEM viewing of one of the MMIC circuits introduced by Allen Podell on Monday.

One of the most important features of the workshop was a discussion on which technologies are appropriate for use in the classroom and the laboratory, and when they should be introduced. While the participants did not agree fully on all points, a strong consensus did appear on a number of points. First, it was agreed that many new technologies, both software and measurement systems, do offer excellent applications for education, but that it is very important that they be introduced with caution. The general rule is that the more complex and automatic the technology, the greater is the caution necessary in using it. Slotted line measurements of VSWR can be introduced early in a laboratory study of transmission lines. Return loss measurement on an automatic network analyzer, however, might require a much greater understanding on the part of the student of the limitations of the measurement system. In the software area, the computer can be used very early to carry out routine calculations of complex numbers, such as for example of a reflection coefficient. A more powerful analysis, such as that done by PUFF, requires more understanding and more caution in its applications. Optimization features, available on still more powerful packages, such as Touchstone and Super Compact, require even more care. In all of these cases it is imperative that the technology be used to explain fundamental concepts or design features, and not to hide critical issues from the user.

Preliminary plans for a second workshop on this subject are underway for July 18-22 of 1988, contingent on the obtaining of funding. This workshop will focus again on the use of modern technology in the classroom and the laboratory, but there will be quite a bit more emphasis on the exploration of how to use such technology effectively, along with more conventional technology. The question of how to avoid misusing powerful technology will receive major attention. Interested persons are invited to contact: Tim Healy, EECS, Santa Clara University, Santa Clara, CA 95053.

Pancakes and waffles are ideal breakfast carbohydrates *if* you avoid high-fat, high-sugar toppings. *Better:* Honey (as sweet as syrup, but you'll use less) ... healthful toppings (nonfat yogurt, skim-milk ricotta cheese, fresh berries) ... low-calorie syrups (they're surprisingly good).

Shape, 21100 Erwin St., Woodland Hills, CA 91367. Monthly: $20/yr.

THE 1987 IEEE NEW YORK/LONG ISLAND SYMPOSIUM

by Matthew Jacobs

On April 28, 1987, The New York/Long Island Chapter of the MTT-S held their fourth annual one day symposium entitled "Computer-Aided Engineering, Design, Manufacturing and Test (CAEDMT) — The road from concept to product made easier with automation," at the elegant Crest Hollow Country Club in Woodbury, Long Island.

The Grand Ballroom's 8000 square feet was filled to capacity with the nearly 60 exhibits of the latest in microwave CAE work stations, CAD software, probers, instrumentions, devices and components, while the stately Starlite Room contained the Technical Program.

The roster of speakers included:

K.C. Gupta	University of Colorado
W. Curtice	RCA
S.E. Sussman-Fort	SUNY, Stony Brook
R.Q. Lane	California Eastern Labs
H. Stinehelfer	Made-It-Associates
E. Strid	Cascade Microtech
J. Fitzpatrick	Hewlett-Packard
D. Poulin	Hewlett-Packard
K. Sivek	RCA
U. Rohde	Compact Software
W. Childs	EEsof
C. Buntschuh	Narda Microwave Corp.
B. Walker	Systron Donner

The symposium opened at 7:30 AM for registration, and coffee and danish were provided. Our Chairman, John Pierro, welcomed the over 350 attendees at 9:00 AM followed by K.C. Gupta delivering his keynote address entitled "Trends in Microwave CAD".

The talks that followed covered many topics, including:

Latest developments in commercial CAD software
Non-linear and linear modeling
De-embedding
Work Stations
Network Synthesis
Computer-aided manufacturing
Standardized ATE languages.

The morning session finished at noon followed by the opening of the exhibits and the serving of a gourmet hot buffet lunch to all attendees.

The afternoon session ran from 2:00 to 6:00 PM, with a coffee break at 4:00 PM and a cocktail hour in the exhibit area from 6:00 PM until closing at 7:00 PM.

This year's symposium was judged a resounding success, based on the extremely positive feedback the committee received from both technical session attendees and exhibitors.

Due to the 1988 IEEE MTT-S International Microwave Symposium being held in New York City, there will be a Long Island Symposium in 1988, however, the Chapter looks forward to producing another one in 1989.

The committee would like to thank the many people and companies who helped behind the scenes to make this symposium a success.

REPORT ON THE EUROPEAN SOLID-STATE SOURCES WORKSHOP IN ULM

by Nigel Keen

The European Solid-state Sources Workshop, organized by the Millimeter-and Submillimeter-Wave Working Group of the W. German MTT-Chapter was held at the firm AEG on September 29-30, 1987, in Ulm. 55 participants from 9 countries attended. The four invited talks were on Gunn Oscillators (Dr. Azan, Thomson, France), IMPATT oscillators (Prof. Claassen, T.U. Munchen, W. Germany), Frequency Multipliers (Dr. Raisanen, T.U. Helsinki, Finland) and Future Devices (Dr. Kelly, GEC, England). These talks were followed by 20 short contributions, and considerable discussion of the various papers.

In the open discussion on the second afternoon, device and measurement problems were addressed, as was the question of device reliability. Future devvelopments at Millimeter- and Submillimeter-Wavelengths should also include quantum devices, fabricated by the newer materials-technologies. IMPATT oscillators at frequencies above 200 GHz are under development, and improved mount-construction appears capable of increasing GaAs G.D.O.-powers to 60 mW up to 100 GHz.

The Chapter would like to express its gratitude to the firm AEG, which generously hosted the workshop, to Drs. Menzel and Kasper for helping to initiate the event, and to Jorg Schroth, the local organiser, for his tremendous contribution to an excellent event.

Proceedings of this (and the previous) workshop can be obtained by sending DM 30,- (thirty german marks) to Professor Peter Russer, MTT- Chapter Chairman, Institut fur Hochfreqenztechnik, Arcisstr. 21, D-8000 Munchen 2, W. Germany.

Biscuits, bakery muffins and croissants contain up to *65%* fat. *Low-fat alternatives:* French bread, Italian bread, bagels, English muffins, pita bread, corn tortillas.

Glamour, 350 Madison Ave., New York 10016. Monthly: $15/yr.

EDUCATION COMMITTEE REPORT

by Krishna K. Agarwal

The Education Committee of MTT- Society has been very active during the past year. Several new scholarships and awards programs were started during 1987. These include the Microwave Graduate Fellowships, Grant-in-Aid and the MTT Student Paper Contest. The two Microwave Graduate Fellowships were awarded to R. Steven Brozovich of Washington University and T. Scott Martin of Texas A&M for graduate studies and research in Microwave and Optics. One Grant-in-Aid was awarded to Dr. Clifford Cloonan of California Poly University, San Luis Obispo to update undergraduate microwave laboratory.

Both the fellowships and Grant-in-Aid are $10,000 each. The fellowship amount was increased from $5,000 to $10,000 at the recommendation of the MTT-S AdCom. This amount is in line with graduate fellowships offered by universities and other IEEE Societies and should cover most of the cost of staying in a graduate school for a year. The credit is due to Jorg Raue, Chairman of the Fellowships and Grant-in-Aid Sub-Committee for his hard work.

The MTT Student Paper Contest was announced in the Fall of 1987 by John Owens, Chairman. This program is intended to increase the awareness of undergraduate students to Microwave engineering and the MTT-S International Microwave Symposium. The contest winners would have an expense-paid trip to present the winning papers at the symposium. This program requires coordination with the Universities and local MTT-S Chapters to publicize the program and attract students as members as well as contestants. I want to congratulate John Owens who started this program. The response has been less than encouraging. John is looking into contacting the local MTT-S chapters to publicize his program.

The Merit Scholarships for the children of MTT Society members was started in 1986 with one award. This award has been renewed to Miss Hinchey who is studying Electrical Engineering at MIT. This year there were two merit scholarships awarded to David Oliver of Cedar Rapids and Monica Gandhi of Salt Lake City. David is attending Iowa State University and Monica goes to the University of Utah. All three of the MTT-Society's merit scholars deserve congratulations.

MTT-Society has been making every effort to broaden the awards criteria. The management of the merit scholarships has been shifted to Citizen's Scholarship Foundation of America, Inc., (CSFA) of St. Peter, Minnesota. CSFA is a national, non-profit student and service organization and plays a leadership role in providing high quality and efficient service to companies, communities, individuals and associations, using a flexible approach to the scholarship program. In addition to merit, SAT/PSAT scores, it considers class rank, grades, teacher recommendations, community service, and some ten other criteria in selecting the scholarship recipients. For the school year beginning August 1988, twelve requests have been received. A package of information and application has been sent to all the candidates on December 8, 1987. This package with complete information is due by February 1, 1988, into CSFA. Awards shall be announced shortly thereafter by CSFA.

John Owens conducted a survey of this year to get an input from accredited Electrical Engineering Departments in the U.S. regarding their microwave education and related programs. Of the 234 survey mailings, 124 questionnaires were returned that included most of the large well-known institutions. Key points of John's findings are:

- -Majority of programs required a single, 3 unit E.M. Theory course, with 1 or 2 senior level microwave electives
- -Majority of programs have 2 or more graduate courses
- -There are about 450 MS and 200 Ph.D. students in graduate microwave education
- -Estimated $13.7 million of research in microwaves
- -Twenty-eight schools have 2 or more faculty, 4 or more graduate research students with 2/3 of research money
- -These 28 schools have vector measurement and microwave CAD capability

The survey also indicated that microwave-related programs need support into five categories:

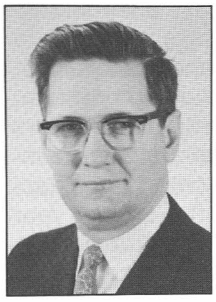
a. Laboratory equipment
b. Help in recruiting students
c. Tutorial material
d. Workshops/short courses on teaching and labs
e. Contact and support with DOD/NSF

If you can be of help, contact John Owens at (408) 554-4482. John has a list of institutions with significant Microwave Programs at graduate level which is available either from John or me.

A new activity is being planned by Jorg E. Raue - MTT-Society Visiting Fellows Program. This is an exchange program between industry/government/university with some financial support from MTT-Society. If you know of such a program or have ideas, contact Jorg E. Raue at TRW (213) 535-7409.

Looking back at the educational activities of the Microwave Society, we are offering a comprehensive and broad program encompassing from High School to Graduate School and beyond. AdCom is committed to broaden its support of Microwave education and I am looking for suggestions and ideas to accomplish this.

PACE REPORT



by R.A. Moore

U.S. COMPETITIVENESS ON THE WORLD MARKET - ATTAINABLE GOAL?

Is U.S. competitiveness deteriorating due to Government policy, business, industry, labor, education or some combination? I am looking at the results of a Harvard Business Review opinion poll of its readers. Nearly 4000 from all fifty states, D.C., Puerto Rico and 34 countries from Algeria to Zimbabwe responded. In a nutshell, 92% believe U.S. competitiveness is deteriorating. 87% believe the problem predates the 1980's. 95% think that diminished competitiveness will hurt America's economic performance for the foreseeable future, and 89% believe the problem represents a threat to the country's standard of living and economic power. Though the results of the survey had plenty of blame to go around, surprisingly or, perhaps, not so surprisingly, 90% place a large share of the burden on U.S. managers.

Simon Ramo, founder of Ramo Woolridge, which later became TRW, speaking to the IEEE Sections Congress, has indicated that in the future neither the U.S. nor any other country will likely dominate technology. Instead, a country's success will depend on its skill in making use of technology that originates all over the world. He suggested that the IEEE's role should be to ensure that scientific and technical advances are made known to all and are quickly transferred.

The success of us all as microwave engineers is very much a function of the competitiveness of the microwave industry. As members of a total industrial community, our future is tightly coupled to the economic health of the total industrial community. Competitiveness is such a consensus agenda item it is almost trite. Its meaning is very much a function of one's views. Accordingly, one can point to research and tax policies that provide industries with incentives for long range commitment ot capital formation, facilities improvements, product and market development. In the views of many, competitiveness also has wide social implications. In this view, for example, competitiveness includes the commitment to a quality educational system that will equip our society to both work with and make use of the technologically advancing products we hope to develop.

If we agree there is a problem of U.S. competitveness, where do we look for the solution? If we believe the Harvard Business Review opinion poll, it is to industry. Government has a responsibility for providing a stimulating environment but industry must be the motor,. This was also essentially the message of former Congressman Ed Zschau speaking to the American Electronics Association (AEA) as described in the November issue of the Institute. it is hard to disagree with these points if we believe in the capitalist system. Certainly, the Ford Motor Company has demonstrated that a U.S. automobile company can compete profitably on a worldwide scale. No doubt Ford is still making adjustments toward greater competitveness. Ford stands out among U.S. automobile companies in its agressiveness since the impact of auto imports became apparent.

As we start to look at individual areas of needed improvement, it is difficult to say much that hasn't been said before. It is, perhaps, useful to look at our background and some of the reasons we became the preeminent industrial power of the world. As we entered the nineteenth century, we were largely an agricultural economy and related to Europe in somewhat the same way Third World countries now relate to the present industrialized nations. Our industry foundations built on supply of the needs of a unified agriculture market. We were intensely innovative. New industries, which have become the giants of today, were regularly starting on new products needed by our agriculturally based economy. We built this industry on the basis of rapid market exploitation of new ideas and a rapidly expanding distribution system that allowed our new industries to market over a greater population than had ever before been possible.

What has now happened? First, we were not the first to learn that the world is now our market place. Similarly, we have been outstripped by foreign competitors in such key areas as labor relations, rapid market exploitation and capital planning. To the extent that these are all management functions, clearly the Harvard Business Review poll is right. Management must be the motor that makes us competitive. If our management can't do it, it isn't going to happen.

If it is management's job to be the motor, are there other influences that may have major effect in management effectiveness? Sometimes, we hear that government: (1) must maintain a level playing field, (2) use tax policy to encourage capital formation and long range planning, (3) promote strong research policies, and (4) encourage a positive management labor environment. Maintaining a level playing field does not mean the proliferation of protectionist laws of the late twenties and early thirties. It is just the proliferation of such laws that is often credited with causing the depression of 1932 rather than the stock market crash of 1929. Everyone can pass protectionist laws. When that happens, everyone's market vanishes, everyone's industry shuts down and we have a depression. Government can and must negotiate improvements in policy with countries when markets are closed or restricted by other than the simple fact that we must get over there

continued on page 75

and compete. When this is a problem, management must be aggressively testing their markets so that government has a firm basis on which to insist on policy change.

Tax policy may be one of the most controversial areas of government policy. Tax policy that encourages capital formation is viewed by some as regressive. Many who feel this way also feel it is government's role to provide jobs for everyone. If we feel that capital formation managed by enlightened entrepreneurship will provide us all, including the poor, a better quality of life, it is up to us to make it happen. This means selling the concepts of constructive capitalism and practicing enlightened management.

A strong research program is a part of capital formation. It is also the enlightened planning that both opens a healthy flow of new techniques and maintains a strong focus on rapid commercial exploitation. It includes effective market development. Research cannot be unbridled and yet it must be free to explore. There must be focussed effort to bring the results quickly to market. Maintaining this balance requires creative management leadership and careful balance. Yet it is a necessity if research funding is to meet its goals.

In such a brief article, it is impossible to cover the breadth of issues related to competitiveness. Much has been written, insufficient has been done. We as microwave engineers have a strong interest in the competitiveness of the microwave industry and consequently of the industrial community. To the extent we realize this, we will focus on improved productivity in our own companies and on U.S. policies which encourage productivity of industry as a whole. We are the microwave community. We can not wait on someone else. It is up to us to make the microwave community productive and strong.

LEGISLATIVE UPDATE

Congressional Fellowships:

Electrical and Electronics Engineers and Applied Scientists are competitively selected to serve a one-year term on the personal staff of individual Senators or Representatives or on the professional staff of Congressional Committees. Fellows shall be selected based on technical competence, ability to serve in a public environment and on evidence of service to the Institute and the profession. Fellows must be U.S. citizens at time of selective and have been in the IEEE at member grade or higher for at least four years. The IEEE plans to award two Congressional Fellowships for the 1988-1989 term. Applications must be postmarked no later than March 31, 1988. Further information can be obtained by calling or writing W. Thomas Suttle (202) 785-0017, The IEEE, 1111 Nineteenth Street, N.W., Suite 608, Washington, D.C. 20036.

Consulting Engineers and Computer Specialists:

We are being asked to contact our senators and representatives to urge repeal of section 1706 of the Tax Reform Act of 1986. This is the section of the Tax Act that makes it almost impossible for individual technical consultants to operate as independent consultants. This section virtually forces the people to work as "employees" of large technical services firms or as employers of the firms for which they are consulting rather than as individual consultants. Legislation that would remedy this problem for most engineering and computer consultants has been introduced in the House by Representative Judd Gregg and Senator Dave Durenberger. In addition, Senators Alphonso D'Arnato and Christopher Dodd and Representatives Joseph R. Dioguardi and George J. Hochbreukner have introduced bills calling for repeal of Section 1706. You can help this along by contacting your own senators and representative.

Engineering Specialty Certification:

Eighteen engineering societies will sponsor a major conference to consider establishing specialty certification for the engineering profession. IEEE is among the sponsors of the conference, which will be held April 12-13, 1988 in Atlanta, Georgia.

Currently, after receiving a college degree in a major technical discipline, engineers can pursue registration as professional engineers, which, in many states, is a broad designation of professional competence that identifies competence in an engineering discipline but not expertise in a specialty area. Such critical issues as granting specialty certification before or after registration; determining qualifications; maintaining certification; legal issues; and benefits and disadvantages of certification will be examined at the conference.

Engineers and engineering societies in all specialty areas are encouraged to participate, as are members of the public. For more information, contact Arthur Schwartz, National Society of Professional Engineers, (703) 684-2845.

USAB Meetings with Key Officials:

Several IEEE and USAB representatives have met with various Federal Government officials to discuss issues of concern to USAB and IEEE members.

- In late July, IEEE President Henry L. Bachman, IEEE General Manager Eric Herz, IEEE Technology Policy Committee Chairman Jose B. Cruz and Washington Office Technical Consultant Robert S. Walleigh met with National Science Foundation Director Erich Bloch and a group of NSF officials to discuss such issues as NSF Engineering Research and Development Centers; Industry-University Centers; and the proposed limitation of federal appropriations to NSF.
- The IEEE-USAB Age Discrimination Committee sent a delegation to Capitol Hill to press for a hearing on the Equal Employment Opportunities Commission's lack of responsivenes in enforcing the law on age discrimination in employment. The group met with staff members of the House and Senate Subcommittees having oversight responsibilities for EEOC.

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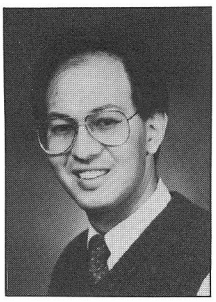
• Intellectual Property Committee Chairman Steuart Bjornsson and members of the Washington Office staff met with key Congressional committee personnel and Federal agency and private organization representatives to discuss such current intellectual property concerns as bills mandating inclusion of copycode scanners in digital audio-tape recorders and the need for expanded protections for computer software.

• An IEEE delegation that included John Richardson, Chairman of the IEEE Committee on Communications and Information Policy; Bruno O. Weinschel, 1986 IEEE President; and CCIP members Claud Davis, Alan McAdams, John Riganati and Jack Keigler briefed a group at the Office of the United States Trade Representative on issues related to the semiconductor industry. IEEE was invited to meet with the Trade Representative after the Office received a position statement on semiconductor trade issues, which was prepared by CCIP and USAB's Committee on U.S. Competitiveness.

CCIP members will be meeting with representatives of other Federal agencies in the upcoming months. Delegations are expected to meet with such officials as Jerry Salemme, of the House Telecommunications and Finance Subcommittee; and Dennis Patrick, Federal Communications Commission Chairman.

For information on these meetings or on the issues discussed, contact the IEEE Washington Office.

MEETINGS OF INTEREST



by Frank Occhiuti

GENERAL INTEREST

SOUTHERN ELECTRIC SHOW & CONVENTION (SOUTHCON '88)
Mar. 8-10, Orange County Convention/Civic Center, Orlando, FL. Contact: Ms. Alexes Razevich, Electronic Convention Management, 8110 Airport Blvd., Los Angeles, CA. 90045, (213) 772-2965

SOUTHEASTERN ELECTRIC SHOW & CONVENTION (SOUTHEASTCON '88)
Apr. 10-13, Hyatt Regency Hotel, Knoxville, TN. Contact: Prof. Reece Roth, Dept. Of Electrical Eng, University of Tennessee, Knoxville, TN 37996-2100, (615) 974-4446

ELECTRO '88 / MINI/MICRO NORTHEAST
May 17-19, Bayside Exposition Center, Boston, MA. Contact: Ms. Alexes Razevich, Electronic Convention Mgmt., 8110 Airport Blvd., Los Angeles, CA 90045, (800) 421-6816

AEROSPACE MILITARY

1988 IEEE AEROSPACE APPLICATIONS CONFERENCE
Feb. 7-12, Salt Lake City, UT. Contact: Fausto Pasqualaucci, Conference Chairman, 3100 Fujita St., Torrance CA 90509, (213) 517-6939

1988 IEEE NATIONAL RADAR CONFERENCE
Apr. 20-21, University of Michigan, Ann Arbor, MI. Contact: Dr. Jack L. Walker, Environmental Research Inst. of Michigan, PO Box 8618, Ann Arbor, MI 48107, (313) 994-1200

NATIONAL AEROSPACE & ELECTRONICS CONFERENCE (NAECON '88)
May 23-27, Dayton Convention Center, Dayton, Ohio. Contact: Maj. Larry Nicholas, Chairperson, 1626 Etta Kable Drive, Beavercreek, Ohio 45432, (513) 257-3112/6738

COMMUNICATIONS

1988 IEEE NETWORK OPERATIONS & MANAGEMENT SYMPOSIUM
Feb. 28-Mar. 2, Sheraton New Orleans Hotel, New Orleans, LA. Contact: Dr. Bruce Kieburtz, AT&T Bell Laboratories, Room 14A-471, Whippany Rd., Whippany, NJ 07981, (201) 386-5371

AIAA 12TH INTERNATIONAL COMMUNICATION SATELLITE SYSTEMS CONFERENCE
Mar. 13-17, Crystal City, VA. Contact: Jack Keigler, Technical Program Chairman, RCA Astro Space Div., Princeton, NJ 08540, (609) 426-2848

TACTICAL COMMUNICATIONS CONFERENCE
May 3-5, Fort Wayne, IN. Contact: Tactical Communications Conference, c/o Eagle Technology Inc., 320 West Street Rd. Warminster, PA 18974, (215) 672-6250

FOURTH INTERNATIONAL CONFERENCE ON SATELLITE SYSTEMS FOR MOBILE COMMUNICATIONS AND NAVIGATION
October 17-19, Institution of Electrical Engineers, Savoy Place, London WC2R 0BL. Contact: Conference Services, IEEE, Savoy Place, London WC2R 0BL, U.K. 01-240 1871

COMPUTERS

DEXPO EAST '88 (14TH DEC COMPATIBLE EXPOSITION & CONFERENCE)
Feb. 16-18, Pier Expo-center, New York, NY. Contact: Susan Werlinich, Expoconsul International Inc., 3 Independence Way, Princeton, NJ 08540, (609) 987-9400

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IEEE COMPUTER SOCIETY COMPCON SPRING '88
Feb. 29-Mar 4, Cathedral Hill Hotel, San Francisco, CA Contact: COMPCON Spring '88, 1730 Massachusetts Ave., NW, Washington DC 20036-1903, (202) 371-0101

INFOCOM '88
Mar. 27-Apr. 1 Sheraton, New Orleans, LA. Contact: Ron Rutledge, Martin Marietta, MS 271, PO Box X, Oakridge, TN 37381, (615) 576-7643

1988 COMPUTER NETWORKING SYMPOSIUM - '88 CNS
Apr. 11-13 Sheraton National Hotel, Washington DC. Contact: Mr. George K. Chang, Chairman, Bell Communications Research, 6 Corporate Pl., Piscataway, NJ 08854, (201) 526-2398

INSTRUMENTATION

IEEE INSTRUMENTATION/MEASUREMENT TECHNOLOGY CONF.
Apr. 19-22, San Diego Princess Hotel, San Diego, CA. Contact: Robert Myers, 1700 Westwood Blvd, Suite 101, Los Angeles, CA 90024 (213) 475-4571

CPEM '88 (CONFERENCE ON PRECISION ELECTROMAGNETIC MEASUREMENTS)
June 7-10, Tsukuba Science City, Japan. Contact: Dr. Toshio Nemoto, c/o Business Center for Academic Societies Japan, Conference Dept., Yamazaki Bldg 4-F, 2-40-14 Hongo, Bunkyo-ku, Tokyo 113, Japan.

MICROWAVES

RF TECHNOLOGY EXPO '88
Feb. 10-12, Disneyland Hotel, Anaheim, CA. Contact: Linda Fortunato, Cardiff Publishing Company, 6300 S. Syracuse Way, Suite 650, Englewood, CO 80111 (303) 220-0600

MICROWAVE TECHNOLOGY & OPTOELECTRONICS EXHIBITION & CONFERENCE ON ULTRA HIGH FREQUENCY ENGINEERING
Mar. 2-4, Wiesbaden, W. Germany. Contact: Network GmbH, Wilhelm-Suhr-Str. 4, D-3055, Hagenburg, W. Germany, Tel. 05033 7057

1988 MICROWAVE POWER TUBE CONFERENCE
May 16-18, Naval Postgraduate School, Monterey CA. Contact: Mark Goldfarb, Conference Coordinator, Palisades Institute, 2011 Crystal Dr., Crystal Park One, Arlington, VA 22202, (703) 769-5588

1988 IEEE MICROWAVE & MILLIMETER- WAVE MONOLITHIC CIRCUITS SYMPOSIUM
May 24-25, New York, NY. Contact: Reynold S. Kagiwada, LRW Associates, Arnold, MD, 21012 (707) 577-3658

1988 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM
May 25-27, Marriott Marquis Convention Center, New York, NY. Contact: Mr. Charles Buntschuh, Narda Microwave Corp., 435 Moreland Rd., Hauppage, NY 11788, (516) 231-1700

ANTEM '88 (SYMPOSIUM ON ANTENNA TECHNOLOGY AND APPLIED ELECTROMAGNETICS)
August 10-12,, University of Manitoba, Winnipeg, Canada. Contact: Prof. L. Shafai, University of Manitoba, Winnipeg, Manitoba, Canada. (204) 474-9615.

18th EUROPEAN MICROWAVE CONFERENCE
September 12-15, Folkets Hus, Stockholm, Sweden. Contact: Secretariat of EuMC 88, Swedish Institute of Microelectonics, P.O. Box 1084, S-164 21 KISTA, Sweden.

42nd ANNUAL FREQUENCY CONTROL SYMPOSIUM
June 1-3, Stouffer Harborplace Hotel, Baltimore, MD. Contact: T.R. Meeker, 2956 Lindberg Ave., Allentown, PA 18103.

FOURTH ANNUAL REVIEW OF PROGRESS IN APPLIED COMPUTATIONAL ELECTROMAGNETICS
March 22-24. Naval Postgraduate School, Monterey, CA. Contact: Dr. R.W. Adler, NPS, Code 62AB, Monterey, CA 93943.

POWER

POWER ENGINEERING SOCIETY WINTER MEETING
Jan. 31-Feb. 5, New York Penta Hotel, New York, NY. Contact: J.G. Derse, 1030 Country Club Rd. Bedminster, N.J. 07921, (201) 725-4388

APEC '88- IEEE APPLIED POWER ELECTRONICS CONFERENCE AND EXPOSITION
Feb.1-5. Fairmont Hotel, New Orleans, LA. Contact: William W. Burns, III, Conference Chairman, Data General Corporation, E213, 4400 Computer Dr. Westboro, MA 01580, (617) 870-9182

RELIABILITY

RELIABILITY & MAINTAINABILITY SYMPOSIUM
Jan. 26-28, The Biltmore Hotel, Los Angeles, CA. Contact: Robert G. Schueppert, Beckman Instruments, Inc., 2500 Harbor Blvd., H-02-D, Fullerton CA 92634, (714)-773-8831

1988 INTERNATIONAL RELIABILITY PHYSICS SYMPOSIUM
Apr. 11-14, Del Monte Hyatt Hotel, Monterey, CA. Contact: Alfred L. Tamburrino, Member, Board of Directors, RADC/RBRP, Griffiss AFB, NY 13441-5700, (315) 330-2813

SOLID STATE

1988 IEEE SEMICONDUCTOR THERMAL & TEMPERATURE MEASUREMENT SYMPOSIUM
Feb. 10-12, San Diego, CA. Contact: Mr. Frank Oettinger, Conference Chairman, National Bureau of Standards, Division 727, Tech/B344, Gaithersburg, MD 20899 (301) 975-2054

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35TH INTERNATIONAL SOLID STATE CIRCUITS CONFERENCE
Feb. 17-19, San Francisco Hilton Hotel, San Francisco, CA. Contact: Lewis Winner, 301 Almeria Ave., Coral Gables, FL 33134 (301) 446-8193

1988 9TH NON-VOLATILE SEMICONDUCTOR MEMORY WORKSHOP
Feb. 22-24, Doubletree at Fisherman's Wharf, Monterey, CA. Contact: Mr. Nadir Radjy, Technical Chairman, AMD, M/S 39 901 Thompson Pl. Box 3453 Sunnyvale, CA 94088, (408) 749-2837

MISCELLANEOUS

1988 INTEGRATED & GUIDED WAVE OPTICS-IGWO '88
Mar. 28-30, Eldorado Hotel, Santa Fe, NM. Contact: IEEE/LEOS, IEEE Service Center, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331, (201) 961-0060, ext. 5563

1988 CONFERENCE ON LASERS & ELECTRO OPTICS (CLEO'88)
Apr. 25-29, Anaheim Convention Center, Anaheim, CA. Contact: IEEE/LEOS, IEEE Service Center, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331, (201) 961-0060, ext. 5563

1988 IEEE AP-S INTERNATIONAL SYMPOSIUM & URSI/USNC RADIO SCIENCE MEETING
June 6-10. Sheraton University Inn & Conference Center, Syracuse, NY. Contact: Prof. A.T. Adams, Chairman, Syracuse University, 111 Link Hall, Syracuse, NY 13244, (315) 423-4397

FOURTH INTERMAG CONFERENCE
July 12-15, Vancouver, Canada. Contact: Diane Suiters, Conference Coordinator, 655-15th St. N.W., Suite 300, Washington, DC, (202) 639-5088.

VISITING FELLOW AWARD QUESTIONNAIRE

1. Type of Visiting Fellow and Recommended $ level of MTT Support. Circle choice and insert $ amount.

Host Organization	Home Organization	In your opinion, is this combination Needed?	Realistic?	A Candidate for MTT Support?	Recommended $ Level of MTT Support
University	University	Yes No	Yes No	Yes No	$ /Yr.
University	Govt. Laboratory	Yes No	Yes No	Yes No	$ /Yr.
University	Industry	Yes No	Yes No	Yes No	$ /Yr.
Industry	University	Yes No	Yes No	Yes No	$ /Yr.
Industry	Govt. Laboratory	Yes No	Yes No	Yes No	$ /Yr.
Govt. Laboratory	University	Yes No	Yes No	Yes No	$ /Yr.
Govt. Laboratory	Industry	Yes No	Yes No	Yes No	$ /Yr.
		Yes No	Yes No	Yes No	$ /Yr.

2. Do you know of a potential candidate for the Visiting Fellow award?

   Name _____ Affiliation _____

3. Please indicate the funding levels of the MTT Educational Awards that you would consider appropriate.

TYPE OF AWARD	RECOMMENDED $ LEVEL OF MTT AWARD	RECOMMENDED NUMBER OF ANNUAL AWARDS	TOTAL FUNDING
GRADUATE FELLOWSHIP			
GRANT IN AID			
VISITING FELLOW			

4. Additional Comments

Please return this form to: *Dr. Jorg E. Raue, MTT-S Educational Awards, TRW Electronic Systems Group, One Space Park - 03/2673, Redondo Beach, Ca 90278*

CALL FOR PAPERS

THE 13TH INTERNATIONAL CONFERENCE ON INFRARED AND MILLIMETER WAVES

December 5-9, 1988

PACIFIC BEACH HOTEL

ON WAIKIKI BEACH, HONOLULU, HAWAII, USA

Sponsored by The Institute of Electrical & Electronic Engineers, Microwave Theory & Tech. Society

PROGRAM

	MILLIMETER WAVES	MATERIALS MEAS. & TECHNIQUES	MMW & SubMM	FEL/ GYROTRON
Mon AM	MMW Sources I	Near MMW Measurements and Techniques	MMW Atmos. Physics	FEL I
Mon PM	MMW Sources II	High T_c Superconductors I	MMW Astronomy	FEL II
Tues AM	MMW Systems & Arrays	High T_c Superconductors II	Microwave—Optical Interactions I	FEL III
Tues PM	Detectors & Mixers	Techniques & Measurements	Microwave—Optical Interactions II	Gyrotron I
Wed AM	Guided Propagation I	Disordered Solids	SubMM Applications	Gyrotron II
Wed PM	Guided Propagation II	Material Characterization	SubMM Detectors	Gyrotron III
Thurs AM	Integrated Circuits I	Semiconductors	SubMM Spectroscopy	Gyrotron IV
Thurs PM	Integrated Circuits II	Materials Properties Applications	Lasers I	Gyrotron V
Fri AM	MMW Devices	Plasma Diagnostics	Lasers II	Gyrotron VI

ABSTRACT DEADLINE: JULY 1, 1988 Authors of contributed papers are urged to submit 35-40 word abstracts to the Program Chairman **before** July 1st:

Kenneth J. Button
Box 72, M.I.T. Branch
Cambridge, MA 02139-0901

Tel: (617) 489-4343

(Winter address)
Box 2455
Satellite Beach, FL 32937

Tel: (305) 777-7293

The Preliminary Program will be published and mailed in September. Late papers will be interpolated into the Final Program and published in the Digest of Technical Papers to be distributed at the meeting. The deadline for contributions (on camera-ready templates) to the Digest of Technical Papers is September 15, 1988. The Editor of the Digest is Richard J. Temkin, M.I.T. Plasma Fusion Center, Cambridge, MA 02139.

There will be an exhibit of commercial instrumentation.

Exhibitors may write to K. J. Button.

Please return this form if you wish your name to remain on the mailing list.

SEND TO:
Kenneth J. Button
Box 72, M.I.T. Branch
Cambridge, MA 02139-0901 USA

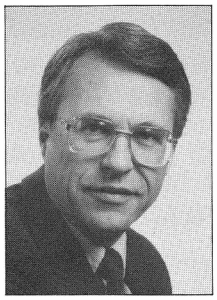
NAME _____

ADDRESS _____

Registration at conference: $125 (IEEE $110)
Proceedings, additional $50

There will be no advance registration.

EDUCATIONAL AWARDS COMMITTEE



by Jorg E. Raue

YOUR INPUT NEEDED!

PLEASE FILL OUT AND RETURN QUESTIONNAIRE

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At the January 1987 meeting, AdCom approved a new education MTT-S award: the VISITING FELLOW award. Since then, approval for this award was received from IEEE headquarters. The plan is to initiate this award for 1989, with publicity planned in early 1988 and applications submitted in Fall 1988. **The purpose of this award program is to facilitate the exchange of engineers and scientists among university, industry and government.** It would recognize and support outstanding microwave oriented engineering faculty, engineers in industry or government labs and provide support for the furtherance of their professional growth in the field of microwaves.

I am soliciting your help. After all, it is your money that is being spent. Your ideas will provide my committee with a useful data base on this subject as well as the needed guidance as to how MTT-S may best serve the needs of its members in this area.

I have prepared a brief questionnaire (page 78) that I would like you to take just a few minutes to complete (by hand, if you like, for your convenience). It is generally self-explanatory. The support MTT is considering to **supplement** what the individual would be receiving from his home and/or host organization. The award would be issued directly to the applicant, the final amount determined by AdCom based on need, justification and budgetary considerations.